

THOMAS MCDERMOTT

EDUCATION

University of Exeter, United Kingdom

PhD in Physics, Supervisor: Dr. Eros Mariani

Sept 2015 - Present

Master of Physics (1st Class Degree), Supervisor: Dr. Eros Mariani

Sept 2011 - June 2015

RESEARCH PROJECTS

PhD Project - Superconducting quantum drums

My PhD project is a theoretical one which investigates the interplay between superconductivity and mechanical oscillations in suspended Josephson junction devices. Our work highlights the existence of new interesting regimes of the Josephson effect in which supercurrent is coupled to mechanical oscillations in a non-trivial way. This produces new characteristics in current-voltage measurements such as mechanically induced hysteresis loops and fractal structures.

Master's Project - Fictitious magnetic fields in strained graphene

For my Master's project I studied fictitious gauge-fields arising due to strain in graphene. In particular we used analytical theory as well as COMSOL simulations to investigate whether it is possible to achieve a uniform pseudo-magnetic field in a suspended sample.

PAPERS

Strong mechanically induced effects in DC current-biased suspended Josephson junctions

Through a combination of analytical results and numerical simulations we have studied the Josephson effect in a novel regime where it is intimately coupled to the mechanical oscillations. We have shown the possibility of measuring resonance frequencies and quality factors using only DC current bias. Published: Phys. Rev. B 97, 014526.

Josephson junctions as nano-mechanical Bloch oscillators

We have discovered a scheme for utilizing Bloch oscillations in Josephson junctions as a coherent source of mechanical vibrations, in much the same way as they have been used as a radiation source in semiconductor superlattices. In this scheme the vibrations are controllable at the level of a single quantum (i.e. a vibron) by a DC current bias and an external magnetic field. Paper to be submitted.

Mechanically induced hysteresis loops in Josephson junctions

We show that several new hysteresis loops develop in the current-voltage characteristics of Josephson junctions when coupled to mechanical oscillations. These are highly dependent on the coupling strength and we derive three separate critical coupling values which define various qualitatively different regimes. Paper to be submitted.

TECHNICAL SKILLS

**Programming Languages
Software & Tools**

Python, C, HTML, Javascript
Mathematica, Latex, COMSOL

CONFERENCES AND RESEARCH TRIPS

Chalmers University of Technology
Gothenburg, Sweden

August 2016

I made a visit to the group of Prof. Andreas Isacsson with whom we collaborated on our recent paper.

APS March Meeting
New Orleans, USA

March 2017

Presentation: "Josephson nano-resonators". APS March Meeting 2017, Abstract: Y39.00001.

Free University of Berlin
Berlin, Germany

April 2018

We briefly visited the groups of Prof. Piet Brouwer and Prof. Felix von Oppen and had an informal discussion of our recent research into Josephson junctions.

Federal University of Uberlândia
Uberlândia, Brazil

May 2018

I spent a month visiting the group of Prof. Antonio Di Lorenzo with whom I am collaborating to extend our previous work on Josephson junctions to the case of superconducting quantum interference devices (SQUIDS) in the hope of developing new qubits.

TEACHING EXPERIENCE

Undergraduate Teaching Assistant - Mathematics 1, Mathematics 2 and Mathematics with Physical Applications.

Project Supervision - Assisting in the supervision of Master's students within our research group.

Peer Mentoring - Teaching maths and physics to students from other disciplines.

REFEREES

Dr. Eros Mariani
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Prof. Saverio Russo
University of Exeter, s.russo@exeter.ac.uk

Prof. Antonio Di Lorenzo
Federal University of Uberlândia, dilorenzo.antonio@gmail.com