GRAPHENUS

Welcome to a this new, informal and interdisciplinary seminar series on recent graphene related research activities at NUS. The talks are designed to be accessible also by non-experts and we encourage everyone including students and post-docs to attend. Each session consists of two talks of ~ 30 minutes with a short coffee break in between.

Friday, Oct. 16 at 12:30pm-2 pm; Conference room S13-M-11
(Coffee and Sandwiches will be provided during)

1)Ultracold fermions in a graphene-type optical lattice

Prof. Benoit Gremaud (Visiting Prof. , Centre for Quantum Technologies (CQT))

Ultracold fermions in a graphene-type optical lattice In a first part, I will present the possibility of studying the physics of graphene using cold atoms in an optical lattice generated by the coherent superposition of three coplanar running laser waves with respective angles $2\pi/3$. We also analyze imperfections in the laser configuration as they lead to optical lattice distortions which affect the Dirac fermions. We show that the Dirac cones do survive up to some critical intensity or angle mismatches which are easily controlled in actual experiments. We also briefly discuss the interesting possibility of fine-tuning the mass of the Dirac fermions by controlling the laser phase in an optical lattice generated by the incoherent superposition of three coplanar independent standing waves with respective angles $2\pi/3$.

In a second part, the attractive Hubbard model on a honeycomb lattice is studied using determinantal quantum Monte Carlo simulations. At half-filling and zero temperature, there is a quantum phase transition at $5.0<U_c/t<5.1$ from a semi-metallic phase to a phase that simultaneously displays phase and density orders. Doping away from half filling, at finite but low temperature, the system always appears to be a superfluid exhibiting a crossover between a BCS regime and a molecular regime as the interaction is increased. These different regimes are analyzed by studying the spectral function. The formation of pairs and the emergence of phase coherence are studied as functions of temperature and interaction strength.

2) Gate-Controlled Non-volatile Graphene-Ferroelectric Memory

Dr. Yi Zheng (Post-doctoral Fellow, Őzyilmaz Group, Physics Department)

We demonstrate a non-volatile memory device in a graphene field effect transistor structure using ferroelectric gating. The binary information, i.e. “1” and “0”, is represented by the high and low resistance states of the graphene working channels, which are controlled by the hysteretic electrostatic doping of graphene by electric dipoles at the ferroelectric/graphene interface. Non-volatile switching can be realized by alternately polarizing and depolarizing the ferroelectric thin film using asymmetrical gate voltage sweep, i.e. asymmetrical bit writing. By introducing a background doping in graphene using normal dielectric gating, the hysteretic ferroelectric doping can be unidirectionally shifted, and symmetrical bit writing has been demonstrated with non-volatile resistance change exceeding 500% and reproducible switching over 10^5 cycles.

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