

Soutenances de Thèses 2012

Jeudi 22 novembre 2012 Auditorium de l'IPN, Bâtiment 100,

Orsay

Matthieu Barbier

De l'impermanence des formes dans les fluides granulaires : Croissance et relaxation dans les mélanges

Ce travail porte sur la dynamique de la matière granulaire dans l'état fluide, et sa réponse à une excitation localisée dans deux limites : une faible perturbation suite à laquelle le système relaxe rapidement vers un état homogène, ou une agitation intense qui engendre une onde de choc semblable à un souffle d'explosion. Cette réponse est affectée par deux caractéristiques des fluides granulaires : les particules macroscopiques qui les composent sont d'une part inélastiques, de sorte que leur dynamique est dissipative et ne possède pas d'état d'équilibre, et d'autre part polydisperses, c'est-à-dire hétérogènes en taille et en masse. Nous isolons d'abord un effet dynamique de la polydispersité en montrant qu'il existe un mélange optimal qui minimise le temps de relaxation du fluide vers son état asymptotique. Nous nous intéressons ensuite au cas où une seule des espèces est perturbée par l'application d'un champ extérieur, et étudions l'état stationnaire hors d'équilibre ainsi établi, dans la limite du traceur où les autres espèces constituent un bain stationnaire. Enfin, nous modélisons la croissance de formes auto-similaires dans ce bain suite à une intense libération ponctuelle d'énergie, que nous comparons au souffle d'une explosion dans un gaz moléculaire.

Lundi 24 septembre 2012 Salle des conseils de l'IPN, Bâtiment 100, Orsay

Tianyou Yi

Modeling of dynamical vortex states in charge density waves

Electronic Crystals is a common form of organization in conducting solids. They take forms of Wigner crystals at hetero-junctions and nano-wires, charge density waves (CDWs) in chain compounds, spin density waves in organic conductors, stripes in doped oxides and high-Tc superconductors. In the CDW ground state, the elementary units can be readjusted by absorbing or rejecting pairs of electrons. Such a phase-slip process should go via topologically nontrivial configurations: solitons and dislocations – the CDW vortices. An experimental access to those states came from studies of nano-fabricated mesa-junctions, from the STM visualizations and from the X-ray micro-diffraction.

Following these requests, we performed a program to model the stationary states and their transient dynamic for the CDW in restricted geometries under the applied field or the passing current. A particular care had to be taken to derive a gauge invariant and current conserving scheme for the interacting condensed and normal charge densities. The model takes into account multiple fields in mutual nonlinear interactions: the amplitude and the phase of the CDW complex order parameter, distributions of the electric field, the density and the current of normal carriers. We have found that vortices are formed stepwise in the junction when the voltage across, or the current through, exceed a threshold. The vortex core concentrates the voltage drop, working as a self-tuned microscopic tunnelling junction. The studied reconstruction in junctions of the CDW is a convenient playground for modern efforts of field-effect transformations in strongly correlated materials with spontaneous symmetry breakings.

Mardi 31 janvier 2012 Université de Rome "La Sapienza", Italie

Michele Castellana

The renormalization group for disordered systems

In this thesis we investigate the employ of the renormalization group for glassy systems. More precisely, we focus on models of spin glasses and structural glasses. Spin-glass models represent disordered uniaxial magnetic materials, such as a dilute solution of Mn in Cu, modeled by an array of spins on the Mn arranged at random in the matrix of Cu, and interacting with a potential which oscillates as a function of the separation of the spins. Structural glasses are liquids that have been cooled fast enough to avoid crystallization, like o-Terphenyl or Glycerol. Spin and structural glasses are physically interesting because their critical properties are known only in the limit where the space dimensionality tends to infinity, i. e. in the mean-field approximation. A fundamental question is whether the physical properties characterizing these systems in the mean-field case still hold for real spin or structural glasses, which live in a space with a finite number of dimensions.

The spin and structural glasses that we study in this thesis are models built up on hierarchical lattices, which are the simplest non-mean field systems where the renormalisation group approach can be implemented in a natural way. The features emerging from this implementation clarify the critical behavior of these systems. As far as the finite-dimensional spin glass studied in this thesis is concerned, we developed a new technique to implement the renormalization group transformation for finite-dimensional spin glasses. This technique shows that the system has a finite-temperature phase transition characterized by a critical point where the system's correlation length is infinite. As far as the structural glass studied in this thesis is concerned, this is the first structural glass model where we showed the existence of a phase transition beyond mean field.

The ideas introduced in this work can be further developed in order to understand the structure of the low-temperature phase of these systems, and in order to establish whether the properties of the low-temperature phase holding in the mean-field case still hold for finite-dimensional glassy systems.

Vendredi 13 janvier 2012 Auditorium de l'IPN, Bâtiment 100, Orsay

Elia Zarinelli

Spin-glass models and interdisciplinary applications

The main subject of this thesis is the physics of spin glasses. After their introduction in the 70s in order to describe dilute magnetic alloys, spin-glass models have been considered prototype models to understand the behavior of supercooled liquids. Among the systems that can be described and analyzed using the language of disordered systems, there are problems of combinatorial optimization.

In the first part of the thesis, we consider spin-glass models with Kac interactions in order to investigate the supercooled phase of glass-forming liquids. Afterwards, we show how some features of spin-glass models can be described by ubiquitous results of Random Matrix Theory in connection with Extreme Value Statistics. Finally, from the interaction of spin-glass theory and computer science, we put forward a new algorithm of immediate application in Financial problems.