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QUANTUM DEVICES WITH 2D SEMICONDUCTORS AND INSULATORS

Hugh CHURCHILL

Department of Physics, University of Arkansas, Fayetteville, AR 72701, USA
churchill@uark.edu

In this talk I will describe two applications of 2D layered materials for quantum devices. First, I will discuss our work to fabricate and characterize gate-defined, accumulation mode quantum dots using monolayer and bilayer WSe_2 (**Figure 1**) [**1**]. The devices are operated with gates above and below the WSe_2 layer to accumulate a hole gas, which for some devices is then selectively depleted to define the dot. Temperature dependence of conductance in the Coulomb-blockade regime is consistent with transport through a single level, and excited-state transport through the dots is observed at temperatures up to 10 K. These devices provide a platform to evaluate valley-spin states in monolayer and bilayer WSe_2 for application as qubits. Second, I will discuss gate-tunable Josephson junction field-effect transistors (JJ-FETs) based on Al/InAs in which the gate dielectric is thin hBN [**2**]. Comparing devices with hBN and AlO_x dielectrics, we observe that the product of normal resistance and critical current, I_cR_n, is comparable for both types of devices, but strikingly higher R_n for the hBN-based devices indicating that the surface is doped less compared to AlO_x gate dielectric. These results demonstrate that h-BN provides a superior gate dielectric compared to AlO_X for JJ-FET devices with applications in superconducting logic and quantum information technologies such as gatemon qubits and topological superconductivity.

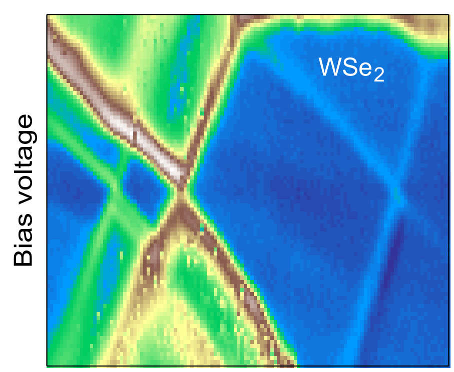

Figure 1. Coulomb diamond with resolved excited states for a gate-defined bilayer WSe_2 quantum dot.

References

[**1**] S. Davari, *et al.* Phys. Rev. Appl. **13**, 054058 (2020).
[**2**] W. Mayer, *et al.* arXiv:2007.12202.