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Electromagnetic Excitation of Intrinsic Josephson Junctions in Classical and Quantum Regimes

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We study electromagnetic excitation inside intrinsic Josephson junctions (IJJ's) realized in layered High-Tc superconductors in two regimes, i.e., long and short junction (layer parallel) scales in order to predict which type of electromagnetic wave radiates from the two types of IJJ's. In this paper, we restrict ourselves the case in no presence of magnetic field. The former regime, i.e., the long junction is a target of classical theoretical treatment and is examined by a semi-exact nonlinear analysis. We reveal that the power of the electromagnetic excitation shows the maximum close to the retrap into the superconducting state from the in-phase rotating state, i.e., the outermost quasi-particle branch. Moreover, we predict how the power depends on the junction plane size. These results are based on nonlinear analysis which enables to estimate the maximum limit of the power of the excitation. In the latter regime, i.e., the short junction is a stage in which quantum feature has a primary role and is investigated by quantum numerical simulations. We pick up only the capacitive coupling between stacked junctions and perform a parallel computer simulation solving directly the Schrödinger equation for a few stacked junctions. We clarify that synchronous feature is enhanced by reducing the junction size based on the simulation results.

Thus, our prediction in the quantum regime is that the electromagnetic excitation occurs in an in-phase manner and the emission style is like coupled laser array.