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Fingerprints of the field-induced Berezinskii-Kosterlitz-Thouless transition in quasi-two-dimensional quantum magnets[1]

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The two-dimensional (2d) easy-plane (XY) model provides a prototypical description of 2d systems exhibiting topological excitations, which drive the Berezinskii-Kosterlitz-Thouless (BKT) transition that occurs in 2d superfluids, electron plasmas, Josephson junction arrays, ultracold atomic 2d Bose gasses, etc. The excitations in the 2d XY model are spin waves and vortices. In the BKT scenario, at low temperatures, all vortices (V) and antivortices (AV) are bound to V-AV pairs, and spin waves dominate in this quasi-long-range-ordered phase with an infinite correlation length, ξ, and an algebraic decay of correlations. At a critical temperature, T_{BKT}, the V-AV pairs start to unbind, driving the transition to a free vortex phase above T_{BKT}, characterized by an exponential divergence of ξ [1]. Vortices remain stable also in quantum 2d anisotropic Heisenberg systems with a very weak XY anisotropy [2]. The BKT scenario appears even in 2d isotropic Heisenberg magnets due to frustration [3] or an external magnetic field [4]. I will focus on quasi-2d spin 1/2 Heisenberg antiferromagnets with extremely weak spin anisotropy [5]. These highly anisotropic layered Cu(II) organo-metallic insulators with relatively low saturation fields, about 6 T, enabled a comprehensive study in a wide range of magnetic fields and temperatures. A response of all compounds to the application of a magnetic field mimics 2d behavior with fingerprints of a field-induced Berezinskii-Kosterlitz-Thouless phase transition. [1] J. V. José (Ed.), 40 Years of Berezinskii–Kosterlitz–Thouless Theory, World Scientific, 2013. [2] A. Cuccoli et al., Phys. Rev. Lett. 90 (2003) 167205. [3] B. Jeevanesan et al., Phys. Rev. Lett. 115 (2015) 177201. [4] A. Cuccoli et al., Phys. Rev. B 68 (2003) 060402(R). [5] R. Tarasenko et al., Phys. Rev. B 87 (2013) 174401.

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