Center for Artificial Low D Electronic Systems

2020 Fall Seminar
with CALDES, IBS & SRC, POSTECH

- ✓ **Date&Time:** October 16 (Fri), 3:00PM~
- ✓ **Venue:** Online (Zoom)
- ✓ **Speaker & Title**

1) 3:00PM~ Prof. Sungjae Cho (KAIST)
   Thickness-Controlled Black Phosphorus Tunnel Field-Effect Transistor for Low Power Switches

2) 4:10PM~ Prof. Noejung Park (UNIST)
   Time-dependent density functional theory calculations of spin-phonon dynamics and band topology of two-dimensional materials

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- **3:00PM~**

Thickness-Controlled Black Phosphorus Tunnel Field-Effect Transistor for Low Power Switches

Sungjae Cho
Department of Physics, KAIST

The continuous transistor down-scaling has been the key to the successful development of the current information technology. However, with Moore's law reaching its limits the development of alternative transistor architectures is urgently needed1. Transistors require at least 60 mV switching voltage for each 10-fold current increase, i.e. subthreshold swing (SS) 60 mV/dec. Alternative tunnel field-effect transistors (TFETs) are widely studied to achieve a sub-thermionic SS and high I60 (current where SS becomes 60 mV/dec) 2. Heterojunction (HJ) TFETs bear promise to deliver high I60, but experimental results do not meet theoretical expectations due to interface problems in the HJs constructed from different materials. Here, we report a natural HJ-TFET with spatially varying layer thickness in black phosphorus (BP) without interface problems. We achieved record-low average SS over 4–5 decades of current, SSave_4dec ≈ 22.9 mV/dec and SSave_5dec ≈ 26.0 mV/dec with record-high I60 (= 0.65–1 μA/μm), paving the way for the application in low power switches.

- **4:10PM~**

Time-dependent density functional theory calculations of spin-phonon dynamics and band topology of two-dimensional materials

Noejung Park
Department of Physics, UNIST

Topological states have commonly been cited as a new classification of materials, and global properties immune to local perturbations have been suggested in terms of topological invariants or associated quantities. For real materials, actual computations for them have been achieved through the theories of linear responses over the static ground electronic structure. In this talk, I first summarize our proposal for alternative ways of computation: calculating the real-time evolution of the Hamiltonian, letting the pumping parameter run periodically through the geometric space of the Hamiltonian. As test examples of this method, we present a trivial insulator, a spin-frozen valley-Hall system, a spin-frozen Haldane-Chern insulator, and a quantum spin-Hall insulators. In later part, we also demonstrate the spin precession dynamics of MoS2, in which the spin is strongly coupled to the optical phonon. This dynamical spin state can be resolved into discrete Floquet-phononic spectra, and once the phonon is pumped so as to break time-reversal symmetry, the resulting spin-Floquet structures induce net out-of-plane magnetizations in the otherwise non-magnetic 2D material.