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Quantum Nucleation of Antiferromagnetic Bubbles with Tetragonal and Hexagonal Symmetries

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Abstract: We study the quantum nucleation in a nanometer-scale antiferromagnet placed in a magnetic field at an arbitrary angle. We consider the magnetocrystalline anisotropy with tetragonal symmetry and that with hexagonal symmetry, respectively. Different structures of the tunneling barriers can be generated by the magnitude and the orientation of the magnetic field. We use the instanton method in the spin-coherent-state path-integral representation to calculate the dependence of the rate of quantum nucleation and the crossover temperature on the orientation and strength of the field for bulk solids and two-dimensional films of antiferromagnets, respectively. We find that the rate of quantum nucleation and the crossover temperature from thermal-to-quantum transitions depend on the orientation and strength of the external magnetic field distinctly, which can be tested by use of existing experimental techniques.

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