

Stoichiometry-Driven Magnetic Frustration in Triangular Lattice Complexes

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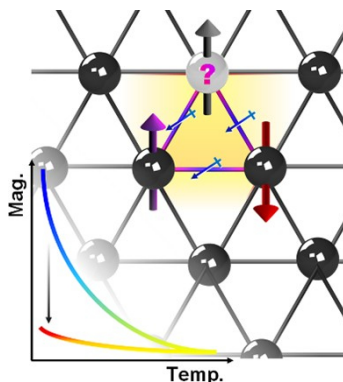
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Frustrated magnetic states rely on topological frustration. Here, we combine topological and Coulombic shielding to ensure magnetic spins remain uncoupled through stoichiometry-directed self assembly. Precise tuning of reactant ratios and solvent environment governs the crystallization of Eu-based formate systems, yielding triangular lattices with distinct metal vertex motifs: mono-nuclear $[\text{Eu}(\text{O}_2\text{CH})_3]_n$ (1) and di-nuclear $[\text{Eu}(\mu\text{-OCHO})(\text{OH})(\text{O}_2\text{CH})_2]_2$ (2). In both systems, assembly results in dipolar ordering of formate ligands, adopting head-to-tail or pairwise antiparallel configurations depending on stoichiometry. These arrangements define lattice organization and local electrostatic environment. In (1), cooperative dipole alignment enhances Coulombic shielding at the metal centers, suppressing magnetic coupling and yielding a non-magnetizable Eu^{2+} state. In contrast, antiparallel dipole pairing in (2) produces a net-zero dipolar field, enabling paramagnetic behavior. We validate this electrostatic control using homologous Gd and Sm analogues. This establishes a tunable route via directed self assembly to programmable spin isolation with potential application in quantum information processing.

Keywords:

Self assembly, Lanthanide-Based Triangular Lattice Frameworks, Qudits, Spin Frustration, Quantum Spin Liquids (QSL)



Frustrated magnetic states. Schematic of triangular lattice in spin liquids with unpaired dipoles leads to frustrated magnetization.