Anisotropic Heisenberg antiferromagnet in the presence of a magnetic field for arbitrary dimension and spin

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In this work we study the Heisenberg XXZ antiferromagnetic model for spin S and dimension d in the presence of an external longitudinal magnetic field. First, we essay a variational approach which uses as trial function a version of the analytic expression for the ground state given by the paired nonmagnetic excitation (PNME) theory [M. Lagos and G. G. Cabrera, Solid State Commun. 67, 221 (1988); Phys. Rev. B 38, 659 (1988)], generalized in order to incorporate the external field. The ground-state energy, sublattice magnetization, and magnetic susceptibility are obtained. Subsequently, we solve the problem numerically for a chain of 12 spins (S=1 and S=3/2) using the Lanczös method [E. Dagotto and A. Moreo, Phys. Rev. D 31, 865 (1985)]. The two approaches give excellent concordance over a wide range of the parameters of the model. We show that our analytic trial function represents accurately the ground state of the system for anisotropies ranging from the Ising limit to the almost iso