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Evidence against a mean field description of short-range spin glasses revealed through thermal boundary conditions[1] JONATHAN MACHTA, WENLONG WANG, University of Massachusetts Amherst, HELMUT KATZGRABER, Texas A&M University — A theoretical description of the low-temperature phase of short-range spin glasses has remained elusive for decades. It is not known if there is a single pair of pure states as predicted by the droplet model, or infinitely many pure states, as predicted by mean field theory. Here we study the three-dimensional Edwards-Anderson Ising spin glass in thermal boundary conditions using population annealing Monte Carlo. In thermal boundary conditions all eight combinations of periodic vs antiperiodic boundary conditions in the three spatial directions appear in the ensemble with their respective Boltzmann weights, thus minimizing finite-size corrections due to domain walls. From the relative weighting of the eight boundary conditions for each disorder instance a sample stiffness is defined, and its typical value is shown to grow with system size according to a stiffness exponent. An extrapolation to the large-system-size limit is consistent with a single pair of pure states in every volume but incompatible with the mean field, replica symmetry breaking picture.

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