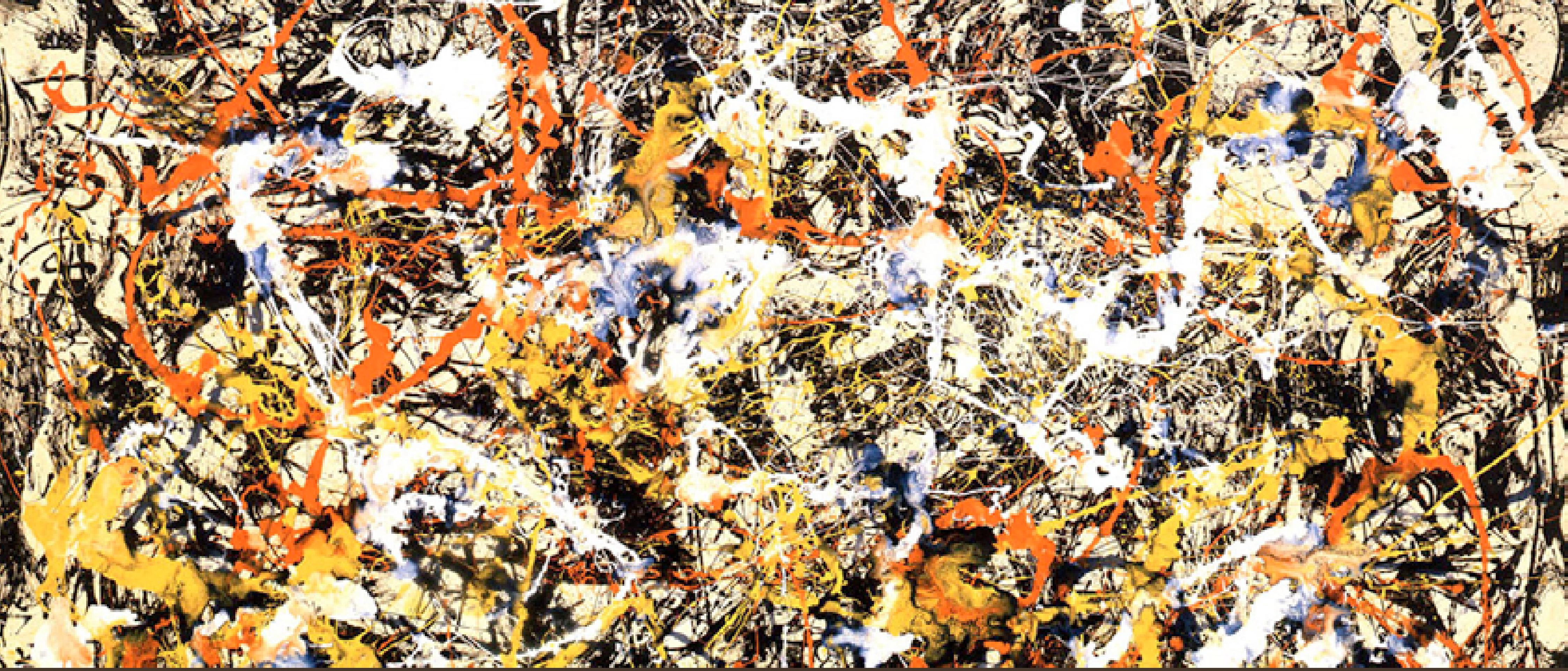

Noise Information & Complexity @ Quantum Scale

Ettore Majorana Centre, Erice (Sicily), Italy

6th – 12th October 2013

Key speakers

Andris Ambainis, Univ. of Latvia, Riga
Alan Aspuru-Guzik, Harvard Univ. Cambridge
Konrad Banaszek, Univ. of Warsaw
Charles Bennett, IBM Watson Research Center
Tommaso Calarco, Univ. of Ulm
John Calsamiglia, Univ. Autonoma de Barcelona
Carlton Caves, Univ. of New Mexico Albuquerque
Andrew Doherty, The Univ. of Sydney
Patrick Hayden, McGill Univ. Montreal
Pawel Horodecki, Univ. of Gdansk
Susana Huelga, Univ. of Ulm
Fabrizio Illuminati, Univ. of Salerno
Alexander Korotkov, Univ. of California Riverside
Giuseppe Marmo, Univ. of Napoli, Federico II
Jian-Wei Pan, Univ. of Science and Technology of China Hefei
Saverio Pascazio, Univ. of Bari
Sandu Popescu, Univ. of Bristol
Renato Renner, ETH Zurich
Vlatko Vedral, CQT Singapore
Reinhard Werner, Univ. of Hannover

Directors

Stefano Mancini, Univ. of Camerino
Andreas Winter, Univ. Autonoma de Barcelona
Maciej Lewenstein, ICFO Barcelona

The meeting is hosted by the Int'l School in Statistical Physics, Directors Peter Hanggi, Univ. of Augsburg and Fabio Marchesoni, Univ. of Camerino

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TO PAY A PERMANET TRIBUTE TO GALILEO GALILEI, FOUNDER OF MODERN SCIENCE AND TO ENRICO FERMI, "THE ITALIAN NAVIGATOR", FATHER OF THE WEAK FORCES

Conference

Noise, Information, and Complexity @ Quantum Scale

E. Majorana Centre (Erice, Italy)
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Stefano Mancini, Andreas Winter and Maciej Lewenstein, Directors

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The Leverhulme Trust

PARTICIPANTS AND ABSTRACTS

Adesso Gerardo

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Talk: Quantum metrology embraced for the worst

Abstract: Not Available

Ambainis Andris

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Lecture: Exact quantum algorithms

Abstract: A quantum algorithm is exact if, on any input data, it outputs the correct answer with certainty (probability 1) - in contrast to the usual model in which a quantum algorithm is allowed to output an incorrect answer with a small probabilities. Coming up with exact quantum algorithms is a difficult task because we have to ensure that no amplitude ends up in a state corresponding to an incorrect answer - on any input. We present the first example of a Boolean function f(x1, ..., xN) for which exact quantum algorithms have superlinear advantage over the deterministic algorithms. Any deterministic algorithm that computes our function must use N queries but an exact quantum algorithm can compute it with O(N^{0.8675...}) queries.

Aspuru-Guzik Alan

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Lecture: Digital Quantum simulation of quantum dynamics - Towards a realistic estimate of what it takes for simulating realistic quantum phenomena using quantum computers

Abstract: In this talk, I will describe the prospects of using a gate-model quantum computer for the simulation of dynamics of systems where quantitative answers as necessary. An example of such a simulation would be to predict the outcome probabilities of chemical reactions in the condensed phase. This would open up the use of quantum computers for predictive rather than explanatory ability of materials, enzymes, etc. This is as opposed to the quantum simulation efforts dedicated to general properties such as phase transitions which require much less degree of controllability and are less related to practical applications for society. For such a program, optimal quantum simulation algorithms are necessary. The understanding of the precision of the simulator, error control strategies and optimal compilation of gate sequences is necessary. I will describe our group's work towards these directions. I will finish by comparing this approach to a dedicated analog quantum simulator approach for open systems using superconducting qubits: A system that is quite the opposite in the spectrum of what is a quantum simulator and yet still useful for understanding photosynthesis.

Guarcello Claudio

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Poster: Noise phenomena in soliton dynamics in Josephson junctions

Abstract: In this work we computationally explore the transient dynamics of a noisy *Josephson junction* (JJ). Principal purpose is to investigate the behavior of the lifetime of the superconductive state as a function of the system and noise source parameters. The relations between the emerging phenomena and the evolution of the *JJ order parameter* ϕ, that is the phase difference between the macroscopic wave functions describing the superconducting condensate in the two electrodes, is deeply investigated. We focus our interest on the switching events from the superconducting metastable state, and in particular on the *mean escape time* (MET). In the used model, a long JJ can be represented by a string composed by a series of phase cells rolling down on a tilted potential, commonly called the *washboard potential*. Analysis of MET behavior reveals, for proper values of system parameters and statistic of noise source, the presence of clear non-monotonic trends. The analysis of the time evolution of ϕ highlights the influence of the noise induced solitons on the MET behavior, and the presence of *breathers* generated by *Lévy flights*. These mechanisms are responsible for switching events.

Haikka Pinja

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Poster: Non-Markovian Quantum Probes

Abstract: Non-Markovian open quantum systems are the focal point of a flurry of recent research aiming to answer, e.g., the following questions: What is the characteristic trait of non-Markovian dynamical processes that discriminates it from forgetful Markovian dynamics? What is the microscopic origin of memory in quantum dynamics, and how can it be controlled? Does the existence of memory effects open new avenues and enable accomplishments that cannot be achieved with Markovian processes?
As an application of memory effects, with the aim of addressing the latter question, we show how non-Markovianity can be exploited in the detection of phase transitions using quantum information probes. This is shown using the physically interesting models of the Ising chain in a transverse field and a Coulomb chain undergoing a structural phase transition. For both models the non-Markovian character of the qubit probe unambiguously pinpoints the phase transition of its environment.