Field-induced quantum phase transitions in 2D antiferromagnets R_2CuO_4

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In the exchange-frustrated tetragonal Pr_2CuO_4 with orthogonal antiferromagnetic spin subsystems along the crystal axes [100] and [010], a new field-induced transition is discovered to the collinear state with the spins being non-orthogonal to the field. If the field is aligned along one of the axes, the transition is the first order, and the spins after the transition make an angle of $\pi/4$ with the field. The transition becomes second order in inclined field, with final spin orientation determined by the pseudodipolar [1] and Zeeman energy as well as by the angle between the field and the crystal axis. The transition to the spin-flop state occurs in the only case of the field orientation along [110]. All second order transitions, being accompanied by strong fluctuations of the order parameter, are quantum in nature. The critical region is studied for the spin-flop transition, and a crossover in the field dependence of the order parameter is found. In the isomorphic Eu_2CuO_4, a structural phase transition with very small orthorhombic distortions takes place below the Néel temperature resulting in extremely weak ($\sim 10^{-4}$ meV) violation of the exchange frustration. Nevertheless, this violation changes completely the system behaviour in the external field, differently for the cases of the field-cooling ad zero-field-cooling from the tetragonal phase. The transition to the collinear phase is also observed, with the spin-flop state being attained in the limit of the infinite field.

[1] D. Petitgrand, S.V. Maleyev, Ph. Bourges, A.S. Ivanov, Phys. Rev. B **59**, 1079 (1999).