

The mystery of rejuvenation and memory in spin-glasses

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The main focus of the talk will be describing our recent success in reproducing in a simulation (using the Janus II supercomputer) the spectacular memory and rejuvenation effects of spin glasses [1]. Although memory and rejuvenation were discovered experimentally more than 20 years ago, convincingly reproducing these effects in a simulation seemed hopeless until now, and for very good reasons. Indeed, many pieces of the puzzle had to be gathered.

First, we have needed to learn how to quantitatively extract the spin-glass coherence length (i.e. the size of the glassy domains) from simulations of non-equilibrium spin glass dynamics. Second, one needs to reach reasonably large coherence lengths in the simulation, a task that demands the tremendous computing power of Janus II. A third step has been learning how to extrapolate from the numerical time and length scales to the experimental ones. Fourth, Janus II has provided crucial understanding about how temperature chaos in non-equilibrium dynamics really is. These milestones have made possible undertaking a nice collaboration with the group of Ray Orbach in Texas. The collaboration with Orbach has taught us how to perform in Janus II true "computer experiments", in which the very same quantities are computed in the simulation and measured in a CuMn single crystal, and analyzed in a parallel way. In fact, the 2022 temperature-chaos experiment by Orbach and Zhai has produced crucial quantitative input to set up a successful simulation of memory and rejuvenation. A big surprise (at least surprising for us) is our finding that no less than three quite distinct length scales control aging dynamics.

Further experimental and numerical work is in progress [1], that explores the quantitative description of the memory effect [2].

References

[1] The Janus collaboration (alphabetical ordering): M. Baity-Jesi, E. Calore, A. Cruz, L. A. Fernandez, J. M. Gil-Narvion, I. Gonzalez-Adalid Pemartin, A. Gordillo-Guerrero, D. Iñiguez, A. Maiorano, E. Marinari, V. Martin-Mayor, J. Moreno-Gordo, A. Muñoz-Siduepe, D. Navarro, I. Paga, G. Parisi, S. Perez-Gaviro, F. Ricci-Tersenghi, J. J. Ruiz-Lorenzo, S. F. Schifano, B. Seoane, A. Tarancon, R. Tripiccion, D. Yllanes, *Nature Phys.* (in press).

[2] The Janus Collaboration and J. Freedberg, E. Dan Dahlberg, J. He, R.L. Orbach, D.L. Schlagel, manuscript in preparation.