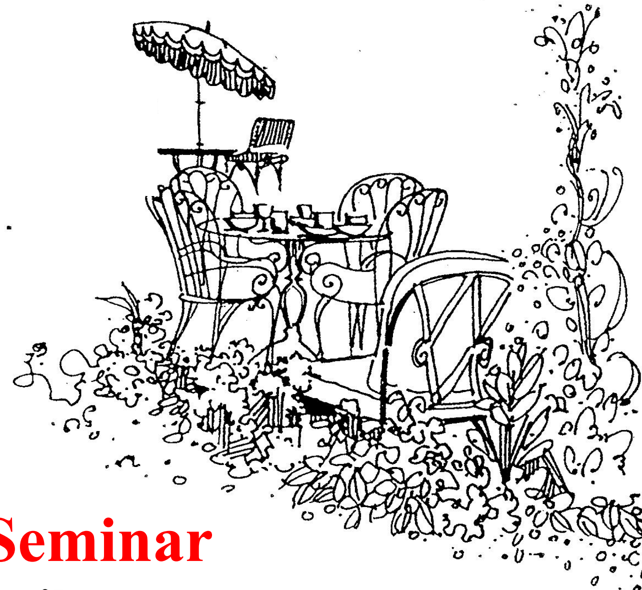
Chez Pierre

Presents ...

Monday, March 21, 2016

12:00pm

MIT Room 4-331



Chez Pierre Seminar

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National University of Singapore

" Controlling many-body states and spin transport in a two-dimensional materials by the electric field effect"

To understand the complex physics of a system with strong electron-electron interactions, the ideal is to control and monitor its properties while tuning an external electric field applied to the system (the electric field effect). Indeed, complete electric-field control of many body states in strongly correlated electron systems would be of great advantage in future condensed matter research. Similarly, the electric field control of spin transport is crucial for many novel device concepts in the field of spintronics. In contrast to bulk materials, two-dimensional material are inherently thin and thus, avoid or at least sufficiently minimize electric screening. This allows their charge-carrier density and/or their spin accumulation or in some cases both to be controlled by electrostatic gating. However, up until recently the choices of 2D materials for such studies was constrained to air-stable crystals. The recent ability to encapsulate 2D materials with atomically thin boron nitride (BN) in an inert gas environment has largely removed this constrain. In my talk I will give three examples. First, I will start with octahedral titanium diselenide (1T-TiSe2), which reveals a charge-density wave and superconductivity in its phase diagram. By combining BN with electrolyte gating we were able to achieve unprecedented control over both the charge density wave transition temperature and over the superconductivity transition temperature [2]. Next I will discuss experiments with Au intercalated van der Waals heterostructures of graphene and hexagonal boron nitride. Pristine graphene has negligible spin-orbit coupling (SOC). However, magneto-transport studies suggest that such intercalation leads to a bulk in-plane spin splitting and a Rashba-interaction with magnitude of 25 meV. A large negative magneto-resistance and a field induced anomalous Hall effect at low magnetic fields < 1T demonstrates that the system obtains a magnetic moment. Persistence of these effects to room temperature suggests the potential of intercalated graphene heterostructures as a dilute magnetic semiconductor. The third example is the all electrical spin injection into black phosphorus. I will demonstrate that ultra-thin, semiconducting black phosphorus is an ideal spin channel material. Based on measurements in the non-local spin valves geometry with pure spin currents, we show that the spin relaxation times can be as high as ~ 4ns with spin relaxation lengths exceeding 6 μm. These values are an order of magnitude higher than what has been measured in graphene and other metals. I will further demonstrate that the spin transport can be manipulated in a transistor-like manner by just controlling the gate voltage. I will conclude my talk with a brief overview on our recent progress in large area CVD graphene research, e.g. it's use as an anti-oxidation barrier film for magnetic hard disc drives.

[1] Transport properties of pristine few-layer black phosphorus by van der Waals passivation in inert atmosphere;
Doganov, R. A., O'Farrell, E. C. T., Koenig, S. P., Yeo, Y., Ziletti, A., Carvalho, A., Campbell, D. K., Coker, D. F., Watanabe, K., Taniguchi, T., Castro Neto, A. H., and Oezyilmaz, B.; Nature Comms., 6: 6647 (2015).
[2] Controlling many-body states by the electric field effect in a two-dimensional material;
Li, L. J., O'Farrell, E. C. T., Loh, K. P., Eda, G., Oezyilmaz, B., and Castro Neto, A. H. Nature 529, 185–189 (2016).