

Séminaire de physique statistique

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Orme des Merisiers Salle Claude Itzykson, Bât. 774

Glassy features in constraint satisfaction problems and dynamical scenarios

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In this talk, I will discuss relevant underlying connections between the jamming transition in amorphous systems and a continuous constraint satisfaction problem, the non-convex spherical perceptron model [1-2]. A renewed interest in this model, borrowed from neural networks and machine learning domain, has been fostered recently once it has been realized that - reformulated in a continuous version - it actually falls in the same universality class as high dimensional sphere systems. I will then present my recent results in terms of a Plefka-like expansion, which turns out to be beneficial to define an effective potential (a Thouless-Anderson-Palmer free energy) and to study marginal properties of glassy systems in the low-temperature regime [3-4]. Interestingly, the jamming phenomenology has a broader spectrum of applicability that one might think at first sight and concerns not only structural glasses but also error-correcting codes, traffic flow, transport in crowded biological environments and evolutionary dynamics. Therefore, in the second part of the talk, I will discuss how a mechanism of optimization in the presence of constraints - as for the perceptron model - can provide a suitable theoretical framework to explain critical properties of large ecosystems appearing to be poised at the edge of stability [5]. I will then present my current research activity and future perspectives in this direction, focusing on the MacArthur and the Lotka-Volterra models, respectively. In the last part, I will also discuss the importance of defining a dynamical mean-field theory formalism for a better investigation of aging dynamics [6] in different universality classes of disordered systems. Such an approach turns out to be of interest in very different contexts ranging from condensed matter, ecology as well as to inference problems.

References: [1] S. Franz, G. Parisi The simplest model of jamming, *J. Phys. A: Math. Theor.*, 145001 (2016). [2] S. Franz, G. Parisi, P. Urbani, F. Zamponi, Universal spectrum of Normal Modes in Low-Temperature Glasses: an Exact Solution, *PNAS* 112, 14539 (2015). [3] A. Altieri, S. Franz, G. Parisi The jamming transition in high dimension: an analytical study of the TAP equations and the effective thermodynamic potential *J. Stat. Mech.* 093301 (2016). [4] A. Altieri Higher order corrections to the effective potential close to the jamming transition in the perceptron model *Phys. Rev. E* 97, 012103 (2018). [5] A. Altieri, S. Franz, Constraint satisfaction mechanisms for marginal stability and criticality in large ecosystems, *Rapid Communication in Phys. Rev. E* 99, 010401(R) (2019). [6] A. Altieri, G. Biroli, C. Cammarota, Dynamical Mean-Field Theory Formalism in the aging regime for a class of solvable models, in preparation (2020).
