

# Field-Controlled Entanglement and Quantum Metrology in a Trinuclear Spin-5/2 Iron(III) Magnet

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Molecular magnets [1] exhibiting nonlocal correlations represent promising candidates for quantum information technologies, including entanglement, teleportation, and quantum computing [2]. Among them, trinuclear systems are particularly attractive for investigating controllable quantum correlations in finite spin architectures. In this contribution, we investigate the magnetic-field-dependent quantum properties of the high-spin iron(III) complex  $[\text{Fe}_3\text{Cl}_3(\text{saltagBr})(\text{py})_6]\text{ClO}_4$  [3] abbreviated as  $\text{Fe}_3$ , modeled as a spin-5/2 Heisenberg triangle (Figure 1). By means of exact diagonalization, we analyze the interplay between magnetic behavior and quantum correlations under external magnetic fields. We demonstrate that weak magnetic fields significantly enhance both pairwise and genuine tripartite entanglement at low temperatures. The entanglement exhibits nontrivial step-like features correlated with magnetization plateaus (Figure 2), revealing a strong link between level crossings and quantum correlations. Remarkably, bipartite and tripartite entanglement persist up to temperatures of approximately 30 K and 70 K, respectively, indicating notable thermal robustness. Beyond correlation analysis, we explore the metrological potential of the  $\text{Fe}_3$  complex. Preparation in Dicke states enables quantum-enhanced sensitivity, and a local-field sensing protocol based on selective perturbation of a single iron(III) ion followed by sequential readout [4] demonstrates the feasibility of

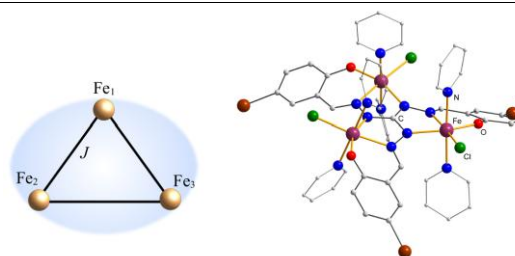
implementing quantum sensing within this molecular platform. These results highlight the potential of trinuclear iron(III) molecular magnets as compact quantum devices for controlled entanglement and quantum metrology applications.

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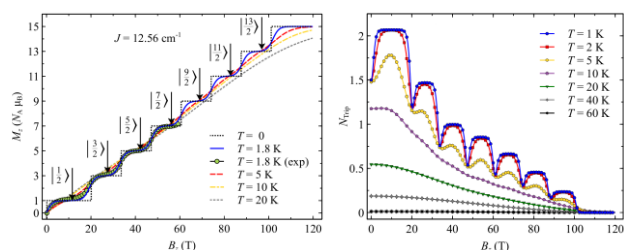
## References

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## Figures



**Figure 1:** The magnetic and molecular structure of the trinuclear high-spin iron(III) complex  $[\text{Fe}_3\text{Cl}_3(\text{saltagBr})(\text{py})_6]\text{ClO}_4$ .



**Figure 2:** Magnetization and tripartite negativity of the  $\text{Fe}_3$  complex as a function of the magnetic field at different temperatures.