# Multilayered spin-wave devices based on transmission and resonance phenomena

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Low energy consumption and high frequencies of spin waves are an essence of the computing based on magnonic logic devices. Steering of the signal is one of key elements in the problem of multifunctional computing units and miniaturized high-efficiency devices are highly desirable. Here, we propose devices based on multilayered ferromagnetic thin-film structures benefiting from the transmission and resonance phenomena. We used the Dzyaloshinskii-Moriya interaction to show the effect of unidirectional coupling where the spin wave can be transferred between the layers in only one direction of propagation. This effect was used to make the spin-wave diode and circulator[1]. The diode bases on the unidirectional coupling with the high-damping element where the spin wave is highly attenuated. The circulator take use of opposite unidirectional coupling due to opposite Dzyaloshinskii-Moriya constant sign in co-planar waveguides. The devices work with high efficiency in wide frequency range. Also, we used the multimode rectangular resonator to propose multifunctional device which can be used to steer the signal depending on the working frequency[2]. This device combine the functionality of directional coupler, circulator, splitter, and wave reflector. The device take use of the existence of the circulating resonant modes of different chirality. Our work opens the possibility to take the step into 3D magnonics and their further miniaturization making them competitive with the electronic logic components.

**References:**

[1] K. Szulc *et al.*, Phys. Rev. Appl. 14, 034063 (2020)
[2] P. Roberjot *et al.*, submitted to Appl. Phys. Lett.

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