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Fast algorithms for glassy materials: methods and explorations[1]

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Glassy materials with frozen disorder, including random magnets such as spin glasses and interfaces in disordered materials, exhibit striking non-equilibrium behavior such as the ability to store a history of external parameters (memory). Precisely due to their glassy nature, direct simulation of models of these materials is very slow. In some fortunate cases, however, algorithms exist that exactly compute thermodynamic quantities. Such cases include spin glasses in two dimensions and interfaces and random field magnets in arbitrary dimensions at zero temperature. Using algorithms built using ideas developed by computer scientists and mathematicians, one can even directly sample equilibrium configurations in very large systems, as if one picked the configurations out of a "hat" of all configurations weighted by their Boltzmann factors. This talk will provide some of the background for these methods and discuss the connections between physics and computer science, as used by a number of groups. Recent applications of these methods to investigating phase transitions in glassy materials and to answering qualitative questions about the free energy landscape and memory effects will be discussed.

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