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Anomalous electrical transport in frustrated intermetallic $RCuAs_2$: the role of spin

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The Kondo effect was a longstanding theoretical puzzle, describing the scattering of conduction electrons in a metal due to dilute, localised d- or f -electron magnetic impurities and resulting in a characteristic minimum in electrical resistivity with temperature. Extended to a lattice of magnetic impurities, the Kondo effect likely explains the formation of so called heavy Fermion systems and Kondo insulators in intermetallic compounds, especially those involving rare earth elements like Ce, Pr and Yb. The hybrisation of the 4f electron states with the conduction band and resultant screening of local moments, required for Fermi liquid behavior in the Kondo lattice, competes with interactions between localised moments. The diversity in the low temperature properties of heavy Fermion metals, as well as their highly tunable nature (with magnetic field, pressure, chemical substitution), make these systems invaluable in the investigation of the emergent properties of highly correlated quantum materials.

Counterintuitively, in a class of ternary intermetallic compounds of the type $RCuAs_2$ (R = rare earth) [1], the rare earths like Sm, Gd, Tb, and Dy with strictly localised 4f character, where the Kondo effect is not anticipated, also exhibit a pronounced minimum in resistivity well above their respective magnetic ordering temperatures. Even more surprisingly, no such minimum is observed for Pr, Nd, and even Yb based members of this series. Recent theoretical predictions suggest geometric magnetic frustration plays a role [2]. More generally, frustration is thought to be an important additional tuning parameter in the Kondo lattice model. A muon spin relaxation investigation of these materials is discussed, shedding light on the role of magnetic fluctuations in determining the electronic transport in heavy Fermion materials.

[1] E.V. Sampathkumaran et al, Physical Review Letters 91, 036603 (2003);
[2] Zhentao Wang et al, Physical Review Letters 117, 206601 (2016)

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