3D transport of spin waves in curved nano-membranes

Spin waves (or magnons) in ferromagnets can propagate over mesoscopic distances without any charge transport involved, paving the way for green data processing. Therefore, using the electrons' spin degree of freedom for data processing instead of its charge is one great challenge. Indeed, in the last decade intense research was made to explore the excitation, transport and manipulation as well as the detection of spin waves mostly in ferromagnetic thin-films. Recent progress in materials science however allows for the production of rolled-up and flexible three dimensional curved magnetic nano-membranes, such as nanotubes, spherical caps. The theoretical works predict that when the curvature radius reaches intrinsic length scales, like the domain wall width or the magnon wave length surprising effects may appear. In simple ferromagnets, the curvature induced magnetochiral effect can lead to the formation of chiral domain walls, stabilize magnetic textures as Skyrmions, or can result in non-reciprocal spin-wave propagation. The project tries to merge spin-wave transport and the magnetochiral effects of exchange and classical dipole-dipole origin. The aim is to develop a fundamental understanding of the influence of the curvature and topology on the spin-wave transport in the three-dimensional curved structures within the framework of micromagnetism. The magnetochiral effect in curvilinear systems, originating from the symmetric exchange and/or dipole-dipole interactions brings further degrees of freedom into the transport and manipulation of spin waves. In addition, the curvilinear systems give the possibility to explore spin-wave transport in the third geometrical dimension.
The variety of geometries considered within the proposal — transition from round to hexagonal nanotubes and to round nanowires as well as the ripple structures and all connected to the previously investigated magnetic nanotubes — are expected to bring effects which in long term perspective can contribute to extend the physical toolbox of spin-wave control and furthermore will promote the three-dimensional nano-membranes in the field of magnonics.