

# SHOBHIT SAHEB DEY

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## EDUCATION

**Indian Institute of Technology Kharagpur**  
BS(Honours) and MS in Physics | [INSPIRE Scholar](#)

2018 - 2023  
CGPA 8.41

## RESEARCH PROJECTS

**Rice University** Oct'23-July'24

-Prof. Guido Pagano

- Building an injection locking module to gain a narrow linewidth, high power 369.5nm beam for Doppler transition in  $^{171}\text{Yb}^+$  ions for quantum simulation. Along with a compact mechanical packaging of the module, I designed an analog electronic PID controller for the temperature locking and stability.
- Additional functionality to actively stabilize the spectral shifts in laser diode due to ambient temperature fluctuations will be made, feeding Fabry-Perot cavity's output back to the current controller.
- Designed a new and mechanically simpler atomic oven owing to specific placement requirements of the system. Maximal heating and collimation with minimal conductive heat loss were ensured. Also designed a mechanical adapter for characterizing the oven in a smaller test vacuum chamber.

**PhLAM, CNRS** May'22-July'22

-Dr. Alberto Amo

- Picosecond resolution imaging of coherently excited exciton-polariton superfluid to observe quantized vortices shredding off a defect and their clustering leading to 2D quantum turbulence. The project involved setting up the excitation and imaging optics, spectroscopy and handling cryogenic setup.
- Sponsored by French Embassy's [Charpak Lab Scholarship](#) given to 30 students from India

**Quantum Research Center, TII** Aug'21-Feb'22

-Prof. Luigi Amico

- Proposed a general framework to achieve Negative Differential Thermal Conductance in electronic circuits, a building block for thermal equivalent of transistors and amplifiers
- Within photonic heat transport regime, utilized conductivity phase transition to get NDTC. Modelled a superconducting circuit to apply and verify our framework[[Physical Review B, 1st author](#)]

**Masters Thesis Project** Aug'22-March'23

-Prof. Vishwanath Shukla

- Developed a robust spectral time-split code to simulate coherently and incoherently excited(Bose-Condensed) exciton-polaritons to study nonlinear phenomena like turbulence, BKT and KPZ physics.
- In the mean-field regime, modelled by a non-hermitian and coupled Gross-Pitaevskii equation, performed a quantum hydrodynamic analysis to probe inverse-cascade of energy and turbulence[[Thesis](#)]

**Autonomous Ground Vehicles** Mar'19-May'23

-Prof. Debashish Chakravarty

- Our team built a fully autonomous ground vehicle for International Ground Vehicle Challenge 2019, Michigan(USA) where I worked on controls and sensors integration.
- For steering and speed control of a self-drive car, coded control systems like Stanley and iterative-LQR
- Worked on Gaussian Process trained constrained iterative-LQG for motion planning and control tackling sensor noise and modelling error through on-the-go learning
- Conducted several reading groups on introductory control systems and LQR to mentor the juniors.
- Mentored about 60 students in an IEEE-certified winter school on autonomous robotics, attended by 1<sup>st</sup> and 2<sup>nd</sup> year students. Taught various topics from Control Systems and Robot Operating System.

## TECHNICAL STRENGTHS

**Programming Languages**  
**Experimental Methods**  
**Analysis and Numerics**  
**Computational Physics**  
**Software & Tools**  
**Miscellaneous**

C, C++, Python, FORTRAN, MATLAB  
Optics, Spectroscopy, Electronics, Cryogenics  
FFTW, Dedalus, Eigen, MPI, Pandas, NumPy, SciPy  
Spectral Methods, Monte Carlo Methods, FEM, DMRG  
EAGLE, LTspice, High Performance Computing, Solidworks  
AVR, Arduino, Control Systems, Image Processing, Computer Vision

## TERM PROJECTS

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### Linear theory of Faraday instability in viscous fluids using Floquet analysis

[Report](#)

*Fluid Mechanics | 4th Semester*

The eventual instability of surface waves in a fluid being oscillated vertically, i.e Faraday Instability was analytically studied. Using Floquet analysis for time-evolution on spatial Fourier modes governed by linearized Navier-Stokes for surface disturbances, I numerically computed the instability boundaries.

### Shadows of black holes and rendering image of accretion disk

[GitHub Report](#)

*General Theory of Relativity | 6th Semester*

To study the shadow of a black hole i.e the null geodesics for different impact parameters are classified using Schwarzschild's metric. The Equations of Motion are further numerically integrated to render the images of an accretion disk around the black hole viewed at different angles.

### Lie Groups: Geometry of dynamics and geometry preserving simulators

[Report](#)

*Mathematical Methods-II | 6th Semester*

Dynamical systems are simulated using the Lie-Group integrators showing to preserve the symmetry of the system  $10^{13}$  times better than Eulerian methods. An  $SO(3)$  system is taken as a numerical example.

### Analytical mechanics in optimal control theory

[Report](#)

*Classical Mechanics-II | 5th Semester*

Pontryagin's principle is used to show how Hamilton's Equations can be used to develop optimal control policy for a system. LQR is derived using this principle and applied to steer a car for path tracking.

### Monte Carlo simulations of Ising and XY-model

[GitHub Report](#)

*Computational Methods | 5th Semester*

The 2D Ising Model and XY model were simulated using Metropolis Algorithm. Critical temperature and effects of the external field were found, while to speed up the codes, MPI parallel programming was used.

### Relativistic Evolution of Synchrotron Radiation

[Report](#)

*Electrodynamics-II | 5th Semester*

In this essay, I use relativistic arguments instead of Lienard-Wiechart equations to characterize the cyclotron-to-synchrotron radiation of an electron and deduce features like angular and spectral dispersion.

## ACHIEVEMENTS

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- [Endowment Prize](#) for the Best Masters Thesis in the Physics Department.
- Charpak Lab Scholarship for internship at PhLAM, CNRS, awarded to 30 students from India
- INSPIRE Scholarship given by the Department of Science and Technology, Government of India
- Won the *Decoherence Competition* at IISc Bangalore in Pravega, 2020
- Part of 2<sup>nd</sup> prize winning team at International Ground Vehicle Challenge 2019, Michigan(USA)
- Best Freshers at Cubiscan event in the techno-management fest, Kshitij 2019, IIT Kharagpur
- Top 1 percentile in the Joint Entrance Examination 2018 given by over 1 Million students
- Won the state-level CBSE Heritage India Quiz, 2015
- Won the regional-level(comprising of 3 states) CBSE Science Exhibition, 2015

## POSITIONS OF RESPONSIBILITY

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### [Awaaz](#)(Chief Editor)

### -Journalism and Technical Writing

- As a campus media body, we have written on topics spanning administrative issues, academic programs, industrial outreach, students' activities, research highlights, college politics and alumni talks.
- We have expanded our reach to 37 Thousand people via our website, Facebook Page, Blogs, annual newsletter and other social platforms.

### Space Technology Students' Society

- Designed the problem statement on 'Gravitational waves and its similarity with electromagnetic waves' in National Students' Space Challenge 2019, largest of its kind in India.
- Gave Astro-workshops to the incoming UG batch of 2019 during their orientation program.

### National Service Scheme

Volunteered for various local initiatives like conducting surveys, sanitation projects and organizing charities