

Mesoscopic fluctuations of the supercurrent in diffusive Josephson junctions

Manuel Houzet¹ and Mikhail A. Skvortsov²

¹ Commissariat à l'Énergie Atomique, DSM/DRFMC/SPSMS, 38054 Grenoble, France,

² Landau Institute for Theoretical Physics, Chernogolovka, Moscow region, 142432 Russia

We study mesoscopic fluctuations and weak localization correction to the supercurrent in Josephson junctions with coherent diffusive electron dynamics in the normal part. Two kinds of junctions are considered : a chaotic dot coupled to superconductors by tunnel barriers and a diffusive junction with transparent normal–superconducting interfaces. The amplitude of current fluctuations and the weak localization correction to the average current are calculated as functions of the ratio between the superconducting gap and the electron dwell energy, temperature, and superconducting phase difference across the junction. Technically, fluctuations on top of the spatially inhomogeneous proximity effect in the normal region are described by the replicated version of the σ -model. For the case of diffusive junctions with transparent interfaces, the magnitude of mesoscopic fluctuations of the critical current appears to be nearly 3 times larger than the prediction of the previous theory which did not take the proximity effect into account.