Double vibronic process in the quantum spin ice candidate $Tb_2Ti_2O_7$ revealed by terahertz spectroscopy

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In geometrically frustrated magnetism, the very nature of the ground state of Tb2Ti2O7, has remained a long standing conundrum. In this pyrochlore material, no conventional spin-ice or long-range magnetic order is stabilized, even at very low temperatures. Quantum fluctuations are suspected of being at the origin of such an exotic quantum phase, yet so far has lacked conclusive evidence. In this rapid communication, high-resolution synchrotron-based terahertz spectroscopy probes the lowest energy excitations of Tb2Ti2O7. By exciting transitions within the crystal electric field and crystal lattice, it is revealed that a double hybridization of crystal-field-phonon modes is present across a broad temperature range. This unique vibrionic process triggers coupling between several degrees of freedom that provides a crucial path for quantum spin-flip fluctuations to inhibit the stabilization of conventional magnetic states. While providing evidence for the unique quantum phase in Tb2Ti2O7, the result also highlights the powerful and complementary nature of terahertz spectroscopy as a probe in the study of exotic magnetic and frustrated phases.

E. Constable, R. Ballou, J. Robert, C. Decorse,J.-B. Brubach, P. Roy, E. Lhotel, L. Del-Rey,V. Simonet, S. Petit, and S. deBrion , **Phys.Rev B 95, 020415(R) (2017)**