Noise-induced effects in Josephson junction arrays

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The aim of the present talk is to give a short review of interplay of effects of suppression of noise and noise delayed switching in Josephson junctions subjected to above-threshold periodic or pulse driving [1,2]. The effect of noise suppression shows up as a minimum of the standard deviation of the switching time (jitter) versus a pump signal frequency or a pulse width, either through existence of a signal-to-noise ratio maximum as a function of a driving frequency. The noise delayed switching is the nontrivial increase of switching time versus the noise intensity, where noise works against switching signal, intended to switch the system into new state. The applications to the important problem of high-speed switching of electronic devices are considered. In particular, minimization of noise-induced errors during high-speed switching of ac SQUIDs and Josephson junctions [2] are analyzed. When solitons in long Josephson junctions are used for the information storage, the noise immunity of the system strongly depends on the system length, configuration and current distribution. In particular, the optimal system length, there maximal decay time is achieved, corresponds to the soliton size for a linear system and to double soliton size for an annular system [3]. Another type of noise suppression effect occurs in relativistic propagation of solitons across Josephson junction arrays. Here due to Lorentz contraction and increase of mass, solitons become more immune to noise than at low propagation speeds [4]. However, due to discreteness of Josephson array the soliton can have Cherenkov tail, which interplaying with thermal noise can lead to a dramatic splash of the propagation time jitter. These effects have important application for design of superconducting fluxonic ballistic detectors as an example of the device in which the soliton scattering is utilized for quantum measurements of superconducting flux qubits. Here the soliton dynamics can be optimized for the measurement process varying the starting and the stationary soliton velocity as well as configuration of the inhomogeneities. Also, mutual effect of quasi-chaotic dynamics and thermal fluctuations has been studied and it has been shown that it can drastically increase the overall effect of noise, as demonstrated for spectral linewidth of Josephson junction arrays [5].

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