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Multiplicative logarithmic corrections to quantum criticality in three-dimensional dimerized antiferromagnets YANQI QIN, Institute of Physics, Chinese Academy of Sci (CAS), BRUCE NORMAND, Department of Physics, Renmin University of China, Beijing 100872, China, ANDERS SANDVIK, Department of Physics, Boston University, 590 Commonwealth Avenue, Boston, Massachusetts 02215, USA, ZI YANG MENG, Institute of Physics, Chinese Academy of Sci (CAS) — We investigate the quantum phase transition in an S=1/2 dimerized Heisenberg antiferromagnet in three spatial dimensions. By means of quantum Monte Carlo simulations and finite-size scaling analyses, we get high-precision results for the quantum critical properties at the transition from the magnetically disordered dimer-singlet phase to the ordered Neel phase. This transition breaks O(N) symmetry with N=3 in D=3+1 dimensions. This is the upper critical dimension, where multiplicative logarithmic corrections to the leading mean-field critical properties are expected; we extract these corrections, establishing their precise forms for both the zero-temperature staggered magnetization, m_s, and the Neel temperature, T_N. We present a scaling ansatz for T_N, including logarithmic corrections, which agrees with our data and indicates exact linearity with m_s, implying a complete decoupling of quantum and thermal fluctuation effects close to the quantum critical point. These logarithmic scaling forms have not previously identified or verified by unbiased numerical methods and we discuss their relevance to experimental studies of dimerized quantum antiferromagnets such as $TlCuCl_3$.
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