

# BHANDARU PHANI PARASAR

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Bangalore, India

## EDUCATION

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**PhD Physics**, Indian Institute of Science (IISc), Bangalore. Jan 2023-

- Advisor: Prof. Vijay B. Shenoy, Department of Physics, IISc
- Cumulative GPA: 9.9/10

**BS-MS (Research)**, Indian Institute of Science (IISc), Bangalore 2017-2022

- Physics major, Cumulative GPA: 9.2/10

## RESEARCH PROJECTS

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- 1. Edge states of fracton systems** *in collaboration with* Yuval Gefen and Vijay B. Shenoy 2024  
Explored the nature of edge states in fractonic systems and revealed its connection with the bulk properties, by studying the Chern-Simons theory of second rank gauge fields. Showed that braiding a quadrupole around a fractonic charge, and braiding two non-parallel dipoles produces a non-trivial statistical phase. Showed that there are two distinct edge modes-one fractonic and the other non-fractonic-and derived their current algebra. Studied the edge-to-edge tunneling and showed that it is a relevant perturbation.
- 2. Delicate semimetals** *in collaboration with* Vijay B. Shenoy 2023  
Proposed and constructed theoretical models for a novel class of semimetals, *Delicate semimetals*, which are protected by unstable homotopies. Our example of a two-band nodal-line semimetal in four dimensions is characterized by a Hopf flux. Studied their remarkable Fermi-arc and drumhead surface states and also generalized this construction using a three-dimensional example in the symmetry class AIII.
- 3. Fermions coupled to  $\mathbb{Z}_2$  gauge fields** *in collaboration with* Vijay B. Shenoy 2022  
Studied fermions coupled to  $\mathbb{Z}_2$  gauge fields on the square lattice and showed that a modulation of fermion hopping realizes of many Obstructed Atomic Insulators (OAI)s. Analyzed the stability of these phases to quantum fluctuations of the gauge fields using mean field theory and found a rich phase diagram with many superfluids and features like Gross-Neveu criticality, triple points etc. Characterized the anomalous mass dimensions of topological and trivial masses at the Gross-Neveu critical point using renormalization group techniques.
- 4. Phase transitions of fractons models** 2021  
*Bachelor's thesis supervisor:* Prof. Vijay B. Shenoy  
Worked on phase transitions of fracton models in three dimensions. Studied classical and quantum phase transitions in the X-cube and the checkerboard models using perturbation theory techniques and variational methods. Mapped the quantum partition function of the X-cube model to the classical partition function of a four-dimensional model, using trotterization.

## PUBLICATIONS AND PREPRINTS

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- Bhandaru Phani Parasar**, Vijay B. Shenoy, *Delicate semimetals: Protected gapless phases from unstable homotopies*, Phys. Rev. B 109, 155131 (2024)
- Bhandaru Phani Parasar**, Vijay B. Shenoy, *Obstructed atomic insulators and superfluids of fermions coupled to  $\mathbb{Z}_2$  gauge fields*, Phys. Rev. B 107, 245142 (2023)
- Bhandaru Phani Parasar**, Yuval Gefen, Vijay B. Shenoy, *Fractons on the edge*, arXiv:2411.19620 (2024)

## WORKSHOPS AND CONFERENCES

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- Presented my research at **APS Global Physics Summit**, Anaheim. March 2025
- Presented a poster at **A Hundred Years of Quantum Mechanics**, ICTS Bangalore. Jan 2025

- Presented a poster at **Young Investigators Meet on Quantum Condensed Matter Theory**, IISER Pune. Dec 2024
- Presented a poster at **Topological order:Anyons and Fractons**, Les Houches, France. April 2024
- Presented my research (virtually) at the **APS March meeting**. March 2024
- Presented a poster at **Condensed matter meets Quantum Information** at ICTS, Bangalore. Sep 2023
- Attended the workshop **Physics of Quantum Matter School** at NISER, Bhubaneswar. May 2023

## FELLOWSHIPS

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- **Prime Minister Research Fellowship (PMRF)**, instituted by the Ministry of Education, GoI 2023-
- **Kishore Vaigyanik Protsahan Yojana (KVPY)** fellowship, instituted by DST, GoI 2017-2022

## TEACHING

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- Teaching assistant for *Solid state Physics, Mathematics for Physics I, Introductory Modern Physics, Electricity and Magnetism* and *Thermal Physics* at Azim Premji University, Bangalore. 2023-2025  
Responsible for weekly interactions and tutorials.
- Teaching Assistant for *Quantum Mechanics II* and *Electricity and Magnetism* (lab), IISc. 2024-25  
Responsible for taking tutorials, demonstrations (lab) and grading.
- Conducted problem solving sessions in physics at Azim Premji University. 2023  
Responsible for mentoring undergraduate students.