Evidence of nested quasi-one-dimensional Fermi surface and decoupled charge-lattice orders in layered TaTe2

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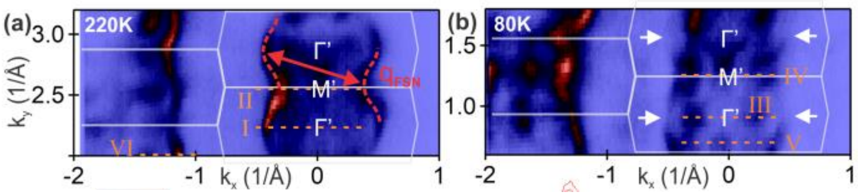
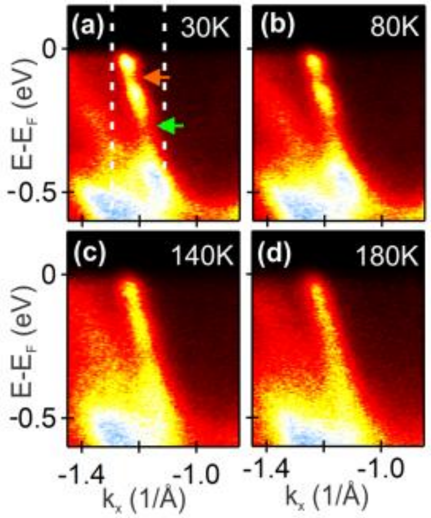
Project Summary: The formations of charge and lattice orders are generally coupled in charge density wave (CDW) materials. Although this situation is usually satisfied in a large class of two-dimensional materials, it falls short in describing the so-called CDW-like phase transition in layered $TaTe_2$, accompanied by anomalous low temperature transport properties and a periodic lattice distortion. Prof. Lanzara' group at Lawrence Berkeley National Laboratory recently studied the anomalous CDW phase transition of $TaTe_2$ using ARPES and low-energy electron diffraction. Their data reveal the presence of a surprising quasi-one-dimensional Fermi surface with nesting condition. They find that the wave vectors of the Fermi surface nesting and periodic lattice distortion are different, suggesting the decoupled formation between charge and lattice orders. This work provides routes for forging unconventional CDW phases and charge-lattice entanglement that would otherwise not be available in materials with fixed dimensionality. The detailed findings are published in Phys. Rev. Res. 4, L022009 (2022).

2DCC Role: The high-quality $TaTe_2$ single crystals used in this study were synthesized using the 2DCC facilities. The close collaboration between 2DCC researchers and the users, together with the 2DCC's combined capacity of bulk crystal growth and characterization, enable this achievement.





Top panels: Fermi surface of (a) high-temperature -$TaTe_2$ and (b) low-temperature-$TaTe_2$. The red vector in (a) denotes the fermi surface nesting wave vector.
Left panel: Temperature-dependent dispersion curves near Γ' measured by ARPES, from which minigaps are probed at low temperatures. The orange and green arrows point to the minigaps.