SEMINARIUM Z MAGNETYZMU I NADPRZEWODNICTWA

Uprzejmie zawiadamiamy, że w **środę**

11 maja 2022 r., o godz.10:00

odbędzie się seminarium **on-line (link podany jest na stronie IF PAN)**,

na którym

prof. dr hab. Tomasz Cichorek

(Instytut Niskich Temperatur i Badań Strukturalnych PAN, Wrocław)

wygłosi referat na temat:

"Nadprzewodnictwo dwupasmowe w ciężko-fermionowych układach $PrOs_4Sb_{12}$ and $CeCu_2Si_2$ - badania poprzez pomiar lokalnego namagnesowania"

Phases of matter are usually identified through spontaneous symmetry breaking, especially regarding unconventional superconductivity and the interactions from which it originates. As the introductory part, we will briefly discuss the superconducting state of Sr_2RuO_4 that for more than 25 years is discussed as a solid-state analogue of the superfluid ^{3}He-A phase - the only well documented chiral spin-triplet state.

The main focus will be directed to the heavy-fermion and multiband superconductor $PrOs_4Sb_{12}$ with broken time-reversal symmetry, spontaneously developing below the critical temperature $T_c \simeq 1.85$K, which is a leading candidate to display chiral superconductivity. Based on measurements of the temperature dependence of the lower critical field $H_{c1}(T)$, we have recently found evidence for the order parameters composed of a sign-changing smaller gap and a large isotropic *s*-wave gap [1].

To develop a detailed understanding of multicomponent superconductivity in $PrOs_4Sb_{12}$, we have extended measurements of $H_{c1}(T)$ down to temperatures as low as 7 mK utilizing a 2DEG Hall magnetometry. We observe a sudden increase in $H_{c1}(T)$ deep in the superconducting state, indicative of a rare case of two nearly decoupled bands. Furthermore, a non-saturating and concave behaviour of $H_{c1}(T)$ below about 0.45 K clearly points at a sign-changing symmetry of the smaller gap. Equally remarkable is a high sensitivity of this characteristic to electron irradiation. Indeed, a concentration of artificial atomic defects as small as a few 0.1% results in both a saturation of $H_{c1}(T)$ at $T < 0.15$ K and a strong suppression of the anomalous enhancement below $\simeq 0.25T_c$, consistent with a destruction of an unconventional order parameter due to the smaller gap. Possible symmetries of the smaller gap as well as results of a comparative study on the two-band isotropic *s*-wave homologue $LaRu_4As_{12}$ (T_c =10.4 K) will be discussed in the context of a putative chiral spin-triplet pairing state in $PrOs_4Sb_{12}$.

In addition, we report in- and out-of-plane $H_{c1}(T)$ dependencies of the prototypical heavy-fermion material $CeCu_2Si_2$ ($T_c \simeq 0.58$ K, S-type), for which two-band and fully gapped superconductivity has been recently observed. For both [100] and [001] directions, we found sharp anomalies (at $\simeq 0.34T_c$ and $\simeq 0.41T_c$, respectively) followed by moderate enhancements. Unlike to $PrOs_4Sb_{12}$, however, both $H_{c1}^{a}(T)$ and $H_{c1}^{c}(T)$ curves saturate in the limit T=0, being more consistent with an $s_{\pm}$-wave scenario than a $d_{xy} + d_{x2-y2}$ band-mixing paring model. Besides, the effect of electron-irradiation on the anomalous enhancement of $H_{c1}(T)$ at $T << T_c$ will be shown.

[1] J. Juraszek et al., Phys. Rev. Lett. 124, 027001 (2020).

The lecture will be given in Polish and the slides will be in English.

Serdecznie zapraszamy

Roman Puźniak
Andrzej Szewczyk
Henryk Szymczak