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Simulation of the dynamics of a annular system of parallel Josephson junctions under the influence of external electromagnetic radiation

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Under the influence of external electromagnetic radiation, a step of constant voltage, the so-called Shapiro step, appears on the current-voltage characteristic (CVC) of a single Josephson junction. The mechanism of the Shapiro step appearance is connected to the frequency locking of Josephson oscillations and external electromagnetic radiation. Under the influence of external electromagnetic radiation, a Shapiro step also appears on the CVC of the annular system of parallel Josephson junctions. Unlike a single junction, in this case the step appears due to the synchronization of external electromagnetic radiation and periodic motion of the trapped fluxon into the system. However, the influence of the external electromagnetic radiation amplitude and the model parameters on the width of this step has not yet been studied.

In this work are presented the results of the developing of toolkit for simulation of the dynamics of the annular system of parallel Josephson junctions using Python in the Jupyter Book environment. Algorithms for mathematical modeling of the dynamics of a annular system of parallel Josephson junctions under the influence of external electromagnetic radiation have been developed. The modeling is based on solving the Cauchy problem for a system of nonlinear equations within the Resistively Capacitively Shunted junction model. An algorithm for calculation of CVC of the system and a parallel algorithm for calculating the dependence of the Shapiro step width on the model parameters have been developed. The CVC of the system has been studied in detail. The influence of the external electromagnetic radiation amplitude and model parameters on the Shapiro step width has been shown.

The simulation was carried out on the ML/DL/HPC ecosystem of the heterogeneous HybriLIT platform (JINR LIT). The investigations are performed under the financial support of the Russian Science Foundation within the framework of project No. 22-71-10022

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