Magnetic properties of RFe$_2$Zn$_{20}$ (R = Y, Gd - Lu): 4f moments embedded in strongly correlated electron host

SHUANG JIA, NI NI, A. SAFA-SEFAT, S.L. BUD’KO, P.C. CANFIELD, Ames Laboratory, USDOE and Department of Physics and Astronomy, Iowa State University, HYUNJIN KO, Ames Laboratory, USDOE and Department of Chemistry, Iowa State University — The RFe$_2$Zn$_{20}$ series of compounds manifest varied magnetic properties, from near ferromagnetism (R = Y, Lu), to enhanced ferromagnetic (FM) ordering of local moments (R = Gd to Tm), to heavy Fermi ground state (R = Yb). Thermodynamic and transport measurement results reveal that these varied magnetic states can be understood in the framework of 4f moments embedded in a nearly ferromagnetic Fermi liquid. In such a highly polarizable electronic host, the different type of 4f moments, null moments for Y$^{3+}$ and Lu$^{3+}$, pure spin-contributed Gd$^{3+}$, spin-orbital-coupling contributed Tb$^{3+}$ to Tm$^{3+}$, and the hybridized Yb ions, correlated with the itinerant electrons, lead to this magnetic versatility. For local moment members (R = Gd to Tm), the Curie temperatures roughly scale with the de Gennes parameter, indicating negligible crystal electric field (CEF) effect on the magnetic ordering, although the CEF on the 4f local moments leads to anisotropic FM ground state for R = Tb to Tm. For hybridized moment member (R = Yb), the Kondo temperature seems to be enhanced, associated with the electronic host.