Massachusetts Institute of Technology
Department of Physics

Condensed Matter Theory Seminar

"Superconductivity by alkali-metal intercalation: superconducting graphene, phosphorene, and a topological insulator"

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Abstract: I will review our recent findings of superconductivity achieved by alkali-metal doping (intercalation). In the case of graphene, despite the long list of exceptional electronic properties and many theoretical predictions regarding the possibility of superconductivity in graphene, its direct and unambiguous experimental observation has not been achieved. We searched for superconductivity in graphene by alkali-metal intercalation of the so-called graphene laminates, consisting of well separated and electronically decoupled graphene crystals. We found robust superconductivity as a result of Ca intercalation and were able to tune the superconducting response by varying the degree of doping of graphene and confinement of the metal layer. This showed that achieving superconductivity in free-standing, metal decorated monolayer graphene is conditional on the optimum confinement of the metal layer and sufficient doping.

In the case of phosphorene, we were able to achieve superconductivity by intercalating different alkali/alkali-earth metals (Li, K, Rb, Cs, Ca) into single crystals of black phosphorus. This made black phosphorus into a superconductor with the transition temperature and other characteristics of the superconducting state independent of the intercalant (same T_c =3.8±0.05 K, same critical magnetic field, anisotropy, flux pinning). We attribute such highly unusual universal superconductivity to superconducting pairing within the heavily-doped individual phosphorene layers, while the intercalated layers of metal atoms play mostly the role of charge reservoirs.

In our most recent work we used K, Rb and Cs intercalation to make three new superconductors from an archetypal topological insulator, Bi_2Se_3. The three materials show qualitatively identical but very puzzling behaviour of magnetization, with several new features, never observed in intrinsic superconductors before. I will show that their unusual behaviour is consistent with characteristics of a topological superconductor.

2:00pm
Friday, June 9, 2017
Duboc Room (4-331)

Host: Leonid Levitov