Toward three-dimensional magnonic crystals

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Magnonic crystals (MCs) are materials with periodically modulated magnetic properties where the spin waves (SWs) band structure consists of intervals of allowed SW frequencies and forbidden gaps in which there are no allowed magnonic states.

In the recent past, most of the studies have been focused on planar nanostructures where the magnetic constituents have the same thickness, while, to the best of our knowledge, there are no reports of SW band structure in 3D MCs. This is mainly due to the difficulties associated with the fabrication of thickness modulated nano-elements by conventional nanofabrication techniques which require multilevel exposure process and alignment between successive fabrications steps.

Very recently, we proposed a new class of MCs constituted by closely packed thickness-modulated nanowires. We show that this kind of structures support the propagation of collective SWs in the periodicity direction, thus demonstrating that layering structure and in-plane modulation are very effective for controlling the characteristics of the magnonic band.[1]

Another possible approach to realize 3D MCs, is to have either an array of layered magnetic elements or an array of ferromagnetic dots deposited on top of a continuous ferromagnetic film. We will present some preliminary results for this kind of structures and discuss the relevant aspects of the spin wave propagation.

[1] G. Gubbiotti et al., “Collective spin waves on a nanowire array with step-modulated thickness”, J. Phys. D Appl. Phys., **47**, 105003 (2014)

[2] G. Gubbiotti et al., “Collective spin waves in arrays of Permalloy nanowires with single-side periodically modulated width", submitted.