JEMS 2019 Joint European Magnetic Symposia

The EUROPEAN MAGNETISM ASSOCIATION

Program & Information

10th Joint European Magnetic Symposia

26-30 August 2019

Uppsala Konsert & Kongress, Uppsala, Sweden

@jems2019

O245 - Spin wave localization on phasonic defects in magnonic quasicrystal

15. Spin waves, magnonics, ultrafast magnetization dynamics and optically driven spin excitations

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Phasons are the structural defects which are specific for quasicrystal. They are a local rearrangements of the constituent elements in the quasiperiodic structure. The phasons in atomic systems diffuse within the structure and coexist with phononic excitations. Here, we investigated the phasons in artificial magnonic quasicrystals – a Fibonacci sequence of Py and Co stripes. We considered phasonic defects in this system as a peculiar kind of static rearrangement of magnetic stripes. The phasonic defects are introduced by swapping the neighbouring Py and Co stripes in selected Py|Co pairs. The main goal of this study is to find the impact of the phasonic-like disorder on the spectrum and on the localization of spin wave eigenmodes in magnonic quasicrystals.

We investigated the perturbed Fibonacci sequences of stripes with lower concentrations of phasonic defects. The introduction of such defects does not change the average values of material parameters for considered composite structures. Therefore, in the regime of long-wavelengths, the spectrum of eigenmodes is the same as for the unperturbed Fibonacci sequence. In the frequency ranges corresponding to the band gaps we observed the gradual smoothing of IDOS which results in the bandgap closing for larger concentration of phasonic defects. We found out, that each spin wave defect mode occupies only few selected locations of phasonic defects. The selection of occupied defect(s) is different for different spin wave modes.

The calculations were done using the plane wave method with the supercell approach and were further compared to the outcomes of the finite element method performed with the aid of the COMSOL Multiphysics package.

The authors acknowledge the financial support of the National Science Centre Poland for Grant No. 2016/21/B/ST3/00452 and UMO-2017/24/T/ST3/00173.

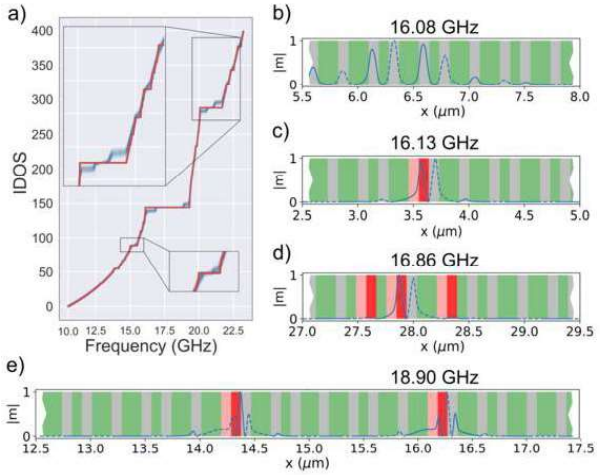

Fig.1. (a) Integrated density of states (IDOS) for the Fibonacci sequence composed of 377 stripes, made of Co or Py, being in direct contact. The stripes are 91 nm wide and 30 nm thick. The red curve represents IDOS for unperturbed quasicrystal. The blue curves show the IDOS for 100 defected Fibonacci sequences of the same length, with randomly placed phasonic defects occupying 10% of possible locations. (b – e) The spin wave profiles for one selected configuration of phasonic defects showing (b) the bulk mode and (c-d) a few defect modes localized on phasonic defects. The solid and dashed lines denote the regions where the spin waves precess with opposite phases. The pink and red bars mark the locations of phasonic defects. We showed only the selected sections of considered Fibonacci structure to show clearly the features of the modes' profiles. The bulk mode is quite extended and preferably occupies the Py stripes (gray and red bars). The strongly localized defect modes occupy few phasonic defects only if there are the same, sufficiently long sequences of Co (green and pink bars) and Py stripes surrounding these defects.