Experimental report

01/07/2022

Proposal: **4-05-833**

Council: 4/2021

Title: Excitations in new disorder-induced quantum spin ice Ho2(Ti0.9Hf0.1)2O7

Research area: Physics

This proposal is a resubmission of 4-05-814

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Samples: Ho2(Hf0.1Ti0.9)2O7

Instrument	Requested days	Allocated days	From	To
IN5	3	3	16/09/2021	20/09/2021

Abstract:

Ho2Ti2O7 is the prototypical spin ice, but lacks sizeable quantum dynamics. Following a theoretical study, we propose to investigate possible disorder-induced Quantum Spin Liquids. In this quantum spin ices, low-energy excitations are expected, which is in stark contrast with their classical counterparts. In Ho2(Ti0.9Hf0.1)2O7, our experimental observations corroborate the persistence of spin ice correlations along with strengthened fluctuations due to disorder-induced transverse fields. We propose to measure the excitations in a Ho2(Ti0.9Hf0.1)2O7 single crystal. This experiment would thus provide a clear demonstration of a QSI in a material based on a large dipole moment and where, therefore, the signatures will be easier to track than in typical QSI candidates based on small moments such as Pr3+ compounds.

Experiment: 4-05-833 : Excitations in new disorder-induced quantum spin ice Ho2(Ti0.9Hf0.1)2O7

A single crystal of Ho2(Ti0.9Hf0.1)2O7 was installed in a dilution fridge (with the HHL plane as scattering plane) and placed in a magnet. A first quick rotation of the sample was performed using an incident wavelength of 4.8 Å is order to evaluate the accessible reciprocal space (Fig. 1) and decided of the spatial and energy resolution to be used for the rest of the experiment.

Once base temperature of the dilution fridge was reached, an incident wavelength of 7 Å was chosen to probe the sample. The measurement revealed the presence of several crystals contributed to the pattern as well as an unusually high background and spurion, probably coming from the magnet (Fig. 2).

Another pattern was measured at 1.2 K before applying a magnetic field of 0.5 T at which point the sample detached from the stick.

Another sample was then mounted, oriented in the same plane and investigated at base temperature, in absence of field and in a magnetic field of 2.5 T using a wavelength of 7 Å. Unfortunately, no inelastic signal could be clearly identified (Fig. 3).

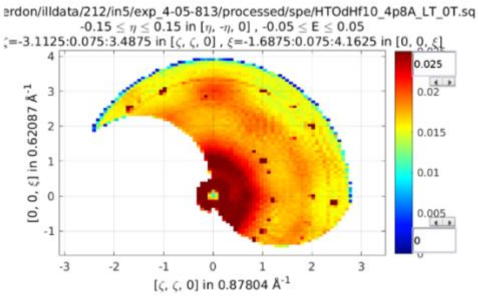

Figure 1: Reciprocal space map at zero energy transfer measured using 4.8 Å incident wavelength.

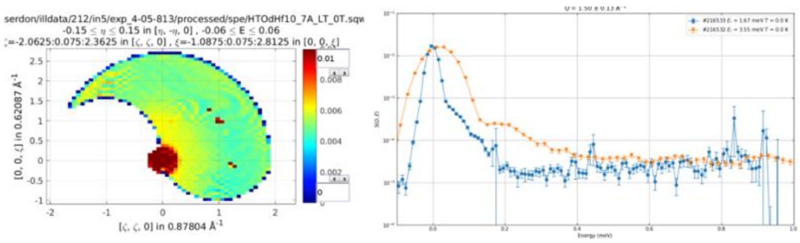

Figure 2: left) Reciprocal space map at zero energy transfer measured using 7 Å incident wavelength. Right) Energy spectra measured at low and high temperatures.

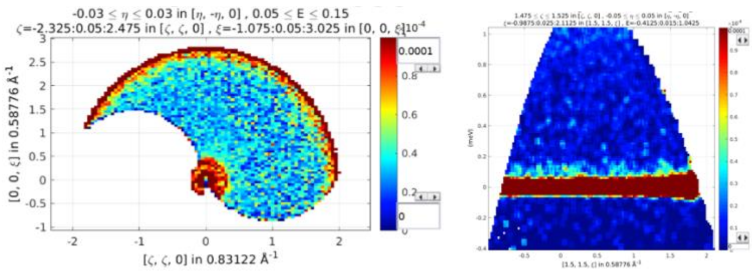

Figure 3: Left) reciprocal map centered at 0.1 meV energy transfer collected at zero magnetic field. Right) Spectra obtained performing a constant-Q cut in data collected under a magnetic field of 2.5 T.