**Intrinsic transport properties of emerging materials and nanostructure electron device applications**

Two-dimensional materials are exciting electron systems for exotic electron physics as well as diverse potential device applications. In this talk, I will talk about our studies on fundamental transport properties of emerging semiconducting materials and, based on such basic studies, the development of nanostructure electron device applications. First, the talk will introduce a non-local direct chemical potential measurement technique using double quantum well heterostructures.  The chemical potential vs density of bilayer graphene was directly measured using the technique, which show signatures of electron-electron interactions and an electron-hole asymmetry.  The quantum Hall effect of bilayer graphene will be also briefly discussed.  The talk will then move on to four-probe intrinsic transport measurements on two-dimensional Indium Selenide (InSe). In particular, the mobility properties of InSe as a function of carrier density, temperature, and electric field will be addressed, accompanied with the discussion of the limiting electron scattering mechanisms in InSe. Lastly, the talk will present negative differential transconductance observed in novel InSe/BP heterostructures based on dynamic band alignment modulation, which can be employed for low-power multi-valued logic devices.