Experimental report

03/11/2019

Proposal: 4-05-725 **Council:** 10/2018

Title: Origins of the Quantum Spin Ice state in Pr2Hf2O7

Research area: Physics

This proposal is a new proposal

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Samples: Pr2Hf2O7

Instrument	Requested days	Allocated days	From	To
IN5	9	6	01/07/2019	08/07/2019

Abstract:

The Quantum Spin Ice (QSI) state, where the two-in-two-out configurations formed by the Ising variables are allowed to tunnel among themselves, is realised in Pr2Hf2O7 based on our last measurements on IN5 (Nature Physics, 14, 711-715 (2018)). The quantum field theory (quantum electrodynamics) that was used to compare with our data, predicts another distinctive feature for this ground state: the suppression of the pinch points, as compared to the sharp anisotropic features observed in classical spin ices, should be progressive as a function of temperature (Phys. Rev. B, 86, 075154 (2012)). We propose to measure this temperature dependence, which will put further limits on the parameters of the theory used to reproduce the experimental data. Moreover, we propose to search for spin-waves in a field-polarised state in order to establish the parameters of the microscopic Hamiltonian that stabilises the zeros-field state. This second part of the experiment is very important as this approached has proved very useful in other rare-earth pyrochlores.

Experiment: 4-05-725

After being carefully mounted on a dilution fridge and placed inside the magnet, the sample (single crystal of $Pr_2Hf_2O_7$) was cooled down to base temperature (~50mK) and oriented in order to scatter in the HHL plane. Data sets were recorded at 4 different magnetic fields: 0T, 0.5T, 0.75T and 2.3T, all along the 1-10 direction. These values were chosen during the experiment, after the first scan in zero field, in order to track the influence of the magnetic field on the sample, allow enough inquiring time to obtain a satisfactory statistic and avoid any technical problems. Resulting patterns can be seen in **figure 1**. One can clearly see the strengthening of the intensity in the 00L direction while the intensity in the HHH direction decreases upon increase of the magnetic field. Further treatment such as absorption correction must be conducted before exploiting the data.

Figure 1: Intensity scattered in the HHL plane and integrated between 0.125meV and 0.275meV. **a**, **b**, **c** and **d** were measured at 0T, 0.5T, 0.75T and 2.3T respectively.