PRSE Magnetics Seminar

"Spin waves in sub-micron magnetic structures"

Shang-Fan Lee

Institute of Physics, Academia Sinica, Taiwan

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126 Engineering (Physics Conference Room)

Abstract

In Spintronics, pure spin current with zero net charge transport, which can be generated by the spin Hall effect, the spin pumping effect, the spin Seebeck effect, magnons etc, is a promising concept. Spin Hall effect can be realized in conducting materials while others can be observed in either conducting or insulating materials. Spin waves (SWs) propagate in both magnetic metals and insulators via magnetization dynamics thus are not limited by electron transport. Magnetic nanostructures serve as waveguides for SWs. Energy dissipation through damping can be low compared to the Joule heating in conventional circuits. We will present our experimental works on generation and propagation of spin wave (SW); and some simulation about the SOT of SW acting on magnetic domain walls.

Employing a micro-focused Brillouin light scattering spectroscopy (BLS) setup, we experimentally realize a spin-wave (SW) generator, capable of frequency modulation, in a magnonic waveguide. The emission of spin waves was produced by the oscillation of nanoscale magnetic vortex cores in a NiFe disk or disk array. The vortex cores in the disk were excited by an out of plane radio frequency (rf) magnetic field. The dynamic behaviors of the magnetization of NiFe were studied. In addition to the discrete ferromagnetic resonance (FMR) signals above external dc saturation magnetic field, we observed clear signals at zero magnetic field where vortex cores are present.

We performed simulations in a quasi-one-dimensional ferromagnetic strip and have found that the SW shows highly anisotropic transmission through different orientations of magnetization inside a domain wall (DW) at a relatively low frequency. When the SW amplitude is large, it induces an effective field torque leading to the rotation of the DW plane and the DW motion. The forward DW motion is a contribution of the demagnetization field due to the increase of the transverse components of magnetization in the DW region, and thus yields an increase of the magnetization orientation of *dj*. The backward motion is attributed to the conservation of the spin angular momentum. The transmission ratios of the SW are in turn determined by *dj* of the DW and show complicated dependence at low frequencies. We can thus manipulate the DW motion by selecting the SW frequency and/or controlling the SW amplitude through adjusting the DW angles.

Dr. Lee received his Ph.D. degree from the Michigan State University, USA. He was then a Postdoctoral researcher in the Universite Paris-Sud, France. He moved back to Taiwan as an assistant/associate/full Research Fellow in the Institute of Physics, Academia Sinica, Taipei, Taiwan.

The research interest of Dr. Lee includes magnetism and magnetic materials and the interplay between magnetism and superconductivity. He has worked on the current perpendicular to plane Giant Magnetoresistance (CPP GMR), magnetic submicron and nano-structures, point-contact spectroscopy, pure spin currents, etc. His current interest includes the transport of spin waves in magnetic nano-structures.