MA 1: Tutorial: Micromagnetic Simulations

Organizers: Karin Everschor, Pedram Bassirian (Johannes Gutenberg Universität Mainz)

In the field of spintronics, micromagnetic simulations are an essential tool to predict new and explain existing phenomena. Nowadays various micromagnetic simulation softwares based on different solving techniques are available and they have accelerated research in different fields of spintronics. The goal of this tutorial is to provide a broad overview of different codes available and of what they are capable of doing. In particular it should be highlighted where the different simulators are good at. With this tutorial we aim to improve the general understanding and applicability of micromagnetic simulations and encourage people to use them more frequently and accurately in their research.

Time: Sunday 16:00–18:30 Location: HSZ 401

Tutorial MA 1.1 Sun 16:00 HSZ 401

An overview of mumax3 with a spotlight on its newest features — Arne Vansteenkiste[1], •Jonathan Leliaert[1], Mykola Dvornik[2], Mathias Helsen[1], Felipe Garcia-Sanchez[3], and Bartel Van Waeyenberge[1] — [1]Ghent University, Ghent, Belgium — [2]University of Gothenburg, Gothenburg, Sweden — [3]INRIM, Turin, Italy

In this talk an overview is given of the GPU-accelerated micromagnetic software package MuMax3, developed at the DyNaMat group at Ghent University. This software solves the time- and space dependent evolution of the magnetization on the nano- to micro scale using a finite-difference discretization. Its high performance and low memory requirements allow for large-scale simulations to be performed in limited time and on inexpensive hardware. We begin with a short introduction to micromagnetism. Next, with the help of live demos, it is shown how to use this software either in its user-friendly web-interface, or via input-files for more complex simulations. Finally, we introduce three new features: first, mumax3-server allows to share simulations between different computers to efficiently execute large batches of simulations. Second, the adaptive time-step algorithm was extended to also simulate nonzero temperatures with optimal performance. Third, we present the possibility to include custom energy terms increases the users* freedom to add more *exotic* energy terms, not present in standard packages, to their simulations.

Tutorial MA 1.2 Sun 16:45 HSZ 401

Micromagnetics simulations with MicroMagnum and OMNeS — •Kai Litzius and Matthias Sitte — Institute of Physics, Johannes Gutenberg-Universität, 55128 Mainz, Germany

The open-source micromagnetics simulator package MicroMagnum is a collaborative effort of the University of Hamburg and JGU Mainz. Based on the phenomenological Landau-Lifschitz-Gilbert equation, its core is intimately connected to experiments, aiding in their interpretation and analysis. In its current version, MicroMagnum comes with a complete set of modules to describe phenomenologically magnetic systems in terms of exchange interaction, magnetocristalline anisotropies, external and magnetostatic fields, spin torques, etc. MicroMagnum has a robust and modular architecture that aims to combine the speed and flexibility of C++ together with the usability of the Python scripting language and allows to use both CPU- and GPU-based multithreaded computing, thereby gaining efficiency on regular grids compared to traditional packages such as OOMMF. It can be easily extended by the user through additional modules such as Dzyaloshinskii-Moriya interaction with arbitrary symmetries (to be released).

In the second part, we present OMNeS as a new, open source environment currently under development in the INSPIRE group at the JGU Mainz. OMNeS uses finite-element methods on unstructured grids as complementary approach to MicroMagnum, thereby allowing us to simulate large real-world devices capable of computing multiple device characteristics in a multi-scale and self-consistent manner.

15 min. break

Tutorial MA 1.3 Sun 17:45 HSZ 401

Computational micromagnetics with JOOMMF — •Hans Fangohr and Marijan Beg — University of Southampton, SO17 1BJ, Southampton, United Kingdom

Computational micromagnetic studies complement experimental and theoretical studies, and are at times the only feasible way to address research challenges, effective industrial design and engineering of various products and systems. In this talk, we will introduce computational micromagnetics by using our Python interface to drive OOMMF, which is likely the most widely used micromagnetic simulation package. A major advantage of this interface is that OOMMF simulation runs are embedded in a general purpose programming language which enables the full use of the ecosystem of scientific libraries available for Python. For example, design optimisation, specialised post-processing, and visualisation can all be carried out in a single script, which significantly contributes to the reproducibility of micromagnetic research. This project is a part of the Jupyter-OOMMF (JOOMMF) activity in the OpenDreamKit project and we acknowledge financial support from Horizon 2020 European Research Infrastructures project (676541). The work is also supported by the EPSRC CDT in Next Generation Computational Modelling EP/L015382/1, and the EPSRC grants EP/M022668/1 and EP/N032128/1.