Centre de Nanosciences et de Nanotechnologies

Séminaire

Mardi 29 mai
11 heures
Salle Pierre Grivet (Salle 44) du C2N site Orsay

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"Problems in Nonlinear Magnetic Dynamics"

Abstract:

The experimental creation [1] of large oscillating microwave fields (200 Oe) in microstructures has generated new directions for investigation. We will look at two special and important cases which have the potential for experimental implementation:

1) Nonlinear excitations and ferromagnetic resonance results for exchange coupled bilayers
Here we study localization and absorption in exchange coupled thin films and find a number of interesting features: (i) There can be a power-dependent localization of energy in one film, breaking the symmetry; (ii) For the antiferromagnetic coupled bilayer, there can be a rapid increase in absorbed energy (4 orders of magnitude) as the input power is increased slightly. This occurs at a new nonlinear frequency and has the potential to be used as a high-frequency power limiter.

2) A magnetic analogy to the Fermi-Pasta-Ulam problem
The original Fermi-Pasta-Ulam (FPU) problem [2] examined nonlinear elastic motion in a chain and was a catalytic study (generating thousands of citations) that gave significant insight in nonlinear physics. In a linear harmonic system one expects that if energy is put into one eigenmode, the energy will eventually be spread out equally through all the eigenmodes (through damping or small perturbations). What FPU found for a nonlinear system was very different. Energy added to one mode was transferred to nearby modes in frequency, but then the system would nearly completely return to the original mode as time progressed. Here we present the first theoretical study of FPU behaviour in nonlinear magnetic chains [3]. In magnetic systems the FPU behaviour exists only under certain conditions and may be turned on and off by varying an external magnetic field. A realistic micromagnetic model shows such behaviour could be measurable.

[1] Y. Khivintsev et al., Appl. Phys. Lett. **98**, 042505 (2011)
[2] E. Fermi, J. Pasta, S. Ulam, Document LA-1940, Los Alamos National Laboratory (1955)
[3] J. Lewis, R. Camley, and N. Anderson, Phys. Rev. Lett. **120**, 167203 (2018)

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