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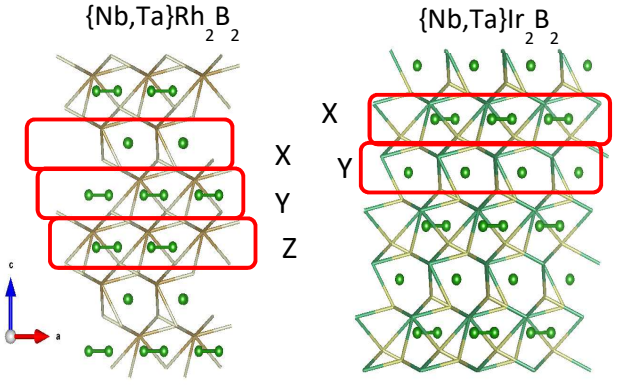
Searching for new superconducting materials - from synthesis through crystal structure to properties

There are more than 1000 reported compounds in the full Heusler family and only about 40 reveal superconductivity [1,2]. Here we present details of the synthesis and physical properties (resistivity, magnetization, and heat capacity) of $MgPd_2Sb$ [2] and the recently reported Li-based ternary intermetallic superconductors $LiGa_2Ir$ [3] and $LiPd_2Ge$ [4]. The first compound, together with isoelectronic $LiGa_2Rh$ [5], is one of the only two superconductors known in this system with valence electron count (VEC) = 16. The experiments confirm bulk superconductivity with T_c = 2.95 K and suggest that $LiGa_2Ir$ is a weak-coupling type-II superconductor. The second compound was synthesized together with $LiPd_2Si$ and $LiPd_2Sn$. Superconductivity above 1.7 K was found only in $LiPd_2Ge$ (T_c = 1.96 K) but theoretical studies suggest that $LiPd_2Si$ and $LiPd_2Sn$ should also reveal superconducting behavior. We propose that the enhanced electron-phonon coupling in $LiPd_2Ge$ is due to presence of the soft phonon modes. Surprisingly, $LiPd_2Ge$ is a type-I superconductor, which is very rare among ternary intermetallic compounds.

In the second part of the lecture, we will present a new class of non-centrosymmetric superconductors (NCS). The boride compounds with MRh_2B_2 and MIr_2B_2 (M = Nb, Ta) stoichiometry were first reported by Carnicom, et al. [6] and Górnicka, et al. [7], respectively. They form in the brand-new crystal structure types, both noncentrosymmetric, presented in the figure below. MRh_2B_2 is found in the chiral space group *P3₁* whereas isoelectronic MIr_2B_2 crystallizes in the monoclinic *Cc* space group. Common features of these subfamilies are boron dimers and repeating units marked as X, Y, Z shown in the figure.



P3₁ (s.g. #144) *Cc* (s.g. #9)

The highest superconducting critical temperature is observed in $NbRh_2B_2$ and $NbIr_2B_2$ with T_c = 7.6 K and 7.2 K, respectively. Slightly lower T_c is observed for $TaRh_2B_2$ (5.8 K) and $TaIr_2B_2$ (5.2 K).

The derived superconducting parameters show that MRh_2B_2 and MIr_2B_2 (M = Nb, Ta) are type II BCS moderately coupled superconductors with the upper critical field $\mu_0H_{c2}(0)$ exceeding the Pauli limit μ_0H_{c2} for the all studies superconductors.

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Uprzejmie zapraszam wszystkich pracowników, doktorantów i studentów Instytutu Fizyki.
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