

Conductance spectroscopy of Majorana zero modes- circumstantial evidence or smoking gun?

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Tuesday, June 14, 2022
10:00 AM • MSEE 239

zoom link: <https://purdue-edu.zoom.us/j/92259553569>

Abstract

Semiconductor nanowire-superconductor hybrid systems provide a promising platform for hosting Majorana zero modes. However, the conclusive experimental detection of these exotic modes is a much debated and contentious issue. In this talk, we will describe conductance spectroscopy measurements and the current experimental status on their detection. Starting from the basics of quantum transport theory, we will demonstrate how to adapt the Keldysh non-equilibrium Green's function (NEGF) technique to model experimentally relevant and current device structures [1-3]. We will then describe various "false positives" associated with conductance spectroscopy on realistic device structures, and how we could capture these effects using quantum transport theory. Moving on, we will describe the non-locality of true Majorana modes that can be described via the concept of topological entanglement entropy [4], which connects directly with the bulk-boundary correspondence of a topological phase [4]. While recent experiments have indeed shown several false positives in the conductance spectra, we demonstrate that the entanglement entropy can indeed signal a genuine transition, regardless of the constituent non-idealities in an experimental situation. Our results point toward furthering the development of experimental techniques beyond conductance measurements to achieve a conclusive sighting of Majorana zero modes.

Bio

Prof. Bhaskaran Muralidharan obtained his B.Tech in Engineering Physics from the Indian Institute of Technology (IIT) Bombay in 2001, his M. S. and Ph. D in Electrical Engineering from Purdue University, West Lafayette, USA in 2003 and 2008 respectively. Between 2008-2012, he was a post-doctoral associate at the Massachusetts Institute of Technology (MIT) and at the Institute for theoretical Physics at the University of Regensburg, Germany. Since 2012, he has been a faculty member in the Department of Electrical Engineering at IIT Bombay, where he is currently a full Professor. His core research area is computational quantum transport and its applications to modeling and simulation of "Beyond Moore" devices. His research output spans diverse areas of emerging nanoscale devices, ultimately built on top of a broad and fundamental foundation of quantum transport. He was also the recipient of the APS-IUSSTF professorship award in 2014, the Shastri Indo-Canadian fellowship 2019 and the SERB-STAR (Indian Govt) award in 2019. He is also a recipient of the Excellence in Teaching Award in IIT Bombay. He is also an Associate Editor in the IEEE Transactions on Nanotechnology, on the Editorial board of Scientific Reports and Materials for Quantum Technology (IOP).

Host: Professor Zubin Jacob, Organized through the COE spintronics pre-eminent team, please send an email to zjacob@purdue.edu if you would like to meet with the speaker on June 13 or June 14