Contribution ID: **17** Type: **Talk**

Influence of the spin-orbit coupling on the electron-phonon interaction in superconductors: several case studies.

Wednesday, 4 December 2019 11:30 (25 minutes)

Recent widespread interest in topological materials intensified studies on various compounds containing heavy elements, like Pb or Bi. This is of course related to the strong spin-orbit coupling (SOC), which should be present in such materials, and should strongly influence their physical properties. Because some of these materials exhibit superconductivity, a natural question arises what is the spin-orbit coupling effect of the electron-phonon interaction and superconductivity of such materials, containing heavy elements?

Thanks to the ongoing development of computational techniques, calculations of the electron-phonon interaction function, taking into account the spin-orbit coupling, became available recently. In this work we present several case studies, where the spin-orbit interaction effects on the electronic structure, phonons, and the electron-phonon coupling (EPC) is investigated using density-functional calculations. As the prime example we will discuss the role of spin-orbit interaction in determining the electronic and phononic properties of the type-I superconductor $CaBi_2$ [1]. In this case SOC, mainly via the modifications of the Fermi surface topology, reduces the strength of EPC almost twice. As the next two cases we will present Pb-Bi alloy, with extremely strong electron-phonon coupling, and noncentrosymmetric $ThCoC_2$, where SOC splits the Fermi surface but surprisingly has a˜little impact on the electron-phonon interaction.

This work was supported by the National Science Center (Poland), project no. 2017/ 26/E/ST3/00119.

Refs
[1] S. Gołąb and B. Wiendlocha, {\it Electron-phonon superconductivity in $CaBi_2$ and the role of spin-orbit interaction}, Phys. Rev. B {\bf 99}, 104520 (2019).

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