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Crystal/magnetic structures, spin correlations and dynamics in Sr_2YRuO_6 double perovskite

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The large number of competing ground states in geometrically frustrated magnets tends to destabilize the magnetic ordering and may lead to remarkable correlated states at sufficiently low temperatures. An interesting and classical example of a frustrated magnetic geometry is the face-centered cubic (FCC) lattice with dominant nearest-neighbor antiferromagnetic (AFM) interaction. This lattice, found in many double-perovskite and spinel compounds, shows a dense population of spin tetrahedra, with triangular faces where the spin interactions cannot be simultaneously satisfied. Here we present a detailed neutron scattering study of spin correlation and dynamics of the monoclinic double perovskite Sr2YRuO6, which shows a quasi-FCC lattice of Ru5+ spins. We observed two-dimensional magnetic correlations below ~ 200 K that condense into a partial long-range ordered state with coupled alternate antiferromagnetic (AFM) YRuO4 square layers coexisting with the short-range correlations at TN1 ~ 32 K. A second transition to a fully ordered AFM state below TN2 ~ 24 K is observed, with the spins directed along the monoclinic unique axis b. Inelastic neutron scattering data taken on this state reveal a gapped low-energy excitation band emerging from [001] with spin-excitations extending to 8 meV. These magnetic excitations are modeled by a simple J1 − J2 interaction scheme allowing quantitative comparison with similar materials. At higher temperatures, the low-energy excitation spectrum is dominated by a quasielastic component associated with size fluctuations of two-dimensional AFM clusters that exhibit asymmetric correlations even at low temperatures. Thus, the FCC lattice in general and the double perovskite structure in particular emerge as hosts of both two-dimensional and three-dimensional dynamics resulting from frustration [1,2].

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