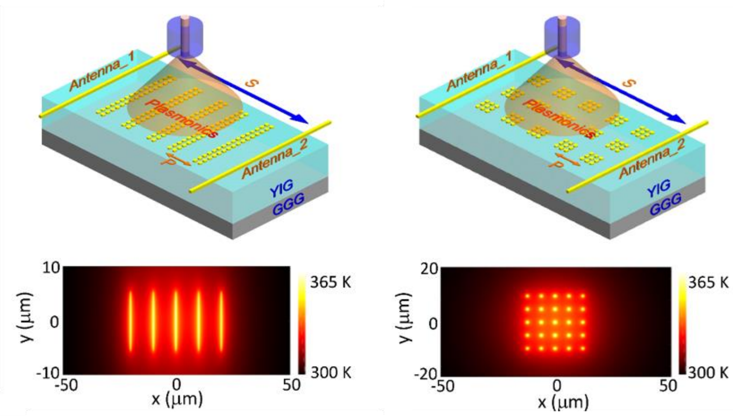
Nanomagnetism and Spintronics Group

Summer Student Positions

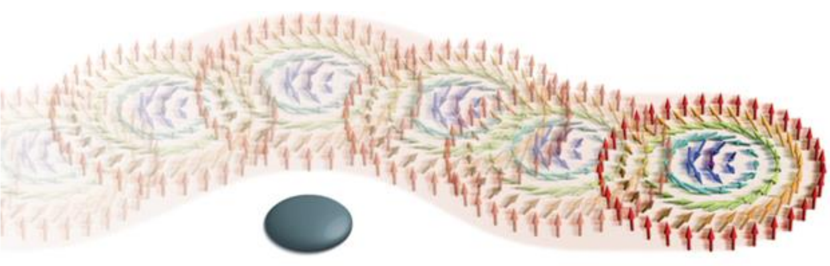
(1) Optical control of magnetic spin waves

Collective spin wave excitations in ferromagnetic materials provide a promising platform for wave-like computing in nanoscale devices at GHz frequencies. Low-power excitation and manipulation of spin waves are key requirements for this future technology. As a summer student, you will explore optical control of spin waves in hybrid samples combining a ferrimagnetic oxide film and metallic plasmonic nanostructures. The proof-of-principle experiments use the notion that forbidden bandgaps for spin-wave transmission can be programmed by optical manipulation of magnetic material properties. Experiments include the growth of ferrimagnetic films onto single-crystal substrates using pulsed laser deposition, nanofabrication of plasmonic nanostructures by electron-beam lithography, and advanced characterization of spin-wave transmission under various illumination conditions. You will also perform micromagnetic simulations in GPU-based MuMax software and electromagnetic simulations in CST studio.



(2) Skyrmions in magnetic thin films and nanostructures

Magnetic skyrmions are sub-micron particle-like excitations with a distinct topology created by 2D magnetic rotations. As well as interesting physical properties caused by their non-trivial topology, they may also be useful for new types of data storage and logic applications. We have been studying these particles in nanometer-thick films, where the magnetic properties are controlled through interfacial interactions. As a summer student you will learn how to make thin films by magnetron sputtering, how to pattern devices in the cleanroom, how to make magnetic imaging and electrical transport measurements of skyrmions, as well as modelling the devices through micromagnetic simulations.



Skyrmion moving around obstacle

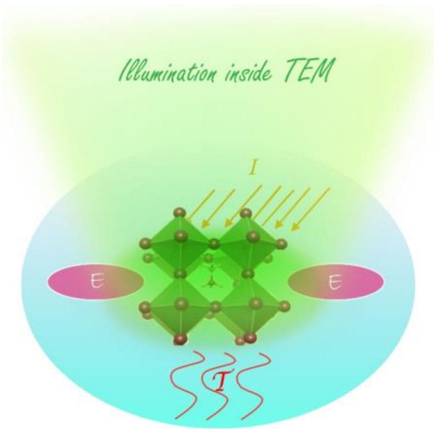
A. Rosch Nat Nano **8**, 160 (2013)

(3) Brain-inspired computing using oxide tunnel junctions

"Brain inspired computing" is an emerging field that aims to build neuromorphic computers that are highly efficient in terms of energy and space, scalable to large networks of neurons and synapses, and flexible enough to run complex behavioral models. Recently, researchers have suggested that ferroelectric tunnel junctions (FTJs), displaying voltage-controlled quasi-continuous resistance variations of two orders of magnitude and fast 10-ns operation, could serve as the basic hardware element of neuromorphic computational architectures. As a summer student, you will study the potential of FTJs for brain-inspired computing. The FTJs will be fabricated by pulsed laser deposition and advanced photo- and e-beam lithography. Electronic transport measurements will be conducted to mimic brain-like operations. Various models for tunneling transport will be used to fit the data.

(4) In-situ transmission electron microscopy of functional materials

Advances in transmission electron microscopy (TEM), such as aberration correction (Cs) and the development of in-situ sample holders for heating, optical illumination, and the application of electric fields, have enabled active material manipulation and characterization at the atomic scale. In recent years, we have established these cutting-edge capabilities in the Aalto Nanomicroscopy Center (NMC). As summer student, you will have the opportunity to learn how to prepare in-situ TEM specimen from nanoscale oxide films or 2D materials and use advanced TEM measurement techniques on a state-of-the-art instrument at NMC. You will focus on high-resolution in-situ TEM analysis of phase transitions and ionic migration processes under various external stimuli. These processes are known to dramatically affect the magnetic, ferroelectric, and electronic properties of complex oxides and, if understood, could greatly contribute to the development of low dimensional electronic and "iontronic" devices. The TEM experiments will be complemented by electro-thermal simulations in COMSOL.



More information about the research activities of the NanoSpin Group can be found on our website:

http://physics.aalto.fi/en/groups/nanospin/