Vortex-antivortex dynamics in superconductor-antiparallel magnetic dipoles bilayers

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Abstract

Artificial Superconductor(S)/Ferromagnet(F) hybrid structures composed by a S film and textured F layer have attracted great interest in the last fifteen years. In the limit of high values of magnetic moments, the ferromagnetic layer filled with magnetic particles (dipoles, nanodiscs, microrings, bars, etc.) can induce spontaneous creation and stabilization of vortex-antivortex (v-av) pairs in the S layer. These v-av molecules interact strongly with external applied currents inducing their annihilation or movement. Despite numerous studies about this subject, only a few of them emphasize the microscopic nature of this phenomena. In this work, the intricate dynamics of v-av molecules birth-death events and how this process influences macroscopic quantities are investigated.

Keywords: Superconductor-ferromagnet hybrids, Vortex-antivortex pairs, Superconductivity

1. Introduction

The study of superconducting materials, in particular nanoscale materials is, nowadays, performed in more advanced way than past decades. Instead of the manufacturing and then after getting system properties, the nanoscience allows currently build nanostructures with desired physical characters [1]. In type II superconductors, the nanostructuring using artificial pinning potentials allows us to obtain materials with optimized physical properties, such as critical current [2] and critical temperature[3].

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