Flat bands in magnonic Lieb lattices

Grzegorz Centała[1] and Jarosław W. Kłos[1]

[1]ISQI, Faculty of Physics, Adam Mickiewicz University Poznań, Uniwersytetu Poznańskiego 2, 61-614 Poznań, Poland

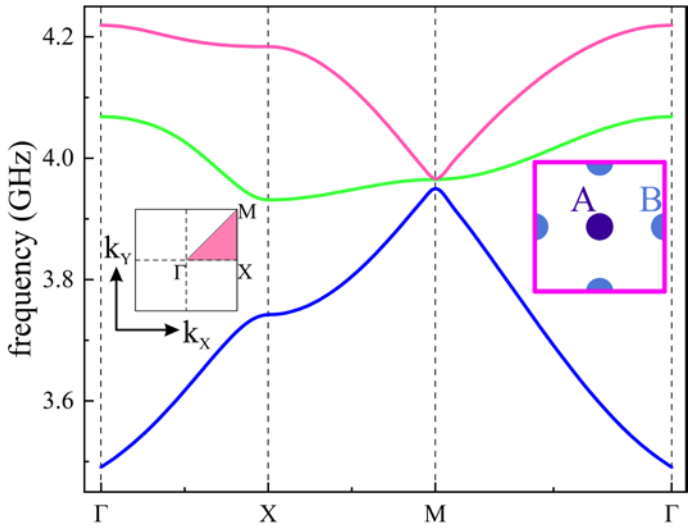

Figure 1. Dispersion relation obtained for magnonic Lieb lattice.

Magnonic crystals are promising structures for future application in spintronics and magnonics since their dynamical properties, described by dispersion relation for spin waves, can be tailored and tuned [1]. Despite keen interest in magnonic crystals [2], not all of their properties are discovered today. In our work, we demonstrate a new kind of localization due to the topological properties of magnonic crystals. In 1986, Bill Sutherland proposed the existence of flat bands by investigating certain Hamiltonians in a tight binding approximation [3]. Recently flat bands were considered in electronics and photonics [4] but there were no reports on the realization of the Lieb lattices in magnonics.

We proposed a perpendicularly magnetized (by field $\mu_0 H$=0.1 T) realistic magnonic structure consisting of a Ga-dopped YIG layer (of thickness 59 nm) with cylindrical inclusions (without Ga content) arranged in a Lieb lattice with a 250 nm period in case of basic configuration. We tailored the structure to observe, for the few lowest magnonic bands, the oscillatory and evanescent spin waves in inclusions and matrix, respectively. Such a design reproduces the Lieb lattice of sites (inclusions) coupled between each other (by the matrix) – see inset in Fig. 1. We present spectra and profiles of spin waves for types of Lieb lattices (differing in the complexity of unit cell), calculated by finite element methods in COMSOL.

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References

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