# Reversing the Josephson current with Aharonov-Bohm interferometry

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The broad interest in mesoscopic physics has recently spurred a renewed impulse in the context of Josephson effect. Because of its large spectrum of applications to nanotechnology, the art of manipulating the supercurrent is presently under the spotlight. Josephson field-effect transistors, for instance, have been proposed[1] and realized both with semiconductors and carbon nanotubes[2]. A growing interest is nowadays devoted to the issue of supercurrent sign reversal : a $\pi$-junctions state, i.e., a Josephson current flowing in the direction opposite to the phase difference between the superconductors, has already been obtained with ferromagnet-superconductor (FS) junctions[3]. In these systems the sign of the current flow depends on the F-layer thickness, which cannot be varied during an experiment though. In view of technological applications, the tunability of a system plays instead a crucial role, and the realization of *controllable* $\pi$-junctions represents a major challenge both on the theoretical and experimental point of view[4,5]. Here we present the electro-magnetostatic Aharonov-Bohm effect as a novel tool to realize a fully controllable Josephson $\pi$-junction. Both the sign and the magnitude of the supercurrent can be tuned in a ring-shaped ballistic normal region coupled to superconducting electrodes by varying the magnetic flux and the electric field around suitable values[6]. We provide a theoretical description of the system within the scattering matrix theory and Bogolubov de-Gennes equations, and discuss its implementation in a realistic setup with semiconductor hetero-structures.

**References**

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