

THE CHINESE UNIVERSITY OF HONG KONG
Department of Physics
SEMINAR

**Collective Phenomena in Double Layer Transition
Metal Dichalcogenides: Quantum Melting of The
Electron Solid and Release from Boltzmann's tyranny;
Supersolid Type Behaviour in Exciton Solids**

by

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ALL INTERESTED ARE WELCOME

Abstract

We discuss recent results on electron-electron and electron-hole plasma induced by external gates in double layer MoS_2 separated by a 5 nm thick BN film. The electron system can form solids that can exist in different symmetries with a melting temperature four orders of magnitude larger than previous results in MOSFETs and GaAs heterostructures. The solidification is accompanied by an increase of the Coulomb drag resistance from Ohms to 100 MegaOhms. This can be exploited as a switch. To cause the current to change by a factor of 10, for present day technology with MOSFETs, the lowest voltage is 60 mV, governed by Boltzmann's distribution (the so-called Boltzmann's tyranny). For our system, the lowest voltage change is 10^{-4}V . The different crystalline symmetries of the electron solid has the potential to be exploited so that the device state is not just on and off, but can have more than two choices. We next discuss the physics.

In two dimensions solids have no long range order but is characterized by a finite shear modulus. The classical description was discussed by Kosterlitz and Thouless in terms of dislocation unbinding. The electron system is quantum mechanical. We discuss quantum dislocations and its coupling to the zero point energy of the phonon field. The quantum dislocation provides for activation type transport at finite temperatures that is observed experimentally. The density dependence of the activation energy provides for an estimate of the quantum effect. The melting temperature is proportional to the shear modulus, which is an order of magnitude higher for the potential modified by the experimental structure.

For the e-h system, the Coulomb drag resistance exhibits plateaus with magnitudes of the order of e^2/h . We found that the system forms an exciton solid because of the effect of the BN. The quantum edge defects exhibits supersolid type behaviour with resistance of the order of e^2/h .