Arrays of magnetic nanoelements as a new reconfigurable magnetic material for magnonic signal processing and digital logic applications

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Advances in microwave signal processing are not possible without the development of novel dynamically reconfigurable magnetic materials with enhanced parameters. An example of such novel magnetic materials is given by nano-patterned arrays of dipolarly coupled magnetic elements. Such arrays support collective spin waves (SW) having spectra that are strongly dependent on the array's geometry and its magnetization state [1]. The magnetization state of an array can be switched dynamically by application of short magnetic pulses [2]. Here, we consider two properties of artificial magnetic materials based on arrays of nano-sized magnetic elements that are important for applications.

First, we consider the interaction of microwave photons with a magnetic nanoelement array. To solve this problem we derive electrodynamic boundary conditions at the array's surfaces [3]. These boundary conditions, determined by the array's SW spectra, define the array's interaction with the external electromagnetic radiation. We demonstrate that the reflection and transmission properties of an array can be controlled dynamically by switching the array's magnetization state. We also show that despite the fact that the thickness of the array is much smaller than the wavelength of the incoming wave, the influence of the array on the electromagnetic radiation is rather significant in resonance structures, such as electromagnetic wave waveguides.

Second, we consider formation in an array of localized SWs that can be confined to the internal boundaries of the array, for example, to the domain walls dividing the regions of the different magnetic order in the array [4, 5]. These domain walls can act as waveguides for the localized SWs, and allow one to bend, split and combine SWs paths. We demonstrate that such waveguides can be used to make a digital logic XOR gate for SWs, which can work as building blocks for the future magnonic logic processors [5].

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Bio

Dr. Lisenkov graduated from Moscow Institute of Physics and Technology, Russia in 2007. After that he joined Kotel'nikov Institute for Radioengineering and Electronics of the Russian Academy of Sciences and completed his PhD there in 2010. After working a few years in Russia with Prof. Nikitov, he joined the group of Prof. Slavin at Oakland University as a postdoc in 2013.