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A ferromagnet in a continuously tuneable random field[1]

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The Random-Field Ising Model (RFIM) has been extensively studied as a model system for understanding the effects of disorder in magnets. Since the late 1970s, there has been a particular focus on realizations of the RFIM in site-diluted antiferromagnets. We observe random-field effects in the dilute dipole-coupled ferromagnet $LiHo_xY_{1-x}F_4$. In the presence of a magnetic field transverse to the Ising axis (H_t), the behavior of $LiHo_xY_{1-x}F_4$ becomes increasingly dominated by the influence of random-field terms in the effective Hamiltonian. This is seen experimentally in the shape of the ferromagentic-paramagnetic phase boundary and in changes to the critical exponents near the classical critical point. We find that above the classical critical point the magnetic susceptibility diverges as $H_t \to 0$, and that the susceptibility both above and below the classical critical point can be collapsed onto a single universal curve using a modified Curie law which explicitly incorporates random-field contributions. The discovery of a ferromagnetic realization of the RFIM opens the door to investigation of the random-field problem with the wide variety of techniques available for probing ferromagnets, including the ability to examine both the statics and dynamics of the random-field problem. It also allows studying the effects of controlled amounts of randomness on the dynamics of domain pinning and the energetics of domain reversal.

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