MAR13-2012-020156

Abstract for an Invited Paper
for the MAR13 Meeting of
the American Physical Society

Nicholas Metropolis Award for Outstanding Doctoral Thesis Work in Computational Physics Lecture: The Janus computer, a new window into spin-glass physics

DAVID YLLANES, La Sapienza Università di Roma

Spin glasses are a longstanding model for the sluggish dynamics that appears at the glass transition. They enjoy a privileged status in this context, as they provide the simplest model system both for theoretical and experimental studies of glassy dynamics. However, in spite of forty years of intensive investigation, spin glasses still pose a formidable challenge to theoretical, computational and experimental physics. The main difficulty lies in their incredibly slow dynamics. A recent breakthrough has been made possible by our custom-built computer, Janus, designed and built in a collaboration formed by five universities in Spain and Italy. By employing a purpose-driven architecture, capable of fully exploiting the parallelization possibilities intrinsic to these simulations, Janus outperforms conventional computers by several orders of magnitude. After a brief introduction to spin glasses, the talk will focus on the new physics unearthed by Janus. In particular, we recall our numerical study of the nonequilibrium dynamics of the Edwards-Anderson Ising Spin Glass, for a time that spans eleven orders of magnitude, thus approaching the experimentally relevant scale (i.e. seconds). We have also studied the equilibrium properties of the spin-glass phase, with an emphasis on the quantitative matching between non-equilibrium and equilibrium correlation functions, through a time-length dictionary. Last but not least, we have clarified the existence of a glass transition in the presence of a magnetic field for a finite-range spin glass (the so-called de Almeida-Thouless line). We will finally mention some of the currently ongoing work of the collaboration, such as the characterization of the non-equilibrium dynamics in a magnetic field and the existence of a statics-dynamics dictionary in these conditions.