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Supercritical propagation of nonlinear spin wave through an antiferromagnetic magnonic crystal

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Analytical model of a nonlinear spin wave (SW) [1] propagating through one-dimensional antiferromagnetic magnonic crystal is proposed for supercritical mode when the SW velocity exceeds the maximum velocity of linear SW in both antiferromagnets (AFMs) or at least in one of them. Both AFMs that comprise the magnonic crystal are assumed to be two-sublattice uniaxial ones. The Landau-Lifshitz equations have been used in the sigma model with account for the exchange bias between magnetic sublattices of both AFMs, the magnetic anisotropy, the magnetic dipole-dipole interaction and the Dzyaloshynskyi-Moriya interaction. The discrete sets of frequencies and velocities for the considered SW are obtained. The boundary conditions for the Néel vector on the interface between two AFMs are derived with the exchange bias between magnetic sublattices of both AFMs taken into account. These boundary conditions are applied for both fully uncompensated interface and fully compensated one for the illustration purposes. Analysis of the results show that the nonlinear SW is reflectionless, phase-coherent and possess a number of parameters that can be considered as degrees of freedom for encoding information. These findings open up new possibilities of digital data processing utilizing nonlinear SW propagating through antiferromagnetic magnonic crystal in supercritical mode.

Reference list

1. O. Y. Gorobets and Y. I. Gorobets, 3D Analytical Model of Skyrmion-like Structures in an Antiferromagnet with DMI, J. Magn. Magn. Mater. 507, 166800 (2020).