

Experimental report

27/09/2023

Proposal: 4-01-1801

Council: 4/2023

Title: Temperature dependence of magnon and phonon in Kagome metal FeGe

Research area: Physics

This proposal is a new proposal

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Samples: FeGe

Instrument	Requested days	Allocated days	From	To
IN8	7	7	05/06/2023	12/06/2023

Abstract:

The antiferromagnetic (AFM) kagome metal FeGe exhibits a novel charge-density-wave (CDW) transition at $T_{\text{CDW}} = 100\text{K}$ well below the Neel temperature (410K). More interestingly, the CDW phase can enhance the AFM peak intensity by presumably increasing the Fe ion moment. This makes FeGe the first example of CDW-enhanced magnetism in strongly correlated systems, offering a new platform for exploring emergent phenomena in strongly correlated materials. In particular, it is important to determine the role of magnon and electron-phonon coupling in the mechanism of CDW. Therefore, we propose to perform detailed temperature dependence measurements on FeGe magnon and phonon spectrum.

Temperature dependence of magnon and phonon in Kagome metal FeGe

The goal of the experiment was to study the interplay between charge density wave (CDW), magnetism and lattice in Kagome metal FeGe, specifically how magnon and phonon respond to CDW and magnetic transitions. To do that, we performed detailed temperature dependence measurements on magnon and phonon spectrum.

To carry out the experiment, we have aligned FeGe single crystals with a total mass of 1 g in $[HHL]$ plane with mosaic less than 1 degree.

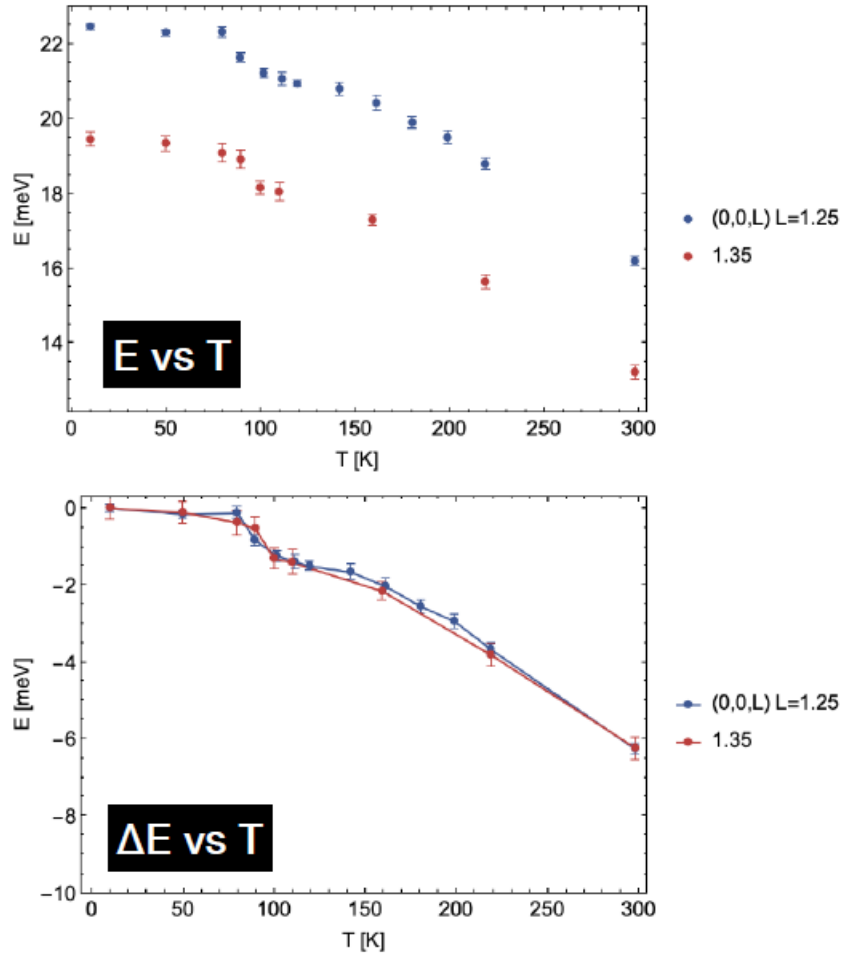


Figure 1. Temperature dependence of magnon dispersion.

We first examined the temperature dependence of magnon dispersion along L direction. We measured energy dependence spectrum at both Brillouin zone boundary $Q = (0,0,1.25)$ and another wavevector $Q = (0,0,1.35)$ from around room temperature to 10 K. For all the spectra, we scaled the spurious peak by the Bose factor as background and fitted the energy peak position. Interestingly, we observed magnon hardening across T_{CDW} (at around 100 K) at both wavevectors (Figure 1). Also, the energy shifts have a similar scale, as can be seen in the bottom figure in Figure 1.

We then examined the temperature dependence of both acoustic and optical phonons. We measured different phonon branches at selected wavevectors at different temperatures as summarized in the attached figure (Figure

2). After carefully subtracting background and fitting collected data, we observed optical phonon hardening at both around 33-39 meV and 25 meV across T_{CDW} at all measured wavevectors, and no noticeable change for acoustic/optical phonons at around 2-16 meV (Figure 3).

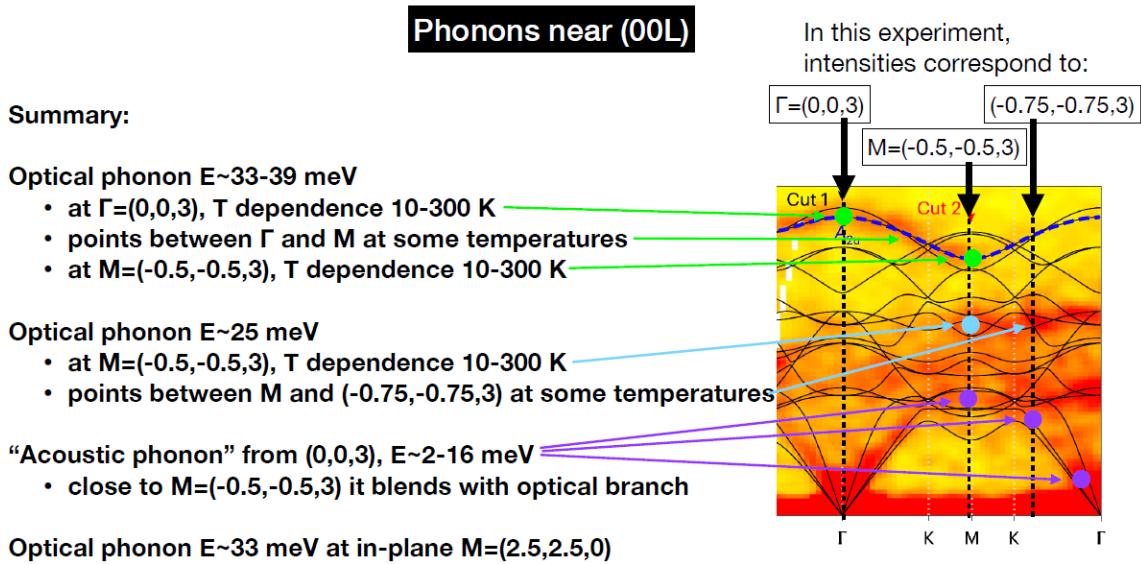


Figure 2. Summary of measurement of phonon dispersion.

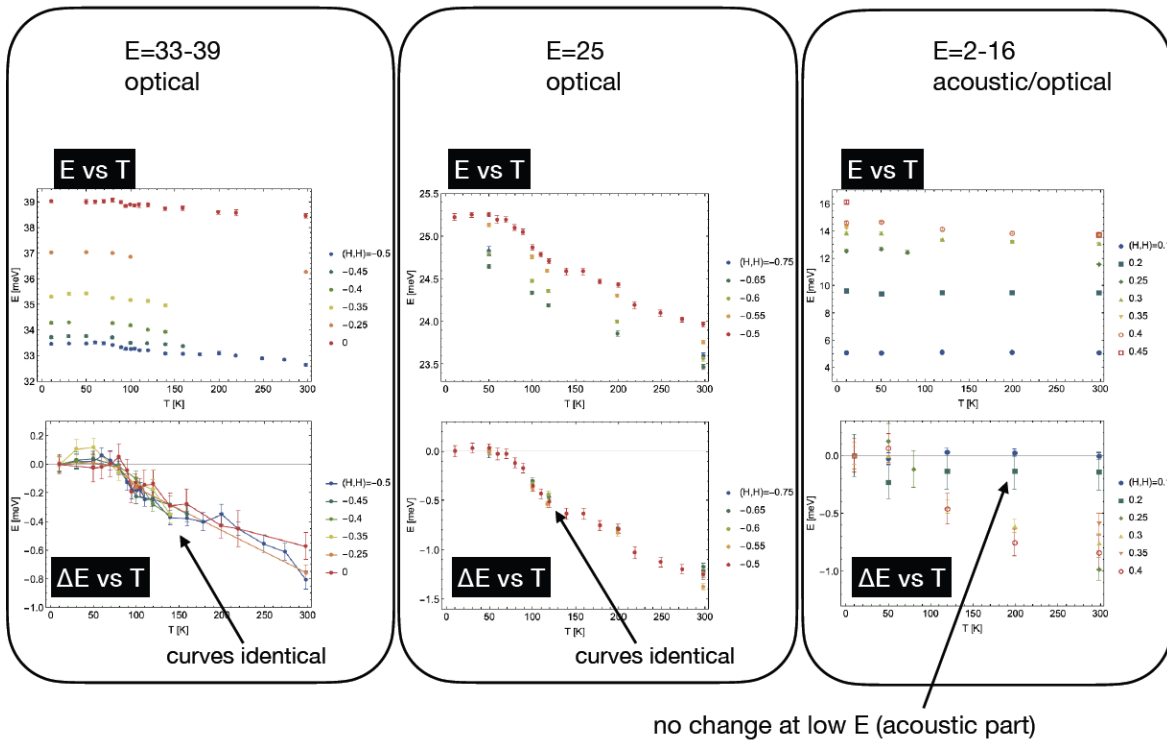


Figure 3. Temperature dependence of phonon dispersion.

In conclusion, we observed both magnon and phonon hardening across T_{CDW} in Kagome metal FeGe, this is a very important to understand what gives rise to CDW in this system.