Evidence for Graphene-Sheet-Driven Superconducting State in Graphite Intercalation Compounds

Graphite intercalation compounds (GICs) are formed by the insertion of arrays of guest species between the layered sheets of the graphite host. This can greatly modify the electronic properties of the graphite and can lead to interesting phenomena, for example, superconductivity. Research into superconductivity in GICs was reinvigorated by the discovery, at the LCN, of superconducting transition temperatures (T_c) orders of magnitude higher than the previous record, in CaC_6 (Weller et al Nature Phys 1, 39 2005). Despite significant recent activity in this area, the nature of the superconducting mechanism is still under debate. Although theory and experiment point towards conventional. electron-phonon mediated (BCS) superconductivity, some important details are still unknown. Most importantly, the exact identity of the electrons and phonons involved.

In a recent paper in Physical Review Letters, researchers from the Brookhaven National Laboratory, in collaboration with the London Centre for Nanotechnology (Chris Howard and Mark Ellerby), have mapped the electronic structure of superconducting GIC, KC_8 and non-superconducting LiC_6. Their work exposes anomalies or kinks in the electronic structures of these materials arising from an electron-phonon interaction. Analysis of this data permits an extraction of the strength of the electron-phonon coupling which, together with similar data from CaC_6, is shown to follow the trend in T_c in these materials.

The main finding is that electron-phonon coupling between graphene derived electrons and graphene derived phonons is sufficient to yield superconductivity without any contribution from intercalant derived electronic bands or phonons. This is important because it points towards superconductivity in the closely related and technologically relevant materials, carbon nanotubes and graphene.

This work has been published in Physical Review Letters (Z-H Pan et al. Phys. Rev. Lett. 106, 187002, (2011))

Journal link: http://prl.aps.org/abstract/PRL/v106/i18/e187002

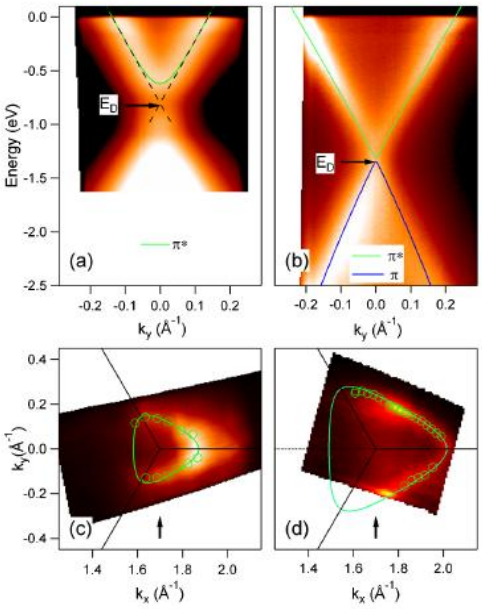

Figure: Electronic structure of LiC_6 (left) and KC_8 (right) Position of the Dirac point is marked (E_D).