Center for Artificial Low D Electronic Systems

2023 IBS-CALDES Seminar

- ✓ **Date & Time:** March 27 (Mon), 2023, 4:00PM
- ✓ **Venue : Seminar Room 302m Science Building #3**
- ✓ **Speaker & Title**

  Prof. Youngwook Kim (DGIST)

  Quantum Hall superfluid in twisted bilayer/double bilayer graphene

Organized by Dr. Jhin Hwan Lee (jhinhwan@ibs.re.kr, 054-279-9894)

- **04:00PM~**

Quantum Hall superfluid in twisted bilayer/double bilayer graphene

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We introduce a novel two-dimensional electronic system with ultrastrong interlayer interactions, namely twisted bilayer graphene with a large twist angle, as an ideal ground for realizing interlayer-coherent excitonic condensates. In these systems, subnanometer atomic separation between the layers allows significant interlayer interactions, while interlayer electron tunneling is geometrically suppressed due to the large twist angle. By fully exploiting these two features we demonstrate that a sequence of odd-integer quantum Hall states with interlayer coherence appears at the second Landau level (N = 1). Notably the energy gaps for these states are of order 1 K, which is several orders of magnitude greater than those in GaAs. Furthermore, a variety of quantum Hall phase transitions are observed experimentally. All the experimental observations are largely consistent with our phenomenological model calculations. Hence, we establish that a large twist angle system is an excellent platform for high-temperature excitonic condensation.

We also observed similar states in a stack of two decoupled graphene bilayers. Indeed, such a Bose-Einstein condensate is observed for half filling in each bilayer sheet when the partially filled level has orbital index 1, whereas it is absent for partially filled levels with orbital index 0. The application of asymmetric top and bottom gate voltages enables to influence the orbital nature of the electronic states of the graphene bilayers and to navigate in an orbital mixed space. The latter hosts an even denominator fractional quantum Hall state at total filling -3/2. Our observations suggest a unique edge construction involving both electrons and chiral p-wave composite fermions.