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Equilibrium and nonequilibrium properties of Boolean decision problems on scale-free graphs with competing interactions with external biases ZHENG ZHU, Department of Physics and Astronomy, Texas A&M University, JUAN CARLOS ANDRESEN, Department of Physics, ETH Zurich, KATHARINA JANZEN, Institut fuer Mathematische Physik, TU Braunschweig, HELMUT G. KATZGRABER, Department of Physics and Astronomy, Texas A&M University — We study the equilibrium and nonequilibrium properties of Boolean decision problems with competing interactions on scale-free graphs in a magnetic field. Previous studies at zero field have shown a remarkable equilibrium stability of Boolean variables (Ising spins) with competing interactions (spin glasses) on scale-free networks. When the exponent that describes the power-law decay of the connectivity of the network is strictly larger than 3, the system undergoes a spin-glass transition. However, when the exponent is equal to or less than 3, the glass phase is stable for all temperatures. First we perform finite-temperature Monte Carlo simulations in a field to test the robustness of the spin-glass phase and show, in agreement with analytical calculations, that the system exhibits a de Almeida-Thouless line. Furthermore, we study avalanches in the system at zero temperature to see if the system displays self-organized criticality. This would suggest that damage (avalanches) can spread across the whole system with nonzero probability, i.e., that Boolean decision problems on scale-free networks with competing interactions are fragile when not in thermal equilibrium.

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