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Weakly Bound and Strongly Interacting: $NbSe_2$ and 1T-TaS_2 in the 2D Limit

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The layered metallic dichalcogenides are known to exhibit rich collective electron phases such as charge density waves, spin density waves, and superconductivity. In the past, studies on graphene and various semiconducting dichalcogenides have shown that taking layered materials to their physical two-dimensional (2D) limit leads to fundamental changes in band structure, allowing for a powerful experimental knob to tune for electronic functionality. In contrast, due to their instability in the ambient environment, the effect of thickness control over such collective electron phases has been largely unexplored in metallic systems. We have recently demonstrated a new experimental platform for the isolation and assembly of environmentally sensitive 2D materials in inert atmosphere. I will discuss our recent studies of the charge density wave material 1T-TaS_2 and superconducting $NbSe_2$ in the atomically thin limit, made possible using this technique. For 1T-TaS_2, we find that the lock-in transition to commensurate charge ordering becomes increasingly metastable for reduced thickness, allowing for all-electrical control over this phase transition in the 2D state. In $NbSe_2$, a small magnetic field induces a transition to a quantum metallic phase, the resistivity of which obeys a unique field-scaling property. These methods and experiments open new doors for the study of other correlated 2D materials in the immediate future.