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Title of the Presentation: Quantum transport in graphene/hexagonal boron nitride superlattices

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Short Biography:

Iwasaki received B.Sc. from Tokyo Denki University in 2012, and M.Sc. from Japan Advanced Institute of Science and Technology (JAIST) in 2014. In 2017, he received Ph.D. from JAIST and completed Research Co-supervision Programme undertaken in collaboration with the Univ. of Southampton. He was the Japan Society for the Promotion of Science (JSPS) Fellow (2017-2018), International Center for Young Scientists Research Fellow at NIMS (2018-Oct. 2020). Currently, he is Independent Scientist at MANA, NIMS. His research interest is quantum transport phenomena in nanodevices based on two-dimensional materials and heterostructures.

Abstract:

Graphene stacked on hexagonal boron nitride (hBN) with the crystallographic axis alignment generates a long-period superlattice potential because of a lattice-constant mismatch of ~1.8%. This moiré superlattice breaks inversion symmetry and modifies the electronic band structure of graphene. Many exotic transport properties have been intensively examined in such superlattices [1], but previous studies have not focused on single-carrier transport. The investigation of the single-carrier behavior in these superlattices would lead to an understanding of the transition of single-particle/correlated phenomena.

Here, we show the single-carrier transport in a high-quality bilayer graphene/hBN moiré superlattice-based quantum dot device (Fig. 1(a)) [2]. To fabricate the high-quality device, we develop an original transfer technique that can assemble the 2D heterostructures without interfacial bubbles [3]. We demonstrate remarkable device controllability in the energy range near the charge neutrality point (CNP) and the hole-side satellite point (Fig. 1(b)). Under a perpendicular magnetic field, Coulomb oscillations disappear near the CNP, which could be a signature of the crossover between Coulomb blockade and quantum Hall regimes. Our results pave the way for exploring the relationship of single-electron transport and fractal quantum Hall effects with correlated phenomena in two-dimensional quantum materials.

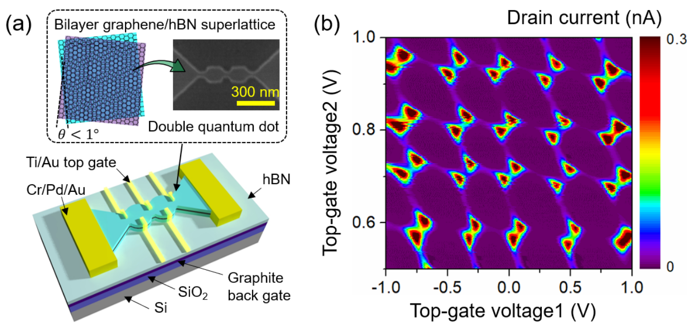

Fig. 1. (a) Schematic and SEM image of the moiré superlattice quantum dot device. (b) Stability diagram of the double quantum dot device at 40 mK.

[1] K. Endo et al., Appl. Phys. Lett. 114, 243105 (2019).
[2] T. Iwasaki et al., Nano Lett. 20, 2551-2557 (2020).
[3] T. Iwasaki et al., ACS Appl. Mater. Interfaces 12, 8533-8538 (2020).