**long range magnetic order in spin-orbit coupled double perovskites Ba$_2$YRuO$_6$ and Ba$_2$CaOsO$_6$ probed with neutron scattering and muon spin relaxation**

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**Abstract**

Frustration manifests in the double perovskite lattice A$_2$BB'O$_6$ (Fig. 1), in which the antiferromagnetically correlated B ions reside at tetrahedrally edge-sharing tetrahedra. Perovskites may be synthesized with most elements from the periodic table, enabling systematic studies of frustration as a function of structural distortion, lattice parameter, ionic contrast to theoretical predictions, despite a lack of evidence for 36K; such a gap is unexpected for an elements from the periodic table, enabling systematic studies of susceptibility, heat capacity and $\lambda$ scaling of the gap with respect to TN and/or the spin-orbit coupling constant $\lambda$. The latter (4 systems) exhibits antiferromagnetism and antiferromagnetism, two- and four- systems, but progressively stronger in 4 systems, but progressively stronger in 4 systems. (i) the gapped state below 36K, and (ii) the systems. The precession/relaxation rates in Ba$_2$CaOsO$_6$ can be compared with the known 2.2 $\mu$B moment in Ba$_2$YRuO$_6$ to derive an estimated ordered moment of 0.2 $\mu$B. This is very difficult to detect in a neutron scattering experiment, but easily accessible to Ba$_2$YRuO$_6$. Chen et al. propose a phase diagram for $d$ systems with sizable SOC, suggesting several candidate AF ordered states for both Ba$_2$YReO$_6$ and Ba$_2$CaOsO$_6$. Ba$_2$CaOsO$_6$ appears to be consistent with this proposal, allowing for the determination of the spin polarized state using $\mu$SR. However, the lack of LRO in Ba$_2$YReO$_6$ despite evidence for structural disorder remains mysterious. Double perovskites, which can be made from elements in the periodic table due to the chemical versatility of the perovskite structure, are a valuable platform for systematic studies of frustration physics.

**References**


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