Spin Liquids and Quantum Criticality In Itinerant Magnets

Prof. Dr. Satoru Nakatsuji
Institute for Solid State Physics
University of Tokyo

A number of nontrivial phenomena have been found in 4*f* electron based itinerant magnets, such as heavy fermion, Kondo insulator, unconventional superconductivity, and quantum criticality. Spin liquid is another emergent quantum state, which has recently attracted much attention. In this talk, we discuss such examples, showing our results on the two Kondo lattice compounds, $Pr_2Ir_2O_7$ and $YbAlB_4$.

First topic is the frustrated magnetism and novel Hall transport found in the metallic pyrochlore magnet $Pr_2Ir_2O_7$ [1,2,3]. Strikingly, a spontaneous Hall effect is observed in the absence of both an external magnetic field and conventional magnetic long-range order [3,4]. This strongly suggests the existence of a chiral spin liquid, a spin-liquid phase breaking the time-reversal symmetry. Our measurements indicate that spin-ice correlations in the liquid phase lead to a non-coplanar spin texture forming a uniform but hidden order parameter: the spin chirality.

Secondly, β-$YbAlB_4$ will be presented as a unique example of an ultrapure heavy fermion material that exhibits quantum criticality without tuning [5,6,7,8]. It is superconducting below 80 mK, but above the transition temperature, it shows local-moment behavior over a wide range of temperature despite its strongly mixed valency [8,9]. This suggests that a spin liquid phase is stabilized on the distorted hexagon lattice of Yb's 4*f* moments, which leads to prominent non-Fermi liquid phenomena.

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