# Experimental report

10/04/2018

**Proposal:** 4-03-1708 **Council:** 10/2014

**Title:** Polarisation of low-energy excitations in a bond-quadrupolar spin liquid

**Research area:** Physics

**This proposal is a new proposal**


**Main proposer:** Mechthild ENDERLE

**Experimental team:** Bjorn FAK

**Local contacts:** Wolfgang F SCHMIDT


**Samples:** LiCuVO4

| Instrument | Requested days | Allocated days | From | To |
|---|---|---|---|---|
| IN12 | 8 | 9 | 28/07/2015 | 06/08/2015 |


**Abstract:**

Spin-nematic quantum ground states are intensely studied theoretically.
LiCuVO4 is a quasi-one dimensional spin 1/2 ferromagnet with antiferromagnetic next-nearest neighbour interactions, and frustrated interchain interactions. It displays a high-field phase with field-parallel incommensurate short-range dipolar order and a 2d-XY like heat capacity anomaly upon entering this phase. We have evidenced this phase to be of a new bond-nematic type. We wish to test precise theoretical predictions concerning the polarisation of the four low-energy modes. We therefore ask for 8 days on IN12 equipped with 12T magnet and dilution insert, polarised neutrons and polarisation analysis.

An about 50 mm$^3$ $LiCuVO_4$ single crystal was aligned in the $(hk0)$ scattering plane and inserted into the dilution insert of the CEA vertical 12 T magnet. The magnetic field was reloaded every day to avoid field loss. The dilution had to be cooled down with a non-standard method, and the base temperature of 50 mK was reached the second day. All measurements were performed at 60 mK and 11.8 T. IN12 was set up with V-shaped polarising guide, PG(002) monochromator, a flipper in $k_i$, and Heusler analyser. We used $k_f = 1.5$ Å$^{-1}$ fixed for most of the experiment and the velocity selector, but no other filter. A considerable number of raw data files had to be hand-edited due to nomad errors.

The vertical flipper current of the incident flipper 1 was dependent on both the magnetic field and the incident energy, as the stray field changes with A2, cf fig.1. Correspondingly tuned, its efficiency was better than that of the flipper 2 in $k_f$ which sits too close to the magnet (see fig.1).

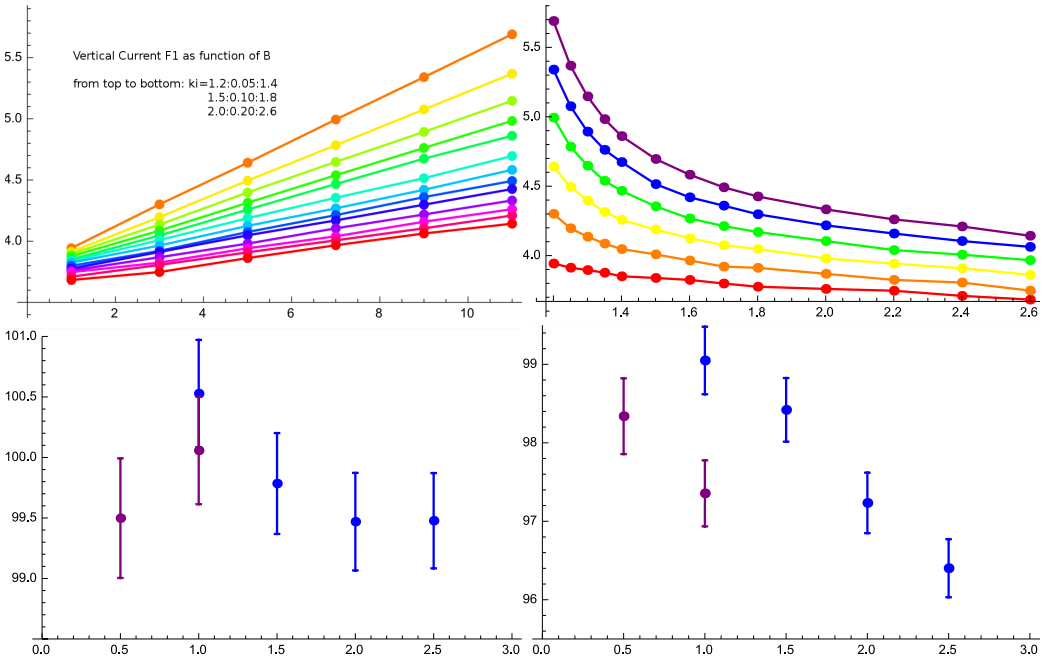


Fig. 1. Top: Left: vertical flipper 1 current as function of magnetic field in the CEA 12 T magnet. Right: vertical flipper 1 current as function of the incident energy for various field strengths. Bottom: Left: Flipper 1 efficiency, Right: Flipper 2 efficiency for small magnetic fields as function of the magnetic field. At higher magnetic field, the currents of flipper 2 are insufficient. We therefore worked with flipper 1 only.

A polarised scan through the short-range order elastic peak at 11.8 T shows as in Mourigal *et al.* PRL 109, 027203 (2012), that the SRO is entirely

parallel to the magnetic field, and that flipper 1 is working properly, figure 2 left. We further made sure, that there is no feedthrough of the SRO-elastic peak at a finite energy transfer of 0.2 meV, figure 2 right. An energy scan over the elastic peak at (1, -0.514,0) displayed a different width and shape of the [incoherent] scattering in NSF and SF channel, see figure 3.

The bulk of the data was taken in form of constant energy scans at 0.3 meV transfer, 1 day was spent on some exploratory elastic scans.

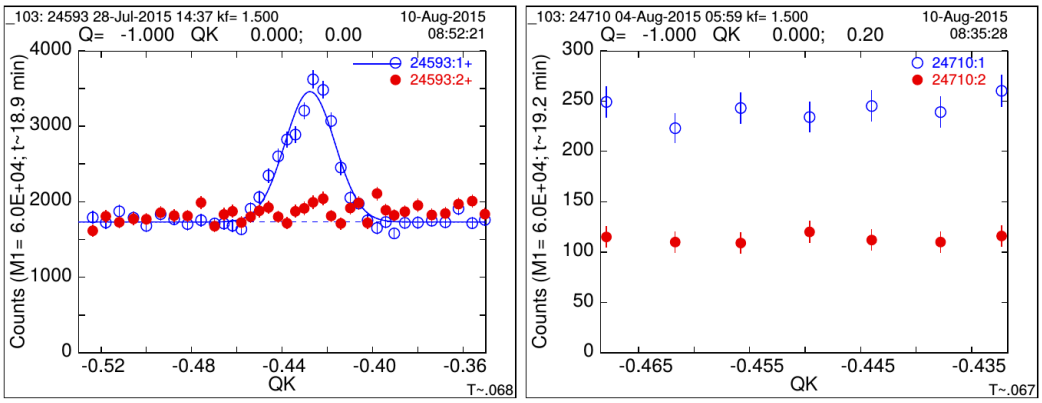


Fig. 2. Left: Polarised $Q_k$-scan over the elastic SRO-peak, indicating perfect functioning of flipper 1 and longitudinal arrangement of the SR magnetic order. Right: Proof of absence of elastic leakthrough at 0.2 meV.

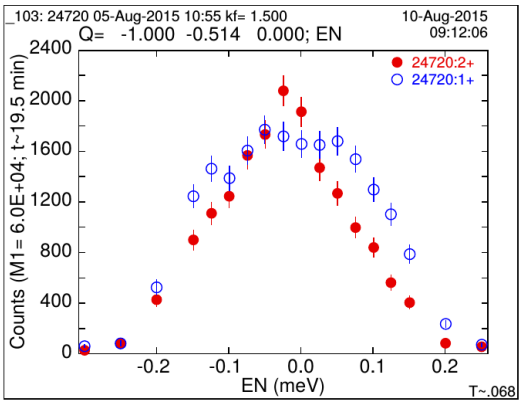


Fig. 3. Polarised energy scan over the incoherent elastic scattering, indicating different shape and width for NSF and SF channel.