

CONDITIONS OF ABSOLUTE GAP OPENING IN THREE-DIMENSIONAL MAGNONIC CRYSTALS

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We use the plane wave method to determine spin wave spectra of three-dimensional magnonic crystals (the magnetic counterpart of photonic crystals) composed of two different ferromagnetic materials. The scattering centres in the magnonic crystal considered are ferromagnetic spheroids (spheres being a special case) distributed in sites of a cubic (sc, fcc or bcc) lattice embedded in a matrix of a different ferromagnetic material. We demonstrate that magnonic gaps in such structures occur at spontaneous magnetization contrast and/or exchange contrast values above a certain critical level, which depends on the lattice type. Optimum conditions for magnonic gaps to open are offered by the structure in which the scattering centres are the most densely packed (the fcc lattice). We show that in all considered lattice types the reduced width of the gap (i.e. the width referred to the gap centre) is, in good approximation, a linear function of both the exchange contrast and the magnetization contrast. Also, the gap width proves sensitive to deformation of the ellipsoidal shape of the scattering centres, and its maximum value to correspond to a scattering centre shape close to a sphere. Moreover, our numerical results seem to indicate that dipolar interactions in general result in an effective reduction of the gap width, but their impact only becomes of importance when the lattice constant of the cubic magnonic structure is greater than the ferromagnetic exchange length of the matrix material.

9.7 cm

13.4 cm

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