Chez Pierre

Presents ...

Monday, December 10, 2018

12:00pm Noon

MIT Room 4-331

Chez Pierre Seminar

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"Quantum Hall Effect and Tunneling in Transition Metal Dichalcogenide Heterostructures"

Transition metal dichalcogenides have attracted significant interest because of their two-dimensional crystal structure, large band-gap, and strong spin-orbit interaction. Recent advances in sample fabrication have allowed the experimental study of low temperature magneto-transport of high mobility holes in WSe_2, and electrons in $MoSe_2$ and MoS_2. We review here the main results of these studies, which reveal clear quantum Hall states, and allow the extraction of fundamental electronic properties, such as carrier effective mass at band extrema, Landau level degeneracy, and spin-orbit coupling induced band splitting. The carrier density dependence on gate bias reveals negative electronic compressibility, and the quantum Hall state sequence dependence on carrier density reveals an interaction-enhanced Landau level Zeeman splitting consistent with the large (0.5-1m_e) carrier effective mass measured in these materials.

We also discuss the realization of rotationally controlled WSe_2 double layers separated by hexagonal boron-nitride tunnel barriers. In samples where the two WSe_2 monolayers are rotationally aligned, we observe energy- and momentum-conserving (resonant) tunneling, manifested by a large conductance and negative differential resistance. In heterostructures where the two WSe_2 monolayers have a 180° relative twist, such that the Brillouin zone of one layer is aligned with the time-reversed Brillouin zone of the opposite layer, the resonant tunneling between the layers is suppressed. These findings provide evidence that, in addition to momentum, the spin-valley degree of freedom is conserved in vertical transport.