Charge density wave in kagome superconductor AV_3Sb_5

Kun Jiang^{*}

Beijing National Laboratory for Condensed Matter Physics, and Institute of Physics, Chinese Academy of Sciences, Beijing 100190, China

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The kagome lattice is one of the most important platforms to investigate quantum many-body physics. For example, owing to its special lattice, the kagome lattice has a standard geometric frustration phenomenon in quantum magnetism. How to utilize this simple lattice to uncover the unconventional quantum phenomenon attracts great attention. Interestingly, the recently discovered kagome superconductors AV_3Sb_5 ($A=K, Rb, Cs$) provide a new route towards the interplay between correlation, topology, superconductivity (SC) [1,2]. Although the SC in AV_3Sb_5 is now proven to be a spin-singlet conventional SC, the AV_3Sb_5 still contains many unconventional features [2]. For instance, an unconventional charge density wave (CDW) order with time-reversal symmetry breaking signature was found in all the AV_3Sb_5 materials with transition temperatures ranging from 80 to 100 K. Therefore, what is the nature of this CDW transition is now becoming an important question in the AV_3Sb_5 investigation.

In this recent work of ref. [3], the authors carefully investigate the CDW transition in CsV_3Sb_5 by nuclear magnetic resonance (NMR) measurements, which provides many striking results of the CsV_3Sb_5 CDW. The first question of any phase transition is what type of this transition is. The sudden jump of the splitting of Knight shift in Figure 2 of ref. [3] gives concrete evidence for the first order transition. And the major splitting of this Knight shift is ascribed to the orbital shift, which confirms a charge nature of this transition. Secondly, this NMR spectrum finds two inequivalent V and Cs sites. Based on recent investigations, there are mainly

two types of CDW configurations: Tri-Hexagonal (TrH) and Star of David (SoD) [2]. Although this work still cannot differentiate these two, the only two inequivalent NMR peaks indicate the configuration must belong to TrH or SoD without mixing. Furthermore, this study confirms the structural modulation along the c axis from the interlaminar ^{133}Cs NMR spectrum. Currently, the X-ray scattering experiments debate about $2a \times 2a \times 4c$ and $2a \times 2a \times 2c$ periodicity [2]. Since we know inversion is an exact symmetry for CDW, these two results give a constraint on the CDW configurations along the c -axis. Taking TrH configurations and $2a \times 2a \times 4c$ as an example, there are four possible C_6 rotation centers for the in-plane $2a \times 2a$ configurations. We can label the four layers as Layer 1-4. We can put the inversion center at Layer 1 without losing the generality. Then, there are only two possible configurations: Layer 1 = Layer 3, Layer 2 = Layer 4 and Layer 1 $\neq$ Layer 3, Layer 2 = Layer 4. Finally, the orbital fluctuations above T_s found in this work are deeply related to the physical origin of the CDW transition, which calls for further investigations. This work is timely and unveils the fundamental nature of CsV_3Sb_5 CDW.

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^{*}Corresponding author (email: jiangkun@iphy.ac.cn)