

HRISHIKESH MALLADI

hrishikeshmalladi@gmail.com — Personal Website

Summary:

Aspiring experimental physicist specializing in quantum many-body physics and ultracold atoms. Experienced in MOT, BEC generation, and laser cooling. Currently investigating signatures of non-Hermitian exceptional points in cold atoms. Seeking a PhD position to advance experimental quantum simulation and condensed matter systems.

Education

Integrated MSc. in Physics (Majors), Mathematics (Minors)

National Institute of Science, Education and Research; Bhubaneswar, India

Graduating:

July 2027

GPA: 8.08*/10.0 (as of 9/10 semesters)

Accomplishments: Secured All India Rank 257 (top 1%) in NEST; 94th percentile in JEE Main (2.5M applicants); JEE Advanced Qualifier.

Relevant Coursework: Many-Body Physics, Advanced Solid State Physics, Quantum Optics, Non-Linear Optics, Special Topics in Quantum Mechanics, Introduction to Atoms & Molecules, Quantum Mechanics (I & II), Electromagnetism (I & II), Statistical Mechanics, Condensed Matter Physics, Applied Spectroscopy (I & II)

Relevant Undergrad Lab work: Physics Open Lab (I & II), Basic & Advanced Electronics Lab, Linear Optics Lab

Technical Skills

- **Experimental Skills:** Optical Alignment, Laser Cooling, System Troubleshooting, Debugging Multi-Parameter Systems
 - **Data Analysis & Programming:** Python (NumPy, SciPy, OpenCV), MATLAB (Intermediate)
 - **Design & Instrumentation:** SOLIDWORKS, LabVIEW
-

Research Experience

Master's Thesis — Exploring Non-Hermitian physics and Exceptional points in cold atoms

Supervisor: Dr. Ashok Mohapatra, NISER, India

(Jan 2026 – Present)

- Established Rb-87 MOT setup.
 - Working on using the Faraday and the Voigt effect to construct a Non-Hermitian Hamiltonian to find exceptional points in polarization space
 - Planning on exploring the extent of sensitivity around exceptional points as predicted by Carl Bender
 - Improving and deepening understanding of atom-light interactions and experimental control of quantum systems.
-

Visiting Research Student— Design and Construction of a Bow-Tie and Superlattices as part of Quantum-Gas Microscope update.

Supervisor: Prof. Wolfgang Ketterle, Massachusetts Institute of Technology (MIT), Boston, USA (Jun 2025 – Dec 2025)

- Independently designed and bench-tested a Bow-Tie Lattice and superlattice setup for future Quantum-Gas Microscope upgrades in the BEC V lab.
 - Developed simulations using Wannier functions to accurately estimate tunneling and superexchange rates in optical lattices.
 - Collaborated on a light scattering experiment investigating closely spaced atom pairs. Link to presentation of the same at the DAMOP conference by Yoo Kyung Lee
 - Audited Prof. Ketterle's AMO-2 course to deepen theoretical grounding in atomic and molecular physics.
-

Visiting Research Student — Generation of Rubidium Atom Cloud in a MOT and Magnetic Transport Optimization

Supervisor: Prof. Yi Wei Liu, National Tsing Hua University, Taiwan (May 2024 – July 2024)

- Worked on a BEC experiment, consistently generating an Rb MOT and optimizing atom transfer to the optical dipole trap (ODT).
 - Achieved a 60% transfer rate and increased the science cell atom count to 1.6×10^8 .
 - Successfully brought the system back to the optical dipole trap loading stage.
 - Gained hands-on experience in laser cooling, MOT dynamics, and atom transport optimization.
 - Improved atom loading efficiency, benefiting ultracold atoms research and BEC experiments while refining experimental control and laser diagnostics skills.
-

Selected Academic Projects

Term Paper — Analytical Investigation of the Bose-Hubbard Model in Quadratic Trap using Mean Field approach

Supervisor: Dr. Anamitra Mukherjee, NISER, India (Mar 2026 – May 2026)

- This term paper presents a theoretical derivation of the trapped Bose-Hubbard model, focusing on the emergence of the spatially separated “wedding cake” phase architecture.
 - Solve the problem using standard mean-field and non-degenerate perturbation theories effectively predicting the bulk Mott-superfluid transition, but they exhibit unphysical divergences at the shell boundaries where the chemical potential matches integer fillings. We resolve these singularities through a nearly degenerate perturbation theory (NDPT) prescription, deriving a non-linear Order Parameter Equation (OPE) that regularizes the transition.
 - We calculate exact shell radii and density profiles for both spherical and ellipsoidal harmonic traps.
 - We discuss the experimental signatures of these nested structures as detected via matter-wave interferometry and rotational Bragg spectroscopy.
-

Open-Lab Experiment — Measuring Geometric Phase via Mach-Zehnder Interferometry

Supervisor: Prof. Shubankar Bedanta, NISER, India

(Jan 2025 – Jun 2025)

- Constructing a Mach-Zehnder interferometer to generate and measure the geometric (Panchratnam-Berry) phase.
 - Performing unitary transformations on the Poincaré sphere using a pair of QWPs and a rotating HWP to generate the said geometric phase.
 - Gaining experience in precision interferometry, quantum optics, and polarization control.
 - Calculated and demonstrated geometric phase for a random path on the Poincaré sphere, in a Mach-Zehnder setup, modeling fundamental quantum optics concepts and experimental techniques in photonics, while improving optical alignment and data analysis skills.
-

Term Paper — Two and Three Body Bound States with Green's Function Approach

Supervisor: Dr. Anamitra Mukherjee, NISER, India

(Oct 2024 – Dec 2024)

- Studied the equation of motion for Green's function in strongly correlated systems.
 - Used Berciu's (2011) approach from *Physical Review Letters*, 107(24) to analyze few-particle bound states.
 - Improved theoretical understanding of Green's function formalism and many-body physics.
 - Explored bound-state formation in few-particle systems relevant to condensed matter physics and ultracold atomic gases while refining analytical and mathematical modelling skills.
-

Open-Lab Experiment — He-Ne Laser and Nd-YAG Laser

Supervisor: Dr. Kartikeswar Senapati, NISER, India

(Aug 2024 – Dec 2024)

- He-Ne Laser
 - Aligned an open-frame He-Ne gas laser in various cavity configurations.
 - Used a birefringent transducer for fine-tuning and mode selection.
 - Conducted beam profiling and analyzed higher-order longitudinal and transverse modes.
 - Developed a deeper understanding of gas laser physics, mode selection, and optical diagnostics.
 - Nd-Yag Laser
 - Characterized a diode-pumped Nd: YAG laser and aligned it in a hemispherical cavity.
 - Achieved passive Q-switching and performed second-harmonic generation.
 - Acquired hands-on experience in laser alignment, nonlinear optics, and cavity design.
 - Successfully optimized SHG in an Nd: YAG system while enhancing experimental troubleshooting and optical system design skills.
-

Leadership & Activities

NISER Astronomy Club (NAC) — President (2024-25), Observation Sessions Committee Head (2022-2024)

- Managed a \$50,000 budget and a team of 300+ members.
- Organized observational sessions, hands-on workshops, and outreach programs.
- Equipped with the know-how of setup and operation of a wide array of telescopes and in-depth knowledge of imaging sensors.

NISER Robotics Club — Active Contributor

- Worked with Raspberry Pi, Arduino, and microcontrollers for robotics projects.
- Proficient in 3D designing and CAD modeling using SOLIDWORKS.

Hobbies and interests:

- Trained in Hindustani Violin. I also play the drums
- Love going on a hike, bouldering and cycling.