Sahaana Vijay

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Research Interests

Computational physics, nonlinear dynamics and chaos, machine learning (e.g., reservoir computing & RNNs), complex networks in neuroscience, ecology or climate dynamics

Education

B.Sc. Physics Hons. with Research (Concentration: Astronomy) **Ashoka University** (Delhi-NCR) 2026

Thesis Advisors: Prof. Bikram Phookun, Prof. Abhinav Gupta, Prof. Ramakrishna Ramaswamy

Publications

1. Surdej, J., Hickson, P., Misra, ..., **S. Vijay** et al. February 2025. The 4-m International Liquid Mirror Telescope: Construction, Operation, and Science. Astronomy & Astrophysics, EDP Sciences. https://doi.org/10.1051/0004-6361/202452667

Formal Research Experience

Tata Institute of Fundamental Research **Mentor:** Prof. Shravan Hanasoge

Undergraduate Y3, June. 2025 -

Incoming summer intern at the seismology group and will be working along the lines of applying ML (transformer-based architectures) to detect low signal-to-noise transits in large-scale, noisy exoplanet survey data such as TESS.

Indian Institute of Technology, Delhi **Mentor:** Prof. Ramakrishna Ramaswamy

Undergraduate Y2, April. 2024 - Mar. 2025

Explored synchronisation in coupled discrete-time chaotic systems, such as the coupled logistic map, and multistability in attractors (transient chaos). Presented work at Ashoka Physics Student Symposium 2024 and Meera Memorial Paper Presentation 2025 at St. Stephen's College, Delhi University

Aryabhatta Research Institute of Observational Sciences **Mentor:** Dr Jean Surdej

Undergraduate Y2, July. 2024 - Sept. 2024

Analysed direct images of the quasars observed with the 4m ILMT telescope and searching for features such as presence of a host galaxies, gravitational lens candidates, significant photometric variability, etc. using SAOImageDS9.

Additional Academic Engagements/Projects

Ashoka University

Undergraduate Y3, April. 2025 - May 2025 **Mentor:** Prof. Somendra M. Bhattacharjee

Implemented a simulated annealing algorithm (inspired by thermodynamic annealing) to solve the Travelling Salesman Problem, a classic NP-hard problem, as part of a computational physics course, modelling city routes to minimise total travel distance and analysing convergence behaviour across solution spaces.

Undergraduate Y2, Feb. 2024 - May 2024 **Mentor:** Prof. Somendra M. Bhattacharjee

Wrote code to generate the Julia set of fractals, explore the implications of projecting the set (renormalization transformation) onto a unit sphere, and study the behaviour on the unit circle, i.e., equator of the sphere, which correlates with dynamical quantum phase transitions.

Undergraduate Y2, Apr. 2024 - May 2024 **Mentors:** Prof. Gautam Menon, Philip Cherian

Numerically simulated basic 1D and 2D random walks with constant step sizes, analysed probability distributions, and compared end-to-end distances with the number of steps. Further simulated 1D and 2D random walks with variable step sizes using exponential and Lévy Flight distributions, and verified conformity with the discrete probability distributions for N walks using Monte Carlo simulations.

Theoretical Division, Los Alamos National Laboratory **Mentor**: Dr Sergi Gonzàlez-Solís

Undergraduate Y1, Jul. - Aug. 2023

Studied and applied Padé approximations to nucleon axial form factors, estimating axial mass and radius from experimental (neutrino-nucleon scattering) and lattice QCD data, thereby replacing the usual dipole parametrisation method with a novel approach. Presented work at Ashoka Physics Students Symposium 2023.

University of California, Berkeley **Mentors**: Iván M. Burbano Aldana, Siddhant Mal, Marco A. Carillo

Undergraduate Y1, Jun. - Aug. 2023

Studied simple field theories (Ising model, O(n) model, etc.) and analysed their statistical properties using Monte Carlo methods. Wrote a technical report on the quantum Ising model, presented a poster at REYES and IEEE STEM Expo @ Ashoka University, and gave a talk at university on using MC methods to simulate the Ising model.

Technical Skills

Languages: Python, SQL, Julia, SageMath

Frameworks and Tools: SAOds9, RSpec Astronomical Spectroscopy Software, Looker Studio, Siril, TinkerCAD, Raspberry Pi, Tableau

Libraries: Pandas, NumPy, Matplotlib, scikit-learn, Seaborn, Tensorflow, Keras etc.

Technical Reports

A Quick Dive into the Quantum Ising Model, Advisors - Ivàn M. Burbano Aldana, Siddhant Mal, and Marco A. Carrillo

The Chronicles of Nucleons: The Neutrino, the Form Factor and the Approximant, Advisor - Sergi González-Solìs (Published the Ashoka Physics Journal 2023)

Teaching Experience

- Teaching Assistant for Prof. Dipankar Bhattacharya, *Physics Lab Module*, (Lodha Genius Programme, Ashoka University, Summer 2024) Assisted in teaching high school students mathematical and laboratory techniques in physics, covering motion and mechanics, wave phenomena, electromagnetism, polarisation, and spectroscopy.

Positions of Responsibility & Miscellaneous Work Experience

Astronomy Society Executive Head of Events (2024-2025)

STEM 4 Everyone Founder (2020-2023)

Lodha Genius Programme Academic Mentor for 4 HS Students (2024)