Quantum transport in van der Waals heterostructures at room temperature

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Interfacial charge transfers and Coulomb interaction at the semiconductor heterostructures give rise to emergent phenomena, which are attractive for both fundamental and applied physics [1, 2]. In conventional epitaxially grown heterostructures, mostly based on III-V semiconductors, the Coulomb interaction of charge carriers is typically weak due to small exciton binding energy and strong screening effects. These conditions render a weak interlayer charge coupling even though the interface in this structure is clean and abrupt. As a result, the quantum phenomena were usually observed at cryogenic temperature, which severely limits their novel physics for pragmatic applications. Van der Waals heterostructures, which consist of two-dimensional layered materials components, have been emerging as promising candidates for studying quantum phenomena at high temperature owing to their strong Coulomb interaction and weak screening effects. The exciton binding energy in these heterostructures has been reported in the range of hundreds of meV, allowing to observing various quantum phenomena at much higher temperature, and even at room temperature [3]. In this presentation, we report observation of the room-temperature quantum interference and Coulomb drag in the multilayer WSe_2 transistor *via* graphene contacts to its top and bottom layers separately. Central layers of WSe_2 act as an insulating region with few-nanometer width, which separate the top and bottom conducting channels spatially and provide a strong Coulomb interaction between them, leading to observing large conductance oscillations at room temperature [4]. The gradual suppression of the oscillations with increasing applied magnetic field and/or injected current further confirms the quantum interference phenomenon. As the temperature decreases, the Coulomb drag effect is obviously represented in the system due to the extended thickness of the insulating region. We also report spin transports in these heterostructures at room temperature under external magnetic field. Our results open up a new opportunity for realization of advanced quantum electronics and spintronics operating at high temperature.

References

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