

EN-Magnonik

The goal of this project is to explore fundamental connections between spin waves, spin polarized electrons and photons, combining the three recently emerged research directions of magnonics, spintronics and photonics. This research is driven by the demand for new concepts, technologies and materials for information processing since, on one side, electronics is reaching its physical limit of speed due to waste heat generation and, on the other side, photonics lacks fast, electronic control on small length scales. Spin waves, being the fundamental dynamic excitations of ferromagnets with frequencies in the gigahertz to terahertz regime, offer the unique opportunity to merge the best aspects of spintronics and photonics opening new pathways for information processing.

Within the scope of this project, three objectives are in the focus of interest: The first objective is to analyze spin-wave transport and manipulation in magnetic nanostructures. This includes the characterization of novel materials and geometries as well as the investigation of the interactions between spin waves and domain walls utilizing the magneto-optical Kerr effect and Brillouin light scattering microscopy. The second objective focuses on the coupling between spin waves and spin currents that are created by the spin Hall effect. We will analyze the excitation, amplification and detection of spin waves by spin transfer torque and spin pumping. Within our third objective, the manipulation of light by spin waves on the nanometer scale, we employ the strong magneto-optical coupling between spin waves and surface plasmons. This allows us to control the propagation of surface plasmons in nanostructures on the time scale defined by spin waves.

Exploring mechanisms of coupling between spin waves and electrons on one side and spin waves and photons on the other, magnonics can close the gap between spintronics and photonics that still operate on different time and length scales.