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Dynamics of glassy systems using new algorithms for exact sampling on multiple scales[1]

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The complex aging and memory effects seen in glassy materials result from relaxation times that are much longer than microscopic times: direct numerical simulations that seek to reproduce these effects of course suffer from the need to run simulations for very long times. It is therefore of interest to find algorithms that will simulate nonequilbrium dynamics on very long time scales. I will present methods for rapid simulation of memory and aging effects in spin glasses and results from those simulations. The methods are based on (1) an algorithm that allows for exact sampling of equilibrium states and (2) simple coarse graining approaches to the dynamics based on exact sampling and ground state calculations. The exact sampling algorithms extend classical Pfaffian techniques to directly generate spin configurations in two-dimensional Ising spin glasses according to their Boltzmann weights, thereby avoiding the long run times needed for Markov chain Monte Carlo simulations. Equilibration can then be imposed at a chosen length scale by repeated selection of subconfigurations (patches) at that scale chosen from a larger sample. At $T = 0$, memory effects can be replicated using this patchwork dynamics. Correlation functions at any temperature can also be exactly calculated. Results on thermodynamic quantities and nonequilibrium effects will be presented for samples of size at least 512^2. This work was carried out in collaboration with Creighton K. Thomas.

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