

Colloquium
Dahlem Center for Complex Quantum Systems

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Magnetic monopoles in spin ice

Location: Hörsaal A (1.3.14)

Time: Tuesday, May 17, 2011, **16:00 c.t.**

Abstract:

Fractionalisation is a striking emergent phenomenon, in which an 'elementary' particle breaks up into two independent entities. A celebrated example of this is spin-charge separation, in which an electron's magnetic (spin) and electric (charge) properties appear to become independent degrees of freedom. The spin ice materials -- Dy₂Ti₂O₇ and Ho₂Ti₂O₇ -- provide a rare instance of fractionalisation in three dimensions: their atomic magnetic dipole moments fractionalise, resulting in elementary excitations which can be thought of as magnetic monopoles [1].

This colloquium presents a self-contained introduction to theoretical concepts and experimental phenomena in the physics of spin ice. It focuses on the unique signatures of the peculiar nature of its ground state and its excitations. These include unusual neutron scattering structure factors [2-4], rich non-equilibrium physics [5], as well as a response to external magnetic fields that promotes spin ice as a magnetic Coulomb liquid [1], a magnetic analogue of an electrolyte [6]. Finally, this talk addresses open questions and future perspectives for detecting individual monopoles, among them a (thought-)experiment inspired by high energy physics.

[1] C. Castelnovo, R. Moessner, and S. L. Sondhi, *Nature* 451, 42 (2008).

[2] H. Kadowaki, N. Doi, Y. Aoki, Y. Tabata, T. J. Sato, J. W. Lynn, K. Matsuhira, and Z. Hiroi, *J. Phys. Soc. Jpn.* 78, 103706-1 (2009).

[3] T. Fennell, P. P. Deen, A. R. Wildes, K. Schmalzl, D. Prabhakaran, A. T. Boothroyd, R. J. Aldus, D. F. McMorrow, and S. T. Bramwell, *Science* 326, 415 (2009).

[4] D. J. P. Morris, D. A. Tennant, S. A. Grigera, B. Klemke, C. Castelnovo, R.

Moessner, C. Czternasty, M. Meissner, K. C. Rule, J.-U. Hoffmann, K. Kiefer, S. Gerischer, D. Slobinsky, and R. S. Perry, *Science* 326, 411 (2009).
[5] C. Castelnovo, R. Moessner, and S. L. Sondhi, *Phys. Rev. Lett.* 104, 107201 (2009). D. Slobinsky, C. Castelnovo, R. A. Borzi, A. S. Gibbs, A. P. Mackenzie, R. Moessner, S. A. Grigera, *Phys. Rev. Lett.* (105) 267205, 2010.