Investigating random Heisenberg spin chains via nuclear magnetic resonance

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Exactly solvable theoretical models as well as suitable experimental techniques encouraged recent studies of the fundamental properties of low-dimensional spin systems (consisting of arrays of spins arranged in chains or ladders). According to renormalization group theory, random exchange couplings between spins favour the formation 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 a convincing experimental identification of this particular magnetic ground state.

In a recent effort, employing nuclear magnetic resonance (NMR), dc magnetometry and numerical simulations, we found strong evidence for the formation of a random-singlet state in this class of materials. 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 a very suitable tool for probing the low-energy physics of other disordered magnets, where extended-scale excitations are dominant.

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