# Experimental report

29/08/2022

**Proposal:** **4-01-1681** **Council:** 4/2020

**Title:** Spin dynamics of the heavy electron system YbCo2Zn20, a case for adiabatic demagnetization refrigerationusing itinerant electron magnetism

**Research area:** Physics

**This proposal is a new proposal**


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**Samples:** YbCo2Zn20

| Instrument | Requested days | Allocated days | From | To |
|---|---|---|---|---|
| THALES | 6 | 5 | 10/03/2021 | 15/03/2021 |
| IN12 | 6 | 0 | | |
| IN3 | 1 | 1 | 25/02/2021 | 26/02/2021 |


## Abstract:

The super heavy electron compound YbCo2Zn20 has been proposed as a model system for adiabatic demagnetization refrigeration using itinerant electron magnetism. The aim of the proposal is to bring microscopic insight into the evolution of the low energy spin dynamics of YbCo2Zn20 under magnetic field in relation with its macroscopic magnetocaloric properties.

The super heavy electron compound $YbCo_2Zn_{20}$ has been proposed as a model system for adiabatic demagnetization refrigeration using itinerant electron magnetism [1]. The aim of the proposal was to bring microscopic insight into the evolution of the low energy spin dynamics of $YbCo_2Zn_{20}$ under magnetic field in relation with its macroscopic magnetocaloric properties. Up to know the field dependence of the spin dynamics of $YbCo_2Zn_{20}$ was studied on powder sample only [2].

**Experimental configuration**

A single crystal sample of 13 mm high and 20 mm width was installed in a dilution fridge inside the 10 T vertical field magnet with the field applied along the [0, -1, 1] direction. The spectrometer was set up in W configuration with full focused mode using a fixed $k_F$=1.1 Å$^{-1}$ with the graphite monochromator and analyser. The velocity selector was in place on $k_I$ and a Be filter was in place on $k_F$. The achieved elastic resolution measured on a small vanadium sample was 0.04 meV.

**Experimental results**

From previous IN12 test experiment, it was established that the q-dependence of the excitation at zero field is weak. Therefore data were only collected under field at the two wave-vectors **Q**=(2,0,0) (zone center) and **Q**=(3,0,0) (zone boundary) for 0, 0.2, 0.5, 1, 2, 3.5, 5, 7, and 10 T. At zero field, the spectrum is composed of a quasielastic signal of relaxation rate of about 0.15 meV and a broad crystal field excitation at around 0.7 meV (with relaxation rate 0.4 meV) as illustrated for **Q**=(3,0,0) on Fig.1. Under field, the spectrum is initialy unchanged on crossing the metamagnetic transition at 0.6 T and above 1 T, both components broaden considerably and overlap which makes their separation more difficult (See Fig.2 for representative scans).

At the maximum field of 10 T, the crystal field level is completely washed out. Surprisingly a new sharp inelastic mode appears (see the shoulder at 0.3meV in Fig.2). Since the position (3,0,0) is a zone boundary without any elastic Bragg signal (magnetic/structural) and low energy phonons, this mode is intrinsic to the (almost) polarized ferromagnetic phase. It is furthermore dispersive and its wave-vector dependence was investigated along the main high symmetry directions. The low energy of this mode is surprising since a Zeeman energy of about 1.5 meV is expected for the induced moment of ~2.5 $\mu_B$ under 10 T (applied along (011)).

Data analysis and calculation for this experiment is still under way.

[1] Y. Tokiwa et al., Science Advances 2 (2016) e1600835.

[2] K. Kaneko et al., J. Phys. Conf. 391 (2012) 012026.

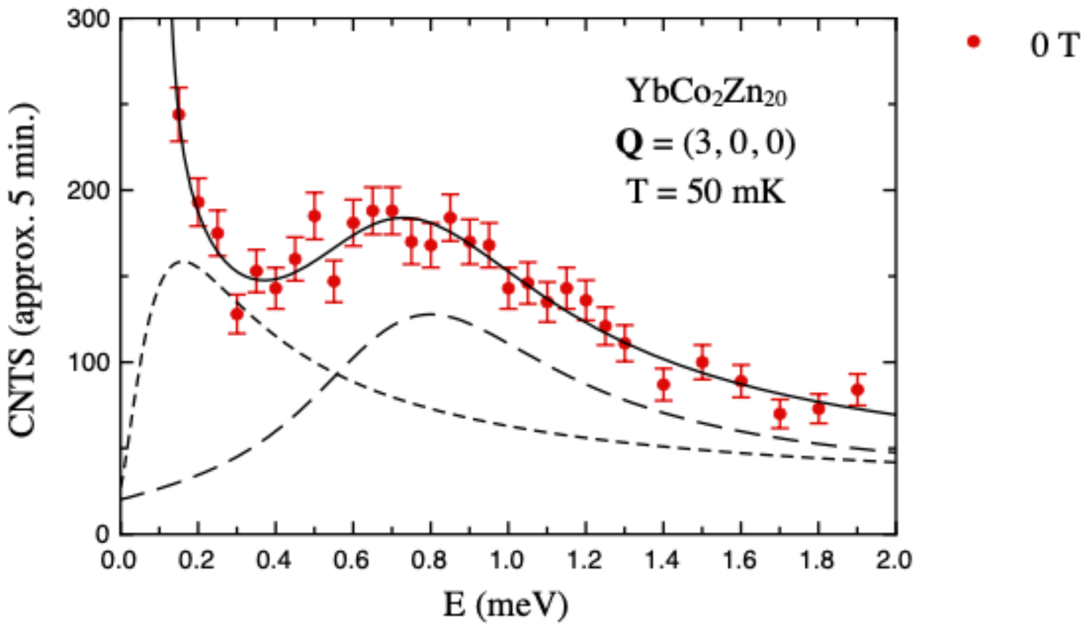


**Figure 1**: Magnetic excitation spectrum of $YbCo_2Zn_{20}$ for **Q**=(3,0,0) at 0 T and 50 mK. The dashed lines show the quasielastic and inelastic parts of the response.

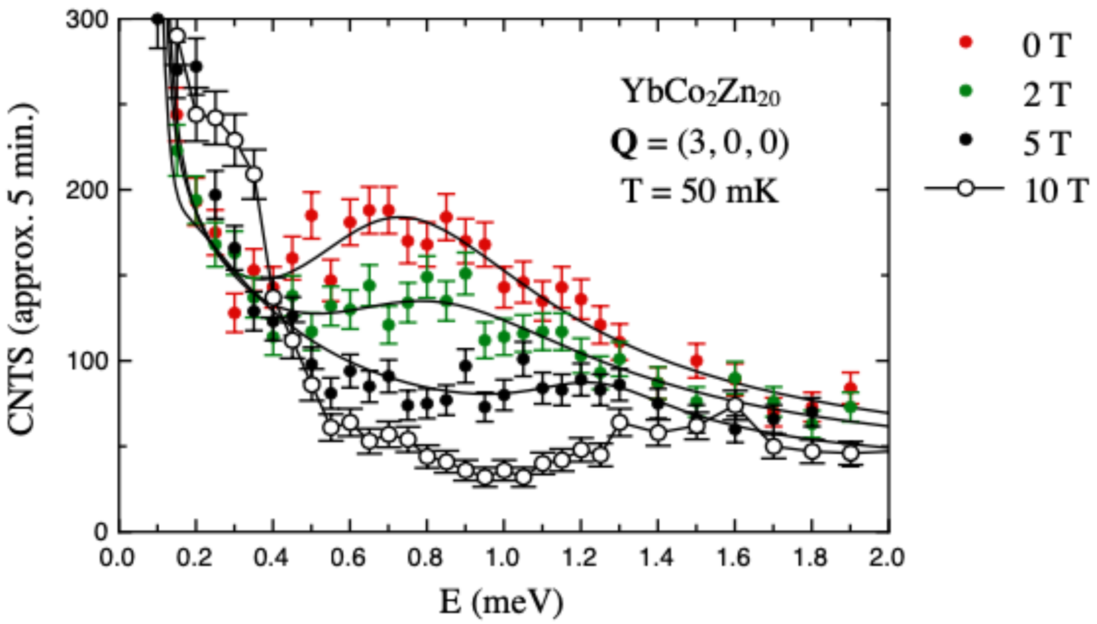


**Figure 2**: Magnetic excitation spectrum of $YbCo_2Zn_{20}$ for **Q**=(3,0,0) for 0, 2, 5 and 10 T and 50 mK. The lines are fit as in figure 1 except for 10 T where it is a guide for the eyes.