Experimental report

25/05/2022

Proposal: 4-01-1735 **Council:** 4/2021

Title: Spin wave dispersion, including related quantum effect, of kagome spin ice HoAgGe by inelastic neutron scattering

Research area: Physics

This proposal is a new proposal

Main proposer: Kan ZHAO

Experimental team: Paul STEFFENS

Local contacts: Paul STEFFENS

Samples: HoAgGe

Instrument	Requested days	Allocated days	From	To
THALES	7	4	29/06/2021	05/07/2021

Abstract:

Spin ices are exotic phases of matter characterized by frustrated spins obeying local ice rules, that minimize the number of spatially isolated magnetic monopoles, in analogy with the electric dipoles in water ice. In two dimensions, one can similarly define ice rules for in-plane Ising-like spins arranged on a kagome lattice, leading to a variety of unique orders and excitations. Based on single crystal neutron diffraction results, HoAgGe is the first natural compound to realize the kagome spin ice state. With incident neutron wavelength 5 Å, centering at elastic scattering point (1/3, 1/3, 0), clearly spin wave excitations appear at 1.5 K on a randomly oriented 20 single crystals pieces. The spin wave has a small gap about 0.2 meV, indicating the Ising anisotropy in the spin Hamiltonian. We plan to further conduct inelastic neutron scattering on the properly oriented crystals to collect useful information on the exchange coupling strength, and related quantum effect, at the ground state, together with the three main magnetic plateaus with magnetic field along b axis below 2 K.

ILL experiment report

1 PRINCIPAL INVESTIGATOR

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2 EXPERIMENT DETAILS

Reference Number: 4-01-1735
Title: Spin wave dispersion, including related quantum effect, of kagome spin ice HoAgGe by inelastic neutron scattering
Equipment/Facility Used: THALES station
Dates Scheduled: July 2021

3 EXPERIMENT REPORT

As planned, we did the inelastic neutron scattering (INS) of aligned HoAgGe crystals at 0.1K on THALES with dilution fridge insert. The transverse field is applied along *b* aixs of HoAgGe crystals under 0T, 1.5T, 2.5T, and 3.8T , respectively.

In Fig. 1(a), one magnetic excitation mode is observed with an excitation gap of 0.4 meV at M point (-0.5, 0.5, 0) and maximum value of 0.8 meV at Γ point (-1, 1, 0). It is interesting that another magnetic excitation below 1.6 meV appears at Γ point (-2, 2, 0), which is really weak for Γ point (-1, 1, 0) case. It seems really unusual, as we would expect the spin wave should be with high intensity in small *q* range. Under H_b=3.8T, due to the shielding of magnetic field, limited q space is available, and the two magnetic excitations in Fig. 1(b) are similar as without field case in Fig. 1(b). The experimental pattern would help us to construct the theoretical model based on kagome lattice of HoAgGe.

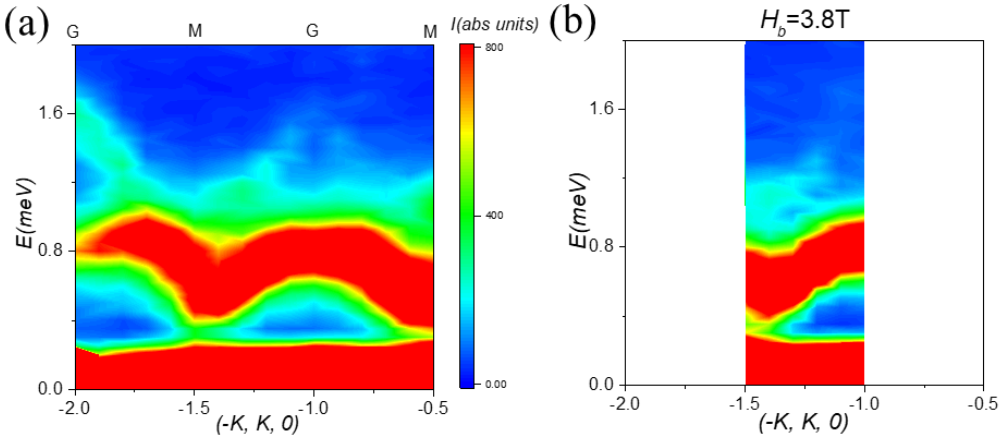

Fig. 1: (a) Wave vector-energy dependence of spin excitation spectrum of HoAgGe along [-K, K, 0] at THALES, ILL at 0.1K. (b) Spin excitation spectrum of HoAgGe along [-K, K, 0] under H_b=3.8T.