Experimental report

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Proposal: **4-05-678**

Council: 4/2017

Title: Spin islands in a depleted strong-rung ladder

Research area: Physics

This proposal is a new proposal

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Samples: (C5H12N)2CuBr4

Instrument	Requested days	Allocated days	From	To
IN3	0	3	28/03/2018	31/03/2018
IN5	5	6	20/04/2018	26/04/2018

Abstract:

We propose to investigate the emergent dynamics induced by defects in th strong-RUNG quantum spin ladder BPCB. This study complements and contrasts to a previous successful study for the strong-LEG ladder DIMPY [1]. The focus will be on defect-induced in-gap states. In BPCB these are expected to be considerably more localized. Part of the data will be collected in applied fields, in a bid to shift the measurement window away from the elastic line.

Spin islands in a depleted strong-rung ladder

The inelastic neutron time of fight experiment was performed at the IN5 cold neutron chopper spectrometer at Institute Laue-Langevin in Grenoble, France. The sample of five fully deuterated BPCB - (C5H12N)2CuBr4 crystals with a total mass of ca. 0.9 g and 2% Zn substitution were mounted on an aluminum sample holder and aligned using the OrientExpress Laue neutron backscattering diffractometer with mosaic of less than 4 deg.

The sample assembly was mounted such that the b axis of the crystals was vertical. To supply and appropriate sample environment for the experiment the sample assembly was mounted in a dilution refrigerator cryostat with base temperature of 60 mK and equipped with a 2.5 Tesla vertical cryo-magnet. For the initial run the indecent beam energy was set to 2.2 meV. This was done in a bid to optimize the neutron intensity and q-space coverage and see the q-space periodicity of the spin islands. The sample was rotated by 150 degrees with a step of 2 degrees. Each frame was counted for 35 minutes. This procedure was repeated both in 0 T and in 2.5 T.

The initial run revealed that the presence of the magnet introduces a broad low energy spurious signal related most probably related with the lack of a beam stopper in the magnet and the original beam being reflected from the magnet back to the sample. To minimize the effect of the neutrons reflected from the magnet the experiment was repeated under the same conditions, however using a 1.2 meV incident energy neutron beam.

Zero field measurements did not do not reveal any considerable differences between the pure and the Zn substituted samples, in accord with the expectation that in a 2% substituted BPCB the average distance between the defects should be far greater that the correlation length and thus the defects should appear as perfectly elastic. Measurements performed at an applied field of 2.5 Tesla reveled an expected Zeeman slitting of the energy level related to the non-magnetic defects. This was manifested by the appearance of an non-dispersive energy level in the gap at ca. 0.3 meV, see Figure 1.

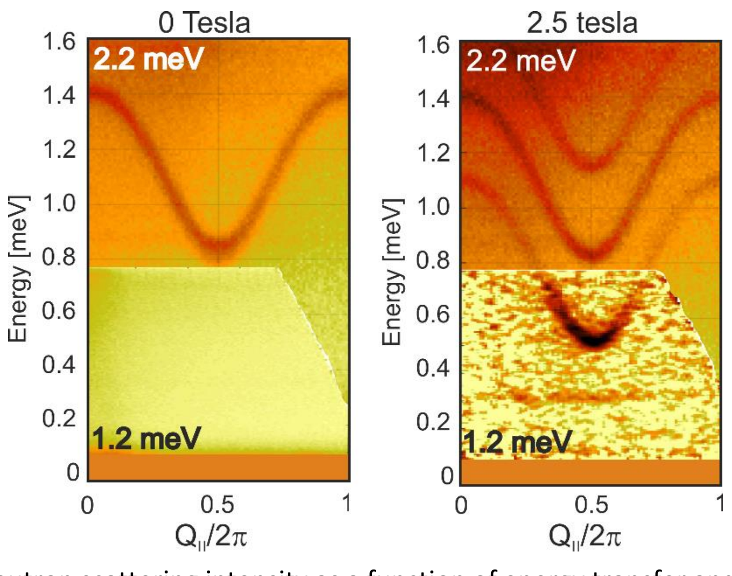

Figure 1 Magnetic neutron scattering intensity as a function of energy transfer and momentum transfer along the ladder leg of the depleted spin ladder BPCB in 0 and 2.5 Tesla. The spectrum were taken using an incident neutron energy of 2.2 meV. The data shown in the insets was measured at a 1.2 meV incident energy in order to minimize the measurement artifacts from the magnet environment. Hatched regions are contaminated by parasitic nuclear incoherent scattering.