Study phase dynamics for superconducting nano Josephson junctions and high temperature superconductor cuprate.

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Abstract

One of the promising objects of superconducting electronics is the Intrinsic Josephson junctions (IJJs) in high temperature superconductors cuprate (HTSC), which are intensively investigated nowadays. Nonequilibrium effects have important role in a stack of IJJs, because the effective layer thickness of the superconducting layer is small ($\sim 3 - 10^{\circ}A$). Such effects can be manifested in a shift of the condensate chemical potential and charge imbalance effect, where an electron and a hole like quasi-particle distributions become different.

In the first part, we investigate the phase dynamics of a single Josephson junction with and without external radiation and demonstrate some main features that characterize the Josephson junction, e.g., hysteresis, appearance of Shapiro steps and devil's staircase. In part two of this study, we consider a quasi-particle current injected through a HTSC which forms a stack of intrinsic Josephson Junctions. This leads to a non-stationary non-equilibrium charge imbalance effect. This charge imbalance is created when the current changes its character from normal current to supercurrent. A precise numerical study is performed to study the effect of charge imbalance on the phase dynamics for a stack of intrinsic Josephson Junctions under external radiation. The effect of charge imbalance is observed on the Shapiro step that shows an infinite slope depending on the nonequilibrium parameter, which is a function of the quasi-particle relaxation time and the thickness of the superconducting layer.

Keywords: Josephson junction - High temperature superconductors layered structure – Shapiro steps – Charge imbalance.

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