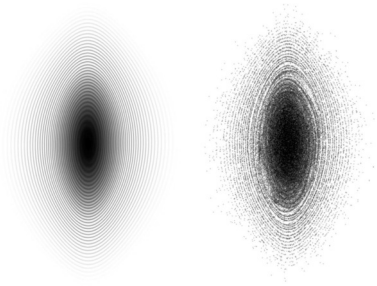
Centre International de Rencontres Mathématiques

CIRM

Mathematical Justification for the Kinetic and Fluid Equations of Plasmas and Self-Gravitating Systems

July 24-28, 2023



Convergence to the Vlasov solution: N-body versus Vlasov simulations in 1D gravity. On the left, the "exact" evolved state of an initially Gaussian distribution function in phase space, with a Vlasov solver, on the right, the result obtained with a N-body code. The finite-N solution is subject to instabilities that disappear in the mean field limit. Images realized by S. Colombi, C. Alard and J. Touma (www.vlasix.org).

SORBONNE UNIVERSITÉ

PNCG Programme National de Cosmologie et Galaxies

Institut Archimède Mathématiques-Informatique Aix*Marseille Université

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Institut Sciences de la Fusion et de l'Instrumentation en Environnements Nucléaires Aix*Marseille Université

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cnrs

Observatoire de la Côte d'Azur

IAP

CPT Centre de Physique Théorique

PIIM

LAGRANGE

CIRM: a breeding ground for talent, a mathematical melting pot!

CIRM is quite a unique place. At the heart of the Parc des Calanques, it is entirely dedicated to welcome researchers from around the world who meet here. Scientists can work together, exchange ideas, share their knowledge and advance the key issues of our discipline. They can also develop ambitious projects with the other sciences and pass on their knowledge and findings to young researchers and doctoral students.

CIRM is a breeding round for talent, a melting pot of mathematical cultures. The particularity of our center is its residential character. Here, the researcher lives in total immersion with his group. He sleeps, eats and works at Cirm. This proximity favors exchanges. The participants, who are entirely taken care of by Cirm's administrative and residential teams, can focus exclusively on their own scientific projects.

We wish all our visitors an excellent and enriching stay with us and enjoyable exchanges, whether physically present at CIRM or at a distance!

Pascal HUBERT, director of CIRM
(https://www.cirm-math.com/directors-welcome-note.html)

The aims of this conference

A primary objective, when studying a complex physical system from a theoretical perspective, is to describe it as simply as possible. With N-body systems such as plasmas, dark matter in the Universe, or even stars in galaxies, the first step in the simplification procedure often amounts to calculating kinetic limits at large N. More specifically, it involves showing that a system with a large number N of particles can be described by a kinetic equation governing the evolution of a one- (or possibly two-) particle distribution function when N tends to infinity, as, for example, the Boltzmann equation. In a second step, one can further simplify the kinetic equation by focusing on the evolution of the first moments of the distribution function. For instance, only considering the first two velocity moments, the Boltzmann equation can be reduced to the Navier-Stokes equations for hydrodynamics, provided the mean free path between two collisions is small compared to the size of the system. Thirdly, under the assumption that specific parameters remain small, a simplified (perturbative) approach to the resolution of the equations of motion makes it possible to reduce the problem to wave-particle interactions or wave-wave interactions. In cosmology for example, perturbation theory is widely used to precisely constrain models of large scale structure formation in the Universe.

The passage to the different limits, kinetic, fluid, or even the justification of the use of perturbation theory remains, because of the associated inherent difficulties and subtleties, the subject of intense discussions between mathematicians and physicists. The purpose of this multidisciplinary workshop is to review and critically evaluate the latest developments on specific aspects of these problems, with a particular emphasis on their mathematical justification.

Sunday July 23rd	Monday July 24th	Tuesday July 25th	Wednesday July 26th	Thursday July 27th	Friday July 28th
Mathematical Justification for the Kinetic and Fluid Equations of Plasmas and Self-Gravitating Systems 24 – 28 July, 2023 — CIRM **Schedule**	7:00-9:00 : breakfast	7:00-9:00 : breakfast	7:00-9:00 : breakfast	7:00-9:00 : breakfast	7:00-9:00 : breakfast
	9:00-10:45 : welcome at CIRM	9:00 : Golse	9:00 : White	9:00 : Cheverry	9:00 : Morrison
	10:15 : coffee break	9:45 : Fouvry	9:45 : Duerinckx	9:45 : Kiessling	9:45 : Barre
	10:45 : welcome address: Besse	10:30 : coffee break	10:30 : coffee break	10:30 : coffee break	10:30 : coffee break
	11:00 : Collot	11:00 : Bardos	11:00 : Tremblin	11:00 : Ricci	11:00 : Giachetti
	11:45 : Rocha Filho	11:35 : Escande	11:45 : Pegoraro	11:45 : Delos	11:45 : round table : Triay
	12:30 : lunch	12:30 : lunch	12:30 : lunch	12:30 : lunch	12:30 : lunch
	14:00 : Feistl	14:00 : Mouhot		14:00 : Vu	14:00 : discussions
				14:20 : Devriendt	
	14:45 : Feliachi	14:45 : Rampf		14:55 : Colombi	
	15:30 : coffee break	15:30 : coffee break		15:30 : coffee break	15:30 : coffee break
	16:00 : Chavanis	16:00 : Nota		16:00 : Munschy	
17:00-23:00 : welcome at CIRM	16:45 : discussions	16:45 : discussions		16:45 : discussions	
19:00-21:45 : cold dinner	19h30 : dinner	19h30 : dinner	19h30 : dinner	19h30 : conference dinner	19h30 : dinner

Mathematical modelling of magnetic reconnection

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Abstract

Magnetic reconnection phenomena collect a wide variety of processes that involve a drastic change of the magnetic field topology in plasmas. We shall give some detail about the mathematical modelling of this class of phenomena and discuss some simplified model, connected to [1]. The work is in collaboration with B.Coppi, in the framework of the IGNITOR project.

References

[1] B.Coppi, J.W-k.Mark, L.Sugiyama and G.Bertin, *Magnetic Reconnection in Collisionless Plasmas*, Ann. of Phys. vol. 119 (1979), p.370-404.