Voltage-induced topological transitions of spin waves in multiferroic structures

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Systems based on semiconductor transistors are commonly used to generate, transmit, and process information signals. However, they have limitations that can be overcome by magnonics, a new trend in condensed matter physics based on the effects of electron spin transfer rather than charge transfer. This opens up new possibilities for the application of spin waves (SW) as elements of microwave and terahertz information processing, transmission, and storage devices [1,2]. Monocrystals and single-crystal films of yttrium iron garnet (YIG) are known to have very low attenuation constants and have long been used for experimental studies of spin-wave phenomena and the fabrication of spin-wave magnonic devices [3,4]. Arrays of YIG microstructures can be used to build magnonic networks for signal processing. In these networks, information is distributed through SW waveguides, and logical operations are based on the principles of spin-wave interference.

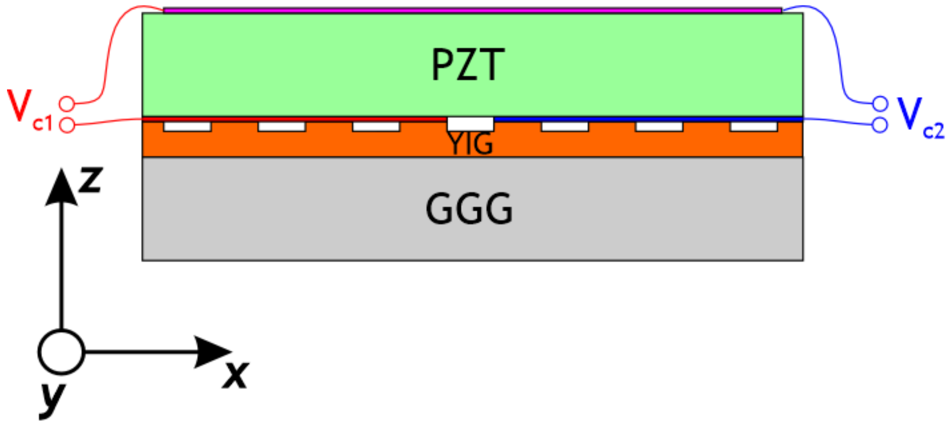

Fig. 1. Scheme of magnonic crystal with piezoelectric layer

To develop more efficient magnonic devices, it is important to be able to control the transmission of spin waves by both electric and magnetic fields [5]. Synthetic multiferroic structures with two-dimensional deformations in the form of mechanically coupled magnetostrictive and piezoelectric layers are of particular interest for magnon straintronics [5,6].

Here, we report the experimental realization of magnonic crystal hosting topological states of spin waves, whose existence and localization is controlled by the externally applied voltage. Such electric tunability is achieved by controlling the distribution of internal magnetic fields in the structure which have the direct effect on the order of magnonic bands as well as the width of the respective gap. Our structure thus realizes electrically tunable topological insulator for spin waves. The study will experimentally and numerically demonstrate the possibility of tuning the frequency band in the spectrum of spin waves due to distributed elastic deformations occurring at the interface between a magnonic crystal and a piezolayer.

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