Research Summary:

I am a theoretical condensed matter physicist with a background in elementary particle physics. My current research interests are in the field of topological quantum matter.

In the last few years, there has been a paradigm shift in the study of condensed matter systems. Instead of studying symmetries of the free energy, there has been a move towards a topological classification of states of matter, where Hamiltonians whose variations do not lead to the closing of a gap are considered to be in the same topological class. There has also been a resurgence of interest in the field of non-abelian anyons and braid group statistics, particularly due to the possibilities of applications in the field of quantum computation. These two fields are related because topological systems with ground states degeneracies have excitations with non-abelian statistics.

More specifically, my current interests include

1. Edge states and edge reconstruction in quantum Hall systems.
2. Weyl semi-metals, their phase diagrams, surface states and transport.
3. Majorana modes and parafermion modes.
4. Transport in graphene, silicene and other two dimensional materials.

Selected recent publications:

1. Proximity induced superconductivity in Weyl semi-metals, Udit Khanna, Arijit Kundu, Saurabh Pradhan and Sumathi Rao, Phys. Rev.**B90**,195430 (2014).
2. Conductance, valley and spin polarization and tunneling magneto-resistance in ferromagnetic-normal-ferromagnetic junctions of silicene, Ruchi Saxena, Arijit Saha and Sumathi Rao, Phys. Rev. **B92**, 245412 (2015).
3. Chiral anomaly induced oscillations in the Josephson effect in Weyl semimetals, Udit Khanna, Dibya Kanti Mukherjee, Arijit Kundu and Sumathi Rao, Phys. Rev. **B** (R) **93**, 121409 (2016).

4. Fingerprints of Majorana bound states in Aharanov-Bohm geometry, Krashna Mohan Tripathi, Sourin Das and Sumathi Rao, Phys. Rev. Lett. **116**, 166401 (2016).

5. Slave fermion formalism for the tetrahedral spin chain, Priyanka Mohan and Sumathi Rao, Eur. Phys. J. **B 89**, 206 (2016).

6. Weyl semi-metals; a short review, Jnl of Indian Institute of Science, 96(2), 145 (2016).

7. Brillouin-Wigner theory for Floquet topological phase transitions in spin-orbit coupled materials, Priyanka Mohan, Ruchi Saxena, Arijit Kundu) and Sumathi Rao, Phys. Rev. **B94**, 235419 (2016).

8. Zero-pi transitions in a Josephson junction of irradiated Weyl semimetal, Udit Khanna, Sumathi Rao and Arijit Kundu, Phys. Rev. **B**(R) **B95**, 201115 (2017).

9. Introduction to abelian and non-abelian anyons, cond-mat/1610.09260, lectures given at the SERC school on 'Topology and condensed matter physics', held in Kolkata, Nov 23-Dec 12, 2015, edited by Somendra M. Bhattacharjee, Mahan Mj and Abhijit Bandhypadhyaya, published by Hindustan Book Agency, 2017.

10. Transport through Andreev bound states in a Weyl semi-metal quantum dot, Dibya Kanti Mukherjee, Sumathi Rao and Arijit Kundu, Phys. Rev. **B96**, 161408 (R) (2017).

11. Spin mode-switching at the edge of a quantum Hall system, Udit Khanna, Ganpathy Murthy, Sumathi Rao and Yuval Gefen, Phys. Rev. Lett. **119**, 186804 (2017).

12. Interplay of Floquet Lifshitz transitions and topological transitions in bilayer Dirac materials, Priyanka Mohan and Sumathi Rao, Phys. Rev.**B98**, 165406(2018).

13. Fabry-Perot interferometry in Weyl semi-metals, Dibya Kanti Mukherjee, Sumathi Rao and Sourin Das, Journal of Condensed matter physics, **31**, 045302 (2019).

14. Quantum charge pumping through Majorana bound states, Krashna Mohan Tripathi, Sumathi Rao and Sourin Das, Phys. Rev.**B99**, 085435 (2019).

15. Bulk-edge correspondence and new topological phases in periodically driven spin-orbit coupled materials in the low frequency limit, Ruchi Saxena, Sumathi Rao and Arijit Kundu, J. Phys. Commun.]bf 4, 075019 (2020).

16. Magnetic flux periodicity in second order topological superconductors, Suman Jyoti De, Udit Khanna and Sumathi Rao, Phys. Rev. **B101**, 125429 (2020).

17. Chiral Luttinger liquids in graphene tuned by irradiation, Sourav Biswas, Tridev Mishra, Sumathi Rao and Arijit Kundu, Phys. Rev. **B102**, 235129, (2020).

18. Emergence of spin-active channels at a quantum hall interface, Amartya Saha, Suman Jyoti De, Sumathi Rao, Yuval Gefen and Ganpathy Murthy, Phys. Rev. **B102**, L081401, (2021).

19. Kohn-Sham density functional theory of abelian anyons, Yayun Hu, Ganpathy Murthy, Sumathi Rao and Jainendra Jain, Phys. Rev.**B103**, 035124, (2021).

20. Fermi arc reconstruction at the interface of twisted Weyl semimetals, Faruk Abdulla, Sumathi Rao and Ganpathy Murthy, Phys. Rev. **B103** 235308.

Current PhD students (at HRI)

1. Suman Jyoti De, currently working on edge reconstruction, Majorana modes

2. Faruk Abdulla, currently working on Weyl semi-metals

3. Nirnoy Basak, currently working on weyl semimetals

Current visiting students(at ICTS)

1. Kishore Iyer
2. Ananya Janardan
3. Krishna Prahlad