When Mott meets BCS.
Molecular conductors and the search for high-Tc superconductivity

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A widespread belief considers electron-phonon superconductors -explained by Bardeen-Cooper-Schrieffer theory- and exotic superconductors -dominated by electron-electron correlations- two independent families with strikingly different properties, starting from the critical temperature.
We show that molecular crystals based on large organic molecules challenge this distinction, and we have now convincing evidence that electron-phonon superconductivity and the Mott physics due to strong correlations can actually coexist and cooperate. This can be the case of organic superconductors like alkali-metal doped fullerides and in particular Cs_3C_{60} [1]

In the first part of the talk we remind how a phonon-driven superconductor emerges when pressure is applied onto an antiferromagnetic Mott insulators in Cs_3C_{60}, and we discuss the general framework to understand the properties of these materials [2].

In the second part of the talk we move to aromatic molecular solids, a new field opened in 2010 with the discovery of superconductivity with T_c=18K in potassium-doped picene [3]. We now have at least four superconductors in this family with critical temperature up to 33K. We discuss the role of electron-electron correlation [4] and electron-phonon interactions in these materials and we argue that the same mechanism we identified in fullerides is likely at work.

[1] Y. Takabayashi et al., Science 323, 1585 (2009); A.Y. Ganin et al. Nature Materials 7 367 (2008)

[2] M. Capone, M. Fabrizio, C. Castellani and E. Tosatti, Rev. Mod. Phys. 81, Rev. Mod. Phys. 81, 943 (2009); Science 296, 2364 (2002)

[3] R. Mitsuhashi et al. Nature 464. 76 (2010)

[4] G. Giovannetti and M. Capone, Phys. Rev. B 83, 134508 (2011)