Magnetic phase diagram of (Sr$_{1-x}$Ca$_x$)$_3$Ru$_2$O$_7$ (0≤x≤1.0) Z.Q. MAO, Tulane University (TU), Z. QU, TU, L. SPINU, University of New Orleans, J. PENG, T.J. LIU, D. FOBES, TU, V. DOBROSAVLJEVIC, NHMFL and Florida State University, H.Q. YUAN, W. BAO, Los Alamos National Laboratory, J.W. LYNN, National Institute of Standards and Technology — The layered ruthenates (Sr,Ca)$_{n+1}$Ru$_n$O$_{3n+1}$ have received widespread attention in recent years since they display a remarkable range of unique superconducting and magnetic properties, such as spin triplet superconductivity and metamagnetic quantum criticality. We have recently studied properties of the double layered (Sr$_{1-x}$Ca$_x$)$_3$Ru$_2$O$_7$ solid solution series and established the magnetic phase diagram of this system using the high-quality single crystals grown by floating-zone method. We have observed rich magnetic ground states in this system: (I) Itinerant metamagnetic state ($0.08 > x \geq 0$); (II) enhanced PM state accompanied by non-Fermi liquid behaviors near $x \sim 0.08$; (III) ferromagnetic cluster glass (CG) phase featuring an extremely large Wilson ratio ($\sim$120) and enhanced electron correlation ($0.40 > x > 0.08$); (IV) long-range AFM state ($1 \geq x \geq 0.40$). Furthermore, we found a new phase which shows an unconventional anomalous Hall effect in a low temperature range immediately above the CG phase. The magnetization of this phase is found to follow a new scaling expression derived by phenomenologically extending the quantum Griffiths phase model.

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