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Dilute anisotropic dipolar systems as random field Ising ferromagnets

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We have shown the equivalence, at low energies, of dilute anisotropic dipolar magnets to the Ising model in the presence of an effective random longitudinal field and an effective transverse field, both of which are independently tunable. In the ferromagnetic (FM) regime [1], these systems constitute the first realization of the classical, as well as quantum, random field Ising model in a FM system, allowing, in particular, the application of a longitudinal field conjugate to the FM order parameter. In the spin-glass regime [2,3] we elucidate the role of both the hyperfine interactions, which couple the system to a spin bath and change the low-energy degrees of freedom, and the off-diagonal terms of the dipolar interactions, which lead to the effective random field. This resolves long standing questions regarding quantum spin glasses in general, and the quantum phase transition between the spin glass and paramagnetic phases in particular.

[1] *LiHo_xY_{1-x}F₄* as a random field Ising ferromagnet, M. Schechter, Cond-mat/0611063.

[2] Significance of the hyperfine interactions in the phase diagram of *LiHo_xY_{1-x}F₄*, M. Schechter and P. C. E. Stamp, Phys. Rev. Lett. **95**, 267208 (2005).

[3] Quantum spin glass and the dipolar interactions, M. Schechter and N. Laflorencie, Phys. Rev. Lett. **97**, 137204 (2006).