With the fast growth in the volume of information being processed, researchers are charged with the primary task of finding new ways for fast and efficient processing and transfer of data. Spin excitations – spin waves and their quanta magnons – open up a promising branch of high-speed and low-power information processing. Down-to-nm wavelengths, GHz-to-THz frequency range, Joule-heat-less transfer of spin information, and access to the novel wave-based computing concepts allow for the developing of a novel technology without drawbacks inherent to modern semiconductor electronics [1].

After the introduction on the first realizations of spin-wave logic gate and magnon transistor [2], I will concentrate on the numerical and experimental studies of spin-wave majority gate. In this device, information is digitized using the spin-wave phase instead of the amplitude. Such approach allows for a trivial embedding of a NOT logic element in magnonic circuits by changing the position of a read-out device by a half-wavelength distance. We have proposed a fully functional designs of the microstructured spin-wave majority gate and tested it by micromagnetic simulations [3] and experimentally.

In the second part of my talk I will present numerical studies of the spin-wave directional coupler needed for the development of future magnonic circuits. In particular, it can be used as power and frequency splitter, as well as for the crossing of magnonic conduits. Finally, the novel designs of XOR and AND nano-scaled logic gates utilizing the interplay between different spin-wave modes will be presented.


We present an overview on optical manifestations of coupling of spins in a ferromagnet to carrier spins in a non-magnetic semiconductor quantum well which is located in the direct vicinity of the ferromagnet/semiconductor interface (the proximity effect). Two main mechanisms responsible for the proximity effect are addressed. The first one is related to spin dependent tunneling of photoexcited conduction band electrons through the interface leading thus to dynamical proximity effect and appearance of non-equilibrium electron spin polarization. The second one is based on effective s-d (p-d) exchange interaction between electrons (holes) and magnetic ions. The latter leads to the equilibrium proximity effect where the spin polarization of electrons and holes is due to the thermal population of spin levels split by the effective exchange magnetic fields produced by the FM layer. Both dynamical and equilibrium proximity effects allow one to read out the magnetization state of the ferromagnet through the circular polarization of the photoluminescence from the quantum well. The strength of each of the mechanisms depends strongly on the choice of ferromagnetic and semiconductor materials.

The spin dynamics in hybrid GaMnAs/InGaAs and Co/CdMgTe systems are discussed. In Co/CdMgTe system we observe equilibrium proximity effect. In contrast to the expected p–d exchange that decreases exponentially with the wavefunction overlap of quantum well holes and magnetic atoms, we find a long-ranged, robust coupling that does not vary with barrier width up to more than 30 nm. We suggest that the resulting spin polarization of acceptor-bound holes is induced by an effective p–d exchange that is mediated by elliptically polarized phonons.