MAR17-2016-020386

Abstract for an Invited Paper
for the MAR17 Meeting of
the American Physical Society

Low energy electrodynamics of the quantum spin ice of $Yb_2Ti_2O_7$

N. PETER ARMITAGE, The Johns Hopkins University

In condensed matter systems, the formation of long range order (LRO) with broken symmetry is often accompanied by new types of excitations. However, in many magnetic pyrochlore oxides, geometrical frustration suppresses conventional LRO while at the same time non-trivial spin correlations are observed. For such materials, a natural question to ask then is what is the nature of the excitations in this highly correlated state without broken symmetry? Frequently the application of a symmetry breaking field can stabilize excitations whose properties still reflect certain aspects of the anomalous state without long-range order. Here we report evidence of novel magnetic excitations in the quantum spin ice material $Yb_2Ti_2O_7$, obtained from time-domain terahertz spectroscopy (TDTS) in both zero and finite applied field. In large applied fields, both magnon and two-magnon-like excitations are observed in a ¡001¿ directed magnetic field illustrating the stabilization of a field induced LRO state. The g-factors of these excitations are dramatically enhanced in the low-field limit, showing a cross-over of these one- and two-magnon states into features consistent with quantum string-like excitations proposed to exist in quantum spin ice in a small ¡001¿ applied field. In zero magnetic field, we report a combined time domain terahertz spectroscopy (TDTS) and microwave cavity study of $Yb_2Ti_2O_7$ to probe its complex dynamic magnetic susceptibility. We find that the form of the susceptibility is consistent with monopole motion and a magnetic monopole conductivity can be defined and measured. Using the unique phase sensitive capabilities of these optical techniques, we observe a sign change in the reactive part of the magnetic response. In generic models of monopole motion this is only possible through introducing inertial effects, e.g. a mass dependent term, to the equations of motion.