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Control of Localization of Spin Excitations in the Dilute Ising Magnet $\mathbf{LiHo_{0.045}Y_{0.955}F_4}$ D.M. SILEVITCH, T.F. ROSENBAUM, Division of Physics, Math, and Astronomy, Caltech, G. AEPPLI, Laboratory for Solid State Physics, ETH Zurich and Paul Scherrer Institut — Collections of quantum mechanical spins with dipolar interactions exhibit a complex set of states and excitations due to the long range and alternating sign of the dipolar potential. These localized excitations can be separated from each other as well as the delocalized continuum by measuring a spectral hole in the ordinary response in the presence of a large amplitude pump whose detailed shape gives insight into couplings among excitations and between excitations and the continuum. We show that in a disordered Ising magnet, $LiHo_{0.045}Y_{0.955}F_4$, the quality factor Q for such holes can be as high as 10^5. In addition, we can sweep the quantum mixing parameter through zero via either the amplitude of the ac pump or a static external transverse field. The zero-crossing is associated with a dissipationless response at the drive frequency. The identification of such a point where localized degrees of freedom are minimally mixed with their environment in a dense and disordered dipolar coupled spin system means that we can control the degree to which qubits emerging from strongly interacting many-body systems can be localized.

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