Chez Pierre

Presents ...

Monday, April 6, 2020

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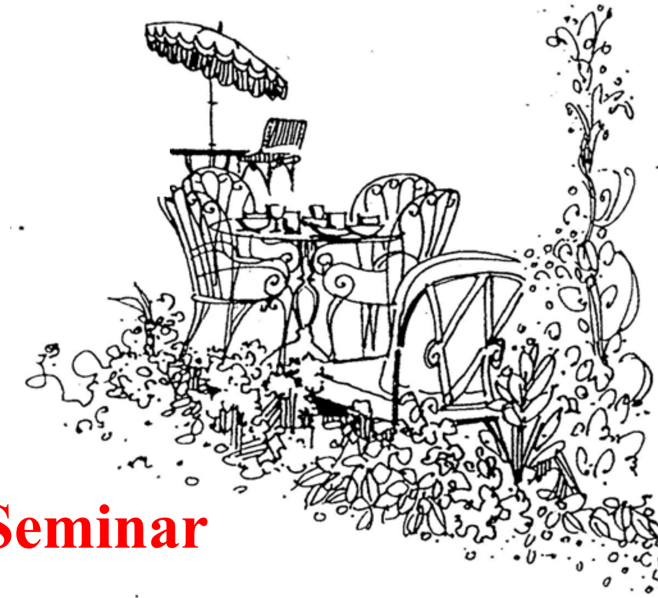
Broadcast via Zoom



Chez Pierre Seminar

Yuan Cao – Massachusetts Institute of Technology

"Competing Orders, Nematicity and Novel Josephson Effects in Superconducting Graphene Superlattices"

The emergence of two-dimensional materials have provided physicists with unprecedented way of studying the motion of electrons in a superconductor. Although superconductivity itself has been studied for more than a century, the recent advances of "twistronics" research in graphene superlattices brings fundamentally new physics into the picture [1,2]. In this talk I will present that demonstrate some peculiar aspects of magic-angle twisted bilayer graphene (MATBG) which has recently been discovered to exhibit correlated insulating phase and unconventional superconductivity. In an in-plane magnetic field, MATBG exhibits a highly anisotropic critical magnetic field within the sample plane that strongly suggests nematicity in the superconductivity. Furthermore, the phase diagrams of some MATBG samples show a distinctive kink in Tc in the 'underdoped' region which is reminiscent of quantum critical point behavior in some cuprates such as $YBa_2Cu_3O_{6+\delta}$[3]. These observations signify the similarity between MATBG and established strongly-correlated systems, and might provide key insight into the underlying mechanism that is responsible for the emergence of 2D unconventional superconductivity. In a second experiment, we performed transport experiments on versatile gate-defined planar junction devices made from MATBG. Our results show that using this device geometry, all-graphene Josephson junctions can be realized by electrostatic gating with configurable tunneling barrier type and strength. Furthermore, we find peculiar Fraunhofer pattern in a magnetic field that exemplifies the intrinsic low dimensionality of the superconducting phase. These results pioneer in novel superconducting devices based on twisted bilayer graphene and might be utilized in future magnetic field sensing applications. I will also briefly discuss some effort we spent to explore other twisted systems beyond MATBG.

[1] Y. Cao *et al.*, *Nature* **556**, 80-84 (2018)
[2] Y. Cao *et al.*, *Nature* **556**, 43-50 (2018)
[3] B. J. Ramshaw *et al.*, *Science* **348**, 317-320 (2015)