Experimental report

12/09/2022

Proposal: **INTER-472** **Council:** 4/2019

Title: Inelastic neutron scattering studyof BaNi2As2 and Ba0.3Sr0.7Ni2As2 under magnetic field

Research area:

This proposal is a new proposal

Main proposer: **Alexandre IVANOV**

Experimental team: Kelly NEUBAUER
Yaofeng XIE
Philippe BOURGES

Local contacts: Alexandre IVANOV

Samples: BaNi2As2
Ba0.3Sr0.7Ni2As2
CsV3Sb5

Instrument	Requested days	Allocated days	From	To
IN8	7	7	29/06/2021	06/07/2021

Abstract:

Proposers:

Dai Pengcheng, Rice University, United States

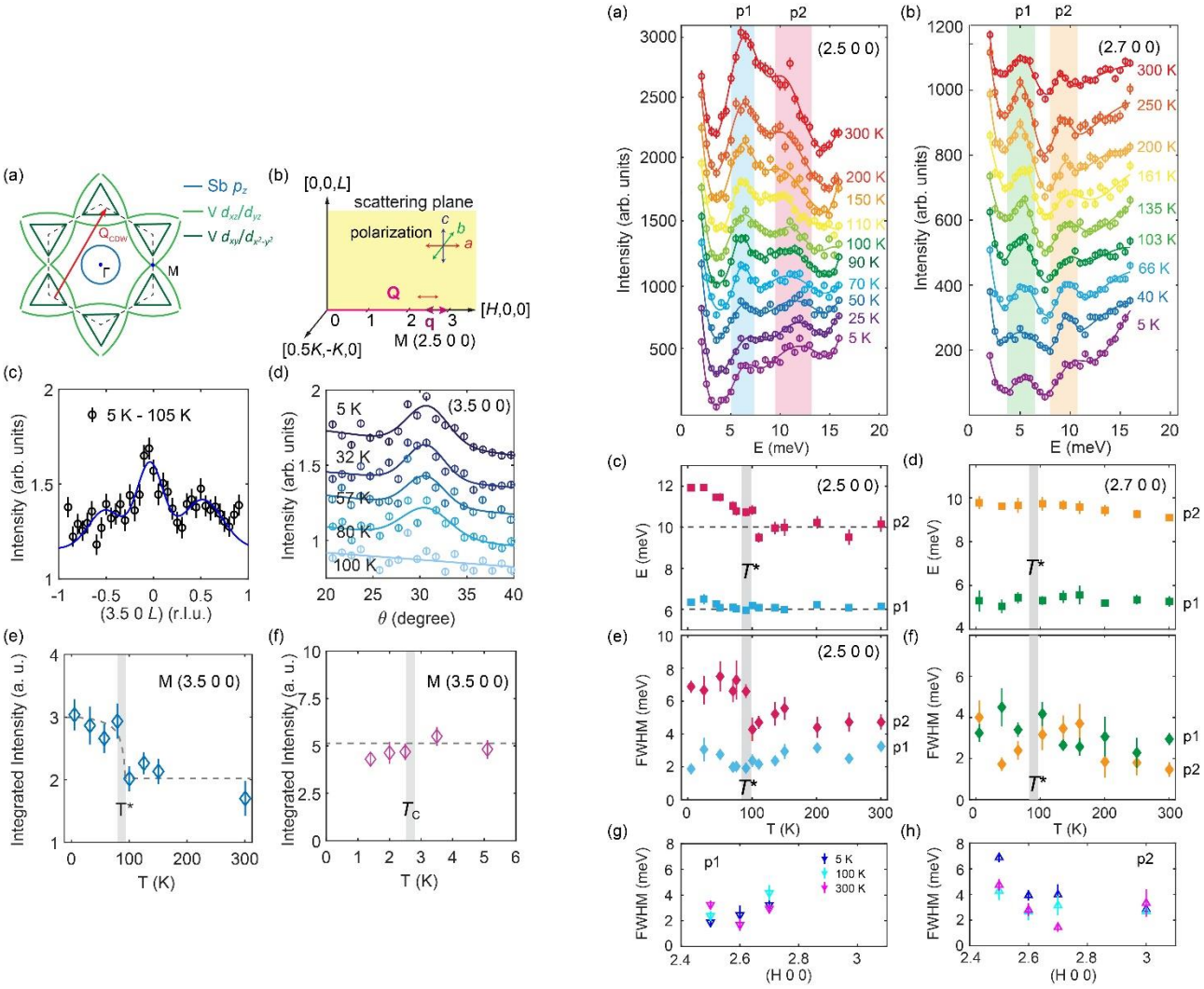
Xie Yaofeng, Rice University, United States

Experiment Objectives:

Kagome compounds have the Fermi level close to the saddle points of linearly dispersive Dirac bands, i.e. van Hove singularities (vHs). In a 2D system, the divergence of the density of states generates enhanced scattering amongst electrons near the saddle points, which may drive not only superconducting but also charge instabilities. The same idea emerged recently in the context of doped graphene and has been applied to the theory of magic-angle graphene bilayers. It was thus proposed that the van Hove singularities (vHs) arising from such saddle points could be attributed to the emergence of CDW order via Fermi surface nesting (FSN) in AV_3Sb_5. However, whether this charge order is a purely electronic instability along the lines of the Periels instability in one dimension is still under considerable debate. First, there is growing theoretical and experimental evidence that FSN picture fails in many real systems and in fact it is the momentum dependent electron-phonon coupling (EPC) that determines the characteristic of the CDW phase. While X-ray scattering did not observe CDW induced phonon anomalies at the CDW wave vector (Q_{CDW}) in RbV_3Sb_5, signatures of EPC have been observed by angle-resolved photoemission measurement (ARPES) and optical spectroscopy, hinting phonon as an important ingredient of the AV_3Sb_5 physics. To understand the role of lattice degree of freedom in AV_3Sb_5 physics, we propose to perform neutron scattering experiment on CsV_3Sb_5 to map out the overall phonon spectrum as a function of temperature. The momentum tunability and good energy resolution of IN8 will allow us to unveil how other branches of phonon are intertwined with the charge order and eventually determine the microscopic details of both the charge order and superconductivity.

Experiment Results:

Our triple-axis neutron scattering experiment on $CsSb_3V_5$ has not only confirmed the 2 by 2 superstructure but also discovered unusual phonon hardening at Q_{CDW} at the onset of the CDW transition temperature, suggesting that lattice degree of freedom must be considered. These pioneering observations and experimental mysteries already demonstrate a physically rich landscape open for exploration in AV_3Sb_5 and more in-depth studies are required to fully elucidate the essential role which phonon could play for the unconventional charge order.



Publication:

Electron-phonon coupling in the charge density wave state of CsV3Sb5

Yaofeng Xie, Yongkai Li, Philippe Bourges, Alexandre Ivanov, Zijin Ye, Jia-Xin Yin, M. Zahid Hasan, Aiyun Luo, Yugui Yao, Zhiwei Wang, Gang Xu, and Pengcheng Dai

Phys. Rev. B 105, L140501 (2022).