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Chapter 5

A STUDY OF CURRENT-PHASE CHARACTERISTIC OF SUPERCONDUCTOR QUANTUM DOT JOSEPHSON JUNCTION

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Abstract

The Josephson transport in mesoscopic superconductor quantum dot(QD) devices is an active area of research from the past few decades due to its potential applications in the field of nanoelectronics. In this review, we discuss the theoretical understanding of the Josephson transport in such hybrid superconductor quantum dot devices. After a brief discussion of some of the important theoretical background, we study the Josephson transport through an uncorrelated single-level quantum dot coupled between two Bardeen-Cooper-Schrieffer (BCS) superconducting leads (S-QD-S System), modeled by single-impurity Anderson Hamiltonian. Green's function Equation of Motion technique is used to solve the Hamiltonian. We have analyzed the current-phase characteristic, and corresponding Andreev bound states (ABSs) energy-phase relation for different positions of quantum dot energy level relative to the Fermi level at

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absolute zero temperature. When the QD level aligns with the Fermi level of superconducting leads, then Josephson supercurrent shows a discontinuity at a phase $\varphi = \pi$, i.e., the Josephson supercurrent change its sign from plus to minus at $\varphi = \pi$ (π-junction). For a finite value of quantum dot energy level relative to the Fermi level, the current-phase characteristic becomes sinusoidal like an ordinary Josephson junction. We have also briefly discussed the better theoretical approximations to deal with correlated quantum dot and to understand the experimental results better.

Keywords: quantum dot, superconductivity, Josephson transport, π-junction, Anderson Hamiltonian

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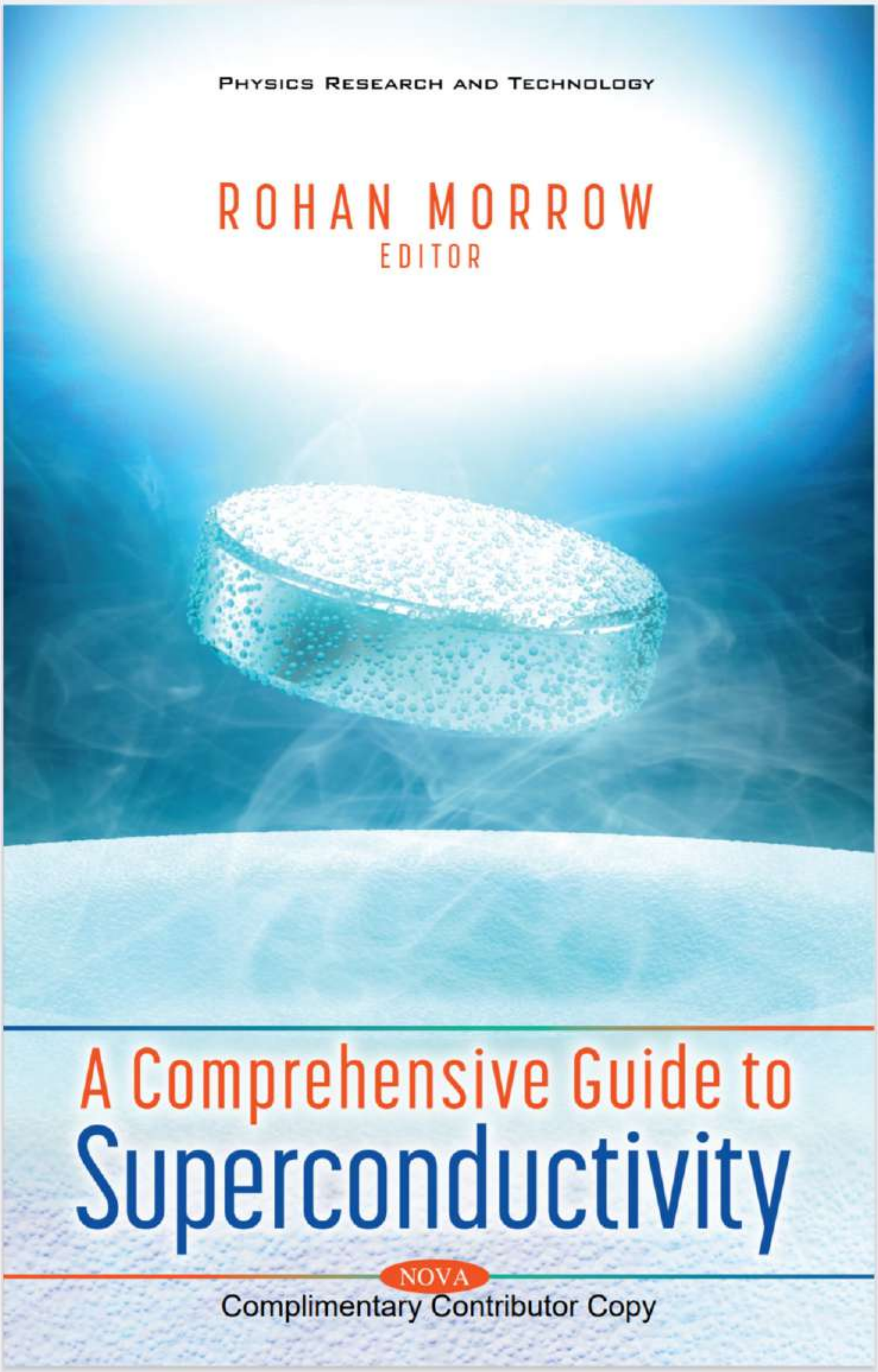
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