Purpose of the visit

The focus of the visit of the Theoretical Physcis Department at Loughborough University was to write a draft of a paper together with Prof. F.V. Kusmartsev which is intended to be submitted to Phys.Rev.B.

A basic first version of the publication with the title

Spin Flop Transitions Associated With Magnetic Structures and Quantum Cellular Automata

has been written.

Short description about the project work

Our model system can be envisioned as a one-dimensional chain of N magnetic particles or thin magnetic layers with nearest-neighbour interactions in terms of antiferromagentic couplings, subjected to an external multi-well potential playing the role of the anisotropy. The total energy of such a spin chain is given by the N-particle Hamiltonian

$$\mathbf{E} = \sum_{i=1}^{N} \left(-J \cos(x_i - x_{i-1}) - H \cos(x_i - \beta) + \frac{K}{2} \sin^2(x_i) \right)$$

We show that in our model system, depending on the number of magnetic particles or layers, a series of spin flop transitions arises. Each of these transitions may be detected in experiments by a Barkhausen jump appearing in the corresponding hysteresis loop.

In fact, these transitions - a simple consequence of the non-trivial multistability character of the system - can lead to the formation of a variety of different of hysteresis loops and magnetoresistance curves. We present exact analytical and numerical results describing the energy spectrum and the magnetisation.

These results may also be applicable to the design of magnetic random access memory (MRAM) elements composed of a few antiferromagnetically coupled layers.

Figure 1 as well as Figure 2 show the appearance of of these discontinuities in the hysteresis curve as well in the energy spectrum for a chain consisting of 13 particles.

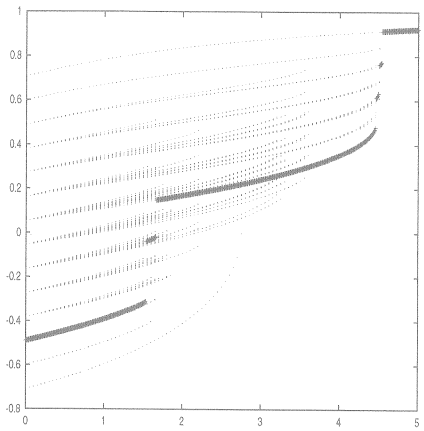

Figure 1. All possible magnetization values as a function of the external field H

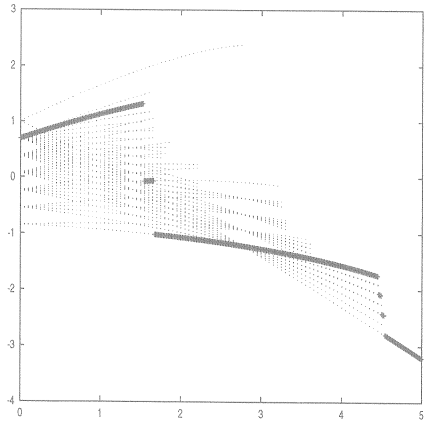

Figure 2. Corresponding full energy spectrum as a function of the magnetic field H

In both figures the full lines show a specific example for the realisation of an experiment, when an increasing external field starting at $H = 0$ is applied.

Future collaboration with the host institution

The long lasting collaboration Vienna-Loughborough with Prof. Kusmartsev will be continued in the future. We plan one more publication in the field of arrays of small magnetic particles and their applications in the near future.