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ARC CENTRE OF EXCELLENCE IN FUTURE LOW-ENERGY ELECTRONICS TECHNOLOGIES

FLEET SEMINAR

High-field magnetic resonance spectroscopies on spin-correlated quantum matter

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Abstract: Magnetic transition metal ions located at the regular sites of a crystalline solid or in the core of metal-organic molecules may build up strongly correlated spin networks of different spatial dimensionality. Depending on the specifics of the chemical bonding and certain geometrical constraints, zero-dimensional (OD) spin clusters, 1D spin chains and ladders, 2D spin planes, or even more complex 3D spin structures can be realized in a number of materials.

An interplay between spin, orbital, charge and lattice degrees of freedom in these strongly correlated quantum magnets yields such spectacular phenomena as high temperature superconductivity, colossal magnetoresistance, multiferroic order, metal-insulator and quantum phase transitions, quantum spin liquid states, magnetic memory effects and spin coherence in supramolecular metal-organic clusters, potentially interesting for quantum computation, and others. For all these reasons the field of quantum magnetism in condensed matter physics is continuously expanding and currently attracts a lot of interdisciplinary interest.

High magnetic field electron spin resonance (ESR) and nuclear magnetic resonance (NMR) spectroscopies have emerged as instructive tools to investigate the low-energy spin dynamics, energy spectrum of the spin states and the spin structure of the ordered phases in a broad class of strongly correlated spin systems, which is of paramount importance for the comprehensive understanding of the above mentioned phenomena. In this talk, this will be illustrated by three examples of research recently conducted at the IFW Dresden on the 0D-heteronuclear Mn-Ni metal-organic complexes showing the so-called single molecular magnet behaviour, on quasi-1D spin chain compound $LiCuSbO_4$ where a combined ESR/NMR study has revealed an exotic spin-nematic liquid state, and on quasi-2D van der Waals crystals of α-$RuCl_3$ where signatures of unconventional fractionalization of magnetic excitations into the elusive Majorana fermions have been obtained.

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