Observation of charge density wave excitonic order parameter in topological insulator monolayer WTe_2

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Strong electron-hole interactions in a semimetal or narrow-gap semiconductor may drive a ground state of condensed excitons. Monolayer WTe_2 has been proposed as a host material for such an exciton condensate, but the order parameter – the key signature of a macroscopic quantum-coherent condensate – has not been observed. Here we report quasi-particle interference (QPI) in monolayer WTe_2[1]. In WTe_2 on graphene, in which the carrier density can be varied via back-gating, QPI confirms the interacting nature of the bandgap in neutral WTe_2 and the semi-metallic nature of highly n- and p-doped WTe_2. For WTe_2 on graphite, we observe additional non-dispersive spatial modulations in the local density of states imprinted on the topological edge mode, which we interpret as the interaction of the topological edge mode with the expected charge density wave order parameter of the excitonic condensate in WTe_2 at low interaction strength due to screening by the metallic substrate[2]. Time permitting, I will also discuss recent angle-resolved photoemission spectroscopy experiments on monolayer WTe_2 on bulk MoS_2 which probe the negative capacitance of the MoS_2 surface due to strong electron-electron interactions[3].

References

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[2] M. Papaj, *Phys. Rev. B* **110**, 165422 (2024).
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Figures

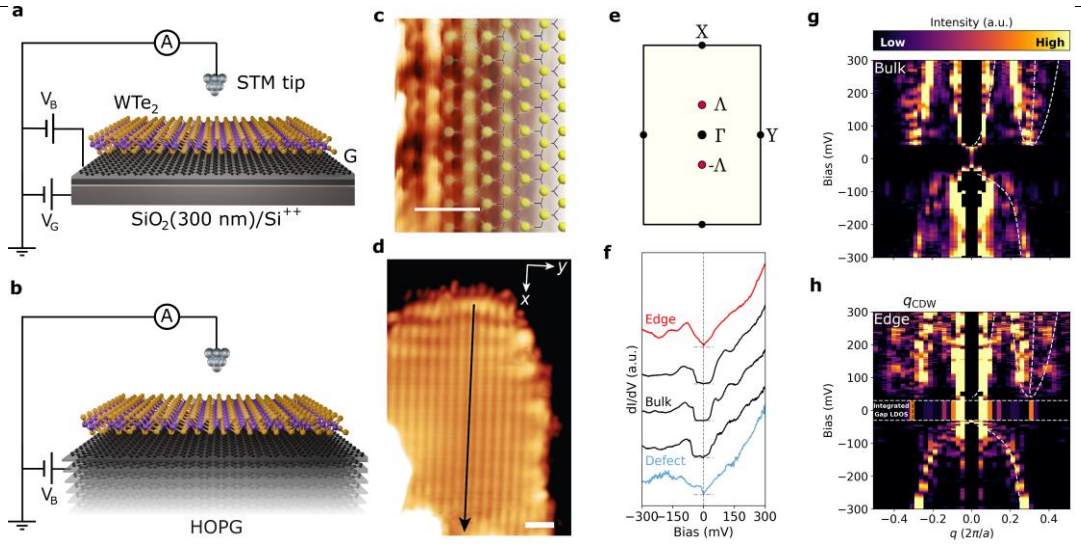

Figure 1: (a,b) Measurement setup for scanning tunnelling microscopy experiments on WTe_2 on graphene (gated) and graphite. (c,d) Scanning tunneling microscope topographs of WTe_2 on graphite, with atomic structure overlaid in (c). First Brillouin zone of WTe_2. The high symmetry points (Γ, X, Y) and electron hole pockets ±Λ are indicated. (f) Differential conductance (dI/dV) measured along the black arrow in (d). The edge, bulk and defect regions are indicated. (g,h) Quasiparticle interference spectra for (g) bulk, and (h) edge regions of WTe_2. In (h), the spectra for -30 meV < V_B < 30 meV are integrated and shown as a single spectrum within the dashed lines. The non-dispersive wavevector of the charge density wave order parameter q_{CDW} can be seen in (h).