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Perturbative Cumulant Monte Carlo Study of $LiHoF_4$ in a Weak Transverse Magnetic Field S.M. ALI TABEI, MICHEL GINGRAS, University of Waterloo, YING-JER KAO, Theoretical Sciences, National Taiwan University, TARAS YAVORSKII — Results from a recent quantum Monte Carlo (QMC) (P.B. Chakraborty *et al.*, Phys. Rev. B **70**, 144411 (2004)) study of the $LiHoF_4$ Ising magnetic material in an applied transverse magnetic field B_x show a discrepancy with the experimental results, even for small B_x where quantum fluctuations are small. This discrepancy persists asymptotically close to the classical ferromagnet to paramagnet phase transition. We numerically reinvestigate the phase diagram of $LiHoF_4$ in the regime of weak B_x. In this regime, we derive an effective temperature-dependent classical Hamiltonian that incorporates perturbatively the small quantum fluctuations in the vicinity of the classical phase transition at $B_x = 0$. Via this effective classical Hamiltonian, we study the $B_x - T$ phase diagram via classical Monte Carlo simulations. In particular, we investigate the influence of various effects that may be at the source of the discrepancy. We also show how our method can be generalized to numerically study the diluted $LiHo_xY_{1-x}F_4$ in the small B_x regime.

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