PhD thesis project

Angular Momentum of Magnons

General Scope:

There has been an increasing realization in recent decades of the fundamental importance of the angular momentum carried by wave fields, which can be separated into spin (SAM) and orbital (OAM) components in certain cases. The latter is a universal feature of waves in uniform continuum media represented by helical or rotational wavefronts, and can potentially encode a large amount of information for mode multiplexed communication channels or multi-level registers of quantum states. Theoretical and experimental investigations of wave angular momentum are already well developed for electromagnetic waves, plasma waves, fluid waves or elastic waves. In recent years, experiments have found angular momentum transfer between spin-waves (SWs) and optical vortices, or elastic waves. Most of these works, however, focused on SAM of SWs, leaving their OAM experimentally unresolved.

PhD Subject:

During this , we propose to study the experimental evidence for non-zero magnon angular momentum inside magnetic disk, by resolving the frequency splitting between magnon modes with counter-rotating wavefronts. This PhD work will consist of i) performing magnetic resonance experiments using a home-built spectrometer on nanolithographically prepared magnetic microdisks and ii) comparing the spectra with finite element simulations.

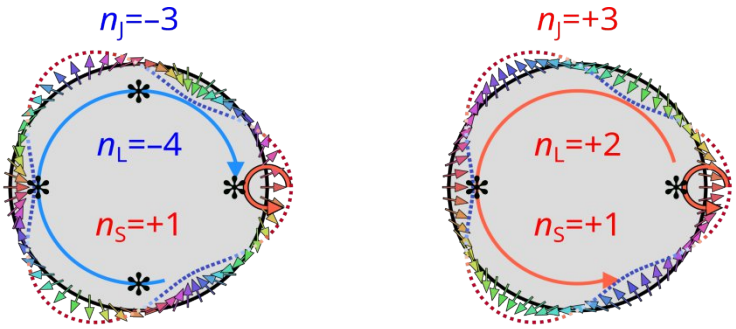

Figure 1: Snapshot patterns formed by azimuthal SW modes of index n_J=±3 propagating in a magnetic disk normally magnetized. Amplitude wise, the index $|n_J|$ counts the number of oscillations of the wavefront (see dotted line) , while $|n_L|$ counts the number of revolutions of the dynamical vector (see the repetition of the orientation at 0°). Polarity wise, each pattern uniquely links the sense of gyration of its wavefront to the direction of the local precession. By convention, a positive index indicates the Larmor direction: right-handed with respect to the magnetization so $n_J=n_L+n_S$.

Bibliography:

T. Valet, K. Yamamoto, B. Pigeau, G. de Loubens, and O Klein

« The Orbital Angular Momentum of Azimuthal Spin-Waves » arXiv:2503.06556

« Field Theory of Linear Spin-Waves in Finite Textured Ferromagnets » arXiv:2503.06557

Required Skills:

A basic knowledge of solid state physics and an interest in experimental developments. The skills that will be acquired during this training are microwave technology, magnetic resonance, and finite element simulations.

Laboratory: SPINTEC

PhD Supervisors:

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