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Geometric Magnetic Frustration in Correlated Metallic Systems

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Systems based on lattices of triangular or tetrahedral units with nearest neighbour antiferromagnetic exchange interactions are the archetypal examples of geometric magnetic frustration, offering a means of accessing novel ground states. Rich phenomenology has similarly been observed in extensive investigations of Ce (4f1) and Yb (4f13) based intermetallic compounds, including heavy fermion behaviour, unconventional superconductivity, or non-Fermi liquid responses in the proximity of a quantum critical point. The ground states of these systems are considered to be mainly governed by the competition between the Kondo and the Ruderman - Kittel - Kasuya - Yosida (RKKY) exchange interaction, both mediated by the conduction electrons. Combining these two arenas, whereas earlier investigations concentrated on insulators, there are an increasing number of studies of frustrated magnetism in metallic systems.

For example, CeCd3As3 is one member of a family of rare earth ternary compounds which crystallise into a hexagonal ScAl3C3-type structure, where the magnetic Ce-ions form a quasi two dimensional anisotropic triangular lattice. Such model systems have been proposed as candidates for quantum spin liquid behaviour [1]. I report a specific heat and muon spin relaxation investigation of the low temperature ordered phase and associated spin fluctuations of this material.

Magnetic systems based on 5d transition metal ions on the pyrochlore lattice are another example, offering a unique opportunity to explore the exotic ground states which potentially arise when the electron-electron Coulomb interaction, electronic bandwidth and spin orbit coupling are all of comparable magnitude. I will compare magnetisation and muon spin relaxation investigations in a series of 4d Mo4+ and Ru4+, as well as 5d Ir4+ based pyrochlores, which may be controllably tuned through a metal insulator transition, providing insight into the magnetic excitations as these finely balanced systems evolve from a localised to itinerant spin character.

[1] P. Fazekas and P. Anderson, Philos. Mag. 30, 423 (1974)

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