SUPERCONDUCTING PROXIMITY EFFECT IN GRAPHENE NANOSTRUCTURES

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Supercurrent through graphene has been studied theoretically by several authors with a focus on low temperature behaviors where the band structure of graphene significantly affects the quantum transport of Cooper pairs, such as Andreev reflection [1]. In this work, we study the superconducting proximity effect in nanostructures including monolayer and bilayer graphene. Especially paying attention to the effects of the band structure of graphene, we study the supercurrent through the nanostructure. The supercurrent is injected and withdrawn from two attached superconducting leads. The free energy of the superconductor-nanostructure-superconductor junction is calculated based on the tunnel Hamiltonian, and the critical current through the junction and the pair amplitude in graphene are obtained. We numerically estimate the critical current for several forms of junctions and discuss the correspondence with experimental observations. The behavior of the proximity effect in monolayer system is rather close to that in normal metal, which shows monotonic dependence on temperature and junction separation. However, remarkably, the bilayer system shows a novel oscillating behavior as a function of temperature and junction separation [2,3]. We discuss the origin of these behaviors by studying the pair amplitude in graphene.

References

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