Post Doc Position in Glassy Statistical Physics and Complex Photonics

Many decades of investigation of glassy materials, ubiquitous in ordinary life, as well as in science, have not yet led to a comprehensive theoretical understanding of their complex behaviour. The statistical mechanical description for a glassy system is that it *lives* in a rather complicated free energy landscape with a proliferation of minima representing the many - hierarchically organized - glassy states. Dealing with such a complex landscape has emerged as one of the central problems of statistical physics. New theoretical and numerical tools are, thus, continuously developed to face open problems related to glasses, such as the onset of the *glass transition*, the nature of the very low temperature *jamming transition*, the role of nonlinear response and the off-equilibrium dynamical properties. Moving from condensed matter to light, optical systems in random media, as well, have been lately studied in this framework. Because of disorder and nonlinearity, light scattering through opaque media or random fibers or, possibly, light amplified by stimulated emission - the so-called *random lasers* - turn out to display glassy behavior.

Random lasing materials (e.g. powders, porous media, precipitates in solution, or photonic crystals with impurities) have been extensively studied experimentally in the last years. Starting from the complicated disordered arrangement of the molecules that scatter the light waves, one would like to build a theory predicting the onset and the properties of the lasing modes: their emission wave-lengths, whether or not they are localized, how they interact, if and how their phases lock as in the standard lasers. With the aim of investigating emerging collective properties of interacting optical systems a Hamiltonian theory is derived and investigated that turns out to be basically a generalization to complex variables Mode Coupling Theory and spherical spin-glass models.

Numerical simulations and numerical resolution of dynamic and static equations for many variables near or in the glassy phase are very demanding. Indeed, to explore the ramified multi-minima free energy landscape is a NPC problem and both algorithmic and computing skills are required to scale to larger and larger sizes. *Parallel computing on GPU*'s is groundbreaking for several approaches to dynamics in structural glasses or in complex photonics systems and, more generally, in systems with continuous variables.

The project proposed for this position is to deepen, by numerical methods, the understanding of the complex collective phenomena in structural glasses and in random photonic systems, and develop optimized codes for continuous variable Monte Carlo dynamics, Population dynamics in Belief and Survey propagation and Cavity method on random graphs.

The successful candidate will be affiliated at the **Sapienza University of Rome** - phys.uniroma1.it -and at the **CNR Institute of Nanotechnology** - nanotec.cnr.it - for two years, will have access to computing facilities, will have considerable financial support to attend conferences and workshops and will enjoy a very lively research environment at the interface between statistical physics, photonics and high performance computing. The expected net amount of the fellowship is about € 28.000 per year.

The research projects will be performed under the supervision of **Giorgio Parisi** and **Luca Leuzzi**.

Candidates with a strong background in statistical physics and parallel CPU and GPU computing are encouraged to apply by sending a CV, as well as three names of references for letters, to **luca.leuzzi@cnr.it**