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Uniform Magnetic Excitations in NiO nanoparticles

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NiO is a textbook antiferromagnet, and was one of the first materials in which antiferromagnetism was studied by neutron scattering. However nanoparticles of NiO exhibit spin dynamics that is different from bulk samples. Due to the finite size, the spin wave spectrum will be quantised. The lowest level (q=0) is a coherent precession of the spin around the magnetic anisotropy easy axis, a uniform magnetic excitation. The energy spacing between such precession states is below 1 meV and almost constant so it will give rise to inelastic resonance peaks, which can be described well by a damped harmonic oscillator model.

The NiO nanoparticles that have been studied are platelet shaped, with a diameter of ∼10 nm and a thickness of ∼3 nm. They have been found to have a large amount (∼500 μ_B) of uncompensated spins in one of the sublattices.

The dissimilarity of the two sublattices has a surprisingly strong impact on the magnetic resonance. Even a modest amount of uncompensated spins will split the spin dynamics into different modes, changing the energy spacings between the precession states. Studying the uniform magnetic excitations thus yields an understanding of the spin dynamics in antiferromagnetic nanoparticles with large uncompensated moments.