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Direct Observation of SU(N) Orbital Magnetism SARAH BROMLEY, XIBO ZHANG, MICHAEL BISHOF, JILA, NIST and University of Colorado, Boulder, CHRISTINA KRAUS, IQOQI of the Austrian Academy of Sciences, Innsbruck, Austria, MARIANNA SAFRONOVA, JQI, NIST and the University of Maryland, PETER ZOLLER, IQOQI of the Austrian Academy of Sciences, Innsbruck, Austria, ANA MARIA REY, JUN YE, JILA, NIST and University of Colorado, Boulder — SU(N) symmetry in matter is predicted to give rise to exotic topological states of matter. In atomic systems such symmetry can occur when the nuclear spin plays no role in the inter-atomic interactions. Ultracold alkaline earth fermionic atoms are expected to obey such symmetry, with the nuclear spin nearly completely decoupled from the electronic angular momentum in the long-lived states. Hence the nuclear spin matters only in quantum statistics, but not in the electronic interaction strength. However, only indirect evidence has been found until recently. Here we use ^{87}Sr and directly show the SU(10) symmetry associated with the 10 nuclear spin states. We directly probe the interactions using Ramsey spectroscopy under different magnetic fields and temperatures. We measure the density-dependent frequency shifts and the evolution of atomic coherence under different population distributions of nuclear spin levels. Our measurements fully determine all eight interaction parameters associated with the nuclear spin symmetry/antisymmetry and the spatial and electronic degrees of freedom. These parameters are determined using a many-body spin model for the spin-orbital dynamics and an analytic relation between the s-wave and p-wave scattering lengths.

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