Numerical simulation of Josephson traveling-wave parametric amplifier

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Superconducting traveling waves parametric amplifier (TWPA) is an important component in quantum sensors and quantum computers. Although standard coupled-mode theory can explain the amplification of the signal, it fails to describe complex behavior beyond the approximations utilized by the theory. To precisely predict the response of the TWPA, it is suitable to solve a system of a large number of nonlinear equations numerically. The most well-known program that allows a simulation of such systems is WRspice. This program has already been successfully used to design some amplifiers [2]. In our work, we used the new program JoSIM which uses a different numerical scheme for solving Josephson junctions circuits. We compare JoSIM [1] with WRspice in simulating the Josephson traveling-wave parametric amplifier impedance-matched to ports by tapers made of Josephson Junctions. It is shown that such a design allows for suppressing ripples in the gain profile. Both programs provide similar results, but JoSIM simulates circuits much faster than WRspice.

References

[1] Johannes Arnoldus Delport et al. "JoSIM—Superconductor SPICE Simulator". In: *IEEE Transactions on Applied Superconductivity* 29.5 (2019), pp. 1–5. DOI: 10.1109/TASC.2019.2897312.

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