A status report on BiS_2-based Superconductors: where are we?

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In 2012, a new family of layered superconductors was discovered [Phys. Rev. B **86**, 220510 (2012) and J. Am. Chem. Soc. **134**, 16504 (2012)]. It contained planes of Bismuth and Sulfur ($\mathbf{BiS_2}$) where it is believed that the superconductivity originates. Since then, close to a 100 experimental and 20 theory papers have been published (or posted in the arXiv repository). Nonetheless, we are not any closer to ascertaining if $\mathbf{BiS_2}$ superconductivity is phonon-mediated or not. On one hand, several similarities with the cuprates and pnictides indicate the possibility of an unconventional pairing mechanism. On the other hand, contrary to cuprates and pnictides, the existence of only p- and s-type bands close to the Fermi energy indicates that strong (or even intermediate) electron correlations should not play a role in the superconducting properties. This is reinforced by comparing Angular Resolved Photoemission Spectroscopy (ARPES) measurements and Density Functional Theory (DFT) calculations and verifying that the ARPES-measured bands are almost not renormalized in comparison with the DFT-calculated bands. Despite that, Scanning Tunneling Microscopy results indicating the existence of a charge density wave phase [J. Phys. Soc. Japan 83, 113701 (2014)], close to the superconducting one, in addition to some anomalous properties in the normal state (like a linear-in-temperature behavior of the resistivity, up to room temperature), are usually claimed as fingerprints of electron correlations. It is worthy noting that the $\mathbf{BiS_2}$ minimal-model band structure [Phys. Rev. B **86**, 220501 (2012)] is reminiscent of that for weakly coupled chains, hinting at a possible increase in correlations due to an effective reduced dimensionality (from two- to one-dimension). In addition, the topology of the Fermi surface, as measured by ARPES and calculated by DFT, containing electron- and hole-pockets, similar to pnictides, adds to the similarities with unconventional superconductors.

Based on the above mentioned existence of electron- and hole-pockets, we will present pairing-function calculations obtained through a multi-orbital Randon Phase Aproximation (RPA) formalism. This RPA-based approach, popular with pnictides [see, for example, New J. Phys. **11**, 025016 (2009)], will be described in general and the specific results for $\mathbf{BiS_2}$ will be briefly outlined, in keeping with the overall objective of this seminar of presenting a general description of the known properties of the $\mathbf{BiS_2}$ materials. (Please, see Phys. Rev. B **87**, 081102(R) (2013) for work by the speaker).