The EUROPEAN MAGNETISM ASSOCIATION

A voice for Magnetism in Europe

Tutorials intro

Olivier FRUCHART

What is a tutorial?

- Objective : use your knowledge and the material from the lectures to conduct work by yourself
- Various implementations: exercises, projects, computer experiments etc.

Implementation

- 2-hour slots, either 100% onsite or 100% online
- 20 participants max per onsite slot, 30 participants max per online slot.
- Every participant may attend from three to four slots over the two weeks
- Lecturers may provide written support and answers to the tutorials
- Express your wishes by the end of session today, from 1 (preferred) to 7

TUTORIALS INTRO – YOUR WISHES FOR PARTICIPATION

Link on Discord#tutorials:
https://www.dropbox.com/scl/fi/bqzs574wapn91lcepi06o/Preferences-for-tutorials.xlsx?rlkey=0vkfb83tkgx1xc1ca0525koxn&dl=0

Note: Excel spreadsheet, two tabs (onsite/online) with your name.
Fill-in only 7 choices !

PREFERENCES FOR TUTORIALS

ONSITE | ONLINE

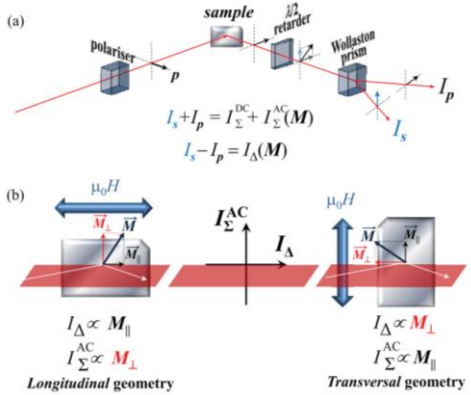
Indicate your preferences for attending practicals from **1 (highest interest) to 5 (lowest)**.

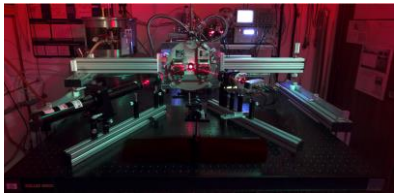
	MOKE (JL Cunnado)	Micromagnetic simulations (P. Olleros)	Sandra Ruiz-Gomez (S. Ruiz-Gomez)	Spin injection and tunneling magnetoresistance (A. Manchon)	How to write a scientific paper? (R. Goldfarb)	Units (O. Fruchart)	Micromagnetics of walls (O. Fruchart)	I-H diagrams of macrospins (O. Fruchart)	Nanofabrication (L. Perez)	Simulations (B. Dupé)	A scientific talk (M. Rivas)
Wed 6 17:30							X				
Th 7 15:30	X	X	X			X				X	
Wed 8 15:30	X	X	X				X			X	X
Th 9 16 15:30	X	X	X	X	X			X			
Wed 13 14:00					X				X		
Th 14 17:30				X				X	X	X	X
NAME	**PREFERENCES**										

MOKE PRACTICAL – JOSE LUIS CUNNADO

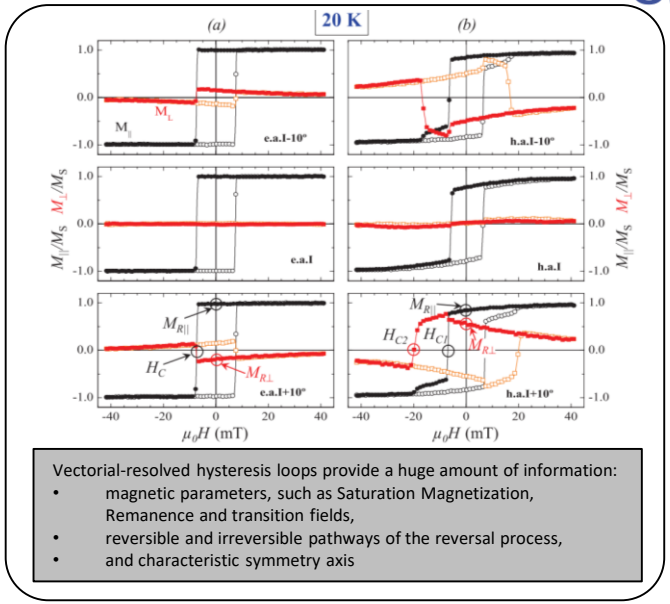
Onsite

Magneto-Optical Kerr Effect is a widely used technique for exploring magnetic properties due to the simplicity of the set-up as well as the velocity of acquisition of data.



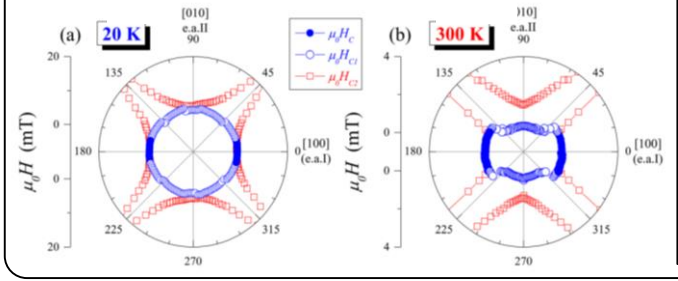


Vectorial Magneto-Optical Kerr Effect (v-MOKE) is a technique that allows to obtain simultaneously two components of the magnetization of a system, by looking at the reflectivity and polarization changes as a function of the applied field of a well defined light beam upon reflecting on the sample's surface.



Vectorial-resolved hysteresis loops provide a huge amount of information:

- magnetic parameters, such as Saturation Magnetization, Remanence and transition fields,
- reversible and irreversible pathways of the reversal process,
- and characteristic symmetry axis



Angular evolution of magnetic parameters obtained by v-MOKE allows to disentangle magnetic anisotropies (for instance, (a) is a system with an almost perfect biaxial magnetic anisotropy, while (b) has a superimposed uniaxial magnetic anisotropy that breaks the biaxial one.

In this tutorial, the student will get in contact with a full angular range v-MOKE, facing the problem of unraveling magnetic anisotropies in an (a priory) unknown magnetic system.

MICROMAGNETIC SIMULATIONS – PABLO OLLEROS FELIPE GARCIA SANCHEZ

Onsite

- Aim: To learn the **fundamentals of micromagnetic simulations**, including:
  - Continuum hypothesis
  - Magnetization dynamics and micromagnetic contributions
  - Finite Differences Method
- We will introduce the **Object Oriented MicroMagnetic Framework (OOMMF)** computational code and will make use of its problem editor for solving 2D problems such as:
  - Calculate *hysteresis loops* in ferromagnetic dots with different anisotropies.
  - Observe *magnetization precession* and *vortex gyrotropic modes*
  - Observe *domain-wall movement* by applying an external field
- Important notes:
  - The OOMMF micromagnetic solver needs to be installed by the students on their own computers. (Installation instructions will be given beforehand)
  - This course is intended for basic learning of the operation of a micromagnetic solver and is oriented to students with no experience in micromagnetic simulations.

DISCOVERING THE HIDDEN INFORMATION – SANDRA RUIZ-GOMEZ

Onsite

- **Interactive tutorial: Analyse images by yourself!**

- We will work with real XMCD-PEEM and TXM images measured at ALBA synchrotron
- We will learn the steps needed for extracting the magnetic information from the images…

  … but, the same steps can be used for extracting other information.
- We will use ImageJ software…

  … but all strategies can be used with other software: Matlab, Phyton.. If you have questions about how to do it, you can ask!
- If you do not have a laptop, we have one for you.

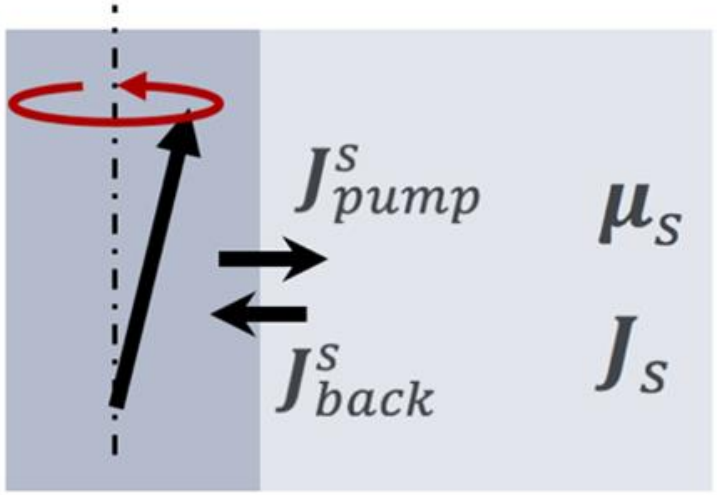
- **Come to learn tip and tricks for image analysis.**

SPIN INJECTION AND TUNNELING MAGNETORESISTANCE – AURÉLIEN MANCHON

Onsite

Online

- The goal of this tutorial is to better understand the conditions for optimal spin injection from a ferromagnet into an adjacent metal.
- We will learn how to use the **spin mixing conductance** together with the **spin diffusion equation** to compute the injected current polarization
- This tutorial will cover both electrical injection and spin pumping
- …and if time allows, we will discuss the physics of spin transfer torque



HOW TO WRITE A SCIENTIFIC PAPER? – RON GOLDFARB

- Students send a draft paper in Word (or possibly PDF) to Ron on 5th morning
- A few papers will be selected for commenting during the tutorial:
- Recommendations to improve (I hope) the titles, abstracts, and in some cases, the introductions

UNITS IN MAGNETISM – OLIVIER FRUCHART

Onsite

Definitions

- MKSA (SI) : meter, kilogram, second, ampere $B=\mu_o(\mathbf{H}+\mathbf{M})$
- Cgs-Gauss : centimeter, gram, second, and ?.. $B=\mathbf{H}+4\pi\mathbf{M}$

Consequences and questions

- Are Gauss and Oe identical ?
- How to convert physical quantities ?
- $\chi_{SI}=\chi_{cgs}$ or $\chi_{SI}=4\pi\chi_{cgs}$? Or maybe $\chi_{SI}=(1/4\pi)\chi_{cgs}$?

Content

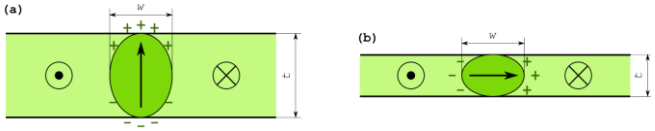
- Propose formalism for unit conversion in physics
- Derive unit conversion for magnetism

MICROMAGNETICS OF DOMAIN WALLS – OLIVIER FRUCHART

Onsite

Online

- Analytical practice
- Work small part at a time; a student volunteers to present on the blackboard
- Content and skills
  - Practice dimensional analysis and a variational model
  - Derive Bloch-wall profile and energy analytically $\theta(z) = 2\arctan\left(\exp\frac{z}{\Delta_u}\right)$
  - Discuss Bloch and Néel walls in thin films
  - Consider the Dzyaloshinskii-Moriya interaction in a domain wall



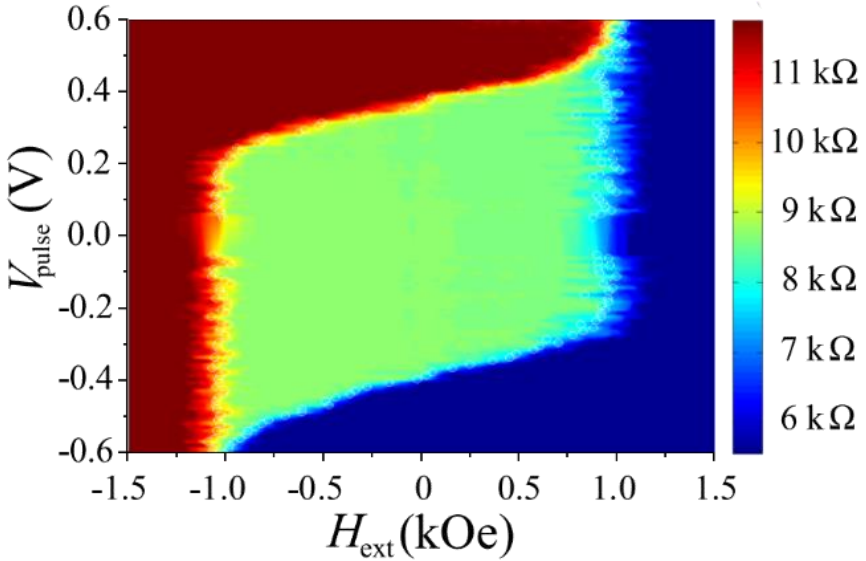
- Note: too long for 2h30. I am happy to stay in touch for those parts not covered, if of interest for you.
- Answers will be provided

FIELD-CURRENT STABILITY DIAGRAM OF MACROSPINS – OLIVIER FRUCHART

Onsite

Online

- Analytical practice
- Derive the magnetic field / applied voltage switching diagram of an macrospin with out-of-plane magnetization in a magnetic tunnel junction
- Learn how the shape of the diagram allows one to extract the strength of the anti-damping like spin-transfer torque
- Answers will be provided



NANOFABRICATION – LUCAS PEREZ

A NUMERICAL STOCHASTIC METHOD IN MAGNETISM – BERTRAND DUPÉ

- Introduction to stochastic numerical simulation
  - github.com/bertdupe/Matjes
  - General principle of Monte Carlo simulation
  - General principle of stochastiv spin dynamics
- Work with the different ensembles
  - Monte Carlo in the microcanonicle and canonicle ensemble
  - Spin dynamics in the canonicle ensemble
- Tricks and typical problems
  - Spatial correlations
  - Time correlation problems

HOW TO DELIVER A SCIENTIFIC TALK – MONTSERRAT RIVAS

Onsite

Online

- Anxious about public speaking?
- How to start?
- Tell your story
- Strike at the end!

Bring your laptop, paper and ballpen.
Onsite: 8 March
Online: 13 March