Kasi Reddy Sreeman Reddy

Curriculum vitae of an undergraduate physics student

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I am interested in doing research in the fields of theoretical high energy physics and cosmology. Particularly I want to do research at scenarios where the quantum effects of gravity cannot be ignored.

Education

2019–Present **Indian Institute of Technology Bombay (IIT Bombay)** .
B.Tech in Engineering Physics
CPI-9.08/10
Pursuing an **Honors** in Engineering Physics and a **Minor** in Mathematics.

Academic Achievements

2019 Achieved **All India Rank 100** in IIT JEE Advanced among 200,000+ candidates.

2019 Achieved **All India Rank 236** in IIT JEE Mains among 1,000,000+ candidates.

2018 Was selected to the **Vijyoshi camp 2018** at IISc Bangalore through the Kishore Vaigyanik Protsahan Yojana (KVPY-2017) exam conducted by the Department of Science and Technology.

2017, 2018 Ranked among the national top 1% in National Standard Examination in Astronomy (NSEA-2017) and National Standard Examination in Chemistry (NSEC-2018) and was selected for INAO-2018 and INChO-2019 conducted by HBCSE.

Projects

Jun-present 2021 **Black hole information paradox**.
Supervisor: Prof. Vikram Rentala, Dept. of Physics
URL
- Studied quantum scalar field theory in curved spacetime and how it compares with QFT in flat spacetime.
- Reviewed the four laws of black hole mechanics and their similarity with thermodynamics and Penrose process in a Kerr black hole.
- Studied **Unruh effect** which explains that the vacuum state of a Minkowski observer will be a thermal state as observed by a Rindler observer and how entanglement between the left and right Rindler wedges prevents a firewall at the Rindler horizon.
- Studied **Hawking radiation**, the conditions in which a black hole can be in stable or unstable equilibrium and currently studying recent advances like AdS/CFT correspondence which are strongly implying that information is conserved and quantum gravity is unitary.

Mar-Apr 2021 **One-dimensional photonic bound states in the continuum**.
URL *Supervisor: Prof. Anshuman Kumar, Dept. of Physics* Course Project
- Studied bound states in the continuum (BICs) which emerge due to precise destructive interference of waves for an electron in an one-dimensional quantum well under an external magnetic field.
- Using the correspondence between the spin states of the above electron model and the polarisation states of an one dimensional photonic system made up of an anisotropic layer conjugated with a 1D photonic crystals consisting of alternating layers, found BICs for the photonic system.
- Calculated numerical values and generated graphs of several quantities such as transmittance, reflectance, Q factor, wave function using python for both the electron model and the photonic model.

Nov-Dec 2020 **Category theory applications in physics**.
Supervisor: Prof. Vikram Rentala, Dept. of Physics
URL
- Studied basic concepts of category theory like Functors, Natural transformations, Monoidal categories.
- Studied axiomatization of physical systems using strict monoidal categories.
- Investigated **FdHilb** category and studied **no-cloning, no-deleting theorems** in categorical quantum mechanics.

Nov-Dec 2020 URL

Covid-19 analysis using a modified SEIR model.

Supervisor: Prof. Amitabha Nandi, Dept. of Physics Course Project

- Studied the normal Susceptible-Exposed-Infected-Recovered (SEIR) model. Later used a modified model to incorporates the fact that asymptomatic or mildly symptomatic individuals play a significant role in the transmission of Covid-19.
- Generated different projections for India under different intervention parameters.
- By varying intervention parameters in the modified model we concluded that testing-quarantining is more efficient in controlling the pandemic than lockdowns.

April 2020 URL

Special and General Relativity.

Guide: Summer of Science mentor under Maths and Physics Club, IIT Bombay

- Studied the principles of relativity. Started with Special Relativity and then read the mathematical prerequisites for General Relativity.
- Studied General Relativity till Schwarzschild metric and analyzed the properties of Schwarzschild black holes in Schwarzschild coordinates and Eddington–Finkelstein coordinates.

July 2020

Orbit Determination.

Guide:Krittika summer projects mentor under Krittika Astronomy club of IIT Bombay

- Learnt basic numerical computing, converting between Altazimuth, Equatorial and Ecliptic Coordinates.
- Wrote code in Python which takes the right accession and declination at 3 points of an orbit as inputs and outputs the orbital elements and ephemeris for the required time interval.

Autumn 2019

Power Inverter.

Supervisor: Prof. Joseph John, Dept. of Electrical Engineering Course Project

- Implemented a modified 555 timer based astable multivibrator circuit to get equal high and low time.
- Integrated the circuit with BC457 (BJT) to obtain full cycle of 50Hz. The pulse high is obtained from 555 timer output and pulse low from inverted output (using BJT inverter)
- Generated time varying currents using IRFZ44 n-channel power MOSFETs and obtained ac voltage by passing time varying currents through 150-0-15 transformer.

Other Projects

Autumn 2019

Digital counter and object detector.

Constructed a proximity censor using LED-IR detector pair. Interfaced 7490 BCD counter to 7447A BCD-to-seven-segment decoder and LT-542 Common-anode Seven segment display to create a manual clock.

Technical Skills

Languages: Python, C++, SageMath, Wolfram Language, Maple, HTML, Markdown

Packages: Numpy, Scipy, Matplotlib, SageManifolds, GRTensorIII, ROOT

Other: LaTeX,Git, Jekyll, SolidWorks, AutoCAD

Key courses

Physics: General Relativity, Quantum Mechanics I, II*, Quantum Mechanics III* (Introduction to quantum field theory), Special Relativity, Electricity & Magnetism, Classical Mechanics, Thermal Physics, Waves & Oscillations & Optics, Nonlinear Dynamics, Photonics*, Data Analysis & Interpretation.

Maths: Complex Analysis, General Topology, Real Analysis, Calculus, Linear Algebra, Basic Algebra*.

Other: Computer Programming and Utilization, Philosophy*, Power Engineering - I, Introduction to Electrical Engineering Practice, Digital Systems.

** Courses to be completed by the end of Autumn 2021-2022*

Positions of Responsibility

Teaching Assistant.

Nov 2020-Jan 2021 URL

MA 109 - Calculus I, Dept. of Mathematics

- Responsible for conducting tutorial sessions every week for a batch of 40 students throughout the course and helping them clear conceptual doubts.
- Corrected all their answer sheets. Made solutions to questions every week for students. Apart from the tutorial sessions solved all their doubts throughout the course through online messaging.

June 2020 –May 2021 **Convener**, *Krittika, The Astronomy club of IIT Bombay, Institute Tech Council*.

- Part of a team of 10, responsible for organising several institute-wide events such as lectures, workshops, group discussions, projects, interactive online activities including quizzes and trivia to foster enthusiasm in Astronomy and Cosmology in the institute.
- Helped in conducting the Krittika Python Tutorials, a novel initiative through which nearly 2000 students got an opportunity to learn basic astronomy and coding.
- Worked as a facilitator for the project Orbit Determination in Krittika Summer Projects. Helped 6 students to complete their project.