Experimental report

08/05/2019

Proposal: 4-05-696 **Council:** 4/2017

Title: Determination of the Spinon Confining Potential in a 1D spin-1/2 XXZ Antiferromagnet

Research area: Physics

This proposal is a new proposal

Main proposer: Bella LAKE

Experimental team: Bella LAKE

Local contacts: Martin BOEHM

Samples: SrCo2V2O8

Instrument	Requested days	Allocated days	From	To
THALES	5	3	15/06/2018	18/06/2018

Abstract:

SrCo2V2O8 is a quasi-one-dimensional, Spin-1/2 antiferromagnet with XXZ anisotropy. Weak interchains coupling gives rise to long-range magnetic order at a suppressed but finite temperature. A spinon continuum is observed above the Neel temperature while below TN a series of resolution-limited sharp modes are found. The modes are due to spinons bound into pairs by the interchain coupling which acts as a confining potential. The bound mode energies and intensities can be described by a new theory based on Tangent-space Matrix Product States. The description is accurate apart from a small but significant shift in the mode energies due to the interchain coupling. To understand the confining potential better as well as to achieve more accurate agreement between theory and experiment, we need to obtian the full Hamiltonian of SrCo2V2O8 including the details of the complex interchain coupling. The goal of this proposal is to measure the interchain dispersions in this compound which will be used to extract the Hamiltonian and will be included in the theoretical model as a random phase approximation.

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Proposal number 4-05-696
Thales Spectrometer of ILL.
15.06.2018 until 18.06.2018.

Introduction:

$SrCo_2V_2O_8$ is a quasi-one-dimensional, Spin-1/2 antiferromagnet with XXZ anisotropy. Weak interchains coupling gives rise to long-range magnetic order at a suppressed but finite temperature. A spinon continuum is observed above the Neel temperature while below T_N a series of resolution-limited sharp modes are found. The modes are due to spinons bound into pairs by the interchain coupling which acts as a confining potential [1]. In a magnetic field applied along the anisotropy (c-axis) direction, the long-range magnetic order is suppressed for a field of 3.8T and for higher fields exotic excitations such as Psinons, antispinon and the long sought after Bethe string modes that were first predicted by Hans Bethe in 1931 [2] are expected. These excitations were observed very recently in this compound using ESR measurements [3]. However ESR is not able to measure all excitations, it is only sensitive to excitations with transverse polarisation, on the other hand neutrons can measure both longitudinal and transverse excitation. The aim of this experiment was to measure the exotic excitations present at high magnetic field in SrCo2V2O8.

[1] A. K. Bera *et al. Phys. Rev. B* 96 054423 (2017).
[2] H. Bethe *Z. für Phys*. **71** 205 (1931).
[3] Z. Wang *et al.Nature* 554 219 (2018).

Experimental setup:

We used the IN14 triple axis spectrometer at ILL and the 15T vertical magnet. The magnet was operated using a Berillium filter with Kf=1.5A-1 and with doubly focusing monochromator and analyser. The sample was oriented with the c-axis vertical and was cooled to 1.8K. Measurements took place at the wavevector (2.3,2.3,0) which corresponds to the antiferromagnetic zone center and an energy scan was measured for different fieldsbetween 0 and 14.5T.

Results:

We successfully observed a series of different excitations including the psinon and antupsinon modes as a function of field see the figure. Unfortunately the sample was moving in a field due to the forces on it and this movement was not reproducible.

Conclusion

This 3-day experiment proved that this measurement is feasible, however the movement of the sample in a field render the data only of qualitative rather than quantitative use. A followup experiment was planned in October with a stronger sample holder.

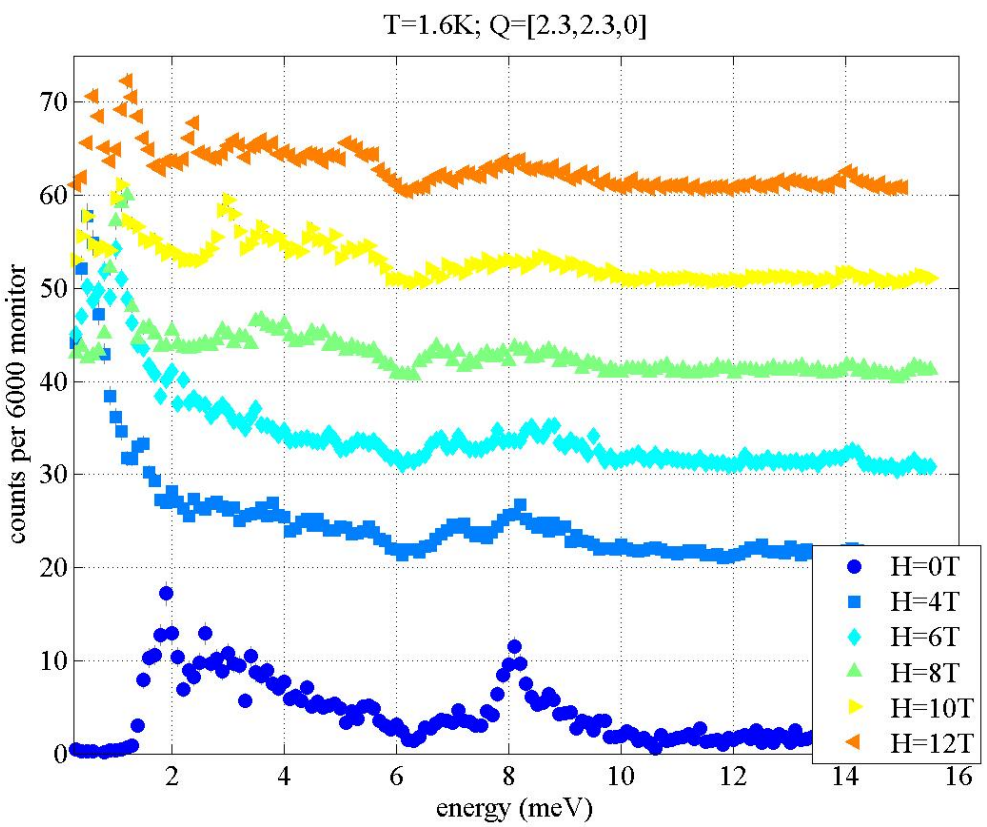

Figure 1: Inelastic Neutron scattering as a function of energy for different magnetic fields applied along the c-axis. The data shows the evolution of the excitations with field.