Soutenances de Thèses 2013

Mardi 15 octobre 2013 Salle des conseils de l'IPN, bâtiment 100, Orsay

Soutenance de thèse

Olga Valba

Statistical analysis of networks and biophysical systems of complex architecture

Complex organization is found in many biological systems. For example, biopolymers could possess hierarchic structure, which provides their functional peculiarity. Artificially constructed biological networks are other common objects of statistical physics with rich functional properties. The aim of this thesis is to develop some methods for studying statistical systems of complex architecture with essential biological significance.

The first part addresses to the statistical analysis of random biopolymers. Apart from the evolutionary context, our study covers more general problems of planar topology appeared in description of various systems, ranging from gauge theory to biophysics.

In the second part of this work we focus our investigation on statistical properties of artificial and real networks. The importance of obtained results in applied biophysics is discussed. Also, the formation of stable patters of motifs in random networks under selective evolution in context of creation of islands of "superfamilies" is considered.

Vendredi 20 septembre 2013 Salle des conseils de l'IPN, bâtiment 100, Orsay

Soutenance de thèse

Pierre-Elie Larré

Fluctuations quantiques et effets non-linéaires dans les condensats de Bose-Einstein : des ondes de choc dispersives au rayonnement de Hawking acoustique

Cette thèse est dédiée à l'étude de l'analogue du rayonnement de Hawking dans les condensats de Bose-Einstein. Dans un premier temps, on présente de nouvelles configurations dans lesquelles l'écoulement d'un condensat atomique réalise l'équivalent acoustique d'un trou noir gravitationnel. Nous donnons dans chaque cas une description analytique du profil de l'écoulement, des fluctuations quantiques associées et du spectre du rayonnement de Hawking. L'analyse des corrélations à deux corps dans l'espace des positions et des impulsions fournit des signatures caractérisant l'occurrence du rayonnement de Hawking. Dans une deuxième partie, nous analysons les propriétés superfluides et/ou dissipatives de condensats de polaritons s'écoulant autour d'un obstacle. L'étude des ondes de polarisation dans ces systèmes nous permet enfin de proposer des signatures prometteuses pour l'observation de l'effet Hawking dans les gaz de polaritons et les condensats atomiques à deux composantes.

Vendredi 19 juillet 2013 Salle des conseils de l'IPN, bâtiment 100, Orsay

Soutenance de thèse

Arthur Lavarélo

Frustation and disorder in quantum spin chains and ladders

In quantum spins systems, frustration and low-dimensionality generate quantum fluctuations and give rise to exotic quantum phases. This thesis studies a spin ladder model with frustrating couplings along the legs, motivated by experiments on cuprate BiCu2PO6.

First, we present an original variational method to describe the low-energy excitations of a single frustrated chain. Then, the phase diagram of two coupled chains is computed with numerical methods. The model exhibits a quantum phase transition between a dimerized phase and resonating valence bound (RVB) phase. The physics of the RVB phase is studied numerically and by a mean-field treatment. In particular, the onset of incommensurability in the dispersion relation, structure factor and correlation functions is discussed in details.

Then, we study the effects of non-magnetic impurities on the magnetization curve and the Curie law at low temperature. A low-energy effective model is derived within the linear response theory and is used to explain the behaviors of the magnetization and Curie constant.

Eventually, we study the effect of bonds disorder, on a single frustrated chain. The variational method, introduced in the non-disordered case, gives a low disorder picture of the dimerized phase instability, which consists in the formation of Imry-Ma domains delimited by localized spinons.

Vendredi 22 février 2013 Auditorium de l'IPN, bâtiment 100, Orsay

Soutenance de thèse

Jason Sakellariou

Inverse inference in the asymmetric Ising model

In recent years new experimental methods have made possible the acquisition of an overwhelming amount of data for a number of biological systems such as assemblies of neurons, genes and proteins. Typically, these systems consist of a large number of interacting components and can be described by high dimensional models such as the well known Ising model from statistical physics. The nature of the data acquired from experiments makes necessary the development of methods that are able to infer the parameters of the model and thus predict the pattern of the interactions between the components of such systems. In this thesis I have studied the particular case of the Ising model with asymmetric interactions which is arguably the most relevant case when dealing with neural networks and could be generalized to fit to other biological systems as well. I will present a new mean-field inference method based on a simple application of the central limit theorem, able to infer exactly the parameters of the asymmetric Ising model from data in a computationally efficient way. I will also discuss some results of numerical simulations where the performance of our new method can be evaluated and compared with other existing methods. Finally, I will also show how the method can be better adapted to the case of sparse networks where, additionally, the amount of data used in the inference is low compared to the size of the system.

Mercredi 9 janvier 2013

Salle des conseils de l'IPN, bâtiment 100, Orsay

Soutenance Habilitation à Diriger les Recherches

Alberto Rosso

La physique des extrêmes : de la diffusion anormale aux systèmes désordonnés