Theory of surface superconductivity

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Abstract

In the usual perception, surface superconductivity is associated with the surface nucleation of a superconducting condensate above the upper critical field in type-II superconductors or with a rearrangement of phonon properties and the electron-phonon coupling near surfaces/interfaces. Recently, it has been found that there exists another example when the surface superconducting temperature is significantly increased as compared to the bulk superconductive temperature due to constructive interference of quasiparticles (without magnetic fields and reconstruction of the phonon spectrum). In this talk, we discuss the latter example of the surface (boundary) superconductivity within the attractive Hubbard model for the two variants: the standard one-dimensional tight binding model with the uniform hopping parameter and the Su-Schrieffer-Heeger model. The first variant represents a metallic chain on top of an s-wave bulk superconductor while the second variant represents low-dimensional topological insulator deposited on top of an s-wave superconducting sample. We discuss the corresponding numerical solutions of the Bogoliubov-de Gennes equations and demonstrate that the critical temperature of the superconductivity nucleation near the chain ends (boundaries) can be considerably enhanced as compared to its bulk value. In the first variant we obtain that all the quasiparticle states are delocalized and occupy the entire volume of the sample. Then, the enhancement of the end critical temperature originates from the quantum interference of different quasiparticle states [1,2]. In the Su-Schrieffer-Heeger model, the scenario of the end superconductivity is more complex: in addition to the interference of the delocalized quasiparticles, one finds the contribution of the topological bound end states [3].

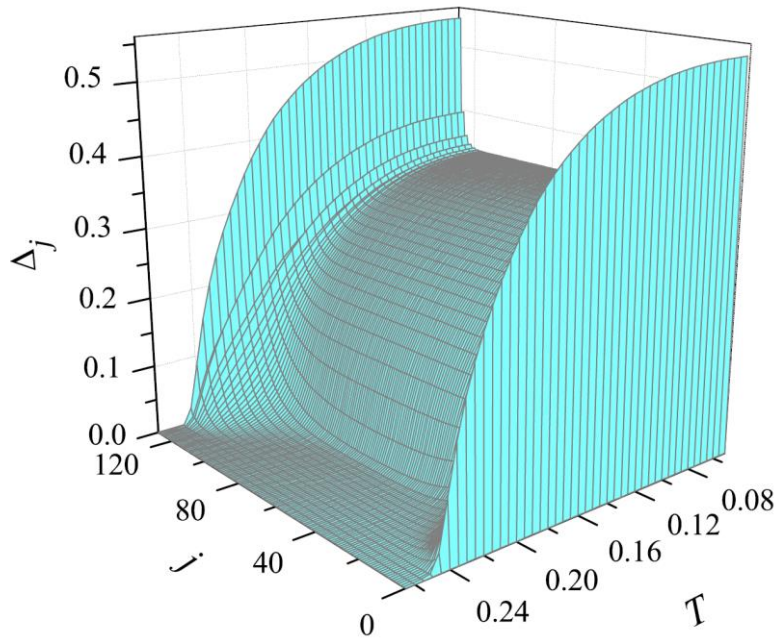

Fig.1 The order parameter as a function of the chain site j and temperature T for the one-dimensional attractive Hubbard model. The results are calculated for the half-feeling case at the coupling g = 2 and the Debye energy 5 (both in units of the hopping parameter). The number of sites N = 128. One can see that the order parameter is zero in the chain center above T=0.2 (also in

units of the hopping parameter) while it survives up to T=0.25 near the chain ends.

Bibliography

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