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Spin-orbit coupling, magnetic anisotropy and hard magnetism in Sr_3NiIrO_6

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Strong spin-orbit coupling is a pre-requisite for hard magnetism with high coercive magnetic fields. Magnetic oxides containing 5d ions such as Ir^{4+} should show significant spin-orbit coupling due to the high Z value. Furthermore, in 5d ions, the comparable energy scales of crystal-electric field splitting, Coulomb repulsion and spin-orbit interactions create unusual electronic ground states that can entangle spins and orbits, mix t_{2g} and e_g levels and drive magnetic exchange anisotropy. Another set of interesting electronic ground states can arise when 5d orbitals overlap 3d orbitals. In the compound Sr_3NiIrO_6, electronic structure calculations predict that the 3d orbitals of the Ni^{2+} ion directly overlap 5d orbitals of the Ir^{4+} ion. In addition to a "Jeff = 1/2" Ir^{4+} ground state that mixes t_{2g} and e_g levels, the Ni^{2+} should show strong single-ion anisotropy [1-3]. We present magnetization measurements of Sr_3NiIrO_6 to high magnetic fields. [4] We demonstrate magnetic hysteresis with a record 55 Tesla coercive magnetic field and long stability over time in some crystals. More generally, the $A_3BB'O_6$ family of compounds shows hard magnetism as B' ion goes from 3d to 4d to 5d. Further complexities to do with evolving magnetic order and magnetic frustration also present in this family.

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