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(G*) Gated quantum structures in 2D semiconductors

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Quantum confinement in two-dimensional (2D) transition metal dichalcogenides (TMDs) offers the opportunity to create unique quantum states that can be practical for quantum technologies. The interplay between charge carrier spin and valley, as well as the possibility to address their quantum states electrically and optically, makes 2D TMDs an emerging platform for the development of quantum devices.

In this talk, we present the fabrication of a fully encapsulated monolayer tungsten diselenide (WSe2) based device in which we realize gate-controlled hole quantum dots. We demonstrate how our device architecture allows us to identify and control the quantum dots formed in the local minima of electrostatic potential fluctuations in the WSe2 using gates. Coulomb blockade peaks and diamonds are observed which allow us to extract information about the dot diameter and its charging energy. Furthermore, we demonstrate how the transport passing through the channel formed by two gates is sensitive to the occupation of a nearby quantum dot. Additionally, we show how this channel can be tuned to be in the charge detection or the Coulomb blockade regime. Finally, we present a new device architecture which exhibits quantized conductance plateaus over a channel length of 600 nm at a temperature of 4 K. Quantized conductance over such a long channel provides an opportunity to incorporate gate defined quantum dot circuits without the nuisance of inhomogeneity within the channel.

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