Publication and Key projects

Einstein Cartan Dirac Equations in Newman-Penrose Formalism

TIFR, Mumbai

Guide: Prof. T.P. Singh, Tata Institute of Fundamental Research; Prof. Urjit A. Yajnik, IIT Bombay — *May'17 - Apr'18*

- Proposed a new Quantum Gravity length scale which gives **General Relativity** and **Quantum Mechanics** as limiting cases
- Studied Newman-Penrose Formalism and Einstein-Cartan Theory to understand their coupling to Dirac equation
- Solved the coupled differential equations corresponding to spin-1/2 particles in Minkowski space-time
- **Published** in Physical Review D, arXiv:1804.11334v2

Determination of Cell–Cell and Cell–Substrate Forces in Tissues

IIT Bombay

Guide: Prof. Raghunath Chelekkot, Department of Physics, IIT Bombay — *Jun'16 - Oct'16*

- Extensively studied particle-based simulation models by Zimmermann et. al and Basan et. al on **Contact Inhibition of Locomotion** (CIL) and **motility force alignment** as mechanism for spreading of colonies in wounded tissues
- Performed MATLAB simulations to study spreading dynamics and mechanical properties of cell segments in situations that closely corresponds to experimental configuration and received **Undergraduate Research Award** for exemplary interdecipilinary research

Applications of Gauge/Gravity Duality to Condensed Matter Systems

IIT Bombay

Guide: Prof. Pichai Ramadevi, Department of Physics, IIT Bombay — *May'18 - Present*

- Reviewed Black Hole thermodynamics, Superconductivity, **Monte Carlo** method and **Numerical methods**
- Studied Supersymmetry and Supergravity to understand basics of AdS/CFT correspondance
- Applied Quantum Critical Transition knowledge to Holographic Superconductors and Quantum Liquids
- Working out **far-from-equilibrium dynamics** of Holographic Superconductors using Numerical methods

Quantum Information Paradox

IIT Bombay

Guide: Prof. Urjit A. Yajnik, Department of Physics, IIT Bombay; Black Hole Physics Group — *Nov'16 - May'17*

- Studied Quantum Information and Entanglement Theory to understand the Quantum Information Paradox
- Reviewed **Hawking's Radiation**, **Page time**, **Black Hole Complementarity**, and **Firewall** proposal
- Used Gidding's model to calculate first-order Firewall effects at Black hole horizon in 1+1 Dimensions

Trajectories in Black Hole Background

IIT Bombay

Guide: Prof. Urjit A. Yajnik, Department of Physics, IIT Bombay — *May'16 - Nov'16*

- Grasped concepts of General Relativity, Schwarzschild Solution, Reissner-Nordstrom Solution, Kerr solution, Perturbation Theory, Penrose Diagram and Field Theory in Curved Spacetime
- Used **Eddington-Frinkelstein** and **Kruskal** coordinates to study near horizon geodesics and maximally extended Schwarzschild solution and compared them to Newtonian solutions

Non-commutative Quantum Mechanics

IIT Bombay

Guide: Prof. Pichai Ramadevi, Department of Physics, IIT Bombay — *Jun'16 - Dec'16*

- Grasped concepts of Differential Geometry and Matrix Geometry to understand non-commutative case
- Studied irreducible form of basic algebra and quantum dynamics in non-commutative space-time manifold to understand 2D harmonic oscillator, Landau problem, Hopf algebras and fuzzy physics
- Studied **Quantum groups** and **Poisson structure** as a commutative, classical limit

Gravitationally lensed Ordinary Type IA Supernova PS1-10afx

IPMU, Tokyo

Guide: Prof. Anupreeta More, IPMU, Tokyo, Prof. Vikram Rentala, Department of Physics, IIT Bombay — *Aug'15 - Nov'15*

- In a group of 2, reviewed the **Gravitational Lensing hypothesis** for anomalous case of PS1-10afx by observing spectral features from detailed .fits files and related research publications
- Downgraded the HST image to match the spatial resolution and PSF smearing to reproduce **Keck specifications**
- Used Anaconda to separate 2 Gaussian components from HST image of [O II] spectrum to fit Keck's spectrum

Technical and Programming Skills

Tools	Matlab, Mathematica, Anaconda, Arduino, AutoCad, OriginLab, SolidWorks, VHDL, GNUplot, VMD
Languages	Python, C/C++, Java, LaTeX, HTML5/CSS, BASIC, Logo

Academic Credentials

2013	**KVPY:** Awarded Kishore Vaidnyanik Protsahan Yojana (**KVPY**) Scholarship for securing **99.4** percentile out of **100 Thousand** candidates	*Dept. of Science, Govt. of India*
2014	**JEE:** Among **top 1%** students in Joint Entrance Examination - Advance, out of **0.15 Million** students	
2016	**URA:** Received **Undergraduate Research Award** awarded to **30** students out of **11,000** students	*IIT Bombay*
2018	**Honors:** Completed an **Honors** Degree in Physics	*IIT Bombay*

Course Projects

Synthesis and Analysis of Graphene Oxide
IIT Bombay

Guide: Prof. M. Aslam, Department of Physics, IIT Bombay; Group members: 2 — *Feb'18 - Apr'18*

- **Synthesized** Graphene oxide nanoparticles using modified Hummers method with reduced toxic emission
- Characterized the nanoparticles using FTIR, Raman, UV-Vis, and XRD spectroscopy and observed **17%** increase in efficiency

A Study of Sloshing Modes
IIT Bombay

Guide: Prof. Kundu Tapanendu, Department of Physics, IIT Bombay; Group members: 5 — *Mar'16 - Apr'16*

- Observed and studied dynamics behind **sloshing modes** of a rectangular tank using Euler and Laplace equations
- Plotted the amplitude of the liquid inside the rectangular container using MATLAB and Image Processing

Synchronization of Chaotic Systems
IIT Bombay

Guide: Prof. Amitabha Nandi and Prof. Raghunath Chelakkot, Department of Physics IIT Bombay — *Oct'15 - Nov'15*

- Studied dynamics of **Chaotic systems** (**Rossler**) and how synchronization of such an oscillator can be achieved by applying an external force or by coupling 2 such systems
- Experimentally observed real world examples of Phase synchronization, Lag synchronization and Complete synchronization, worked out its dynamics and computationally analysed the system

Hives, A Smart Living Solution
IIT Bombay

Guide: Prof. Raj Jaswa, Chairman, CEO and President, Dyyno, Inc.; Group members: 6 — *Jul'18 - Present*

- Conducted market research and generated a potential startup business model for **'capsule homes'**
- Developed and presented a complete business model canvas to **100+** different hotels, hospitals and entrepreneurs

Remotely Controlled Ping-Pong game using FPGA module
IIT Bombay

Guide: Prof. Pradeep Sarin, Department of Physics, IIT Bombay; Group members: 2 — *Mar'16 - Apr'16*

- Designed a 2-player/single-player ping-pong game in **VHDL** and implemented it using FPGA (DE0-nano board)
- Created a **VGA** circuit to convert the FPGA input/output and display it on a screen

Internship Experience and Positions of Responsibility

Teaching Assistant | Electronics Lab I
Department of Physics, IIT Bombay

Jul'18 - Present

- Responsible for creating and testing dynamic lab assignments for **40+** students with **'bonus'** problems challenging TAs
- Reviewed Instrumentation and application of LCR circuits, semiconductors, diodes, transistors, and logic gates thoroughly

ClearTax | Taxation and Financial Solutions
Mumbai, Sales and Marketing

Jun'17 - Jul'17

- Worked in a team of **5** to figure out the most effective marketing strategies to publicize Cleartax GST solution
- Presented to a crowd of **10000+** CAs in 3 different cities and 10+ business firms with **5000+** b2b invoices
- Point of contact for over **500** CA firms; responsible for their customer grievances

Computer Secretary
Hostel-9, IIT Bombay

Jul'15 - Mar'16

- Worked in a team of 3 responsible for overall maintenance of hostel's computers and LAN/Internet related problems
- Managed a budget of **INR 200 Thousand** to ensure the safety and maintenance of equipments in hostel computer room

Coordinator | *Team Informals, Mood Indigo 2015*
IIT, Bombay

Asia's largest cultural festival with a footfall of **150,000+** — *Jul'15 - Dec'15*

- Coordinated in a team of **30** to assist in ideation and conceptualization of over 35 events
- Organized and executed informal events like MI Election, Hogathon etc. with **5000+** participants

Maintenance Secretory
Hostel-15, IIT Bombay

Sep'14 - Apr' 15

- Cooperated in a team of 9 to provide the best possible services to **1000+** hostel inmates
- Managed human resources and ensured that they worked properly and problems were solved at the earliest

Co-Curricular Activities

- Received Certificate of Appreciation for teaching underprivileged children by **National Service Scheme**, IIT Bombay
- Excelled in **boxing** course conducted by Summer School of Sports, IIT Bombay
- Completed introductory course in **French** language under Summer School of Cult, IIT Bombay
- Acted, directed and edited a short movie on student life in IIT Bombay for freshizza 2014