Institute Colloquium

S. N. Bose National Centre for Basic Sciences
(An Autonomous Research Institute established under DST, GOI)

25 August 2022 | **4.00 PM** at Silver Jubilee Hall, SNBNCBS | **Webinar Link** | **YouTube Link**

Title:
The search for the elusive Majorana modes: conductance gap closure and the topological gap protocol

Abstract:

Taking the current, but contentious issue of the detection of Majorana zero modes, this talk plans to address the issue of whether a conductance gap closure can be used as a smoking gun for the detection of topological edge modes [1,2].

Semiconductor nanowire-superconductor hybrid systems provide a promising platform for hosting Majorana zero modes. However, the conclusive experimental detection is a much debated and contentious issue. We will describe the conductance spectroscopy measurements, the topological gap protocol [2] and the current experimental status focusing especially on the "false positives" associated with this technique. Starting from the basics of quantum transport theory, we will then demonstrate how to adapt the Keldysh non-equilibrium Green's function (NEGF) technique to understand the local and non-local conductance spectroscopy and the purported gap closure signatures [1].

Moving on, we will describe the non-locality of true Majorana modes (and topological edge modes in general) can be described via the concept of topological entanglement entropy [1] and can indeed signal a genuine transition, regardless of the constituent non-idealities in an experimental situation. Finally, we will touch upon how to extend our transport formulation to more realistic device structures [3-5] including the currently pursued magnetic insulator-nanowire hybrid set up [5], and how to include disorder and dephasing in topological devices in general [6].

References:

[1] A. Kejriwal and B. Muralidharan, Phys. Rev. B (L), 105, L161403, (2022) [Editors' Suggestion]

[2] M. Aghaee et.al., ArXiv: 2207.02472, (2022).

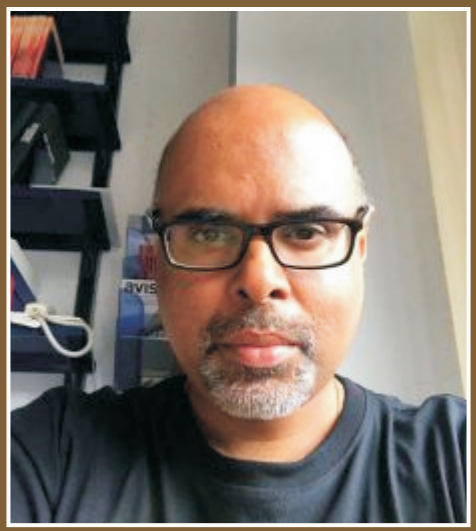
[3] P. Sriram, S. Kalantre, K. Gharavi, J. Baugh and B. Muralidharan, Phys. Rev. B, 100, 155431, (2019).

[4] C. Duse, P. Sriram, K. Gharavi, J. Baugh and B. Muralidharan, JPCM, 33, 365301, (2021).

[5] R. Singh and B. Muralidharan, ArXiv: 2203. 08413 (2022).

[6] K. Jana and B. Muralidharan, npj 2D materials and applications, 6, 19, (2022).

Speaker:



Bhaskaran Muralidharan
Department of Electrical Engineering, Indian Institute of Technology Bombay

Short biography of the Speaker

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 in the Department of Electrical Engineering at IIT Bombay, where he is currently a 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 utilizing quantum transport for novel functionalities. He was also the recipient of the APS-IUSSTF professorship award in 2014, the Shastri Indo-Canada fellowship 2019 and the SERB-STAR award in 2019. He is a recipient of the Excellence in Teaching Award in IIT Bombay. He is an Associate Editor in the IEEE Transactions on Nanotechnology, on the Editorial board of Scientific Reports and Materials for QuantumTechnology (IOP). He has also been a regular visiting Professor at the Institute for Quantum Computing (IQC) in the University of Waterloo, Canada.