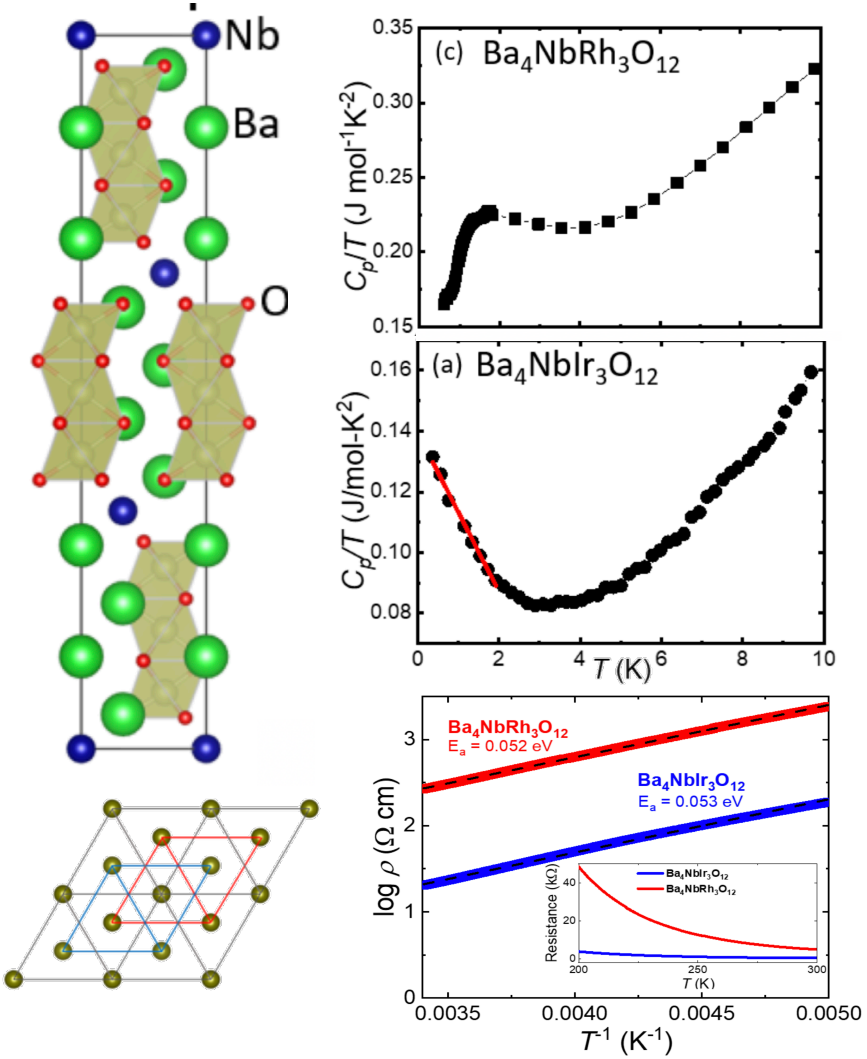
New trimer-based spin liquid candidates

Institute for Quantum Matter EFRC DE-SC0019331



Scientific Achievement

A previously unreported family of materials has been discovered with unconventional magnetic properties that are consistent the realization of the quantum spin liquid. The materials consist of triangular lattices of magnetic trimer molecules of the form Rh_3O_{12} and Ir_3O_{12} with 4d and 5d electron based magnetism.

Significance and Impact

Interacting magnetic moments in solids generally develop symmetry breaking static magnetic structures when cooled. However, theoretical work shows a quantum fluctuating state of matter called a quantum spin liquid is possible. While further experiments are needed, $Ba_4NbIr_3O_{12}$ shows physical properties that are consistent with this new state of matter.

Research Details

High T susceptibility data show $Ba_4NbIr_3O_{12}$ and $Ba_4NbRh_3O_{12}$ contain interacting magnetic moments associated with trimers. However, no indications of magnetic ordering is found in $Ba_4NbIr_3O_{12}$. Instead the specific heat has sub-linear T-dependence at low T, which is indicative of a large low energy density of states much as a heavy fermi liquid. Since the material is an electrical insulator we must look to anomalous quantum magnetism to account for this. The small activation gap of just 0.052 eV may play an important role in stabilizing a liquid like magnetic state of matter despite charge localization.

Nguyen, L. T., Cava, R. J., Phys. Rev. Materials, **3** (1), 014412, (2019).

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