

Multiscale magnetic models of ultrafast magnetic processes.

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Magnetic materials make a vital contribution to a number of technologies, including of course magnetic recording. Increasingly, materials are structured on the nanoscale in order to produce the desired properties for specific applications. In addition, future applications may require heating of the material up to and beyond the Curie temperature characteristic of the magnetic phase transition. The important consequence is that the usual formalism, termed 'micromagnetics', cannot be used to investigate such complex phenomena. I will describe the development of new approaches linking electronic structure calculations and atomistic spin models of magnetic materials and outline applications to the fundamental understanding of ultrafast magnetisation reversal. In particular I will show that magnetisation reversal in a timescale of 300 femtoseconds is possible, and will describe the implications for heat assisted magnetic recording. Finally, I will outline recent developments which allow the bridging of the atomistic and mesoscopic lengthscales, allowing the models to be applied to the understanding of macroscopic experiments and ultimately to device design. This model will be applied to the investigation of heat assisted magnetic reversal and also opto-magnetic reversal, in which magnetisation reversal occurs in response to a pulse of circularly polarised laser light. It is shown (in agreement with experiment) that switching times on the sub-picosecond timescale are possible, with important implications for magnetic recording and spin-electronic devices.