Chez Pierre

Presents ...

Monday, February 5, 2018

12:00pm Noon

MIT Room 4-331

Chez Pierre Seminar

Hadar Steinberg – Racah Institute of Physics, Hebrew University, Jerusalem, Israel

"Spectroscopy of bulk and ultrathin $NbSe_2$ with van-der-Waals tunnel junctions"

Superconductors of the transition metal dichalcogenide (TMD) family have seen a revival of interest subsequent to developments in device fabrication by mechanical exfoliation. Recent studies[1] show that at the ultrathin limit, $NbSe_2$ and similar TMDs can sustain superconductivity at very high in-plane magnetic fields, well beyond the Pauli limit[2]. This apparent stability is associated with Ising spin-orbit coupling, which keeps spins oriented out of the sample plane, thereby providing strong protection against depairing. In my talk, I will report our recent spectroscopy measurements of $NbSe_2$ using vdW tunnel devices[3]. Our devices are fabricated by placing insulating barriers on top of exfoliated $NbSe_2$ using the mechanical transfer technique. The resulting tunnel junctions exhibit extremely stable currents, and are characterized by a hard gap. At mili-Kelvin temperatures, the tunneling spectra exhibit a well-resolved separation into a two-gap structure. We show that by applying in-plane magnetic fields to bulk devices (20-50 nm thick), it is possible to distinguish between the kinematics of quasiparticles which belong to different gaps. When probing ultra-thin devices (3-4 layers), we find the larger energy gap to be almost fully protected to depairing, an effect consistent with transport studies. Finally, I will discuss the implications of our technique to vortex-bound state spectroscopy.

1. X. Xi, Z. Wang, W. Zhao, J.-H. Park, K. T. Law, H. Berger, L. Forró, J. Shan & K. F. Mak. Ising pairing in superconducting NbSe2 atomic layers. **Nature Physics 12**, 139-143 (2016).

2. J. M. Lu, O. Zheliuk, I. Leermakers, N. F. Q. Yuan, U. Zeitler, K. T. Law & J. T. Ye. Evidence for two-dimensional Ising superconductivity in gated MoS2. **Science 350**, 1353-1357 (2015).

3. **Dvir et al., arxiv:1711.09615**