## Nanoscale physics

# Inner-gap structure in transport characteristics of superconducting junctions with degraded interfaces

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The unique mechanism for electrons transporting across the interfaces in superconducting (S) multilayered junctions makes these structures the most important building blocks in superconductor-based electronic devices. Although the main features of the charge transport across NIS and SIS junctions (N and I stand for a normal metal and a nanometer-thick insulator, respectively) are well known, sometimes unexpected in-gap structure appears in the measured curves. In particular, it relates well-pronounced dips instead peaks at gap values in tunneling NIS and high-transparency SIS characteristics as well as unusual inner-gap peaks in current-voltage curves for SIS tunneling samples.

We explain the anomalous features as an effect of degraded interfaces which results in the formation of an additional non-superconducting (n) interlayer between I and S films. The main ingredient of our theoretical analysis is an elastic scattering process at the n-S interface, known as Andreev effect [1], when an electron (hole) incident on the interface from the n side is retroreflected into a hole (electron). The constructive interference of electron and hole waves within the n interlayer leads to the shift of maximums in transport characteristics to lower voltage positions and appearance of well-defined dips at voltage biases which in superconducting junctions without degraded interfaces correspond to the energy gap value. The calculations were based on a scattering formalism taking into account this effect as well as transmission and reflection events in the insulator [1].

We argue that the same effect should be observed in four-layered junctions with a conducting ferromagnetic interlayer and compare results of our theoretical simulations with experimental data.

This work was performed within the German-Ukrainian project SE 664/18-1 supported by Deutsche Forschungsgemeinschaft (DFG).

**1.** *Belogolovskii M.* Proximity effect / Applied Superconductivity. Handbook on Devices and Applications. Vol.1. P. Seidel (ed.), Wiley-VCH, Weinheim, 2015. - P. 49-65.