Nanomagnetism and Magnetic Relaxation in Nanostructures.

Advanced Course for undergraduate students at the end of bachelors Physics course (Italian Laurea Magistrale). Graduate and PhD students from other disciplines but with basic knowledge in electromagnetism, thermodynamics and quantum mechanics may well follow and appreciate the course.

Prof. Miguel Alexandre Novak,
Physics Institute of the Federal University of Rio de Janeiro
dates: 3-4-5 -10-11-12 May
time 15h to 17h

Program:
Introduction to nanomagnetism with a review of relevant topics on magnetism and molecular magnetism.

Magnetism in zero dimension: nanoparticles, single molecule magnets and single ions magnets. Paramagnetism, anisotropy, superparamagnetism and the thermodynamics of paramagnetic relaxation. Stoner Wohlfarth model.
Neel and Brown models and relaxation in magnetic nanoparticle systems. Magnetic Quantum Tunneling in nanoparticles and molecular clusters.

Magnetism in one dimension: magnetic chains. Antiferromagnetic, ferromagnetic and ferromagnetic regular chains. Regular chains and alternating chains, Spin Peierls transition and random exchange models. Heisenberg, Ising and anisotropic Heisenberg models. Interactions between chains and dimensional crossover to 3D order.

Two dimensional magnetic systems: Ising model, Heisenberg and anisotropic models and simulations. Magnetism in thin films and interfaces, exchange bias.

Long range order versus short range order. Magnetic relaxation, slow dynamics and magnet behavior of nanostructured materials.

General experimental methods in magnetism and beyond magnetic measurements. Dynamic and static measurement techniques in magnetism and nanomagnetism.

Case studies of real system and model systems in nanomagnetism. According to availability in the research labs, measurements of real systems, data analysis and interpretation with a report and seminar presentation of each student at the end of the course.

Course duration 30 hours distributed in 10 classes of 2 hours (20 hours), plus at least 10 hours experiments in the lab. 2 topical seminars and presentation of student seminars within a total time of 3 months.

General References:

-Magnetism and Magnetic Materials, J.M.Coey, Cambridge University Press (2012).
-Molecular Magnetism- O. Kahn, VCH Weinheim (1993)
- The physical Principles of Magnetism, A. H. Morrish (1966) Wiley, NY.
- Molecular Nanomagnets – D. Gatteschi, R. Sessoli and J. Villain, Oxford Univ. Press (2006).
- Magnetic Relaxation in Fine-Particle Systems, J. L. Dormann, D. Fiorani and E. Tronc. Advances in Chemical Physics, Vol. 98, 283–494.

Assorted topical references will be given during the course.