Mathematical Contributions to the Dynamics of the Josephson Junctions: State of the Art and Open Problems

M. De Angelis

Univ. of Naples "Federico II", Scuola Politecnica e delle Scienze di Base. Dip. Mat. Appl. "R. Caccioppoli", Via Cinthia, 26 – Complesso Monte S. Angelo – 80126, Naples, Italy.

Abstract: Mathematical models related to some Josephson junctions are pointed out and attention is drawn to the solutions of certain initial boundary problems and to some of their estimates. In addition, results of rigorous analysis of the behaviour of these solutions when $t \to \infty$ and when the small parameter ε tends to zero are cited. These analyses lead us to mention some of the open problems.

Keywords: *third order parabolic operator; fundamental solution; superconductivity; Josephson junction.*

Mathematics Subject Classification (2010): 82D55, 74K30, 35K35, 35E05.

1 Introduction

Our purpose is to:

i) furnish a short review of the mathematical contributions to the dynamics of the Josephson junctions,

ii) introduce some possible open problems.

From the mathematical point of view, many descriptions of superconductivity phenomena have been developed and an important contribution has been given by Brian David Josephson. He predicted in 1962 the tunnelling of superconducting Cooper pairs through an insulating barrier to pass from one superconductor to another (Josephson effect). He also predicted the exact form of the current and voltage relations for the junction (Josephson junction) [1]. (Experimental work proved that his theory was right, and Josephson was awarded the 1973 Nobel Prize in Physics.)

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* Corresponding author: `mailto:modeange@unina.it`