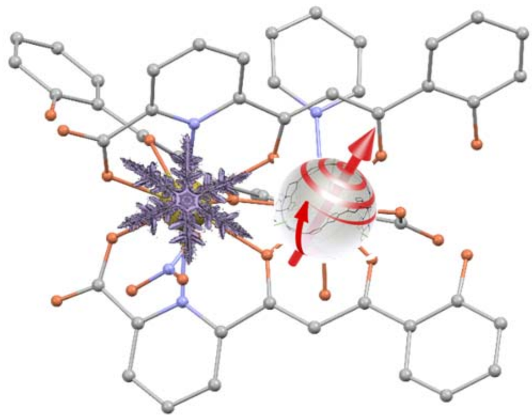
SELF-COOLING MOLECULAR SPIN QUDITS

Guillem Aromí,[a] Fernando Luis,[b] Leoní A. Barrios,[a] Stefano Carretta,[c]
Olivier Roubeau,[b] Valentin Novikov[a]

[a] Universitat de Barcelona, Dept. Chemistry, Barcelona, Spain
[b] Universidad de Zaragoza, Depto. Física de la Materia Condensada, Zaragoza, Spain
[c] Università di Parma, Dipt. Scienze Matematiche, Fisiche e Informatiche, Parma, Italy

Achieving the coherent control of quantum states of matter for the the realization of quantum algorithms demands optimal technology. Within this race, spins within molecules benefit from the atomistic control and reproducibility of synthetic chemistry, which converts them into suitable candidates for the realization of the qubits conforming quantum computers [1,2]. One of the inherent requirements is to operate at very low temperatures. We address this challenge by integrating, in the same molecule, a quantum bit and magnetic refrigeration component. We exploit the ability to obtain selectively heterolanthanide coordination complexes, used in the past as prototypes of 2-qubit conditional quantum gates [3] to present a new molecule with these two functions. It consists of a [GdEr] complex, where Er(III) encodes a qubit while Gd(III) provides a large magnetocaloric effect [4]. The properties of each component are separately studied in isostructural [LaEr] and [GdLu] complexes, where each functional ion lies next to a diamagnetic metal otherwise exactly in the same environment as in [GdEr]. We show the magnetic, heat capacity, and EPR measurements for all compounds, emphasizing that the presence of both ions in the same molecule has a synergic effect on both functionalities. Thus, the coupling between Er(III) and Gd(III) leads to a d = 16 set of spin states that, as revealed by pulse EPR measurements, exhibit coherent spin dynamics. In turn, Er(III) enhances the magnetocaloric effect compared to [GdLu], extending it to lower temperatures. This is corroborated by direct magnetocaloric measurements, which demonstrates that this material can cool itself, and a device, down to 0.4 K.



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