The European School on Magnetism 2017 – Christian Back
Universität Regensburg

Content of the lectures(2 x 1,5 h)

Lecture 1: "Magnetization reversal processes in bulk materials and thin films."

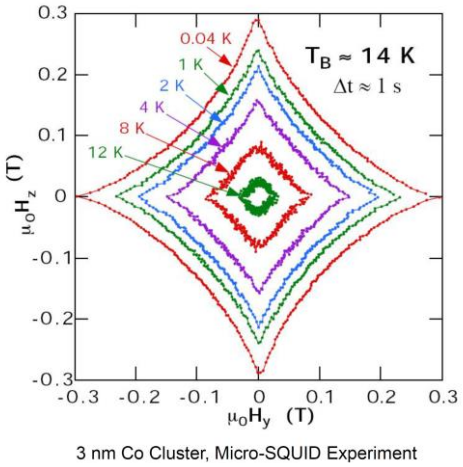
Lecture 2: "Control of the magnetization by magnetic fields, spin polarized currents, electric fields and photons"

Contents:

- Simple magnetization reversal processes (Stoner-Wohlfarth-model, buckling, curling) and hysteresis
- Effects of thermal agitation
- Magnetization reversal by domain wall motion
- Precessional magnetization reversal
- Magnetization reversal by spin polarized currents
- Electric field induced magnetization reversal
- Light induced magnetization reversal

In these lectures I will first concentrate on simple magnetization reversal models. I will begin with the Stoner-Wohlfarth-model which describes magnetization reversal for microscopic particles that act as one large macrospin. This simple model can be used to explain the origin of hysteresis loops. For larger particles or influence of temperature this model breaks down and more complicated models have to be adopted. Finally for bulk samples and extended magnetic films magnetization reversal is driven by nucleation and propagation of magnetic domains.

Stoner-Wohlfarth-like behavior can be recovered when using ultra short magnetic field pulses to reverse the magnetization in a precessional manner.



3 nm Co Cluster, Micro-SQUID Experiment

Magnetization measured in a Co nanoparticle that acts as a perfect Stoner-Wohlfarth particle at low temperatures. Shown here is the so-called Stoner-Wohlfarth switching asteroid. At higher temperatures thermal excitations compromise this behavior.

M.Jamet et al., Phys. Rev. Lett. **86,** 4676 (2001)

For small magnetic elements (in particular magnetic nanopillars) magnetization reversal driven by spin polarized currents becomes more

efficient than magnetic field driven reversal. I will shortly give examples for this phenomenon.

In ultra magnetic thin films sandwiched between dielectrics an applied voltage can lead modification of the magnetic energy landscape and ultimately magnetization reversal which I we shortly address.

Finally, also intense laser pulses can lead to magnetization reversal, a process that is not fully understood, yet.

Literature:

Stephen Blundell, „Magnetism in Condensed Matter“, Oxford University Press
J.M.D. Coey, „Magnetism and Magnetic Materials“, Cambridge