Orbital Angular Momentum of Azimuthal Spin-Waves

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In the context of a growing interdisciplinary interest in the angular momentum of wave fields, that of spin waves has yet to be fully explored, with the extensively studied notion of spin transport being only part of the story. Here we report experimental evidence for magnon orbital angular momentum by observing the lifted degeneracy of waves with counter-rotating wave fronts [1]. This requires an unambiguous formulation of spin and orbital angular momenta for spin waves, which we provide in full generality based on a systematic application of quantum field theory techniques. The results unequivocally establish magnetic dipole-dipole interactions as a magnetic-field controllable spin-orbit interaction for magnons (see Fig.1). Our findings open a new research direction exploiting the spectroscopic readability of angular momentum for azimuthal spin waves and beyond.

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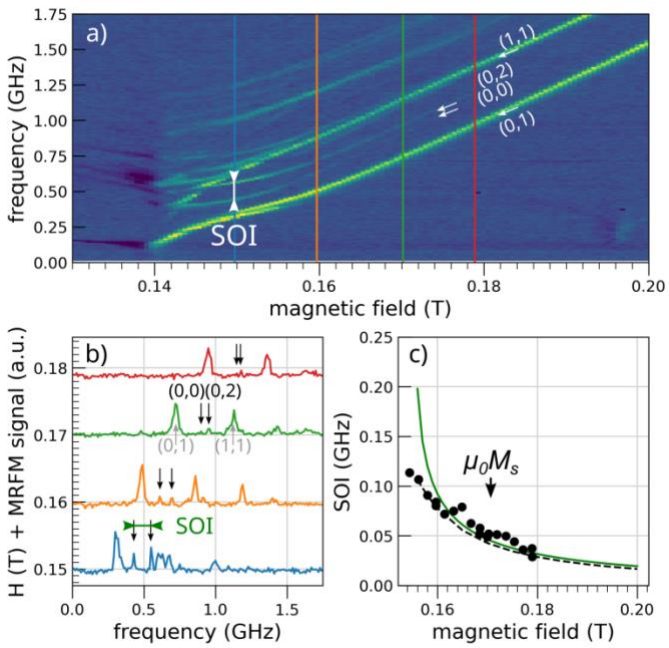

Fig.1 : (a) Magnetic Resonance Force Microscopy spectroscopy of the aziumthal SW spectra in a normally magnetized 1µm diameter YIG disk. (b) The spin-orbit interaction (SOI) is measured from the frequency split between (0,2) and (0,0) modes which have opposite orbital index n_L=±1. (c) Magnetic field dependence of the SOI. The dots are the experimental points, the solid line is the analytical prediction and the dashed line is the result of the micromagnetic simulation, assuming a misalignment of ~0.5° between the applied magnetic field and the normal of the disk.

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