ABSTRACT

Radiative Characteristics of a Josephson Junction in a Resonant Cavity

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This thesis presents a theoretical investigation of the spontaneous and stimulated emission characteristics of a Josephson junction within a microcavity and in free space. The one-photon process is examined for spontaneous emission while for stimulated emission, the one-photon and two-photon processes are studied. Using the classical form of the pair current density in the interaction Hamiltonian for the junction-cavity system, the steady-state amplitude of spontaneous emission is obtained. For stimulated emission, the photon-assisted pair current density for the junction was used with the electric field operator to obtain the amplitudes.

For spontaneous emission, the magnitudes of the magnetic induction and voltage needed to enable emission from the junction for the first five resonant frequencies of the system were calculated. For stimulated emission, an oscillatory dependence of the count rate on $\Delta\varphi$ and $\Delta\varphi'$ was found for the one-photon and two-photon processes, respectively – $\Delta\varphi$ is the difference between the initial

Cooper pair phase difference and the phase of the applied field, while $\Delta\varphi'$ is the difference between the initial Cooper pair phase difference and twice the phase of the applied field. For $\Delta\varphi = \Delta\varphi' = 0$, magnitudes of the applied radiation amplitude and d.c. voltage were calculated for the first five junction-cavity resonances for the first three emission maxima of the one-photon process and for the first four maxima of the two-photon process.

By adjusting the reflection and transmission coefficients, the amplitudes for the junction in free space were determined. These results indicated increased count rates for the junction in the microcavity.

Keywords: Andrea Tricia Joseph; Josephson junction; stimulated emission; spontaneous emission; one-photon process; two-photon process; microcavity.