Experimental report

13/09/2018

Proposal: **DIR-157** **Council:** 4/2017

Title: Metastable Skyrmions in Zn-Doped Cu2OSeO3

Research area:

This proposal is a new proposal

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Samples: Cu2OSeO3

Instrument	Requested days	Allocated days	From	To
D33	6	3	30/03/2018	02/04/2018

Abstract:

Experimental Report - D33 DIR157

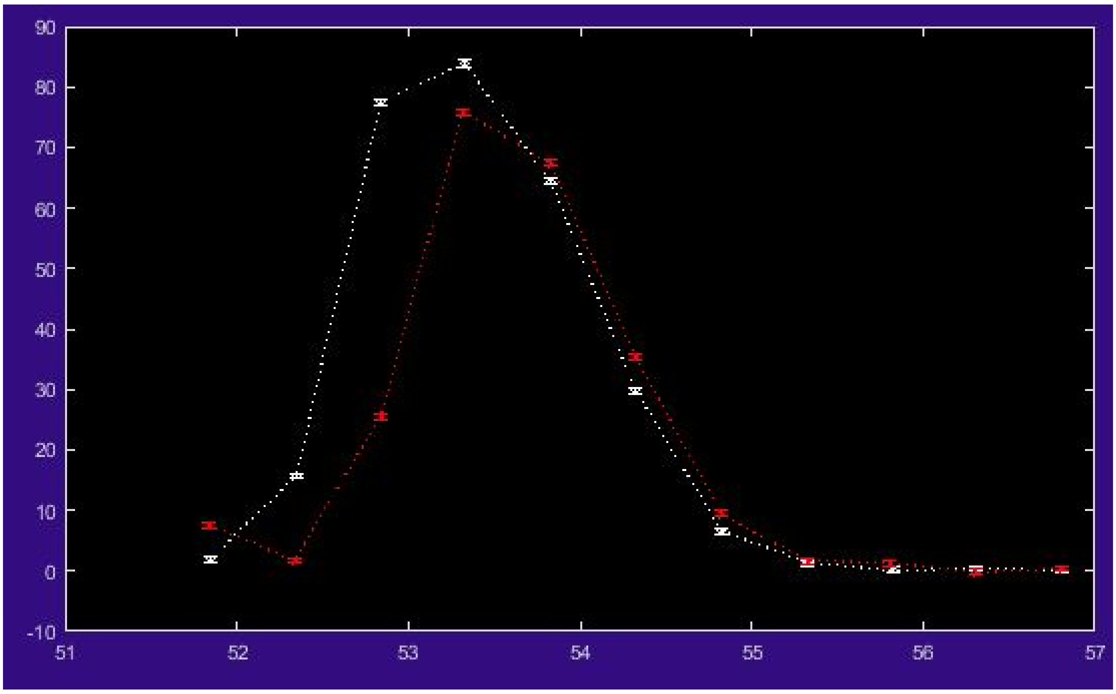
The purpose of this experiment on D33 was to study the metastable skyrmion lattice in Zn doped Cu2OSeO3. We used small angle neutron scattering to characterize the field and temperature dependence of the metastable skyrmion lattice.

Material:

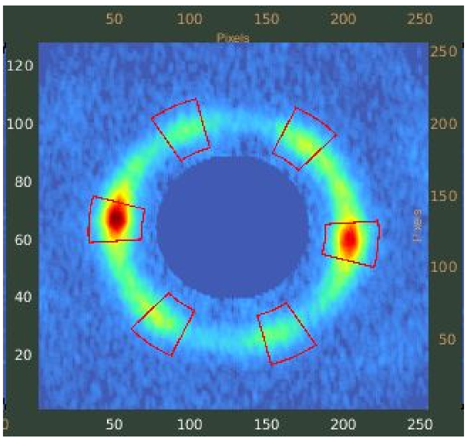
A single crystal of 12% Zn Doped Cu2OSeO3 with a mass of 53mg has been aligned on OrientExpress and mounted in the Blue Charlie cryostat on D33.
The non magnetic doping introduced via Zn ions in the Cu2OSeO3 crystal structure, introduce a disorder that we expect to favour the formation and the stabilization of the metastable skyrmion lattice.

Experiment and results:

We choose a wavelength of 10A and a 12m collimation length. After the alignment of the sample, we started by characterizing the equilibrium skyrmion pocket both in increasing (red) and decreasing(white) T.

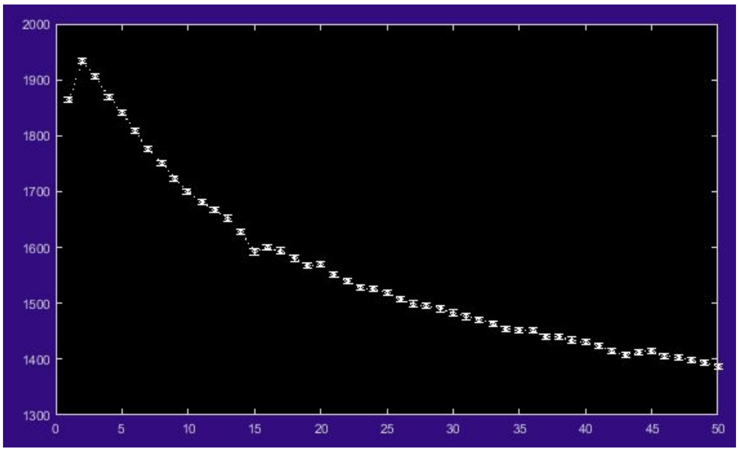


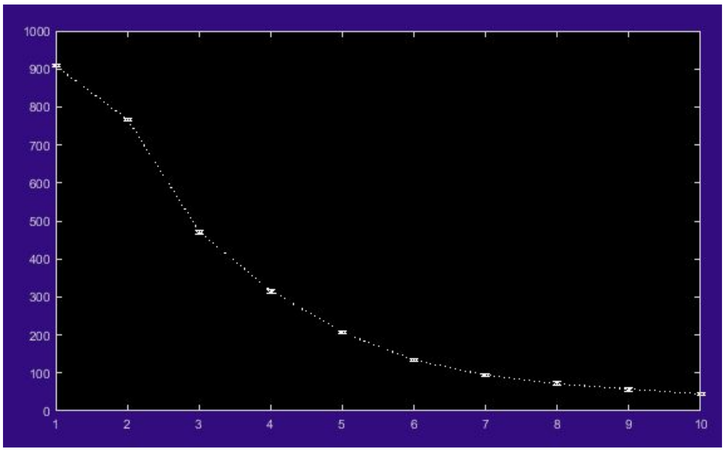
The results correspond to the AC susceptibility data we previously obtained.
We then proceeded to a fast field cooling to check enter the metastable skyrmion state.



With a cooling rate of 5K/min, we FC down to 10K obtaining a metastable skyrmion state, as shown in the image on the right.
We characterized the metastable skyrmion phase with field sweeping measurements recorded at 5K.
The metastable skyrmion lattice survives without any applied magnetic field, even if with a lower intensity.
The metastable phase has been characterized also in T: we FC to 45K and recorded one rocking scan each

T, going down to 5K in step of 5K each and then increasing T to 55K in the same way.
The lost intensity of the metastable skyrmion lattice, going down in T, is not recovered when increasing T, confirming the metastable nature of this magnetic phase.





We have studied the decaying time of the metastable state, and measured different lifetimes depending on the temperatures. Above, the figure on the right correspond to the intensity measured over time (in this case expressed in steps of 170s) FC to 50K, while the one on the left is FC at 52.5K. A clear dependance on the target temperature of the cooling procedure is shown. During the experiment, we have probed also the persistence over time of the equilibrium state, which intensity is constant over time.

<u>Conclusion:</u>
We have proved the existence of a metastable skyrmion state in Zn doped Cu_2OSeO_3.
We have been able to fully characterize both the magnetic phase diagram of this compound, and to measure a dependence of the metastable skyrmion lifetime with temperature.
With a further analysis of the data, we are planning to extract the correlation lengths in the three dimensions of skyrmion lattice and their behavior over time.

The experiment has been very successful, and it proved the importance of non magnetic doping in a skyrmion bulk material for increasing the stability of the metastable skyrmion state.
The results of this experiment will be expanded with the study of different concentration of Zn doping in Cu_2OSeO_3. A proposal has been submitted to continue this work on D33 for the next cycle.