Colloquium on Solid-State Physics

Date: Thursday, Nov. 15, 2012

Time: 17.15 h
Coffee, tea and cookies at 17.00h in front of the lecture hall

Place: Hörsaal HS 3
Physik - Department
Technische Universität München

Seminar of the Collaborative Research Centre/Transregio TRR 80:

Dipolar interaction in spin systems: emergent monopoles, avalanches and quantum phase transitions

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The continuous quest for increased storage density forces us to store information in ever smaller magnetic bit volumes. Ideally, such elements should be magnetically decoupled, however, even ideally separated elements as in bit patterned media or even isolated spins are subject to dipolar interactions. Our understanding of dipolar interactions has significantly increased during the past few years and several striking phenomena have been discovered both at a classical and a quantum scale: In spin ice, classical low energy excitations have been proposed that act as emergent magnetic monopoles which interact via Coulomb interaction. While direct space observations of emergent monopoles in 3D spin ice compounds have not been possible so far, artificial arrays of nanomagnets offer the possibility of real space observations via microscopy techniques. We discuss such observations and how magnetization reversal in such an artificial spin ice system proceeds via nucleation and avalanche-type dissociation of emergent monopole-antimonopole pairs along 1D Dirac-string like objects. This avalanche behaviour, confirmed via Monte Carlo simulations, is in stark contrast to conventional domain growth and provides a striking example of dimensional reduction due to frustration. The quantum nature of the dipolar interaction becomes manifest for certain rare earth trihalides. It is shown how an applied field triggers a series of quantum phase transitions in which the Berry phase plays a pivotal role. This behaviour is in accordance with neutron scattering experiments and it is shown that these systems are described by a quantum spin version of the Bose Hubbard model.