Contribution ID: **383** Type: **Poster report**

Superconducting Tunnel Junctions as Nuclear Particle Detectors

Tuesday, 13 October 2020 18:35 (20 minutes)

Josephson current between two one-dimensional nanowires with proximity induced either s-wave or p-wave pairing and separated by a narrow dielectric barrier in the presence of Rashba spin-orbit interaction (RSOI), in-plane and normal Zeeman magnetic fields (ZMF). A topological superconducting phase in a Josephson junction of s-wave superconductors (s-JJ) is realized under the condition $|\ |^2 > B^2 + h^2$, where Δ, B, and h are correspondingly the gap, Zeeman energy of in-plane and normal magnetic fields. Instead, the condition $_k = \frac{\vec{k}}{|k|}\ _0$ guarantees an existence of a conducting state in the gap and realization of a generic topological phase of the p-wave superconductor (p-JJ). Andreev retro-reflection is shown to be realized through two different channels. A scattering in a conventional particle-hole channel, when an electron-like quasi-particle reflects to a hole-like quasi-particle with opposite spins, provides the current which depends only on the order parameters'phase differences ϕ, and oscillates fractionally with 4π period. Second anomalous particle-hole channel, corresponding to the Andreev reflection of an incident electron-like quasiparticle to hole-like quasiparticle with the same spin orientation, survives only in the presence of the in-plane magnetic field. The contribution of this channel to the Josephson current oscillates with 4π period not only with ϕ but also with orientational angle of the in-plane magnetic field θ resulting in a magneto-Josephson effect. Evident expressions for the effects of RSOI and ZMF on Andreev bound state energy are found in several asymptotic cases for both s-JJ and p-JJ. RSOI and ZMF are shown to split the quasi-electron and quasi-hole excitation states in the superconducting gap, and two quasi-particle and quasi-hole pairs instead of one pair appear in the gap, which are localized symmetrically around Fermi level. ZMF is shown to destroy this symmetry. Even in the absence of the magnetic fields in s-JJ the energy gap between the Andreev bound states decreases with increasing RSOI. Investigation of ac-Josephson current in s-JJ shows that the width of the resulting Shapiro steps in such a system can be tuned by varying the RSOI constant. In the presence of RSOC and normal-to-plane magnetic field h in p-JJ, a forbidden gap is shown to open in the dependence of Andreev bound state energies on the phases ϕ and θ at several values of RSOC strength and ZMF, where Josephson current seems to vanish.The formalism that we develop here may be extended to regime of strong α and B where the presence of Majorana bound states shapes the characteristics of the Josephson current.

Primary author: Mr SULEYMANLI, Bahruz D. (National Research Nuclear University MEPhI)

Co-author: Dr NAUMOV, Petr Yu. (National Research Nuclear University MEPhI)

Presenter: Mr SULEYMANLI, Bahruz D. (National Research Nuclear University MEPhI)

Session Classification: Poster session 3 (part 1)

Track Classification: Section 3. Modern nuclear physics methods and technologies.