Generation of SFQ-Pulses in SNS-Junctions: Learning Physics Using the COMSOL Multiphysics® Software

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Abstract

Single Flux Quantum, or SFQ, dynamics is at the heart of superconducting electronics. So are the Josephson junctions, or in a wider context, weakly-coupled superconducting junctions, in particular, superconductor-normal metal -superconductor, or SNS, junctions. Despite the COMSOL Multiphysics® software does not yet have a special superconductivity module, its general mathematical interfaces are capable of solving the time-dependent Ginzburg-Landau, or TDGL, equations and present the results in the form of highly informative animations, which help in visualizing the related physics, understand phenomena, and predict new features. In this research we present animated dynamics of planar SNS junctions on TDGL basis, and describe how the single-flux Abrikosov vortices are being launched in the junction at the DC biased current above the certain critical value, move along the junction, escape from it and generate SFQ pulses at the moment of escape. This process is periodic in time. The reversed (also animated) process is considered when application of the SFQ pulse to the steady state under-critically DC biased junction launches an Abrikosov vortex. These results help to visualized the physical mechanisms on picosecond scale. They assisted us in predicting the behavior of physical devices and helped in finding the ways of optimizing them.

Figures used in the abstract

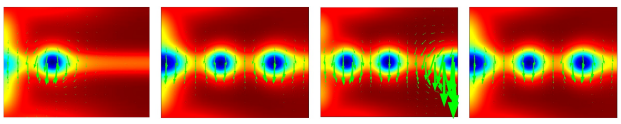

Figure 1: Periodic SFQ pulse generation using planar SNS junction.