Optic & Nanomagnetism
Thursday, October 23rd 2025

Room 4-A014 – Institut Jean Lamour

9 : 10 – 10 : 00 (talk : 40 min, Q&A : 10 min)

Optical control of spin waves in hybrid magnonic-plasmonic structures (Prof. Sebastiaan van Dijken, NanoSpin, Department of Applied Physics, Aalto University School of Science, Aalto FI-00076, Finland)

10 : 00 – 10 : 20 : Coffee break

10 : 20 – 11: 10 (talk : 40 min, Q&A : 10 min)

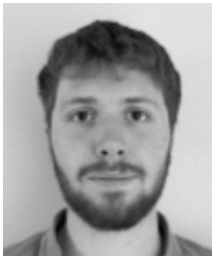
Amplification of Magneto-Optical Activity Through Plasmonic Modes Hybridization (Dr. Paolo Vavassori – IKERBASQUE Professor and co-leader of the Nanomagnetism group, CIC nanoGUNE BRTA)

11: 10 – 12: 00 (talk : 40 min, Q&A : 10 min)

Applications of all-optical switching of magnetization: Photonic memory, magnetic sensors and writing skyrmions (Prof. Bert Koopmans - Department of Applied Physics, Eindhoven Hendrik Casimir Institute)

Amphi 200 – Campus ARTEM

14: 00 –



PhD defense « All-optical helicity-dependent switching in magnetoplasmonic structures » (Yann Le Guen – SPIN team, Institut Jean)

Journée organisée dans le cadre du programme interdisciplinaire MAT-PULSE (*Materials and Physics @ Ultimate Scale: Nanotech for a sustainable digital world)*

Abstracts

Optical control of spin waves in hybrid magnonic-plasmonic structures (Prof. Sebastiaan van Dijken, NanoSpin, Department of Applied Physics, Aalto University School of Science, Aalto FI-00076, Finland)

Magnonics, which exploits spin waves as information carriers, offers significant potential for next-generation wave-based computing due to its scalability, broad frequency range, and nonlinear dynamics. A central challenge is achieving rapid, reconfigurable control of spin-wave transport. In this talk, I will present a hybrid magnonic–plasmonic platform enabling spatiotemporal manipulation of spin waves at micrometer scales and sub-microsecond timescales. The system integrates low-damping yttrium iron garnet (YIG) films with periodic arrays of gold nanodisks forming plasmonic metamaterials. Short laser pulses (100–500 ns) excite surface lattice resonances in the nanodisks, inducing thermoplasmonic heating that modifies the local saturation magnetization of YIG. Two configurations are studied: YIG with dense nanodisk arrays and YIG with nanodisks arranged in periodic stripes. Time-resolved propagating spin-wave spectroscopy reveals temporal suppression of spin-wave signals up to 20 dB, as well as tunable bandgaps and minibands resulting from Bragg reflection. These results establish thermoplasmonics as a versatile tool for engineering magnonic band structures and controlling spin-wave propagation, bridging magnonics and plasmonics, and opening pathways toward reconfigurable hybrid magnonic devices.

Amplification of Magneto-Optical Activity Through Plasmonic Modes Hybridization (Dr. Paolo Vavassori – IKERBASQUE Professor and co-leader of the Nanomagnetism group, CIC nanoGUNE BRTA)

We explore magnetoplasmonic-disk/plasmonic-ring nanocavities to achieve free-space light excitation and hybridization of multipolar modes. We show that the enhanced tunability and linewidth sharpening of Fano resonances in non-reciprocal metasurfaces made of periodic arrangements of such hybridized magnetoplasmonic nanocavities produce a large amplification of the magneto-optical response together with the control of reflectance (Kerr configuration) and transmittance (Faraday configuration), well beyond that achievable using conventional magneto-plasmonic nanostructures [1].
We found that the multipole composition of these hybrid eigenmodes result in a peculiar scattering directivity of electromagnetic waves leading to a vastly wider range and tunability of collective lattice resonances when the nanocavities are arrange on periodic patterns.
Given the specific interest associated with the possibility to induce a strong coupling between collective lattice resonances and two-level systems, like quantum-emitters (QEs) [2], the here studied optical non-reciprocal metasurfaces may constitute an interesting candidate to control quantum-optical properties of light emitters integrated therein by enabling long-distance interaction between QEs and causing cooperative effects, including the QE entanglement [3].

[1] A. López-Ortega et al., “Enhanced magnetic modulation of light polarization exploiting hybridization with multipolar dark plasmons in magnetoplasmonic nanocavities”, Light: Science&Applications 9, 49 (2020).
[2] J. Straubel, R. Filter, C. Rockstuhl, and K. Słowik, “Efficient mode conversion in an optical nanoantenna mediated by quantum emitters”, Optics Letters 41, 2294-2297 (2016).
[3] P. K. Jha et al., “Metasurface-mediated quantum entanglement”, ACS Photonics 5, 971 (2018).

Applications of all-optical switching of magnetization: Photonic memory, magnetic sensors and writing skyrmions (Prof. Bert Koopmans Department of Applied Physics, Eindhoven Hendrik Casimir Institute)

Novel schemes for controlling the ferromagnetic state at femtosecond time scales by pulsed laser excitation have received great interest. By driving systems into the strongly non-equilibrium regime, it has been shown possible not only to quench magnetic order, but also to switch the magnetization by single laser pulses – so-called all-optical switching (AOS). In parallel, it has been found that pulsed laser excitation can also induce spin currents over several to tens of nanometers, which can act as an additional source of sub-picosecond magnetization dynamics. Thereby, a scientifically exciting link between the fields of ‘femtomagnetism’ and spintronic transport physics has emerged. Moreover, it is being envisioned that combining the two fields could pave the way to a new class of hybrid spintronic-photonic devices, in which data is copied between photonic and magnetic (spintronic) domain without any intermediate electronic steps, leading to ultrafast and highly energy-efficient IT solutions.

In this seminar, the underlying phenomena will be introduced, and a selection of experimental results will be presented. Simple models will be explained that provide an intuitive feeling of the various phenomena involved and their interplay. After this introduction, some of our recent experiments on applications of AOS will be presented. First, I will discuss recent progress towards realizing integrated spintronic-photonic memory, by demonstrating on-chip magneto-optical reading and on-chip AOS. Then I will address experiments on optically switching of the ‘exchange bias’ effect, which could be used for reprogrammable magnetic field sensors. Finally, I will report on our first attempts of field-free all-optical creation and annihilation of skyrmionic textures by single femtosecond laser pulses.