SUNDAY 16 SEPTEMBER, 09.00-10.30

S14/1 THE EMERGENCE OF COMPUTATIONAL SCIENCES

Location: IoE – Room 804 **Chair and Commentator:** Agar, Jon (UCL)

Organiser(s): Hashagen, Ulf

The digitization of the scientific world began after World War II when scientists started using the recently invented electronic digital computers to manage complex calculations and computation problems in science and engineering. While on the one hand computer science was established as a new scientific discipline in the following decades, on the other it became almost natural for scientists to use computers as a scientific instrument or research technology in the last third of the 20th century. As a consequence in some scientific disciplines novel computational methods were widely used. In mathematics numerical analysis was transformed by the computer from a former marginal sub-discipline into an important research field. Hereby only the computer as an enormously fast and programmable machine made it possible to process the many newly invented numerical methods for the solution of algebraic and differential equations and other mathematical problems. Furthermore a bunch of computer-based techniques arose in the following decades in various disciplines and transformed the researchers' work in fundamental ways. For example the well-known Monte Carlo Method was created in the context of war research in atomic physics, algorithmic approaches and scientific visualization in application fields. Among these new research technologies computer simulation became the probably most important tool, and in scientific communities the question appeared whether simulation is a third scientific method beyond experiment and theory. Moreover the scientists' eagerness for high performance computing devices had also a strong impact on the hardware development (supercomputers or parallel processing) and resulted in the setting of computer centers as service providers for scientific research in academic institutions all over the world. Moreover, in various disciplines forms of computational sciences emerged, such as computational astronomy, computational fluid dynamics and computational chemistry. While only few aspects of this eminent historical development have been explored so far—such as supercomputing at the large national research laboratories, the use of the computer in high-energy physics and in X-ray crystallography and the efforts to computerize bio-medical research—the field has been dominated by studies on computer simulation, mostly with a strong philosophical orientation. In general the emergence of computational sciences and the use of developments have not become a central topic for historians of science and technology so far and there are still large gaps in the knowledge on the history of computational sciences. This symposium aims at considering different developments of computerization and computer-assisted methods in various periods, nations, societies and cultures. These views support the interpretation of disunited paths of scientific disciplines to their computational continuations. The studies in this symposium will highlight relations between these scientific disciplines and aspects of politics, technology, and economics, which are part of the process that terminates in the computational turn. Finally, the symposium refers to the question whether the particular developments of disciplines are just parts of one unique process of "computationalisation". Is the second half of the 20th century the beginning of an era of computational sciences or rather of a unified computational science?

Hashagen, Ulf (Deutsches Museum, Munich)

SUNDAY 16 SEPTEMBER, 09.00-10.30

A Failed Attempt to Make Computational Science a Scientific "Cross-Discipline" in the Kaiserreich in Germany

The invention of the computer has had a significant influence on the disciplinary development of the sciences in the 20th century. Take the cases of the computational sciences (e.g. computational physics) which emerged as subdisciplines in many natural sciences in the 1960s. Whereas historians of science would surely agree that numerical methods were widely used long before the computer was invented, the question, if computational sciences have existed as disciplines prior to that time, seems to be hypothetical. This talk will present a counter-example to this assumption by analyzing the failed attempt of establishing scientific computing as a discipline in the Kaiserreich. In the 1870s the director of the Berlin observatory Wilhelm Foerster founded an Astronomisches Recheninstitut as well as a Seminar für wissenschaftliches Rechnen at the University of Berlin. In his view the methods scientific computing and the evaluation of measurement results should be taught to all students of the exact sciences and his newly founded seminar aimed at introducing students to the theory and practice of scientific computation in a systematic manner. Foerster's attempt failed in the long run since the disciplinary influence of his Seminar for Scientific Computing remained limited to astronomy and found only few emulators at other German universities. It proved impossible to institutionalize scientific computing as a new scientific "cross-discipline" and to get over the boundaries between the scientific disciplines set up in the 19th century.

Durnová, Helena (Masaryk University, Brno)

Emergence of prescribing the computational procedure description

How do we quickly compare the efficiency of two computational procedures? Such a comparison can be enabled, or hindered, by the language used. When a computational procedure is described in plain language, ambiguities arise, making comparison difficult. Thus the call for finding a uniform way to describe them may be interpreted as a natural consequence of these difficulties. I take the example of the minimum spanning tree (shortest spanning subtree), problem in discrete mathematics. The principal task lies in connecting points through lines of non-negative lengths in such a way that the total length of those lines is minimal. Diverse plain-language formulations of the problem appeared before WWII, and the mathematicians asking to deal with the problem also provided several plain-language and intuitively clear solutions to the problem. However, it was not until April 1972 that a minimum spanning tree algorithm appeared in the Algorithms section of the Communications of the ACM, a decade after the section was established. From the point of view of mathematicians, there are two, maybe three, significantly distinct ways to find the correct solution, whose use can be a matter of taste. Taste, however, was not a good enough measure for programmers. Their attempts to measure the taste resulted in a more engaged discussion than the intuitive solution of the rather banal problem, from which mathematicians run away after having solved it, leading to re-assessment and re-formulations of the old solutions, as will be shown in the talk.

Eckert, Michael (Deutsches Museum)

The Rise of Computational Fluid Dynamics

Computational Fluid Dynamics (CFD) applies to the flow of liquids in natural environments and hydraulic machinery, the air flow in aeronautics and ballistics as well as flows on geophysical and even astrophysical scales. The application of numerical methods for flow problems was analyzed from a theoretical vantage point as early as in the 1920s, but the potential of these methods became exposed only with the use of fast computational machinery in World War II and the subsequent development of electronic computers. Among the first applications were computations of shock waves spreading from a pointlike detonation and numerical weather prediction. The Cold War fueled the development of powerful computers which in turn extended the applicability of CFD. By the late 1960s CFD could be discerned as a rising specialty. With its wide range of applications CFD became the vanguard of computational sciences at large. Beyond its uses in applied areas, CFD also played a role for fundamental research fields

such as the turbulence problem. Due to the limitations of the computational mesh direct numerical simulation of turbulent flows was in most cases prohibitive. This gave rise to the development of turbulence models and other efforts by which the motion down to the smallest scales could be taken into account – and thus resulted in a renaissance of basic research on turbulence. The paper is focused on the nascent CFD and the transformation exerted by its use in basic and applied fluid mechanics.

van Helvoort, Ton (Acta Biomedica)

A 'Silent' Revolution at the University

Half a century of computers driving centralisation and decentralisation This paper concerns the digitisation or computerisation of the University of Groningen during the second half of the 20th century, while also discussing computer policies at all Dutch universities. My analysis is a story of the particular and the general at the same time. Groningen university was, on the one hand, an archipelago of institutes, laboratories, disciplines and bureaucratic organisations, seemingly governed at first by the Curators and later by the 'Board of Governers'. On the other hand, the university was largely centrally funded by Dutch Government. When the first digital computing machines were introduced in Groningen for a select number of scientific fields — such as astronomy and X-ray diffraction — the national government soon realised that coordination of such heavy investments was necessary. More and newer computers were acquired and were housed in a central building — the Computing Centre — where scientists and students were taught how to program software and executing the computer programs. The introduction of these costly machines was an outspoken computer revolution. The pendulum of centralisation towards decentralisation and back again, becomes visible only when computer history is analysed at the level of the actual disciplinary use of computers in past and present. These tendencies structured the workings of university laboratories, departments and offices. It is this dynamics that forms the silent or hidden aspect of the computer revolution but is formative to the emergence of computational sciences.

S10/1 THE BUREAU DES LONGITUDES (1795-1932): COOPERATION AND COMPETITION NETWORKS

Location: IoE – Room 822 **Chairs:** Schiavon, Martina, and Rollet, Laurent

Organiser(s): Schiavon, Martina, and Rollet, Laurent

Created in 1795, the Bureau des longitudes was an international academy devoted to science and technology: a place for collective expertise and an advisory committee for the French government. It played a primary role in the organization and development of astronomy and celestial mechanics, the adoption of the decimal metric system, the definition and implementation of time standards, the production and transmission of time signals, the development of earth physics and geodesy and the organization of major scientific expeditions. In the 19th and 20th centuries, its prestigious members – scientists, military and naval officers, and precision instrument makers – organized and participated in various national and international projects: the international geodetic association, the spread of standardization and the study of units of measurement, the dissemination of time signals, the adoption of the Greenwich meridian, among others. The Bureau des longitudes is thus a crucial place to study various cooperation and competition processes: from science to technology via the military, from scientific diplomacy to politics through economy, and vice versa. This symposium will be devoted to the analysis of such questions, in particular: § Circulation and priority conflicts concerning instruments and scientific discoveries § The influence of war on scientific organizations § Cooperation, rivalry and priority disputes § Conflict and collaboration between amateur and expert § Editorial rivalries (for instance between La connaissance des temps and other ephemerides) § Metrology, the metric system, almanacs and annuaires § Professional and institutional rivalries (scientists, military men, precision instrument makers, etc.) § Unity and discord between centre(s) and periphery(ies) The weekly minutes of the Bureau des longitudes from 1795 to 1932 are available online at http://bdl.ahp-numerique.fr.

Fox, Robert
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Dunn, Richard (National Maritime Museum)
After 1815: British science through a French prism

The archives of the Bureau des longitudes provide a rich resource revealing not only the inner workings of that institution but also how the work of scientific institutions and practitioners from other countries was being discussed in France. This paper will look at what discussions at the Bureau des longitudes might tell us about British institutions and practitioners in the post-war decades after 1815, a period that saw significant changes in the way scientific work was organised in both countries. By highlighting individual case studies around the practical application of astronomy and related research areas, it will look at issues of collaboration, rivalry and accommodation.

Belteki, Daniel (University of Kent)
A Model Instrument - Exhibiting the Airy Transit Circle at the Exposition Universelle 1855

George Airy (director of the Royal Observatory, Greenwich) exhibited at the Exposition Universelle 1855 in Paris, a set of models showing features of his newly designed Transit Circle. Using Airy's personal correspondence with the makers and the supervisors of the models, the

paper investigates how individuals interpreted the models, and why attempts failed to gift them to French scientific institutions and to the Paris Observatory.

S01/3 UNITY AND DISUNITY OF THEORY AND PRACTICE IN RESEARCH ON ECONOMICALLY SIGNIFICANT SPECIES

Location: IoE – Committee Room 2 **Chair:** Loskutova, Marina

Organiser(s): Fedotova, Anastasia, and Mueller-Wille, Staffan

This symposium will be devoted to economically significant species as research objects and their impact on research agendas, methods, strategies, and institutional frameworks in natural history and biology. The topic is deliberately conceived as a very broad one that could potentially encompass a vast array of disciplinary fields within the life sciences. The panellists will consider research on such objects as crops, officinal plants, domesticated animals, fish and wildlife game species, insect pests, and species transmitting contagious diseases. It makes sense that economically significant species have always enjoyed better chances to become privileged research objects; however, there are numerous examples also when some of these species remained under-researched for a long time. The economic, ecological or medical significance of a given species may considerably vary from one national or regional context to another and from one point of time to a different century or decade. Technological changes, in particular, would inevitably lead to enhancing the importance of some species that previously never attracted focussed attention, while other species would cease to be treated as a valuable resource or commodity deserving such attention. Geographic location and economic conditions exercise a powerful influence upon what counts as a biological resource, and thus might affect the making of specific institutional, regional or national traditions and 'schools' within specific fields of study. The focus on economically significant species may have provided a convenient strategy to legitimise and enhance the credibility of a particular research agenda in the eyes of academic administrations and private and public sponsors. But even if the choice of some of these species as principal research objects was thus often pragmatically motivated, it could still lead to substantial changes in the institutional and methodological landscapes of science. In earlier periods in the history of life sciences, for example, local agents – farmers, craftsmen and entrepreneurs, hunters and healers, etc. – would usually have had vastly more substantial experience in dealing and working with a specific species than travelling naturalists who produced first scientific accounts of these species. Growing awareness of the economic importance of such species by the state would thus have pressured metropolitan scholars into changing social and institutional arrangements to tap into these knowledge sources at the periphery, forcing them to leave their familiar environment and relocate to new, often challenging and potentially dangerous milieus. At the same time, knowledge gathered in this way needed to be reported back and systematized, often causing major changes in the material culture and publication regimes of science. By looking at the history of research on economically significant species, we hope to arrive at a better understanding of the entangled histories of supposedly 'pure' and 'applied' research in different regions of the globe and what unites and separates different national and regional traditions in the history of the life sciences from the early modern period to the present.

Fedotova, Anastasia (Russian Academy of Sciences, St Petersburg) and Kouprianov, Alexei

Dissolving interdisciplinary and interspecific borders: Boris Uvarov and the hybrid origins of locust phase theory (1911–1921)

Despite their proverbial pest status, locusts were rather poorly studied until the 20th century. An important breakthrough in locust control became possible due to Boris Uvarov's (1886–1970) phase theory (1921). His study of migratory locust, in which Uvarov transgressed the pure / applied entomology divide characteristic of his elder colleagues, was a paradigmatic example of a fruitful hybridisation of taxonomy, biogeography, and locust control practice. Nicolai Adelung (1857–1917), a curator at Zoological Museum in St. Petersburg, worked on the problem of migratory locust species identification using genitalia structure but retreated facing the lack of comparative material. Fyodor Lebedev (1858–1927), an officer at the Department of Agriculture, was a keen observer and practical expert but lacked interest in taxonomic subtleties. During his first anti-locust campaign (Stavropol, 1911–1913), Uvarov, trained as a taxonomist and biogeographer, tried to solve the problem of identification of two migratory locust species (*Pachytylus migratorius* and *P.danicus*). A combination of museum zoology practices, routine exposure to thousands of specimens in the field, observation and mapping of locust swarms led Uvarov to the rejection of his original ideas and acceptance of conspecific nature of the two forms. The 1913–1915 experiments by Uvarov's correspondent Vasilii Plotnikov (1877–1954) confirmed the possibility to breed *P.danica* from *P.migratoria*. WWI and Revolution distracted Uvarov from his work but right after settling in London (1920) he embarked on the taxonomic revision of migratory locust. Further analysis allowed Uvarov to reduce all forms of migratory locust to the single species *Locusta migratoria* (with gregarious and solitary "phases") and extend his phase theory to other locust species.

Pannhorst, Kerstin (MPI, Berlin)

Unity and Disunity between Taxonomy and the Decorative Arts Trading Insects in early 20th Century Taiwan

This paper focuses on practices of collecting, processing and trading insects in early 20th century Taiwan and explores the entanglement of a mass-fabrication of research specimens, insect decorative art and knowledge. In the early Japanese colonial period, the small town of Puli in Taiwan's central mountain range became a hub of commercial insect trade which decades later would become the center of an industry that turned the island into the world's largest exporter of butterflies. Taiwan's insects gained this economical significance as a resource for the production of decorative art. Preserved specimens, mainly butterflies, were sent to entomologist Yasuhsi Nawa in Gifu in central Japan and turned into commodities such as paper fans, hair pins or postcards at the Nawa Entomological Institute. Simultaneously, the only recently accessible island Taiwan attracted entomologists looking to find insect species not yet scientifically named. One of the most prolific collectors was Hans Sauter, a German entomologist turned collecting entrepreneur permanently based in Taiwan who made Puli one of his main field sites, employing some of the same insect collectors as Nawa. Together with the German Entomological Museum in Dahlem, today a part of Berlin, Sauter aimed towards a „mass-fabrication of knowledge": Tens of thousands of carefully packaged specimens were sent to European museums along global trading routes with the goal of a successive publication of the „complete fauna of Formosa" by taxonomists all over Europe. Before the First World War, the Dahlem museum moved its focus to insects from Taiwan, even founding a new annual journal that in its first five years exclusively published papers about insects sent by Sauter. Fueled by the demand for Japanese decorative arts, collecting insects became a lucrative skill for the rural population in early 20th century Puli, enabling the mass production of research specimens and leading to changing entomological research and publication regimes.

Kelly, Ann (KCL)

Detinova on Safari: Cold War Entomologies and the Labours of Eradication

This paper focuses on techniques of mosquito dissection, a crucial element in the understanding of the dynamics of disease tradition. Specifically, I explore the history of a method pioneered in the 1940s by Soviet entomologists. The Detinova Technique, as it would become known in the West, offered a highly precise way of determining the exact physiological age of the female

Anopheles mosquito by counting the dilations in the ovariolar stalk left by each egg. This information was crucial for the estimations of the vectorial capacity of mosquitoes in any given region of concern, and was heralded as a game-changer for global malaria eradication. Yet the degree of manual dexterity implied by the technique limited its diffusion and led eventually to its demise. The article explores the dynamic tension between technical precision and pragmatic doability, and the delicate fate of interventions that rest on forms of highly skilled practice. The history of the Detinova Technique also allows us to trace connections between Soviet researchers and malaria control in sub-Saharan Africa, and thus expands the geographical and political horizons of global health beyond the traditional focus on Western science.

Martinez, Alejandro (Universidad Nacional de La Plata)

Unity and disunity in pest control research during the 1910s

It is well known and demonstrated that locust outbreaks have no respect for political boundaries and have affected crops in almost all continents. Although not equally harmful in all regions, nations and colonial territories, they represent a global economical and environmental risk. At the turn of nineteenth and twentieth century the concern for its control was beginning to scalate from the local level to a certain international cooperation. In this scenario the circulation at a world scale of information, knowledge, people, technologies, and instruments related to locust control was a key. Here I will focus on the work of French-Canadian bacteriologist Felix D´Herelle in the “fight against locusts” in Mexico, Argentina and Tunisia during the second decade of the twentieth century. My aim is to underline and analyze the character of research on an economically and ecologically significant insect pest spread among different political and cultural contexts. D´Herelle´s story is an interesting case in the history of pests´ biological control and would contribute to highlight what unites and separates fundamental from applied research, theory from practice, labwork from fiedwordk, different local research experiences with locust outbreaks and also what makes scientific and political interests either to converge or diverge.

S58 UNITY AND DISUNITY IN MATHEMATICAL MAGIC SQUARES ACROSS CULTURES AND LANGUAGES

Location: IoE – Room 731

Chair and Commentator: Calvo, Emilia (University of Barcelona)

Organiser(s): Comes, Rosa

Magic squares are potent symbols of unity. Composed of cells in an equal number of rows and columns containing a string of consecutive natural numbers arranged such that the sum of each row, column and main diagonals is the same, the numerical relationships within a magic square remain the same however it is rotated or presented as a mirror image. Magic squares also symbolise disunity, since as the number of cells in a square is increased there is a corresponding, almost exponential, increase in the number of its possible magical arrangements. Historical and modern discourse on magic squares also reveals elements of unity and disunity as magic squares appear in a variety of literary and artistic settings across a huge chronological and geographic range. In Islamicate literature, magic squares first appear in 9th- and 10th-century medical contexts, where their healing power was imagined to have a natural cause. The earliest Arabic treatises devoted to magic squares, however, were written by well-known mathematicians such as al-Būzjānī (10th c.) and Ibn al-Haytham (10th-11th c.) and were purely mathematical in scope. The Islamicate tradition of mathematical interest in magic squares inspired the Byzantine grammarian Moschopoulos to write the first European mathematical treatise on magic squares in the 14th century. In the 10th-century Epistles of the Brethren of Purity, we find the first discussion of the magic squares in an environment that is both mathematical and arguably magical. The Andalusian astronomer al-Zarqālī (11th c.) was perhaps the first to propose the astrological-talismanic use of the first 7 magic squares associated with the 7 planets. The first dateable reference to a magic square in Latin Europe derives directly from the work of al-Zarqālī and is found in the Alfonsine Astromagia (13th c.). In fact, the standard European term “magic square” arose because only Arabic magical and not mathematical treatments of the squares were known. Later Islamicate treatises, such as those attributed to al-Būnī (12th -13th c.), combine discussions of the magical uses of the squares with mathematical descriptions of their construction, and the earlier astrological and natural philosophical explanations of their talismanic powers give way to explanations rooted in letterist and Sufi traditions. In Europe, Athanasius Kircher (17th c.) wrote the first known European mathematical description of magic squares since Moschopoulos, and employed his insights in this area to his attempts to decipher the hieroglyphs of the ancient Egyptians. Many Arabic and Persian treatises dealing with purely mathematical squares have been surveyed in recent decades, but most of the Arabic and Latin works dealing with their magical and astrological aspects are neglected. More generally, modern scholarly research into the history of magic squares has been hindered by a tendency to impose artificial unity on the historical source material while assuming disunity between, for example, authors dealing with mathematical aspects of the squares and their magical applications. This symposium seeks to reassess the history of magic squares, focussing on instances of unity and disunity, while accepting both their mathematical and their magical and astrological aspects.

Comes, Rosa (University of Barcelona)

Some Remarks on Unity and Disunity Regarding Magical Square Construction Systems as Shown in Latin Manuscripts

The earliest Arabic treatises on mathematical squares, as indicates the title Harmonic Disposition of the Numbers, deal with their construction system. In some Arabic treatises written in al-Andalus, as Azarquiel's Kitāb tadbīrāt al-kawākib (11th c.) we find, for the first time, the first seven squares related to the virtues of the seven planets, , as used in talismans. This tradition has its roots in the Rasā'il of the Ikhwān al-Ṣafā' (10th c.), heirs of the Hermeticism and the so called "Neo-Pythagoreanism", received through the Sabians, where we find the first seven squares in a magical environment, although not related to the planets. Regarding Latin texts on magic squares, we observe that the squares shown in them are constructed following different construction systems. The paper intends to establish the links among the surviving traditions by comparing the methods of construction of the squares and the texts; rituals; elements of the animal, vegetable and mineral world and planetary data, among them and with the Picatrix III, De attractione virtutis planetarum … per planetas, figuras …, sufumigaciones,… et status celi necessarii cuilibet planetarum, while in IV, magical squares are related to the planets, although without the figurae. Also, the paper will focus on the traces of a possible Arabic original, like the expression "scias quod", the Arabic اعلم أنه, or the frequent misunderstanding of numbers 3 and 8 that betray an Arabic original in abjad alphanumerical notation.

Hallum, Bink (British Library)

Unity and Disunity in the Tradition of the Seven Planetary Magic Squares

Modern students of the history of magic squares have imposed unity and continuity across huge chronological, geographical and ethnolinguistic expanses. Scholars have focused on questions of historical precedent for the methods of construction for squares of various orders, and adequate importance has rarely been attached to the wider cultural significance of the squares. The magical and talismanic use of the squares is a case in point. The story of the magic-square talismans has not been taken seriously in relation to the history of the sciences. This paper takes a nuanced look at the tradition ofthe planetary magic squares while problematising this tradition, highlighting its many points of unity and disunity. Following the discussion of the planetary squares in Agrippa's *De occulta philosophia* (1533), their popularity boomed across Europe. Agrippa presented the planetary squares in the context of Neoplatonic philosophy and Jewish cabala. In the Islamicate world their talismanic use can be traced back to al-Zarqālī's (d. 1100) *Treatise on the Movements of the Planets.* Agrippa's immediate source was a Latin translation of extracts from al-Zarqālī's treatise. Cardano reversed the system of correspondences between the squares and the planets used by Agrippa. Some modern scholars have claimed that Cardano's system of correspondences is derived from an old Ḥarrānian astrolatric tradition passed down via Thābit b. Qurra, but thisis baseless speculation. A further point of disunity between the European and Islamicate traditions of the planetary squares is in their theoretical underpinnings.

Chahanovich, W. Sasson (Harvard University)

Magic Squares in Pseudo-Ibn al-ʿArabī's The Tree of Nuʿmān: A Case Study in Ottoman Apocalypticism and Occult Prophecy

The Ottoman period constitutes a renaissance in the history of magic squares. Subsequent to the conquest of Constantinople, the Sultan-Caliphs cultivated an imperial ideology of eschatological apocalypticism. They imbued their authority through an alchemical amalgam of astronomy, lettrist prophecy, and the occult authority of magic squares. One of the most important, yet unstudied, texts that demonstrates this fact is The Tree of Nuʿmān. Herein one encounters the language, style, and method of Ottoman apocalyptic ideology, and its unique reliance on magic squares, diagrams, and astrological charts. This text is apocryphally attributed to Ibn al-ʿArabī (d. 638 AH/1240 CE). In my paper, I propose a case study of The Tree of Nuʿmān and interwoven importance of magic squares, astronomical charts, and lettrism. I

tentatively argue that this tricephalic methodology was employed primarily to imbue the nascent Ottoman Sultans' apocalyptic-imperial ideology with legitimacy. Magic squares, astrology, and gematria possessed a matrix of 'street cred' among the educated elite. I prove this by tracing the history of this practice to their Timurid predecessors who pioneered the genre. I present the issue of apocryphal attribution to Ibn al-ʿArabī as a crucial piece of evidence that points to aʻdarker' side of mystical musings. The author(s) were well-acquainted with the works of Ibn al-ʿArabī. Magic squares there afford us a new lens through which to understand the post-classical development of Islamic apocalypticism and mystical thought in the Ottoman period.

Tolsa, Cristian (Independent Scholar)

Multiple-association systems in the medieval magic squares and the Hellenistic astrological tradition

Maybe the most basic feature of medieval treatises on magic squares derived from the Arabic tradition (including Old Castillian, Latin and Greek Byzantine texts) is that such squares are associated in the texts through one-to-one correspondences with metals, plants, stones, and most importantly with planets. In this paper I will trace back this kind of grid-like structure to specific Hellenistic and ancient Greek cultural practices, especially within the Hellenistic astrological and Pythagorean traditions. It is thus no surprise that the earliest Arabic texts propounding a correspondence between magic squares and the planets bear a close relation with this kind of Greek sources (Brethren of Purity) or are deeply familiar with astrology (Al-Zarqali). What is more, the magic square texts normally include astrological lore such as the effects of the planets, the phases of the moon, retrogradations, and exaltations. In this respect, it will be illustrative to compare the medieval magic square treatises with Greek astrological and Pythagorean texts, and with magical texts of the Greek tradition, such as the Hermetic treatise on the decans, featuring a similar series of instructions for the construction and use of engraved talismans associated with astrological entities.

S34/2 HISTORY BEHIND STATISTICS: UNITY AND DISUNITY BETWEEN SCIENTIFIC COMMUNITIES AND BUREAUCRACY

Location: IoE – Room 736 **Chair:** Daniel, Claudia

Organiser(s): Lanata Briones, Cecilia T., and Daniel, Claudia

Statistics can be perceived as facts detached from producers and users that are unproblematic and certain, as ready-made science (Latour 1987). Since the nineteenth century, nation-states have produced and relied heavily on statistics, to the extent that governments' performance began to be evaluated by what numbers (do not) show. Economic and social statistics became the foundational backbone of modern government. The incorporation of numbers into public life aimed to depoliticise functions of public and private administration through rationalisation (Stapleford 2009). How were quantification tools constructed? Who developed them? How were public statistics and measurement tools used in different fields (science, politics, firms, etc.)? How have these instruments changed through time? This symposium examines the ways to produce statistical knowledge and the role played by statistical quantification tools throughout history. The panels bring together socio-historical approaches that enhance the social and political foundations that explain the transformations of quantification techniques, practices and languages. The unfolding of the history of statistics merged research categories that were born separately: one referring to the history of institutions and statistical systems and the other to mathematical statistics and probabilities. This convergence added complexity to the way we understand what statistics do and what we do with them. The encounter is linked to the fact that probabilities and macro-social descriptions of public statistics have been continuously intertwined, meeting and separating (Desrosières 2004). Therefore, the studies of its historical evolution should address both the academic and administrative dimensions of statistics, as they reciprocally shape each other (Porter 2000). Statistics is simultaneously a tool of constructing and proving scientific facts and a technical language used in the social debate with great capacity for persuasion (Desrosières 2008). This power lies on its double source of authority, of science and the state. The study of statistics has developed across a variety of fields, settings and actors, joining several histories. The history of economic facts and the trajectory of schools of thought were intertwined with the evolution of technical tools and statistical models used by economists. The production of sanitary statistics was connected with the social history of health and disease, the development of the medical profession, the public health movement, and of life insurance. Both the historic population moves and the development of demography were involved with the historical and political nature of censuses and the generation of vital statistics and statistical nomenclatures. Linking elements only distant in appearance, the history of statistics shows that the institutionalisation of concepts, practices and statistical tools does not follow linear trajectories. Quite the contrary, they are basting formulations made in national statistical agencies or academic spheres, discussions in statistical communities, applications in the practical world, and mobilisations of private interests or state support. These entangled histories sometimes portray tensions and controversies within scientific communities or between scientific societies and state bureaucrats. The inclination of statistical language towards universality intersects with specificities marked by national traditions. Lastly, private and public uses of statistical tools could also be seen as factors of union and disunion.

Aragão, Roberto (University of Amsterdam)

Macroeconomic Indicators in Brazil: Lessons from a historical analysis

Macroeconomic indicators are a part of society's decision processes. GDP, inflation and public debt help assessing economy conditions and governmental capacity. Despite of their apparent simplicity and objectivity, synthetizing concepts into a single number is a difficult task, subject to methodological shortcomings and influence from powerful actors. Methodological changes in statistics, determined behind the scenes by statistical experts, are constantly overlooked. This paper contributes towards filling this gap by analyzing the methodological evolution of Brazilian GDP, Inflation, Public Debt, and Public Deficit. Brazil is a middle-income country with a satisfactory level of governance and democracy standards. Brazil is unique because the country has some statistical data provided simultaneously by several different institutions including the National Statistical Office. This situation creates conflicts when the indicators show different tendencies. When these indicators coincide, they serve to validate each other and reinforce the measurement. Using a process tracing approach, I show that Brazilian indicators were not created in a linear way, but instead are products of conflicts between internal actors as well as the influence of international organizations encouraging the adoption of international standards. Moreover, this paper sheds light on the roles of different actors in pushing methodological changes, filling an existing gap of knowledge about the construction of macroeconomic indicators outside the North Atlantic region. I identify which actors were most relevant in the definition of the Brazilian macroeconomic indicators' methodology and to what extent Brazilian macroeconomic indicators comply with international standards.

Touchelay, Béatrice (Université de Lille)

To what extent the French Colonial Statistics is a tool to manage the Empire (19-half 20th C.)?

The aim of this communication is double. It consists at first in presenting the making of some demographic and economic colonial statistics in various configurations of French Colonial Empire (Old Colonies of the Antilles, French dependences in Africa and in Indo-Chinese Peninsula) at different periods (the conquest, the end of slavery, the beginning of the 20th Century when the Colonial Empire was forced to acquire the budgetary autonomy and 1930s when the Metropolis realizes the economic importance of its Empire). Secondly, this communication aims to wondering about the purposes of those colonial statistics: to what extent the colonial statistics is considered, in Colonies and in Metropolis, as one efficient management tool of the Empire? Who are his followers, his users and his producers. The hypothesis of departure is the insufficiency of the credit attributed to the French imperial statistics and the weakness of its results. The aim of this communication is to discuss that hypothesis and to find the way to analyze the French colonial statistics independently of the "British model".

Prévost, Jean-Guy (Université du Québec)

Genesis and migration of a concept: quality in statistics (and elsewhere)

"Quality" is the 21st century a motto of official statistics. Its definition varies including relevance, accuracy, timeliness, coherence and comparability, interpretability and accessibility. Entanglement between statistics and quality is older and deeper. This paper traces quality's genesis and migration across several fields, settings and agents since the 1920s. Five stages/settings exist: (1) Industry, where statistical control of quality was first introduced at the Hawthorne General Electric plant and from there transferred to other domains of production; (2) The 1940 United States census, when sampling methods were introduced defining quality as error reduction; (3) The postwar reconstruction of Japanese economy which saw the implementation of the idea that quality control should move from the end product back to all of a firm's operation, integrating suppliers, producers and consumers; (4) The dissemination of these ideas in American and Western management theory throughout the 1980s and 1990s; (5) The adoption of quality, quality frameworks and codes of

practice by all national statistical agencies from the early 1990s on. Ontologically quality posits variation as a dimension of reality. Epistemologically it envisions phenomena through probability. Ethically and normatively its action models predict and control. Quality is a nomadic practical concept rooted in statistics. As it questions the distinction between quality and quantity – quality can be "quantified" as well as the quality of quantities can be estimated –, it offers an example of unity/disunity in science, and of unity/disunity between science and the practical world.

S39/2 CULTURES, STARS AND NUMBERS: INTERCULTURAL EXCHANGES IN EAST ASIAN MATHEMATICS AND ASTRONOMY

Location: IoE – Room 790 **Chair:** Cullen, Christopher

Organiser(s): Cullen, Christopher

Pre-modern East Asia was the home of distinctive traditions in both mathematics and astronomy. During the first millennium CE these traditions, first developed in China, became common to the whole region, including Korea and Japan. Within the broad theme of the conference, 'Unity and Disunity', the aim of this panel is to encourage discussion of relevant issues in a regional and global historical and cultural context. Despite their common roots, the theory and practice of mathematics and astronomy was by no means uniform across the whole East Asian land-mass. It is thus illuminating to trace the way that elements of these disciplines were appropriated, adapted and developed as they moved across regional and cultural boundaries. Moreover, pre-modern East Asia was highly permeable to the flow of ideas from the rest of the Eurasian continent - first from South Asia in the context of the coming of Buddhism in the first millennium CE, then from the Islamicate world from the Yuan dynasty (1271-1368) onwards, and finally from early modern Europe with the arrival of Jesuit Christian missionaries in the later part of the 16th century. The complex interactions that followed from these contacts are revealing not only of the nature of the East Asian traditions in astronomy and mathematics, but also of the traditions that scholars in East Asia encountered afresh.

Qu, Anjing and Yuan, Min (Northwest University, Xian)
How did astronomer survey the distance between Beijing and Samarqand in 1220 AD?

In his Gengwu epoch calendar (1220), Yelv Chucai (1190-1244) invented the *Licha* method which was used to calculate the difference of longitude from Yuan Dadu (Imperial Observatory of Yuan). According to the result and its application of geodesic survey leaded by Yixing (724AD), we find an interesting link between Yixing's survey and the *Licha* method. From this, we may reason what the picture of the shape of earth in the mind of Yelv Chucai could be.

Sôma, Mitsuru (National Astronomical Observatory of Japan)
Time System in the Heian Period in Japan Inferred from Midô-Kanpaku-Ki

Mido-Kanpaku-Ki is a diary during the years from AD 998 to 1020 written by Fujiwara-no-Michinaga, who was a court noble in the Heian Period in Japan. The diary was written in blank spaces of the calendar called Guchû-reki, and in the Guchû-reki the times of sunrise and sunset were written in the time system used in the calendars at that time. From them we have found that in that time system 1 day consists of 12 double-hours, and each double-hour consists of 4 koku 1 fun, where 1 koku equals 6 fun. From analyses of the times of sunrise and sunset we have also found that the latitude of the observation place of the sunrise and sunset was about 35.5 degrees and the standard deviation of the errors in the times of sunrise and sunset is 2.4 minutes as measured in the current time units. The errors are especially small for the latter half of the year, and the standard deviation becomes 1.4 minutes for this period. Calendars and miscellaneous data at that time were brought to Japan from China but the data for the times of sunrise and sunset shown above cannot be found in China. Therefore it is a mystery how they obtained such precise times of sunrise and sunset at that time in Japan.

Tang, Quan (Xianyang Normal University)
Chinese Solar Theory in the Sui and Tang dynasties: was it influenced by the other civilizations?

Chinese astronomers calculated the position of the sun according to the mean sun before the middle of sixth century. After Zhang Zixin declared his discovery on the non-uniform motion of the sun, his successors began to design the solar equation table to calculate the true motion of the sun. Considering the fact that Indian astronomy knowledge were always introduced into China from the Southern and Northern period to the Tang dynasty, it is still necessary, interesting and challenging to investigate the question that if Chinese solar theory in the Sui and Tang dynasties was influenced by Indian astronomy. In this paper, we compare the solar theory in the Sovereign Pole System, the Great Patrimony System and the Great Expansion System with the solar theory in Indian astronomy work Pañcasiddhāntikā, which was completed in the sixth century. After comparing the similarities and differences between Indian and Chinese solar theory in the Sui and Tang dynasties, we do not rule out the possibility that Zhang Zixin's significant astronomical discoveries and solar theory in the Sui and Tang dynasties were influenced by Indian astronomy. But we want to say the influence of Indian solar theory to Chinese solar theory is very limited because Chinese astronomy tradition is very strong.

Tanikawa, Kiyotaka (National Astronomical Observatory of Japan)

Japanese Astronomy in the seventh and eighth centuries

The initial Astronomy in Japan did not develop monotonically. I will talk about the reason of non-monotonicity together with the contents of the astronomy itself. Japanese observational astronomy started in the seventh century AD. Astronomical records are contained in the first Japanese official history book `Nihongi' edited in AD 720. The number of records is 31. The number of Emperors is eight, and correspondingly, the number of volumes of the Nihongi in the seventh century is 9. The serial number of the volumes runs from 22 to 30. The astronomical records are dispersed in these volumes. We found that records in volumes 22, 23, 28, and 29 are observed ones. There are only three records in volumes 24, 25, 26, and 27, and these are considered to be not observed. six records of solar eclipses in the volume 30 are predicted. We identified three groups of the volumes of the Nihongi with different characters of astronomical records. The astronomical records of the eighth century AD is contained in the second official history book `Shoku-Nihongi'meaning the continuation of the Nihongi. In this book, all records of solar eclipses are predicted ones.

SUNDAY 16 SEPTEMBER, 09.00-10.30

S20/1 SCIENCE AND SPIRITUALISM IN THE MODERN AGE

Location: IoE – Room 780 **Chair:** Rocha, Gustavo Rodrigues

Organiser(s): Sera-Shriar, Efram

Traditionally, scholars and an interested public have attributed the rise and growth of spiritualism over the past two centuries to the so-called nineteenth-century crisis of faith. However, when conflicts did occur within discussions regarding ghosts, spectres or psychical forces, the cruxes of the arguments often revolved around issues of evidence (or lack of it), rather than around beliefs or disbeliefs per se. The central question to emerge was: who had the burden of proof, believers or sceptics? Therefore, this panel will suggest that when studying the phenomena of spectres, spirits and psychical forces the emphasis should not be on their relation to a crisis of faith, but instead to a crisis of evidence. By asking more insistently what the methods and ideas of spirit investigators and psychical researchers were, this panel aims to develop a more rigorous understanding of how our modern conceptions of ghosts, spectres and psychical phenomena have been formed over the past two centuries. Such an approach will help to better contextualise the relationship between spirit studies, psychical research and other sciences, showing how scientific fields such as physics, psychology, anthropology and physiology have influenced spirit studies and psychical research, and how spirit studies and psychical research have influenced them.

Sera-Shriar, Efram (Leeds Trinity University)
Challenging the Master: Andrew Lang, Spiritualism and the Limits of Animism

Andrew Lang was one of the most prolific folklorists and popularisers of anthropological theories in Britain during the second half of the nineteenth century. He had a particularly keen interest in both the anthropology of religion, and psychical research, and over the course of many years, he had been collecting ghost stories from all over the world. This material was eventually worked up into the book, Cock Lane and Common-Sense (1894). The title referred to one of the most famous British-based hauntings of the modern period: the Cock Lane ghost. Lang identified this alleged haunting as a prime example of spiritualism in modern society, and it acted as a starting point for his anthropological investigation of spirits and psychic forces. Originally following in the footsteps of his mentor, Edward Burnett Tylor, Lang examined the history of ghost stories through a cultural evolutionary lens, arguing that the continued presence of these stories in modern society were potentially a survival of 'primitive' thought. However, he had some reservations about this conclusion, and he questioned whether animism alone could account for the survival of ghost stories in the 'civilised' world. Was the spirit hypothesis deserving of more consideration than anthropologists were willing to give it? This paper will examine Lang's writings from Cock Lane and Common-Sense, linking it to larger discussions in Victorian anthropology on the modern spiritualist movement and evidential standards.

Richardson, Elsa (University of Strathclyde)
Ghost Hunting in the Highlands: Ada Goodrich-Freer and Scottish Second Sight

In 1893 the Society for Psychical Research (SPR) launched an Enquiry into Second Sight in the Highlands that saw members of the organisation turn their attention to a form of prophetic vision long associated with Gaelic folklore. Headed by Frederic W.H. Myers and financed by the influential Scottish nationalist Lord Bute, the investigation aimed to delineate the characteristics of the second-sighted vision, establish its incidence, and determine its supernormal qualities. Intended to contribute to the ongoing Census of Hallucinations, the Enquiry started as a schedule of questions dispatched to sympathetic parties in request of information regarding instances of prophetic sight in their local community. When this survey

failed to produce any serviceable data, of nearly 2000 questionnaires sent out only sixty-four were returned with useable information, a decision was made to send a researcher north to conduct interviews and collect evidence in the field. The decision to dispatch an emissary to the Highlands was an unusual one for the organisation, but if the structure of the investigation was somewhat anomalous, then the figure chosen to lead it was even more so. Focusing on its chief researcher, Ada Goodrich-Freer, a self-identified clairvoyant, expert in crystal vision and sometimes spiritualist medium, this paper tells the story of this unusual investigation and considers what it might reveal of the complex relations between the folkloric and the psychical in this period.

McCorristine, Shane (University of Newcastle)

What is the matter with ghosts? Or, why aren't they naked?

"What is the *matter* with ghosts?": this was a key philosophical question for people interested in spiritualism and psychical research in Victorian Britain. Sceptics and ghost-seers alike delighted in thinking about how exactly ghosts or spirits could have form and force in the material world. How did ghosts affect perception, move objects, and touch living bodies? Just what kind of *stuff* were they made of that allowed them to share our plane of existence, in all its mundanity?

These debates - sometimes profoundly metaphysical, sometimes absurd - are worth examining because they were influential in forming popular and scientific opinion on the validity of ghost belief. This paper starts to sketch out the parameters of these debates by focusing on the knotty issue of the clothes of ghosts.

The director of the recent film *A Ghost Story* (2017) described the white sheet that the lead actor wears as "the biggest challenge of the entire movie" because "if the sheet billowed in the wrong way, it ruined the illusion"; "it's an inherently goofy image", he said. This image of the ghost as a figure in a white winding sheet or death shroud has retained its iconic status because it suggests continuity between corpse and spirit. Yet from the early modern period, most reported ghosts appear in everyday and contemporaneous (or near contemporaneous) clothing. This raised two problems that can help elucidate themes in the *Science of Ghosts* project.

Firstly, if the ghost was an objective reality, why should it be wearing clothes? If the tenets of spiritualism were true, should the soul which has returned to visit the earth be formed of light or some other form of ethereal property? How can spirits wear everyday clothes? Were the clothes also spiritual, and if so, did they share in the essence of the spirit or were they the ghosts of clothes in their own right? As F.W.H. Myers pointedly asked, "how has the meta-organism accreted to itself a meta-coat and meta-trousers?" The contention that "ghosts are never without drapery" fed into the position advocated by some psychical researchers that ghosts were the projections of the mind. From such small and knotty minutiae theories were formed and positions staked.

Secondly, apart from a handful of examples, there are very few naked ghosts recorded. Why aren't more spirits naked? Is this because they were *essentially* dressed or because the ghost-seer mentally dressed them? If they were mentally dressed was this because of morality, fashion, or an instantaneous remembering of how the deceased was last seen? In other words, were ghosts mundane features of Victorian supernatural experience [Latin: *mundanus*: "belonging to the world"] or did they stand out as supra-mundane beings clothed in ideal robes that were disconnected from material reality?

This paper will pose these questions, sketch out some of the contemporary positions, and attempt to catalogue some of the ghostly fashions of of the nineteenth century.

Lamont, Peter (University of Edinburgh)

The Psychology of Error: A Debunking Strategy of Endless Use

The reported facts of Victorian Spiritualism provoked a 'crisis of evidence', because some of the facts were hard to explain. One response to the 'crisis' was the emergence of a psychology of error. This was part of a broader psychology of belief that sought to provide natural explanations for 'supernatural' phenomena, including references to pathological conditions and the deceptive strategies of conjurors. The psychology of error was more specific: it emphasised

the errors and biases to which the normal mind is prone (modes of self-deception), and claimed that they could be avoided by using proper scientific methods. For example, W. B. Carpenter, stressed how 'prepossessions' lead us to misinterpret what we see in line with our beliefs and expectations, and that expert knowledge of such fallacies was needed in the investigation of 'supernatural' phenomena. The basic argument was hardly new, but it became a popular debunking strategy, and was deployed by many sceptical psychological scientists in Britain, Europe and America.The psychology of error had wider relevance beyond the debunking of psychic phenomena. It reflected two of the most important problems for early scientific psychologists: the claim to objectivity, and the applicability of psychological knowledge to society. When used to debunk psychic phenomena, however, it amounted to little more than a circular argument that certain beliefs were erroneous, and so were the result of error. Despite this, it continued to be used, and continues to be used, in this way.

S50 UNIFYING LIFE FROM THE SCIENTIFIC REVOLUTION

Location: IoE – Committee Room 1

Chair and Commentator: Stein, Claudia (University of Warwick)

Organiser(s): Dyde, Sean

One assumption is that the Scientific Revolution primarily affected the physical sciences. This panel argues that its most profound effects occurred in the life sciences – not least what it meant to have a 'life' to be scientific about. Though competing natural philosophies, through much soul-searching in the aftermath of war and new experimental practices, from the early modern period emerged new ways of ordering the cosmos which privileged some aspects – the living – above others, which have since become an important framework for humanity to understand itself.

Garau, Rodolfo (Bard College Berlin)
Naturalizing the Human Body in the Early Modern Period

The theme of life during the once-called "Scientific Revolution" has sometimes been described by scholar as "uncontroversial." According to this view, early modern inquirers were generally uninterested in defining what makes life phenomena unique, by contrast assimilating them to physical ones. While this view – carrying a general rebuttal of teleology, and in turn of underplaying the idea of organic unity – misrepresented some essential features of biological entities, it also contributed to the rise of modern biology with the "disenchantment" of living matter from the hylomorphic heuristic of scholastic Aristotelianism. When applied to the human body, such a materialistic turn transformed the combined operations of the three Aristotelian souls in a series of mechanical, iatrochemical, or hydraulic ones, often implying a re-discussion of the nature and function of the immortal soul. While the most renown solution to such problems was represented by Descartes' substance dualism, the revival of Epicurean philosophy, underpinned by a materialistic understanding of the human soul and of its operations, paved the way to an alternative vision of the human soul, and therefore, of the human body. Focusing on the works of Pierre Gassendi (1592 – 1655), Thomas Hobbes (1588 – 1679), and Thomas Willis (1621 – 1675), in this presentation I show how the revival of the Epicurean idea of "corporeal soul" allowed to emancipate the study of organic functions from immaterial principles, therefore contributing significantly to the "disenchantment" of the realm of life.

Dyde, Sean (University of Leeds)
The Blood of the Lamb

In 1667, one of the first animal-to-human transfusions took place in London. It worked, though precisely what worked and how depended upon who you asked. This talk investigates how various groups and actors responded to such experiments, from the Royal Society physicians who conducted the experiment, to the periodical press who mocked the pretensions of the new 'men of science,' as well as the patient himself, whose madness was allegedly eased because of the new blood. More significant, however, were discussions that arose that tried to take account of the disgust which people towards such experiments: not a fully-fledged concept, but a feeling, an ethical charge. What arose, this talk details, became an idea central to how we see ourselves and the world: the sanctity of 'life.'

Wolfe, Charles (University of Ghent)
From the early modern ontology of Life to Enlightenment proto-biology

Well prior to the invention of the term 'biology' in the early 1800s by Lamarck and Treviranus (and lesser-known figures in the immediately prior decades), and also prior to the appearance of terms such as 'organism' under the pen of Leibniz in the early 1700s, the question of 'Life', i.e., the status of living organisms within the broader physico-mechanical universe, agitated

different corners of the European intellectual scene. From modern Epicureanism to medical Newtonianism, from Stahlian animism to the 'animal economy' idea in vitalist medicine, models of living being were constructed in opposition to 'merely anatomical', structural, mechanical models. It is therefore curious to turn to the classic narratives of the Scientific Revolution and find there a conspicuous absence of worry over what status to grant living beings in a newly physicalized universe. Neither Harvey, nor Boyle, nor Locke (to name some likely candidates, the latter having studied with Willis and collaborated with Sydenham) ever ask what makes organisms unique, or conversely, what does not. Here, I examine how something we might call 'the knowledge of Life' (using an expression of Canguilhem's) emerged in the early modern era without being part of the mainstream history of life science, leading to the question: can one can correlate early modern "knowledge of life" with the emergence of a science called 'biology'? How do we account for the increasing fascination with the ontology of Life during the decades prior to the 'naming of biology' (McLaughlin), at the end of the eighteenth century?

S43/3 WHEN SCIENCE DIPLOMACY DIVIDES

Location: IoE – Room 828 **Chair:** Adamson, Matthew

Organiser(s): Robinson, Sam, and Adamson, Matthew

The concept of science diplomacy has gained traction in recent years, as the foreign offices of various nations have appreciated and begun reassessing the influence and importance of the soft power of science and technology. Scientists themselves are also recognising the diplomatic roles they have played historically and how they have contributed to global relations. This symposium (divided in five sessions), focusing on the history of science diplomacy, draw together a variety of scholars exploring different aspects of science, technology, and diplomacy at the international and transnational levels. Rather than merely echoing and reifying the scientists' own accounts about the benign effects of science diplomacy, they challenge them with provocative case studies and newly proposed interpretative frameworks.

Meredith, Margaret O. (Vrije Universiteit, Amsterdam)
Thomas Jefferson as Philosopher and Statesman: Diplomacy and Science in the Enlightenment

There is a long history in late-modern statecraft of deploying scientists in diplomatic functions at the behest of the state. Their utility in this overtly political function is predicated on their special apolitical status as disinterested, neutral actors. Before the mid-nineteenth century, however, such a clear professional divide between the statesman and the scientist did not yet exist. Instead, most men elected or appointed to political offices, including diplomatic posts, were men of learning. The reason for this is that both were the products of a university education in one of the three professions, medicine, theology, and law. The amalgam of the two within the learned world is highly suggestive because it implies that diplomacy and science were far more intertwined in this period than has been understood. And it raises the question of whether the social attributes associated with learning, such as disinterestedness and judgment, also had value in diplomatic functions. The coupling of learning and diplomacy in the late eighteenth and early nineteenth centuries is nowhere more perfectly embodied than in the American statesman Thomas Jefferson. Although Jefferson's wide-ranging philosophical interests, which spanned the moral and the natural sciences, are well known, historians have never viewed them as being intertwined with his long and impressive political career. In fact, he was one of many men of learning in the eighteenth century for whom diplomacy and other political posts served as a platform for philosophical inquiry. Moreover, he undertook most of his scientific endeavors while in serving one of the many political offices he held, for instance while governor of Virginia (1778-1780), Minister Plenipotentiary to France (1784-1789), and president of the United States (1801-1809). Jefferson's election in 1801 to the prestigious Institut National des Sciences et des Arts beautifully captures both the conventionality of and the high value accorded to the coupling of statecraft and the natural sciences, for he was awarded it on the basis of his distinguished work as both a philosopher and a statesman. This paper draws on several moments in Jefferson's political career to illustrate the entanglements between science and diplomacy during this period. These relationships were not straightforward. Just as with the late-modern period, what was understood to be necessary for philosophical inquiries--disinterestedness--was impossible to maintain in a diplomatic function where one acted in the interest of one's government. Jefferson's engagement in philosophical inquiry and diplomacy played out precisely along this divide, resulting in two distinct modes of coupling the two. I illustrate the first of these through Jefferson's use of his diplomatic post as Minister to France as a platform for furthering his philosophical endeavors. Here his diplomatic function augmented his philosophical achievements by virtue of his location within a large community of well-connected men of learning. The second mode, which I take up in the last half of the paper, plays out in Jefferson's use of philosophers, precisely because of their intellectual

prowess and authority, in negotiations with France over the Louisiana Territory during his first term as president of the United States. Here we see the merging of philosophy and diplomacy for political ends.

Somsen, Geert (University of Maastricht)

The Philosopher and the President: Henry Bergson's International Relations Missions between 1914 and 1925

Henri Bergson, the famous French philosopher of "élan vital", served to represent science as well as the French Republic on several international relations missions between 1914 and 1925. When the First World War broke out, Bergson was the president of the *Académie des Sciences Morales et Politiques*, in which capacity he fiercely defended his country's war cause and developed philosophical justifications for fighting Germany. In the beginning of 1917, he was sent to the United States with the aim of convincing the American government and public to join the war on the French side – successfully, as it turned out. After the war Bergson was chosen to preside over the International Committee on Intellectual Cooperation (ICIC), the League of Nations' own showcase Republic of Letters.
In all of these efforts, Bergson drew on his own philosophical work in order to construe an image of civilization that was at the same time universal, anti-German, and pro-French. In my contribution, I will analyze this paradox and raise the question why it was that scientists and intellectuals like Bergson were to play such major roles in inter-state diplomacy during and after The First World War.

Sinelnikova, Elena (St.Petersburg Branch of Institute for the History of Science and Technology)

Scientific societies as diplomatic instruments for the international policy of Soviet Russia in the 1920s

After the October Revolution most states did not give Soviet Russia diplomatic recognition. The main goal of the new government was to overcome diplomatic isolation, the great importance was given to scientific diplomacy, and scientific societies played not the least role in it. The system of scientific societies in Russian Empire grew at a significant pace, and they had a great influence in the international scientific community and extensive international scientific links. Therefore soviet authorities encouraged restoration and development of broad pre-revolutionary international links of scientific societies, as well as creation new ones. Indeed, sometimes international contacts of scientific societies were built and developed even before the official state contacts. For example, the Russian Entomological Society exchanged books with scientific institutions of Argentina, with which official diplomatic relations were established only in 1946. The international communication developed actively in different forms, especially as a publish exchange. The Russian Mineralogical Society, for example, exchanged with 200 foreign research organizations and higher education institutions in 1923. At the same time the Society of Ancient Literature and Art sent its publications to the New York Public Library and the Institute of Slavic Studies in Paris. The Russian Entomological Society sent its publication to Romania, Bulgaria, Austria, Czechoslovakia, Yugoslavia, Spain, Japan, and others. The Russian Physicochemical Society sent its journal to the UK, France, the USA, and Italy. Scientific societies used a membership of foreign scientists for developing the international scientific relations as well. For example, in the Russian Mineralogical Society there were 124 (44 honorary and 80 active foreign members), and in the Russian Botanical Society 51 (2 honorary and 49 active foreign members). This also contributed to the strengthening of international scientific contacts. Another form of international collaboration was the participation of scientific societies' members in conferences, congresses, and jubilee celebrations abroad, as well as missions to foreign museums, archives and libraries. So, they managed to visit Spain, Egypt, France, Norway, Germany, Poland, Italy, and England. The authorities understood the importance of such trips as elements of diplomatic activity to strengthen the prestige of the new government in the international arena. Scientific societies

also protected national interests at the international level. Thus, in 1922, the Russian Geographical Society (RGO) protested against the proposal of the London Geographical Society to remove the names in Tibet associated with the names of Russian travelers. This protest, supported by the NKVD, was sent to the London and some other foreign geographic societies. In 1923, RGO protested against the Norwegian renaming on Novaya Zemlya. Thus, soviet government in the 1920s, quite successfully used scientific societies and their international contacts as diplomatic instruments for to achieve geopolitical goals.

S42/1 THE GREEN AND DARK SIDE OF ENVIRONMENTAL ISSUES IN CITIES (1850-1950)

Location: IoE – Room 709a **Chair:** Hochadel, Oliver

Organiser(s): Gomes, Inês; Miralles Buil, Celia; and Duarte Rodrigues, Ana

In 1984, the expert on French urban history, Bernard Le Petit, stated that "the city is neither a context nor an environment, but the expression of practices and social relations". This symposium's ambition is to bring back "la part du milieu" (Braudel, 1949; Massard-Guilbault, 2002) into the cities, focusing on the question of hygiene. Hygienic issues in cities have been studied by different scholars, through different lenses. We argue for a change of perspective, connecting urban history of sciences and technology, garden history and urban environmental history. In particular, this symposium focuses on the role played by nature and/or environment (concepts that we want to clarify during discussion) in the healthy/unhealthy city. On the one hand, bringing "nature" (e.g. trees, plants or animals) and its natural elements (e.g. sun or air) into the city was considered a solution to solve some of its hygienic problems. On the other hand, the "nature" in the city was, periodically, considered as a source of danger for dwellers' health. What kind of "nature" inhabitants, municipal authorities, doctors or other actors which addressed urban problems wanted in the city? Who were, in fact, the leading actors claiming for healthier cities - doctors, gardeners, engineers, or others? Did they agreed or disagreed about the necessity and effectiveness of the proposed measures? What policies were required to transform the city from dark to green? Are there similarities among those policies in different cities dispersed worldwide? How did, different actors, in their discourses and practices, try to unify or des-unify nature and city? These are the main questions addressed in this symposium. The diversity of case studies covered seeks a comparative analysis between cities – with different size, political importance or economic affluence - in Europe, America, Russia or India, highlighting the importance of experts', ideas and models circulation, at a global scale. Furthermore, it also emphasizes the importance of local exchanges between different social groups in the construction of healthier cities, challenging the traditional center-periphery model. The variety presented in this symposium offers an overview of the significance of environmental urban history to our understanding of the history of science and technology in the city. This symposium is divided into three sessions, focused on animals and pathogenic organisms; cities and infrastructure; and gardens and green grounds arrangements. This symposium is divided into three sessions, focused on animals and pathogenic organisms; cities and infrastructure; and gardens and green grounds arrangements. Focusing on gardens and landscape through the lenses of the urban history of science and technology, the third part of this session shows how different contexts lie behind similar solutions in European cities. The disunity of causes between London and Holland or between Paris and Lisbon are opposite to a certain unity recognized in the renewal of urban green grounds.

Alves, Daniel (Universidade Nova de Lisboa), and Queiroz, Ana Isabel
Plant pests in urban environments. The case- study of invasive ants in Funchal, Madeira island (1850-1930s)

The difference between a rural village and an urban environment is one of degree, defined by several factors, including population density and land use. Urbanization converts villages into towns and cities, widening the built-up area by changing fields and woodlands, formerly on the outskirts. During this process, urban space has to be administratively defined (or redefined),

and territories with a rural land use become part of the towns. They have a crucial role in the citizens' food supply and leisure areas and constituted opportunities to build housing or industry, in the most diverse architectural models. A non-contiguous expansion results in a mosaic of highly fragmented uses around an older core center. In this framework of highly dynamic, complex and multi-functional cities, plant pests' management is an imperative. Insects and other pathogenic organisms impact on green areas, be them vegetable gardens and orchards or ornamental gardens and parks. Local perceptions and responses to invasive ants in Funchal (Madeira, Portugal) from 1850 to the 1930s are presented as case-study. Historical and ecological conditions explained why certain harmful plant pests affected so extensively the inhabitants of Funchal and how the municipality and the regional government had to act for controlling them. The history of invasions works on data registered in scientific publications, literary writings, newspapers and official archives.

Robichaud, Andrew (Boston University)

Livestock and Slaughterhouse Regulation in 19th Century Boston

This paper explores livestock regulation in Boston in the nineteenth century. In the wake of the American Civil War, American cities undertook major projects of relocating livestock and slaughterhouses in new ways, leading to the exclusion of livestock from downtown cities and the creation of legally-sanctioned slaughterhouse and nuisance districts on the outskirts of cities. Amid urbanization, Boston's slaughterhouse district in Brighton saw increased environmental and sanitary pressures in the 1860s. A growing public health movement—and new agencies of the state to implement health policy—created a new regulatory capacity to remove animals from American cities, and to establish new physical and legal spaces for slaughtering and processing animals in the 1860s and 1870s. This paper explores this particular urban transformation—happening in many cities in the United States and worldwide—and the social, legal, technological, economic, and scientific developments that enabled and shaped these changes. With an eye toward comparisons to other American cities—along with cities worldwide—this paper considers the story of Boston's slaughterhouse district alongside others. Where do we see overlap and commonality, and where are there distinctions? In particular, how did developments in scientific knowledge and sanitation create a new urgency in regulating animals and slaughterhouses in 1860s Boston?

Gomes, Inês (Universidade de Lisboa)

Allies or enemies? Dogs and the prevention of rabies in the second half of 19th century Lisbon

The study of urban environment is usually pursued in the realm of urban history, history of science and technology and urban hygiene. Urban areas impose themselves on natural areas, being usually seen as antagonists. The second half of the nineteenth century saw, however, a 'reconciliation' of nature and cities, with an increased interest on the creation of public gardens worldwide, as a way to bring the 'countryside' fresh air and healthier conditions to the city space. Notwithstanding, the development of the modern city led to the need of dealing with animals' co-habitation with humans. The 'naturalness' of animals in urban areas faded, leading them to a status of urban pest. This talk seeks to identify and describe the actions of some of the actors which addressed urban problems associated with the interactions between dogs and urban society taking place in the growing city of Lisbon (Portugal) in the second half of the nineteenth century, when the friendly and useful dog became a true enemy for human health. Different visions collided regarding the measures to be taken to control stray dogs which were potentially rabies-prone, and no consensus emerged. Tensions among various agendas helped to outline approaches to public health. How have dogs shaped the city space and the practices of city inhabitants over time in the context of the political efforts taken to control and exclude them? How can urban pests contribute to our understanding of the history of the city? These are some of the question this talk addresses.

S33/3 STABILITIES AND INNOVATIONS IN THE ASTRAL SCIENCES: PERSPECTIVES FROM CHINESE, SANSKRIT, ARABIC, AND LATIN SOURCES

Location: IoE – Room 777 **Chair:** Husson, Matthieu

Organiser(s): Husson, Matthieu

It is often a tacit belief in the study of history of science that habitual and customary practices are of lesser interest than innovations and novelties. The agency and creativity of historical actors are supposed to chiefly required for innovations, whereas the stability of their practice implied some sort of passivity. This view also usually implies that innovation need to appear against or in spite of conservative forces. In contrast, we want to explore a more dialectic interpretation of stabilities and their relations to innovations, by investigating questions such as: • What are the particular knowledge elements that remained stable in given context of scientific practices? • What kind of active choices and concrete actions endorsed by historical actors allow those knowledge elements to remain stable in a given context of practices? • How do these efforts to maintain stability of specific knowledge elements allow historical actors to investigate reconfigurations of other aspects of their scientific practices? We hope to substantiate the view that there is a plurality in the ways of a scientific practice to select and retain a specific set of knowledge elements as stable within a given context; and to use them to explore other possibilities of reconfigurations and innovations. For instance in Alfonsine astronomy, during the late medieval period in Europe, astronomical parameters remained stable for almost two centuries while the layout and organisation of tables varied a lot. We expect to address these general methodological issues in the history of science from case studies in the development of the astral sciences in Arabic, Sanskrit, Chinese and Latin sources. While astral sciences is not the only field of exploration for these questions, it certainly offer a promising start to this endeavour. For instance Astronomical practices involve a range of knowledge elements from fundamental mathematical ones like numbers or geometrical objects to more global ones like epistemological values expressed, for instance, in cosmological theories, observations, or reasoning practices. The material cultures of astronomical practices are also quite diversified. Multiple different kinds of instruments are known to be used and various different form of texts are available to us, for example: oral texts (prose or verse), numerical tables, technical diagrams, iconography, etc. Moreover, the practices of astral sciences were often socially distributed across various milieus. These ranged from highly specialized individuals working in intellectual, political or religious institutions to more modest practitioners engaged with astronomy in some specific and limited way. In this way, the field of astral sciences offers a choice of relatively well-connected historical contexts necessary to explore these issues, while at the same time, it provides a topical focus to compare various case studies in a meaningful and effective manner.

Minkowsky, Christopher (University of Oxford)
The Philosophy of Foundations and the Exact Sciences in Sanskrit

David Pingree once remarked that the exact sciences in Sanskrit – astronomy, astrology, and mathematics – were advanced by a conspicuously small number of original thinkers, who operated in an intellectual setting that was not tightly connected with other, more prestigious systems of knowledge in Sanskrit. Indeed, while Indian authors in logic and exegetical theory (Nyāya and Mīmāṃsā) the philosophical systems most concerned with what constitutes good reasons, began their texts with consideration of its foundations and with extended rationales

for the practice of their discipline, it appears that the astronomers did not feel it necessary to include a discussion of their science's philosophical basis. The methodological passages of the most intellectual astronomical texts, the siddhāntas, may identify the questions to be answered - relative positions, conjunctions, eclipses and so on. They may cover spherics and some principles of the motions of the luminaries in circles and epicycles, but they offer no justification for the science beyond making claims about utility and accuracy. The same situation obtains in the astrological compendia (saṃhitās). In the early modern period this changed. Astronomers and astrologers alike began to include just such discussions in their works. In this talk I will consider some passages in Mīmāṃsā texts. I will discuss what these passages meant for the intellectual history of the exact sciences, and the reasons for jyotiṣas' evident confidence in the legitimacy of their discipline.

Feke, Jacqueline (Université de Waterloo)

The Physics of Ptolemy's Astrology

In his astrological text, the *Tetrabiblos*, Ptolemy describes celestial bodies as transmitting their powers through the heavens and into the sublunary realm. The way they do this is by means of rays. Ptolemy nowhere states what these rays consist of, if anything, or how the stars transmit them, and yet they bring the powers of the stars into contact with one another as well as with sublunary bodies and souls. It is because the stars' rays come into contact with the elements comprising the sublunary region that the stars and their movements effect changes there, including meteorological phenomena and even the characteristics of human souls. In this paper, I will explore the nature and movements of these celestial rays by drawing on Ptolemy's physical theory as portrayed in the *Tetrabiblos* as well as his *On the Kritêrion and Hêgemonikon*, *Planetary Hypotheses*, *Optics*, and fragments from his lost *On the Elements*. I will argue that Ptolemy may have adjusted his element theory in order to maintain the consistency of the astrological theory of rays with his physics.

Husson, Matthieu (Paris Observatory)

On John of Saxony comments's to John of Lignères *Cujuslibet arcus...*: Stabilities and innovations in a (pedagogical) commentary practice

John of Lignières and John of Saxony were two important Parisian astronomers in the first half of the 14th c. The first wrote an encyclopaedic set of Canons and tables in the early 1320 (canons dated 1322, epoch dates of tables 1321) inspired from Albattani but also introducing then relatively new Alfonsine ideas in Latin. These alfonsine ideas had then a great success and progressively became dominant in Europe up until the 16th c. This success is attested also by the numerous manuscripts copies of another set of Canons to the Alfonsine tables wrote in 1327 by John of Saxony who was trained to mathematical astronomy by John of Lignères. Several manuscripts sources provide evidence of this pedagogical relationship between the two astronomers. More precisely we are going to look at the chapter on shadows of the canons of John of Lignières and at two types of comments, essentially mathematical, produced by John of Saxony on them. The first are very close to the redaction of the treatise and the second, more systematic were produced more than 10 years later. The differences in the material presentation of the comments, the content they point to in the commented text, the way they extend, precise or interrogate it, will be clues to explore how stabilities and innovations are related at a micro-level in this particular situation.

Hirose, Sho (ETH Zürich)

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Samso, Julio (Universitat de Barcelona)

Tradition and innovation in Western Islamic astronomy

Although depending on an Eastern input which arrived to al-Andalus until ca. 950, a moment in which the connection with Eastern Islam was interrupted, Andalusian astronomy became highly original in the 11th century. My talk will deal with the following topics: • A correct determination of the length of the Mediterranean, through the use of the water meridian. This took place towards the end of the 10th c., probably as a result of an observation of a lunar eclipse in Córdoba, which was compared to a computation of the same eclipse using al-Khwārizmī's zīj. • The theoretical innovations introduced by Ibn al-Zarqālluh (Azarquiel) (d. 1100): trepidation theory, motion of the solar apogee, solar model with variable eccentricity, correction to the Ptolemaic lunar model. All these innovations were introduced and developed in the Maghrib in the 13th and 14th c. • The survival of a Khwārizmian tradition which used sidereal mean motions, as opposed to another tradition of tropical astronomy, both in the Iberian Peninsula and in the Maghrib. The introduction in the Maghrib of tropical Eastern zījes from the 14th c. onwards.

S03 BETWEEN UNITIES AND DISUNITIES, CIRCULATIONS AND DISRUPTIONS: THE MOVEMENT OF MEDICAL KNOWLEDGE ACROSS TRADITIONS AND CONTEXTS IN THE EARLY MODERN WORLD

Location: IoE – Room 826 **Chair:** Brixius, Dorit

Organiser(s): Brixius, Dorit, and Kroupa, Sebestian

This session seeks to explore the movement – and the lack of it – of medical knowledge across vastly different geopolitical spaces and cultural traditions over the course of the seventeenth century. Drawing on the writings of European medical professionals stationed in Southeast Asia and on medical recipes of royal physicians in Europe, the papers in this session seek to bring together material, social, local, and global approaches to the history of medical knowledge, as well as point to the overlaps between medicine, power and politics. Encompassing the epistemic, cultural, political and economic relevance of healing and remedies, each paper explores the unities and disunities underlying the mobility of early modern medical knowledge. Rather than reiterating practices involved in its circulation and running the risk of privileging knowledge which travels over its other forms, the aim is to point to the processes which led to incompatibilities in knowledge traditions and disruptions in knowledge flows. The first two papers explore the world of island Southeast Asia. Looking at the works of the VOC agent and naturalist Georg Everhard Rumphius (1627–1702), Genie Yoo examines his understanding of 'magic' and 'superstition' in the context of Malay cosmologies of healing and supernatural power. Through a comparison of the information found in Rumphius' Kruydboek and the Malay Kitab Tibb/Kitab Obat-Obatan (Book of Medicine), she explores the scales of difference and similitude in the Dutch and Malay writings about magic and medicine. Secondly, Sebestian Kroupa focuses on the Jesuit pharmacist and missionary Georg Joseph Kamel (1661–1706) stationed in Manila, and his strategies to mobilise Philippine materia medica from the local to a European context. Drawing on Kamel's treatise of the St Ignatius bean, Kroupa will discuss how and why certain instances of the hybrid knowledge in question successfully made the move between the Philippines and Europe, while others proved inherently incongruous and were lost in translation. Looking at the role of (non-) European remedies in England and France, papers three and four present case studies revolving around the practices of court physicians, highlighting the political implications of their endeavours. Examining the work of three royal physicians, Tom Tölle investigates royalty and imperial knowledge as a source of political conflict. In so doing, he brings together imperial medical knowledge and the politicisation of healing practices at the court, which have been traditionally treated largely in isolation from one another. Lastly, Dorit Brixius explores the practices of Noël Vallant (1632–1685), who worked as a physician and secretary to prominent courtly figures in Paris and whose medical correspondence network involved the exchange of treatments, recipes, and remedies at a pan-European level. Here, Brixius discusses to what extent the needs of Vallant's patients – females in particular – shaped his medical practice and incited his search for novel knowledge and therapies, the purpose of which was not necessarily to cure but to maintain the body's vitality. In sum, this panel provides insights into factors which governed whether early modern medical knowledge travelled – or not – across different contexts and traditions.

Yoo, Genie (Princeton University)

Between Tongues: Magic and Medicine in G.E. Rumphius' Het Amboinsch Kruydboek and Malay Kitab Tibb/Kitab Obat-Obatan

Among descriptions of stems and petals, leaflets and pods, one will also find, in Rumphius' *Het Amboinsch Kruydboek* ('*The Ambonese Herbal*'), a strange account of a plant that gave the young a more 'subtle tongue'. Schoolmasters recommended it and students eagerly took it. Whether medically or magically induced, the dexterity of the tongue was believed to be a gift—in this case, a holy gift that helped Malay-speaking children pronounce Arabic correctly. Rumphius named the plant *ABC daria* and mentioned that plants like it were called *oebat moerit*, the 'scholar's drug' in Malay, by 'Moorish Papists' that populated the archipelago. The difficult link between magic, religion, and medicine in Rumphius' *Kruydboek* has yet to invite an analysis of how this European naturalist tried to negotiate cosmologies of knowledge in the East Indies with a writer's expectations of a European readership for his texts. Living on the island of Ambon from the age of 25 until his death, Georg Everhard Rumphius (1627-1702) explored, experimented, and wrote about the natural world of the Indies while working as an administrator for the United Dutch East Indies Company (VOC). Through his engagement with local Muslim practitioners of medicine, not only was he able to procure recipes of healing and perform local experiments that tested the efficacy of natural material, but he was also able to document practices he described as magical and superstitious. While this invites easy critique, I suggest that by reading Malay textual sources, variously titled *Kitab Tibb/Kitab Obat-Obatan* (Books of Medicine), alongside Rumphius' *Kruydboek*, one might get a better sense of how scales of difference and similitude—for example, between magic and medicine, the superstitious and the supernatural—came to be manifested through the process of documentation.

Kroupa, Sebestian (University of Cambridge)

Jesuit beans and vomitory nuts: Philippine materia medica on the move

When stationed in Manila at the turn of the eighteenth century, the Jesuit pharmacist and missionary Georg Joseph Kamel (1661–1706) produced extensive accounts about the Philippine flora, which were later printed in Europe. Drawing on the example of the St Ignatius bean, a medicinal plant native to the Philippines monopolised by the Jesuit order, I will explore Kamel's strategies in mobilising Philippine *materia medica* from the local to a European context. I will argue that in introducing this unfamiliar plant to his European readers and in convincing them of the credibility of his accounts, Kamel downplayed the novelty of the 'Jesuit bean'. Instead, he identified it with the *nux vomica* of the medieval Arabian physician Serapion, whose work had been adopted into European traditions of medicine centuries ago. This association endowed the plant with a clear place within European frameworks of knowledge, as well as with specific virtues: *nux vomica* means literally a 'vomitory nut'. To bolster this carefully constructed link, then, Kamel relied on his own medical practice and provided accounts of medical cases which clearly attested to the emetic qualities of the plant, asserted by Kamel. Perfectly blending erudite and empirical evidence in this fashion, he thus managed to smoothly transplant the St Ignatius bean in Europe. I will suggest that this attitude in treating Philippine medicinal plants stemmed directly from his Jesuit education which, on the one hand, was rooted in canonical texts endorsed by the Church, but on the other, fostered active and practical methods in conjunction with high esteem for utility, mundane labour and individual initiative. The latter raises the question of a distinct, Jesuit empirical culture. At the same time, I will discuss the traces of non-European traditions in Kamel's treatises of Philippine *materia medica* and highlight some instances of hybrid knowledge which, conversely, were lost in translation and failed to successfully make the move between the Philippines and Europe.

Tölle, Tom (Princeton University)

The Heir, the Empire, the Jesuit's Bark: Royal Physicians and the Politics of Imperial Knowledge in Augustan England

Early modern subjects used avenues of empire to produce medical knowledge. Healing practices became politicized wherever they concerned 'ruling' families. Historians have discussed both statements, by and large, in isolation from one another. My paper is concerned with the connection between the two. Around 1700, during a period of intense domestic conflict over imperial politics, I discuss to what extent 'empire' featured in the treatment of British royalty. I argue that the imperial origins of medical knowledge, be they real or imagined, shaped the partisan politics of royal physicians.

Bracketed off into distinct sub-disciplines, Augustan historiography does not treat royal health as a political concern. Only a slowly growing number of historians concern themselves with political implications of medical practice: despite the fact that William and Mary and also Anne and George suffered periods of unstable health, as well as that both royal couples failed to produce a single surviving heir. Historians of (party) politics saw the importance of the 'royal closet' waning. Even seminal works on Anne's household famously conceded that parliament, not the court increasingly mattered after 1688. Anne's body (and the Queen's body more generally) continue to attract scholarly attention, but cultural historians often pay little attention to those seeking to remedy royal frailty. And while works on political economy have recently challenged the centrality of domestic politics and the clear-cut party dualism, most historians have studied royalty disconnected from imperial knowledge.

This paper homes in on three royal physicians, John Radcliffe, John Arbuthnot and David Hamilton. I raise three questions: To what extent did medical knowledge become a source of political conflict in Augustan England? What advantages did the use of imperial knowledge promise royal physicians? Lastly, why should the use of medical knowledge, be it practices, material objects or texts, concern historians of European political history?

Brixius, Dorit (Institut historique allemand Paris)

The medical practices of Noël Vallant (1632–1685): Healing, superstition and the maintenance of the body

The French physician Noël Vallant (1632–1685) worked as both a physician and a secretary to some of the most prominent courtly figures in Paris (the duchess de Sablé, the duchess de Guise), who were closely connected to Jansenism and the Fronde. Looking at the noble household as a site of illness and medical care, I explore Vallant's medical correspondence network, which involved an exchange of treatments, recipes and remedies at a pan-European level (France, Italy, England). I will argue that Vallant relied on his networks for both the acquisition of knowledge and remedies, as well as discuss to what extent the duchess de Sablé and her needs in particular incited Vallant to look into new therapies and fashionable remedies, the purpose of which was not necessarily to cure but to maintain the body's vitality of (aging) women. These therapies were partly of a superstitious nature, employing namely human skull against heavy menstruation and children's blood to prolong life, but also closely connected to religion and God's grace (e.g. the balm called *manus dei*, or God's hand).

SUNDAY 16 SEPTEMBER, 09.00-10.30

R70/1 BSHS OEC PROVOCATION 1: HISTORY OF SCIENCE AND SCHOOLS

Location: SciM – Lecture Theatre **Chair:** Haines, Elizabeth

Organiser(s): BSHS Outreach and Education Committee

All over the world, science, technology, engineering, and mathematics are prioritised in education as a means to improve standards of living and to increase economic wealth. By offering social and cultural contexts to past scientific and technological discoveries, history of science can add richness to otherwise 'dry' curricula and increase students' capacity to learn STEM. However, historians of science often contest simple stories of progress, and their narratives add complexity to already pressured curricula. How is that managed in different contexts? This session will take advantage of an international meeting to invite experts to discuss how history of science is presented in secondary schools in different national education systems, and through informal settings such as museums.
This 'provocation' session complements the official conference programme, and is organised by the British Society for the History of Science Outreach and Education Committee (http://www.bshs.org.uk/outreach-and-education).

S56 UNIT AND DISUNITY OF THE MODELS OF LEARNING ENGINEERING: CASE STUDIES FROM FRANCE, PORTUGAL AND SPAIN (1808-1930)

Location: SciM – Dana Study

Chairs: Cardoso de Matos, Ana; Sampaio, Maria de Luz; and Roca-Rosell, Antoni

Organiser(s): Roca-Rosell, Antoni

This symposium dedicated to engineering education aims to present studies of four authors in three different countries: France, Portugal and Spain and to strengthen the units and links between the approaches as well as to disseminate their results. We intend to contribute to deepening the chapters of the history of engineering dedicated to analyzing the circulation of the teaching process and their impact on the production of technical and scientific knowledge. The current research allows to identifying the theoretical - practical models of this teaching engineering and aims to connect them to the needs of industrial and technological development. It should be remembered that the establishment of formal schools to provide this engineering learning is relatively recent and was adopted in late nineteenth century, after many controversies. In this symposium, we would like to gather several case studies to contribute to the debate on unity and disunity of engineering education. The comparative analysis of some cases in Portugal, Spain, and France will present the tendencies and its theoretical framework. We will analyze the international alignment and the unity between different options and models, or its disunity, given by the need of adjustment imposed by the local cultural, political and economic contexts.

Gouzévitch, Irina (Centre Maurice Halbwachs, EHESS (Paris)) and Gouzévitch, Dmitri (CERCEC, Ecole des Hautes Etudes en Sciences Sociales)

The “Model of Ecole polytechnique” and the national systems of technical education in Europe: From general reference to local peculiarities

This paper highlights the misconceptions and abusive interpretations that were developed about the “model of the Ecole Polytechnique” in connection with the rise of several national education systems. Simultaneously we will make a summary review of the international studies devoted to the Ecole Polytechnique that is indisputably associated with the history of the processes of spreading knowledge and its different interpretative and terminological connotations. Conceived on the principle of “circulation of models” it benefits the country that houses it and focuses the analysis on the choice and adaption of teaching models according to local interest. Considered from the point of view of "foreign influences", it amplifies the role of the donor-country and provides an abundant rhetoric about appropriation and foreign experiences. The use or rejection of certain terminologies varies according to the discourse intended. The comparative studies about the 'model' revealed and underlined the influences, and appropriations of the national studies. The problem worsens due to the polysemy of the terms: each researcher contributes with a particular nuance about the meaning of the «model». Some historians of the Ecole polytechnique are conscious of the difficulty of the term, and they conclude that polysemy makes the study almost impossible. This paper is a contribution to enlighten this polysemy, trying to define the semantic field that it covers and establish a hierarchy of points of views for its use.

Bettahar, Yasmina (LHSP-Archives Henri Poincaré, UMR 7117 /CNRS & Maison des Sciences de l’Homme Lorraine)

[Industrial teaching in Algeria during the French colonial period]

In this presentation, I intend to focus my approach on the implementation and the development of industrial teaching in Algeria during the French colonial period (1830-

1962). After a fast introduction of the model of technical education established by the colonial authorities, I'll try to prove (with few examples) that the institutionalization of this technical education was mostly oriented to the European populations and they were very concerned to « Indigenous » populations. This technical education doesn't really contribute to the mobility and to the circulation of the scientific knowledge and its model between the French metropolis and Algeria.

Montava, Maria (Universitat Politècnica de Catalunya)

First steps to establish Mechanical Schools in Spain

In this paper we are going to highlight the design and first's steps in the constitution of the mechanical schools in Barcelona framed in a project that enclosed all the Spanish provinces. We will expose the initiative that was carried out by a doctor from Barcelona; Francesc Santponç (1756-1821). This early project took place in the first years of XIX century with the sponsorship and approval of the Junta de Comerç of Barcelona. The Junta de Comerç was an institution that represented the interests of the commercial and industrial bourgeoisie and promoted the renewal of economic activity in Catalonia. It started up several free schools since 1769. Francesc Santponç was involved in Mechanics and was elected member of the Royal Academy of Sciences and Arts of Barcelona in 1786. By 1804, he acquired a deeper knowledge in Mechanics after designing and constructing a Steam Machine which worked a spinning factory in Barcelona. His mechanical knowledge facilitated the creation in 1808 of the Mechanical School of Barcelona, which attracted many students (artisans, young gentlemen). He drove the project with enthusiasm translating into Spanish two books for teaching mechanics and mathematics that were edited by himself. During the Peninsular War, Santponç proposed the extension of the school of Barcelona to other Spanish cities. The experience of the Barcelona School is considered as the early establishment of mechanical engineering in Spain. The aim of this paper is to go-in-depth in the Barcelona School. This work was developed within the frame of Spanish project HAR2016-75871-R.

Sampaio, Maria da Luz (Universidade Nova de Lisboa)

Engineering schools in Portugal in the first decades of the XX century: The unity and framework of their models

This paper intends to highlight the process of creation of the Faculdade Técnica do Porto, (later on Faculdade de Engenharia da Universidade do Porto) and of the Instituto Superior Técnico in Lisbon, in the period from 1911 to 1926. The study of these two engineering schools in Portugal in the twentieth century, born of the Polytechnic School created in the nineteen century, allows us to analyse its practical and theoretical framework and find the links to international models and practices. The economic and technological context boosted the reorganization of the existing model of higher education and their traditional courses, but also demands the creation of others like electrical engineering. In the core of the curriculum we found new disciplines like "Electric machines", "Construction machinery" "Reinforced concrete - Bridges". They were implemented in order to train qualified engineers, capable of answering the needs of new projects in public works and the installation of public networks of water, gas and electricity supplies that were taking its first steps in the biggest urban centres in Portugal. This comparative study between the educations provided by the two engineering schools allowed us to ascertain the unity and disunity between the different models and schools.

R62 PAPER INSTRUMENTS AS TOOLS OF UNIFICATION IN EARLY MODERN PRACTICAL MATHEMATICS

Location: SciM - Dana Study **Chair:** Kremer, Richard L.

Participants: Axworthy, Angela (Technische Universität Berlin)
Gaida, Margaret (University of Oklahoma)
Jardine, Boris (University of Cambridge)
Tracey, Kevin (Swansea University / Science Museum)

Proof of the interconnectedness of early modern mathematical practice and its consumers, paper instruments belong to a vibrant continuum unifying expert and amateur, producer, user, and product. The design and construction of such instruments were natural facets of many mathematicians' careers, and of many users' introductions to – and appreciations of – the mathematical sciences. Companion artefacts to the externalised practice of 'doing' mathematics, they were found in print and in manuscript, in the leaves and fold-outs of texts and notebooks. These material constructions point to recognizable sites of mathematical practice with shared disciplinary methods and techniques, in which engravers, instrument makers, and printers, as well as cartographers, astronomers, and surveyors, all interacted. Paper instruments were emblematic of early modern mathematics, and studying their production and use is therefore a means to more successfully unite the theory, pedagogy and practice of disciplines such as astronomy, navigation, dialling (or time finding) and cosmography in the period. Despite a pronounced and vibrant interest in the 'visual' culture of early modern science, an appropriate characterization of mathematical instruments – and, in Jim Bennett's term, a suitable awareness of what they were for – remains fertile ground for enquiry. To this can be added a consideration of instruments' accompanying texts as hybrid objects, particularly when in the hands of a user: objects which are not simply textual presentations, but instead material artefacts in which is found evidence of intention, interpretation, and of use. At the same time, the practices of modern collecting institutions have seen instruments and texts on or containing instruments divorced, both intentionally and otherwise. This has in part contributed to difficulties in methodological practice in the history of science, with a number of recent studies calling for unified modes of study that more appropriately reflect how these material objects existed and operated in tandem. By attending specifically to the users of these hybrid artefacts, a truer history of instruments in print and practice - and the interconnectedness of their theorists, practitioners, makers, and amateurs - can come to light. By considering the methodological and disciplinary problems and opportunities presented by the study of paper instruments, this roundtable will move from a consideration of the apparatus (visual, textual, and instrumental) used by mathematical authors to users' experiences of their finished material products. By redirecting the focus from the figure of the 'mathematical practitioner' toward the users of the instruments themselves, it will discuss ways to shed more light on the manipulation of mathematical instruments and texts by such audiences, whether hobbyist, amateur, or professional. We will consider how paper instruments helped to unite the mathematical elements of disciplines including navigation and time-finding in new studies such as cosmography, and will question the role of such instruments in driving the structures of practical and theoretical knowledge. Tracing early modern artefacts to their modern day collections will allow for a discussion on the methodological issues of the definition and historiography of scientific instruments, their use, and their subsequent collection.

I109 MATERIAL CULTURES OF MEDICINE

Location: SciM - Dana Studio **Chair:** TBA

Avelãs Nunes, José Carlos (CIUHCT - Interuniversity Center for the History of Science and Technology, Faculty of Sciences, University of Lisbon)
An [white] elephant in the room: entanglements between medicine, politics, architecture and expertise in the Great Sanatorium of Lisbon, 1936-1946

At the turn of the 20th century, following new medical developments, tuberculosis could be fought on a global scale, catering renewed attention of experts. By the 1930s, medical and architectural paradigms for tuberculosis shifted, giving way to radically new plans for sanatoria conceived within innovative political agendas. In Portugal, during the 1933-dictatorship, the vision of the minister of Public Works (Duarte Pacheco) and the empowerment of the private National Assistance for Tuberculosis (Lopo de Carvalho) were behind the project by the architect Vasco Regaleira of the construction of the Great Sanatorium (1936-1946) in the Portuguese capital - Lisbon - prone to high rates of tuberculosis. This sanatorium was an imposing building of unprecedented scale and morphology. Its various plans were developed following scientific travels to international reference sanatoria by a special committee composed of physicians, architects and engineers, and directly sponsored by Salazar's government. Various reasons account for dictatorship new commitment in the fight for tuberculosis, not restricting the appropriation by the Portuguese dictatorial regime of the Modern Movement of architecture. A plurality of motives, culminating with the development of proficient chemotherapy at the end of the 1940s, which overcame the confinement imperative and implied a drastic change in the public image of sanatoria, account for the non-materialization of the project. This failure enables one to discuss how the confluence of continuities and discontinuities, uniting or disuniting current options vis-à-vis past medical,political, architectural and urban choices became emblematic of this "elephant in the room" meant to control the white plague.

Nott, John (Maastricht University)
Technology and the teaching hospital: objects, concepts and curricula in Ghanaian medical education, c. 1923-2018

Established in 1996 in order to address the dearth of medical education in Ghana’s northern savannah, the University of Development Studies (UDS) hosts an innovative medical school curriculum developed in conjunction with Maastricht University. Such international collaborations must, however, be considered in view of the history of European involvement in African medical education. By offering a broadly defined and ethnographically informed history of teaching technologies at UDS this research will provide insight into the assumptions of universality which underpin an internationalized medical education – itself an under-investigated medical technology – as well as its translation into an African context. Drawing on historical and ethnographic study at UDS, this paper explores how pedagogical technologies – both material and conceptual – have traveled to northern Ghana. Rarely produced with a mind to students in the Global South, material technologies found in African medical schools are imbued with assumptions relating to the presentation of disease, to cultural preconceptions of health, to environment and to infrastructure. However, STS scholars have shown that a technology’s inscription does not equate to its use (e.g. Akrich 1992; de Laet & Mol 2000). The process of technological translation is further complicated by abstract technologies of ethnicity and language which collude to skew medical knowledge toward national and international standards. Using concepts borrowed from STS as well as medical anthropology, this paper intends to explore the histories of disunity which are implicit within an ostensibly universalistic but ultimately postcolonial systems of medical education.

Tybjerg, Karin (Medical Museion, University of Copenhagen)
Surgical instruments and scientific instruments

Surgical instruments sit in an uneasy relation to scientific instrument and these tensions – the unities and disunities – make them a tool for casting light on ways of understanding scientific instruments and their relations to technology, collection sciences and historical instruments. Surgical instruments are like standard tools – scissors, knives – but treated in groups or collections they become scientific instruments for uncovering the body's inner working or specialized technologies for treatment. In groups the instruments are also used to create taxonomic order in surgery and used like natural history collections or ethnographic collections to exhibit resemblances and developments. Considering surgical collections reveals connections between experimental and collection sciences and the importance of viewing instrumentation in groups as well as in single entities. The paper draws on a history of the surgical collections at the Surgical Academy in Copenhagen (founded 1787) and the Medical Historical Museum (founded 1907). One collection was used to teach surgery and display surgical knowledge. The other was collected for a museum for the cultural history of medicine. The two collections evolved independently, but merged at the middle of 20th century. Following the parallel history of the two collections shows how historical instruments were employed in both teaching and public displays. Surgical instruments, which have often been excluded from accounts of scientific instruments (van Helden and Hankins, Bud and Warner), highlight how instruments often work in groups, how instruments may be used taxonomically and how historical instruments play important roles in teaching.

Guarrasi, Ivana (University of California, San Diego)

Hybrid Instruments and Non-medical Excess in Patient Simulations

This paper examines contemporary standardized patient simulations as hybrid instruments of medical training. Medical educators use "standardized patients" to train patient interaction in simulation laboratories. The term standardized patient refers to a live performer in a clinical simulation who portrays a patient with a disease for training purposes of medical students. Using feminist epistemology in science and technology studies and medical humanities, the analysis engages with the qualities of human patient models that are perceived as necessary to negotiate lifelike medical simulation that is acceptable as a rigorous medical training. I propose that the lifelike qualities of patient simulations generate the sense of human that exceeds the narrowly defined understanding of the patient body as an object of biomedical gaze. In doing so, I analyze a comparative case of using Florentine wax models in the eighteenth-century medical training in Vienna. I consider both types of patient models as hybrid instruments of medical training. Building on these presumed - or collapsed - boundaries between subjects and objects in patient simulation, I draw attention to the function of corporeal non-medical excess. I call non-medical excess the proliferation of cultural meanings in patient simulation that extends beyond its intended instructional function. This historical case suggests that patient simulation as a tool of medical training puts the authority and credibility of the physician's profession at stake. This paper considers the ways in which cultural configurations become meaningful for the acceptance of patient simulation as a legitimate instrument of medical training.

R17 POPULAR SCIENCE IN FRANCO'S SPAIN

Location: IoE – Room 802

Chair and Commentator: Nieto-Galan, Agustí (Universitat Autònoma de Barcelona)

Participants: Florensa, Clara (Universitat Autònoma de Barcelona)
Gorostiza, Santiago (Universitat Autònoma de Barcelona)
Carandell Baruzzi, Miquel (Independent Scholar)
Gil-Farrero, Judit (Universitat Autònoma de Barcelona)
Ferran Boleda, Jordi (Independent Scholar)

Although, in the last decades, the historiography of popular science/science popularization has significantly evolved from the "deficit model" legacy to "knowledge in transit" and the "participatory turn" (Secord 2004, Bucchi, Neresini 2007, Topham 2009, Nieto-Galan 2016), not much is known about the role of popular science in 20th-century Western societies (Bowler 2009, Schirrmacher 2013), and even less about the role of science popularization in dictatorial regimes, in the "age of extremes" – as historian Eric Hobsbawm defined the century-. Since non-democratic, dictatorial regimes have a very weak "public sphere", often submitted to strict government control and censorship, the audiences' epistemological role remains highly problematic. To what extend did readers, visitors, patients, users, and consumers, among other audiences, shape science in that kind of top-down, vertical and hierarchical political contexts? Was there "knowledge in transit", if any, under a strict social control and repression? Was popular science/science popularization a tool for the legitimation of a dictatorship? This round table will try to answer these questions through the analysis of several cases studies in Francoist Spain (1939-1975) (Riquer, 2010). The regime resulted from the fascist victory in the Spanish Civil War (1936-39), and lasted up to the 1970s (Preston 1995), in a country, in which, after years of totalitarian rule – 1940s and 1950s-, the introduction of economic liberalism – from the 1960s onwards- was fully incompatible with political freedom in the public sphere. Papers on environmental controversies (Santiago Gorostiza), national parks (Judit Gil), Darwinism (Clara Florensa), popular astronomy (Pedro Ruiz-Castell), science on the air (Jordi Ferran), the public image of the chemical industry (Agustí Nieto-Galan), among other examples, will contribute to build up a stronger interpretative framework on how and why did popular science circulate in that dictatorial regime.

I135 PHYSICS 2

Location: IoE – Room 804 **Chair:** Reed, Peter

Mitchell, Daniel Jon (RWTH Aachen)
Concepts of Virtual Entities in the Bohr-Kramers-Slater Interpretation of Quantum Theory

Historians have reached the consensus that the Bohr-Kramers-Slater ("BKS") interpretation of (the "old") quantum theory offered a diversion from the main theoretical route to matrix mechanics. On a conceptual level, however, the virtual entities invoked in BKS remain the subject of divergent interpretations, in particular (a) whether virtual oscillators provide the basis for an alternative model to the state-transition picture of the atom, or merely serve an interpretive function dependent upon this picture; and (b) whether virtual radiation is ontologically distinct from classical electromagnetic radiation, and, related to this, whether it transmits energy and momentum. No single work handles both these issues accurately. They are resolved here by adopting a historiography that is consistent with a conception of BKS as a research program based upon a reinterpretation of Bohr's postulates of quantum theory, and which draws upon recent scholarship on the correspondence principle and dispersion theory. In particular, the development of the concept of the virtual oscillator is given a historical structure consonant with a Kuhnian analysis of scientific discovery. The findings lead to a stress upon continuity over "crisis," at least insofar as Bohr and Kramers perceived the BKS research program. Finally, suggestions are made for the study of the conceptual origins—–and by implication the interpretation—–of other virtual entities in physics.

Okuda, Kenzo (Independent Scholar)
UK and US Atomic Energy Strategy towards Japan and British Psychological Warfare in the 1940's-1950's

During World War II, the US and the UK closely cooperated in developing atomic bombs, and after the war, the both countries continued their developments. In 1948, Britain established the Information Research Department (IRD) as a part of its political warfare. Its first objective was "to use international propaganda to fight against the Soviet Union and Communism." The UK's policies and actions, however, were limited in the US occupied Japan. In 1953 when the US President Dwight Eisenhower came to power after Japan became independent, British Prime Minister Winston Churchill reviewed the IRD's political warfare and concluded that the UK needed to cooperate with the US on psychological warfare. Accordingly the UK developed policies that emphasized overt propaganda using BBC service to penetrate the Iron Curtain in cooperation with the US. It expanded this political warfare also to Japan. In May, 1955, Japan invited "the Atomic Energy Peace Mission" from the US. However, after that, it greatly changed its policy of the introduction of atomic energy because the US was behind in substantial nuclear energy development. The UK promoted the introduction of nuclear reactors while being conscious of the US. It allowed a Calder Hall type reactor to be adopted in Japan. This was the first commercial nuclear reactor in the Japan. Britain was able to do this thanks to its mutual understanding with the US regarding nuclear energy that began before the war and continued after the war with psychological warfare.

Panoutsopoulos, Grigoris, and Arabatzis, Theodore (National and Kapodistrian University of Athens)
The (Dis-)unity of CERN

In this paper we will employ Ian Hacking's insight that "unity" has a double meaning, singleness and harmonious integration, to revisit the recent history of CERN. CERN is an extremely complex institution, where diverse groups (experimentalists, theorists, engineers, and technicians) are called upon to cooperate. This lack of singleness confers upon CERN a diverse dynamics of multiple goals, perspectives and ideas. Nevertheless, if this diversity were not counterbalanced by specific mechanisms of integration (particular hierarchies, shared modes of

communication, cohesive publication policies, uniform research policies, etc.), CERN could not retain its standing as a unified organization and would deteriorate into a formless sum of diverse groups. This case study will reconstruct a major CERN episode that highlights this tension between unity and disunity: the UA1 and UA2 experiments in the early 1980s, which led to the discovery of the W and Z bosons. The UA2 experiment was designed and carried out in order to confirm the validity of the results obtained by UA1. Both experimental teams, working independently and with different mentalities, built separate detectors and refrained from systematically sharing their data. This gave rise to strong antagonisms and diametrically opposed opinions over what conclusions could legitimately be drawn from the resulting data. Our analysis will focus on the mechanisms which compensated for this disunity and eventually led to a unified consensus between UA1 and UA2. We thus aim at understanding how the competition between the two experiments reinforced the credibility and robustness of the experimental process as a whole.

Romano, Luigi (University of Bari, Italy)

Unity and disunity in Foundations of Relativity Theory: Franco Selleri's 'Weak Relativity'

Franco Selleri (1936-2013) played an important role in the modern research of Foundations of Physics. After his research in Particle Physics and Foundations of Quantum Mechanics, Franco Selleri showed an increasing interests in Relativity Theory since 1990. He built an alternative theory to the Special Relativity Theory, the Weak Relativity, based on the so-called Inertial Transformations, a generalization of Lorentz Transformations. He always showed a 360° wide angle sight, combining his meaningful sight to history and philosophy of physics, with his deep theoretical research on physics. He always searched for unity between theory and experiments as, for instance, in his intervention to PIRT VII, September 2000, concerning Relativity-the experimental situation. In his last work, whose title is The Weak Relativity, after explaining his whole theoretical work, he introduces several practical application as, for instance, clocks synchronization, time on rotating platform, Sagnac effect, absolute simultaneity, and so on, that could have in his thought a better explanation with the inertial transformations than with Relativity Theory. In the present work I am going to introduce very briefly Franco Selleri, his contribution to critical studies on Special Relativity Theory and the eight practical application he made. Eventually I am going to introduce well a peculiar application field of his theoretical results, the explanation of the Sagnac Effect.

Laguens, Florian (Panthéon-Sorbonne University)

Unity and Relativity. Unification and friction about spacetime

Dès la publication de la version finale de la relativité générale, l'espace-temps courbe à quatre dimensions posé par Einstein fit l'objet de vifs débats. S'il a unifié deux concepts jusqu'alors considérés comme indépendants, l'espace et le temps, il a provoqué une série de dissensions parmi les physiciens. On se concentrera – en invoquant notamment des archives inédites – sur les discussions au sein de la communauté britannique, qui ont opposé par exemple A. S. Eddington, J. Jeans, O. Lodge ou encore E. A. Milne. Einstein lui-même a remarqué que l'espace-temps n'allait pas sans susciter un « frisson mystique ». Il est vrai que sa théorie heurte l'intuition et bouleverse un usage hérité de Newton. La fameuse éclipse de 1919 a largement contribué à élever la théorie d'Einstein au rang de nouveau paradigme. Si les rayons lumineux sont déviés en passant près du Soleil, c'est en vertu de la courbure de l'espace-temps. Il faut donc dire que ce dernier est capable d'agir sur la lumière. Est-ce à dire qu'il existe ? Au carrefour de la relativité générale et de l'expérience, le débat autour de l'espace-temps se cristallise donc autour d'une question : s'agit-il d'un simple artifice mathématique permettant de « sauver les phénomènes » ou bien faut-il affirmer que le monde est réellement un espace-temps courbé ? Si Einstein a unifié le réel, il a divisé les physiciens britanniques.

S23 SYMBOLIC LANGUAGE IN THE ALGEBRAIZATION OF MATHEMATICS (16TH – 18TH CENTURIES)

Location: IoE – Room 822 **Chairs:** Massa-Esteve, M. Rosa, and Serfati, Michel

Organiser(s): Massa-Esteve, M. Rosa, and Serfati, Michel

This research on the symbolic language is framed within the context of a more extensive investigation concerning the transformations of mathematics and natural philosophy and their relationship from the sixteenth century to the eighteenth century. The publication in 1591 of In artem analyticen isagoge by François Viète (1540–1603) constituted an important step forward in the development of algebra. As his work came to prominence and spread at the seventeenth century, other authors also began to consider the utility of symbolic language and algebraic procedures for solving all kinds of problems, and mathematics, to a very considerable degree, became algebraized. After Viète, the two major stages were completed by Descartes (1596-1650) and Leibniz (1646-1716). Indeed, Descartes' Géométrie of 1637 marked the breaking point with the writing of mathematics in natural language. It served during the XVIIth century as the model for deciphering new symbolic texts (according to the so-called "principle of the Rosetta Stone"). It is the first historical text directly readable by mathematicians and scientists today. Leibniz then theorized this practice. This process of algebraization allowed and promoted the invention of what is now called analytic geometry (via Descartes) and the development of infinitesimal calculus (via Leibniz). One aspect that we have to consider is the unity and disunity in the establishment of specious logistics as a new language in mathematics that was fundamental to this process. In this perspective, Leibniz has developed a philosophical doctrine of harmony, that is to say, unity in diversity. Therefore, we would like to analyze the significance of the symbolic language in this process of algebraization of Mathematics. Relevant research questions include: Could the manipulation of this new language be considered an art or a procedure? Moreover, was it a useful means of obtaining new results or only a different way to arrive at known results? In some cases, it is possible that symbolic language was only a way of expressing ideas that already existed? Nevertheless some authors thought that this language was useful to clarify the understanding of these ideas. We wish to discuss the evolution of symbolic language considering these aspects. In order to do this, we will show and compare the representation they used for unknowns, the way they operated with numbers that were expressed by letters, the way they solved equations, the organization of the mathematical calculation (and hence of thought) according to a tree structure, and how the different symbolic representations contribute to development of mathematical reasoning and invention. The symbolic notation is not a transcription in signs - nor a form of shorthand - of the natural language. This issue is a key element in the philosophy of language.

Serfati, Michel (Université Paris Diderot)
The constitution of mathematical symbolic language. A philosophical study

Communication between scientists today is undoubtedly made through mathematical symbolism. Symbolic writing is actually a new language, and has become a practice that is both specific and universal, regardless of the part of the world that it concerns (i.e., it is not limited to Europe). In this lecture, I will briefly describe - within the frame of my previous works on the symbolism — what I have called the "symbolic revolution"; that is, the historical passage, from the writing of mathematics in natural language to the new mathematical symbolic language.

This was done in the XVIth and XVIIth centuries with Viète, Descartes and Leibniz as its main protagonists. The final organization of symbolic representation involved six patterns, which I will briefly describe, with an emphasis on what I have called the "dialectic of indeterminacy", that is the representation of 'arbitrary but fixed' numbers (introduced by Viète). If I have time, I will also briefly comment on the (very important) practice of substitution in the symbolic language, which is carried out in a radically different way from its production in the natural language.

Romero Vallhonesta, Fàtima (Universitat Politècnica de Catalunya)
Symbolism and Algebraic Thought in Early Spanish Algebraic Treatises

In 1552, the *Libro Primero de Arithmetica Algebratica* by Marco Aurel was printed in Valencia. This was one of the books that contributed to the introduction of algebraic procedures in the Iberian Peninsula. The work of Aurel is divided into two parts; the first is about arithmetic and the second, about algebra. This form was to be followed by Juan Pérez de Moya in his Arithmetica Practica y Speculativa (1562) and by Antic Roca in his Arithmetica (1564). Despite their differences, these three works have many aspects in common, not only regarding the structure but also the specific content. All share the idea of algebra and emphasize the relevance of continued proportion in the algebraic procedures. The continued proportion reveals the relationship between the unknowns, which the symbolism used in these works does not express. Symbolism is crucial in the process of algebraization of mathematics, but symbolism and algebraic thought do not necessarily go hand in hand.In this communication, we analyse some passages of these works and of other works of the second half of 16th century written in Spanish. This analysis allows us to discern if symbolism only has the role of shortening some rhetorical expressions, or if they led to the creation of new objects. These new objects will enable new results to be obtained as well as contributing to transform mathematical reasoning.

Mellado, Antonio (University of Murcia)
The Role of Hérigone's Symbolic Language in the Numerical Resolution of Equations

From the end of the 16th century, the use in mathematical procedures of a new symbolic language was gradually replacing the predominantly rhetorical used until then. Two works historically mark the crucial moments of this process, so-called algebraization of mathematics: "In artem analyticen isagoge" (Viète, 1591) and "La Géométrie" (Descartes, 1637). Between these two works, Pierre Hérigone (1580-1643) wrote a mathematical course divided into six volumes, the first four of them published in 1634, the fifth one in 1637 and the sixth volume in 1642, entitled "Cours mathématique, démontré d'une nouvelle, brieve et claire méthode, par notes réelles et universelles, qui peuvent être entendues facilement sans l'usage d'aucune langue". One of the goals fixed by Hérigone was the introduction of a method of demonstration by employing a new symbolic language applicable both pure and mixed mathematics. Hérigone spread Viète's work in his mathematical course with his new symbolic language, which allowed him to express ideas and mathematical procedures with more clarity and brevity, as well as generalize results and get new proofs. The study of Hérigone's work is relevant in relation to the process of algebraization. We present a general account about the features of Hérigone's symbolic language and we compare it with the one used by Viète. In this contribution our aim is to analyze Hérigone's numerical resolution of equations showing its advantages with respect to Viète's procedure appeared in "De numerosa potestatum" (1600).

Massa-Esteve, M. Rosa (Universitat Politècnica de Catalunya)
Symbolic Language in Mengoli's *Geometriae Speciosae Elementa*

The publication in 1591of *In artem analyticen isagoge* by François Viète (1540–1603) constituted an important step forward in the development of a symbolic language. Viète used symbols to represent both known and unknown quantities and was thus able to investigate equations in a completely general form. As his work came to prominence at the beginning of the

17th century, other authors, like Pietro Mengoli (1626/7–1686), also began to consider the utility of algebraic procedures for solving all kind of problems. Mengoli followed the algebraic research of Viète in order to construct geometry of species that allowed him to use algebra in geometry through the study of infinite procedures of computation. In this communication we focus on the specific role of symbolic language in Mengoli's *Geometriae Speciosae Elementa*. Mengoli considered his algebra as a technique in which symbols are used to represent not just numbers but also values of any abstract magnitudes. He dealt with new mathematical objects, new procedures, species, and summations of powers, forms, triangular tables, quasi ratios and logarithmic ratios. However, the most innovative aspect of his work was his use of letters to work directly with the algebraic expression of the geometric figure. This allowed him to study geometric figures via their algebraic expressions and at the same time through triangular tables and interpolated triangular tables to derive known and unknown values for the areas of a large class of geometric figures.

Martinez, Domingo (Universidad de Murcia)

The use of symbolic language in the treatment of infinity in the Algebra by Benito Baïls (1731-1797)

In 1779, the Spanish mathematician Benito Baïls (1731-1797), born in Sant Adrià de Besós (Barcelona), published the first three volumes of his mathematical course Elementos de Matemáticas (Elements of Mathematics). This work was composed of 11 volumes, the first three of which were dedicated to Pure Mathematics. Baïls had studied mathematics at the University of Toulouse and later moved to Paris where he collaborated with D'Alembert (1717-1783). This collaboration allowed him to introduce in his course the current contents of the European mathematical thought of the time, becoming a text of reference in the military Academies and civil Institutions. In fact, the text of Bails was reissued in Spain and South America until well into the next century. In the volume dedicated to Algebra, Baïls considered this subject as the most portentous discovery of mathematics, and perhaps the most fundamental, although he pointed out, for example, the difficulty of managing, defining and representing the concept of infinity or the concept of non-existent numbers and imaginary. Our aim in this communication is to analyze how Bails, with a clear didactic intention and following, the Englishman Emerson (1701-1782) and the Frenchman D'Alembert, used the symbolic language and the non-symbolic language closely related to a geometric vision. We will show how he tried to define and explain clearly the abstract concept of mathematical infinity, differentiating it from the ambiguous concept of metaphysical infinity of the time.

S04/1 INTERPRETING ANCIENT EGYPT: THE ONE AND THE MANY

Location: IoE – Committee Room 1 **Chair:** Navratilova, Hana

Organiser(s): Navratilova, Hana; Bednarski, Andrew; Dodson, Aidan; and Lewis, Clare

Commentator: Gold, Meira (University of Cambridge)

The study of ancient Egypt embraces a wide range of academic disciplines, from archaeology and historical scholarship, through a multiplicity of 'scientific' approaches, from anthropology to zoology, straddling the humanities and sciences divide. As with other humanities and scientific disciplines, modern social and political attitudes and opinions have impacted on Egyptology, affecting how ancient Egypt has been interpreted over time. In recognition of the resulting fluctuations in the theoretical principles underlying the practice of the discipline, there has been a growing trend in international Egyptology to reflect more rigorously on its own history, which has exposed both continuities as well as discontinuities of practice. The historiography of Egyptology is thus a multifaceted endeavour, embracing research paradigms concerned with an ancient civilization, and their subsequent application of knowledge in modern contexts. Egyptology has addressed its own conceptualization and practices since at least the beginning of the twentieth century, including reflection – or the lack thereof – on sociological and political perspectives. Studies have both diversified and intensified over the past two decades, with a more conscious appreciation of Egyptology as fundamentally interdisciplinary endeavour, with established geographical, chronological, and cultural boundaries. The time-boundaries embrace the period from pre-history to the Islamic conquest, the geographical ones the Nile-valley and surrounding areas. Cultural boundaries are set wide, encapsulating all those which have impinged on this chronological-geographical area, but in particular on users of the ancient Egyptian language, both in its hieroglyphic form, and in its final Coptic incarnation. Egyptological historiography benefits from histories of other disciplines; vice versa, it complements other disciplinary historiographies, as well as broader intellectual and cultural history. For example, colonial and postcolonial studies have highlighted aspects of Western (or European) interest in the ancient and modern history of the colonised regions that were a result, as well as a tool, of national competition and control, which extended into the realms of local memory and history. The productive element of thinking along these lines is obvious: a widening of the scope of the history of science induces a research reflexivity that sensitises practitioners of archaeology and Oriental studies to the context of their activities, and the formation of their practices. However, the approach may be also be developed in a reductionist mode, explaining the production of knowledge predominantly in terms of politics, power and control, offering a rather selective intellectual history. In a mostly sensible attempt to de-mythologise the history of Egyptology, complexities, constraints, as well as individual agency of researchers may be lost, and new 'myths' created by over-application of theoretical approaches. A diversified methodology might be more productive, including the adoption of a global concept of the history of science that emphasizes a hybrid production of knowledge. The symposium intends to address the position of Egyptology among histories of humanities and sciences, and the diversity of approaches to Egyptological historiography. Fundamentally, the panel seeks to probe the permanence and disruption of interpretive frameworks and their social and political situatedness, to develop and inform a wider understanding of Egyptological historiography.

Gertzen, Thomas (Selma Stern Zentrum, Berlin)

"Germanic" Egyptology? – Scholarship and politics as resources for each other and their alleged binary relationship

The interdependency of scholarship and politics is a striking characteristic of German academia. The humanities as well as science benefited from state funding from the wars of liberation and the reforms of Wilhelm von Humboldt onwards. Research was expected to further national goals, culminating in the "mobilisation" of science during the two world wars.
German humanities in particular upheld the concept of "*Freiheit* [= freedom] *der Wissenschaft*". The alleged "purity" of research lead to positivism and to self-sufficiency, especially of "*Orchideenfächer*" (= exotic disciplines). To justify continuing public support German Egyptologists created the concept of their discipline as a means to achieve "*Weltgeltung*" (= international standing). National rivalries (mostly with France) and reciprocal effects of national decline (after the loss of World War I) were the immediate consequences.
In the 1920s Egyptologists therefore tried to re-model their discipline as "*völkisch*" (= folkish), shifting the focus of their research from (positivist) philology to (racial) anthropology. Remarkably, this did not lead the National Socialists to view the "Semitic discipline" positively perhaps because some of its foremost representatives were of Jewish descent. Consequently, others underwrote the concept of Egyptology as a "national" discipline as a source of international prestige, which was still effective at least until the earlier phases of East-German Socialism.
This presentation analyses the interdependence of scholarship and politics as complimentary resources (MITCHELL ASH). It will also address the observation of British historians that in the historiography of German Egyptology, research and politics appear as "two stable worlds" or "binary" system.

Omar, Amr, and Haikal, Fayza (both American University in Cairo)

Egyptian Egyptology: The Founding Institutions

The modern history of Egyptian Egyptology has been deeply impacted by two major events in the Twentieth Century: The opening of the Higher School for Egyptian Archaeology in 1923 and the appointment of the first Egyptian Director of the *Antiquities Service* in 1953. The School, which developed in what became later Cairo University, offered perpetual courses in Egyptology for the first time, after all previous efforts to open an Egyptology school in Egypt since 1869 failed. Graduates of this University and its preceding schools taught and trained young Egyptian students with the academic knowledge, professional experience and technical skills necessary to develop a career in the *Antiquities Service* or in academia. Many among them were internationally recognized and respected because of their publications and excavations they conducted in several sites within Egypt and Nubia. They founded new Egyptology and archaeology departments in Egypt and the Arab world, in addition to teaching and conducting research projects in several European Universities as well. This presentation seeks to demonstrate how the vivid spectrum of programs at both the undergraduate and graduate levels, which Cairo University regularly renewed and adapted to new needs for the proper formations of future Egyptologists, has been making Cairo University Egypt's primary research, teaching and learning center in Egyptian Egyptology.
The appointment of Dr. Moustafa Amer, Director-General of the *Antiquities Service* in 1953 marked a major turning point for this institution, and transformed it into one large organization, managing Egyptian archaeological heritage from Prehistory down to the 19th Century, including Islamic & Coptic Archaeology. This presentation will also give a comprehensive survey of the development of the *Antiquities Service* since 1954, and highlight how far this *Egyptianisation* movement gave the Egyptians the long awaited opportunity to actively excavate, preserve and protect the heritage of their own land, with the support and collaboration of their international counterparts.

Loktionov, Alex (University of Cambridge)

A revolution in Egyptology, or an Egyptology of the Revolution? Changing perspectives on Ancient Egypt in Russia, 1880 – present

Profound change in official state ideology often drives developments in academic culture, whether through voluntary evolution or state coercion. The changing theoretical basis of Egyptology in Russia, from the late Empire to the present, provides an interesting insight into how practitioners of this field negotiated the various intellectual demands of their time. Egyptology in Imperial Russia was heavily influenced by Western European scholarship, concentrating on expanding collections and producing new translations. Research was therefore overwhelmingly focused on Egyptian 'elite' culture, which dominates the evidential record. However, Soviet rule saw theories of historical materialism and class exploitation rapidly gain influence. On the one hand, this sparked a novel interest in hitherto under-researched themes, such as 'non-elite' domestic life, mechanisms of administrative and judicial order, and the economic functioning of the Egyptian state. On the other hand, the reality of Soviet rule compelled researchers to interpret evidence in ways amenable to Marxism, often resulting in pre-determined conclusions or suppressed findings.
This paper looks at how Egyptological knowledge has been constructed in Russia in view of these developments, and what this can reveal about both the creative and destructive influence of state ideology. This is achieved through several short case studies of Egyptological projects carried out in Russia before and after the onset of Soviet rule.

Bednarski, Andrew (University of Cambridge) (in absentia)
Building a Disciplinary History: the challenge of Egyptology

The past decade of work on the history of Egyptology has made one thing very clear: writing such a history is no mean feat. This statement is not surprising, given how painful disciplinary self-reflection can be in general, and given the complexities intrinsic in making sense of an international, interdisciplinary area of study in particular. Such an historical investigation is not helped by the lack of consensus amongst professionals on what constitutes Egyptology, how and why one should do it, and how it should be taught. Barring a few exceptions, professionals tend to shy away from even debating such things. Yet despite these factors, Egyptology remains a vibrant, relevant, and productive area of study within the humanities. This paper will explore current and past definitions of Egyptology in an attempt to address challenges now facing the discipline. Such an exploration is central to understanding the motivations that drove, and continue to drive, figures and events that have created, and continue to create, knowledge of mankind's shared, ancient past. In the face of upheavals affecting the study of the humanities in general, such an investigation, highlighting the historic importance of the discipline and the value it continues to offer, is particularly pertinent.

Janssen, Rosalind (IoE, UCL)
Egyptology and Biblical Studies: The Role of Anglicanism

This paper explores the theological impact of global Anglicanism in cementing the interdisciplinary relationship between Egyptology and Biblical Studies. What was it that made this particular form of Christianity so significant in the past? As far as the mother church in England is concerned, can the fact that Anglicanism is both a broad and established church help us in answering our question? In his *A History of Global Anglicanism*, Kevin Ward, while devoting some space to aspects of colonialism and racism, but ultimately plays down its Western hegemony. He even touches on the role of women. We home in to the Thirty-Nine Articles of Religion which 'are agreeable to the Word of God and may be assented unto with a good conscience by all members of the Church of England", as a methodological tool. We position them as a bridge between the Land of Israel and Ancient Egypt, using the Articles to deconstruct what is was that drove so many Victorian Anglican clergymen to take extensive voyages up the Nile. How did their theology, in the form of the Thirty-Nine Articles that they

had signed up to, impact on what they saw? How can such a theoretical approach prove useful to us as a historical method today?

S57 THE FABULOUS 1930S IN THE HISTORY OF SCIENCE AND TECHNOLOGY

Location: IoE – Committee Room 2 **Chair:** Simões, Ana

Organiser(s): Simões, Ana, and Sánchez, Antonio

The role of artisans, of various shared practices and legitimizing discourses, vernacular sources, hegemonic discourses, the historicity of concepts and practices, popular cultures, context and locality, social influences, grand narratives, are all historiographical concepts, to name just a few, which have informed currents such as historicism, social constructivism or cultural studies of science, and have impacted on the history of science and technology, from the 1980s onwards and still do presently. However, they are far from new. During the fabulous 1930s, individually or integrated in groups or schools, several scholars anticipated many of them, albeit with different trappings and with diverse purposes. Such is the case of Robert Merton, Boris Hessen, Michael Polanyi, Edgar Zilsel, Henryk Grossman, Franz Borkenau, Ludwik Fleck, Antonio Gramsci or Lewis Mumford, to name just a few. We propose to revisit this amazingly rich decade from the perspective of the history of science and technology, not just as an act of historical retrospection, but mainly as a methodological exercise which enables us to reflect on the main historiographical trends shaping presently our discipline, at the same time reassessing their theoretical limits. Many problems faced presently by historians of science (and also by philosophers of science) were tackled and discussed by them as is the case of the debates around the old dichotomy unity vs. disunity of science, putting forward impressive insights, both at the empirical and theoretical levels. Engulfed by the ravages sweeping Europe at the time, language and ideological constraints, many simply passed by unnoticed or were progressively forgotten. Presently, a fresh look at their contributions informed by today's concerns and agendas promises to offer rich vistas and a salutary exercise on disciplinary auto-reflexivity.

Sánchez, Antonio (Autonomous University of Madrid)
Rethinking early modern Europe from "the fabulous 1930s": Leonardo Olschki, Edgar Zilsel and the artisanal knowledge

The 1930s were particularly significant for the development of the history and philosophy of science and technology. This paper is based on the idea that some authors from this period introduced influences on historiographical categories of analysis that hegemonic narratives have deliberately left out of the mainstream for different reasons, whether historical, historiographical or even ideological. This is especially noticeable in the history of early modern science and in debates surrounding the "Scientific Revolution" and the origins of European scientific modernity. These categories, which often occur in the form of dichotomies (vernacular vs. Latin, craft cultures vs academic cultures, amongst other), provide a new look at both geographical spaces and epistemological communities that have traditionally and systematically been neglected. For instance, the relations between science and empire in the Iberian world, the native communities of America, Africa and the East in the constitution of a global science, amongst other, are scarcely considered in history of science studies. In short, the aim of this communication is twofold: to highlight the historiographical virtues that some of the categories of the 1930s have for the historian and the philosopher of science and technology today; and to illustrate this phenomenon through the work of two authors: Olschki and Zilsel.

Raven, Diederick (Utrecht University)
[The Problem with Zilsel's Explanation of the Emergence of Early Modern Science]

In this paper, I will take up the vexed question of the why Zilsel's detailed historiographical work on the emergence of early modern science stands in such a sharp contrast to the shallow theoretical illumination of the central social argument that drives the hybridisation process of the intellectual and artisanal resources that is central to the Zilsel thesis. I will go into the genesis of the Zilsel thesis in Zilsel's own work, and based on a close reading of his own work spell out how Zilsel argued for the theoretical plausibility of the thesis. Crucial step in my argument will be that although Zilsel is an astute philosopher, he never showed any acumen in the finer details of what a sociological explanation should amount to. To put a less finer point to it at best he was casual and hence unsophisticated in his sociological thinking. The reason is that, to put it in anachronistic terms, he subscribes full heartedly to what is known today as the orthodox consensus. The crucial flaw in the traditional Zilselian argument about the merging of brain and hand as the essential step in the emergence of modern science is that it makes science into theoretical practice. This is the inverse position of the better known but equally incorrect thesis that practice is applied science. Both are untenable positions. A brief look at Diderot's attempt to appropriate the arts in the Encyclopédie will be used to illustrate what is the fatal theoretical flaw at work here.

Olesko, Kathryn (Georgetown University)

Ludwik Fleck, Alfred Schütz, and the Social World: What They Mean for Us

The 1930s marked some of the darkest days in Central Europe, home to Alfred Schütz (1899-1959) and Ludwik Fleck (1896-1961). They probably never met or corresponded. Yet both published groundbreaking works in that decade—Schütz's *The Phenomenology of the Social World* (1932) and Fleck's *The Genesis and Development of a Scientific Fact* (1935). Decades later, after the untimely deaths of both authors, these works became powerful foundations for understanding how facts are constructed through human interaction. Although Schütz was concerned with the construction of social facts and Fleck with scientific ones, they shared similar approaches. Both examined how facts relied on the communication of intersubjective meaning; how individuals behaved and changed as they learned; and how historical contingencies impacted fact production, individual development, and group communication. This essay examines how the work of Fleck and Schütz can be used to break new ground in the history of science education. To date Fleck's importance in the history of science education has been overshadowed by Thomas Kuhn's *Structure of Scientific Revolutions* (which was probably inspired by Fleck), while Schütz's work as well as that of his successors in social constructivism (not social constructionism) like Peter Berger and Thomas Luckmann have remained nearly unnoticed. Yet both offered powerful ways of understanding how meaning is constructed through mutual engagement, a process of central importance in both teaching and learning.

Bertoldi, Nicola (University Paris 1)

The Modern Evolutionary Synthesis between positivism and materialism: which lessons from the 1930s for contemporary history and philosophy of biology?

Recent advances in developmental biology, genomics and ecology have challenged the adequacy of the Modern evolutionary synthesis (MES), which has constituted the dominant paradigm of evolutionary biology since the 1930s. A growing number of biologists, philosophers and historians have thus started to call for an "Extended evolutionary synthesis" (Pigliucci & Müller 2010). Such attempts to revise the MES raise some crucial problems: which lessons should we draw from the most recent advances in the life sciences for assessing existing historical accounts of the MES? How to combine such lessons with those that can be drawn from the historiography of science, or even the philosophy of history? This paper will focus on such questions, by assessing the historical account of the MES given by V. Betty Smocovitis (1996). Such an account sets the origins of the MES in the broader context of the "science unification program" launched by the Vienna Circle, in the light of three fundamental concepts: "system", "progress" and "materialism". This paper will evaluate the relevance of such concepts for interpreting the history of evolutionary biology in the 1930s, by drawing both from

contemporary scientific criticisms of the MES and from the way in which the question of the relations between history, materialism and knowledge has been articulated by Antonio Gramsci (1996).

Lopes, Quintino (Nova University of Lisbon)

The contribution of Portugal to the fabulous 1930s: the History and Philosophy of Science in a Europeanised Portugal

In the early 1930s the Portuguese academic community enjoyed a level of official support which enabled it to keep abreast of scientific developments and participate in international science communication networks. Support was mainly provided by the Junta de Educação Nacional (National Education Board, 1929-36). The aims of the board were to Europeanise science and pedagogy of Portugal in the 1930s. In pursuit of these aims, the board granted scholarships both at home and abroad, provided funding for research centres and promoted the dissemination of knowledge produced in Portugal. One researcher funded by the board was Delfim Santos. With a view to setting up a History and Philosophy of Science course at one of the Portuguese universities, which would prevent the type of education that identified science with the results produced, Santos obtained funding to take part in the Vienna Circle seminars. His growing disenchantment with neopositivist ideas led him to follow the teachings of Nicolai Hartmann in Berlin in 1936, where he returned after a visit to Cambridge in 1937. After producing a work entitled *The Evaluative Stance of Positivism* in 1938, he submitted it to the University of Coimbra as his PhD thesis. However, a baseless accusation of lack of originality prevented him from obtaining a doctorate and joining the teaching staff of the University of Coimbra. Despite resistance by Portuguese universities to the innovative dynamism of the National Education Board, it enabled Portuguese researchers to actively participate in "the fabulous 1930s in the History of Science and Technology".

I127 SCIENCE AND RELIGION

Location: IoE – Room 736 **Chair:** TBA

Bovolo, Carlo (University of Eastern Piedmont)
A Catholic Science: Apologetical Uses and Attitudes on the Italian Catholic periodicals (1848-1914)

My paper deals with the attitudes toward, the uses and the receptions of the science on the Italian Catholic press in the second half the the 19th Century. During the nineteenth century and particularly in the second half of the century, science started having a growing influence on Italy's society and culture, threatening the authority and the influence of the Church and of Catholicism in Italy, which was in turn already under pressure because of the slow but gradual secularization and the national unification process (1861), which led to the end of the pope's temporal power with the conquest of Rome (1870). The centrality of science in the nineteenth century, moreover, put Catholics up against the question on how to react and face modernity, which had its strength in science and in the positive method, thus safeguarding the role of the Church and orthodoxy. Hence the spreading in some sectors of the catholic movement, especially in some clerical periodicals, of the need to build a science in accordance with Revelation, with the idea of developing strategies to embrace scientific matters through a Christian perspective, to respond to the lay and positivist materialistic theories of scientists, to strengthen a Catholic public opinion also in the sciences, and to strive for a scientific dissemination harmonised with faith. The paper analyses how the science was faced and used by the clerical press, focusing in particular on three main topics: the evolution, the technological progress, and the medicine.

Mathieson, Stuart (Queen's University, Belfast)
'I do not well see how scripture and science properly understood can well come into collision': Sir George Gabriel Stokes on conflict and harmony between science and religion

The nineteenth century was a period of astonishing developments in British science. Discoveries in geology and biology drastically changed how people understood the world and their place in it. Yet some of these changes had implications for other fields, including theology. Many conservative people of faith were perturbed by the apparent discord between science and religion, which had previously been understood to operate in perfect harmony, following the natural theology tradition of William Paley. This sense of discord was seized upon by a rising class of professional scientists, such as T. H. Huxley and John Tyndall, who wished to see their disciplines professionalised and secularised. Yet not all of Britain's prominent scientists shared this approach. Three of the most prominent Victorian physicists, Lord Kelvin, James Clerk Maxwell, and Sir George Gabriel Stokes, were vocal in their belief that science and faith coexisted harmoniously. Stokes, a Cambridge professor, was president of both the Royal Society, and the anti-evolutionary Victoria Institute. As one of Victorian Britain's leading scientists of faith, Stokes was the public face of science and religion in unity. This paper examines Stokes's work as a public scientist, with the Royal Society, at the Victoria Institute, and as a lecturer on natural theology. It uses Stokes to examine the processes of professionalisation and secularisation of the sciences, harmony between science and religion, and philosophical issues of what constituted science, 'properly understood', in Victorian Britain.

Petakos, Dimitris (Independent Scholar)
Re-inventing the boundaries between natural philosophy and natural theology: The correspondence between Samuel Clarke and Joseph Butler

The aim of this paper is to examine the correspondence between Samuel Clarke and Joseph Butler, which took place between 4 November 1713 and 8 April 1714. The correspondence is of high importance, if we want to understand the intellectual processes through which Newtonian natural philosophy was appropriated in the first decades of the eighteenth century. The main

question is: What drove the two thinkers to think differently of the Newtonian natural philosophy? This correspondence took place in the multifaceted British sociopolitical context and was related with the wider discussion concerning the relationships between mathematics and natural world, theology and natural philosophy. Was this battle a symptom of the theological pluralism of the first half of the eighteenth century in England? We should examine whether the differences between thinkers mark specific ideological (religious and sociopolitical) contexts. Were Clarke's and Butler's theological commitments imprinted on the concept of absolute space and time? Clarke was deeply persuaded that the Newtonian natural philosophy was more than a proper natural-philosophical language which described the mathematical relations among the natural phenomena. It was the undisputed proof for the existence of a God of "Dominion". On the other side, Butler's theological agenda drove him to appropriate Spinoza's philosophy so as to argue, quite surprisingly, against anti-trinitarianism. Did God and nature remain the same after the mathematical developments of Newtonian natural philosophy? The intellectual boundaries between theology and philosophy began to erode. Philosophers elaborated different theological approaches, reinterpreted older ones and questioned the self-evident theological truths.

Wagner, Michał (Cardinal Stefan Wyszyński University in Warsaw)

Unity of reception of Darwinism in Polish Church - from total denial to total acceptance

The first complete Polish translation of Charles Darwin's "Origin of Species" was published in 1884. It initiated the first confrontation of Polish evolutionists with creationists, who were mainly represented by the Church. Attacks on Darwinism were so ferocious that the main promoter of evolutionary theory Bronisław Rejchman began to doubt whether this theory would ever be accepted by Poles. These fears were justified, because the Church as an institution connecting Poles when their country was under the partition, had a huge impact on public opinion. However, the Church's position on the theory of evolution changed dramatically in the second half of the twentieth century. Christian intellectuals began to make attempts to reconcile the theory of evolution with Christian dogma (mainly because of the teachings of John Paul II). But these attempts were disrupted when prof. Maciej Giertych began to popularize the views of American creationists in the years 1986-1987. The answer of the Catholic intellectual environment was unequivocal - the condemnation of creationism promoted by Giertych and defense of the theory of evolution. And so, the Polish church environment, which was attacking Darwinism in the first half of the nineteenth century, took over the role of its main advocate. In my speech, I will present how this change in the position of the Polish Church in relation to Darwin's theory took place and what were the main reasons for this evolution of opinion: from condemnation to defense.

Borgato, Maria Teresa (University of Ferrara)

Galileo and the Jesuits: divergences and convergences on free fall

The subject of this communication concerns a case of scientific rivalry between Galileo and the Jesuits which, however, brought about significant contributions to the study of free fall on the part of the Jesuits. Direct verification of Galileo's law of free fall was carried out for the first time by the Jesuit, Giambattista Riccioli, with the help of his brothers, in Bologna between 1645 and 1650. This fact is emblematic of the contradiction the Jesuits themselves were subjected to, caught between free research and fidelity to orthodoxy. The Galilean law presented different points of discussion (independence of speed from weight, difformity of motion, law of odd numbers ...) that came into conflict with the Aristotelian tradition. We will retrace some stages of this problem, which was central to the renewal of natural philosophy, and closely linked to many other physical and cosmological questions.

I116 EARLY MODERN ASTRONOMY

Location: IoE – Room 790 **Chair:** Mosley, Adam

Carolino, Luis Miguel (Lisbon University Institute (ISCTE-IUL), CIES-IUL)
The Heritage of Clavius: Unity and Dissent among Jesuit astronomers in the 1610s and 1620s

In the last edition of his famous Commentary of the Sphere (1611), Christoph Clavius alluded in a somewhat enigmatic manner to the consequences of the recent astronomical observations, which seriously undermined the notion of the solidity and immutability of heavens he held for decades. In the face of those observations carried out by Galileo and others, Clavius pleaded "since this is so, astronomers will have to see how the celestial orbs may be arranged so that the phenomena can be saved". After the death of Clavius, in 1612, Jesuit intellectuals provided different and, in some cases, contradictory answers to this plea. If Christoph Scheiner recognized that the astronomical observations urged astronomers to accept the fluidity of heavens, his confrere Christoph Tanner argued that celestial novelties did not contradict the solidity of heavens. Some years later, the Italian Jesuit Cristoforo Borri accepted both the notions of celestial fluidity and imperfection based on the same astronomical observations. This led to different planetary rearrangements. This paper examines the dispute over the astronomical legacy of Clavius, an author usually recognized to have played a crucial role in the Jesuit astronomical conservatism. By analyzing the different astronomical and cosmological theories put forward by Jesuit intellectuals in the 1610s and 1620s, it argues that there was a strong dissent among the Jesuit community which coexisted with vigorous efforts to establish doctrinal uniformity by Jesuit authorities. This led to the elaboration of particular cosmologies such as that of Giovanni Paolo Lembo, which shall be analysed here.

Débarbat, Suzanne (Observatoire de Paris)
Observatoire de Paris-Bureau des Longitudes: Union-Désunion, 1795-1877

A la création de l'Académie Royale des Sciences (première réunion officielle le 22 décembre 1666) et celle de l'Observatoire Royal (achat du terrain le 7 mars 1667), ce dernier se trouve sous la tutelle de cette académie. Le financement de ses astronomes et de leurs voyages dépend alors directement de Louis XIV et de son ministre Colbert. Cette situation va durer jusqu'à la nomination, en 1771, du troisième des Cassini par brevet de directeur général de l'Observatoire. Son fils lui succède en 1784, mais -suite à la Révolution de 1789- il abandonne ce poste et quitte l'Observatoire en 1793. A la création du Bureau des Longitudes, par la Loi du 7 Messidor an III (25 juin 1795), et le renouveau de l'Académie des sciences en octobre suivant, l'Observatoire de Paris est bientôt placé sous la tutelle collégiale de ce Bureau; le poste de directeur en titre n'est pas rétabli. Cette situation durera jusqu'au décès d'Arago, en 1853, circonstance qui sera saisie par Le Verrier pour obtenir la séparation des deux entités. Après sa mort, en 1877, l'indépendance des deux institutions sera conservée, situation qui se perpétue de nos jours. La communication se fonde sur les archives et documents de l'Observatoire de Paris et du Bureau des longitudes.

French, Linda (National Science Foundation)
John Goodricke, Edward Pigott, and their Changing Interpretation of Stellar Variability

In late 1782, John Goodricke and Edward Pigott of York began a project of observing "stars which are variable or are thought to be so" (Goodricke journal). On 12 November, Goodricke observed a sharp diminution of the brightness of the star Algol over several hours. In his report to the Royal Society, Goodricke wrote: "…I should imagine [the cause of this variation] could hardly be accounted for otherwise than either by the interposition of a large body revolving round Algol, or some kind of motion of its own, whereby its body, covered with spots or such like matter, is periodically turned towards the earth" (Goodricke 1783). Privately, in their journals, Pigott and Goodricke speculated that the "large body" might be a planet. Nearly a

century later, spectral analysis showed that Algol is, in fact, an eclipsing binary star, with a fainter star regularly transiting in front of its brighter companion. Today, observation of such transits is the technique by which most extrasolar planets have been discovered. In Goodricke and Pigott's own time, however, the "starspot" hypothesis was favored by such prominent astronomers as William Herschel and Nevil Maskelyne, the Astronomer Royal. Gradually, the two came to accept starspots rather than transits as the correct explanation for Algol as well as the other variable stars they studied during Goodricke's short lifetime. The reasons for this change are never stated explicitly; they seem to stem from both observational concerns and social pressure from prominent astronomers.

Gambaro, Ivana (Università di Genova, Italy)

Jesuit science and internal censorship in the 17th century cosmological debate

During the 17th century the Societas Jesu has been one of the religious order most engaged in pedagogical and scientific activities. However, only recently the nature and the extent of the Jesuit contributions to the scientific knowledge have been object of historical studies. Among the relevant investigations due to Jesuit astronomers or mathematicians I concentrate on the ones developed in post-Galilean period, and analyzing some of them through books, letters and other sources, the lack of a monolithic, rigid uniformity of views emerges. In fact, among mathematicians, philosophers and theologians belonging to the order, we can find a continuous tension between the necessity of adherence to the Aristotelian-Thomistic tradition and the interest to the innovative ideas developed in mechanics and/or cosmology by researchers external to the religious milieu. Besides the internal supervision achieved by the "Revisori Generali", the individual researchers were often forced to find a complex equilibrium between personal interests and innovative research on the one side, and the true doctrine on the other. I illustrate here briefly the case of C.F.M. de Chales, H. Fabri, G. B. Riccioli, G. Schott, A.Tacquet with reference to the cosmological debate.

Bienias, Barbara (Institute for the History of Science, Polish Academy of Sciences)

Edward Gresham's "Astrostereon" (1603) and the 'Copernican Paradox'

In his unpublished astrological treatise "Astrostereon, or a discourse of the falling of the planet" (1603), Edward Gresham (1565-1613) expresses hope that the heliocentric views regarding the system of the world 'which hath be[e]n hitherto paradoxall and incredible shalbe most opinionable and orthodoxall'. Gresham – a London astrologer, mathematician and almanac maker – alludes to the so-called 'Copernican paradox' which is defined in John Bullokar's "An English expositor..."(1616), though as a concept can be found in much earlier works. 'Paradoxall' – that is 'beyond the common opinion and belief' – is burdened with exclusion and periphery, and it is in itself a paradox that early modern culture seems to be centred around the notion of 'paradox'. The purpose of this paper is to situate Gresham's outlook on the 'Copernican paradox' in a broader context of what Peter G. Platt called 'the culture of paradox' and Rosalie Colie 'an epidemic of paradoxy in the Renaissance'. Gresham's views and rhetorical devices will be presented against the background of the writings of Guillaume du Bartas, Thomas Nash and Thomas Peacham – in order to investigate the aesthetic roots of the 'scientific paradox'. My aim will be to show a 'paradox' as a form of disunity of thought striving at the unity with the acceptable worldview in England in the early 17th century.

S21/1 CONTINUITY AND DISCONTINUITY OF UNIVERSITY EDUCATION AND RESEARCH ACTIVITIES OF CENTRAL EUROPEAN SCHOLARS DURING WORLD WAR II

Location: IoE – Room 784 **Chair:** Sekyrkova, Milada

Organiser(s): Jůnová Macková, Adéla; Sekyrkova, Milada; and Kokowski, Michał

Commentator: Ash, Mitchell

World War II changed and challenged generations of European researchers, and impacted on the existence of research institutions. Several occupied countries had to close their higher education institutions in 1939 (Protectorate Bohemia and Moravia, Poland), scholars lost jobs and students opportunities. One solution that maintained a research career as a viable option for scholars consisted of teams in non-university research institutions. It was a way of survival that offered work, and sustenance, even though with limited teaching opportunities, and limited publication outlets. A generation of students had to leave the universities, and their younger followers did not have a perspective – army life and factory work was an imposed solution. An alternative applied in Austria, Hungary, and Germany itself was to embark on research projects and teaching plans deemed acceptable to the regime and to war conditions. Across Nazi-controlled Europe, racial laws, army conscriptions, and enforced exile exercised a considerable influence, next to a reorientation of research programmes to contributions to the war effort. Historiography mapping and interpreting a profound war impact in occupied regions concerns both institutional histories and individual, more biographically oriented aspects. Personal histories of Central European researchers on diverse sides of the conflict included also resistance to the Nazi regime. The symposium panel is concerned with a continuity and discontinuity of research institutions, disciplines, and research interests of Central European researchers during the war. Both institutional and individual aspects have been incorporated, mapping diverse strategies and outcomes. The individual perspective also includes everyday existence, and very personal aspects of habitus, with practices and representations set in highly complex situations, such as exile, resistance, war effort, or survival in a totalitarian regime.

Simunek, Michal (Czech Academy of Sciences)
Outlines and Limitations of Nazi Science Policy Towards the Czech Scientific Community in the Protectorate of Bohemia and Moravia, 1939–1945

Nazi science policy in countries occupied by Nazi Germany varied both in its ideological premises (esp. the racial doctrine) and with respect to the level of violence and exploitation (financial, technical, and aimed against the personnel) or utilitarian pragmatism. In some cases, however, there also existed plans for incorporating and utilising the potential of local scientific communities. The aim of this contribution is to outline their development and limitations – both internal and external – using the example of the Protectorate of Bohemia and Moravia. This territory, occupied in 1939–1945, was the longest occupied part of Europe where the majority of population was non-German. At the same time, it included centres with a tradition of scientific research going back to the Habsburg monarchy. The paper will also touch upon the issue of a significant shift towards applied and departmental research.

Jůnová Macková, Adéla (Masaryk Institute and Archives of the CAS, v. v. i.)
The Oriental Languages School and the Oriental Institute during World War II

The Oriental Institute (OI) in Prague was established as a research institute and a learned society in 1922, and provided a platform for Oriental studies specialists (conceptualized broadly, from Orientalist disciplines to business studies related to the 'Orient'), based either in

the academe or outside it as independent scholars. As a research platform, the OI functioned well, however, it was not in position to provide funded research posts. Its main activities included a fellowship programme, an outreach programme, and specialist classes. The fellowship programme supported both business experts and researchers visiting 'Oriental' countries (covering a broad selection from Northern Africa to Eastern Asia), conducting fieldwork, or staying in research institutions abroad. The outreach programme covered more specialised talks for the fellows, and lectures for general public. The specialist classes included 'Oriental' language modules. The language teaching element was strengthened during WW II, as other academic institutions were either closed or found their activities severely curtailed. The Oriental Languages School secured a continuity of Oriental studies in Czechoslovakia (in terms of teaching and subsistence for the teacher generation), and primed a future generation of scholars for their subsequent work in the Czechoslovak Academy of Sciences, founded in 1952. The continuity of professional publishing was secured via a periodical, *Archív Orientální*. The OI Languages School illustrates a case study in strategies, scientific and financial possibilities and limits of Central European scholars during World War II.

Gecko, Tomáš (Masaryk Institute and Archives of the CAS, v. v. i.)

Survival, Adaptation and Opportunity. „Habitus" of three Scholars in Czech Lands in 1930s and 1940s

Proposed paper deals with the question of continuity and discontinuity of scholars´ professional careers in the Czech lands during the late 1930s and the early 1940s. Those „troubled times" of the Czech history included not only the severe economic crisis (the so-called Great Depression of 1929) but also the dissolution of Czechoslovakia in 1938/1938 and creation of Protectorate Bohemia and Moravia. Incorporation of the Czech lands into German economic and political sphere of influence in 1939 (Großraumwirtschaft) created a rather hostile environment for scholars teaching at universities as well as those concentrated around the non-university research institutions, who had to maneuver very carefully to stay clear of German occupation authorities. This research subject offers a broad range of survival and negotiation strategies (the question of adaptability, conformity and opportunity), from which the paper will select the most essential ones on the example of three highly influential scholars (such as the indologist Vincenc Lesný, the japanologist Gerolf Coudenhove-Kallergi and the archaeologist Jaroslav Böhm). Using the archival and statistical sources as well as theoretical framework of „habitus" concept of Pierre Boourdieu, the paper aims to analyze the efficiency of preferred strategies in context of broader economic, social and political changes in central Europe.

Mészáros, Andor

Relocation, Evacuation and Stability: Hungarian Universities during the World War II

The war age was a highly hectic period for the Hungarian higher education; it was present simultaneously the institutions' network expansion, the limiting of the number of students and the evacuation of the institutions and theirs students in the final period of the war. The first and second Vienna Award also affected the institutional network of the Hungarian higher education. The most significant change was the reorganization of the former second Hungarian university, the University of Kolozsvár (Cluj) following the return of Northern Transylvanian territories to Hungary. This institute has worked in Szeged in the interwar period, therefore also a new, but narrower; Szeged University of Science was created at the same time. In 1941, there were nearly 2500 students at the Kolozsvár institution, but the predominance of Budapest did not decrease in higher education at this time, and even increased until the end of the World War. This meant the stability of the higher education system in the first part of the war period. However, the number of students significantly decreased and restructured in the final period the war and the last war months were already the period of the evacuation of institutions and the mobilization of students completely rearranged and destroyed the previous system of higher education. In my paper I would like to present the history of these processes on the basis of the most typical example, the history of the Szeged/Kolozsvár University.

Oset, Željko (University of Nova Gorica)

Life trajectories of three professors of the University of Ljubljana: The impact of the Second World War on their careers

The Slovene university professors as elite national representatives was during the WW II under substantial pressure, on one they were pressured from the occupation authorities and the other hand from underground liberation movement with a communist at the helm who was expecting public support for the liberation movement. After the war, new communist regime rapidly redefined understanding of academic freedom, hence several university professors were sacked from the University and academic freedom was endangered. The paper focuses on careers and life trajectories of three university professor of University of Ljubljana: Fran Ramovš (1890-1952, slavicist, assistant professor in University of Graz – 1917-1918, a professor at the University of Ljubljana – 1919-1950, rector of the University of Ljubljana – 1934/1935, president of the Slovene Academy of Sciences and Arts – 1950-1952), Maks Samec (1881-1964, chemist, a professor at the University of Ljubljana – 1919-1945, rector of University of Ljubljana – 1935-1937, purged from the University after Second World War but later became head of the newly established Institute of Chemistry at the Slovene Academy of Sciences and Arts – 1946-1964) and Ljudmila Dolar Mantuani (1906-1988, geologist, in 1940 became Assistant Professor, and before the end of the war in 1945 emigrated to Canada where she established herself in the private sector.

S59 FROM DISUNITY TO UNITY: A LONG WAY OF WOMEN'S INTEGRATION INTO SCIENTIFIC COMMUNITY (17TH – 19TH CENTURIES)

Location: IoE – Room 784 **Chair**: TBA

Organiser(s): Baum, Elena Zaitseva (Moscow State University), and Trofimova, Violetta (Independent Scholar)

The seventeenth century was crucial for European culture in its turn to rationalism and freethinking. At that time learned women started to take active part together with learned men in the free association of intellectuals, or The Republic of Letters, existing in virtual space of communication. In this light we would like to re-evaluate women's presence in the intellectual circles of the 17th and early 18th centuries, to find new intellectual spaces or networks based on correspondence, created by female amateurs of natural sciences. While intellectual networks were the basis for the first scientific academies (e.g. Royal Society of London and French Academy of Sciences), our task is to understand women's connections with scientific academies from their foundation to their heyday in the nineteenth century. Gradual integration of women into university corporation also started in the seventeenth century (Elena Cornaro was the first woman who received Ph.D. from the University of Padua in 1678). In the Age of Enlightenment the salon became the "home" for the citizens of the Republic of Letters. It was in this intellectual space where women could get acquainted with the leading scientists of their time. Parisian salon of Madame Paulze-Lavoisier became the space for the "new chemistry" ideas in the second part of the 18th century. Women were becoming active members of various scientific circles, and their works were published in scientific journals and presented at academy meetings. Nevertheless, most of the female amateurs of sciences were not professionals; they did not have university education and degrees, although there were several exceptions. What was the percentage of female participation in such intellectual spaces in different countries in the Age of Enlightenment? Which scientific disciplines showed highest female representation? These questions, together with female admission into universities as professors (e.g. first women professors in Italian universities), are the subject of this part of the symposium. The rise of female professionalization in sciences in the late 18th and 19th centuries was connected with the new possibilities for their self-education, such as the wide spread of public lectures and journals on natural sciences, and in the second part of the 19th century with the new opportunities to enter universities. In numerous countries women received academic degrees and became equal members of scientific societies and academies. It was not just the process of women's inclusion into scientific masculine community; it was its gradual transformation under the feminist wave. We propose to estimate gender element in the development of scientific societies as specific scientific research centres and in reinforcement of their scientific potential. Such connection of female and male competencies based on partnership that took place in the nineteenth century definitely stimulated the productivity of their activities.

Martins, Ana Cristina (New University of Lisbon)
Women and archaeology in Portugal during the 19th century: a long and unknown way of integration

The historiography of archaeology in Portugal has been focused mainly in the role played by major institutions and their leading figures, mostly men. Nevertheless, and even if less than men, there were women interested in archaeology; attending conferences and libraries; visiting

museums; collecting artifacts and donating artifacts to museums; promoting temporary exhibitions; becoming members of erudite societies, both local and national; drawing artifacts to be included in special editions; teaching and guiding pupils to museums; financially supporting excavations. It is therefore our purpose to analyze and characterize women who contributed to the development and spreading of archaeological knowledge in the country during the second half of the 19th century. In order to do so, we will scrutinize the archive of the Association of Portuguese Archaeologists, founded in Lisbon in the year of 1863; cross analyze these data with the ones obtained from secondary sources, such as newspapers, journals and monographs. Only then we will understand their social, cultural and scientific nets and networks; their motivations; putative consequences of their involvement in such a recent science as archaeology; and how men evaluated their presence and probable contributions, comparing this specific reality to the ones already known from other countries.

Werner Soukup, Rudolf (University of Vienna) and Rosner, Robert (University of Chicago)

"Fräulein Doktor!" Scientific contributions of the first female chemists of the University of Vienna

In 1897, the first female students were admitted at the Faculty of Philosophy at Vienna University. The first dissertation in chemistry was approved in 1902. In the next few years only one or two women were annually enrolled, while the number of male students of chemistry fluctuated around 22. In the first year of WWI four women completed their doctorates, six in 1917, and ten in 1919. In that year the number of female students exceeded that of male colleagues. Margarete Furcht, the daughter of a Jewish stockbroker, was the first women chemist with a doctoral degree certificate in the Austro-Hungarian Empire. Her paper „Über die Veresterung von Sulfosäuren…", published in 1902 together with her academic supervisor Prof. Rudolf Wegscheider was one of the first scientific chemical publications of female authors in Austria. After her promotion Dr. Furcht was employed at the „Technologisches Gewerbemuseum". Regarding the women graduates within the next two decades only a small number worked as chemists: Rosa Stern wrote together with Fritz Feigl the first comprehesive review on spot test analysis. Rudolfine Menzel, nee Waltuch characterized together with Ernst Zerner ketoxylose. Susi Glaubach found an adequate employment at the Pharmacological Institute and Elisabeth Lant, nee Ekl became assistant at the Technische Hochschule. The main sources of the investigation were the university archives and the Shoa Names Database of Yad Vashem.

Loyson, Peter (Nelson Mandela University)

First Woman Doctorates in the World: Italy leading the way!

A study carried out in the 1970s by Maria Tonzig from the University of Bologna in Italy and other more recent research work by Logan, Frize, Guernsey and Cavazza showed that the first three women in the world who qualified with a Doctorate from a recognized University were all Italian. Elena Piscopia from Venice received her qualification in Philosophy from the University of Padua in 1678 at an elaborate ceremony attended by the cream of high society. The second lady was Laura Bassi who obtained her qualification from the University of Bologna, also in Philosophy, in 1732. She was particularly interested in physics and became the 1st Professor of Applied Physics at the University of Bologna. The third lady to qualify was Cristina Roccati from Rovigo in 1751, also from the University of Bologna with a Doctorate in Philosophy, specializing in Physics. Italy was the first country in the world to have women qualifying from a University with its highest award. This lecture will cover the lives of these brilliant Italian ladies, who broke tradition and carried the torch for women education. A time-line will also be presented showing a list of Universities across the world where a woman first qualified with its highest degree. This data will be based on a survey carried out by Tonzig in 1973 and on recent research by the author in the Archives of Padua and Bologna.

Taddia, Marco (University of Bologna)

The broken dreams of Clara Haber

Clara Immerwahr Haber (1870-1915) put dramatically an end to her life in the garden of the house where she lived with Fritz Haber, Nobel Prize 1918 for Chemistry. The event has inspired films, documentaries and novels but the fact that Clara, before marriage, was launched towards a promising scientific career is less known. She was the first German woman to achieve the PhD in Physical Chemistry on December 12, 1900. Her thesis supervisor was Richard Abegg (1869-1910) a chemist who contributed as few others to the affirmation of the theory of valence and to the octet rule. After gaining her doctorate, Clara became assistant of Abegg and wanted to pursue a scientific career. Within a couple of years she published six scientific papers both in the field of electrochemistry and photochemistry, some of them in collaboration with her thesis supervisor. The present communication will discuss not only the results of her researches but also the Clara's deep involvement in popularization of science especially among women. It's known she gave popular lectures on physics and chemistry in the household (Physik und Chemie in Haushalt) under the auspices of the Breslau Society for the Welfare of Women, helping to bring women closer to the scientific community.

Erman, Sarah (Université Paris Diderot)

Women botanists at the Jardin des Plantes and the Faculté des Sciences, 1880-1900

This contribution offers a glimpse at women in science (more specifically in the field of Botany) in the late nineteenth century, in the Muséum National d'Histoire Naturelle and at the Faculté des Sciences in Paris. The specific aims of these institutions – i.e., the expansion of the collections, teaching of students in the natural sciences, and the performace of lab-based research - led to a complex division of labour, in which women's involvement took a variety of shapes and forms. Women's participation, although part of research was given very little visibility and was also hindered by a number of laws which favored male access to subaltern position in academic hierarchies. But women slowly but firmly started joining the Société de Botanique de France, where they encountered academics from Paris and further away. In this long story of contrasted participation, women's ability to engage in university studies, to join learned societies and to entertain a network of scientific collaboration through letter-writing played an important rôle in the slow development of their careers, without ever escaping the gendered power relations at stake. The specific scientific scope of the Faculté, the Museum and the social opportunities conveyed by the Société, meant that the status of « amateurs » and « professionals » were under constant negociation, without necessarily creating opportunities for (aspiring) women scientists.

S20/2 SCIENCE AND SPIRITUALISM IN THE MODERN AGE

Location: IoE – Room 780 **Chair:** Rocha, Gustavo Rodrigues

Organiser(s): Sera-Shriar, Efram

Traditionally, scholars and an interested public have attributed the rise and growth of spiritualism over the past two centuries to the so-called nineteenth-century crisis of faith. However, when conflicts did occur within discussions regarding ghosts, spectres or psychical forces, the cruxes of the arguments often revolved around issues of evidence (or lack of it), rather than around beliefs or disbeliefs per se. The central question to emerge was: who had the burden of proof, believers or sceptics? Therefore, this panel will suggest that when studying the phenomena of spectres, spirits and psychical forces the emphasis should not be on their relation to a crisis of faith, but instead to a crisis of evidence. By asking more insistently what the methods and ideas of spirit investigators and psychical researchers were, this panel aims to develop a more rigorous understanding of how our modern conceptions of ghosts, spectres and psychical phenomena have been formed over the past two centuries. Such an approach will help to better contextualise the relationship between spirit studies, psychical research and other sciences, showing how scientific fields such as physics, psychology, anthropology and physiology have influenced spirit studies and psychical research, and how spirit studies and psychical research have influenced them.

Sommer, Andreas (Independent Scholar)
Women at the Margins: Eleanor Mildred Sidgwick, Alice Johnson, and the Society for Psychical Research

Historical scholarship on the Society for Psychical Research (SPR) has tended to focus on prominent early male representatives such as physical scientists William Crookes and Oliver Lodge, and psychologists such as Edmund Gurney and Frederic W. H. Myers. In comparison, historians of the sciences have paid little attention to the most active female workers within the early SPR at Cambridge, Eleanor Mildred Sidgwick (a mathematician, former collaborator of Lord Rayleigh's at the Cavendish Laboratory, and second Principal of Newnham College), and the embryologist and first director of the Balfour Biological Laboratory, Alice Johnson. Sketching the unusual careers of these women in conventional, as well as in heterodox science, this talk will connect to the panel theme 'crisis of evidence' by highlighting some of the responses by critics of the SPR, who dismissed its work arguing that a society encouraging female participation could not be scientific. Moreover, by restoring visibility to hitherto understudied figures who chose the pursuit of hotly disputed fields of study over comparatively low-risk scientific careers, I will address historiographical problems with traditional perspectives focused on 'great men of science' active in marginalized disciplines such as psychical research.

Kaalund, Nanna (University of Leeds)
"Ghosts Deceptive, Subjective, and Objective": John Tyndall's Investigations into Spirit Phenomena in 1855

Michael Faraday, then the Fullerian Professor of Chemistry at the Royal Institution, rejected an offer to attend a séance with Daniel Dunglas Home. Faraday was not interested in engaging further with the topic unless, he argued, the medium would "consent (and desire) to be as critical upon the matter and full of test investigation as regard to the subject as any natural philosopher is in respect of the germs of his discovery." This matter was revived in the pages of the *Pall Mall Gazette* in May 1868, with the scientific naturalist John Tyndall taking a centre stage. At the crux of the argument was the question of how can you experimentally test the claims of self-professed mediums. Home argued that it was never possible to control what

happened in the séances, given the involvement of spirits. Therefore, the experimenter should approach séances with an open mind. On the other hand Tyndall, and Faraday before him, argued that those who claimed to be mediums should let their performances be tested as the experimenter saw fit. This was not Tyndall's first engagement with spiritualism, and throughout the 1860s he was engaged with the question of how to examine and test the claims of self-professed mediums. This paper will explore Tyndall's investigations of spirit phenomena within the context of the debate regarding Faraday's investigation of Home, and its re-emergence in the Pall Mall Gazette the year after Faraday's death.

Noakes, Richard (University of Exeter)

Mechanical Objectivity versus Psychic Subjectivity: The Problems of Instrumental Evidence in Spiritualism, Psychical Research and Parapsychology

The emergence and growth of Modern Spiritualism coincided with what Lorraine Daston and Peter Galison have described as the rise of mechanical objectivity in the sciences. From the mid-nineteenth century photographic cameras, self-registering barometers and a host of other instruments were employed to produce representations of nature that were believed to be devoid of the subjectivities weakening representations arising from purely human agency. For many nineteenth century spiritualists, however, this goal of the sciences was of questionable importance in their own enterprise: soulless machines were not as effective as specially gifted human subjects (mediums) in apprehending spirits and were thought to be too expensive and complex for most spiritualists to use. However, some spiritualists regarded spirit photographs, mechanical tests of levitation, and spirit communication devices and similar approaches to be critically important in their struggles to distinguish 'objective' evidence of psychic effects from evidence of fraud and delusion. Many spiritualist arguments for the importance of instrumental evidence were developed later in the nineteenth century by psychical researchers and moreover, by parapsychologist from the 1930s onwards. This paper suggests that that while proponents of these newer approaches to psychic effects embraced instrumental evidence more vigorously than spiritualists, they doubted whether such evidence could ever replace the experiences of psychic subjects, who appeared to be connecting to a realm (the non-physical) largely transcending that to which instruments were sensitive.

Ambrosio, Chiara and Cristalli, Claudia (UCL)

Revisiting Charles S. Peirce's 'Telepathy'

'Telepathy' (1903) is one of Peirce's most enigmatic manuscripts. Often interpreted as a philosophical contribution to Peirce's theory of perception, the text has been rarely connected to the historical context in which it was produced. In 1887, the American Society for Psychical Research commissioned Peirce a report on Gurney, Myers and Podmore's Phantasms of the Living (1886). Peirce produced a scathing assessment of the authors' misapplication of probability in conducting experiments on telepathic phenomena, which led to a lively controversy with Gurney on how to interpret the existing evidence and testimony in the Proceedings of the American Society for Psychical Research. It is to this controversy that Peirce returns in 1903. We argue that Peirce's mature theory of perception in 'Telepathy' is functional to a larger epistemological and methodological aim, which places Peirce firmly into the debate around the status of empirical evidence in psychical research. In a much discussed passage, Peirce states that dreams, hallucinations and telepathic phenomena are real insofar as they are types of perceptions. Predictions about telepathic phenomena can still be 'rational', but they are 'apt to be falsified'; this is because when placed in relation with other perceptions they lead to judgements that do not pass the test of experience. In taking telepathy seriously, Peirce embarked on a project for expanding perception that ultimately functioned to reassess and expand the limits and scope of empirical science and of the scientific attitude.

S38/5 SPACES OF CIRCULATION AND COLONIAL / IMPERIAL LANDSCAPES: CRITICISMS AND CHALLENGES

Location: IoE – Room 731 **Chair:** Kury, Lorelai

Organiser(s): Silva, Matheus Alves Duarte

Discussion of processes that cross political, geographical, or cultural boundaries has increased among historians of science in the past years. Following this "global turn", the problematic of intercultural interaction has been mobilized to make sense of the construction of different forms of knowledge — geographical, natural historical, linguistic, ethnic to name but a few. According to this conception, knowledge thus circulates within circumscribed spaces that are always the result of encounters and negotiations. The rising deployment of the problematic in the past decade notwithstanding, many scholars continue to conceive the term as a synonym for diffusion, transfer, transmission, mobility, or simply fluidity, and are perplexed by its implied concession of agency to all participants in contexts of colonial or other asymmetrical power relations between social or ethnic groups. By bringing together scholars who have used the framework of circulation in their work as well as those who have reservations as to its relevance, we would like in this symposium to develop the problematic through a dialogue between these different positions in order to establish a better understanding of the prospects and methodological nature of the idea of circulation. Moreover, the intention of the symposium is to explore the implied conception of 'spaces of circulation' within which bodies of knowledge, know-hows, practices, and norms are constructed and shared, and beyond which they need again to be negotiated in order to move. Finally, the question of unity and disunity is strongly tied to all such concerns, as circulation – or, for its critics, at least movement and mobility – is in itself a main cause of all manner of mergers and splits. Participants are invited to explore the possibilities and the methodological and theoretical challenges inherent to this approach, to probe its limits, and to engage in conversation with skeptics. Albeit empires and colonial settings themselves constitute a multiplicity of deeply diverse historical entities, the symposium includes contributions which focus on the production of knowledge in this kind of political formation, both European and non-European, from circa 1500 to 1945.

Gesteira, Heloisa (Museum of Astronomy and Related Sciences, Rio de Janeiro)
[Maritime Currents, Astronomers, and Rio de Janeiro]

The position of Rio de Janeiro placed the city on the path of the maritime currents of the South Atlantic, and for this reason it was an obligatory stop for the ships going to India, both through the Magellan Strait and when going around the Cape of Good Hope. Of interest here are the reflections of Richard Drayton, when he argued that the maritime currents were important agents in the shaping of overseas networks, stimulating connections between places and individuals, initiating the flow of goods. According to Drayton, it is important to understand how "natural facts, written into the structure of the seas, shaped how the British, and not the British alone, made both knowledge and Imperial power" (Drayton, 2005:72). It should be noted that the same maritime current which shaped imperial routes allowed more autonomous connections on the part of the astronomers on board and the ones established in some specific point, as Bento Sanches D'Orta in Rio de Janeiro between 1781 and 1788. Although they were at the service of their respective states, could take advantage of the circumstances, which could sometimes result in personal advantages, but which certainly promoted a type of exchange of ideas and information that escaped imperial control. For all of these reasons, Rio de Janeiro,

where numerous ships were obliged to stop, cannot be considered through the prism of cultural isolation, inherent in the colonial condition, which will be demonstrated in our reflection.

Goodman, Jordan (University College London)
Circulating Knowledge, Maritime Assemblage and Moving Plants: The St Vincent-London-Calcutta Circuit, 1790-1800

Whose circulating what, where and why are the questions that I wish to ask. I have chosen to try and answer this question by looking at a particular exchange of living plants between three sites of knowing and growing – the British Government's botanic garden in St Vincent, west Indies; the royal gardens at Kew; and the East India Company's botanic garden in Calcutta. This plant exchange was one of the most ambitious in the history of botany, organized but only partially initiated by Joseph Banks. It involved the transfer of around one thousand living plants indigenous to the west and east Indies, Europe, Africa, India and China, and growing in the three habitats, using Royal Navy and East India Company ships, especially altered to carry the plants during the long and often perilous voyages. These 'floating gardens' were the key to the whole project. They were sites where knowledge, like objects and people, was placed on board, and consequently remade, negotiated and circulated anew as the ship sailed. Living plants, each variety carrying its own 'care instructions', were placed in a specially constructed greenhouse on the quarterdeck, in a sensitive space normally reserved for the intricacies of sailing the ship and providing a social area for the ship's officers. The plants and those who tended them, and their instructions for the completion of the oceanic trajectories, similarly contributed to the process of knowledge making, which continued until the plants reached their final destination and beyond.

Charles, Loic and Orain, Arnaud (Université de Paris 8 Saint-Denis)
Scientific knowledge, governance and political economy: Reshaping the French Colonial Empire in the second half of the 18th century

The aim of this paper is to discuss how the French colonial policy evolved in the second half of the eighteenth century. The disastrous outcome of the Seven Years War as well as the growing critique of the French colonial policy either by political writers or by a part of the political elite created a vacuum at the highest level. Torn between the necessity to reform and the tight knot of the patronage system that ruled at the top of the royal administration, the French government organized a series of colonial experiments. These experiments were placed under responsibility of enlightened administrators – such as Pierre-Paul de la Rivière, Pierre Poivre, Thibault de Chanvallon and Etienne de Turgot. Moreover, these men were handed the task to define a comprehensive program of reform that encompass large scale experiments in the domains of government as well as that of science, especially natural history. On the one hand, they prepared and sometimes conducted political reforms such as free trade and representative government. On the other hand, they design scientific experiments such as the implementation of new plants and cultivation, the circulation of knowledge throughout the French colonial empire and the implementation of botanical gardens. Drawing on Pamela O. Long's work, our thesis is that these experiments are best understood when they are interpreted as 'arenas' in the context of a French colonial empire that became in the second half of the 18th century a 'trading zone'.

Kent, Stacie (University of Chicago)
Colonization by Numbers: Commercial Statistics in Late Qing China

Beginning in the second half of the nineteenth century, a new routine of statistical customs reporting translated the particularities of commercial circulation in China into just such a set of abstractions: commodities born by the vicissitudes of markets accumulating into values and transforming into government revenues. In doing so, they rendered commerce in China formally equivalent to commerce elsewhere: navigable by the numbers. The agency producing the numbers was the Qing Empire's primary interface between itself and global capitalism: an

institutional innovation, established in 1861, led by a British subject, and designed along European lines. This paper examines the processes through which these statistics were made and their effects, both material and discursive. Comparing these reports with other forms in which knowledge about commerce in China was produced — Chinese-language local gazetteers and official memorials as well as English-language guides and dictionaries, I argue that the statistical reporting was unique in its ability to simultaneously deterritorialize and reterritorialize Chinese space. This paper seeks to better understand the extent to which the effects of the statistical project inhered in the abstracting project and its universalizing, numerical form or issued from the hands and offices that held the information. It is part of a larger project thinking about the relationship between forms of circulation and the global.

Van Wickeren, Alexander (University of Köln)

Ignorance and Knowledge: Agronomic Tobacco Science and the Atlantic Space of Circulation around Mid-19th Century

Around mid-19th century in many parts of Europe and its tropical empires, entrepreneurs, state officials and private experts experimented with import substitution of Cuban cigar tobacco by transferring agricultural and industrial know-how from tobacco farms and workshops of the Spanish colony to various sides in Europe, Africa and Asia. Thereby, they deeply transformed a scientific culture of tobacco improvement that had gained importance in the realm of European colonialism since late-18th century. While historians of science have mostly shown how the creation of modern science depended on the circulation between ‘colonies’ and ‘metropoles’, my paper takes up such strands, yet also analyzes bodies of knowledge that did not move. Focusing on France where engineers of the state monopoly for tobacco production showed interest to imitate Cuban ways of cigar production, my account understands Paris as a contact zone for Cuban and French agronomic scientists' exchange on contemporary methods of tobacco improvement. Secondly, I argue that this scientific was heavily shaped by the experience of African slaves, Chinese ‘coolies’ and local farmers operating in the Cuban cigar production. Yet, as the third part of my paper shows, a certain part of this ‘practical’ experience remained outside of the Atlantic trajectories of scientific circulation and was not mobilized at all. French and Cuban scientists especially perceived indentured Chinese ‘coolie’ laborers as cigar experts with skills that could hardly be translated into an abstract scientific discussion. Thus, my case study reveals the importance of non-transfer, ignorance and exclusion of knowledge.

S43/4 WHEN SCIENCE DIPLOMACY DIVIDES

Location: IoE – Room 828 **Chair:** Oslakova, Doubravka

Organiser(s): Robinson, Sam, and Adamson, Matthew

The concept of science diplomacy has gained traction in recent years, as the foreign offices of various nations have appreciated and begun reassessing the influence and importance of the soft power of science and technology. Scientists themselves are also recognising the diplomatic roles they have played historically and how they have contributed to global relations. This symposium (divided in five sessions), focusing on the history of science diplomacy, draw together a variety of scholars exploring different aspects of science, technology, and diplomacy at the international and transnational levels. Rather than merely echoing and reifying the scientists' own accounts about the benign effects of science diplomacy, they challenge them with provocative case studies and newly proposed interpretative frameworks.

Lalli, Roberto (MPI, Berlin)
Spacetime Diplomacy: Unifying the international general relativity community during the Cold War

Historians of modern physics and physicists agree that the theory of general relativity underwent a major transformation during the post-World War II period. After a long phase of stagnation, in which Einstein's gravitation theory occupied only a marginal position in the scientific enterprise, by the end of the 1960s it had returned to the mainstream of physics. This shift looked so magnificent to some actors that it was dubbed the "renaissance of general relativity." One of the most striking aspects of this process was that it was fuelled by numerous attempts at explicit community building pursued at the transnational level. When these activities began, research related to the theory of general relativity was highly dispersed both at the epistemic and the social level. Epistemically, research in this field was split in many different agendas with only loose connections between each other. Socially, the growing number of research centers involved in topics related to general relativity worked in isolation, especially because of geopolitical and cultural divides. By the mid-1950s some scientists launched a series of initiatives with the explicit purpose to unify the field by increasing the international cooperation between the various groups. Shortly, these attempts were institutionalized through the establishment of the *International Committee on General Relativity and Gravitation* (ICGRG) in 1959, which transformed into a full-fledged scientific society called the International Society of General Relativity and Gravitation in 1974. Since its inception, the pursuit of building an international community of 'relativists' with an identifiable institutional framework was characterized by a strong mixture of scientific and political agendas, for the ideal to build a unified field called 'General Relativity and Gravitation' (GRG) came to coincide with the goal to bridge the geopolitical divides of the Cold War via the diplomatic actions of the involved scientists. In the talk, I will discuss the multiple intentions behind the diplomatic efforts aimed at unifying the GRG field as well as the major tensions that undermined this endeavor between the mid-1950s until the mid-1970s. Idealistic views about the emergence of a unified international community working in peaceful cooperation had to face a myriad of tensions of a surprisingly varied nature, ranging from cultural differences to generational conflicts, from epistemic divisions to political contrasts, which all showed how much disunity still characterized the research field as well as the related community. In particular, I will focus on the different views the actors exposed as to where to draw the boundary between scientific and political matters in the activities of the committee and what this boundary-work implied in the historical development of these scientific-diplomatic efforts. Building on This focus, I will argue, shows that, while these diplomatic efforts enjoyed a certain degree of success with the establishment of the International Society, the emerged community and the related institutional representation was very different from what had been originally envisioned.

Barrett, Gordon (University of Oxford)

'In the Spirit of Democratic Consultation, Solidarity, and Cooperation': Chinese Science Diplomacy at the Peking Science Symposia and the Sino-Soviet Split

In 1964, Beijing hosted the largest international scientific event to have been held on Chinese soil since the Chinese Communist Party (CCP) took power in 1949. The Peking Science Symposium brought to the People's Republic of China (PRC) hundreds of scientists from throughout Asia, Africa, Latin America, and Oceania whose areas of research were as diverse as their places of origin. The symposium's organisers not only pointedly excluded participants from the USSR, the USA, and Canada, but also Europe as a whole in an overt bid to challenge the superpowers and establish the PRC as the centre of scientific gravity in the developing world. The CCP intended it as first of many such biennial conferences to be held under the Peking Science Symposium banner, but the chaos of the Cultural Revolution derailed these plans following the follow-up Summer Physics Colloquium held in 1966. Both conferences contained a heady mix of science, politics, and propaganda, thereby providing a window on the CCP's strategies for utilising science diplomacy to help advance its increasingly radical foreign policy agenda during the 1960s. These conferences in particular highlight scientists and scientific organisations' evolving role within the country's foreign affairs system. Indeed, this paper demonstrates that these were collaborative undertakings by the PRC's foreign relations and scientific communities, notably drawing on recently declassified internal documents from the Ministry of Foreign Affairs Archive in Beijing and government archives in Beijing and Shanghai. While senior foreign affairs officials bore ultimate responsibility, individual scientists, working alongside personnel from national and local science organisations, were primarily responsible for organising and executing the events. For all that these conferences were billed as academic events aimed at building unity and collaboration within the socialist and developing worlds, in actuality they were rooted in Sino-Soviet competition for influence in these regions and the failures to make breakthroughs at the expense of the Soviets in left-leaning international organisations such as the World Federation of Scientific Workers.

Lunteren, Frans Van (University of Leiden)

The International Bureau of Weights and Measures and the Politics of Science

On May 20, 1875 diplomats of 17 nations convened in Paris to sign an international treaty, known as the Metre Convention. Its aim and outcome was the replacement of the existing French metre and kilogram prototypes by new international standards, as well as the establishment of an international Bureau of Weights and Measures in Paris. Three years earlier an international commission of weights and measures had appointed a committee of 12 experts that was to supervise the construction of the new prototypes and to prepare the way for the diplomatic convention. The negotiations leading up to the convention clearly reflected the European transfer of power from West to East. Above all, they show a striking contrast between the political scheming of the scientists involved and the more disinterested stance of the politicians. Surprisingly, the secretary of the said committee, the Dutchman Johannes Bosscha, sided with the wronged French experts, who strongly rejected another German intrusion into French territory. He did everything in his power to thwart the foundation of the planned Bureau. The final result of his failed attempts was the complete isolation of the Netherlands in international metrology.

Eckhard, Wallis (Université Pierre et Marie Curie)

Setting standards in timekeeping – a case of science diplomacy

The two decades after 1945 were a period of profound transformation of the international system of time metrology, most prominently represented by the spread of the new technology of atomic clocks. What had initially been an activity of collective astronomical observation coordinated exclusively by the International Astronomical Union (UAI) gradually integrated new practices coming from other disciplines like physics and radio engineering. Likewise, other

international organization entered the scene, notably the International Telecommunications Union (ITU) and the organs of the Meter Convention. A central institutional actor in this process was the Bureau International de l'Heure. Functioning since 1919 as a department of the Paris Observatory, this central bureau of the UAI occupied a key place in international timekeeping. In this talk, I will analyze the international activity of its director André Danjon during this transformative period. I will argue that the establishment of metrological and practical standards in time measurement needs to be understood as a simultaneously scientific and diplomatic activity, serving disciplinary, institutional and national ends. In accordance with Arnaud Saint-Martin's works on the *Astronomie d'État* 1900-1940 this shows how the conflation of scientific and diplomatic-bureaucratic practices in French astronomy persisted and evolved after World War II. From 1945 onwards, Danjon actively worked to strengthen the Observatory's position, that had suffered from the isolation during the German occupation. Inside the traditional UAI setting, the Paris Observatory had to face a logic of informal, yet routinized competition, incited through regular comparisons of the precision of time services that participated in the works of the BIH and the International Time Commission, commission 31 of the UAI. At the same time, the position of said UAI commission was questioned altogether by developments in the International Telecommunications Union (ITU). At the 1947 ITU conference in Atlantic City, US proposals for a new network of standard frequency broadcasts and time signals threatened to marginalize the importance of the UAI's astronomical Time Bureau BIH. The Paris Observatory's response to this situation involved both local improvements of its time service and international action: In a process beginning in 1948, Danjon advanced a first formal definition for the until then traditionally defined unit of time. Despite being of astronomical nature, the definition eventually was adopted by the General Conference for Weights and Measures in 1960, thus becoming legally binding among adherents of the Meter Convention. Moreover, an instrument designed in Paris, the Impersonal Astrolabe, became an internationally renowned apparatus during the 1950s. The recommendation of the Astrolabe for use in the International Geophysical Year showed that the Paris Observatory had remained able to set international theoretical and practical standard. My case study will show the multiple functions of Danjon's science diplomacy: It may be read as a part of the defense of the French position against American advances in ITU, as a strengthening of the Paris Observatory inside the network of international astronomy and as the defense of astronomer's ideas about time measurement against those of radio engineers.

Robinson, Sam (University of York)

Anticipating Ocean Exploitation and the Law of the Sea (1968-84)

The UN Law of the Sea (1968-1984) was intended to legislate for the new capabilities that developments in underwater science and technology opened up for developed nations. In reality the negotiations became a point when the superpower technological hegemony of the global ocean was challenged by the 'Group of 77' – nations that saw the negative potential of new technologies in terms of the external exploitation of their resources. Science policy was formed in response to the anticipated capabilities of such technologies which far outweighed the realities of extracting deep-sea minerals and resource exploitation in remote and inhospitable environments. Thus, the discussion of ocean science and technology within the treaty negotiations were built on anticipatory understandings of the potential exploitation of the oceans. This paper will argue that international law-building for science and technology can be framed as an anticipatory response to claims made for potential future use. Thereby these negotiations, based on unsettling scientific futures, are themselves forms of scientific imaginaries. The navigation of potential uses of science, by diplomats, reveals the role of science communication within complex negotiations, and the importance of the distinction (and sometimes the blurring) of the real and the imagined in international relations. The Law of the Sea was a site where scientific futures were imagined in several contexts; a uniquely challenging moment in international law creation where lawmakers looked to the future rather than responding to their past or present situations.

SUNDAY 16 SEPTEMBER, 11.00-13.00

S42/2 THE GREEN AND DARK SIDE OF ENVIRONMENTAL ISSUES IN CITIES (1850-1950)

Location: IoE – Room 709a **Chair:** Duarte Rodrigues, Ana

Organiser(s): Gomes, Inês; Miralles Buil, Celia; and Duarte Rodrigues, Ana

In 1984, the expert on French urban history, Bernard Le Petit, stated that "the city is neither a context nor an environment, but the expression of practices and social relations". This symposium's ambition is to bring back "la part du milieu" (Braudel, 1949; Massard-Guilbault, 2002) into the cities, focusing on the question of hygiene. Hygienic issues in cities have been studied by different scholars, through different lenses. We argue for a change of perspective, connecting urban history of sciences and technology, garden history and urban environmental history. In particular, this symposium focuses on the role played by nature and/or environment (concepts that we want to clarify during discussion) in the healthy/unhealthy city. On the one hand, bringing "nature" (e.g. trees, plants or animals) and its natural elements (e.g. sun or air) into the city was considered a solution to solve some of its hygienic problems. On the other hand, the "nature" in the city was, periodically, considered as a source of danger for dwellers' health. What kind of "nature" inhabitants, municipal authorities, doctors or other actors which addressed urban problems wanted in the city? Who were, in fact, the leading actors claiming for healthier cities - doctors, gardeners, engineers, or others? Did they agreed or disagreed about the necessity and effectiveness of the proposed measures? What policies were required to transform the city from dark to green? Are there similarities among those policies in different cities dispersed worldwide? How did, different actors, in their discourses and practices, try to unify or des-unify nature and city? These are the main questions addressed in this symposium. The diversity of case studies covered seeks a comparative analysis between cities – with different size, political importance or economic affluence - in Europe, America, Russia or India, highlighting the importance of experts', ideas and models circulation, at a global scale. Furthermore, it also emphasizes the importance of local exchanges between different social groups in the construction of healthier cities, challenging the traditional center-periphery model. The variety presented in this symposium offers an overview of the significance of environmental urban history to our understanding of the history of science and technology in the city.

Miralles Buil, Celia (Universidade de Lisboa)

Building a green city to fight against tuberculosis? Barcelona 1929-1936

This communication analyses how the fight against tuberculosis in the discourses and practices of the actors which addressed health issues was articulated with the discourses of improvement of the urban environment in the case of the city of Barcelona during the Second Republic (1929-1936, before the Civil war). First, I will address how the regulation of unhealthy environments was put in place and how it was articulated with the bacteriological theory. I argue that after Koch's discovery, in 1882, the fight against tuberculosis in Europe focused on killing the germ.; in that perspective, the city was the main receptacle for the germ. To eradicate the disease, it was mandatory to control the urban environment in which it was located. Secondly, the communication focuses on the establishment of specific infrastructures to improve health in Barcelona during the Second Republic. By remarking how doctors and architects came together to improve health and the urban environment, I argue that their main issue was to bring the sun and the greenery into the city. Finally, I will discuss the utopian vision of the healthy city. Using the physicians' discourse, I will illustrate how their visions of a healthy city changed, from the model of the garden city to the acceptance of a new model proposed by modern architecture.

The vision of "nature" in the city, and its status as a health guarantor, in this new model were articulated differently.

Poerschke, Ute (Pennsylvania State University)
The Architect as Hygienist

The German architectural critic Adolf Behne stated in 1930 that the "architect today is easily more hygienic than the hygienist" and further explained that "hygiene" in the design of mass housing "is exclusively sun orientation." Indeed, European architects and urban planners of the late nineteenth and early twentieth century were deeply engaged in discussing the best orientation of single- and multi-family dwellings in metropolises and satellite garden cities as a main factor of healthy living. Particularly in the 1920s, many famous architects, such as Walter Gropius, J.J.P. Oud, Alexander Klein, Le Corbusier, and the CIAM group included sun studies not only in technical drawings but also in illustrative renderings, backed with writings about the necessity of correct building orientation. But not only architects and urban planners raised their voices on best solar orientation of housing: hygienists and doctors, too, for example Arthur Korff-Petersen, wrote extensively on the benefits of solar exposure of rooms, facades, and streets in medical journals. The discussion was fueled by two controversial opinions: While most studies before that period stated that the best orientation of housing is facing the building's long side toward South, a majority of architects and hygienists preferred the orientation of the building's long sides to East and West. The paper will describe the course of this controversy and analyze the reasoning for the modernist orientation preference that contradicts with most studies before and after High Modernism, including today.

Salazar Marulana, Carolina (Universidad Nacional de Colombia)
The English company Pearson and son and hygienization in the Latin American city at the beginning of the 20th century

With the construction of modern urban equipment in the late nineteenth and early twentieth centuries, recommendations for public hygiene were applied with scientific vision by professionally trained engineers, who designed and built infrastructures to produce healthy and hygienically urban environments, putting into practice the main advances of the Second Industrial Revolution. In this modernizing scenario, the role of European companies that developed projects in Latin America was fundamental, as they not only contributed to the sanitation of cities, but also fostered the homogenization of knowledge and the market. This situation was the result of the transfer of knowledge generated by the migration of professionals and the dissemination of techniques and products achieved in publications and universal exhibitions. One of the main companies was the British Pearson & Son, who built important sanitation works in American countries such as the United States, Mexico, Brazil and Colombia in the first decades of the 20th century, introducing the advances of British engineering in projects for water supply and treatment in overseas Europe. In doing so, the concepts of order, sanitation and social control, began to appear in Latin American cities as reflections of progress. Likewise, they became the guiding threads for reforms applied in favour of urban health and, in which, sanitation networks in Colombian cities like Bogotá, Medellin y Cartagena, became one of the main projects in charge of European engineers.

Chakravarty-Kaul, Minoti (University of Delhi)
Hygiene in New Delhi. The last Imperial capital of British India (1857-1947)

Delhi, although ceded to the British in 1857 by the last Moghul Emperor became the capital of British India only in 1911 when it was 'gifted' to the people by King George the V. Uniquely, an Asiatic city became politically peripheral to London and European metropolis. Delhi as a tropical metropolis had to necessarily be re-assessed to suit hygienic norms required for a European Viceroy in Delhi who was a direct representative of the King. The Viceroy and the Secretary of State Crewe in London set the stage for the transformation of the new capital. Such an exercise revealed some historic similarities in trends between London and Delhi specially in

matters of environmental norms of hygiene and the science of municipal planning of cities and governance. Such comparison was interesting because both the capital cities had inherited centuries' old architectural wonders as buildings and fortresses; and canals with decorated gardens and parks. The ancient parks of the city like Lodi Gardens and Qudisa were embellished, by the services of a Forest Department. Characteristically the architects Lutyens and Baker were inspired by the greenery so much a part of the city. The city's physical environment despite being green even in the British period experienced disastrous famines and pestilence. New Delhi from 1911 aroused enquiry from London's Parliament. Consequently, the city appropriately to responded by means of municipal administration of water supply, drainage and primary health precautions which were becoming essential in metropolitan London.

I124 CULTURE AND SCIENCE

Location: IoE – Room 777 **Chair:** Fyfe, Aileen

Aven, Håvard B. (Oslo Metropolitan University, Centre for the Study of Professions)
'A particle of angst and a wave of hope': Nuclear Physics, 'The Two Cultures' and Environmental Futures in the Technoscientific Public Sphere

The paper explores the transnational transfiguration of the 'two cultures' idiom, popularised by CP Snow (1959), by studying how it was received, construed and circulated in the meetings and journals of the Nordic techno-scientific communities. The idea of a split between (natural) scientists and literary intellectuals – more commonly referred to as technoscience or industry and the humanities in this setting – was invoked in (and shaped) a host of heated controversies: over the destructive potential of nuclear physics (1940s-), the reinvigorated environmental movement (1960s), Limits to growth and futures studies (1970s) – and, continuously, technical journalism, popular science, and the relationship between technoscience and the public. By studying these exchanges, I respond, first, to the conference's call to study unity and disunity in the public culture of science, notably how the engineering and techno-scientific associations discussed, negotiated and blurred the boundaries between engineering, physics, the humanities and the public (cf. Bensaude-Vincent 2001; Shapin 2012). Second, the paper addresses the question of unity and disunity within and across diverse sciences, notably by discussing the claim that modern environmentalism has been all but inseparable from the development of futures studies and a concomitant new interdisciplinary meta-expertise (Andersson 2012; Blanchard 2015; Warde & Sörlin 2015; Seefried 2017).

Meyer-Spasche, Rita (MPI für Plasmaphysik)
Science Fiction Meets Reality: Hannes Alfven's 1966-Vision of Future Computers

Under the pseudonym OLOF JOHANNESSON, the Swedish-American plasma physicist HANNES ALFVEN (1908-1995, Nobel Prize in 1970) published a science fiction story about the future impact of computers, in Swedish (1966), English (1968), and in German (1970), describing how the development of computers did lead to a global world society in which EVERYTHING is automated and organized by computers. Finally computers even reproduce themselves and some computers service the others and prevent the whole system from breaking down. It is amazing to read this text today: some of Alfven's predictions did become real in the meantime, others are still desirable for the future, and others are strongly unwanted or clearly a satire. It is unclear how much Alfven's booklet influenced the development of technology and society. In Germany, KLAUS BRUNNSTEIN (1937-2015) used it in 1973 to start a public discussion about the future role of computers. Brunnstein (computer scientist, politician and IFIP officer) had strong influence on German legislation with respect to IT security, social accountability and information privacy.

Pihlaja, Päivi Maria (Independent Scholar / Finnish National Committee for the History of Science, Technology and Medicine)
Narratives of scientific discovery and visual strategies in promoting and popularizing late nineteenth-century theories of the Aurora Borealis

This paper seeks to contribute to discussions bridging science and art by intestigating through visual means popular narratives of scientific discovery and effects that these may have on scholarly careers. As case study, it uses visual and narrative reports given by physicist Selim Lemström (1838–1904) who in the late nineteenth-century received, both in popular press and within the scientific community, acceptance for his new theory concerning the origins of the aurora Borealis (a phenomenon of light also known as the northern lights, which at the time remained scientifically unexplained). The origins of the theory will be detected in powerful personal impressions or a 'key experience' of the author while performing direct observations in nature. It will also be shown how the images in which the author sought to capture and

mediate this event and its settings were transformed into a scientific argument, drawing especially from visual analogies with laboratory experiments with electric currents. The ideas conveyed through these images will then be analysed against certain archetypical nineteenth-century narratives of scientific discovery, where scientific truth or breakthrough unfolds like an instantaneous 'vision'. It will be proposed that adherence to such visual and narrative strategies when promoting his (later refuted) theory may partly explain the course of Lemström's later career, including his incapability to adjust his views in front of new paradigms.

Pyenson, Lewis (Western Michigan University)

Ut pictura mathesis: Vision and Perspective in Picasso's and Einstein's Education

A close examination of Picasso's and Einstein's formal education reveals a number of themes in common. Picasso and Einstein attended schools sharing a number of attributes in architecture, teaching collections, and curriculum. Both Picasso's and Einstein's teachers were accomplished in science and mathematics, on the one hand, and drawing on the other hand. Both young men received instruction in the tradition of projective and descriptive geometry: Picasso practically in his drawing lessons, Einstein both practically and theoretically so. Picasso's and Einstein's schools were adorned with full-scale copies of classical statuary used for drawing lessons. Einstein's schools had fine collections of copies and photographs of classical and medieval works of art and architecture. In his student years and especially in the years leading into general relativity, Einstein would have been familiar with three-dimensional models of higher-dimensional surfaces, and it is likely that similar models were familiar to Picasso's close artist colleagues. It seems that around ten years after leaving school, Picasso and Einstein came back to lessons overlooked when they set out as an independent artist and theoretical physicist. The lessons had been internalized by many of their contemporaries, however, who were quick to embrace Cubism and general relativity because the new work resonated with what they knew but could not express well. The paper is based on one chapter in a forthcoming book, *The Shock of Recognition: Motifs of Modern Art and Science*; related discussion in the volume *Being Modern*, ed. Robert Bud, et al. (London: UCL Press), in press.

Fulford, Tim (De Montfort University)

Romantic Science: the Culture of Enquiry and Dialogic Form in the 1790s and 1820s — Humphry Davy and his Circle

I will publish this year *The Collected Letters of Sir Humphry Davy*. This paper will investigate the model of enquiry forged in 1790s Bristol between Davy and his poet friends, and show how it a. persisted beyond the two developments that Davy has been credited with by recent critics and historians — 1. promoting the figure of the scientist as the heroic master of nature through laboratory experiment (see Schaffer on experiments and automatic registration) and 2. precipitating the institutionalisation of knowledge-production into separate disciplines (see Klancher) b. was reconstituted in remodelled form in a number of works that revived the long quiescent dialogue form (The Excursion, Sir Thomas More, Salmonia, Consolations in Travel). That later works of Southey, Wordsworth and Coleridge as well as Davy should have revived a dialogue form, and invoked 1790s' writing modelled on conversation, is itself a significant though oft-nelgected development in Romanticism. This formal turn shows that the shared culture of enquiry that the Bristol circle had forged in earlier years was still the most powerful model of discovery they could create. Davy's dialogues are conversational, poetic, digressive, situated: as such they reveal that Romantic-era science was not increasingly a discourse of the solitary experimentalist in the laboratory produced from a position of disciplinary separation. It was in dialogue with literary discourse as a means of demonstrating that the subjectivity of the enquirers was to be included in enquiry: experiment narratives were not in opposition to poems and travel narratives but intersected with them.

S19/2 MATHEMATICS EDUCATION IN EUROPEAN MILITARY ACADEMIES (18TH AND 19TH CENTURIES): UNITY OR DISUNITY?

Location: IoE - Room 826 **Chair:** Bruneau, Olivier

Organiser(s): Blanco, Monica, and Bruneau, Olivier

It is well known that military academies and schools contributed essentially to the production and circulation of higher mathematics in 18th- and 19th- century Europe. Over the past thirty years there has been a fair amount of historical work on mathematics education in European military academies, approaching the subject matter in a variety of ways. A number of studies focus on the mathematical courses produced and used at the Spanish military academies and pinpoint their outreach. Others address the importance of the military academies of Woolwich and Sandhurst in the circulation of mathematics in Great Britain and in the appropriation of mathematical knowledge across the Channel. Meanwhile, recent works on the American military schools (e.g. West Point) consider the mathematical exchanges between France and the United States. Finally, the École Polytechnique and its school of application in Metz played a central role in the development of mathematics early in the 19th century. Throughout the eighteenth and nineteenth centuries, these military schools and academies underwent several evolutions regarding their status, their ways of recruitment and changes in their curricula. So far such evolutions have been studied mainly individually, from a local or national perspective exclusively. Such a simplistic pattern has led up to a lack of case studies dealing with the mathematics education in military academies with a wider global perspective, and studying the local obstacles within the pedagogical, institutional or diplomatic framework. Through this symposium, we envisage exploring the local and national dynamics involved, and assessing their impact on mathematics education in the military context. More cross-national and comparative case studies will doubtless contribute to improve our understanding on the construction and circulation of mathematical knowledge in 18th- and 19th-century Europe. Hence, the circulation of mathematical knowledge between a number of military schools and academies, not only within national boundaries, but also across borders, will be considered. We are also interested in discussing whether changes in mathematics curricula took place simultaneously or rather independently. That is, if one school underwent a change of curriculum, could the same change be tracked down at other national or international schools? Or did they prefer to stick to a more traditional education? In short, the aim of this symposium is to provide a cross-national comparative analysis of the production and circulation of mathematics in European military academies through a number of case studies from the 18th and 19th centuries. This crossnational comparative analysis can help identify points of unity or disunity in the military educational context.

Domingues, João Caramalho (Universidade do Minho)
Mathematical curricula and textbooks in Portuguese military engineering education in the 18th century

There are no explicit regulations on mathematical curricula for Portuguese military engineering education before the middle of the 18th century. A few textbooks were published and were traditionally the only source in reconstructing these curricula. However, recently it has become clear that until about 1760 students relied (probably on an exclusive basis) on manuscript notes, that included much more pure, elementary mathematics than previously acknowleged. These notes confirm and reinforce the influence of French authors – despite the fact that

Portugal was a constant ally of Britain, and that Portugal and France were on opposite sides of the War of the Spanish Succession and of the Seven Years' War. We will present the evolution of these mathematical curricula, as they can presently be reconstructed, as well as the textbooks adopted or adapted into lecture notes.

Preveraud, Thomas (Université d'Artois)

Considering and reconsidering the role of France in the mathematics education within American military academies (1800-1850)

In the beginning of the nineteenth century, American engineers and officers were trained in West Point Military Academy, the only engineering/military school of the country between 1800 and 1820. In its early years, the Academy featured few standards for teaching contents – above all for mathematics - and organization and the cadets' training was therefore very deficient both in extent and structure.
For reasons this talk will detail, French teaching structures and contents were carefully considered by Secretary of War and used to reform West Point organization, including its governance, the routine of cadets, its curriculum and the textbooks list (not only in mathematics, but also in military tactic or in natural philosophy). This French influence can also be noticed in the edification of curricula in opening new military academies, for instance at the American Literary, Scientific and Military Academy (Norwich, Vermont, 1819) or at the Virginia Military Academy (Lexington, Kentucky, 1839).
But mapping in such a manner the French presence in the mathematical training of American officers and engineers erroneously depicts a strongly polarized history, with so-called beaming French science and retarded American continent, the later benefiting from knowledge coming from the other side of the Atlantic. Yet, this transfer was associated with a set of deep and active transformations to fit the local needs and contexts, and of which the communication will discuss.

Puncher, Sebastian (Royal Military Academy, Sandhurst)

Royal Military College Mathematics: Useful Skill or Self-Indulgence?

This paper examines the central part that mathematics played at the Royal Military College in the regulation of the course of studies between 1802 and 1870. It touches upon contemporary perceptions, often differing, of the importance of mathematical training for the British infantry or cavalry officer. That there were differing opinions was symptomatic of the understanding of British society, and its army, of what constituted an effective military education and how this was best obtained. It will look particularly at whether the type of mathematics taught was meeting, or on the other hand, confirming, observations of critics.
This paper argues that it was the position of Army educationalists to set about creating a college in 1802 in which the position of mathematics was not dissimilar to that held traditionally in France for its potential infantry officers. The intention was to create a large subset of future officers in the army destined for high appointments. However, as time progressed the 'neo-feudalist' position of prizing practical skills and moral attributes increasingly put the position of mathematics at the RMC under pressure. However, it retained its place partly due to the poor level of secondary education in mathematics throughout the country - meaning the RMC needed to 'level' the cadets before starting their professional subjects – and secondly, there were irrefutable uses for mathematics in fortification, surveying and various staff work which could not be dismissed. Indeed, the attitude to mathematics at the cadet college was bound up with its perceived relevance at the Staff College. This conflict is borne out by the fact that even after the adoption of the French-inspired changes to education after the Crimean War, which should have seen the RMC as a purely practical School of Application, the college was still not able fully drop mathematical teaching. For almost a decade after the War, owing partly to a series of aborted changes, it retained vestiges of its previous function as a sort of 'Junior Staff College'. Not until the War Office authorities were pondering the implications of the Franco-Prussian

war did mathematics finally disappear from the course with a narrower focus on purely professional subjects.

Navarro Loidi, Juan (Cátedra Sánchez Mazas)

Foreign influence in Mathematics in the Spanish College of Artillery (1764-1842)

Founded in 1764 following the model of the Accademia militare di Artiglieria of Naples, the Spanish College of Artillery of Segovia had for head of Mathematics from 1777 to 1803 the Italian Pedro Giannini, a disciple of Vincenzo Riccati, who published Curso Matemático. This Italian influence was not usual, Spanish mathematicians followed ordinarily French authors. For instance, Bezout's Cours de mathématiques used in French military academies inspired Benito Bails' Elementos de Matemáticas a celebrated book in Spain. This circumstance changed in 1803 when Francisco Datoli replaced Giannini. He began the publication of a new manual for the College following the French mathematician S. F. Lacroix. The Peninsular War stopped his publication. After 1814, translations of Lacroix's manuals were employed. For specific matters books of Francoeur, Monge or the Spaniards Zorraquin and Vallejo were used too. The College was closed by the king in 1823. When it reopened in 1830 the adopted manual was Curso completo de matemáticas by José Odriozola, where the French influence can be noticed, but less strongly than before. In 1837 the syllabus had to be reduced to get faster new officers to fight in the Carlist War. Lacroix, and Monge were again recommended, beside Odriozola. In 1842 a general military academy was created to be a first step for all the branch academies of the army, and the college became an Application School of this military academy.

Patergnani, Elisa (University of Ferrara)

The teaching of the mathematics in the military school of the Napoleonic Piedmont

After the conquest of the Piedmont (1800) Napoleone made to also found in Turin a regimental school of artillery (1st June 1801). The school of Turin was one of the eleven schools of artillery French; the other ones were found to La Fère, Besançon, Grenoble, Metz, Strasbourg, Douai, Auxonne, Toulouse, Rennes, Valence, managed by the Ministry of War. In every regimental school there was a teacher for the mathematical sciences, physics and of fortifications and a teacher for the sketch. The first commander of this school was Louis Victor Aubert de Lamogère (1758 -1837) and the first teacher of mathematics was Jean-Antoine-Marie Lombard (1756 - 1828), the child of Jean-Louis Lombard (1723 -1794) who had been teacher of Napoleone. For health problems Lombard didn't maintain the charge and the new teacher was the young Giovanni Plana, student of Lagrange to the École Polytechnique. The Italian military school of the French empire moved to 1805 from Turin to Alexandria where Plana taught until the nomination, in 1811, of teacher of astronomy to the University in Turin. The education was separated in theoretical education and practical education. Teachings were different to second that they were destined to the troop or to the non-commissioned officers. Mathematical teachings included the study of the elements of the geometry, trigonometry, algebra and mechanics.

S11/1 HISTORICAL MOMENTS IN THE PUBLIC UNDERSTANDING OF SCIENCE (C.1600-1900)

Location: SciM – Lecture Theatre **Chair:** Nielsen, Kristian H.

Organiser(s): Ampollini, Ilaria; Gouyon, Jean-Baptiste; and Nielsen, Kristian H.

These two panels are intended to bring together studies of historical instances related to the construction of the public cultures of science. Taken together, the papers presented in these two panels highlight the variety of the aims, contexts, outcomes, and actors—audiences and producers—of an endeavour—the communication of scientific knowledge in public contexts—consubstantial to the development of modern science, which has remained a constant since the 17th century. As a whole, the papers presented in these two sessions intend to highlight the value of historical enquiry, and of an historical sensibility, for the development of current scholarship in and about science communication and the public understanding of science. The first panel lines up case studies from c. 1600 to 1900, the second panel concentrates on the 20th century. The title for these two panels is borrowed from the title of a rubric in the journal *Public Understanding of Science*. Since 2016, this rubric offers short essays on the history and the historiography of science communication on a regular basis.

Ampollini, Ilaria (University of Trento)
The Emergence of Risk Communication in the XVIIIth century

As many scholars have shown, in the XVIIIth century crucial changes in the perception and cultures of risk occurred, also following the mathematicalisation of probability. But what about the communication to the wide public of these relatively new, hard-to-explain notions? This paper aims at analysing the emergence of risk communication, focusing on the French area in the period between 1720 and 1780 circa. We will first consider if there were any debates within the scientific community about the best ways to communicate the risk's values to lay people. We will then investigate if and how the risk communication developed in the gazettes, penetrating the public arena. Finally, we will try to identify some instances of the early practices of risk communication. One of the most significant examples comes from 1773, when the Académie des Science discussed how communicate small values of risk. The debate was triggered by an essay by J. Lalande about the likelihood of an impact between comets and the Earth, that had produced a terreur panique throughout Paris. Starting from here, we will broaden the analysis to the previous decades and to those after 1773. We will focus, for instance, on the case of smallpox inoculation: little attention has been given to date to the ways the risks associated to the inoculation were discussed and communicated to the broad audience. Other issues investigated in the present study will also include the communication practices related to the mortality tables.

Vaccari, Ezio (University of Insubria)
Popular knowledge and geological sciences: a comparative study in the history of scientific communication in France and Italy during the 19th century

The aim of this paper is to investigate how a new concept of natural environment developed in the 19th century society in France and Italy through the growing of a new literature of popular science, which reached a great number of readers, also creating a new audience for naturalistic subjects related to the history of Earth. Within this context, linked to the history of modern scientific communication, the new science of geology had a relevant role, very little studied to date. Consequently, works by L. Figuier, C. Flammarion, L. Simonin and other French scholars will be analyzed and compared with Italian contemporary authors such as A. Stoppani or P. Lioy. Their contribution to the popularization of natural sciences will be considered with particular reference to the establishment of a new concept of natural environment: an

environment with a very long history (shown by the recognition of several geological changes and by the discovery of the "deep time"), extraordinary and powerful natural phenomena (discovered by studies in volcanology and hydrology), a great variety in the development of life (demonstrated by new research works in palaeontology, botany, zoology), a significant richness in subterranean resources (described by mineralogy and mining studies). This extended concept of natural environment comes from a new kind of scientific knowledge based on books and periodicals of 'popular science', which adopted specific narrative styles and visual languages.

Turbil, Cristiano (KCL)

Medicine and politics in post unified Italy: Paolo Mantegazza's medicine in the public square

In the second part of the nineteenth century the Italian physiologist, anthropologist, politician and populariser of science Paolo Mantegazza (1831-1910) was becoming an internationally recognised figure due to his extravagant scientific and political ideas. In just over thirty years of activity Mantegazza produced more than 1500 publications on various topics including public medicine and hygiene, food science, love, sexuality and physiology. Mantegazza aimed his work at two different types of audiences. He produced cutting edge research for the Italian medical community while actively contributing to convincing politicians to fund medical research. Nonetheless, Mantegazza also considered it extremely important to medically educate the general public. As an advocate of positivism and hygiene, Mantegazza recognised that the only way to modernise Italy was by starting with medically educating the whole population. In the 1860s, Mantegazza began a long-term plan to change the way Italians approached scientific and medical knowledge. He organised and delivered medical talks about hygiene, published short popular volumes called almanacs and wrote several fictional works where he presented controversial medical ideas. This paper will offer an insight into late nineteenth century Italian medicine in both its professional and popular forms. The analysis of Mantegazza's work, in particular, will show the link between medicine and the political function of its popular understanding.

Hjermitslev, Hans Henrik (University College South Denmark)

Circulating natural knowledge in rural and urban Scandinavia 1870-1900

In the 19th century, the three Scandinavian countries, Denmark, Norway and Sweden, established compulsory education for all children. Moreover, public enlightenment initiatives such as the folk high school movement blossomed from the 1860s. It resulted in relatively well-educated rural as well as urban populations and very high literacy rates compared to other European countries. However, it was only from around 1880 that natural science took centre stage in the education of the people. By then knowledge of the natural world became relevant to educators for a variety of reasons. Religious educators realised the utility of natural science in their attempt to modernise agriculture, while urban freethinkers applied scientific theories such as Darwinism in their ideological struggle against Christianity. From the 1890s, moreover, Scandinavian publishers realised the fiscal potential of natural science when they launched successful popular science journals and book series that reached more than 100.000 readers. In this paper, I will discuss the appropriations and applications of natural science in the Scandinavian countries from 1870 to 1900. I will focus on how natural knowledge became part of both modernisation processes and cultural struggles and how both ideological and economic factors influenced the establishment of a vigorous scientific marketplace.

S49 NINETEENTH-CENTURY PRACTICES OF COLLECTING NATURE

Location: SciM – Dana Study **Chair:** Secord, James

Organiser(s): Dubald, Déborah, and Madruga, Catarina

Commentator: Nieuwland, Ilja (ING, Roy. Neth Acad. Sc.)

The presenters in this panel contribute to the historiographical shift that moves away from looking at large natural history collections in established institutions to considering what took place outside the museum's walls. The topic of this panel is a valuable, but under-explored part of the formation of natural history collections, that is, the role of collaborators who do not necessarily fit usual categories of museum practitioners. In our papers, we examine the practices and motivations of different types of collectors and collators, and analyse what happened in the worlds of collection and collation outside of the museum.

During the nineteenth century, natural history collections and museums were often depicted as representative of regional, national, or imperial projects. Collections of local flora and fauna were used to crystallise nationalist discourses and the personal successes of men hailed as national heroes. For various reasons and in multiple settings, natural history museums became the centres around which these identities cohered. Centres of calculation, however, required the gathering of considerable amounts of data and specimens.

By looking at practices of collecting we reveal that not all the contributions to museum collections were systematic, whole, homogeneous, or obsessed with completion. Sending, shipping, or selling materials to a museum were not politically-neutral acts, and it is possible to identify many different typologies of suppliers of specimens who were neither professional nor amateur collectors. These different types of collators were not necessarily the learned explorers or collectors usually associated with large-scale museums. Most museums' 'agents' in the field were, in fact, mediators and facilitators, or even retailers of nature in the field or colony. They became recognised centres for accumulation in their communities, active nodes of a larger network, preparing, shipping, and corresponding with the museum.

Acknowledging such collators as valuable contributors, museums issued sets of instructions according to which collection, preparation and shipment were standardized. In addition, museums would pay for shipments, and provide instruments and materials for the field, in the hope of enticing more collaborators. Thus, relations of power and authority between the museum and its network of collaborators were reinforced. However, the papers in this panel will show how colonial administrators, diplomats, or more occasional contributors would in their turn be very aware if the materials supplied were or not incorporated into museums. The negotiation of authority over the specimen's value, and its role inside the museum once offered, is shown to be complex. Many museum collaborators entered a relationship with museums in terms of a gift economy that has not received sufficient attention.

As places of standardizing, sterilizing, and crystallizing knowledge, natural history museums constructed their authority to transform nature into knowledge, encapsulated in the collected objects and specimens. The study of the logistics of practices of collecting nature as seen from the outside of the museum will hopefully contribute to a better understanding of how the authority of museums and herbaria was built and negotiated.

Béllego, Marine (Ecole des Hautes Etudes en Sciences Sociales, Paris)

Local Ambiguities: Collecting, Drying and Classifying Plants for the Calcutta Herbarium at the end of the Nineteenth Century

The Calcutta Botanical Garden was created at the end of the 18th century by the East India Company to acclimatize and cultivate economically-useful plants. By 1900, it had become a major institution of botanical knowledge and evolved into a showcase for imperial botanical achievements. Inside the Garden, the herbarium was central to the elaboration of what European botanists considered to be scientific botanical knowledge, and at the turn of the 20th century, it was considered one of the main herbaria in the world. Collecting, identifying, and classifying plants contributed to the imperial project of territorial appropriation, and the project of establishing an exhaustive list of so-called Indian plants was meant to reinforce the claim that botany was a European enterprise. However, most workers contributing to herbarium work were not European. Collectors sent to remote places had to rely on the knowledge of 'natives'. While most work was performed by Indians, Europeans kept complaining about the workers they were dependent on. This fraught relationship with local workers mirrored the ambiguous way in which British botanists considered all things local. Their interest in local plants existed only through a denial that local people were able to benefit from what grew on their lands, be it in terms of taxonomy or agriculture. This paper shows that in the particular colonial conditions of Calcutta, Herbarium operations epitomised the biased imperial relationship with the local.

Brassington, Laura (University of Cambridge)

Corresponding and Collecting across Classes, Nations, and Empire

In October 1872, John Scott, the son of a tenant farmer from rural Scotland, wrote to Joseph Dalton Hooker, 'It has always been my wish to refund the sum Mr. Darwin so kindly gave me to enable me to come to India.' Corresponding from Calcutta Royal Botanical Gardens, where Scott worked as curator, he thanked Charles Darwin for securing him the position. A station otherwise beyond someone of Scott's means, Darwin's patronage involved not only a disinterested recommendation of Scott's scientific ability, but also financial support. Yet when Scott assumed their mutual interests transcended class boundaries and suggested they go into business together, the gentleman quickly reinforced hierarchies. Darwin enabled Scott to contribute to science, but blackballed him from élite societies. In the nineteenth century, British naturalists depended upon correspondence networks to collect information and specimens. The importance of these networks to eminent figures has been widely studied, but, even whilst relied on by men such as Darwin, networks of working-class naturalists remains neglected. This paper draws on the work of the Darwin Correspondence Project (Cambridge University, 1975-present) to ask what it meant for the most celebrated gentleman naturalist and a humble Scottish artisan to cooperate in botanical collecting. I address unity and disunity by exploring how status, class, and professionalisation were mediated through correspondence across Britain and Empire. Arguing that participation in a shared scientific culture could reinforce social stratifications, I support histories of science approached simultaneously from above and below.

Dubald, Déborah (European University Institute)

Nobody's Collection? Collecting for the French Municipal Museums, 1800-1870

There is always a local hero whose generosity 'made' the museum collection. These stories were key to the fashioning of the prestige and authority of the museum. However 'big' donations cannot be taken for granted as the essence of museum collections which were rather the result of a complex interplay between a multitude of actors: the museum conservator, private collectors, merchants or more random suppliers of specimens. Practices of collecting were less straightforward than they seemed. Considering the interactions between the collectors and suppliers of the museum and the skill of the museum director in developing (or not) a method for collecting for the museum contributes to calling into question the centrality of the museum in the circulation of specimens by interrogating the making of its authority. This paper will

draw attention on the multiplicity of objects and collectors involved in practices of collecting using some cases of the French provincial cities in the nineteenth century. The exceptional will be examined in light of the mundane of everyday collecting, in order to illuminate whether or not natural history museums can generate a typical form of collecting for museums. More specifically, the variety of natural specimen suppliers and strategies of collecting reveal a general but unsystematic shift from a more 'traditional' way of collecting inherited from natural history cabinets, to collecting for the sake a municipal institution, which posed the problem of collection ownership, standardisation and professionalisation.

Madruga, Catarina (University of Lisbon)

'It was of a beautiful celestial blue, when it was alive'. Practices of collating information and shipping zoological specimens from the Portuguese Colonies to Lisbon (1865-1885)

It was of a beautiful celestial blue, when it was alive' was one of many details not available to nineteenth-century cabinet naturalists in zoology museums. This description accompanied a shipment of two flasks containing snakes from the Portuguese colony of São Tomé in 1869 to the zoological museum in Lisbon. Earlier, in 1862, the Zoological Section of the 'Museu Nacional de Lisboa' had issued a set of instructions that were distributed to the colonies. They called for the collation, preparation, and shipment of zoological specimens back to Lisbon. The instructions requested participation in an 'imperious need of science and national decorum' represented in zoological knowledge and reified in the national museum's collections. As expected, the instructions did not predict all complications in isolated territories, but nor could they have predicted the different agencies and creativity of some of the collaborators, who acted as go-betweens, mediating nature, colonial life, and research in the metropolitan museum. This paper identifies differences and commonalities between some of the contributors to the Lisbon museum, and unpacks practices of collation, preparation, and mediation taking place in a distant colonial setting. With these contributions, the Lisbon museum assumed a relevant role regarding other European museums. From the contributors' perspectives, on the other hand, the museum was a means to achieve social recognition and participate in the advancement of the imperial agenda.

I111 VISUAL CULTURE AND BIOLOGY

Location: SciM – Dana Studio **Chair:** TBA

Almeida, Maria Strecht (Instituto de Ciências Biomédicas Abel Salazar, University of Porto)
Between staining and drawing – Abel Salazar's microscopic explorations of the Golgi region in mammalian cells

The present paper addresses the place of visual representations in scientific practice and its role in knowledge production. Specifically, it looks at the research developed in the early twentieth century by the histologist Abel L. Salazar (1889-1946). Medical doctor, professor, scientist and visual artist, Abel Salazar is a multifaceted figure of the Portuguese cultural setting of his time. Expelled from academia by political reasons, his research career has been relatively short. This paper examines his effort in the implementation and improvement of methodological approaches for the study of mammalian tissue slices, and particularly the work focused on the Golgi region in mammalian cells. The tanno-ferric method on which Salazar based his research enabled him to identify a specific area in this region, highly tannophilic and which he conceived, observing at the resolution then possible, as a distinct organelle from the Golgi apparatus itself. In a time when the existence of the Golgi was still controversial, these results disclosed part of its structure as it became understood later. Salazar´s writings about the procedure of microscopic drawing are another expression of the methodological concern that seems to pervade his research work. Building upon published texts and archival sources, my analysis takes into consideration aspects of unity and disunity in the dynamics of science and attempts an integrated account of those two different aspects of representation in Abel Salazar's research work. I will argue that staining and drawing are closely linked tools in his work, both present at the level of knowledge production.

Jardim, Maria Estela and Vera Jardim, Nádia (CFCUL; CQE; University of Lisbon)
Serial photography, cinema and the physiological body at the turn of the 19th Century

Serial photography and cinema were used to measure, segment and quantify pathological movements in neurological diseases. With the collaboration of Muybridge, the neurologist Dercum (1856-1931) did some quantification in abnormal gait of his patients based on his chronophotographic serial photography of human locomotion (Dercum, 1895). Similar methodology was used by Marinescu (1863-1938) in the Romanian Hospital Pantelimon with the Lumière cinematographer: the frames of his films were transformed into line drawings by his collaborator Neyliès for the analysis of the decomposed movements (Marinescu,1900). In the early 1920s the Portuguese neurologist and later Nobel prize winner in Medicine (1949), Egas Moniz (1874-1955), undertook a task of obtaining the radiographic imaging of the human brain, in order to visualize cerebral abnormalities, thus launching a new technique named angiography. Serial angiography was later used to measure the speed of blood in the brain with an instrument designed by one of his collaborators, the physician Pereira Caldas (Moniz, 1932). In this paper we will examine medical cases in this period 19th-early 20th centuries when measurements were performed in clinics and hospitals using serial photography and cinema. We will discuss to what extent these new technologies improved knowledge on the physiological body.

Rego Robles, Miguel Ángel (Instituto de Filosofía, CSIC)
A drawing notebook for the neurosciences: SRyC´s visual epistemology

Notebooks have been useful research objects for the history of science as artists' drawing notebooks have been for the history of art. Also scientific drawing books are original objects for historicizing both the sciences and the plastic arts. This is the case of a notebook by Spanish neuroscientist Santiago Ramón y Cajal (1852-1934), whose notes were drawings of the neurons, essays in images of inflamed tissues and nerve endings in vertebrate animals. The

drawing and text notebooks are considered as knowledge acquisition practices that are, as Elaine Leong (2013) has defined them, processes of "knowledge codification". I consider these drawn elements of his notebooks as epistemic visual and textual objects. In this communication I will present a history of a particular notebook, the one entitled by Ramón y Cajal himself as Diario de Observaciones, and to reconstruct its contents. For this aim I will focus on particular cell drawings and their shapes so as to propose a trajectory of a style of representing cells at the end of the 19th century by histologists and cytologist. Cajal´s drawings supposed the continuation of the growing field of histology during the 19th century but, at the same time, established a rupture from the understanding of the nervous system of the brain.

Worliczek, Hanna Lucia (University of Vienna, Department of History, DK "The Sciences in Historical, Philosophical and Cultural Contexts")

Visual Cultures and Epistemic Judgement in Cell Biology – Tensions between Basic and Translational Research in Image-based Knowledge Production of the 1970s

Immunofluorescence microscopy (IFM) was established as an epistemic tool for Cell Biology during the 1970s by a relatively small number of researchers, mainly based in the USA and Germany, leading to a substantial transformation of the visual culture of the field. In this period, primarily knowledge about subcellular architecture was produced by IFM, ultimately defining the "biochemical anatomy" of the cell. Questions about function and mechanisms, described as being characteristic for Cell Biology after World War II, could not be addressed as such. IFM can be interpreted as a unifying factor between two lines of inquiry: basic and translational research, each having different epistemic interests, but working collaboratively on developing and establishing IFM. From a descriptive and morphological quality of knowledge produced jointly to some extent, motivations for applying IFM parted quickly, leading to a separation after a short phase of unity and collaborative actions. In this paper I aim to explore how the epistemic qualities of IFM-images were utilized differently in research and publication practice, and how their epistemic value was judged: By scientists doing basic research and by those doing translational research, where differentiating the healthy from the pathological was equally important as the characterization of phenotypes of cancer cells. I aim to carve out the dynamics and effects of this alteration of unity and disunity in the field of Cell Biology with regards to the relevance of knowledge producible by the very same technique, that was accompanied by an alteration between morphological and functional epistemic interests.

Lovecchio, Nicola (Università degli studi di Bari "Aldo Moro")

Nature in art and art in Nature: the monistic unity in Ernst Haeckel's thought

During the conference holded by Haeckel on 1892 in Altenburg, he has defined the biological monism concept. It has undergone an epistemological shift in the first half of XX century: its evolution starts from synthesis attempt to reality fragmentation in her single aspects. In fact, sciences have increased experiment activities and Haeckel's monism has failed meeting Ernst Mach's economical principle (1901). So, it has lost his main feature: the reality synthesis. The objective of this discussion is to get back the unity theme of science and sciences, in particular biological, which will be tracted in this venue according to art. With Haeckel's point of view, we will show the art and science ambivalent union. We will make so thanks to morphological descriptions about living beings and their illustations which we find in Kunstformen der Natur (1900). This work will be as much subliminal as explicative because the biological law of recapitulation - heuristic complement of Darwin's evolution theory - will find an explication in artistic forms of nature. Finally, Haeckel can be a cause for reflection to discuss how the visual history of science is important to understand theories.

S37 UNITING AND DISUNITING RESEARCH THREADS: THE COLLABORATIVE RELATIONSHIPS BETWEEN GIUSEPPE LEVI, VIKTOR HAMBURGER, RITA LEVI-MONTALCINI, AND JOSEPH NEEDHAM

Location: IoE – Room 802

Chair and Commentator: Richmond, Marsha L. (Wayne State University)

Organiser(s): Dröscher, Ariane

Our session will approach this year's general topic – Unity and Disunity – from the point of view of collaborative relationships. The lives of Giuseppe Levi (1872-1865), Viktor Hamburger (1900-2001), Rita Levi Montalcini (1909-2012), and Joseph Needham (1900-2001) intertwined in multiple ways, forming in some moments clusters and breaking up in others. A common scientific bond among the four scientists, who were active in Italy, Germany, Great Britain, and the US, were their innovative contributions giving rise to neuroembryology. Yet the investigative paths that led to this new field were complex. Very roughly speaking, the "Italian" approach, starting with Levi, focused on the phenomena of life and death, of senescence and immortality, and based its research on the methodology of cell culture, whereas the "German" one concentrated on Spemann's concept of the "organizer". In the 1930s, these threads continued in Great Britain and the United States, where they developed in unexpected ways. The innovative investigations of Hamburger, Needham and Levi Montalcini elaborated on and combined methodologies and concepts from neurology, embryology, developmental biology, and molecular biology, eventually resulting in the seminal discovery of the nerve growth factor (NGF) in the 1950s. In particular, alongside with a comparison of the philosophical and cultural underpinnings of their scientific and experimental works, the session seeks to shed light on the complex collaborative relationships between the four researchers. Those relationships began with mentorship by Levi and Hamburger and concluded with the rise of Levi Montalcini to global leadership in science, science policy, and civic engagement. Needham, who started like Hamburger from a Spemannian fundament, represents an alternative path yet with numerous intersecting instances.

Dröscher, Ariane (University of Verona)
Death, immortality, and regeneration: Giuseppe Levi's dynamic approach to neuron development

Giuseppe Levi (1872-1965) is mainly remembered for his neurohistological studies, for his pioneering role in the development of cytological techniques like cell culture and microcinematography, and for having three Nobel students – Renato Dulbecco, Salvador Luria, and Rita Levi Montalcini. His relationship with Levi Montalcini was particularly strong and climaxed during the years of persecution, when they first flew to Belgium and then worked in a secret laboratory in Turin. They had many things in common: personal backgrounds, philosophical views, and scientific preferences. When Rita Levi Montalcini left for the USA, Levi's imprint continued to lead her way. My talk will analyse this "Italian" path towards neuroembryology and the discovery of the nerve growth factor (NGF). Special attention will be given to Levi's dynamic and holistic conception of structure and his studies on the phenomena of life and death, of senescence and immortality.

Jiang, Lijing (SHI) (in absentia)
Seeing Experiments Differently: Viktor Hamburger and Rita Levi-Montalcini's Study of Neuron Development before 1950

In the late 1940s, Italian biologist Rita Levi-Montalcini (1909-2012) conducted a series of experiments in the laboratory of German-American embryologist Viktor Hamburger's (1900–2001) to assess their different views about how central neurons develop. Hamburger formed a hypothesis of inductive growth to explain the central neuron development in chick embryos in 1934. Around 1940, with evidences gained through silver impregnation technique, Levi-Montalcini nevertheless hypothesized that cell death, a phenomenon newly found in neuron development, is more important. Their collaborations resulted in a 1949 paper in which Hamburger revised his inductive view and incorporated cell death as one biological strategy in development. In the collaboration, Hamburger and Levi-Montalcini expressed disparate views about the same series of experiments. Having been trained in the Hans Spemann laboratory that embraced the idea of induction, Hamburger saw these experiments as empirical tests to solve a theoretical puzzle. Junior in her research field, Levi-Montalcini on the other hand was eager to establish a scientific career and felt insecure about the validity of classical experimental embryological techniques. She thus emphasized the technological power of experiments in constructing phenomena. As a result, the two researchers interpreted the phenomenon cell death with different emphasis. While Hamburger downplayed the novelty of the phenomenon, Levi-Montalcini saw the power of demonstrating new phenomena as a justification for the method. Their diverse view demonstrated the divergent disciplinary foundation of what we now know as neuroembryology.

Abir-Am, Pnina G. (Brandeis University)

A combination of Marie Curie and Maria Callas? Gender, ethnicity, & discovery in the life of Rita Levi-Montalcini, (1909-2012) superstar scientist

Rita Levi-Montalcini's (hereafter RLM) life and career, offer a rare opportunity to explore the intersection of 20th Century history & identity politics (gender, race/ethnicity, class) with scientific discovery. As a scientist she is best known as co-discoverer of the nerve growth factor, or NGF, with her collaborator Stanley Cohen, when both worked at the Wahington University in St. Louis, Missouri. Their discovery was recognized with major awards, such as the Lasker, the LG Horowitz/Columbia Univ., the Rosenstiel/Brandeis Univ. and the most coveted of all, the Nobel Prize in 1986. Since RLM's collaboration with her mentors Giuseppe Levi (at the University of Turin, Italy, until 1946) and Viktor Hamburger (at Wahington University in St. Louis, Missouri, 1946-1952) will be covered by speakers Ariane Cora Droescher (who is also the session organizer) and Jiang Lijing, respectively, this talk will focus on RLM's resourceful construction of her global persona as an embodiment of 20th Century history. Dimensions to be discussed include: - how a scientist can survive under a fascist regime without compromising oneself or one's research? - how a woman scientist can survive patriarchal society in both Italy and the US, as well as sexism in the scientific community, so as to persuade the world that despite debts to older and younger collaborators, the discovery reflected her own scientific genius? and last but not least, how a superstar scientist could promote civic international engagement in various causes ranging from science education to social justice.

Passariello, Alessandra (Ben Gurion University)

[Needham's search for the chemical identity of the neural organizer]

After examining the fate of Hamburger's inductive model of nerve growth through the encounter with Levi Montalcini's model of cell death driven neural development, we explore another, biochemical amendment to the inductive model: the search for the chemical identity of the neural organizer by Joseph Needham. In 1931 and again in 1933, Needham, together with the biochemist Dorothy Moyle Needham and the embryologist Conrad Hal Waddington, joined Otto Mangold's laboratory at the Kaiser Wilhelm Institute of Biology in Berlin-Dahlem. Those two stays condense Needham's first personal contact with the German tradition of Experimental Embryology, the same basin, which gave rise, under the supervision of Hans Spemann, to Hamburger's scientific career. Needham's aim was to gain mastery in the micro-surgical techniques, which allowed the experimental dissection of what was called at the time

the “organizer effect”. At that time, following a longstanding tradition, the action of the organizer was framed under the explanatory concept of "induction" and Needham's first attempt as a biochemist aimed at finding the chemical identity of the inducing substance. Biochemical assays gradually made this concept shift into the more nuanced concept of evocation and finally into the model of a biochemical pathway in gear with the metabolism of the embryo. Needham’s research thus provides another important shift in the explanatory role played by the concept of induction. While Spemann's heritage in Hamburger's research submitted to Levi-Montalcini's model, this same heritage followed in Needham a different though arguably parallel path.

S63 THE UNIFYING ROLE OF VISUALISATIONS IN EARLY MODERN SCIENCE

Location: IoE – Room 804 **Chair:** Basse, Christoffer Eriksen

Organiser(s): Basse, Christoffer Eriksen; Georgescu, Laura; and Present, Pieter

The sciences make use of a wide range of visual practices, aids, and devices to reason about phenomena, to represent theories, and to illustrate observations. Historians of art as well as historians of science have shown that imagery has been used in the most diverse areas of early modern science: from natural history to the mixed-mathematics disciplines, and from mechanics to natural philosophy (e.g. Baldasso (2006), Hunter (2010), Kusukawa and Maclean (2006), Mahoney (2004), Lüthy and Smets (2009)). Today, it is widely accepted that visual imagery – be they images, tables, or diagrams – is an important instrument for knowledge communication (e.g., Kusukawa 2006). What remains still somewhat controversial is claiming that visual media (and visualisations) are not simply *instrumental* to knowledge production, but have a substantial, non-trivial, and irreducible role to play in knowledge production. Differently put, visual media have *epistemic* value. The goal of this symposium is to substantiate the claim that visualisation is conducive to knowledge: it is by no means a redundant detour in the route to propositional knowledge, or to a propositional argument – it cannot be discarded without epistemic loss.
The individual papers of the symposium will present different cases in which visualisation plays a unifying role in early modern science: Diagrams were used to bridge theory and observation in the physico-mathematics of Petrus van Musschenbroek; Edward Wright reasoned with diagrams in order to specify a technique for finding the latitude at sea; and Nehemiah Grew used his botanical illustrations to negotiate the problem of scale.

Present, Pieter (Vrije Universiteit Brussel)
Cum Physica conjuncta fuit Mathesis: Petrus van Musschenbroek (1692-1761)'s use of diagrams in his physico-mathematics

Following the example of Newton, the Dutch natural philosopher and professor Petrus van Musschenbroek emphasised the indispensable role of mathematics in the practice of physics. At the same time, van Musschenbroek also warned that one should be conscious of the difference between physical demonstrations and the "pure demonstrations" provided in mathematics. Mathematics works by reasoning on "pure ideas", disregarding the question whether or not these ideas correspond to physical reality. Therefore, mathematics can only be fruitfully applied in physics through the mediating role of experiments. In this presentation, I will analyse the role of diagrams and images in van Musschenbroek's textbooks in unifying mathematics with physics. On the one hand, I will explicate van Musschenbroek's own views on the relationship between mathematics and physics and how they were informed by his empiricist epistemology. I will then show what role, according to him, experiments could and should play in physical demonstrations. After that, I will analyse the functions diagrams can have in this view. On the other hand, I will analyse the way diagrams and illustrations were put to work by van Musschenbroek in the teaching of physico-mathematics. I will show how these visual elements played a unifying role, helping the student to link together geometry, natural philosophy, and his observations of demonstration experiments performed by van Musschenbroek in his courses.

Georgescu, Laura (Rijksuniversiteit Groningen)
Rotating magnetised needles diagrammatically: Edward Wright's use of diagrams in mixed mathematics

Novel, but conceptual content does not come pre-made and already fit for the scientific problem at hand. It takes work to "make" a concept (or cluster of concepts) to be *that* concept and not another, to tailor a concept such that it responds to local problems, to be tuned to the other relevant concepts, and so on. In this presentation, I will focus on how diagrams (and diagrammatic reasoning) contribute to the scientific work of conceptual determination. More specifically, I defend the epistemic function that visualisations have in the sciences by showing that, sometimes, reasoning with and through diagrams is necessary in order to specify the relevant conceptual content at stake in the investigation at hand. I will do this by looking at how Edward Wright in his *Certaine Errors in Navigation* (published in 1599 and republished with revisions in 1610) reasoned with diagrams in order to specify a technique for finding the latitude at sea. The technique makes use of Gilbert's account of magnetism– especially his conception of magnetic inclination combined with basic knowledge about spherical trigonometry. It involves the generation of tables of latitude calculated relative to values of magnetic measurements of inclination. The presentation will not delve much into the method of calculation itself. Instead, it will focus on explaining *why* the method looks the way it does. I will show that the relevant conceptual content informing the trigonometry relies on a distinction between arcs of rotation and arcs of declination, distinction which is not simply "given" in experience or "given" in an experimental setup, but it is construed in the diagrammatic interpretation of an experimental setup. If so, then the relevant conceptual content informing the trigonometry is determined by choices in the construction of the relevant diagram(s) and by the specific ways in which relevant empirical variables were transferred diagrammatically.

Basse, Christoffer Eriksen (Aarhus Universitet)
The "reall bignesse" of specimens: Nehemiah Grew's botanical illustrations as negotiation of scale

In a recently rediscovered notebook containing Robert Hooke's first sketches of what would become the schemas of the *Micrographia* (1665), some of the magnified insects are paired with drawings of the same insect, but according to its "reall bignesse". This graphic strategy of representing both scales next to each other was taken up again and applied systematically by Nehemiah Grew in his *Anatomy of Plants* (1682). Here, all illustrations of roots, branches and seeds are accompanied by a small drawing representing the unmagnified specimen. In this presentation, I will show how early modern microscopists, and Grew especially, negotiated the scalar relationship between the visible world of unenhanced perception and the sub-visible world of microscopic observations. They did this, I argue, through visual as well as verbal description. The challenge for observers like Grew was that specimens could look very different when studied under the microscope. For instance, Grew showed that the sap-vessels of roots hitherto believed to be a continuous structure actually – when viewed through the microscope – was revealed to be discontinuous and consisting of small bladders. By being very careful to specify how objects looked with and without using the microscope and by presenting different scales next to each other in his tables, he was successfully attempting, I argue, to frame a unified conception of nature in which different scales were commensurable with each other.

S10/2 THE BUREAU DES LONGITUDES (1795-1932): COOPERATION AND COMPETITION NETWORKS

Location: IoE – Room 822 **Chair:** Fox, Robert

Organiser(s): Schiavon, Martina, and Rollet, Laurent

Created in 1795, the Bureau des longitudes was an international academy devoted to science and technology: a place for collective expertise and an advisory committee for the French government. It played a primary role in the organization and development of astronomy and celestial mechanics, the adoption of the decimal metric system, the

definition and implementation of time standards, the production and transmission of time signals, the development of earth physics and geodesy and the organization of major scientific expeditions. In the 19th and 20th centuries, its prestigious members – scientists, military and naval officers, and precision instrument makers – organized and participated in various national and international projects: the international geodetic association, the spread of standardization and the study of units of measurement, the dissemination of time signals, the adoption of the Greenwich meridian, among others. The Bureau des longitudes is thus a crucial place to study various cooperation and competition processes: from science to technology via the military, from scientific diplomacy to politics through economy, and vice versa. This symposium will be devoted to the analysis of such questions, in particular: § Circulation and priority conflicts concerning instruments and scientific discoveries § The influence of war on scientific organizations § Cooperation, rivalry and priority disputes § Conflict and collaboration between amateur and expert § Editorial rivalries (for instance between La connaissance des temps and other ephemerides) § Metrology, the metric system, almanacs and annuaires § Professional and institutional rivalries (scientists, military men, precision instrument makers, etc.) § Unity and discord between centre(s) and periphery(ies) The weekly minutes of the Bureau des longitudes from 1795 to 1932 are available online at http://bdl.ahp-numerique.fr.

Schiavon, Martina, and Rollet, Laurent (both Université de Lorraine)

1919: War and Post-War debates inside the French Bureau des longitudes

The Bureau des Longitudes was created in 1795 in Paris by Henri Jean-Baptiste Grégoire. Since its foundation, this small academy has been in close contact with the French Academy of Sciences; indeed, until today, a large part of the members of the Bureau – be they mathematicians, astronomers, geographers, engineers, etc. – have been recruited within the Academy. During the First World War, the Bureau des Longitudes maintained its meetings but, because of their mathematical, technical and geographical expertise, its members had to deal with many military and diplomatic questions: the circulation of astronomical information (ephemeris, small planets, etc.) and the organisation of international scientific associations without German influences, the recovery of Alsace and its astronomical Observatory in Strasbourg. The purpose of this talk is to explore continuities and discontinuities between War and Post-War debates through the minutes of the Bureau des longitudes, a new and original source for the history of science (http://bdl.ahp-numerique.fr). We will do this focusing on one year of weekly minutes: 1919.

Le Lay, Colette (University of Nantes)

Hippolyte Fizeau's fight against a magnetic explanation of sunspots and solar flares

Everybody knows the Doppler-Fizeau effect and Fizeau's experimental determination of the speed of light. But we want to focus on a less-known episode: Fizeau's fight against a magnetic explanation of solar activity. As a member of the Bureau des longitudes, during the weekly meetings, he gave negative accounts of the hypotheses of William Ellis (1828-1916) and Johann Rudolf Wolf (1816-1893) drawing a link between solar activity and magnetism. He found an ally in William Thomson (becoming Lord Kelvin in 1892). The procès-verbaux of the Bureau des longitudes (now online) give a vivid image of Fizeau, thirty years after the apex of his career, resisting to a new «paradigm».

Soulu, Frédéric (Université de Nantes)

French Time and Maghreb Space: the factory of time in the empire

If the actors of French astronomy in the Maghreb during the colonial period and protectorate (19th and 20th century) are the manufactors of the time, the State relies on the Bureau des longitudes in Paris which, as pointed out by the organizers of this symposium, plays "a direct

role in the administration of the state". Tensions and competitions are structured along several axes: between European actors in the imperial territories and scientific rulers of the metropolis, between European occupants and indigenous populations. The communication aims to describe the slow emergence of an Algerian hour in the colonial era. In the 1840s, public clocks were supposed to compete with minarets. The coordination of clocks on the territory becomes possible only with the telegraph in the years 1860. With the help of the Bureau des longitudes, the astronomer of Algiers, connected to the port economy of the hour, impose little by little his clock. As distribution of time is strategic for the appropriation of Saharan spaces in the early 1880s, a group of scientists, some of them military, is installed in Algiers. Coming from Montsouris in Paris, they underlined a break with the past local practices. The Algerian time contributes to the construction of the empire under the Bureau supervision. This communication highlights the circulations between the metropolis and peripheries, actors and ideas, but also circulations within peripheries. It relies on unpublished sources of the General Government of Algeria, the Ministry of Instruction publique and the minutes of the Bureau des Longitudes.

S47/1 MEANINGFUL COLOUR: EPISTEMOLOGY OF COLOUR IN THE SCIENCES (EARLY MODERNITY TO TODAY)

1. COLOURS AS SYMBOLS: EXPLORING THE REPRESENTATIONAL-MIMETIC-DIVIDE

Location: IoE – Room 828 **Chair:** Bock von Wülfingen, Bettina

Organiser(s): Bock von Wülfingen, Bettina

From amazingly colourful antique relics to the attempts to standardise colours in biomedical imaging – colour is gaining in relevance in the sciences. Yet the epistemic role of colour, its long-standing neglect due to historic symbolic, in part gendered, ascriptions, and the function of colour in visualizations for internal scientific use have not received much attention in the sciences and humanities to date. This is especially the case for non-mimetic colour use. With the term non-mimetic we refer to colours that are not applied to mimic colours of nature (such as the sky blue, urine, or plant colours) but are of (sometimes hidden and unintended) semiotic relevance. The internal use of colour in the sciences raises different epistemological questions to those that arise with images for external communication. The choice and symbolism of colour in the latter case is guided to a greater degree by a need for simplification and considerations as to the expectations of a broader public. Coloured images for internal scientific use emerge during the research process itself (as a medium for self-reflection) or are produced in appliances and used for intersubjective communication and to obtain feedback from the scientific community. Digital publishing has enhanced the use of colour in scientific images, in contrast to the costly use of colour in print media, whilst the globalisation of the scientific community challenges the idea of universal colour symbolism. Meanwhile standardisation of colour applications in scientific images seldom occurred and occurs, leaving a broad diversity of colour symbolism within fields. All this raises the need for colour awareness. The history of the ontology of colour has already gained some attention in history of science. It is of course not to disentangle from its meaningful use or non-use. Still, the session rather focuses on the meaningful application of colour and its interpretation by the sciences – and the history of such theorising. It explores the colour conventions and strategies in scientific images that predominate today as well as in historical perspective and across disciplines. This encompasses the issue of the neglect of colour as an object of scientific self-reflection and as an object of the humanities' research on the sciences. In brief: in this session we investigate the epistemic dimensions of colour in the sciences, across disciplines and across history.

Friedman, Michael (Humboldt University Berlin)

Coloring the fourth dimension? Polytopes and curves at the end of the 19th century

Starting from the 1850s, n- and 4-dimensional spaces were taken into serious mathematical consideration. This prompted questions regarding the visualization of 4-dimensional mathematical objects, being problematic to visualize. I aim to show, focusing on two examples: 4-dimensional polytopes and complex curves, that although these two belonged to different mathematical traditions, the solution that several mathematicians found for the problematic of visualization was via the usage of colour. To consider the first example, as just as in the 3-dimensional space one can find the five convex regular polyhedra (i.e. the Platonic solids), one can find six convex regular 4-dimensional polytopes. Ludwig Schläfli discovered this in 1852, but the question remained – how can one visualize these polytopes. In 1888, Alicia Boole Stott contributed to Charles Howard Hinton's book *A new Era of Thought*, describing ways to grasp the fourth dimension. In Hinton's book, one of the ways to visualize a 4-dimensional cube is via multicolored cubes; when assembled, they could be used to visualize a hypercube in the fourth

dimension. Boole Stott was familiar with other models, which represented sections of all the four-dimensional polytopes, and built them accordingly. The question about the visualization of complex curves was answered similarly.

Moreau, Jean-François (University of Paris)
[Colour and Doppler Ultrasound Artifacts]

For centuries and except on blackboards and positive X-Ray films, anatomists and radiologists used shades of grey with the blood vessel walls in black and the lumen in white. "It has been shown by reason and experiment that blood by the beat of the ventricles flows through the lungs and heart and is pumped to the whole body", physiologist William Harvey said in 1628. Then, when printers could feature color scales, the oxygenated aortic blood has been colored in red, the caval venous system in blue, the lymphatic one in yellow. Color Doppler real-time digital ultrasound is the only medical imaging technique using blue and red coding for hemodynamics but this doesn't reflect the O2 blood saturation. The ultrasonic probe recollecting the echoic waves plays the role of the "heart". In red the wave figures the blood flow coming to the probe, the wave in blue is centrifuge. Moreover the lighter the flow the faster. Heterogeneous structures induce the aliasing phenomenon. Pulsed Doppler ultrasound provides the associated vision of the curve of the blood flow. Artifacts induced by the sonographer malpractice are current causes of misinterpretation of intrinsic or extrinsic syndromes. Skilled dopplerists only are able to "think" Doppler's language.

Pisano, Raffaele (Lille University); Giller, Cole; Mornet, Patrick; and Rossi, Michael (University of Chicago)
"Green is Refreshing": Colour and Healing in Nineteenth-Century Medicine

Among the many meanings of particular colours in the European and American medical literature of the early 19th century, the colour "green" was especially associated with qualities of healing, recuperation, and rejuvenation. From manuals on best nursing practices, to treatises on workplace health, to advice for better living, expert and popular healers alike tended to subscribe to the commonplace wisdom that the colour green was a salubrious and efficacious way of reviving both flagging spirits and ailing bodies. This paper examines the symbolic, semantic, and practical dimensions of the colour green in nineteenth century medicine — from its mimetic associations with nature and growth, to its place in formalising otherwise occult physiological processes, to its role in regulating visual and bodily health and conduct. Ultimately, the healing properties of the colour green for nineteenth century medical practitioners comprised part of a larger attempt to describe a novel relationship between mind and body, and science and sensation. This relationship was required at once to preserve the common-sense distinction between imponderable soul and material corporeality, while allowing for novel epistemologies of the sensing, feeling, thinking body – including (but not limited to) physiology, psychophysics, and (eventually) biomedicine.

Bock von Wülfingen, Bettina (Humboldt University, Berlin)
Mimetic and Symbolic Colour Use in Scientific Diagrams: Biochemical Pathways

Scientists draw chemical pathways since Kekulés times around the end of the 19th century. Those were reaction pathways entailing only some elements. The terminology „biochemical pathways" or „metabolic pathway" begins to appear recently in the 1940s, labelling charts such as the one of the first metabolical path, the Glycolysis, which was then for the first time fully put together. In the following decades more and more charts of different metabolic paths in humans, animals and plants were published. Ultimately, these pathways used specific symbolic colour codes. One of the internationally best known had been set by Gerhard Michal who as a PhD student at Böhringer in 1965 started to draw complete pathways integrating all metabolic paths known in organisms to that day into one map. These were updated in the next editions to come. All were hand-drawn until 2002. The colours used were red, green, blue and the achromatic black for the fleches between the metabolised molecules. Since 2014 a first online-

version of this map was published and promoted as 'interactive', as different parts could be enlarged. Since the end of the 1990s however, and partly together with new cybernetically informed disciplines such as systems biology, different digital-tools for natural science's use appeared in publications in print and online.

S14/2 THE EMERGENCE OF COMPUTATIONAL SCIENCES

Location: IoE - Room 731 **Chair and Commentator:** Agar, Jon (UCL)

Organiser(s): Hashagen, Ulf

The digitization of the scientific world began after World War II when scientists started using the recently invented electronic digital computers to manage complex calculations and computation problems in science and engineering. While on the one hand computer science was established as a new scientific discipline in the following decades, on the other it became almost natural for scientists to use computers as a scientific instrument or research technology in the last third of the 20th century. As a consequence in some scientific disciplines novel computational methods were widely used. In mathematics numerical analysis was transformed by the computer from a former marginal sub-discipline into an important research field. Hereby only the computer as an enormously fast and programmable machine made it possible to process the many newly invented numerical methods for the solution of algebraic and differential equations and other mathematical problems. Furthermore a bunch of computer-based techniques arose in the following decades in various disciplines and transformed the researchers' work in fundamental ways. For example the well-known Monte Carlo Method was created in the context of war research in atomic physics, algorithmic approaches and scientific visualization in application fields. Among these new research technologies computer simulation became the probably most important tool, and in scientific communities the question appeared whether simulation is a third scientific method beyond experiment and theory. Moreover the scientists' eagerness for high performance computing devices had also a strong impact on the hardware development (supercomputers or parallel processing) and resulted in the setting of computer centers as service providers for scientific research in academic institutions all over the world. Moreover, in various disciplines forms of computational sciences emerged, such as computational astronomy, computational fluid dynamics and computational chemistry. While only few aspects of this eminent historical development have been explored so far—such as supercomputing at the large national research laboratories, the use of the computer in high-energy physics and in X-ray crystallography and the efforts to computerize bio-medical research—the field has been dominated by studies on computer simulation, mostly with a strong philosophical orientation. In general the emergence of computational sciences and the use of developments have not become a central topic for historians of science and technology so far and there are still large gaps in the knowledge on the history of computational sciences. This symposium aims at considering different developments of computerization and computer-assisted methods in various periods, nations, societies and cultures. These views support the interpretation of disunited paths of scientific disciplines to their computational continuations. The studies in this symposium will highlight relations between these scientific disciplines and aspects of politics, technology, and economics, which are part of the process that terminates in the computational turn. Finally, the symposium refers to the question whether the particular developments of disciplines are just parts of one unique process of "computationalisation". Is the second half of the 20th century the beginning of an era of computational sciences or rather of a unified computational science?

Alberts, Gerard (University of Amsterdam)
Continuities and discontinuities in the rise of computational approaches

The same historical phenomenon of growing use of computers in the sciences appears with strong continuities, when looked upon from the perspectives of computational methods developing and spreading, and appears with bumps and hickups when observed from the side of the disciplines and their methods.
Perhaps the oldest right of birth of a scientific practice called computational, is held by CFD, Computational Fluid Dynamics, when it gradually superseded Aero- and Hydrodynamics; or in the German speaking world "Strömungslehre". The practices, around the increasingly automated machinery show strong continuities. Certainly, fields like astronomy, or christallography were at least as computer-intensive, but these did not bother to designate a branch as "computational". By contrast a plethora of disciplines followed suit of CFD and developed computational niches, from computational chemistry and computational physics in the 1960s to computational management science in the 1980s. These niches were quite innovative, but in an incremental way, showing continuity. From the perspective of the receiving disciplines a different picture emerges, that of a methodological and epistemic revolution. For example, computational chemistry, like a cuckoo's egg, developed from niche to dominant approach, marginalizing other approaches. By the turn of the millennium, the computational approach had become the predominant one in chemistry. It had become "only natural" to use computers and computational methods in every step of chemistry, from searching literature, to searching components with specific qualities, to reformulating basic equations, and to doing experiments in virtuality. Seen from the receiving end, becoming "computational" implied revolutionary discontinuities in methods and in ways of knowing. What was considered to be the "natural approach" had undergone drastic changes. Continuities and discontinuities make the historian acutely aware that it makes all the difference which perspective is chosen in rendering the "rise" of computational appoaches.

Borelli, Arianna (Technische Universität, Berlin)

Beyond "artificial reality": The many faces of Monte Carlo computations in early particle physics

The classical reference on the history of Monte Carlo computations is Peter Galison's (1997) study of their origin in nuclear weapon research and subsequent diffusion in scientific and engineering practices as an "artificial reality" in which experiments could be virtually performed. Casting doubts on some aspects of this picture, I will show how the view that Monte Carlo computations "simulate" reality was initially not so dominant as would be the case later on, and how the Monte Carlo method could be assimilated not only to experimental practices, but also to theoretical ones. Using examples taken mainly from early particles physics I will argue that, depending on the context, the "same" Monte Carlo computation could be seen as a simulation of physical processes, as a tool to numerically estimate analytical expressions or as a means to represent theoretical models of particle interactions. Only later on did the idea that Monte Carlos "simulate" reality became dominant, and it should not be more or less implicitly regarded as a "natural" consequence of technological developments in computer science, as often done today. My presentation addresses various issues at the core of the symposium, especially the question of whether processes of "computerization" in different areas of science and technology can be seen as mutually related, and how far, and for which time period, it may be historically plausible to speak of an overarching process of "computationalisation".

Seising, Rudolf (Deutsches Museum, Munich)

Computational Statistics as a Fusion of Data Science and Artificial Intelligence

The cybernetic idea of constructing "devices out of logical elements with neuron-like properties" resulted in McCulloch and Pitts's "logical calculus of the ideas immanent in nervous activity" (1943). In 1949 the neuropsychologist Hebb explained the concerted function of living neural "cell assemblies" as processing units and tried to explain "learning" and when the psychologist Rosenblatt established his theory of "perceptrons" as a class of brain models" (Rosenblatt 1958) he used a model of Hebbian learning. Another path to analyze learning

behavior started with statistical work on biological classification (Belson 1959), verbal learning (Feigenbaum 1959) and concept learning as “experiments in induction” (Hunt, Martin, Stone 1966). Statisticians construed binary segmentation programs (Morgan and Sonquist, 1963) and algorithms for matching and prediction (Belson 1959) in data sets. These works resulted in the new field “data analysis” (Tukey, 1962). Some decades later the discipline of statistics stood at a crossroads (Friedman 1997). The different disciplinary backgrounds, statistics and machine learning, resulted in a dissimilar understanding of the mathematical tools to analyze data of random or complex processes. The data modeling approach is based on the assumption that a given stochastic model generates the data and that the statistician aims to estimate some probability distribution. Instead, members of the machine learning assumed that a complex but unknown “mechanism” generates present data. Using an algorithm, they tried to imitate (simulate) the observations, which remains an optimization problem (Breiman 2001).

I130 MATHEMATICS 2

Location: IoE – Room 736 **Chair:** Nocks, Lisa

Cerroni, Cinzia and Brigaglia, Aldo (Università di Palermo)
The "Circolo Matematico di Palermo" and the first world war: the crisis of scientific internationalism

The year 1914 for the "Circolo Matematico di Palermo" was a wonder-year, but also a very difficult one. It had achieved some prestigious goal: with almost 1.000 members, the Circolo was the more important mathematical association in the world (from a numerical point of view, at least); it had two thirds of members from abroad; the editorial board of its journal (the Rendiconti) was at its highest level (Hilbert, Klein, Borel, Picard, Fredholm, Moore, Volterra, Segre, Castelnuovo, Enriques, Bianchi, …). But, on the contrary, many new difficulties had appeared: in the same year the founder and president of the Circolo, Giovan Battista Guccia, died and the first world war broke out, with the well-known consequences on the international relations among scholars. The new director of the Rendiconti, Michele De Franchis, had to face a very awkward situation. While he intended to be faithful to the ideals of scientific internationalism, some members of the editorial board (particularly Picard and de la Vallée Poussin) strongly demanded the exclusion of the German associates. Since 1914 to 1928 the Circolo was perhaps the only European scientific association with German (Hilbert, Landau, Courant) as well as French associates. During the '30s, the nationalist politics of the fascism and above all the racial laws will give a deadly blow to the Circolo as an international scientific association. We will use the rich correspondence in the Circolo's archives to shed some light on this.

Ciesielska, Danuta (Institute for the History of Science Polish Academy of Sciences, Warsaw)
Young Poles in Göttingen: A Difficult Struggle for the Unity

At the turn of the 20th century University in Göttingen was a "world Mecca" of the scientists. Students from all over the world were arriving to this university to study under the supervision of notable scientists: David Hilbert (1862–1943), Felix Klein (1849–1925), Constantin Carathéodory (1873–1950), Ludwig Prandtl (1875–1953), Hermann Minkowski (1864–1909) and others. At that time, international communication in science and international scientific collaboration started. Göttingen was one of the centres of the united world of scientists. Young people arriving there wanted to become a part of the "international scientific union". Among those who came to Göttingen were young men and women united by Polish nationality and/or language. They formed quite a large group, so staying in Göttingen gave them an opportunity for discussions in their mother language. During these discussions, some of them were dreaming about "independent Poland" and "national science". In November 1918 three parts of Polish lands, annexed in the end of the 18th century by Austria, Prussia and Russia, united into one independent country – Poland. Educated in Göttingen Polish mathematicians, physicists and astronomers were crème de la crème of Polish scholars. In the years after World War I they manage to combine two really different ideas, i.e. "national" and "international" science. In the talk I will present some results of research concerning this phenomenon.

Michel, Nicolas (University Paris-Diderot (Paris VII))
Escaping the gaze of the Gorgon: On the permanent reshaping of mathematical objects

A long-standing problem in the historiography of mathematics is that of reconciling the supposedly atemporal and universal character of mathematical truths and objects with the multiplicity of concrete practices, but also of conceptualisations of said objects. In this talk, we explore a case-study borrowed from the history of 19th century geometry, which brings this difficulty to the fore. In the wake of important discoveries by French geometer Michel Chasles, several mathematicians, anchored within radically different scientific communities, set out to

expand on his results. Each used what they considered to be the adequate mathematical tools for modern geometrical practice. In so doing, not only did they end up with incompatible notions of an object as elementary as a conic, but also with a robust disagreement on the very veracity of one of Chasles' central claims. Our aim is to provide an historical account of this episode which explores the material techniques and resources used in the shaping of these incompatible notions of geometrical objects. We then compare these concrete practices with the normative discourses held by these actors on what constitutes a proper mathematical investigation. Exploring how mathematical objects are shaped and twisted through the displacements from one such "mathematical laboratory" to another, we claim, allows for an outlook that preserves the unity behind the intellectual dynamics at play, without subsuming the originality and peculiarity of each of these conceptualizations, as a reading informed by recent developments in algebraic geometry would necessarily do.

Besler, Gabriela (University of Silesia in Katowice, Poland)

Unity and Disunity between Gottlob Frege and Giuseppe Peano on the Basis of their Correspondence in the Years 1891-1903

Frege – Peano correspondence contains 12 documents and was started before 1891 by Peano, who sent Frege his papers. Definitely, there was a unity of their aims in mathematics: to improve it by logic. As Peano wrote, they had much to gain from the parallel between their systems: Peano's mathematical logic and Frege's conceptual notation. They compared their symbolisms: Peano's sign of deduction and Frege's conditional stroke; quantifications and its understanding. Peano translated a number of Frege's formulas into his mathematical logical symbolism. Frege praised Peano for introducing two kinds of propositions: general and singular. Both Frege and Peano distinguished universal and existential quantifiers. However, there was a disunity between them as well. For Peano logic was a tool to examine the principles of arithmetic and geometry (mathematical logic). For Frege arithmetical notions can be defined in terms of purely logical notions and arithmetical principles can be derived from the laws of logic alone (logicism). They did not agree how much their systems count primitive terms and which signs should be treated as primitive. Frege criticized Peano's definitions of equality and addition. They both did not agree as to what it means to create a good definition. Frege regarded his conceptual notation as better than Peano's in many respects. They used different signs to express quantification. There was much more unity than disunity between them. They well understood each other. However, there is a lot of constructive and serious mutual criticism in their letters. It is unity in diversity.

S18 THE CORRESPONDENCE OF JOHANNES HEVELIUS: BETWEEN SCIENCE AND SCIENCE POLICY. WORK-IN-PROGRESS REPORT

Location: IoE – Room 780 **Chair:** Halleux, Robert

Organisers: Włodarczyk, Jarosław, and Grell, Chantal

Johannes Hevelius (1611–87), the astronomer based in Danzig, published more than 20 scientific treatises which strongly resonated with the contemporary academic world. Moreover, he left a massive collection of correspondence, comprising more than 2000 letters and approximately 430 correspondents, scholars as well as people wielding political power at the local and continental scale. Presently the correspondence of Hevelius remains probably the largest understudied collection of letters written by the scholars from 'the age of scientific revolution'. For the last several years, however, under the patronage of l'Union Academique Internationale and International Academy of the History of Science, we have been running an international project to prepare a critical edition of Hevelius's letters. The project will significantly contribute to our understanding of the 17th century science, of the links among various scientific centres, the relations between scholars and their patrons, as well as of the historical, social and intellectual factors conditioning scientific research. The project renders also a cumulative picture of the fifty years of the evolution of the scientist figure in the early modern period. The symposium consists in the presentation of the newest findings as regards Hevelius's correspondence.

Grell, Chantal (Université de Versailles)
The correspondence between Johannes Hevelius and Pierre des Noyers, as the mirror of scientific novelties

Pierre des Noyers (1608–93), a disciple of Gilles Personne de Roberval, is the most important correspondent of Johannes Hevelius. Their correspondence consists of 257 letters, in a corpus of 2700 letters, i.e. about 10% of the total. Pierre des Noyers came to Poland with the Queen Louise-Marie de Gonzague. During his travel he spent some time in Gdansk (dec. 1646) and met the astronomer who was a prominent member of the city elite, as one of the most important brewers. In this time, Hevelius was achieving his *Selenographia* (1647) and Pierre des Noyers was very helpful to enlarge to Europe a network that already included Marin Mersenne and Pierre Gassendi. The relations between the two scholars were very intense. After the death of the Queen (1667), des Noyers stayed in his friend's house. The last letter is dated October 1686. Hevelius died in January 1687. Pierre des Noyers remained in Poland where he died in 1693. The contents of the letters are very diverse, especially about the new progresses in scientific actuality of which the present paper aims to give some samples.

Jasiński, Maciej (Polish Academy of Sciences)
Stanisław Lubieniecki and Johannes Hevelius: (Extra)ordinary "men of letters"

Stanisław Lubieniecki (1623–75) seems to be one of the most important correspondents of Johannes Hevelius. There are over ninety letters they wrote to each other in nine years' time. Some of these letters are quite voluminous and contain lots of attachments dealing with various astronomical issues, mainly comets. Significantly enough, these letters constitute the third largest part of the corpus of Hevelius' correspondence. The analysis of Lubieniecki's book *Theatrum Cometicum* (3 vols., Amstelodami 1666–68), where he published his astronomical letters, shows that also in this case the letters to Hevelius were the third most numerous group. In my paper, basing on the manuscripts from the Paris Observatory Library, I will scrutinize the correspondence between Lubieniecki and Hevelius. Specifically, I intend to explain what these two participants of the Republic of Letters tried to accomplish with their letters, what methods they applied and why the correspondence between two men of so vastly different scientific

standing could be so numerous and long-lasting. Furthermore, I will compare Hevelius' correspondence to other collections of letters in Lubieniecki's *Theatrum Cometicum*. This will serve to demonstrate both the ordinary and the unusual features of their correspondence.

Mallet, Damien (Université de Bordeaux-Montaigne)

Pierre des Noyers, a scholar and a courtier

Pierre des Noyers was a major personality at the court of Queen Louise-Marie. Officially her secretary and personal treasurer, he was also a man of science, a scholar interested in astronomy, astrology, and medicine, always curious about prodigies and miracles. Pierre des Noyers was an important courtier and middle-man for French and Polish relations. Through him materialized the French attempt to bring the prince of Condé on the Polish throne for instance. Long time correspondent of Johannes Hevelius and Ismaël Boulliau, he knew all but too well how critical patronage was for scientists of the time – he himself, was well cared of by no other than the Queen of Poland. Hampered by an empty treasury and a constant state of warfare, the king of Poland Jan Kazimierz could never provide Hevelius the protection he deserved. This paper focuses on des Noyers' efforts to promote the works of Hevelius in France, through his network of friends, fellow astrologers and powerful nobles.

Włodarczyk, Jarosław (Polish Academy of Sciences)

'Peripheral' astronomy in the correspondence of Johannes Hevelius: A case study of Maria Cunitia and Elias von Löwen

The letters of Johannes Hevelius reveal a very interesting map of the European astronomy of the 17th century. Significantly, Hevelius was not only a key agent in the transmission of scientific information among the main centres which, for example, made Gdańsk equally important as London and Paris for early modern uranography. Hevelius exchanged also letters with astronomers whose achievements are hardly ever discussed within the framework of the general history of astronomy. And yet the analysis of their activities allows for the complete reconstruction of the 17th century astronomy, including its diversification which stemmed from the tensions between tradition and modernity as well as from the specific research interests of minor scholars. One such case is Maria Cunitia (1610–64) and her husband, Elias von Löwen (Crätschmair; c. 1602–61) based in Silesia. Maria Cunitia is acknowledged for her *Urania Propitia* (1650), an innovative adaptation of the mathematical astronomy of Johannes Kepler's *Rudolphine Tables*. In turn von Löwen authored astronomical calendars and ephemerids. Their correspondence with Hevelius – 22 letters from the years 1648–1654 – constitutes an important source of knowledge about the astronomical 'background' which allowed them to complete their published works as well as about the activities of such astronomers from outside the major scientific centres. It is my intention to discuss the astronomical content of these letters.

S21/2 CONTINUITY AND DISCONTINUITY OF UNIVERSITY EDUCATION AND RESEARCH ACTIVITIES OF CENTRAL EUROPEAN SCHOLARS DURING WORLD WAR II

Location: IoE - Room 784 **Chair:** Jůnová Macková, Adéla

Organiser(s): Jůnová Macková, Adéla; Sekyrkova, Milada; and Kokowski, Michał

Commentator: Ash, Mitchell

World War II changed and challenged generations of European researchers, and impacted on the existence of research institutions. Several occupied countries had to close their higher education institutions in 1939 (Protectorate Bohemia and Moravia, Poland), scholars lost jobs and students opportunities. One solution that maintained a research career as a viable option for scholars consisted of teams in non-university research institutions. It was a way of survival that offered work, and sustenance, even though with limited teaching opportunities, and limited publication outlets. A generation of students had to leave the universities, and their younger followers did not have a perspective – army life and factory work was an imposed solution. An alternative applied in Austria, Hungary, and Germany itself was to embark on research projects and teaching plans deemed acceptable to the regime and to war conditions. Across Nazi-controlled Europe, racial laws, army conscriptions, and enforced exile exercised a considerable influence, next to a reorientation of research programmes to contributions to the war effort. Historiography mapping and interpreting a profound war impact in occupied regions concerns both institutional histories and individual, more biographically oriented aspects. Personal histories of Central European researchers on diverse sides of the conflict included also resistance to the Nazi regime. The symposium panel is concerned with a continuity and discontinuity of research institutions, disciplines, and research interests of Central European researchers during the war. Both institutional and individual aspects have been incorporated, mapping diverse strategies and outcomes. The individual perspective also includes everyday existence, and very personal aspects of habitus, with practices and representations set in highly complex situations, such as exile, resistance, war effort, or survival in a totalitarian regime.

Cain, Friedrich (Erfurt University)
Knowledge from the Underground. Polish Academia During the German Occupation, 1939–1945

During the German occupation of Poland, a rigid regime was installed. Though many governmental institutions were not closed and could even keep Polish staff due to the lack of German specialists, this only maintained the occupiers' structures. No official (diplomatic) German-Polish relations existed and Poles could only exist as low ranked individuals. Any collective effort was forbidden or mistrustfully supervised, cultural and social life could not carry on as before. Science was not spared either: Universities, research institutes, and the Academy in Cracow were closed and only few re-opened as German institutes. Nevertheless, Polish academic research and teaching did not seize to exist. After some time, former colleagues reconvened to organize seminars for their old (and also new) students. Such clandestine activities grew to respectable numbers: about 6.000 people studied at the so called Underground Universities that were organized in private flats, cellars, or under other cover. Many scholars also tried to re-/establish research activities. Devoid of laboratories and libraries they organized necessary equipment or thought about possible ways to replace parts of the apparatus or the apparatus as such. After the war a bulletin of the Cracow Academy listed not less than 626 works prepared and written between 1939 and 1945. The paper examines the effects the specific conditions on underground research and its results, covering theoretical and

practical frameworks, techniques of the scientific self and the status of research in the Polish community. An outlook on post war careers and the legacy of the underground will be given.

Neuenschwander, Erwin (University of Zurich)
Three case studies of mathematicians in the Third Reich: Bessel-Hagen, Hausdorff, and van der Waerden

The mathematician Erich Bessel-Hagen (1898–1946) is perhaps best known for the many jokes that still circulate about him although having been an excellent and very decent mathematician. Hel Braun tells in her autobiography that Carl Siegel threw on a sea trip the only copy of Bessel-Hagen's habilitation thesis overboard – which he had to review – because this task hindered him in his own work. Another well-known joke goes back to Kerékjártó who referred in his book on topology to Bessel-Hagen by a topological diagram with oversized ears. Because of his shyness, Bessel-Hagen did not publish much. However, during World War II, he was on account of his physical handicap for a long time the only mathematician at Bonn University and helped among other things to preserve the papers of his Jewish colleagues for posterity. Bessel-Hagen's papers are an important source for mathematics under the Nazi regime. They contain besides his extensive correspondence great parts of the literary remains of Otto Toeplitz, who emigrated in 1939 to Palestine. Bessel-Hagen was one of the very few persons who held close contacts with Felix Hausdorff during these difficult years. It is therefore not surprising that I discovered around 1990 when I arranged the papers of Bessel-Hagen in the University Archive in Bonn Felix Hausdorff's farewell letter. Another important source for the Nazi period is the voluminous correspondence of B. L. van der Waerden on which I am presently working.

Franc, Martin (Masaryk Institute and Archives of Czech Academy of Sciences)
Wartime roots of research teams of the Czechoslovak Academy of Sciences

The closure of Czech universities during the WWII, in 1939, significantly disrupted the career path of many naturalists. After the Nazi occupation they had to seek new paths for scientific work. Many emerging found their way into industrial research on the territory of the Protectorate of Bohemia and Moravia, which was, of course, a considerable change for them from their previous experience in the academic world. The foundations of teamwork were created there, aimed at quite clearly stated objectives with practical outputs. Although traditional hierarchical networks were established in industrial research, this area still offered, somewhat paradoxically, greater opportunities for professionally and organizationally talented younger researchers than the very rigid academic environment, replete with a variety of personal ties and yet very narrow. Several important centres of scientific work were established, the breeding grounds for prominent scientists who played an important role in their fields after the WWII. These exceptionally talented experts began to build teams of collaborators that had a major impact on the staffing of several sites, especially in the Czechoslovak Academy of Sciences (CSAS). Probably the most prominent example of a CSAS site built around people grouped during the WWII was the prestigious Institute of Organic Chemistry and Biochemistry, headed by František Šorm, President of the Academy in 1962-1969; Šorm was an extremely capable scientist and organizer and had been very active in the Association for Chemical and Metallurgical Production during the times of the Protectorate.

Šoukal, Jiří (Masaryk Institute and Archives of the CAS, v. v. i.)
Czech professors from Medical Faculties and their career strategy during the World War II

Czech Professors from medical faculties and their career strategy during World War II The generation of natural scientists born in the 1880s and 1890s reached the top at Czech universities in the 1930s. Unfortunately, the occupation of Czechoslovakia interrupted their careers. On 17 November 1939 the Czech University and all other Czech institutions of higher learning were closed, a situation that lasted until the end of the war. The Professors were either transferred to other departments, reassigned to secondary schools, or sent on leave with waiting or into retirement. This paper deals with the question of what strategy the Professors

chose. Some of them remained on leave or in retirement while others worked in research institutions. The difference between the strategy of heads of departments or institutions and younger lecturers or assistant professors is pointed out. Their approach was closely related to the position of the scientists, their habitus, family background and ambitions. One of the most important research institutions was the State Health Institute (today the National Institute of Public Health), which focused on the research of medications, especially vaccines. Some Professors continued researching there. Research in this Institute was an important contribution to the development of Czech hygiene, epidemiology and microbiology. Based on archival research and memories, it is possible to identify changes in the Professors' research and their standing in science.

S36/2 THE IMAGE OF SCIENCE IN RUSSIA AND THE USSR

Location: IoE - Room 790 **Chair:** Samokish, Anna

Organiser(s): Samokish, Anna

The symposium will be devoted to the topic of how an image of science is formed through the perceptions of society. The means and mode of acceptance of science by society is one of the most important research areas for historians. Science cannot exist in a vacuum; its fate depends on how it is perceived by society, how it is governed by authorities, and the success of its practical applications. We propose that the panellists address the question of how the development and achievements of the natural sciences were perceived by society in Russia, the Soviet Union and East European countries under the Soviet rule. Of particular interest is how scientific achievements were presented in periodical press, fiction books and in school and university textbooks. How the authorities reacted to different scientific theories, thus revealing how the image of a scientific theory can divide or unite not only specialists but members of the general public. Textbooks and curricula are of special interest since they reflect the evolution of ideologies at certain periods of time Especially vital were the methods of education in the natural sciences and the perception of scientific knowledge during the tragic periods of the first post-revolutionary years and the period of Lysenkoism. Of interest are also attempts to adapt certain scientific theories to various cultural and political environments. The "German Darwin" Ernst Haeckel is best known not only for advocating Darwinism on the Continent, but also for his attempts to convert Darwinism into a universal worldview. Yet, Haeckel's scientific and philosophical heritage found its way into the curricula of as different environments as USA, Nazi Germany, GDR and the USSR. The examination of figures like Haeckel and of their influence in various socio-political systems contributes to the understanding of relationships between science and the state. The image of science in literature, first of all, in science fiction, will also be considered. The fiction books have always been much freer from pressure by soviet authorities than the periodical press. At the same time, authorities tried to use the influence of especially popular fiction writers for constructing an image of science that would serve the needs of dominating ideology. An important link in the connection of science and society has always been environmental protection. Discussion of reserves, conservation issues was at the soviet time an opportunity for scientists to bring their point of view to the broad audience. The analysis of periodicals is crucial for the reconstruction of this discussion. In sum, this panel will cover the diverse aspects of public image of science in the USSR and its satellite states.

Levit, Georgy (Kassel University)
Ernst Haeckel in Germany and Russia: Two Ways of Radicalizing Darwinism

Ernst Haeckel is one of the crucial figures in the history of Darwinism and is known as "German Darwin". Haeckel is also known for his efforts to radicalize Darwinism and to make it into a universal worldview (monism). In his *Generelle Morphologie der Organismen* (General Morphology of Organisms), published in 1866, Haeckel, for the first time, started to formulated his basic concepts. Yet, General Morphology was never translated into other languages, and reached a limited audience even in the German-speaking lands. The promotion of Haeckel's ideas followed the publication in 1868 of a collection of lectures titled *Natural History of Creation.* This popular science book became a bestseller and was also translated into many different languages including Russian. Haeckel's another bestseller *The Riddle of the Universe* (originally published in 1899) was translated into Russian as well, but both books experienced serious troubles with the censorship in the tsarist Russia, because of their emphasis on the

"animal origin of man". Later in the 20th century both Nazi Germany and the USSR tried to adapt Haeckel to their needs. Certain groups of Nazi ideologists attempted to use his authority to substantiate the racial theory. On another side, Haeckel's scientific heritage found its way into the school curricula in the USSR, where his Darwinism and, especially, his "embryos" were used to substantiate the "materialist" view of nature. The examination of Haeckel influence in various socio-political systems contributes to the understanding of relationships between science and the state.

Kolchinsky, Eduard (Russian Academy of Sciences, St Petersburg)

Sacralization of Conflict N. I. Vavilov and T. D. Lysenko in the Literature and the Press

Conflict of N.I. Vavilov and T.D. Lysenko in the literature and the press is reflected in several sacral dichotomies: "the genius-evil", "scholar-quack", "the patriot-traitor". Depending on the authors' views and social contexts, both parties are described as innocent victims, and their opponents as the incarnation of evil. Their biographies, like the lives of saints, nourish myths about some hostile powers interfering the science like in the kingdom of truth and goodness. Comparative historical research of the evolution of the narrative about Vavilov and Lysenko shows that the origins of such sacralization date back to the 1920s. The concept of "heroes" and "villains" of Russian science dominated in the years of perestroika, and Lysenkoism became a symbol of pseudoscience. In contrast, soon Vavilov and Lysenko were portrayed as representatives of the unified "Stalinist science", who competed hard for finance, for the attention of the powers, for dominating their schools, and for creating their own "scientific empires". The conflict of late years has acquired a new sacral meaning. Some depict Vavilov as a great scientist, the forerunner of the "green revolution" that saved humanity. Others continued to accuse him of scientific barrenness, of cosmopolitanism etc. He is opposed to Lysenko as a patriot and a true Orthodox, a defender of the identity of Russian science and a brilliant agronomist. Lysenko is credited with foreseeing epigenetic and prions.

Samokish, Anna (Russian Academy of Sciences, St Petersburg)

The struggle of scientific theories in school textbooks

Teaching a school subject is usually closely related to the development of a scientific discipline. However, various non-scientific factors often interfere with this process. In Russia and the USSR it was especially difficult. After the October Revolution (1917) all the obstacles, religious and political, burst and natural science became one of the main school subjects. The first post-revolutionary years teachers in Petrograd sought to bring school textbooks closer to the real development of biology, even the basics of genetics were taught. But in the middle of twenties the "complex¨ programs appeared and the natural science was replaced with the agronomy classes. During that time evolutionism existed in school as a general idea only because it was very convenient for the political situation. As soon as the era of Lysenkoism began, textbooks immediately reacted to this. In 1938 curriculum along with a detailed description of the basics of genetics one can see the description of Lysenko's work. In 1948 the scientific foundations of textbooks merely disappeared and were replaced by "fantastic knowledge" on the basis of Lysenko's ideas. After the fall of Lysenko and the rehabilitation of genetics, new textbooks had to be prepared urgently. Otherwise, the ideas of Lysenkoism lasted much longer in the students' minds. The book by Yuri Poliansky and his colleagues was prepared in a very short time. None of the authors was a schoolteacher, although almost everybody actively participated in the life of the secondary school of that period.

S34/1 HISTORY BEHIND STATISTICS: UNITY AND DISUNITY BETWEEN SCIENTIFIC COMMUNITIES AND BUREAUCRACY

Location: IoE – Committee Room 1 **Chair:** Lanata Briones, Cecilia T.

Organiser(s): Lanata Briones, Cecilia T., and Daniel, Claudia

Commentator: Beaud, Jean-Pierre (Université du Québec à Montréal)

Statistics can be perceived as facts detached from producers and users that are unproblematic and certain, as ready-made science (Latour 1987). Since the nineteenth century, nation-states have produced and relied heavily on statistics, to the extent that governments' performance began to be evaluated by what numbers (do not) show. Economic and social statistics became the foundational backbone of modern government. The incorporation of numbers into public life aimed to depoliticise functions of public and private administration through rationalisation (Stapleford 2009). How were quantification tools constructed? Who developed them? How were public statistics and measurement tools used in different fields (science, politics, firms, etc.)? How have these instruments changed through time? This symposium examines the ways to produce statistical knowledge and the role played by statistical quantification tools throughout history. The panels bring together socio-historical approaches that enhance the social and political foundations that explain the transformations of quantification techniques, practices and languages. The unfolding of the history of statistics merged research categories that were born separately: one referring to the history of institutions and statistical systems and the other to mathematical statistics and probabilities. This convergence added complexity to the way we understand what statistics do and what we do with them. The encounter is linked to the fact that probabilities and macro-social descriptions of public statistics have been continuously intertwined, meeting and separating (Desrosières 2004). Therefore, the studies of its historical evolution should address both the academic and administrative dimensions of statistics, as they reciprocally shape each other (Porter 2000). Statistics is simultaneously a tool of constructing and proving scientific facts and a technical language used in the social debate with great capacity for persuasion (Desrosières 2008). This power lies on its double source of authority, of science and the state. The study of statistics has developed across a variety of fields, settings and actors, joining several histories. The history of economic facts and the trajectory of schools of thought were intertwined with the evolution of technical tools and statistical models used by economists. The production of sanitary statistics was connected with the social history of health and disease, the development of the medical profession, the public health movement, and of life insurance. Both the historic population moves and the development of demography were involved with the historical and political nature of censuses and the generation of vital statistics and statistical nomenclatures. Linking elements only distant in appearance, the history of statistics shows that the institutionalisation of concepts, practices and statistical tools does not follow linear trajectories. Quite the contrary, they are basting formulations made in national statistical agencies or academic spheres, discussions in statistical communities, applications in the practical world, and mobilisations of private interests or state support. These entangled histories sometimes portray tensions and controversies within scientific communities or between scientific societies and state bureaucrats. The inclination of statistical language towards universality intersects with specificities

marked by national traditions. Lastly, private and public uses of statistical tools could also be seen as factors of union and disunion.

Chazaro, Laura (Departamento de Investigaciones Educativas, Cinvestav-IPN)
A state searching for a national census: medics, statisticians and bureaucrats confronted regarding measurements of the Mexican population

Studies of the history and politics of population statistics show how population censuses are linked to the emergence of nation-states. These histories emphasise that the statistics produced within the administration of modern states are linked to science's spirit and practices of precision. The measurements linked to discourses and scientific practices created an enumerative spirit that administered society. Although in Mexico this trend is corroborated, the connections between the states' practices of population counting and those produced by scientists and scientific societies are disconnected from those produced by the national bureaucracy. The censuses produced by the Mexican bureaucracy faced technical, authority and political legitimacy problems. Enumerations, calculations and approximations made by scientists, doctors and educators, however, enjoyed greater credibility and authority. This paper examines what made it possible to produce censuses and enumerations of the population and how the administrative possibilities of measuring the population were created. Through the analysis of the quantification practices of bureaucrats and medics, this paper questions how a numerical description constitutes, constructs or intervenes on certain social configuration and what regulations create the public sphere. The aim is to examine how bureaucratic census production transformed medical measurements examining what is created or what is constructed when counting. The paper focuses on the practices that made the counting possible, on how the administrative possibilities to measure the population and account for its economic and health status were created.

Erdelyi, Matyas (Central European University)
You Are Not a Doctor: Medical Statistics in the Habsburg Monarchy

Statistical knowledge combines public discourse, disciplinary competition and statistical methods. Medical statistical tools' perceived universality is disrupted by disciplinary competition and credibility struggle. They involve a multi-dimensional analysis of knowledge production at the backdrop of increasing disciplinary competition, conflicting social values and habitus, and numerical interpretations. Hungarian statistician József Kőrösy advocated compulsory vaccination against smallpox using statistics. Kőrösy was questioned because "he is not a doctor", "he is not noble". The controversy exemplifies knowledge production: statistical tools' mathematical validity; competition between statistics, medicine and law; the scientists' background and political implications. My paper broadens this examining the production and application of medical statistics by people of different backgrounds. Abnormal lives in life insurance or the nomenclature and statistics of causes of death linked and confronted Eduard Buchheim, insurance physician in Prague, and Ernst Blaschke, mathematician at the Technische Hochschule in Vienna. The narrative exemplifies how the structure of the academic and semi-academic field in the Habsburg Monarchy was an outcome of the way people used it and how knowledge production happened on different semantic and social levels. It is the story of how differences and interpretations were constructed, and how agents contested and re-interpreted norms. They share "cultures of knowledge", but there is tension the old genteel society and the newcomers of de-feudalization, industrialization and democratization. These cases include power struggle over control of knowledge production, while agents must constantly negotiate and re-negotiate what counts as intellectually-established and culturally-legitimate.

Wallut, Quentin (Université du Québec)
Unity and disunity of contemporary censuses

Censuses are a form of governmental survey. "Traditionally" it is one of the most considerable peacetime government undertakings used to organize the polity. This enquiry has an impact on

political questions and identity, being invested by interest groups and political actors. Despite certain evolutions, there is continuity in most censuses. This continuity is at risk to be disrupted by methodological change. Yet, there is a trend towards a new census model. In Europe, a growing proportion of national censuses are discarding exhaustive enumeration in favor of register-based operation, sometimes alongside representative surveys. The rationale of the reforms is diverse: cost, timeliness, burden of the respondents, privacy concerns, fears of polarization and politicization. Generally, these reforms did not induce controversy nor had meaningful public attention. Oppositions forbid change in the US and Canada. The 2010 Canadian Census Crisis related to a methodological modification decided by the government, a decision reversed by the next government. In the USA, tension arises and any reform faces political opposition. If there is a wealth of technical and methodological analysis of these changes, the phenomenon has not been documented through political science concepts. Yet the census is a very specific political issue. Could such a shift bring a “post census” era through a radical transformation of its definition and symbolic content? This paper explains that the modification of the census procedures could affect its political and philosophical understanding, showing that these technical and methodological transformations might affect national political equilibrium.

S43/5 WHEN SCIENCE DIPLOMACY DIVIDES

Location: IoE - Committee Room 2

Science and Diplomacy Group EGM

S42/3 THE GREEN AND DARK SIDE OF ENVIRONMENTAL ISSUES IN CITIES (1850-1950)

Location: IoE - Room 709a **Chair:** Simões, Ana

Organiser(s): Gomes, Inês; Miralles Buil, Celia; and Duarte Rodrigues, Ana

In 1984, the expert on French urban history, Bernard Le Petit, stated that "the city is neither a context nor an environment, but the expression of practices and social relations". This symposium's ambition is to bring back "la part du milieu" (Braudel, 1949; Massard-Guilbault, 2002) into the cities, focusing on the question of hygiene. Hygienic issues in cities have been studied by different scholars, through different lenses. We argue for a change of perspective, connecting urban history of sciences and technology, garden history and urban environmental history. In particular, this symposium focuses on the role played by nature and/or environment (concepts that we want to clarify during discussion) in the healthy/unhealthy city. On the one hand, bringing "nature" (e.g. trees, plants or animals) and its natural elements (e.g. sun or air) into the city was considered a solution to solve some of its hygienic problems. On the other hand, the "nature" in the city was, periodically, considered as a source of danger for dwellers' health. What kind of "nature" inhabitants, municipal authorities, doctors or other actors which addressed urban problems wanted in the city? Who were, in fact, the leading actors claiming for healthier cities - doctors, gardeners, engineers, or others? Did they agreed or disagreed about the necessity and effectiveness of the proposed measures? What policies were required to transform the city from dark to green? Are there similarities among those policies in different cities dispersed worldwide? How did, different actors, in their discourses and practices, try to unify or des-unify nature and city? These are the main questions addressed in this symposium. The diversity of case studies covered seeks a comparative analysis between cities – with different size, political importance or economic affluence - in Europe, America, Russia or India, highlighting the importance of experts', ideas and models circulation, at a global scale. Furthermore, it also emphasizes the importance of local exchanges between different social groups in the construction of healthier cities, challenging the traditional center-periphery model. The variety presented in this symposium offers an overview of the significance of environmental urban history to our understanding of the history of science and technology in the city. This symposium is divided into three sessions, focused on animals and pathogenic organisms; cities and infrastructure; and gardens and green grounds arrangements. This symposium is divided into three sessions, focused on animals and pathogenic organisms; cities and infrastructure; and gardens and green grounds arrangements. Focusing on gardens and landscape through the lenses of the urban history of science and technology, the third part of this session shows how different contexts lie behind similar solutions in European cities. The disunity of causes between London and Holland or between Paris and Lisbon are opposite to a certain unity recognized in the renewal of urban green grounds.

Woudstra, Jan (University of Sheffield)
After the Great Stink; the creation parks, open spaces and thoroughfares during the transformation of London (1855-1889)

As many other cities in Great Britain and abroad the main conduit for disposal of waste was the river, in the case of London the Thames, providing a situation that was not just unhygienic, but also a dangerous source of disease and fumes. In the end it was the miasmic theory which believed that diseases were transmitted through bad air rather than water that caused a change

of policy. The cleansing of the London metropolis after the Great Stink of the mid-nineteenth century became the responsibility of the Metropolitan Board of Works (MBW), founded in 1855. It included a new sewage system, but also introduced additional infrastructure of roads and an underground system. The engineering achievements of this by Sir Joseph Bazalgette (1819-1891) have been justly celebrated, but other aspects have been overlooked as a result of continual criticism of corruption of the MBW and causing its demise in 1889, which has put the whole organisation and its contribution in bad light. However, the improvements included the creation of a greenspace network conceived not only as part of the improvement of general hygiene of the capital, but also to beautify the city in a way to rival the Hausmannian improvements of Paris. This paper investigates how physical and aesthetic considerations coincided with the engineering objectives of the MBW and how this contributed to and, by concentrating on the issue of parks, open spaces and thoroughfares, changed the general nature of the capital.

Fleischer, Alette (Independent Scholar)

Between Ideology and Idyll: Planning and Building Public Parks in 19th century cities in the Netherlands

From the mid 19th century onward, the appearance of Dutch cities gradually changed. Motivated by a growing industrial and colonial economy, cities expanded outside their 17th century bulwarks. The bulwarks and defense canals became the first type of public promenade parks with curvy lanes and water features as a green border between old and new urban neighborhoods. Health and ethical considerations, that German and English examples show, played equally in the Netherlands a role in the design of public parks in the new urban areas. However, when it came to actually building public parks this went together with economical and societal motivations in the young Dutch Kingdom. The idyll of a large public park, where one could enjoy beautiful environment, meet different layers of society, and get fresh air, proved to be more an ideology then a practice. This paper wants to contribute to the discussion of the awareness of health and hygiene in relation to urban history of science by looking on how two groups of actors. Those who propagated parks as a sound and healthy enterprise, a “green lung” for the entire community. And those who believed that parks were a waste of money, un-Dutch, or irrelevant. My argument helps to further understand how new inventions and novel ideas have to be molded and reshaped before it can be applied in a society. Dutch public parks, that today define the cities, have their present-day form and function (in part) because of the 19th century tensions within society.

Duarte Rodrigues, Ana (Universidade de Lisboa)

Lisbon's Lungs: integrating Landscape in the city

During the nineteenth-century, as cities grew, and the negative effects caused by the Industrial Revolution accentuated, many voices pleaded for the reintegration of natural elements into the urban landscape by creating green grounds that answered both demands of health and recreation. Many urbanists compared cities to organisms, and green spaces qua their lungs. This is the rationale behind the construction of many parks in European cities. However, I argue that the growth of Lisbon’s lungs was projected for Campo Grande in the nineteenth-century, before Monsanto, and has different roots. The goal of Lisbon's City Council was to enhance the city as a great European capital, head of an Empire, and at the same time to provide healthy environment, comfort, honest recreation for the citizens, but above all to build a modern city, following the French standards. Pollution caused by industrialization was not the reason behind Frederico Ressano Garcia’s utopic project for the enlargement of Lisbon to the north in the late nineteenth-century. Highly influenced by French urbanism and landscape architecture, Ressano Garcia projected Campo Grande as Lisbon’s ‘Bois de Bologne’. At the same time, the doctors and engineers claimed for the necessity of this large park. Therefore, I argue that Lisbon's lungs stand as an important case-study to discuss center-periphery because although appropriating

models from the centers, different reasons lie behind greening the city in the nineteenth-century: Modernization rather than Industrialization.

Mexi, Alexandru (University of Bucharest)

Designing the first public garden in Bucharest. Context, reasons and decisions

Designed by the mid-19th century at the periphery of Bucharest, the Kiseleff garden is one of the oldest public gardens in Romania. It was built after the Russian general Pavel Kiseleff refused the honor of being erected a public monument and asked the local administration to use the funds allocated for his statue to create a space for public use. However, this was not the only reason and neither the most important that lead to the creation of this garden. Moreover, as there was no actual need for planted spaces in Bucharest, nor did the society demanded public gardens at that time, the project becomes even more unclear and debatable. To this end, this paper aims to analyze the history of the garden and the political, economic and cultural reasons that lead to the decision of creating the first public garden in Bucharest. The study will be based on a historical analysis of some recently discovered archival materials as well as on comparative analysis between the Kiseleff garden and other similar examples of public planted spaces in Romania and Europe.

S39/3 CULTURES, STARS AND NUMBERS: INTERCULTURAL EXCHANGES IN EAST ASIAN MATHEMATICS AND ASTRONOMY

Location: IoE - Room 777 **Chair:** Cullen, Christopher

Organiser(s): Cullen, Christopher

Pre-modern East Asia was the home of distinctive traditions in both mathematics and astronomy. During the first millennium CE these traditions, first developed in China, became common to the whole region, including Korea and Japan. Within the broad theme of the conference, 'Unity and Disunity', the aim of this panel is to encourage discussion of relevant issues in a regional and global historical and cultural context. Despite their common roots, the theory and practice of mathematics and astronomy was by no means uniform across the whole East Asian land-mass. It is thus illuminating to trace the way that elements of these disciplines were appropriated, adapted and developed as they moved across regional and cultural boundaries. Moreover, pre-modern East Asia was highly permeable to the flow of ideas from the rest of the Eurasian continent - first from South Asia in the context of the coming of Buddhism in the first millennium CE, then from the Islamicate world from the Yuan dynasty (1271-1368) onwards, and finally from early modern Europe with the arrival of Jesuit Christian missionaries in the later part of the 16th century. The complex interactions that followed from these contacts are revealing not only of the nature of the East Asian traditions in astronomy and mathematics, but also of the traditions that scholars in East Asia encountered afresh.

Yang, Hong-Jin (Korea Astronomy and Space Science Institute)
The transmission of astronomical culture in Korean peninsula since the prehistoric period

Korea has many astronomical heritage such as observational records, observatories, star maps, and so forth. Especially Korea has a long history of star maps, dating from the prehistoric period. Notable star maps in the prehistoric age are star-like cup-marks carved on cover stones of dolmens. Korea has the greatest amounts of dolmens in the world, and some of them have constellation-like cup-marks such as the Big Dipper, Sagittarius, Corona Borealis, Pleiades, etc. The patterns of constellation in dolmens are also appeared in the Goguryeo(高句麗, 37BC–AD668) tombs. Meanwhile, Chinese constellation system was firstly introduced and to be generally accepted by Goguryeo period. It means that aside from Chinese constellation system, Korean typical astronomical knowledge has been accumulated from preceding era. Recently a cobble stone, which was unearthed in distribution of typical Upper Paleolithic remains, was founded in Korean peninsula. The cobble has many tiny holes on the surface. As a hypothesis we identified the artificially pecked holes with stars and found constellations. The identified constellations were engraved in their relevant positions in the sky corresponding to those of ~40,000 years ago, based on the calculations of the proper motion and precession of stars. Although it needs more analyses, the holes can be supposed that the location of punctuation corresponds to astronomical chart.
In this talk, we would like to introduce the transmission of typical astronomical culture in Korea from the preceding era.

Yuan, Min
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Zhao, Jiwei (Northwest University, China) and Li, Gang
Some Notations on the Method of Double False Positions

In medieval China and Arab, the method of double false positions is an effective tool in solving the linear problems of two variables. Fibonacci in his *Liber Abaci* (1202) develops this method into an iterated algorithm of multi-fold double false positions which can solve the system of n-variable equations, and this algorithm is simplified greatly by Clavius in his *Epitome Arithmeticae Practicae* (1583). However, the evidence of the adaption of this method to the approximate solution of nonlinear equation is fairly late except the popular conjecture that Fibonacci used this method when he solved accurately a famous cubic equation in his *Flos* (1225). We find that, Cardano uses this method in Chapter 30 of *Ars Magna* (1545) to evaluate a root of equations of higher degrees up to four. In fact, he develops this method in a different way into another algorithm which we now call the iterated method of linear interpolations. We check his four examples and find that there is an apparently reasonable result which is due to wrong calculations. In the end, based on the analysis of this defect as well as the extant reconstructions of Fibonacci's numerical solution of his cubic equation, we provide a new explanation of Fibonacci's solution.

Lee, Eun Hee (Yonsei Universty Observatory, Korea)

A study on the two astronomical tables in the Sultani zij: The oblique ascension and the parallax correction tables

The Sultani Zij is an astronomical treatise that was published by Ulugh Beg at Samarkand in 1438-1439. Particularly, this paper deals with the two astronomical tables listed in the Sultani Zij: The oblique ascension table for calculating the length of the day and night, and the parallax correction table for calculating the parallax to the prediction of solar eclipse. In this study, we examine the layouts and contents of these two tables and compare with those of other Islamic zijes compiled in 14th~15th century such as Tibetan Sanjufini Zij, Chinese Huihui-lifa and Korean Chiljeongsan-Oepyeon. As well, their features and relation are traced and discussed.

S35 UNIFYING PHENOMENA IN A DIVIDED WORLD: HISTORY OF CLIMATE AND METEOROLOGY IN EUROPE (17TH-19TH CENTURIES)

Location: IoE - Room 826 **Chair:** Miglietti, Sara

Organiser(s): De Bianchi, Silvia and Miglietti, Sara

Among the most pressing scientific, political and financial questions that the world is facing today there are the implementation of International agreements and common measures to be taken against and to reduce the effects of climate change, as the recent Paris Agreement testifies. Our view of climate changed throughout centuries, but constituted a central question for scientists and natural philosophers already in early modern Europe. The purpose of this symposium is to explore the notion of climate in different Countries (England, Switzerland, Prussia and Spain) and periods, by taking into account the place that the study of climate had within meteorology, which kind of technology was employed for its implementation and which role the study of climate played at the Institutional and economic level in different contexts. Thus, by exploring tendencies of unity and disunity in employing different technologies in different political and economical contexts, the symposium will address in an original way the ESHS conference strand of unity and disunity in science, technology, and medicine within and across nations and will promote the discussion of the notion of climate from the historical perspective and beyond.

Miglietti, Sara (Johns Hopkins University)
An early-modern Anthropocene?

The idea of anthropogenic climate change in the early Royal Society While the term "Anthropocene" is of relatively recent coinage, the concept of human climatological agency that lies at its core has a long and complex history. The ancient Greek philosopher Theophrastus already identified a correlation between deforestation and changes in rainfall patterns, and the reactivation of his ideas during the Renaissance triggered a new generation of studies into how human activities on the land may alter local climates in more or less deliberate (and more or less desirable) ways (Grove 1996). This paper will explore the links between early-modern meteorology and the emergence of early ideas of anthropogenic climate change based on manuscript evidence from the archives of the Royal Society. While early Royal Society fellows and affiliates often tackled the question of human agency in and on nature from the perspective of contemporary ideologies of "improvement" (Slack 2015), the paper will show that this early-modern discourse of mastery and improvement was not blind to the possible side-effects of man's environmental intervention. Beginning with the "hortulan" utopias of FRS John Beale and John Evelyn in the mid-seventeenth century (Leslie and Raylor 1992) to conclude with the climatological thought experiments of the Swiss natural historian and FRS Johann Jakob Scheuchzer in the early 1700s (Barton and Miglietti 2015), the paper will show that the environmental reflexivity of early-modern scientific networks was in fact much more complex, fraught, and self-scrutinizing than is usually acknowledged.

De Bianchi, Silvia (UAB)
In search of unifying patterns: meteorology, technology and power (1750-1795)

In this paper I shall analyse different approaches and technologies that scientists endorsed in the 18th century in discussing meteorology and the study of climate in particular. I shall clarify in which sense scientists talked about "climates" (plural) and in which sense they made several attempts to unify them under a notion of "climate" in the 1790s. In order to reach this goal, I shall consider the attempts at finding an equation to calculate the mean temperature at different latitudes and the like (e.g. Kirwan 1787) and the development introduced by Euler in geodesy at the Berlin Academy of Sciences in mid-1750s. In the second part of my contribution,

I shall show how in the 1780s and early-1790s scientists started organizing joint campaigns in France, England, Prussia and Russia, by using instrument calibration and which kind of attitute was held by monarchs and research Institutions in their respective Countries with respect to their studies.

Jankovic, Vladimir (University of Manchester)

A British Fetish: 'National Climate' and the Victorians

The idea of a 'national' or 'hereditary' climate has a long genealogy. With the ascent of neo-Hippocratic medical practices, European physicians linked local climates to native bodies assuming a nervous sympathy that enabled external stimuli to move into the body's interior. Societies exposed to specific climates literally assimilated those climates. Not only did nations mimic their climates, they also owed their achievements to climatic stability that prevented migration and enabled sedentariness and civilization. Strangely, the British climate has never been a stable cultural entity. In this paper I analyse a sample of widely diverging Victorian claims about the British climate to establish how its uses naturalized social and racial values rather than refer to the trivialities of weather. The Victorian climate was in this process de-weathered and de-naturalized to the point of becoming a Victorian meme – and a fetish – that allowed the literary and otherwise 'climatosophes' to make mutually opposing argument about the British national achievement, or failure, depending on a reading they adopted about the country's climatic identity.

Pometti, Kevin (University of Aix-Marseille) and Alberola Romá, Armando (Universidad de Alicante)

Temperature oscillations, droughts and storms in the Spain of the 18th century: from the perception of people to the instrumental meteorological registers

The eighteenth century witnessed the last phase of the Little Ice Age. But the last part of this climatic instability was not reflected into an immediate moderation of temperature oscillations, as meteorological registers testify. Furthermore, the end of this climatic oscillation did not affect the stabilization of the meteorological instability. In Spain, the last years of Maunder minimum (upon 1715) and the last years of 'Maldá' anomaly (1760-1800) were characterized by the effects of extraordinary climatic events that had deleterious consequences over the agricultural production and over life conditions in general. This contribution highlights through detailed archival research the effects of this changing weather conditions from 1760s onward. The present research is based on meteorological data recovered from individual observers and scientific institutions and/or meteorological data extracted from newspapers. Our objective is to show the usefulness of these sources for the understanding of the impact and incidence of climatic oscillations over society. Moreover, we shall emphasize how the detailed analysis of extraordinary events can help to detect periods in which the environmental conditions changed and how these changes in the environment could have effects over the public health.

S11/2 HISTORICAL MOMENTS IN THE PUBLIC UNDERSTANDING OF SCIENCE (C.1600-1900)

Location: SciM – Lecture Theatre **Chair:** Ampollini, Ilaria

Organiser(s): Ampollini, Ilaria; Gouyon, Jean-Baptiste; and Nielsen, Kristian H.

These two panels are intended to bring together studies of historical instances related to the construction of the public cultures of science. Taken together, the papers presented in these two panels highlight the variety of the aims, contexts, outcomes, and actors—audiences and producers—of an endeavour—the communication of scientific knowledge in public contexts—consubstantial to the development of modern science, which has remained a constant since the 17th century. As a whole, the papers presented in these two sessions intend to highlight the value of historical enquiry, and of an historical sensibility, for the development of current scholarship in and about science communication and the public understanding of science. The first panel lines up case studies from c. 1600 to 1900, the second panel concentrates on the 20th century. The title for these two panels is borrowed from the title of a rubric in the journal Public Understanding of Science. Since 2016, this rubric offers short essays on the history and the historiography of science communication on a regular basis.

De Ceglia, Francesco Paolo (University of Bari)
The origins of Italian scientific cinema (1908-1938)

The history of Italian non-fiction filmmaking is not well-known in Italy and almost completely overlooked abroad. Retracing the steps of its development could shed light on the way in which science was understood and represented by filmmakers, researchers and spectators. Italian documentary cinema was long identified with films which, disinclined to use narrative structures, relied on shots of small animals and natural phenomena, often reproduced in the laboratory. Paradigmatic from this point of view is the figure of Roberto Omegna, the most important Italian scientific filmmaker of the first half of the twentieth century. He worked before for the Ambrosio Film, in Turin, then for the Istituto Luce, which, in line with the Fascist political program, accompanied the usual laboratory reconstructions with innovative scenes of agrarian landscapes.

Casonato, Simona (Museo nazionale della Scienza e della Tecnologia Leonardo da Vinci), and Canadelli, Elena (Università di Padova)
A museum with a view: cinema, science and dissemination at the Museo Nazionale della Scienza e della Tecnica of Milan (1954-1964)

The Museo Nazionale della Scienza e della Tecnica (MNST) was founded in Milan in 1953 in the name of Leonardo da Vinci, celebrated as the the symbol of the union between humanities, arts and science. In October 1954 the MNST opened a cinema theatre directly in its building, an unprecedented choice for an Italian museum. Cinema was a most popular entertainment in Italy in the 1950s, but the originality of the MNST project was stressed by the screenings programs, which included almost exclusively documentary and scientific cinema. Our paper will analyze the activity of the MNST cinema hall between the mid-1950s and mid-1960s. The recent reorganization of the MNST historical archives allowed to uncover the multiplicity of perspectives involved in it. The curators addressed the large debate that in the 1950s spread in the Italian universities about the educational and scientific role of cinema. At the MNST, films – even fictional movies – were regarded as tool of observation and discovery, implicitly reminding of the uses of cinema in the science laboratory. But the uses of cinema in the MNST were fostering also a different perspective on the culture of moving images of the time. We will enlighten how, throughout cinema, the MNST provided a fresh perspective in science dissemination, which not only wanted to overcome the traditional separation between

humanistic and scientific culture, but put also in discussion a strict separation between academic and popular scientific culture.

Boon, Timothy (Science Museum)
'What Manner of Men?' Meeting Scientists through Television

The Prizewinners (11 December 1962) was a key programme in the path-dependent development of televisual grammar for the representation of science in Britain. This was the first of a small flurry of interview programmes with scientists that, rather than seeking to convey the content of science instead placed the emphasis on the character, beliefs and personality of élite, male, scientists as a way of making science palatable to viewers. Although scientists had long appeared on television and in documentary films, this was the point at which personality became a self-conscious concern for television producers with, I will argue, significant results in subsequent televising of science and, indeed, in other media, including museum displays.

Gouyon, Jean-Baptiste (UCL)
From engaged citizen to lone hero. An investigation into the ecology of British television science

The presentation of Nobel laureates in the British television programme Horizon has evolved over the decades from politically engaged citizens to isolated Promethean figures. Of particular interest in this evolution is the narrative turn which the programme took in the late 1990s-early 2000s. Two kinds of primary material can help probe this narrative turn: the television programmes themselves, and oral history interviews with producers and editors of the series between the late 1960s and the mid-2000s. When contrasted, these two types of material tell a slightly different story. This paper examines this contrast, and reflects on the different value of TV programmes and oral history interviews, for understanding the history of science on television.

Nielsen, Kristian H. (Aarhus University)
'For the nation as a whole and for each individual in it': The Royal Society's public understanding of science report (1985) in historical context

The Royal Society's 1985 report on public understanding of science resulted from the work of an ad hoc group established in April 1983 under Walter F. Bodmer. The Society's interest in public understanding of science grew out of continuing concerns over low recruitment into the science and engineering sectors and over failing public and political support of basic research since the introduction of market-based approaches to scientific governance in the 1970's. The report argued that public understanding of science was fundamental to society. Better public understanding of science would boost national economy, improve the quality of public and private decision-making, and enrich the lives of individual citizens. Public understanding of science, Vice-President D.C. Smith concluded in the preface, is an issue 'that is important not only, or even mainly, for the scientific community but also for the nation as a whole and for each individual within it.' Based on published sources and archival material, this paper places the report's broad understanding of public understanding of science as well as its various recommendations to the scientific community, the educational system, the mass media, industry, museums, and government in a historical context. Key contextual elements to be addressed include prior changes to British science policy and the deliberations of the members of the ad hoc group as they forged the Royal Society's views on public understanding of science.

I107 MATERIAL CULTURE, DISCIPLINE FORMATION AND EDUCATION IN ENGINEERING

Location: SciM – Dana Studio **Chair:** TBA

Eychenne, Bertrand (Université Paris Saclay)

The integration of the engineering school of Bogota to the *Universidad Nacional de Colombia* and their separation: the consequences on the training of Colombian engineers (1868-1880)

The government of the radicals, which intends to implement educational reforms and with them to transform the society, uses the university to prevent the breakup of the federal State threatened by the regional authorities' quest for autonomy. By focusing on the engineering school, we wish to show how the union of several institutions with the aim of creating the university thus allowing the training of Colombian civil engineers to develop, and how the civil war of 1876, caused by the educational reforms, led to the separation of the engineering school from the university and altered the way it operates by orienting it towards the training of scientific officers.

Our analysis will focus on the debates which sprung from the integration and then the separation of the engineering school and the university.

Wittje, Roland (Dept. of Humanities and Social Sciences, Indian Institute of Technology Madras)

Instruments of Development: Indo-German Scientific Collaboration and Engineering Practices at IIT Madras

This paper aims to explore Indo-German scientific and technological collaboration during the Cold War by looking at the history of the Indian Institute of Technology (IIT) Madras. IIT Madras was founded and set up between 1959 and 1974 with the assistance of the Federal Republic of (West) Germany during an evolving development discourse. The history of the Indian Institutes of Technology has so far been understood as the import of an MIT-type institution into post-independent Nehruvian India that facilitated outsourcing and the rise of the Indian IT industry. The history of IIT Madras, however, reveals a more complex story. As part of the Indo-German agreement, a number of German experts joined IIT Madras as professors for the initial years to set up laboratories and engineering curricula, to supervise students and research scholars, and to establish a corresponding research agenda. German ideas and practices of engineering education and research are manifested and materialised in laboratory setups and large amounts of German scientific equipment. How did the German professors think Indian engineers should be trained? How did German conceptions correspond to viewpoints and expectations of their Indian counterparts? How did Indian students, faculty and others experience the first decades of Indo-German collaboration? How did ideas and practices of engineering education and research unfold and transform in the Indian and local environment? I will trace the first generation of German experts, laboratory equipment and practices at IIT Madras and place them within concepts and practices of science and engineering education and research.

Valeriani, Simona (Victoria and Albert Museum)

Models as experiments? Methodological (dis)unity between engineering and architecture in the 19th century

This paper will take as its starting point the building of 'Albertopolis', the district in West London host to a number of cultural institutions, to look at the role played by experimentation within the engineering and architectural culture of the second half of the 19th century. A wealth of primary sources, including published articles and archival material, testifies to the importance placed on carrying out 'experiments' by the military engineers trusted with the design of a number of this iconic buildings, including the Royal Albert Hall and the South Kensington Museum (V&A), as a legacy of the Great Exhibition of 1851. In many cases the idea

of 'experiment' is closely linked with 3D models. These were a tool widely used by architects and –at least since the Renaissance– had been at the centre of a debate about usefulness and truthfulness. A commentator, in 1843 described modelling as 'an excellent handmaid to the philosophy of architecture' (*The Builder,* vol. 1, 1843) The paper will analyse the language and practice of experimentation on the building site, placing it in the context of other kinds of experiments military engineers regularly conducted in their practice, documented in professional journals and internal memos. Connecting this with the rich literature on the somewhat uneasy relationship between engineers and architects, who –in the period– were establishing themselves as a profession (e.g. founding of the Royal Institute of British Architects in1837), the paper analyses methodological convergences and divergences between the two professional and scientific cultures.

Thébaud-Sorger, Marie (CNRS/Maison Française d'Oxford)

Fire-Fighting across Eighteenth-Century Europe. The Elaboration of collective Knowledge and shared Practices

During the seventeenth and eighteenth centuries, as demographic growth increased, making the urban environment a safer place became a matter of general concern. New approaches to fire fighting emerged, notably preventive methods to ward off the risk of fire by employing non-combustible materials or coatings. This involved popular know-how, an understanding of chemistry, and practical skills, all of which were put into use in different ways in different places, and with variations over the period. In the second half of the eighteenth century, many experiments were carried out in public in different cities, such as London, Paris, Brussels, Hamburg, Suhl, Vienna, St. Petersburg. The urban setting became the theatre of new scientific experiments and technical demonstrations during which the public was invited to contemplate houses which withstood the flames, thus reversing the dramatic and tragic association of large fires with the destruction of buildings. By retracing how this concern was addressed in different contexts, my aim is to underline the convergences observable within individual countries and operating within certain circles, such as municipal governments and academic societies. The knowledge shared by enlightened amateurs, apothecaries, physicians, and architects circulated through Europe with the support of learned bodies and societies (Royal Society, Society of arts, German œkönomische Gesellschaften, French provincial academies…), fostering discussions on the process of combustion, flammability, the role of air, and encouraging speculation on the properties of different materials, as well as contributing to debates over the composition of recipes and nature of substances used for fireproof coating.

Zakharchuk, Polina (S. I. Vavilov Institute for the History of Science and Technology of the Russian Academy of Sciences)

The Work of the Learned Mining Committee in Imperial Russia: 1825–1917

Mining and metallurgical industries have been the key sectors of the Russian state economy since the 17th century. This paper addresses cooperation and unity within the production sector and the scientific and engineering communities. In particular, this paper describes the foundation of the Learned Mining Committee, focuses on the results of its activities. Although Russia had already been training competent professionals for the mining and metallurgical enterprises, for many reasons, including the lack of the relevant professional periodicals, technological innovations sometimes took long to reach these enterprises. To address this problem, the LMC was set up in 1825 under the Mining Department (established in 1806) on the initiative of the Emperor Alexander I. The Committee combined renown scientists, practitioners, and managers of iron and steel enterprises. One of the Committee's core functions was scientific reviewing of the projects concerned with the developing mining and salt industries. The Committee also published *Journal of Mining* and facilitated the publication of technical works on the subject. The Committee members collected, processed and published statistical data and conducted studies on the history of metallurgy and mining. After the October 1917 Revolution, the Committee was dissolved, and the *Journal of Mining* first changed

its name and then was temporarily discontinued. However, the experience of the Committee was taken into consideration in setting up the Soviet public administration bodies. The publication of the *Journal of Mining* was resumed. It is still being published in Russia.

R31 NINETEENTH-CENTURY SCIENTIFIC CORRESPONDENCE NETWORKS

Location: IoE - Room 802

Chair: White, Paul (Darwin Correspondence Project)

Commentator: Neary, Francis (University of Cambridge)
Participants: Ferraz, Marcia H. M. (CESIMA-PUCSP/UCL)
Flannery, Maura C. (St. John's University, NY)
Gianquitto, Tina (Colorado School of Mines)
James, Frank A. J. L. (Royal Institution and UCL)
McCarthy, Gavan (The University of Melbourne)
Miknienė, Giedrė (Wroblewski Library of the Lithuanian Academy of Sciences)
Segala, Marco (Università dell'Aquila)
Weldon, Stephen (University of Oklahoma)
Pearn, Alison M. (University of Cambridge)
Brassington, Laura (University of Cambridge)

A consortium representing major correspondence corpora, among them the letters of Tyndall, Hooker, Faraday, and Darwin, is recreating the networks of scientific practitioners in the long nineteenth century. This session will be focussed around the first public release of Epsilon (www.darwinproject.ac.uk/Epsilon), a flexible technical framework that links letter-texts from multiple sources for cross-searching and analysis. It will explore the potential of recombined scientific correspondence from this period to prompt new directions in research, to reveal the contributions of women and other historically under-represented groups, to promote public engagement, and to provide data for present day scientific studies. The technical challenges will also be addressed. Epsilon, which was announced at the meeting of the History of Science Society in Toronto in November 2017, is being designed to promote and support the digital creation, delivery, and preservation of scientific correspondence, whether from existing editions or in small-scale research datasets, it will facilitate exploitation by the next generation of scholars and exploration by the widest possible public audience. The symposium will include a demonstration of the resource, together with roundtable presentations and open discussion. The roundtable will be organised around the major themes of: current approaches; technical challenges; research potential of linked 19th century scientific correspondence. Speakers will each give short presentations with ample time for open discussion. Topics include recovering informal exchanges; linking to other materials; the challenges and benefits of moving beyond the Anglo-American network; new perspectives on colonial/post-colonial science; links between letter writing, collecting and other practices; new ways of appraising participation, power and influence in the production of knowledge; reflections on the relationship and uses of digital and non-digital editions.

S66 JAMES JOULE'S BICENTENARY: SCIENTIFIC AND PEDAGOGICAL ISSUES CONCERNING ENERGY CONSERVATION

Location: IoE - Room 804 **Chair:** Lopes Coelho, Ricardo

Organiser(s): Maurício, Paulo, and Lopes Coelho, Ricardo

With this symposium, proposed and organized by the Inter-Divisional Teaching Commission (IDTC) of the DHST/DLMPST, we intend to celebrate James Joule's bicentenary in 2018. His famous paddle wheel experiment with which he calculates the mechanical equivalent of heat is presented in every physics textbooks as a decisive if not crucial experiment in surpassing the caloric framework. The experiment is offered in the mentioned textbooks in a too much simplified form; in fact, he could not had performed it as he reported as recent replication of his experiment established. This symposium, has a threefold aim: a) celebrate James Joule achievement considering the most recent historiographic and epistemological work; b) discuss the scientific and pedagogical issues related to energy and energy conservation and how they are presented in textbooks and worked out in classroom, and, finally, c) discuss the present situation of teaching and learning science through the use of history of science both in K-12 and college level with an emphasis on energy and related concepts. J. Brian Pitts will discuss the implications of the development of the field theory to energy conservation and conclude that although the mathematical theory of the field theory is complicated, modest efforts could reduce students' misconception on energy conservation. Fabio Bevilacqua will discuss Helmholtz's (1847), Rowland's (1880), Planck's (1887) and Haas' (1909) interpretation of Joule work emphasizing the necessary outcome of the concept of conservation. From this he will bring up to discussion some didactical implications. Manuel Bächtold, will present a teaching strategy supported on the study and replication of Joule's paddle-wheel experiment. He will discuss the efficiency of this historical-based teaching strategy in students' outcomes. Ricardo L. Coelho will address how energy become understood as a substance through the time span between Clausius' 1850 paper and Lodge new concept of energy (1885) thus addressing a pressing issue in education that is the assignment of a substance-like ontology to energy by students and most teaches alike. Finnaly, Shaul Katzir argue that an incomplete notion of the principle of energy conservation was developed earlier than the historiography usually reports. Namely he will discuss the period between late 1810s to the 1840s where Fresnel, Ampère, Fr. Neumann, Roget, Faraday and Liebig employed incomplete notions of conservation to reach physical conclusion and laws in wave optics, electrodynamics and theory of batteries. From this he would suggest a diachronic view of its history, unlike the simultaneous discovery perspective.

Pitts, J. Brian (University of Cambridge)
Conservation of Energy: Missing Features in Its Nature and Justification and Why They Matter

The gap between what even many academics believe and what physicists know about energy conservation is striking. Justifications for energy conservation are partly empirical, such as Joule's paddle wheel experiment, and partly theoretical, such as Lagrange's statement in 1811 that living force (vis viva) is conserved if the potential energy does not depend on time. Noether synthesized and generalized such old results as Lagrange's and analogous results for momentum conservation and spatial homogeneity (due to Hamilton and Jacobi). She also proved a converse in 1918: symmetries imply conservation laws and vice versa. Conservation

is thus not a categorical result, but (bi)conditional upon symmetries. The rise of field physics during the 1860s-1920s made a further difference: energy is in particular places, and conservation applies first not to the whole world, but to each place separately. The energy in any mathematical spatial box remains constant except insofar as energy flows through the walls; it cannot disappear in Paris and reappear in London, whether instantaneously or later. A global conservation law can be derived from adding up local conservation laws over the whole universe. This addition could fail to make mathematical sense, however, and probably doesn't for realistic cosmologies. Conceptions about conservation laws leads even academics to make poor arguments, such as has occurred for centuries about the mind-body problem. The mathematics of field theories and local conservation laws (partial derivatives) is too advanced for secondary school chemistry or physics. However, secondary education could reduce teaching misconceptions with modest effort.

Bevilacqua, Fabio (Pavia University)

Unifying natural phenomena: theoretical and experimental formulations of "energy" conservation and their historiography

Friedman (2008) outlined that two Neo Kantian trends influenced Kuhn (1962), a more abstract one inspired by Cassirer (1910) and a more substantialist one by Meyerson (1908). Both wrote extensively on the history of energy conservation. Kuhn's debt to Meyerson is evident in his (1959) paper, which, despite its fame, presents a number of problems. The term "discovery" linked with "simultaneous", the assumed convergence of numerous efforts towards a "conservation of energy" that we (now) know exists, an unrecognized debt to Haas (1909), serious misunderstandings, eg: of Helmholtz (1847). A closer analysis shows the disunity of the "discoverers'" efforts; eg: a century and half after Leibniz (1686, 1695) had chosen to measure all natural phenomena through their effects in space (and not time), Mayer relied on the cause-effect principle (1842) and on the Eleatic ex nihilo nil fit, nil fit ad nihilum (1845) to establish his mechanical equivalent through a thought experiment; Joule, paradoxically, relied on the "Creator" (1843, 1845, 1847) to average out some very discordant results; Helmholtz (1847) misread Joule's unity of measurement and based his approach on a largely Neo Kantian theoretical framework; Weber (1848) and Clausius (1876) relied on a mathematical constraint (work as an exact differential) to agree with the impossibility of perpetual motion and thus with conservation. Before Meyerson and Cassirer, physicists analyzed in detail the history of these contributions, eg: Rowland (1880) and Planck (1887). The resulting interplay of principles, models, experiments and mathematics in the alternative formulations still makes very fascinating reading.

Katzir, Shaul (Tel Aviv University)

The use of energy conservation before the formulation of the law

The historiography of the principle of energy conservation has concentrated on the formulation of the law by a few individual scientists. In this talk I will turn the analysis into the employments of the law before it was well formulated, and claim that these uses played an important role in the emergence of energy physics. From the late 1810s to the 1840s physicists like Fresnel, Ampère, Fr. Neumann, S. Carnot, Roget, Faraday and Liebig employed incomplete notions of conservation to reach physical conclusion and laws in wave optics, electrodynamics, thermodynamics and theory of batteries. Thereby they extended the validity of the law beyond non-frictional mechanical system, where the conservation of living forces (vis-viva) was accepted at the early 19th century. The examination of the uses of the principle would suggest a diachronic view of its history (unlike the simultaneous discovery perspective), and an understanding of its power in scientific inferences, and thus would suggest reasons for its development.

Lopes Coelho, Ricardo (Universidade de Lisboa)

How energy became a substance, 1850-1885

According to Joule, Rankine (1850) and Clausius (1850), heat is motion. In 1851, Thomson adhered to the dynamical theory of heat and introduced the concept of mechanical energy of a body. In 1852, Thomson divided the stores of mechanical energy available for men into two sets: the static and the dynamical. Rankine (1853) eliminates the adjective 'mechanical' in Thomson's 'mechanical energy' and characterises those two sets in potential and actual. Thomson (1854) uses Rankine's terminology in interpreting Joule's experiments. Rankine (1855) defines energy as the capacity of a body of doing work. In Maxwell's Theory of Heat, published several times in the 1870s, "the energy of a body may be defined as the capacity which it has of doing work". This definition was criticised by Lodge. He introduced then the concept of 'transference of energy' (1879). Thus, energy must be something that can be stored in a body and transferred from one body to another. In the cases, in which the bodies involved in transference of energy are not connected with each other, Lodge makes recourse to a linking element, the ether, through which energy could move (1885). Towards the end of the 19th century, some physicists raised objections to the concept of energy as a substance.

Bächtold, Manuel (University of Montpellier)

Introducing Joule's paddle wheel experiment in high school physics teaching: does it contribute to the learning of energy?

How to improve students' understanding of energy transformation and conservation remains a major challenge of energy teaching. To address this challenge, we developed a new teaching strategy suited to high school based on history and philosophy of science (HPS). This strategy was built and implemented in the frame of a collaborative and iterative work involving researchers and teachers. At the core of this strategy lies a sequence based on the study and replication of Joule's paddle-wheel experiment, which played a major role in the emergence of the idea of energy transformation, contributing thereby to the unification of physics in the middle of the 19th century. In this communication, we will investigate the following question: does such a teaching sequence built in the light of HPS and introducing some elements of HPS help high school students to better understand the concept of energy? We will first present the method for building, implementing and assessing the HPS-based strategy for teaching energy, before providing and discussing selected outcomes. The latter show that such a teaching strategy can indeed be efficient for many students with respect to their understanding of the notion of energy transformation and the principle of energy conservation.

S48 UNITY AND DISUNITY IN PSYCHOLOGICAL AND MEDICAL SCIENCE(S)

Location: IoE - Room 822 **Chair:** Borck, Cornelius

Organiser(s):

The disunity of science has often been, and still is, viewed by many researchers and professionals as threat and as a most salient problem among the human sciences. Sometimes this concern even let to the diagnosis of a state of crisis in the historical development of the discipline, such as it happened in the field of psychology and medicine in Germany in the 1920ies. Historical narratives of the first half of the 20th century aimed at counter-acting this trend, by pointing to discipline's common historical roots and constructing a coherent picture. Thereby, scientific criticisms, academic splits and heated debates about theory and practice were sometimes used justified some sub-division in scientific labor or disciplines while, other times, there were belittled, and even silenced. Thus, more research is needed to return to these problematic debates and tensions and to reflect critically on the role of historiography as powerful instrument to justify unity and disunity in sciences related to the human being, such as psychology, pedogology (science of the child), pedagogy, neurology, general medicine and psychiatry.
In this panel we focus on the different rivaling approaches and techniques that emerged and were developed at a certain place and time, leading to debates about scientific expertise and professional boundaries. Questions such as the following will be explored: how did psychologists, pedologists, pedagogues and physicians deal with the diverse and contradictory views about mental 'abnormality', suicide and deafness? To what extend were some experts able to take control and homogenize approaches and techniques in these fields? How did the psychiatric establishment react to the multidisciplinary approach (Heilpädagogik) in the treatment of nervous diseases and the attempt to found neurology as autonomous discipline?

Mülberger, Annette (UAB)
Hygiene, Schooling, and Psychological Ruling: Detecting 'Mental Abnormality' in Spain

The paper deals with the different ways in which 'mental abnormality' was used as scientific category in psychological, pedagogical and medical texts in Spain during the first half of the 20th century. At that time, classifications of human beings into different psychological categories gained relevance. Clinical, psychological and pedagogical classifications were supposed to be based on 'objective' (scientific) criteria, imposing a 'rational' way of stratifying human society. Among them, also the category of (ab-)normality gained popularity and was subdivided into different types. I will first present some historical examples of social interventions aimed at detecting and selecting mentally abnormal schoolchildren. Such intervention took place in Spain during the first decade of the 20th century by means of intelligence testing. After that, I deal with the expansion of mental testing and its applications in schools in the following two decades. Finally, I show how the category of "mental abnormality" was used during the first period of the Franco regime. One striking characteristic of the uses of the category of mental abnormality is the lack of unity and consensus in definition and criteria. I argue that a progressive standardization of proceduresturned the category of 'human abnormality' into an effective instrument of classification and segregation. Thus, the historical cases evidence the scientists' political and professional agenda. It reflects and expresses their different social reform projects and connect these to the discussions about disciplinary boundaries and scientific expertise between psychologists, physicians and pedagogues.

Byford, Andy (University of Durham)
The Unity and Disunity of Soviet Pedology, 1920s – early 1930s

The paper considers the institutionalisation of child science or 'pedology' as a Soviet 'state science'. It deals with the institutional dynamics involved in incorporating the heterogeneous field of child science into the Soviet state apparatus across various (complex) state departments (the Commissariats of Education and Health). This involved a series of unpredictable institutional restructurings, yet which were seemingly irrevocably governed by the centrifugal drive of state centralisation, organisational rationalisation and ever-increasing administrative control. This process, however, also depended on the opposing, centripetal, dynamics of both administrative and scientific turf wars – ongoing divisions between government departments, as well as rivalries between research groups and disciplinary agendas. At the centre of the paper, however, is the analysis of how Soviet pedology was 'made', or more precisely, how its meanings as a 'Soviet science' evolved over the course of the 1920s-30s. In this context, the paper looks, first, how in the first half of the 1920s pedology formed a convenient 'bandwagon' formation that brought together a multiplicity of research programs and agendas around the study of the child and its development. Second, how soon after new leaders in the field, such as Blonsky, Vygotsky, Basov and Molozhavyi, sought to define pedology as a 'complex' discipline in its own right. Third, how, finally pedology was turned from a (pragmatic) 'bandwagon' and (wishful) 'synthesis' into a (political) 'program of takeover' of what was a highly amorphous and divided field.

Arnaud, Sabine (Centre Alexandre Koyré)

When deaf writers write back: the blind spots of psychological discourses

Starting in the 1880s, the importance of addressing a (supposedly) specific psychology of deaf people became a dominant trend in the conception of deafness held by French teachers, psychologists, and physicians, extending beyond conflicts about the limits of their fields. In fact, the focus gave psychological assumptions greater importance than the strict measure of an auditory imbalancein their understanding of deafness. This paper will examine the ways in which French deaf writers were aware of this curve from the start, and set themselves the task of denouncing such constructions. As early as 1882, and for over thirty years, Henri Gaillard questioned the use of the term abnormal, which, in the name of distinguishing a sensory difference, was soon equated with a mental difference, as well. In brochures, articles, and journals Gaillard either created, edited, or supported, he reviewed some of the most offensive publications, at times setting psychologists against teachers. Starting in1886, the writersLimosin and Eugene Nee dedicated diatribes to highlighting how this psychological trend went hand in hand with pedagogical priorities that no longer fully allowed deaf pupils to develop their intellect.This paper will show how these deaf writers reactivated both unity and disunity across the sciences that were competing with each other to objectify them, thus defying the comfortable position of specialization.

Talavera Cabrejos, Gonzalo (University of Leeds)

Max Isserlin and the institutionalization of neurology in Munich 1914-1936 – a story of unity and disunity

At a time when a unification between psychiatry and neurology gains adherents, I consider of critical importance to understand the processes whereby they had been institutionally separated. While clinical neuropathology was a thriving specialism in late nineteenth century Germany, it was not yet an autonomous discipline. The First World War presented a unique opportunity for some doctors, psychiatrists and neuro-anatomists throughout Germany to secure institutional autonomy for neurology. This paper focuses on how the Munich-based psychiatrist Max Isserlin (1879-1941) and his colleagues fought for the autonomy of neurology by securing private funding and city support for the first neurology clinic in Munich in 1925. At the same time he promoting a multidisciplinary approach for treating nervous diseases, based on empirical psychology and special education (Heilpädagogik). This was accomplished despite the opposition of internists and psychiatrists holding university chairs, who argued that this development would be detrimental for medical progress and a waste of public funds. I argue

that Isserlin's success resulted from his mobilization of clinical research. While Isserlin thus briefly defeated the medical establishment, the subsequent rise of National Socialism entailed that that the autonomy of neurology was only finally achieved in Germany by the 1960s. To show that the institutional reforms of Isserlin were crucial for that end, I use (mostly unpublished) correspondence to be found in the Special Collections at the University of Leeds.

Serrano, Sara (UAB)

Suicide and the unity of neuropsychiatry in Spain (1900-1936)

The process of how suicide became a focus of medical concern in many countries during the 19th century has been already described by several historians. Under the influence of French alienism, this also happed in Spain. There, in the first third of the 20th century, and especially during the 1920s, suicide became one of the most salient topics in the professionalization and institutionalization of psychiatry. Firstly, most Spanish (neuro-) psychiatrists, when addressing suicide, distinguished on a methodological level, their clinical way from other, philosophical and statistical, approaches to suicide. Secondly, they justified the exclusive legitimacy and authority of their professional and theoretical approach to suicide, by remarking the homogeneity and unity of professional experiences of psychiatrists within the clinical context. Thirdly, they promoted prevention of suicide to be exclusively limited to the new institutional network of psychiatric services. Thus, this paper will show which theoretical and professional strategies where used by these psychiatrists to defend the unity of neuropsychiatry and how these constituted an essential part of the process of medical colonization of suicide in Spain during the first third of the 20th century.

S51 LITTLE SCIENCE

Location: IoE - Room 828 **Chair:** Martin, Joseph D.

Organiser(s): Roqué, Xavier

Compared to all that we know about Big Science, little is known about little science. The concept itself lacks a proper definition: what does "little" stand for? Inexpensive? Of scarce interest to the media? Little or slow? Little science risks being conceived of as the negative counterpart, the obsolete precursor, or the poor sister of Big Science, a scientific practice on its way to extinction. The symposium will challenge these meanings and explore ways to think about little science on its own. For the sake of clarity, little science will be provisionally defined as a contemporary knowledge-making practice performed by small teams of researchers that know each other and acknowledge that personal relations are central to research; as a practice that does not necessarily entail transnational cooperation and certainly does not depend on multi-million budgets; as a practice that may focus on what appears to be well-trodden paths with little promise... But crucially and paradoxically, too, as a practice that is disproportionally relevant and disruptive, and contributes to a great extent to produce new knowledge. The Superconductivity Group at the Universitat Autònoma de Barcelona provides an example. Consisting of seven members, combining theoretical and experimental physicists, and building prototypes from scratch in a tiny lab, its research on magnetic cloaks and wormholes was published in leading journals and featured in international news agencies. How does this fit with prevailing images of contemporary scientific practice? How does it relate to a broader argument about the long march of professionalization and the corresponding increase in size of the scientific enterprise? The symposium will therefore dwell on the theme of unity and disunity in the sciences, and the epistemic importance of little science, by looking at the relation between scale and relevance, broadly conceived.

Butrica, Andrew (Independent Scholar)
Planetary Radar Astronomy: Between Little Science and Big Science

Planetary radar astronomy, despite its origins in Big Science, quickly became and continued to remain Little Science. One can describe it accurately as a contemporary knowledge-making practice performed by small teams of researchers. It contributes dramatically to the production of new scientific knowledge, while existing on modest budgets, but relying nonetheless on Big Science primarily for instrumentation. Radar astronomy has always been conducted by small teams of researchers whose numbers literally have declined over time. They all know each other and have common institutional ties. Transnational cooperation existed only in the early days through collaboration with Jodrell Bank (UK). In contrast, radar astronomy has relied on access to large-scale, expensive equipment made available thanks to Big Science. Military spending provided the initial budgets, but funding later shifted to the civilian sector, specifically the National Science Foundation (NSF) and NASA. The actual budgets, though, always remained small. Despite its diminutive size, radar astronomy contributed fundamentally to astronomical science. On one hand, they provided raw data, for instance, for the compilation of the astronomical ephemerides used worldwide. On the other, their imaging abilities contributed in such areas as the topography of Venus and the shape and motions of asteroids. Thus, radar astronomy presents an example of a very successful program of scientific research carried out under Little Science conditions, although dependent on Big Science spending on equipment.

Martin, Joseph D. (University of Cambridge)
Before New Big Science

The mass spectrometer found its first success as a means to determine the isotopic masses and constitutions of chemical elements. As the last known elements were analysed, its future in physics and chemistry laboratories was in doubt—and its inventor, Francis Aston, reportedly said so. From the 1940s to the 1960s, however, the mass spectrometer transformed from an instrument refined to answer a well-defined problem within a specific theoretical program into a flexible analytical tool that brought together researchers from disciplines across the natural sciences. This paper examines that transition through the cohort of young mass spectroscopists who was instrumental to finding new realms where their favoured tool could be applied and to building an interdisciplinary community around it. It argues that the reinvention of the mass spectrometer that the likes of Alfred Otto Carl Nier, Kenneth Bainbridge, and Edward Jordan helped effect prefigured a similar transition in accelerator laboratories, which Catherine Westfall and Robert P. Crease have called "new big science," some decades later, suggesting that features of new big science reflect more general patterns of instrument use and the relationship between theory and experimental practice. This story further offers a useful perspective on unity and disunity in the history of science. In its first iteration, the mass spectrometer was strongly tied to unified theoretical programme. But it was principally by decoupling itself from that programme, and embracing a diverse but conceptually disunified set of applications, that it become the locus of a unified instrumental community.

Oliveira, Raiany (University of São Paulo)

Unity and Disunity within the Little Science done by the Physics Group of the FFCL-USP throughout the 1950s

This paper intends to discuss how the production of scientific knowledge was made in Brazil throughout the 1950s by means of the case study of the scientific work done by the Physics Group inside the Section of Science of the Faculty of Philosophy, Sciences, and Languages of the University of São Paulo, FFCL-USP. The Section of Science assembled the huge range of basic sciences, precisely Mathematics, Physics, Chemistry and Natural History. Their professors shared positions, teaching different subjects and promoting flow connections among different disciplines of knowledge. That community of scientists was based on mixed groups composed by both locals and European professionals who had been encouraged to come and be part of the University staff since its foundation in 1934. The creation of the Physics Department was marked by the presence of Gleb Wataghin, an Italian Professor that has introduced Experimental Physics by researching on quantum electrodynamics. After coming back to Italy, due to issues related with the Second World War, his pupils proceeded to researches on Experimental Particle Physics, as Marcelo Damy de Sousa Santos, the one who implemented the first particle accelerator in Brazil - the Betatron. At the same time, Oscar Sala struggled to start working on a Van de Graaf linear accelerator and during the whole 1950s, the researches made in the Physics Department were centered on experiments to improve the efficiency and precision of the electron accelerators using local technology and resources. This Little Science has contributed to developing a more accurate Nuclear Physics.

Roqué, Xavier (UAB)

Magnetic hoses, cloaks, and wormholes: a case-study in little science

In this paper I describe and analyse the work done by the Superconductivity Group at the Universitat Autònoma de Barcelona as a case-study in little science. This is a stable group of 5 to 10 researchers working within the Physics Department of the university. Combining theoretical and experimental skills in electromagnetism and materials science, the group builds working models displaying theoretically intriguing, potentially useful phenomena. They have devised and shown the first magnetic cloak (2012), a magnetic hose (2014), and a magnetic wormhole (2015). Even though this research has featured in leading journals, attracted funding, prompted international collaborations, been awarded, and drawn media attention, the group keeps working in relatively small premises with modest means. Rather than being a hindrance, the group's size appears to have worked to its advantage, stimulating creativity and favouring

cooperation and cohesion amongst its members. I will build on this example to reflect on the current meanings and prospects of little science. Is this a useful category? If so, what would be its main features? How does it relate to other ways of categorising contemporary scientific practice?

I129 MATHEMATICS 1

Location: IoE - Committee Room 1 **Chair:** TBA

Berenguer, Joaquim (Universitat Politècnica de Catalunya)
Tomàs Cerdà: Introducing Differential Calculus in Spain. The fluxion of the product and areas of curves

In the beginning of Differential Calculus, new concepts were employed in different approaches by eighteenth century European mathematicians. The teaching of the Differential Calculus in Eighteenth century Spain was introduced by several authors, such as Pedro Padilla (1724-1807?), Johannes Wendlingen (1715-1790), Tomàs Cerdà (1715-1791) and Christian Rieger (1714-1780) influenced by mathematicians such as Christian Wolff (1679-1754), the Marquis of L'Hôpital (1661-1704), Colin Maclaurin (1698-1746) and Thomas Simpson (1710-1761), among others. Cerdà, a Catalan mathematician, published a treatise on Differential Calculus entitled *Tratado de Fluxiones*, which is an adaptation of Simpson's *The Doctrine and Application of Fluxions*. Our aim in this paper is to explain Cerdà's special contribution to the Newtonian theory of fluxions based on the definition of fluxion given by Simpson. Specifically, we seek to show that Cerdà on the one hand deduced the fluxion of the product of two variables and on the other hand the area under a curve. This mathematician arrived at these demonstrations by establishing the fluxion of a curvilinear surface, which was a different reasoning than that employed by other contemporanious mathematicians and teachers in Spain. In his Tratado de Fluxiones, Cerdà basically follows Simpson's text, while also introducing certain Leibnizians elements, such as the notation of the Leibnizian differential, which provides a new perspective on the Newtonian conception. He also includes relevant reflections on Leibnizian orientation, which emphasise how much pedagogical factors prevail over the differences between the two visions of the Differential Calculus in the approach adopted by this Catalan mathematician.

Fiocca, Alessandra (University of Ferrara)
"A Masterly Though Neglected Work": Boscovich's Treatise on Conic Sections

The paper embraces the conference theme of 'Unity and Disunity' within and across diverse sciences, mathematics and natural philosophy, diverse nations, Italy and England, different periods, Eighteenth and Nineteenth centuries. In 1754, in the second edition of his *Elementa Universae Matheseos* Roger Joseph Boscovich (1711-1787) published the work *Sectionum Conicarum Elementa*. Boscovich started his treatise on conic sections by their definition in the plane, as the locus of points whose distances from a fixed straight line (directrix), and a fixed point (focus), are in constant ratio. Although this property was known to Pappus, it was Newton who brought it fully to light in his *Principia Mathematica.* As Newton, also Boscovich favoured the synthetic method to the analytical one, and through this definition he introduced a completely new tool, the so called "eccentric circle", by which he developed the whole theory of conics. The aim of this paper is to discuss the genesis of the Sectionum Conicarum Elementa, together with the motivations which led Boscovich to wrote this work, to illustrate the structure of this treatise, and to show how he developed the idea of the eccentric circle. Finally, we comment on the reception of his treatise especially in England, where Boscovich's influence was very strong because his ideas in natural philosophy become an integral part of the reigning Newtonian tradition and moreover, he was viewed as the great Continental ambassador of Newtonian ideas.

Jordi Taltavull, Marta (Johannes Gutenberg Universität Mainz - Institut für Mathematik)
On the boundary between physics and mathematics: Fresnel's wave surface and projective geometry

Geometrical optics is one of the most ancient parts of optics, which deals with the laws of light propagation. The basic laws of geometrical optics have survived for centuries over different

conceptions of the nature of light and of vision, thus geometrical optics provides us with a fascinating object of study on the boundary between mathematical and physical approaches to optics to analyze the dynamic relationship between both domains. My idea is to analyze one specific mathematical-physical object of geometrical optics from this perspective, in particular the wave surface, proposed by Augustin Fresnel in 1821 to understand the propagation of light through anisotropic, biaxial crystals. Crystals had been a challenge in optics ever since the discovery of double refraction in the late 17th century, for light behavior depended on the direction of light propagation. Most interestingly, in few years after 1821 the ways to manipulate Fresnel's wave surface diversified, between physics and mathematics. For Fresnel had not published any derivation of the formula of the wave surface, other physicists after him, like James MacCullagh and William R. Hamilton, explored alternative methods to do so. In this context Fresnel's surface soon became the most prominent example of a quartic surface in the mathematical literature on projective algebraic geometry, a new branch of mathematics emerged in the 1830s. What is the relation between the origin of both Fresnel's surface and projective algebraic geometry? Until which extent does Fresnel's surface speak to a dynamics of differentiation or/and cross-fertilization between disunited fields of knowledge?

Ogawa, Tsukane (Yokkaichi University)

The Mathematical Philosophies of Seki Takakazu and Aida Yasuaki

Seki Takakazu (?-1708) is hailed as the founder of traditional mathematics of the Japanese Edo period (1603-1867). In those times, his Seki school was the main mathematical school. However, few of his contemporaries truly understood his mathematical philosophy due to his achievements begin widespread and his philosophy ahead of the times. In short, his main philosophy was one of generalization or abstraction. All his works, which deal with many different problems, aimed at this. For example, he tried to find the sum of p-th powers of the first n natural numbers and discovered the Bernoulli-Seki numbers. He was also the first mathematician who studied equations themselves as a subject. No one before him had thought about equations in general and finding all their solutions. Seki's pupil Takebe Katahiro (1664-1739) was one of the few mathematicians who reasonably understood Seki's mathematics and philosophy. For instance, he extended his master's acceleration method for calculating pi to obtain a value of 42 digits in 1722. But it is impossible to say that even he inherited and developed his master's philosophy.
Aida Yasuaki (1747-1817) - who founded Saijo school against Seki - also tried to generalize problems, but he too didn't quite recognize Seki's philosophy. He wrote "Survey of Ancient and Modern Mathematics" in 1797 and criticized the work of Seki and Takebe. Considering his argument, I will compare Aida's mathematical philosophy with Seki's and clarify their characteristics.

I114 INSTRUMENTS AND MAPPING THE WORLD

Location: IoE - Room 736 **Chair:** Clifton, Gloria

Chen, Zhihui (Inner Mongolia Normal University, China)
Ancient or modern? -- Astronomical Instruments at the Ancient Observatory of Beijing in the Eyes of Europeans in the 1870s and 1880s

The Ancient Observatory of Beijing, which now is still perfectly preserved, can date back to the year 1279. For several hundred centuries, traditional Chinese astronomical instruments and afterwards Europeanized instrument established by Jesuits were installed on the terrace of the Observatory. As early as the 1870s, Europeans had been interested in the Observatory that was still used for observation at that time. In the International Congress of Orientalists 1876, British sinologist Alexander Wylie (1815-1887) read a paper entitled "The Mongol Astronomical Instruments in Peking". After Wylie, the Irish astronomer J. Dreyer and his friend S. M. Russell, who was an astronomical professor at the Tongwenguan (同文館, College of Foreign Languages). Dreyer's paper had drawn the Amiral Mouchez (1821-1892), who was the director of the Observatory of Paris. In 1887, Mouchez requested some photographs of the instruments the astronomical museum established by him at the Paris. These photographs were not only presented in the scientific magazine La Nature, but also exhibited at the Paris World Exposition afterwards in 1889. Through the introduction and promotion by these European scholars, Astronomical Instruments at the Ancient Observatory of Beijing had been presented before the European people with an image of high level scientific instruments and exquisite arts in the history of science. Different from the sinologists' concentration on the tradition of the instrument in ancient China, the Exposition focused on the Europeanized instruments constructed by the help of Jesuits, in order to show the achievement of the European modern science in the Eastern world.

Yang, Wei-Ting (Institute of History, National Tsing-Hua University, Hsinchu, Taiwan)
An Analysis of Genealogy of Japanese Buddhist World Maps

We study the relationships between Buddhist world maps made in Japan from the 14th to 19th century. The maps of the same area sometimes look different because they show different cartographic styles and represent various knowledge and concepts of different periods. To reconstruct the relationships between the maps, this paper attempts to discuss the applicability of the methodology of "textual analysis" for the study of cartography. The 18 maps are divided into three groups: "Go Tenjiku zu" 五天竺圖, "Nansenbushu bankoku shoka no zu" 南瞻部洲萬國掌菓之圖 and "Nan'enbudai shokoku shuuran no zu" 南閻浮提諸國集覽之圖 according to their style and background. We designed two methods: one is an analysis of the directions and distances of several points on the maps conducted in order to identify their specific features; the other is a computer-aided method that we designed on the basis of phylogenetic method developed in biology to build a genealogical tree of maps. We will compare the results of these two methods to analyze their effectiveness, discuss the relationships between the maps in each group and draw a genealogical tree for all the maps of the three groups.

Zhang, Jiuchen (Institute for the History of Natural Science, Chinese Academy of Sciences)
How Modern Geology Was Published: A Case Study of Chinese Geological Journals, 1919 to 1948

Modern geology was introduced into China in the early twentieth century. This subject was accepted by Chinese people after the processes of introduction, acceptance and growth. As academic periodicals were the main information carriers, and were also the medium of communication for scientific research achievements, this paper examines the creation and development of the geological journals which were published in China from 1919 to 1949. This

research reflects the transmission of modern geology into China from the research on the development of the types and an increase in quantity of geological journals; unifying terminology and using of scientific language, changing of the author group, and social impacts such as the Second Sino-Japanese War. The study draws the conclusion that the process of scientific transmission includes introduction, reconstruction, and output. Its goal is to become international.

Ivanov, Konstantin (Institute for the History of Science and Technology, Moscow)

Astronomers and Surveyors in the Struggle for the "Upper Oxus State": A Few More Episodes in the Great Game of Middle Asia

The territory of the Central Asia, occupied by Imperial Russia between 1865–1878, was mainly desert land that contained just a few small, densely populated oases. Why was it necessary to gain control of it? It did not serve any military purpose, because the better protection of the southern frontier of the Empire were the notorious deserts and dry steppes. Economically, it was also a questionable venture. The advance of Great Britain into the same region from the opposite side reflected the same trend. Paradoxically, the only rational reason to move into the region was a scientific one. At that time, the Central Asia was still a blank spot on the European maps and it was the only region on Earth in which the great empires had not yet confronted each other. The frontier lines of both empires were bound to move in on each other, even if unfavorable for each of them. In my talk, I am going to show how the war for the territory eventually turned into a war against the territory. The main agents of that war were the British and Russian military geodesists and surveyors, who used their skills to advance their careers. Rather than a hostile confrontation, to them, their collaboration during the demarcation between the Russian Empire and Great Britain in 1885, brought the pleasure of sharing topographical and geographical information. As a result, this region was surveyed and explained not only in terms of geography, but also economically, ethnically, and historically.

Godinho, Carlos (University of Lisbon)

[The Armillary Sphere and the Virtue of Hope]

Present across material cultures in media such as books, paintings and sculptures, the armillary sphere is arguably one of the most commonly depicted scientific instruments from Antiquity to the Renaissance. Nevertheless, the significance of this geocentric model of the universe as a way to understand the cultures of science has not been fully assessed. While it has been discussed in the historiography, the key role of the model as an object in which astronomy and theology intersect in the Renaissance has not been considered. The lack of a standard terminology between the Middle Ages and the Renaissance makes it hard to identify all the possible references to the armillary sphere in textual sources. A deeper reading of those sources, and, especially, a careful analysis of its visual representations are both required to disclose the cultural meaning of the model during this period. I will try to relate theoretical worldviews with contextualized material cultures by exploring the association of the armillary sphere with the theological virtue of Hope. I claim that this virtue, which worked as one's desire and expectation of union with God, was believed to be potentiated through the visualization of the armillary sphere. Relying on a number of visual and textual evidence, I propose that the model was seen as a godlike archetype. Built on a Christian Neoplatonic tradition embedded in Portugal's 16th century astronomical and theological culture, the sphere represented an ambiguous relationship of unity and disunity between the Creator and the Cosmos.

I136 HUMAN SCIENCES

Location: IoE - Room 780 **Chair:** Morton, Alan

Dadaian, Anna (UCL - CMII (Health Humanities))
Jung on the Unity and Disunity of Science and the Role of Psychology

In this paper, I outline Carl Gustav Jung's position regarding the notions of 'unity' and 'disunity' in psychology, as well as in science in general, based on his writings in 'Psychological Types' originally published in 1921. The aim of this paper is twofold. In the first part, I illustrate that at the heart of Jung's theory of psychological types is a plea for disunity in psychology. In particular, I show that Jung's typology provides a basis for a pluralistic methodology in psychology. In 'Psychological Types', Jung argues that 'the assumption that only one psychology exists or only one fundamental psychological principle is an intolerable tyranny, a pseudo-scientific prejudice of the common man' (Jung, 1971, p. 41). In the second part of this paper, on the other hand, I show that Jung conceptualised his typology as a way of overcoming the bias, or 'subjectivity', of the scientist and moving towards 'objectivity' and unity. From this perspective, psychology is conceived of as the 'unifying language' of science. I explore why Jung thinks this is the case by looking at how he conceptualised his theory of psychological types—its philosophical basis. I argue that Jung follows William James in his contention that 'the history of philosophy is, to a great extent, that of a certain clash of temperaments' (James cited in ibid., p. 300). Jung's typology, then, and, by extension, psychology, can be understood as a meta-epistemology—an analytical framework, or a language, allowing us to acknowledge our epistemological biases and engage in fruitful discussions.

Pannese, Alessia (University of Oxford)
One Self: the autonomic nervous system and the (dis)unity of consciousness

Aristotle distinguished between intellectual and moral virtues, holding that the former result from instruction whilst the latter from habit. Nineteenth-century empirical evidence confirmed that much of everyday action consists of habits: by the end of the century, William James estimated that ‘ninety-nine hundredths or, possibly, nine hundred and ninety-nine thousandths of our activity is purely automatic and habitual.’ The pervasiveness of habit in human behaviour mirrors the centrality of automaticity in human physiology. Physiological accounts of automaticity made great strides in the second half of the nineteenth century, thanks to discoveries made by Claude Bernard (1813-1878), Walter H Gaskell (1847-1914), Walter Bradford Cannon (1871-1945), and John Newport Langley (1852-1925), who, in 1898, introduced the term "autonomic nervous system". Based on the experimental evidence accrued from these and other investigators' physiological studies, it became clear that the autonomic nervous system fulfils an essential role for the organism's integrity and survival because it maintains homeostasis, i.e. internal unity and balance in the face of variability in the external environment. Drawing on the 19th-century physiological literature, I will suggest that this realisation problematised the understanding of the self (as defined by conscious control) and of its relation to self-regulation (as dominated by automaticity). I will present my case by examining ways in which the discovery and characterisation of the autonomic nervous system as major player in self-regulation led to a novel understanding of human conscious experience of the self as uncoupled (dis-united) from self-regulation, and of self-regulation as coupled (united) with automaticity.

Tanghe, Koen (Ghent University)
On the non-Existence of a Science of Man: A View from the Past

The project of a science of man is older than both the idea of a science dedicated to the study of the Earth (‘geology’) and the concept of a science of life (‘biology’). And yet, anno 2018, a young student can aspire to become a biologist, specialized in molecular genetics, or a geolo-gist, specialized in volcanology but she can still not embark on a study of what might be called

andropology and subsequently specialize in bio-anthropology, economics or medieval archaeology. Why was the creation of geology and biology through the integration of, respectively, eighteenth-century Earth sciences and nineteenth-century life sciences successful whereas scarce attempts to integrate the sciences that study our species have failed? The common denominator of the former two integrations offers the beginning of an answer to that question: they were facilitated by the discovery and study of the deep history of Earth and life. Nothing makes sense in geology or biology, except in the light of that history. The main reason why the deep, binary or bio-cultural history of man has not, likewise, acted as a catalyst for an integration of the human sciences must be sought in the ancient conflict between the study of life and the study of man. The main, counter-intuitive thesis of this presentation is that biology is the chief culprit of this chronic friction and, ipso facto, of the lingering lack of an integration of the human sciences, based on the bio-cultural history of our species.

Tarbuck, Derya (Bahcesehir University)

Religious, Scientific and Philosophical Accounts of Melancholia in the Eighteenth Century

The relationship between a study of Moral Philosophy, eighteenth-century Medicine and the changing understanding of Melancholia is not such straightforward one. It is already established that the Enlightenment study of mind and emotions was a branch of moral philosophy. Especially when one consideres that the main purpose of the Scottish thinkers in the eighteenth century was a study of Man. This study includes an assessment of the self as a man with feelings, sociable instincts etc. When one considers feelings as expressions of mind, this opens up a new territory for an understanding of Melancholy. The questions I would like to ask in this respect are how did the eighteenth-century theorists of Reason and Emotion think about Religious Morality? How were the scientific categories and philosophical conclusions about the conception of Morality in the eighteenth century negotiated with the Religious approach to Ethics? How did the evolution of Moral Philosophy in the eighteenth century have an effect on the ways in which Religion moderated the Moral Behaviour? The aim of this paper is to elaborate these points of view within the general framework of the secularization of Melancholy, by examining religious, philosophical and medicine related treatises that dealt with the subject in the eighteenth century.

Limeira Da Silva, Victor Rafael (UFBA/UEFS)

Between uniformity and human diversity: a proposal of an ethnography of the Uaupes Indigenous in Wallace's scientific travel on the Amazon

In spite of the fact that historians have paid more attention to the travels of Alfred Russel Wallace on the Brazilian Amazon (1848-1852), the historiography has focused on his practice as a neophyte scientific collector, and no research has engaged in studying his ethnographic work on the Amazonian indigenous people. The labeling of imperial reports reinforced the homogenization of upper Amazon indigenous as "savages" through comparative categories with well-known groups, such as the Tupi-guarani, the so-called "civilized". Initially under this logic, Wallace dedicated his two last trips to the Uaupes river to collect and register ornaments, instruments, moralities, racial constitutions, musicalities and languages of the natives with whom he came into contact. This communication is an effort to contribute to the history of the ethnographic dimension of Wallace's travel to the Amazon and of his interaction with the emerging Human Sciences. It intends to reflect upon Wallace's contributions to the Amazonian indigenous ethnology. It also concentrates on analyzing the classificatory schemes applied by Wallace, in order to question the extent to which it corroborates the idea of "uniformity", derived from the indigenous tutelage system lexicon, or "diversity", a notion that emerged with the growing interest in the humankind history by early Ethnology and Anthropology. This communication also aims at addressing possible reverberations of this study to the historiography of Wallace's fieldwork and scientific production, still massively interested only in the entomological and zoological aspects of the Amazonian incursion of the young British naturalist.

S21/3 CONTINUITY AND DISCONTINUITY OF UNIVERSITY EDUCATION AND RESEARCH ACTIVITIES OF CENTRAL EUROPEAN SCHOLARS DURING WORLD WAR II

Location: IoE - Room 784 **Chair:** Svobodný, Petr

Organiser(s): Jůnová Macková, Adéla; Sekyrkova, Milada; and Kokowski, Michał

Commentator: Ash, Mitchell

World War II changed and challenged generations of European researchers, and impacted on the existence of research institutions. Several occupied countries had to close their higher education institutions in 1939 (Protectorate Bohemia and Moravia, Poland), scholars lost jobs and students opportunities. One solution that maintained a research career as a viable option for scholars consisted of teams in non-university research institutions. It was a way of survival that offered work, and sustenance, even though with limited teaching opportunities, and limited publication outlets. A generation of students had to leave the universities, and their younger followers did not have a perspective – army life and factory work was an imposed solution. An alternative applied in Austria, Hungary, and Germany itself was to embark on research projects and teaching plans deemed acceptable to the regime and to war conditions. Across Nazi-controlled Europe, racial laws, army conscriptions, and enforced exile exercised a considerable influence, next to a reorientation of research programmes to contributions to the war effort. Historiography mapping and interpreting a profound war impact in occupied regions concerns both institutional histories and individual, more biographically oriented aspects. Personal histories of Central European researchers on diverse sides of the conflict included also resistance to the Nazi regime. The symposium panel is concerned with a continuity and discontinuity of research institutions, disciplines, and research interests of Central European researchers during the war. Both institutional and individual aspects have been incorporated, mapping diverse strategies and outcomes. The individual perspective also includes everyday existence, and very personal aspects of habitus, with practices and representations set in highly complex situations, such as exile, resistance, war effort, or survival in a totalitarian regime.

Kokowski, Michał (Polish Academy of Sciences)
Higher education and research activities in Poland and in exile during World War II (a review of main issues)

The paper discusses the state of higher education and research in Poland during World War II in the areas occupied both by the Third Reich (until 22 June 1941, only the western part of Poland, including Poznań, Warsaw and Kraków; short after this date – all territory of Poland) and by the Soviet Union (until 22 June 1941, the eastern part of Poland, including: Vilnius and Lviv). It considers, among others, the imprisonment and murder of Polish scholars by the invaders (e.g. Sonderaktion Krakau, starting on 6 November 1939 in Kraków and ending with the deportation of Polish scholars to the Sachsenhausen concentration camp; the murder of Lviv scholars by the Nazis in June 1941; the murder of Polish scholars by the Soviets in 1939–1941); the closure of Polish universities; the looting of scientific goods, both material and intellectual, belonging to Polish academic institutions or scholars; the devastation of academic buildings; the Nazification and the Sovietization of higher education and research activities in the areas of Poland occupied by the Third Reich and the Soviet Union respectively; the foundation of new scientific institutions; the public and secret academic activity of Polish scholars; the clandestine higher education in Poland; the emigration of many Polish scholars abroad; the Polish institutions of higher education and research in exile; the very difficult and complex issue of historical axiology, i.e. patriotism and collaboration with the occupants.

Wójcik, Wiesław (Jan Długosz University in Częstochowa)
The creation of new research centers in the West by Polish mathematicians emigrating during the Second World War

In the paper I demonstrate the creation of new research centers in the West by Polish mathematicians emigrating during the Second World War. The rapid development of the Polish School of Mathematics was interrupted by the outbreak of World War II. During the war, scientific activity in the occupied Polish lands almost completely froze. Some mathematicians emigrated (mainly to the United States), where some of them have created significant research centers. The examples of such mathematicians are: Antoni Zygmund, Samuel Eilenberg, Alfred Tarski, Jerzy Spława-Neyman, Mark Kac. These centre can be treated as a continuation of the Polish Mathematical School (I will try to justify it in the article). I will focus on the most important mathematical centers created by Polish mathematicians. I will outline their significance for the development of mathematics, and on selected examples, I will also show the specific scientific achievements of these centers.

Vogt, Annette B. (MPI Berlin)
Scientists and their resistance against the Nazi regime

During the long-durée investigation of female scientists at the Kaiser Wilhelm Institutes and at the Berlin University, we found out only very few male and female scientists who were strictly against the Nazi regime, from the very beginning, or later (Vogt (2007), pp. 383-411). Eight out of 710 female doctoral students at the Berlin University and very few scientists in the Kaiser Wilhelm Society were involved in resistance activities. First, I'll sketch out the situation for German scientists under the Nazi regime, and the circumstances becoming either an active Nazi, or being opportunistically and building one's carreer, or following their mind and heart and becoming one of the very few people to resist. Second, I'll describe the different activities of resistance, the various resistance groups and their actions. Third, I'll illustrate some examples of these resistance activities of male and female scientists who were working in some Kaiser Wilhelm Institutes, at the Berlin University, and in other research units in Berlin and other towns. These scientists had in common their great courage, they maintained severe discipline, they were ingenious to help persecuted people, and to help each other. After the unconditional surrender of the Nazi regime most of them didn't talked about their resistance activities, they kept their secret resistance fights silent. Although they belonged to a very small minority, it should be the duty to investigate and to remember their activities.

Sekyrková, Milada (Charles University, Prague)
Life Unity and Work Disunity of Czechoslovak Historian Otakar Odložilík during WWII

The WWII changed the fate of most people who experienced it. Its impact was, of course, as a rule negative. Paradoxically, there are people who have moved on in their working career strongly in a way they have not dared before, or war period gave them the possibility of living freer, more naturally of their nature and of their founding. The paper focuses on the research and the private trips and contacts of historian Otakar Odložilík (1899-1973), professor of Czechoslovak history at the Charles University in Prague, until the outbreak of the WWII and during it. Paper explains the continuity of Odložilík's travels during the war in time of his first emigration in the U.S.A. and later in the U.K. where he worked for the Czechoslovak exiled government. In addition, it speaks about his achieved research results, and shows how the war has changed or didn´t changed his research goals and his private life. He returned to Prague for three years after the war, but in 1948 he finally emigrated and died abroad. Paper is based on Odložilík´s diaries, correspondence and his personal archive funds from Czech archives.

S47/2 MEANINGFUL COLOUR: EPISTEMOLOGY OF COLOUR IN THE SCIENCES (EARLY MODERNITY TO TODAY)

2. THE REPRESENTATIONAL MATTER OF COLOUR: ITS EPISTEMIC WEIGHT

Location: IoE - Room 790 **Chair:** Bock von Wülfingen, Bettina

Organiser(s): Bock von Wülfingen, Bettina

From amazingly colourful antique relics to the attempts to standardise colours in biomedical imaging – colour is gaining in relevance in the sciences. Yet the epistemic role of colour, its long-standing neglect due to historic symbolic, in part gendered, ascriptions, and the function of colour in visualizations for internal scientific use have not received much attention in the sciences and humanities to date. This is especially the case for non-mimetic colour use. With the term non-mimetic we refer to colours that are not applied to mimic colours of nature (such as the sky blue, urine, or plant colours) but are of (sometimes hidden and unintended) semiotic relevance. The internal use of colour in the sciences raises different epistemological questions to those that arise with images for external communication. The choice and symbolism of colour in the latter case is guided to a greater degree by a need for simplification and considerations as to the expectations of a broader public. Coloured images for internal scientific use emerge during the research process itself (as a medium for self-reflection) or are produced in appliances and used for intersubjective communication and to obtain feedback from the scientific community. Digital publishing has enhanced the use of colour in scientific images, in contrast to the costly use of colour in print media, whilst the globalisation of the scientific community challenges the idea of universal colour symbolism. Meanwhile standardisation of colour applications in scientific images seldom occurred and occurs, leaving a broad diversity of colour symbolism within fields. All this raises the need for colour awareness. The history of the ontology of colour has already gained some attention in history of science. It is of course not to disentangle from its meaningful use or non-use. Still, the session rather focuses on the meaningful application of colour and its interpretation by the sciences – and the history of such theorising. It explores the colour conventions and strategies in scientific images that predominate today as well as in historical perspective and across disciplines. This encompasses the issue of the neglect of colour as an object of scientific self-reflection and as an object of the humanities' research on the sciences. In brief: in this session we investigate the epistemic dimensions of colour in the sciences, across disciplines and across history.

Txapartegi, Ekai (University of the Basque Country)

Color images as not-so-confusing representations

"Why does Descartes seem to place such epistemic weight on picturing?" asked Baigrie (1996: 86) echoing the perplexity that always produces to find so many pictorial illustrations in the scientific works of this rationalist philosopher. Given the material falsity that Descartes famously attributed to colour sensations as obscure and confused ideas for (not) being able to represent the mechanical nature of the real physical colours (AT VIIIA 34; AT VII 44; AT VII 233-5), one is tempted to conclude that his advice to scientists would be: "Never use colour images to describe the world. Represent always mathematically!". However, Descartes never abandoned the use of arbitrary (or partially arbitrary) conventional signs as words or illustrations to describe the world through 'visualization'. The main idea that I will argue for is that, according to Descartes, colour sensations (or colour images, for that matter) are perfectly representational (De Rosa 2007), intellectually necessary even, and that Descartes did not question their representational value for certain cognitive functions. The epistemic role of

colour sensations (or colour images, for that matter) to intellectually grasp the natural world might not be, according to Descartes, as avoidable after all.

Kleinwächter, Tanja C. (Technical University, Berlin)

Colour samples for creating natural history - Ignaz Schiffermüller (1727-1806)

An increasing number of publications on colour in the second half of the 18th c. shows a growing interest in colour and in colour order. Contributions to the systematisation of colours were delivered out of Arts, Sciences, and Economy. Natural history played an important role for the systematisation of colours. The obviously urgent need for an order of colours led to a significant number of contributions on the nomenclature, the reference, and the order of colours. In my proposal I address the question for the internal use of colours in 18th c. natural history. In my opinion, unpublished samples, scales, and reference tables were much more important for scientific research and education than published ones. It is difficult to proof my assumption with quantities of examples, because just a few of these work-in-progress colour samples and scales survived and are available for examination. Instead I'd like to show the internal use of colour during the research process at the example of Ignaz Schiffermüller. Schiffermüller was a Jesuit priest and natural researcher in Austria. Well known for his classification of the Viennese butterflies he published a system of colours as well.

Gerontas, Apostolos K. (University of Applied Sciences, Coburg)

The early history of chromatography: bringing back the colours in chemical analysis

The chromatographic cluster of techniques has been revolutionary in the history of chemical analytics twice: once in its pre-mechanised version in the 1930s and, once again, through the introduction of chromatographic apparatuses from mid-1950s on. While it is so successful today, it is often forgotten that chromatography entered the theatre of history with a major failure. In its first introduction by its founder Mikhail Tswett at the beginnings of the 20th century, it has met the almost unanimous rejection of the chemical community. Introduced as an experimental/analytical solution to the then current problem of chlorophyll, chromatography was making a then radical claim: separate molecules may be definitely recognized, and considered isolated, only by their notable physical properties, in the case of the three chlorophylls, their colour. This claim came in conflict with the norms of contemporary chemistry –a fact that led to the shelving of chromatography for the next two decades. This paper offers a narrative of the first steps of chromatography and the controversy that surrounded it, while suggesting the potential explanations for both the initial rejection of chromatography, as well as its reintroduction and eventual canonization in the 1930s.

Cobbold, Carolyn (University of Cambridge)

From palette to palate: the invisibility and elusiveness of chemical colours in nineteenth-century food

From the 1850s chemists created hundreds of new synthetic dyes that transformed the colour and consumption of material goods, revolutionising the textile industry and initially delighting consumers. However, these novel substances, created at the cutting edge of chemical science, also came to permeate food and drink products invisibly across the western world, passing through a complex international supply chain from chemical factory to wholesale and retail chemists to the food industry, with their physical and chemical origins becoming more and more obscured. Despite their brilliant colours and ubiquitous presence in nineteenth-century food, their existence was hard to detect and, moreover, continues to be invisible historically. I will examine how chemists from different cultural and institutional backgrounds sought to understand, detect and assess the new colourings being used in food. Chemists had used colour as an analytical tool in assessing substances and mixtures since the sixteenth century, but no standard method of measuring colour or detecting dyes was established. The new chemical colours proved to be elusive boundary objects, moving from being epistemic laboratory-based

substances to becoming commercial commodities and objects of political, public and scientific inquiry, understood in different ways across a range of communities.

S38/6 SPACES OF CIRCULATION AND COLONIAL / IMPERIAL LANDSCAPES: CRITICISMS AND CHALLENGES

Location: IoE - Room 731 **Chair:** Gesteira, Heloisa

Organiser(s): Silva, Matheus Alves Duarte

Discussion of processes that cross political, geographical, or cultural boundaries has increased among historians of science in the past years. Following this "global turn", the problematic of intercultural interaction has been mobilized to make sense of the construction of different forms of knowledge — geographical, natural historical, linguistic, ethnic to name but a few. According to this conception, knowledge thus circulates within circumscribed spaces that are always the result of encounters and negotiations. The rising deployment of the problematic in the past decade notwithstanding, many scholars continue to conceive the term as a synonym for diffusion, transfer, transmission, mobility, or simply fluidity, and are perplexed by its implied concession of agency to all participants in contexts of colonial or other asymmetrical power relations between social or ethnic groups. By bringing together scholars who have used the framework of circulation in their work as well as those who have reservations as to its relevance, we would like in this symposium to develop the problematic through a dialogue between these different positions in order to establish a better understanding of the prospects and methodological nature of the idea of circulation. Moreover, the intention of the symposium is to explore the implied conception of 'spaces of circulation' within which bodies of knowledge, know-hows, practices, and norms are constructed and shared, and beyond which they need again to be negotiated in order to move. Finally, the question of unity and disunity is strongly tied to all such concerns, as circulation – or, for its critics, at least movement and mobility – is in itself a main cause of all manner of mergers and splits. Participants are invited to explore the possibilities and the methodological and theoretical challenges inherent to this approach, to probe its limits, and to engage in conversation with skeptics. Albeit empires and colonial settings themselves constitute a multiplicity of deeply diverse historical entities, the symposium includes contributions which focus on the production of knowledge in this kind of political formation, both European and non-European, from circa 1500 to 1945.

Kury, Lorelai (Casa de Oswaldo Cruz)

Brazilian woods and plains: Auguste de Saint-Hilaire's global biogeography

This paper analyses the theoretical and practical botanical work accomplished by the traveler-naturalist Auguste de Saint-Hilaire (1779-1853). My focus here is to understand how he incorporated local knowledge about Brazilian vegetation and, at the same time, accumulated data aiming to develop means for acting at a distance. He chose the Brazilian region of Minas Gerais as a case study. He distinguished various types of primitive and altered woods and plains, using words extracted from the traditional knowledge he learned during his trip. A central part of his analysis of the vegetation of Minas Gerais was based on his interaction with Brazilian inhabitants, during fieldwork. Nevertheless, once in France, he tried to follow the model of the Scottish naturalist Robert Brown, who studied the flora of Australia. Brown and Saint-Hilaire used analytical descriptions of species, classifying methods and a comparative perspective to organize plants originated from non-European areas. They endeavoured to find patterns of plant distribution on Earth. The confluence of biogeography and the so called "natural method" increased the possibilities of "action at a distance". Their work created expectations concerning science and its possibilities. Botany could be a powerful tool for predicting which kind of plant could exist in a given region or for determining which kind of

virtue one could expect to find in a recently discovered plant. Acting at a distance could open access to plants while avoiding contact with local people.

Hossain, Purba (University of Leeds)
Crossing the Kala Pani: Indentured Networks and the Calcutta Public in the Long 1830s

Contractual labour migration was a longstanding phenomenon in the nineteenth-century; one that became the theme of debates around labour rights, mobility, and imperial responsibility towards citizens of the Empire. With the emigration of indentured labourers from India to Mauritius in 1834 and British Guiana in 1836, the indentured system gained ground and soon emerged as a systematised network of overseas migration to colonial sugar plantations. As the site of embarkation and disembarkation, the colonial capital of Calcutta occupied a unique position in global indentured networks—one where local personages and periodicals participated and contributed to global discussions around migrant labour and servitude. This paper explores the linkages across Empire through the lens of indenture, and seeks to locate Calcutta within these networks.

Chamelot, Fabienne (University of Portsmouth)
Transferring archival science to the colonies: the making of French colonial archives in French West Africa and Indochina, 1911-1958

Academic debates on colonial archives have mostly focused on archives as documents or sources and have little engaged with archival science and its definition of archives: a set of fonds respecting the principle of provenance. Yet, this approach allows the opening of a new field of reflection with regards to the relationship between archives and power. The French colonial administration offers relevant case studies to investigate this question. For instance, an archives office was created both in French West Africa (AOF) and Indochina approximately at the same time. The two archivists appointed head of each archives came from the Ecole des chartes: Claude Faure in AOF and Paul Boudet in Indochina. Therefore, these archives should have been similar. But the administration in Indochina found itself with one of the most efficient classification system France has ever known while the administration in AOF had hardly any organised archives As archivists coming from the metropole and trained in a school aimed at a national setting, Faure and Boudet had to reinvent themselves and find innovative ways to transfer their knowledge and skills to a colonial setting. They each did that according to the specific social and political context they faced, resulting in contrasted outcomes. This paper will show that colonial archives were a political tool in the repertoire of power of the French administration which could be used to reinforce the administration and contribute to its persistence in order to dominate a population or to exercise control over its own administrators.

Korge, Lisa (University of Konstanz)
From pragmatic to professional, from local to international? The emergence of a specific road construction knowledge for the tropics in the Dutch East Indies

The proposed contribution examines the emergence of a specific body of expertise concerning the construction of modern and trafficable roads for the tropics. Dutch administrators and engineers already had several decades of experience in the construction of paths and roads under the geographically and climatically conditions of their archipelagic colony. However, with the introduction of the first motorcars, the requirements regarding overland routes changed drastically. This subsequently led to two different developments in the way the road construction knowledge in the colony was produced and disseminated. The first is the transition from a rather pragmatic to a more professional, and even scientific, approach. At the beginning of the century, the main task was to teach colonial officials without much technical experience how to plan and build roads. The required knowledge was laid down in manuals that were compiled by experienced engineers. As road requirements became technically more complex and maintenance more expensive, the pragmatic know-how ceased to suffice. This lead

to the establishment of a test laboratory for construction materials fit for the tropics. This shift to the second development: as Dutch engineers and researchers reached the limits of their expertise, they soon began to look for technical solutions and best practice beyond their colony. The paper intends to tackle the problematic of circulation by carefully examining the media in which the road construction knowledge was accumulated, namely manuals, professional publications and conference reports. This approach promises also to check if their results subsequently were adopted in (inter)national contexts.

Haines, Elizabeth (Royal Holloway, University of London)

Harnessing political influence around the Zambezi, 1880-1920: Circulating referees

The maps of Zambezi that passed between the BSA Co. and the British Colonial Office have largely been read with one of two approaches. Through this first lens, maps are part of the legitimation of territorial claims within the rhetoric of European statecraft. Recently more attention has been paid to the same maps as evidence of African political systems that predetermined the shape of colonial territorial demarcations. On the ground, emergent colonial states were also realised through a series of fiefdoms of white colonialists, which are recognised metaphorically. This paper, however, takes that metaphor seriously, and reconsiders governmental cartography of the middle-Zambezi to trace the generation of two such fiefdoms. First of these is Val Gielgud, first BSA officer, then labour agent. Second, William Harding, soldier and personal secretary to Cecil Rhodes. Rather than reading the maps generated by these officers as part of the prehistory of an emergent modern political territory with a centralised government, I will expose them as a record of mobility. I propose that Gielgud and Harding offer us documentation of a moment in which the complexity of power and knowledge was institutionalised into a system of political governance under indirect rule. In this process, controlling information, and in some cases retaining it locally, created a “centrifugal" system of colonial authority. The nature of flows within that system continued to depass the bounds of territory yet gradually became hidden within the dominant representational forms of an apparently ‘modern’ government.

I126 GEOGRAPHY

Location: IoE - Committee Room 2 **Chair:** TBA

Hopkins, Andrew (LSE)
Conspicuously Cumulative? Aspects of 'Progress' in the History of Geology

Geology is predominantly an historical science which seeks to uncover the Earth's history by making inferences from field-based observations in the present about events and processes that operated in the deep past. Although there is also an experimental aspect to geology which mainly takes the form of numerical and physical modelling, this is secondary to its historical dimension. So while some explanations in geology are causal and nomothetic, there is a clear disposition towards narrative forms of explanation that are appropriate to its historical nature. Another characteristic of geology is that new discoveries or ideas tend to clarify or modify existing theories rather than overturn them completely. Hence geological knowledge generally proceeds by absorbing new evidence into existing theoretical frameworks: in Martin Rudwick's words, geology is "conspicuously cumulative". Even the acceptance of the theory of plate tectonics in the 1960s, probably the most profound transformation in thinking in the history of geology, is widely viewed as a non-Kuhnian event that drew heavily on existing ideas. This paper uses cases from the history of geology to explore the possible connections between these distinctive aspects – historical, field-based, narrative and cumulative – that we find in the way geologists have, over time, explained and re-explained the Earth's history. It is in addition, a significant question whether these characteristics are critical to the distinction between historical and experimental sciences generally – a fundamental aspect of disunity - as emphasised in recent years by Carol Cleland.

Lund Jacobsen, Lif (The Danish National Archives); Lajus, Julia (Department of History, National Research University Higher School of Economics, Petersburg); Fedorova, Irina
The exchange of seismic technology and knowhow between USA and the Soviet Union, 1961-1965

Originally developed in the 1880s to record seismic waves emitted from earthquakes, seismographs of various designs were placed in stations across the globe. However, in the 1950s it became clear that global seismic monitoring was the most reliable method to detect underground nuclear tests and a key technology to uphold an international nuclear test ban. In September 1961, Professor Maurice Ewing of Columbia University was contacted by Professor Eugene Savarensky of the Institute of Physics of the Earth, the Academy of Science in Moscow, who suggested that the two institutions could exchange seismographs on a scientific basis. The underlying interest was to gain access to the counterparty's technology to increase verification possibilities, a goal that could not be achieved through the usual diplomatic channels. Over the next four years, the two regularly keeping in contact (but never met) and, guided by their political and military hinterland, expanded the initial scope of the exchanges to include visits of scientists and experts. At times of high tension, like under the Cuba Missile Crisis, both parties used third-parties' like scientists from Denmark or Finland, or international organisations like UNESCO, to further depoliticize the situation or act as a go-between. Based on original archival material from USA, Denmark and Russia, relating to the above described exchange of technology and knowhow, this study will exam, how science and scientists was used as diplomatic tools to facilitate nuclear negotiations in a seemingly neutral setting and discuss the findings in the wider context of science diplomacy.

Nizovtsev, Viacheslav (Lomonosov Moscow State University)
Dualism of views in the formation of anthropogenic landscape science

At the turn of the XIX-XX centuries in Russia the works of V.V. Dokuchaev, L.S. Berg, A.A. Borzov and other scientists have established the classic landscape science, where the issues of

anthropogenic transformation of landscapes were closely examined. In the 1930s, L.S. Berg called landscapes, transformed by human activity, cultural, and A.A. Gozhev and B.N Gorodkov called them anthropogenic. Later, this discrepancy led to a different interpretation of such landscapes, resulting in heated debates and discussions in the scientific literature and geographical conferences. A new dualism of views on anthropogenic landscapes appeared in the second half of the XX century with the formation of a new scientific direction in landscape science - anthropogenic. Its founder F.N. Milkov believed that anthropogenic landscapes are complexes where on all or the most part of their area any of the components of the landscape is subject to a fundamental change further to a man influence and that a separate discipline should study them. F.N. Milkov believed that a landscape is a natural and socio-historical unity. According to his main opponent A.G. Isachenko, the landscape is an exclusively natural formation. It should be noted that this discussion has remained unfinished. For example, V.S. Preobrazhensky (1997) argued that landscape science will not survive if it is considered a mere physical and geographical study rather than general geographical science. Contrary to that, I.I. Mamai (2006) believed that "Anthropogenic landscape science has fulfilled its task and begins to impede the development of all landscape studies".

Nordlund, Christer (Umeå University)

Understanding Field Science Institutions: On Opportunities and Conflicts

From the oceans to the mountains and the vast in-between scientists have created institutions for scientific work in the field. Long-lived or temporary, more or less institutionally authoritative, magnificent or humble in scale, these spaces and infrastructures in the landscape and seascape have provided an organizational domestication of migratory science and facilitated scientific work on nature beyond urban centers of learning. As such they have played a significant role in the history of knowledge production, yet not always in ways predicted by their founders. Opening a field research station, for example, can be an attempt to unite center and periphery, to counter potential land use conflicts, or to gather scientists from different disciplines in order to foster exchange of ideas and multidisciplinary collaboration. But it might as well result in severe conflicts between scientists, amateurs and locals as well as between scientists with different goals and interests. Furthermore, a permanent institution in the field might facilitate long-term measurement of environmental change and become a site of scientific authority, but it might also be trapped in its own tradition and eventually prevent scientific renewal and advancement. This paper draws on and present the forthcoming book *Understanding Field Science Institutions*, eds. Helena Ekerholm, Karl Grandin, Christer Nordlund & Patience Schell [to be published by Science History Publications/USA in the spring of 2018], which analyses both similarities and differences within the complex history of field science institutions and their relation to other types of academic institutions, from the seventeenth century onwards.

Wess, Jane (Independent Scholar)

Maths and Maps: Investigating unity and disunity between theory and practice at the Royal Geographical Society in the long 19th century

The paper explores the relationship between the mathematical theory of projections, contour lines, and the four- colour theory with the cartographic practice evident at the Royal Geographical Society in the long 19th century. It argues that there was disunity between theory and practice to the extent of a lack of knowledge of theory among prominent members of the Society. It will also argue that the development of contour lines, unlike that of other isolines such as isotherms or magnetic charts, was held back by the skilled nature of hachuring, so that disunity was set up between a mathematical approach to map making and an artistic one. Britain appears to have lagged behind other parts of Europe in producing new representations of the globe, and in representing heights by isolines. It appears to have lagged behind the United States in producing maps compliant with the four colour theorem. The paper presents surveys of the collections and discussions at the Royal Geographical Society, together with material

from contemporary textbooks, and images from a wide range of sources, to formulate the arguments. It can be considered in the light of the 'Unexpected Effectiveness of Mathematics' debate first promulgated by Eugene Wigner in 1960 and still very much alive today. As for the case of longitude in the 19th century it will be argued that mathematics actually had little effectiveness on practice.

I128 EARLY MODERN MATHEMATICS

Location: IoE - Room 709a **Chair:** TBA

Chikurel, Idit (Tel Aviv University)
Manifold in Unity: Influences of Greek Geometrical Analysis on Maimon's Notions of Analysis

It is often claimed that analysis, defined in the most general sense as "manifold in unity", is grounded on the principle of contradiction alone. Synthesis, however, defined as "unity in manifold", is grounded not only on the principle of contradiction but on pure intuition as well. This distinction is inaccurate. In my talk, I discuss the notion of analysis as something that can be grounded on sensibility as well. For this purpose, I present practices of Greek geometrical analysis and discuss how they shaped philosophical and mathematical notions of analysis that are broader than merely logical analysis. I present the case of the philosopher Salomon Maimon (1753-1800) and his work on the different notions of analysis. Maimon's work on analysis is entwined with his work on invention. When writing the outlines of a theory of invention, he turns to Euclidean geometry and practices of Greek geometrical analysis as his main source of influence. This influence is extended not only to his formation of methods of invention but also to his notions of analysis and invention. He presents several notions of analysis, philosophical and mathematical, that are grounded not only on the principle of contradiction but on intuition as well. My discussion of such influences will be accompanied by examples taken from Euclid's Elements and Data. This study of the different forms of analysis is meant to shed light on the less known aspects of the practice of manifold in unity.

Dobre, Mihnea (ICUB, University of Bucharest)
The role of mathematics in Samuel Clarke's annotations to Jacques Rohault's *Traité de physique*

One of the most curious receptions of a physics treatise in the early modern period is provided by the history of the publication of Jacques Rohault's *Traité de physique* (1671). The book had a tremendous success; it was quickly translated into Latin and published in numerous places around Europe. In England, the Traité had an intricate history, especially in the form of the various editions prepared by Samuel Clarke, from 1697 to 1723, when the first English version of the treatise was printed. As other scholars have noted, Clarke's Rohault is peculiar because it contains Newtonian annotations. My paper will explore the development of these annotations in the various editions prepared by Clarke. By building on the excellent work by Michael Hoskin and Volkmar Schüller on the annotations, I plan to examine the changes in Clarke's notes from a different angle. More specific, I intend to explore the use of mathematics and how mathematics was employed in the annotated text. In doing so, I take into account changes in each edition issued by Clarke and examine how mathematical reasoning was presented as solving some of the problems indicated by Rohault's text. I further corroborate the findings with the independent publication of the English version of Rohault's *A Treatise of Mechanicks* (1716, translated by Thomas Watts, with a preface by William Whiston). Due to such joint approach, the paper aims to provide a more comprehensive picture for the interaction between Cartesianism and Newtonianism in the early eighteenth century.

Meyns, Chris (University of Pittsburgh and Utrecht University)
Data (Long) Before Big Data

Was there a concept of data before the data revolution? Scarcely any work has been dedicated to the philosophical (pre-)history of the concept of data. Rosenberg (2013) has argued that the concept develops in the early modern period, naturalizing in the mid-eighteenth century as a “rhetorical concept”, signifying whatever in a given dialogical context is agreed beyond argument. In this paper I challenge this picture on two fronts: (1) I argue that relevant philosophical use of the concept of data can already be found earlier than Rosenberg suggests,

namely in the seventeenth century; and (2) the concept of 'data' in these early modern debates is no more (merely) 'rhetorical' than any of the other core concepts in its vicinity, such as 'fact', 'probability' or 'objectivity'.

Vida, Grigore (University of Bucharest)

Abstraction and Mixed/Practical Mathematics in the Early Descartes

If we think about the mathematization of physics in terms of the relation which results between the two disciplines, we see that mathematics and physics can remain independent or become one and the same thing. In the first case we encounter the language of "applying" mathematics to physics, "imposing" a formalism on physical reality, "approximating" the natural etc. The second case is more radical: physics just is mathematics. Descartes belongs to this camp and it's hard to find among his contemporaries someone else who held such a conception. It cannot be ascribed to Galileo, for instance, in spite of his alleged Platonism (though to speak about Platonism here can be misleading). How did Descartes arrive at this singular view? Since its main elements can be identified in the Regulae, my focus will be on the period until 1628. First, I analyze the different levels of abstraction in the Regulae and show how after the abstraction of sensible qualities from bodies, the remaining bare geometrical figures are again abstracted, so as to arrive at magnitudes in general. At this this higher level, however, Descartes describes the abstraction in a quite Aristotelian fashion, with numbers and shapes as being properties; it's just that the objects of which they are properties are objects formed in the imagination. Next, I argue that the use of this theory of abstraction in mixed and practical mathematics (in which the early Descartes was engaged) can result in a conception in which bodies are "geometrical objects made real".

Malet, Antoni (Universitat Pompeu Fabra)

Sixteenth-Century Tracts on Ratio and Proportionality

From Luca Pacioli's "Sermo" of 1508, to Oronce Fine's *De arithmetica practica* (1532), to Maurolico's "Sermo de proportione" (1554) and "Compendium" of Book V (1567), to Cardano's *Opus novum de proportionibus* (1570), to Guidobaldo del Monte "Commentarius" (c. 1600), to mention just the famous names, a number of commentaries and criticisms of Book V of the Elements were written (and most of them printed) throughout the 16th century. My talk will address a few general questions about these tracts. In what measure are they sharing a common perspective in their critical views on Euclid's definitions of ratio and proportionality? Did those authors' criticisms derive from practical concerns? What alternative definitions were they setting forth? How were the new definitions received? Were the alternative definitions similar to each other in important features? Finally, how do sixteenth-century critiques relate to the substantial, theoretical 17th-century criticisms of Borelli, Tacquet, and Wallis?

I133 MEDICINE 3

Location: IoE Room 777 **Chair:** TBA

Samuelsson, Jonatan (Department of Historical, Philosophical and Religious Studies at Umeå University, Sweden)

Battery-Mouths and Mercury-Breathers: Oral Galvanism and the Onset of Late Modern Swedish Dental Amalgam Controversy

Understanding the nature and role of uncertainty is vital to studying processes at the border of science, policy and public life in the risk society. Shackley and Wynne (1996) describe representations of uncertainty as boundary-ordering devices, which structure and uphold modes of science-policy interaction. This paper studies oral galvanism and the origins of the "Third Amalgam War" in Sweden in the late 20th century, highlighting such uses of uncertainty. During the 1980s and 1990s, the issue of potential poisoning from dental amalgam – a widely used, mercury-containing dental filling material – provoked public controversy in many countries. In Sweden, this controversy led to extensive care programs and research efforts, as well as parliamentary and expert panel investigations. At the onset, however, mercury was not the main issue; oral galvanism was. Oral galvanism is an electrochemical phenomenon that occurs when metallic dentures and saliva come together to form a so-called galvanic element - a battery in the mouth. It was this phenomenon that became associated with a variety of symptoms, attracting a growing interest from science, politics and the media during the late 1970s. Poisoning from dental mercury entered the scene in the early 1980s, proposed as the main explanation for discomfort from oral galvanism. This paper details how oral galvanism was established and perceived as an important scientific, social and political problem in Sweden, by examining its international intellectual history prior to the controversy, as well as its mediated, scientific and political life in Sweden until the early 1980s.

Sugden, Nicola (CHSTM, University of Manchester)

'Habeus Cerebrum': Donald Winnicott and the Physical Therapy Controversies in the British Medical Press

The opposition of psychoanalyst and paediatrician Donald Woods Winnicott (1896-1971) to 'shock treatment' and psychosurgery - as against contemporary enthusiasts such as William Sargant - is regarded as being in alignment with the principles of his life and work, and has in some quarters been understood as a position representing the insights of psychoanalysis in contrast to the errors of hospital psychiatry. The dichotomy employed in such narratives belies the variety and nuance of medical opinion on the physical therapies in mid-Twentieth Century Britain. Detailed examination of a series of controversies in the correspondence pages of the *British Medical Journal* and the *Lancet* between 1943 and 1956 allows these differences to come to the fore. Medical opinion differed not only by disciplinary allegiance or by increments along a scale of enthusiasm, but according to different conceptions of scientificity, ethics, and the nature of mental disease; different priorities in the treatment of patients; and different hopes and fears for the future of scientific psychology. This paper discusses these themes alongside an exposition of the development of Winnicott's views on physical treatments for mental illness.

Varino, Sofia (Humboldt Universität zu Berlin)

"Material (Dis)Unities: historicizing celiac disease as a disorder of malabsorption in Willem Dicke's Experimental Studies 1948-49"

From Samuel Gee to Sidney Haas and Willem Dicke, and even presently, a large number of scientific articles published on celiac disease research either appear in pediatrics journals, or are written by pediatricians or researchers working in pediatrics departments. Although today celiac disease may appear to be "all grown up," classified as an autoimmune genetic disorder that can be studied through sophisticated laboratory techniques and understood via elaborate biomedical models, in this talk I want to emphasize the unities between its rudimentary past as

a malabsorptive condition and contemporary celiac clinical practices. I turn to Dicke's foundational experimental study of celiac children between 1948-49 in the Netherlands to show how its simple design and accuracy, measuring malabsorption as fecal fat coefficient, continues to be applicable for an understanding of celiac beyond visible signs of damage to the intestinal mucosa. Unable to visualize the atrophied villi that would, after the introduction of the jejunal biopsy, became crucial for a conclusive celiac diagnostic, Dicke developed a way to effectively study the signs of malabsorption due to wheat ingestion that were causing malnutrition and failure to thrive in celiac children. I argue that it is this same logic of disease mechanisms that is applicable today for studying, diagnosing and treating celiac beyond its visible intestinal damage, by finding unities and disunities in its long history and status as a disorder of malabsorption and malnutrition.

Wulff, Enrique (Instituto de Ciencias Marinas de Andalucía (CSIC))

Cancer Diagnostic: Findings of Allfrey and Mirsky at the Roots of a Probe Coming from Ochoa's School in the US

The sorts of interactions between the research programs described in this contribution, those of Severo Ochoa and Vincent G Allfrey, help to understand the diagnostic probe invented at Manuel Perucho's laboratory to screen for mutant ras genes and detect single point mutations in mammalian genes. A unified theory for the development of cancer involving genetic and epigenetic changes supported the consideration of an original mutation event as the initial trigger of cancer and the concept of genetic instability as critical in its development.
Cancer results from the malfunctioning of the expression of an "invisible college" of viral proteins in the cell nucleus that is essential to its survival. Allfrey and Mirsky showed in 1959, that the activity in these nuclear systems requires the presence of a polyacidic matrix whose specificity is clearly defined. Their findings introduced the possibility that more subtle mechanisms may exist which permit both inhibition and reactivation of RNA production at different loci along the chromosome. Given the physiological relevance of the polymerase that synthesizes DNA and RNA, scanning methods for the detection of point mutations frequently needed in the field of cancer and molecular genetics are closely related with this shock strategy. These methods for the detection of single base substitutions in eukaryotic genes played a major role in making possible the 1985 PCR revolution. It is expected to explain here that this useful approach was of very general applicability and why it was presented by Severo Ochoa to the US National Academy of Sciences.

Olechnovičienė, Jadvyga (The Lithuanian Academy of Sciences)

The Development of Allergology Science in Lithuania in 1926–1990

The presentation deals with the development of allergology science in Lithuania from its very beginning in 1926 to the re-establishment of Lithuania – in 1990. Two main fields in allergology science in Lithuania – experimental and clinical – have been established. Rudiments of this division are observed during the initial period of the development of allergology science, and they revealed themselves most clearly during the late soviet period. Having analysed the material collected it has been established that 32 authors published 270 scientific publications in the field of allergology during the period between 1926 and 1990. Almost half of the publications (48%) cover the field of experimental allergology. The development of allergology science in Lithuania was divided into three periods: the initial period of allergology (1926–1944), the early soviet period (1945–1963) and the late soviet period (1964–1990). The most characteristic features of every period have been analysed. The development of allergology science in Lithuania is related to the activity of Vladas Lašas. He made a great contribution to the investigations into allergology science and laid foundations for the school of experimental allergology of Lithuania. The sources of literature and archives that have been analysed showed that allergology science in Lithuania from 1926 to 1990 was developed and research was carried out at Kaunas Institute of Medicine, Vilnius University and the Institute of Experimental

Medicine, however, at that time the most intensive studies were conducted at Kaunas Institute of Medicine.

S61 CRAFT HUMANISM IN THE EARLY MODERN WORLD

Location: IoE - Room 826 **Chair:** Avxentevskaya, Maria

Organiser(s): Avxentevskaya, Maria

The panel session aims to explore the category of craft humanism understood as the phenomenon of employing classical legacy and learned discourse for the development of the early modern competences of practical knowledge, such as botanical expertise, alchemy, medicine, lapidary arts, and map-making, in their social, epistemic and technical aspects. The panel participants will focus on the role of humanist strategies, such as verbal and visual rhetoric, loci communes, and the performativity of speech, in ensuring the social credibility, political authority, and intellectual persuasiveness of epistemic patterns and actions within the early modern history of specific crafts. In this view, the session will examine the humanist regularities of effective collaboration for the purposes of knowledge-making, in the form of correspondence and knowledge-sharing, the humanist approaches to building codes of practices and procedures necessary to ensure the social and economic acceptance of practical knowledge, as well as the translation of humanist values of ingenuity between specific crafts and aspirations concerning the liberalization of knowledge practices within censored and emerging crafts, in the context their related scientific occupations. The panel will address a range of specific questions aiming to clarify more broadly but concretely the role of humanist learning in the development of practical knowledge, such as: how the discourse and methodologies of practical arts were influenced by the supposedly liberating involvement of humanist culture; how the social credibility function of humanism affected the knowledge-making of craft practices; how the classificatory features of humanism (e.g. Ramism and anti-Ramism) could influence the procedures and routines of specific practical arts; and how did humanist legacy in the development of natural history facilitate a strife for tracing the applicability of specific substances through the local geography of their origins. The panel participants will also examine the genres of textual, visual, and material culture, which provided possibilities for displaying early modern craft humanism, such as alba amicorum, emblematic botanical illustrations, manuals on lapidary arts, tacit narratives on alchemy, and the framings of early modern maps. We will contribute to discussing the main theme of the conference - the unity and disunity of knowledge - by considering the far-reaching legacy of humanism as a factor in verbally defining and publicly presenting the identity of specific crafts, in organising their internal operational classifications, and in arranging their relationships among themselves, with more formal scientific practices, as well as with institutions of knowledge and the bureaucracies of the state.

Avxentevskaya, Maria (MPI, Berlin)
Craft Humanism in the Artisanal Alba Amicorum

The manuscript genre of album amicorum, also known as “traveling friendship book” became popular in mid-sixteenth century in the Protestant circles, where a manu propria entry by Luther or Melanchthon could serve as a collectable rarity and a letter of recommendation. The genre implemented represented a collective variety of loci communes, which produced rich and diverse volumes of autographs, drawings, and prints, often protected by embossed leather bindings and cases. Alba amicorum participated in the economy of knowledge networking, as many of them were kept by scholars, physicians and educated artisans peregrinating between learned communities within the reformed part of Europe, across the continent, and beyond. Most of the alba entries contained verbal and visual reflections on professional issues, and displayed relations of trust within and between intellectual groups. But entries in the artisanal

alba amicorum also more specifically displayed the epistemic tensions between and within specific areas of craft knowledge. For instance, the learned apothecary from Augsburg, David Wirsung (1554-1592) collected reflections on the unity and specificities of medical occupations in delivering treatment for body and soul. The alba amicorum which belonged to goldsmiths (another numerous category) reflected more on the social and economic turns of the craft fortune. The genre also encouraged an exchange between artisanal, scientific, theological, and legal values. My paper will examine the humanist techniques of reflections on the practices of specific crafts in the genre of craftsmen's alba amicorum - a display of early modern craft humanism.

Bycroft, Michael (University of Warwick)

Humanism and Writings on the Lapidary Arts in Louis XIV's Paris

Writings on the lapidary arts flourished in Paris in latter decades of the seventeenth century. Lapidaries, goldsmiths and jewellers were responsible for a range of published texts that described how to cut and polish precious stones, how to distinguish one variety of stone from another, and how to profit from the local or global trade in these valuable commodities. These texts are notable for their precocity and variety. They predated the Encyclopédie of Diderot and d'Alembert by nearly a century, and they emerged from a range of literary and institutional contexts, including travel narratives, guild regulations, and state-based commercial administration. Missing from this list is the Paris Academy of Sciences: the codification of the lapidary arts was the work of artisans and administrators rather than naturalists and philosophers. These writings therefore show the vitality and autonomy of extra-scientific literature on the crafts. My paper will reflect on the identity of lapidary craft practices in early modern France, and will explore the humanist features of narratives depicting lapidary arts, to outline the role of humanist techniques in developing the functions of authority and credibility in knowledge-making.

Benison, Liam (Freie Universitaet Berlin)

Humanist Knowledge Practices in the Cartography of Terra Australis Incognita

Jonathan Swift’s famous satirical remark, ‘So Geographers in Afric-maps/ With Savage-Pictures fill their Gaps’ is often credited as encapsulating the notion that much of the rich repertoire of illustrations on early modern maps and globes can be explained by cartographers’ horror vacui. But it was not only savage-pictures that filled the gaps on maps; in particular, the framing of maps contained information intended to ensure the credibility and authority of knowledge presented in visual form. Cartouches with elaborate classical frames contained elaborate poetic dedications to the contemporary political leaders, and explanations of the classical authorities in natural history, on which the cartographer had relied for the geographical knowledge represented on the map. For instance, Gerard Mercator used such authorities to support his description of the extensive coastline and toponyms of his theoretical Terra Australis Incognita. In this paper, I will reflect on the theme of universality and discrepancies in the early modern geographical representations by discussing some less-known examples of such "framings of authority" on a selection of maps representing Terra Australis Incognita. I will argue that these frames employed the techniques of humanist visual rhetoric and the legacy of classical learning to serve the rhetorical purpose of persuasion and performative engagement of the viewer - a point which is crucial for understanding the methods of ensuring credibility and authority in the framework of early modern cartographic practices.

R70/2 BSHS OEC PROVOCATION 2: HISTORY OF SCIENCE AND POLITICAL ACTIVISM

Location: SciM – Lecture Theatre **Chair:** TBA

Organiser(s): BSHS Outreach and Education Committee

Academic scholarship in the history of science provides a long view on scientific and technological developments that had (and in some cases still ahve) profound ethical and political impacts for society. But how does that long view affect contemporary debates? How and when might history of science become activism? In this session, historians of science from around Europe, and at all stages of their careers, will discuss instances where activism and history of science collide.
This 'provocation' session complements the official conference programme, and is organised by the British Society for the History of Science Outreach and Education Committee (http://www.bshs.org.uk/outreach-and-education).

I102 FOCUS ON OBJECTS IN THE HISTORY OF SCIENCE AND TECHNOLOGY

Location: SciM - Dana Study **Chair:** TBA

Forschner, Dirk (Technische Universität Berlin)
Standardization of the Motive Power and the Rolling Stock of the Schantung Eisenbahn Gesellschaft / China, 1899-1935

After occupied the Jiaozhou area and built the Qingdao Colony, Germany started - as an essential plan of the occupation - the building of the Schantung Eisenbahn Gesellschaft ("SE") from Jinan West to Qingdao. As an isolated railroad, the SE started its operation in 1904 in Shandong province. When the SE was connected to the Tientsin - Pukow Rly ("TPR"), the German standards for air brakes, coupling systems and other locomotive equipment were not in line with the Chinese standards applied to the TPR and other railways. Therefore, step by step, the SE had to make adjustments in the above-mentioned aspects mainly by creating the Henricot coupling system and using Westinghouse air brakes. By 1930s, all relevant – not usable - German standards were annulled, by which SE started to become aligned with the standards of other Chinese railways.

Reininger, Alice (University of Applied Arts Vienna)
Handprinting Device for blind Maria Theresia von Paradis: A device developed by Wolfgang von Kempelen in 1779 for the blind artist and pianist which enabled her to communicate in writing

Despite all her talent, Maria Theresia von Paradis was still unable to write by the time she was twenty years old, nor had she mastered the alphabet. Wolfgang von Kempelen helped her to do this. The Pressburger Zeitung reported on 6th July 1779, how Kempelen proceeded to teach the blind artist how to read and write: "He gave her preliminary instructions in how to spell, and then let her put the words together herself using Latin letters cut out of cardboard". When she was completely familiar with this method, he constructed a printing device for her, with which she could "print her letters properly instead of writing them". The article closed with the sentence: "The rarity of such an invention, together with the value of this humane attempt, deserves to be known the world over." A few years before, the physician, hypnotist and magnetist Franz Anton Mesmer (1734-1815), who, in Vienna, was excited by his proclaimed animal magnetism, tried to heal the blind girl, but this was a complete failure. Only an order of the souvereign Maria Theresia in 1777 put an end to this fraud. Mesmer had to leave the city. The young woman, however, remained blind. In 1784 von Paradis set out on a so-called "art trip". In Paris she met with Valentin Haüy, the founder of the first blind school in Paris. Valentin Haüy presented his "manière d'élever les aveugles" to the French Academy of Sciences. The essay precisely described Kempelen's method and the small printing device.

Ritchie, Tom (Science Museum/University of Kent)
Child's Play: Meccano as the nuts and bolts of British engineering

Meccano was developed as a child's construction toy in 1901 by Frank Hornby, who intended for it to be both a toy and an educational device. Thirty-three years later, Douglas Hartree used Meccano to build Britain's first differential analyser at the University of Manchester. What remains of the Hartree Differential Analyser now sits in the Science Museum, representing a unity of play, creativity, autodidacticism: essential components in the science of engineering. Through exploring the language of the original Meccano patents, this paper demonstrates Hornby's desire for his invention to fill a 'long felt want' in society: a toy that could inspire young minds with practical engineering principles. It further analyses different articles from the Meccano Magazine, highlighting how language was used to render the toy a legitimate scientific and engineering instrument. Finally it will discuss the Hartree Differential Analyser in the period leading up to the Second World War, demonstrating how the Meccano used to

construct the machine represented more than simply a child's toy; it also served as the 'nuts and bolts' of British engineering, collapsing the boundaries between work and play.

Sumner, James (University of Manchester)
Computers and national identity: the strange and exceptional roots of the 'Brexit phone'

"The big flagship phones are made by American, Korean, Japanese and Chinese names. There isn't much option for British people to get behind the national flag and show off a British name! We want to change this." So states the announcement of the Acorn Micro Phone C5, launched as a crowdfunding opportunity in 2018. The device is, as bemused industry commentators pointed out, essentially a rebranded version of the existing Leagoo S8, and will be made in China. This paper explores the rhetoric and realities of the British IT industry as a case study in national technological culture. Technological divergences are often subtle but powerful markers of national identity at both the practical and symbolic levels: consider incompatible power plugs, or analogue television systems. Computers present a somewhat more complex case. Though they can be made highly distinct in form, their central defining quality – programmability – means that they can often be cajoled to imitate each other's most seemingly idiosyncratic features. In the marketers' arsenal of rhetorical devices, boasts of a nationally specific culture of excellence co-exist happily with the reassuring appeal to global interoperability.Beginning with the earliest promotion of commercial computers in the 1950s, I will consider the rising appeal of global standards (an approach often described at the time as 'Americanisation') and the reaction that coalesced in a highly distinct national culture around the microcomputer boom of the 1980s – a culture whose legacy encompasses both inclusive educational initiatives, and the bombastic challenge of the 'Brexit phone'.

Pilkington, Helen-Frances (Birkbeck, University of London)
Sealed and certain? Unity and disunity in railway company seal designs in the nineteenth century

As a key signifier guaranteeing the legality of the share, railway company seals were a critical site of unity with suitably respectable institutions and differentiation to attract investors to this scheme rather than another. Despite being united by form, these seal designs nevertheless show a remarkable ingenuity of different designs including the promotion of industry, showcasing the latest locomotive, arguments using intricate allegorical motifs and championing civic harmony. Drawing on an unstudied archive of 763 railway seals held in the National Railway Museum in York, this paper will chart the major trends of railway company seals during the nineteenth and early twentieth centuries before focussing on seals from the first half of the nineteenth century as it was these seals which started many of the railway tropes and narratives today. The paper will conclude by reviewing the railway seal designs in the context of railway share certificates and will show that both the early nineteenth-century railway share seals and certificates were highly derivative from eighteenth-century bank note and coin designs. Due to their linkages to such financial instruments, disunity from crashes or business failures was never far away.

I139 ASIAN AND GREEK MATHEMATICS

Location: SciM - Dana Study **Chair:** TBA

Guevara-Casanova, Iolanda (Universitat Autònoma de Barcelona)
The geometry of the Sulbasutras, the Nine chapters and the Elements. Unity and Disunity in the squaring of polygonal figures and in the use of the Pythagorean theorem

Pythagorean Theorem, procedure of the base and height ... there are different names for this theorem that appears in various places and at different times in the history of mathematics. A problem that uses this result is the transformation of polygonal figures, in particular a rectangle, into a square in the same area. Many cultures have made geometric constructions to transform polygonal figures into squares of the same area. In this communication some constructions of the Vedic geometry are analysed (800 BC - 200 BC), and some of the propositions of the Elements of Euclid (around 300 BC). In both, the result of the Pythagorean theorem is used directly. The transformation of figures that conserve areas also underlies the demonstration of the Pythagorean theorem, both in the Elements and in the Nine chapters on mathematical art (Jiuzhang Suanshu) compiled, it seems, between the 2nd and 1st centuries BC. What unites and breaks these geometric constructions is what will be discussed in this communication. In a certain way, it reflects the concern of mathematics teachers who bring to their classes the idea of mathematics as a science in continuous evolution, related to contexts and situations in which mathematical knowledge does not appear spontaneously but based on the one constructed by different people that one place or another thought and worked on the same problems.

Kvasz, Ladislav (Charles University in Prague)
On the cognitive unity of Thales' mathematics

There is a gap of more than 500 years between the times of Thales and of the reports by Diogenes Laertes and Proclus of his mathematical achievements. This led some scholars (Dicks 1959) to question the authenticity of these reports and to doubt whether Thales produced any mathematics et all. In the paper I will characterize the cognitive unity of the six mathematical results ascribed by the tradition to Thales. I will argue that they (1) lacked generality, (2) lacked compositional synthesis, (3) lacked deductive synthesis, (4) were based on the principle of equality. So several theorems ascribed to Thales are special cases of more general theorems that can be found in Euclid. They lack compositional synthesis in the sense that they concern usually one single isolated object (in contrast to complex configuration which Euclid constructs by means of ruler and compass constructions, which are the tool of Euclid's compositional synthesis). The theorems ascribed to Thales can be proven by recognizing a symmetry of the single isolated object, thus the proof does not contain a sequence of deductive steps (the deductive synthesis of the Euclidean proofs). And finally almost all theorems ascribed to Thales are about equality of two single objects (as opposed to similarity or proportionality). The main argument for the authenticity of Thales' mathematics is that for the authors living in an era when mathematics has successfully overcome these cognitive limitations it would be very difficult to find six mathematical results with such a high cognitive coherence.

Thomann, Johannes (University of Zurich)
Two Ancient Values for the Solar Apogee Ascribed to Persian Astronomers: Observations or Borrowings from Indian Astronomical Works?

Finding the solar apogee was a difficult task in premodern astronomy. Ptolemy's value had an error of 5°37'. Ibn Yūnus devoted a chapter in his Zīj to the solar apogee and its motion. Besides his own measurement (86°10' in 1003 CE) and that of Ptolemy (65° 30' in 139/140 CE), he mentions three more measurements in order to reinforce his opinion that the solar apogee moves with a constant velocity, which he believed to be identical with the precession of the equinoxes. For that purpose, he gives approximate timespans between the three intermediate

measurements. Two of them are said to have been made by Persian astronomers (77° 55' and 80°) with a time interval of "approximately 160 years". The third measurement mentioned is well-known, made by the astronomers of the Caliph al-Ma'mūn (82° 40' in 829 CE). Its time-distance from the later Persian measurement is given as "approximately 200 years". According to that, the Persian measurements would have been made in about 470 CE and 630 CE. Far reaching conclusions about Persian astronomy coming prior to Indian astronomy have been drawn from this information by some historians, but were rejected by others, and the case remained controversial. A fresh look at the relevant sources shows that the matter is more complex than it has been assumed. The conversion methods between tropical and sidereal coordinate systems are key to understanding the different values for the solar apogee within a comparatively short period in time (5th/6th century CE).

Hosking, Rosalie (Seki Kowa Institute for Mathematics)

Not Just Geometry: Broadening the definition of Sangaku

During the isolation of the Japanese Edo Period (1603-1868 CE), wooden tablets containing mathematics were dedicated to Shinto Shrines and Buddhist Temples. These tablets were known as *sangaku*. While most *sangaku* contained geometrical problems and theorems, a smaller percentage dealt with calculating the heights of mountains and distances between towns and Shrines. To date, no investigation of *sangaku* dealing with land surveying has ever been conducted, and academics have largely ignored this area. Subsequently published academic works refer to *sangaku* as mathematical tablets dealing with problems in geometry. This I argue, has created an undeserved disunity in the tradition, separating it into *sangaku* proper – tablets containing geometrical problems - and *sangaku* minor - 'landscape sangaku'. In this paper I closely examine the contents, purpose, and design of these 'landscape sangaku'. I argue that they should be treated not simply as a subtype of *sangaku*, but as part of the main tradition along with geometrical tablets. I promote a changing of the definition of *sangaku* to include investigations in cartography and land surveying as well as geometrical puzzles, such that the term *sangaku* does not automatically infer tablets containing geometrical problems.