magnum.np - A PyTorch based GPU enhanced Finite Difference Micromagnetics

Florian Brucker[1], Claas Abert[1], Sabri Koraltan[1], Dieter Suess[1]

[1] *Faculty of Physics, University of Vienna, Austria*

magnum.np is a micromagnetic finite-difference library based on PyTorch, which makes it easy to maintain and extend. It is perfectly suited for the investigation of novel algorithms and modeling approaches.

On the other hand, magnum.np benefits from the devices abstraction and optimizations of PyTorch enabling the efficient execution of micromagnetic simulations on a number of computational platforms including GPU and potentially TPU systems. We demonstrate a competitive performance to state-of-the art micromagnetic codes such as *mumax3* and show how our code enables the rapid implementation of new functionalities. Furthermore, handling inverse problems becomes possible by using PyTorch's autograd feature.

Figure 1 shows visualizes the high-level structure of the code and presents some detailed timings of the Exchange Field calculation. High-level optimizations like Just-In-Time compilation via e.g. *torch.compile* allow competitive performance without changing the simplicity of the code.

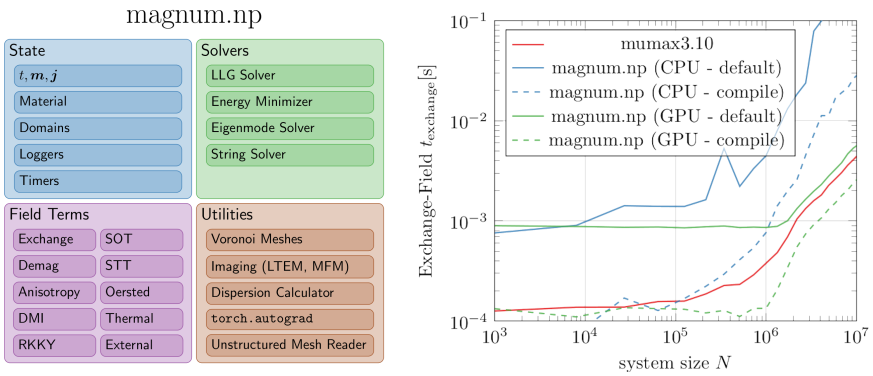

Figure 1: (left) Overview of the high-level interface of magnum.np. (right) Timings of the Exchange Field evaluation for different system sizes.

Magnum.np is open-source under the GPL3 licence and can be found at `https://gitlab.com/magnum.np/magnum.np`. Different demo scripts are part of the source code and can be tested online using Google Colab, without the need for local installations or specialized hardware like GPUs. A list of demos can be found on the project gitlab page `https://gitlab.com/magnum.np/magnum.np#documented-demos`

References

[1] F. Bruckner, S. Koraltan, C. Abert, and D. Suess: *magnum.np – A PyTorch based GPU enhanced Finite Difference Micromagnetic Simulation Framework for High Level Development and Inverse Design*, arXiv preprint arXiv:2302.08843, 2023.