MAR14-2014-021116

Abstract for an Invited Paper
for the MAR14 Meeting of
the American Physical Society

Three-Leaf Quantum Interference Clovers in a Single-Molecule Magnet

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The study of single-molecule magnets bridges the world of the simplest quantum spin systems (S = 1/2) and the macroscopic ensembles that merge with the classical experience. By examining the magnetic behavior of these molecules at low temperature, where the obfuscating effects of thermal fluctuations are practically eliminated, a wealth of detail is revealed about the spin dynamics and the corresponding role played by internal molecular degrees of freedom, with ramifications for the structural symmetry and the specifics of the individual constituent ions. This is the case of the molecular magnet reported in this talk, where the trigonal symmetry imposed by the spatial arrangement of three constituent manganese ions and the corresponding orientations of their single-ion anisotropy tensors results in a fascinating three-fold angular modulation of the quantum tunneling of the magnetization (QTM) rates, as well as in trigonal quantum interference patterns that mimic the form of a three-leaf clover. Interestingly, although expected in all the QTM resonances for a trigonal molecular symmetry, the three-fold modulation only appears at resonances for which a longitudinal magnetic field is applied (i.e. resonances numbers $|k| > 0$). At $k = 0$, where no longitudinal field is present, the QTM probability displays a six-fold transverse field modulation. This comes as a direct consequence of a three-fold corrugation of the hard anisotropy plane, a predicted but previously unobserved feature which acts as an effective internal longitudinal field that varies the precise conditions required to maintaining a resonance when a transverse field is applied. The sophisticated behavior of the QTM in this molecule allows an unequivocal association of the trigonal distortion of the local spin-orbit interactions with the spatial disposition of the constituent ions. Finally, and of particular significance for the molecular magnetism community, the clear elucidation of the behavior of different resonances with the magnitude of an applied transverse magnetic field unveils the applicability of the spin selection rules within the nature of QTM, including tunneling in odd-numbered resonances.