Low-temperature features of random Heisenberg spin chains

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Low-dimensional spin systems, consisting of arrays of spins arranged in chains or ladders, have been intensively investigated in recent years using both exactly solvable theoretical models as well as a wide range of experimental techniques. In case of random variations of the exchange couplings the renormalization group theory predicts the existence of a random-singlet (RS) state, corresponding to spins coupled at all possible distances and energy scales. However, the scarce availability of suitable random systems has so far prevented the experimental identification of this peculiar magnetic ground state.
In a joint effort using nuclear magnetic resonance (NMR), dc magnetometry and numerical simulations we found compelling evidence of the formation of a random-singlet state in this class of materials.[1] Randomness seems to generate a distribution of local magnetic relaxations, in turn reflected in a stretched exponential NMR relaxation. This distribution exhibits a progressive broadening with decreasing temperature, caused by a growing inequivalence of magnetic sites, as expected from RS theory. Our work suggests that NMR is the tool of choice for probing the low-energy physics also in other disordered magnets, where extended-scale excitations are dominant.

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