High spin cycles: Topping the spin record for a single molecule verging on quantum criticality

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Theory has predicted a number of interesting quantum critical points for one-dimensional magnetic systems. At such points the ground state and thus low-temperature properties of a material change drastically upon variation of an appropriate external parameter. Competing exchange interactions constitute one possibility to drive a magnetic system into criticality. But since one cannot design the size of exchange interactions at will, it remains open whether certain fascinating systems can ever be realized in the lab.

Here we report on the chemical synthesis of a mixed 3d/4f coordination cluster that turns out to be very close to a quantum critical point. It also shows a ground state spin of $S = 60$, one of the largest ever observed. $[Fe_{10}Gd_{10}(Me\text{-}tea)_{10}(Me\text{-}teaH)_{10}(NO_3)_{10}]\cdot 20MeCN$ ($Fe_{10}Gd_{10}$ in short) forms a nano-ring system of alternating gadolinium and iron ions with a nearest neighbour coupling and a frustrating next-nearest neighbour coupling between adjacent iron ions only. Such spin systems are termed delta (or saw-tooth) chains. They exhibit a variety of frustration effects, among them giant magnetization jumps as well as macroscopic degeneracies of the ground state with profound caloric consequences [1].

1. A. Baniodeh, N. Magnani, Yanhua Lan, G. Buth, C.E. Anson, J. Richter, M. Affronte, J. Schnack, A.K. Powell, npj Quantum Materials 3 (2018)