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EC-02. Magnon Fluxonics INVITED.

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The field of magnonics considers the operations with data carried by spin waves and their quanta, magnons [1]. Traditionally, magnonics has been a room-temperature research discipline. Nowadays, the new direction of cryogenic magnonics attracts increasing attention. The decrease in temperature, in particular, results in the reduction of thermal population *n* of magnons below 1 opening access to single-magnon quantum physics [2]. Moreover, cryogenic temperatures allow for combining magnonics with superconductivity [3-5]. Ferromagnetism and superconductivity are fundamental cooperative phenomena in condensed matter physics. Entailing opposite spin orders, they share an essential conceptual similarity: Disturbances in magnetic ordering in magnetic materials can propagate in the form of spin waves (magnons) while magnetic fields penetrate the majority of technologically relevant (type II) superconductors as a lattice of magnetic flux quanta (fluxons, Abrikosov vortices). Despite a rich choice of wave and quantum phenomena predicted, magnon-fluxon coupling has lacked experimental scrutiny so far. In this talk, a selection of our recent results [5] on the interaction of spin waves with the flux lattice in ferromagnet/superconductor Py/Nb bilayers will be presented - see Fig. 1. In this system we found the magnon frequency spectrum to exhibit a Bloch-like band structure (as shown in Fig. 1(b)) which can be tuned by the biasing magnetic field. Furthermore, the frequency spectra of spin waves scattered on the flux lattice moving under the action of a transport current in the superconductor exhibit Doppler shifts. The resonance absorption of spin waves is explained by their inelastic scattering on the vortex lattice constituting a reconfigurable magnonic crystal [6]. The observed Doppler shifts arise due to the modified dispersion relation for spin waves scattered on the moving vortex lattice constituting a moving Bragg grating. In addition, manipulation of spin waves and tailoring of their transmission spectra in Py will be exemplified by using adjacent Nb layers with nanofabricated pinning potential landscapes. A special attention will be devoted to direct-write hybrid superconductor-based systems with fast relaxation of non-equilibrium effects and supporting ultra-fast vortex motion at >10km/s velocities [7]. Research leading to these results was done in collaboration with R. Sachser, T. Brächer, T. Böttcher, V. Kruglyak, R. Vovk, V. Shklovskij, M. Huth, B. Hillebrands and A. Chumak.

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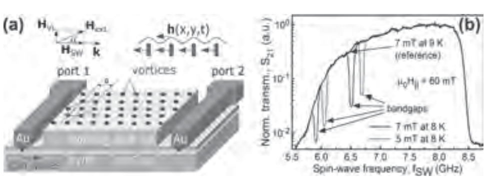

(a) Sketch of the experimental system. (b) Fluxon-induced reconfigurable magnonic crystal: Bandgaps in the spin-wave transmission spectra in Py are observed when the Nb layer contains an array of Abrikosov vortices.