Phase shift of spin waves traveling through the interface with broken spatial inversion symmetry

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One of the biggest challenge in magnonics is spin waves (SWs) amplitude and phase manipulation at subwavelength distances [1]. Nowadays, the SW phase shifters attract much attention of researchers for development the logic devices encoding information in the phase of travelling SW packets and utilizing them for data processing. We study analytically transmission of normally incident SWs through an ultra-narrow interface with asymmetrical properties. The system consisting of two semi-infinite ferromagnetic medias separated by an interface is considered. Between those medias we assume boundary conditions with broken spatial inversion symmetry (BSIS) [2]. The total energy density of such a system can be written (Eq. 1):

$$W = \int dx \Big\{ A(x)\vec{M}_1\vec{M}_1 + \frac{1}{2}\Big(\alpha_1(x)\big(\partial_x\vec{M}_1\big)^2 + \alpha_2(x)\big(\partial_2\vec{M}_2\big)^2 - \beta_1(x)\big(\vec{M}_1\vec{n}_1\big)^2 - \beta_2(x)\big(\vec{M}_2\vec{n}_2\big)^2\Big) - \vec{H}_0\vec{M}_1 - \vec{H}_0\vec{M}_2 + d_{il}^{12}M_{1i}\partial_x M_{2l} + d_{il}^{21}M_{2i}\partial_x M_{1l}\Big\} \quad (1)$$

where $\vec{M}_1$ and $\vec{M}_2$ are the magnetization vectors of the first and the second ferromagnets correspondingly, parameter $A(x)$ denotes the uniform exchange between sublattices, $\alpha_1(x)$ and $\alpha_2(x)$ are the parameters of non-uniform exchange for the first and the second ferromagnets, parameters $\beta_1(x)$ and $\beta_2(x)$ correspond to uniaxial magnetic anisotropies of the first and the second ferromagnets, the corresponding vectors $\vec{n}_1$, $\vec{n}_2$ are the unit vectors of the uniaxial magnetic anisotropy axes, d_{il}^{12}, d_{il}^{21} - are tensors of BSIS, the indexes *i, l* denote the projections of the magnetization vectors onto the axes of Cartesian coordinate system. The dependence of phase shift between the transmitted and incident spin waves on parameters of BSIS is analysed in this system. The new possibility to introduce a controlled phase shift of the propagating SWs is in transmission through interface with BSIS.

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