WWTF Project MA14-044

Thermally controlled magnetization dynamics

Abstract

Magnetic data storage will undergo a significant growth during the next decade driven mainly by the increase in mobile devices which store their data in the cloud. Future hard disks will use localized heating to provide additional energy to write onto tiny, hard magnetic grains. The successful development of this technology requires a significant modeling and simulation effort. Simulation of heat assisted magnetic recording faces three major challenges:
(1) The material undergoes a phase transition which is reflected in the change of the nature of the underlying partial differential equation (PDE).
(2) Trusted physical models for magnetization dynamics at high temperatures are only available at the atomistic level.
(3) The local heat spot creates random fluctuations of the magnetization. This results in a stochastic PDE with coefficients that rapidly very in time and space.

In order to address these issues, the project brings together an interdisciplinary team of mathematicians, physicists, and software engineers. We aim to develop mathematically reliable, numerically stable, and computationally effective methods for the simulation of thermally driven magnetization dynamics. In particular, we provide a coarse graining technique in order to derive the coefficients of the PDE. We implement the developed and analyzed finite element integrator to simulate heat assisted recording on massively parallel hardware. Model and software will be tested against and validated with experimental data provided by a major hard drive manufacturer (Seagate Technologies).

Scientific disciplines:
101014 - Numerical mathematics (40%) | 103009 - Solid state physics (30%) | 102009 - Computer simulation (30%)

Keywords:
micromagnetics, Landau-Lifshitz-Gilbert equation, magnetization dynamics, heat assisted magnetic recording, phase transitions

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Status: Completed (01.01.2015 - 30.09.2018) 45 months

Funding volume: EUR 585,000

Further links about the involved persons and regarding the project you can find at
https://archiv.wwtf.at/programmes/mathematics/MA14-044