Mesoscale Priority Research Direction

(Meso Magnets- Understanding the quantum to classical transition)

Opportunity

Understanding of magnetism in bulk and at the nano scale is quite advanced. However the transition from quantum magnetism (such as obtained from the Heisenberg model for instance) to classical magnetism (such as obtained from micromagnetism) is lacking.

Approach

Quantum calculations to understand limitations of classical micromagnetics. Structural and magnetic studies of individual mesomagnets. Key steps are needed to understand how the classical regime evolves from the quantum one. Understanding magnetism at various length scales by studying coupling and consolidation of nanomagnets; experimentally and theoretically

Meso Challenge

Meso magnetism becomes important when length scales are comparable to domain wall widths (typically a few 10s of nm). Consolidation of MesoMagnets into bulk opens up new science and applications. Understanding the role of disorder poses a major challenge.

References: H. Zeng et al, Nature 420, 395(2002), O. Gutfleisch, J. Appl Phys.D: Appl.Phys. 33, R157(2000), G. Hadjipanayis, IEEE Spectrum August 2011, I. Roshchin et al, EPL 86, 67008(2009)

Impact

- Understand which quantum properties survive into the classical regime, across multiple length scales.
- Great impact into the development of low and high energy product magnets useful in the energy storage, transformation and production.
- Considerable savings of natural or strategic resources such as rare earth materials

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