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Theory of inelastic neutron scattering in a quantum spin nematic

NIC SHANNON, ANDREW SMERALD, Okinawa Institute of Science and Technology — The idea that a quantum magnet could act like a liquid crystal, breaking spin-rotation symmetry without breaking time-reversal symmetry, holds an abiding fascination. However, despite being a viable form of magnetic order, None the less, experimental evidence for "spin nematic" states in magnetic insulators remains scarce. And the very fact that spin nematic states do not break time-reversal symmetry renders them "invisible" to the most common probes of magnetism — they do *not* exhibit magnetic Bragg peaks, a static splitting of lines in NMR spectra, or oscillations in μSR. However, as a consequence of breaking spin-rotation symmetry, spin-nematic states *do* posses a characteristic spectrum of dispersing excitations which could be observed in inelastic neutron scattering. With this in mind, we develop a symmetry-based description of long-wavelength excitations in a broad class of spin-nematic states, based on an SU(3) generalisation of the quantum non-linear sigma model. We use this field theory to make explicit predictions for inelastic neutron scattering, and argue that the wave-like excitations it predicts could be used to identify the symmetries broken by the unseen spin-nematic order.

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