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Exotic magnetism on the quasi-FCC lattices of the d^3 double perovskites $La_2NaB'O_6$ (B' = Ru, Os)

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B-site ordered double perovskites with quantum spins S = 1/2 (d^1) and S = 1 (d^2) on the B' site have attracted a great deal of recent interest, due to the possibility of studying 4d and 5d magnetism combined with magnetic frustration on the face-centered-cubic (FCC) lattice. There has been less focus on d^3 systems, as they are generally expected to behave more classically and yield simple, commensurate magnetic ground states. In contrast, we find evidence for long-range and short-range (ξ = 70 Å at 4 K) incommensurate magnetic order on the quasi-FCC lattices of the monoclinic double perovskites La_2NaRuO_6 and La_2NaOsO_6 respectively. Incommensurate magnetic order on the FCC lattice has not been predicted by mean field theory, but may arise via a delicate balance of inequivalent nearest neighbor and next nearest neighbor exchange interactions. Furthermore, in the Ru system with long-range order, inelastic neutron scattering reveals a spin gap Δ = 2.75 meV. Magnetic anisotropy is generally minimized in the more familiar octahedrally-coordinated $3d^3$ systems, so the large gap observed for La_2NaRuO_6 may result from the significantly enhanced value of spin-orbit coupling in this $4d^3$ material.