Experimental report

06/09/2017

Proposal: **4-05-656** **Council:** 4/2016

Title: Polarization study of the excitation in the short range order of $SrDy_2O_4$ frustrated magnet

Research area: Physics

This proposal is a new proposal

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Samples: $SrDy_2O_4$

Instrument	Requested days	Allocated days	From	To
IN12	5	5	28/09/2016	03/10/2016

Abstract:

$SrDy_2O_4$ is part of the family of rare-earth frustrated magnets which are good candidates to study strongly correlated fluctuating ground states. The material does not have long range magnetic order down to 50 mK but 1D correlations are observed under 1.4K. A change of regime occurs under 0.7K, as seen in magnetic susceptibility, diffuse and inelastic neutron scattering. In particular, a non dispersive excitation emerges at 0.33 meV. The absence of dispersion and Ising nature of the system suggest that the excitation are domain walls in the 1D chains. The dynamics of these domain walls is crucial to understand the short range fluctuations responsible for the absence of long range order, like it is the case for the magnetic monopoles in spin ice. We therefore propose to determine the polarization of the 0.33 meV excitation in $SrDy_2O_4$ to describe its nature and explain the low temperature regime of this compound.

Polarization study of the excitation in the short range order of $SrDy_2O_4$ frustrated magnet

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Abstract

The experiment 4-05-656 on IN12 was performed from September 27th to October 3rd, 2016. The inelastic spectrum of $SrDy_2O_4$, a frustrated magnet which stays disordered down to $T = 60$ mK, was measured using Cryopad on IN12 spectrometer. The polarization of an excitation around $E = 0.35$ meV was measured at different positions in reciprocal space. We confirmed that it is a magnetic excitation and, within the accuracy of our measurements, there are no chiral component and nuclear-magnetic interference terms. The polarization of a crystal-field level at $E = 8$ meV was also investigated. We again confirmed that it is a magnetic excitation and that there are no chiral component and nuclear-magnetic interference terms.

$SrDy_2O_4$ is part of a family of rare-earth frustrated magnets which are good candidates to study strongly correlated fluctuating ground states. This material does not have magnetic order down to 50 mK but 1D correlations are observed below 1.4 K. In the 1D regime, a non-dispersive excitation at 0.33 meV appears under 0.7K. This excitation is field-independent up to 0.3T, where it vanishes at the crossover from 1D correlations to 3D field-induced magnetic order. The objective of the experiment was to determine the polarization of the excitation to describe its nature and have a better understanding of the fluctuations responsible for the absence of long range order.

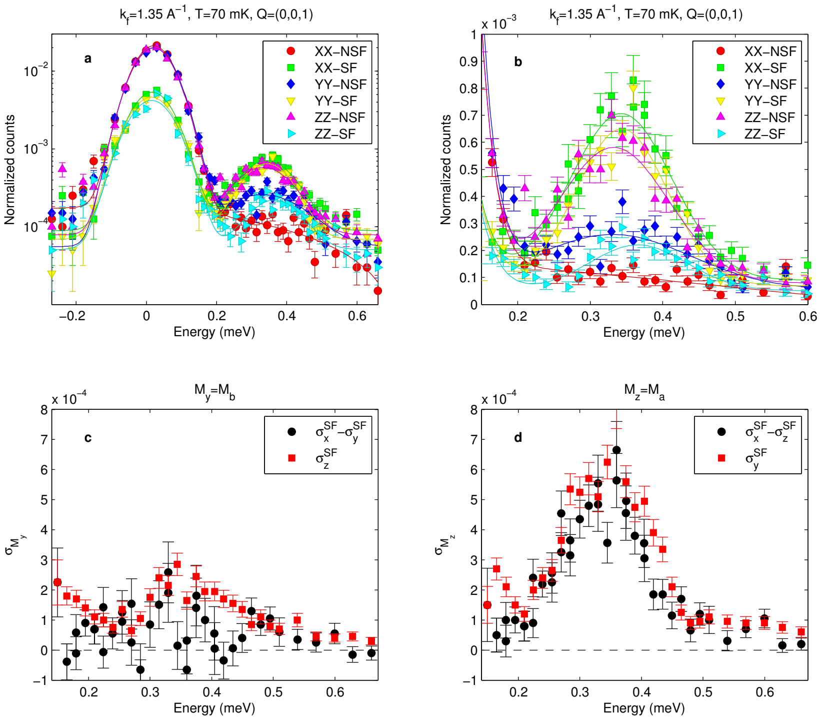

Figure 1: (a-b) Constant Q-scans at $Q = (0, 0, 1)$ for different longitudinal polarization channels. Components (c) M_b and (d) M_a obtained from two different combinations of the channels. The data represented by the black dots is corrected for background (nuclear spin-incoherent scattering) but results in less precise results.

Single crystals with a total mass of 1 g were coaligned in the kl plane and inserted in dilution refrigerator in Cryopad setup on the IN12 spectrometer. The measurements were done at $T = 70$ mK with $k_f = 1.35$ Å^{-1} and 1.7 Å^{-1}. The polarization of the excitation near $E = 0.35$ meV was investigated at $Q = (0, 0, 1)$ (fig. 1) and $Q = (0, 1.75, 0)$. In both cases, the excitation appears in the the spin-flip channel for neutrons polarized along X, indicating that it is magnetic. The separation of the magnetic components shows that it is the strongest along the a-axis. Off-diagonal elements of the polarization matrix were measured on the excitation at $Q = (0, 0, 1)$ and found to be negligible. The dispersion of this excitation was measured along $(0, 0, l)$ and $(0, k, 0.4)$. It was found to be very weakly dispersing.

The crystal-electric-field level observed at $E = 8$ meV was also studied. The excitation appears in the the spin-flip channel for neutrons polarized along X, indicating that it is magnetic (fig.2). No evidence for chiral or nuclear-magnetic interference contributions were observed.

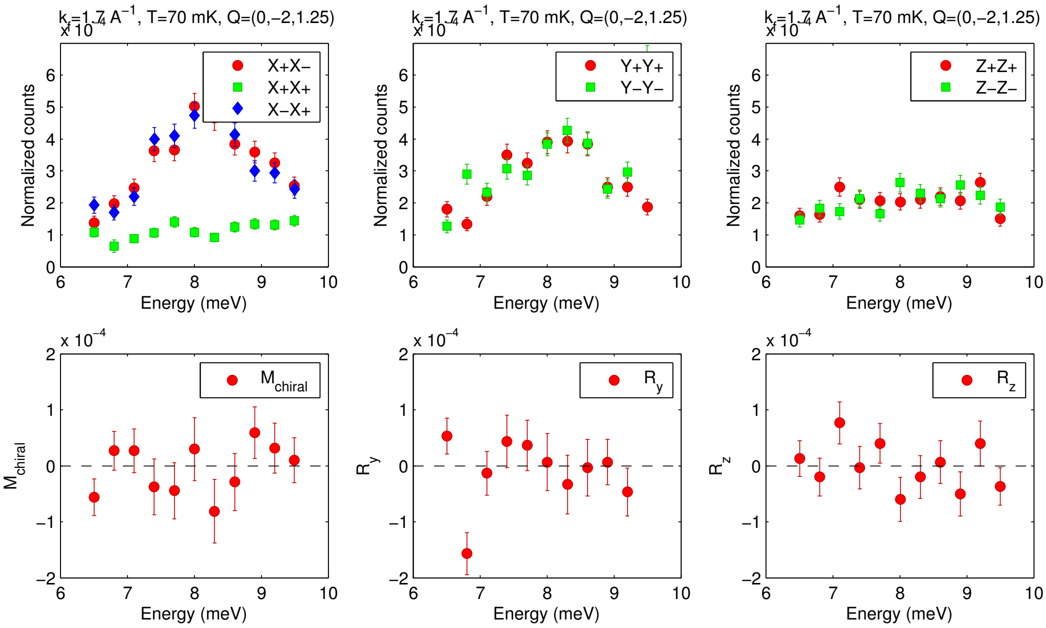

Figure 2: Top row: Constant Q-scan at $Q = (0, -2, 1.25)$ for different polarizations. Bottom row: difference between the two datasets for each subplot of the top row, indicating that M_{chiral}, R_y and R_z are zero.