

Arpan Dey

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SUMMARY

Arpan Dey is an incoming Masters student at the University of Montpellier's IDIL (Inter-Disciplinary In-Lab) Graduate Program (Modelling Biological and Environmental Systems, MoBiEn – Physics Track). He holds a Bachelor of Science degree in physics from St. Xavier's College, Kolkata. In physics, he is mainly interested in the theoretical aspects of quantum mechanics, statistical mechanics, nonlinear dynamics and the philosophy of physics. He has written and edited many science articles (original research and review) for different journals and magazines. He has worked on several research projects and also presented at his college and beyond. He has published a popular science book on physics: *Our Physics So Far: A Journey through Spacetime, Consciousness and the Fundamental Nature of Reality*. He is also the founder of a physics blogging site, *The Journal of Young Physicists*, where students can submit their physics articles for review and publication.

EDUCATION

- **University of Montpellier, Montpellier, France**

IDIL Masters student, Physics

2025 – Present

Modelling Biological and Environmental Systems (MoBiEn) – Physics Track

- **St. Xavier's College (Autonomous), Kolkata, India**

Bachelor of Science B.Sc. (Honors) in Physics

General Elective Subjects: Mathematics, Computer Science

CGPA: 8.02/10 (First Class)

2022 – 2025

Undergraduate dissertation project: Feynman's path integral formulation of quantum mechanics

- **Delhi Public School, Burdwan, India**

Senior secondary high-school graduate

2008 – 2022

Senior School Certificate Examination (CBSE) – 12th Standard (Science), Score: 94.33%

Secondary School Examination (CBSE) – 10th Standard, Score: 98.17%

EXPERIENCE AND EXTRACURRICULAR ACTIVITIES

- **Summer Research Intern, Institute of Mathematical Sciences**

Jun 2025 - Jun 2025

I was accepted into the Summer Research Program (under Theoretical Physics category) offered by the Institute of Mathematical Sciences, Chennai, India. As part of my internship, I worked in the intersection of nonlinear dynamics and computational biology under the guidance of Prof. Sitabhra Sinha, by studying synchronization in coupled Kuramoto-type oscillators with nonlinear feedback. I am currently interested in further studying the effect of different lattice geometries (square, hexagonal etc.) and the different types of networks (fully-connected, loosely-connected, directed, undirected etc.) on synchronization. This could have potential applications in modelling spiking behavior in neurons or contraction dynamics in human heart, among other things.

- **Summer Research Fellow, Physical Research Laboratory**

Jun 2024 - Jul 2024

I received the Summer Research Fellowship (2024) offered by the Indian Academy of Sciences. As part of the fellowship, I studied the modular group and modular symmetries. More specifically, I investigated the fundamental domain of the modular group, and possible applications of the same in the Standard Model and other areas of theoretical high energy physics. I worked under the supervision of Dr Ketan Patel of the Theoretical Physics division at Physical Research Laboratory, Ahmedabad, India.

- **Senior Physics Editor, Young Scientists Journal**

Jul 2020 - Present

As senior physics editor, I review and manage all physics articles – research and review – that are submitted to the YSJ – an international, peer-reviewed publication for young students – as well as coordinate the junior physics editors. Before my appointment as a senior physics editor, I worked as a junior editor of physics, mathematics and astrophysics for the YSJ. I also briefly served as a curriculum developer for YSJ's *reSTEM* project, which is an initiative to set up an international network of research clubs and introduce high-school students to research.

- **Virtual SOAR Scholar, Emory University Laney Graduate School**

Jun 2023 - Aug 2023

I was selected to Emory University's 2023 LGS-SOAR (Laney Graduate School – Summer Opportunity of Academic Research) program, and was recognized by the university upon successful completion of the program.

- **Associate Student Editor-in-chief - Pebbles 2025, St. Xavier's College Science Association**

Nov 2024 - March 2025

I have served as the associate editor-in-chief of Pebbles 2025, the annual magazine of the Science Association of our college. Prior to this, I was a member of the editorial board of Pebbles 2024. As part of my role, I reviewed articles and interviewed researchers from different scientific disciplines. I was also a part of the student committee of Horizon 2025, the annual magazine of the Department of Physics, St. Xavier's College, Kolkata. I was involved in editorial, interviewing and advisory responsibilities, and also contributed an article to the magazine.

- **Founder and Contributor, The Journal of Young Physicists**

Jul 2020 - Present

The Journal of Young Physicists is a platform for young physics aspirants to get their physics articles reviewed and published for free. We are committed to popularizing physics and fostering the growth of young physicists.

- **Research Guide, Xaverian Astronomical Society**

Oct 2024 - April 2025

As a research guide of the Xaverian Astronomical Society (XAS) of my college, I have mentored a junior on a project exploring the interplay between entropy, information, quantum information and potential applications in understanding the black hole information paradox. The final result was a report titled "Preserving Information in the Void: A Quantum Computational Approach to Black Holes." During my time at XAS, I was also part of a student group that was learning Bayesian cosmology.

- **Young Member of The Junior Academy, The New York Academy of Sciences**

Sep 2020 - Jul 2022

The Junior Academy is a STEM program for high-school students, where students from all over the world are put in small groups and given the chance to work on real-life, challenging STEM problems. I worked in an international team of five students on two challenges: first, designing a telemedicine app and second, studying COVID vaccination statistics in different countries and designing an effective vaccine distribution scheme.

- **Science communicator and content creator, YouTube**

Jun 2019 - Present

I create physics and science videos for my YouTube channel – Arpan D, as well as videos about aviation, travel and life in general. My channel currently has over 2.5 lakh views and 1000 subscribers. In my free time, I also write songs and produce music. I have collaborated with several vocalists worldwide and released thirteen original songs and an album (Unsettled Bliss). All of my songs can be found in my second YouTube channel – Arpan Amplified.

- **Member, American Physical Society**

Jun 2023 - Jul 2024

I was an undergraduate student member of the APS. During my membership, I connected with physicists from all over the world and attended interesting and important webinars on the most pressing topics in physics today.

- **Author, Notion Press**

Jul 2021 - Sep 2022

I have published two books with Notion Press: a popular science book on physics (*Our Physics So Far*) and a Sherlock Holmes adventure (*The Adventure of the Injured Cabman*).

SELECTED ARTICLES AND PUBLICATIONS

- **Dyadic Emotional Modelling: A Nonlinear Dynamics Approach (2025)**

<https://zenodo.org/records/16622702> [DOI: 10.5281/zenodo.16622702]

In this article, we present a mathematical model for studying the emotional and relationship dynamics between two individuals, using a system of four coupled nonlinear differential equations, two of which represent the time evolution of the emotional states of the two individuals, and the other two equations represent how their feelings for each other evolve over time. The differential equations were designed to reflect key features of emotional and relationship dynamics, drawing on insights from empirical psychological studies. Our model incorporates features such as internal emotional regulation, asymmetrical relationship influence, reciprocity and noise (external and internal). We further define a parameter that quantifies the overall emotional alignment between the two individuals, and study its evolution over time for different initial conditions. Numerical simulations reveal realistic behaviors such as emotional damping, fluctuating interpersonal influence and stabilization over time.

- **Investigations on the Fundamental Domain of the Modular Group (2024)**

<https://zenodo.org/records/15737745> [DOI: 10.5281/zenodo.15737745]

This article investigates the nature of the transformations from any arbitrary point on the upper half of the complex plane into the fundamental domain of the modular group. The upper half complex plane has been divided into appropriate regions and a Python simulation has been run to verify the transformations that maps the points inside the fundamental domain for each region.

- **Path Integral Formulation of Quantum Mechanics (2025)**

<https://zenodo.org/records/15564781> [DOI: 10.5281/zenodo.15564781]

This article presents a rigorous introduction to Feynman's path integral formulation of quantum mechanics. It begins by outlining the motivation behind the path integral formulation, and then builds the mathematics required for defining the sum-over-paths. Then it derives the free particle propagator, as well as the propagator for a particle with a non-zero potential energy, with particular focus on linear and quadratic potential energies. Using these results, the Planck-Einstein equation, de-Broglie equation and Schrödinger equation are derived. Then, using Python plots, the difference between the wave function and propagator is studied visually and mathematically. In the end, the article also touches on the basic idea behind perturbation theory by using the free particle propagator to study a particle that moves between two potential-free points in spacetime, but via intermediate points with non-zero potentials.

- **On the Quantum Mechanical and Temporal Origins of Entropy: Exploring the Interplay between the Cosmological Arrow of Time, Thermodynamic Arrow of Time and Heisenberg's Uncertainty Principle (2025)**

<https://zenodo.org/records/15669080> [DOI: 10.5281/zenodo.15669080]

In this article, we explore the possibility of understanding the increase in the entropy of our universe as a consequence of quantum uncertainty. The question of the arrow of time is also addressed: whether the arrow of time is a result of the second law of thermodynamics or the opposite. The most widely accepted view is that entropy is responsible for the unidirectional nature of time. However, we argue that the cosmological arrow of time – which is a result of the expansion of the universe – comes first, and the second law of thermodynamics and the thermodynamic arrow of time follow. And while quantum uncertainty might not be directly responsible for driving the increase in entropy, it certainly leaves room for entropy to increase in our universe.

- **Complexity: The Next Big Thing in Physics (2024)**

<https://www.journalofyoungphysicists.org/post/complexity-the-next-big-thing-in-physics>

[DOI: 10.5281/zenodo.13913639]

This article aims to give a broad overview of the study of complexity and recent developments in the field. The article starts with a brief discussion on the various approaches to quantify complexity and then discusses assembly theory – a recent, novel and promising approach to study complex systems, touching upon other new and relevant theories like constructor theory. Then some interesting properties of complex systems – like emergence, self-organization and unpredictability – are discussed, along with how ordered complexity can arise from randomness and finally, the article discusses consciousness from a complexity perspective.

- **Our Physics So Far: A Journey through Spacetime, Consciousness and the Fundamental Nature of Reality (2022)**

ISBN: 978-1685090234, ASIN: B0BD8MC5NW

<https://www.amazon.com/dp/b0bd8mc5nw>

Our Physics So Far is a popular science book on physics which narrates the story of physics and science from Newton's days to the present. The book starts with a discussion on cosmology, then moves on to mathematics, classical physics, special and general relativity and quantum mechanics. The next part focuses on particle physics, information paradox and the hunt for a unified theory. Then, the book turns to the physics of complexity and chaos theory, following which the question of the nature of consciousness is addressed, with some brief discussion of neuroscience and psychology. Finally, there is a discussion on metaphysics, paradoxes and the fundamental nature of reality. Adding to the book's appeal is an interview with renowned physicist Edward Witten. The book has mostly received positive feedback from readers worldwide.

- **Beyond Quantum Mechanics: Black Holes, Information, Unification, Extra Dimensions and the Future of Theoretical Physics (2025)**

<https://www.journalofyoungphysicists.org/beyond-quantum-mechanics>

[DOI: 10.5281/zenodo.16793345]

Commemorating the first hundred years of quantum mechanics, this article discusses some foundational ideas in quantum mechanics and some approaches toward a theory of quantum gravity.

- **A Study on Improving Take-Off Efficiency of Airplanes (2023)**

<https://zenodo.org/records/8284591> [DOI: 10.5281/zenodo.8284591]

This article explores the pros and cons of a movable forward-set split-flap-like structure in the main wing of an airplane, and its effectiveness in improving take-off efficiency and maneuvering capabilities of airplanes.

- **Can the de Broglie Relation be Modified for Accommodating Relativistic Modifications in the Schrodinger Equation? (2023)**

<https://zenodo.org/records/8284632> [DOI: 10.5281/zenodo.8284632]

This is a study on the viability of using the mass-energy-momentum relation to derive de Broglie's equation, and in turn, Schrodinger's time-independent equation.

- **Investigations on Isotopic Elements in Terms of Quarks (2023)**

<https://zenodo.org/records/8284563> [DOI: 10.5281/zenodo.8284563]

This article establishes certain relations, in terms of atomic number, number of up/down quarks in the nucleus (etc.), regarding isotopic elements.

- **Mathematics: The Future of Physics? (2025)**

<https://www.arpandey.net/post/mathematics-the-future-of-physics>

A speculative piece on the future of theoretical physics, and why mathematics might play an increasing important role here.

SELECTED PRESENTATIONS, INTERVIEWS AND PODCASTS

- **Exploring Synchronized Oscillations in Kuramoto-type Oscillators with Nonlinear Feedback – Summer Research Program 2025** (*Institute of Mathematical Sciences, Chennai*)

Slides: https://drive.google.com/file/d/1DZXavKDiAGfqmth4plAvpAd0_8LekSKv

- **Path Integrals, Uncertainty, Entropy and Information – Quantum Foundations Summer School 2025** (*Bhaktivedanta Institute, Kolkata and Centre for Development of Advanced Computing, Patna*)
Slides: <https://drive.google.com/file/d/1-TJCTQD7HtMRrarqDJoWhG6CaJxhSI9F>
- **Assembly Theory and the Evolution of Complex Systems – Spectrum 2024 Paper Presentation Competition** (*St Xavier's College, Kolkata*)
Slides: <https://docs.google.com/presentation/d/1HV3gbNrKba6oBoFCPuGZAI7GXYsLAjK5Xs08PPmqyHk>
- **The Journey of a Young Physicist – by Mayank Dora, STEMz Perspectives 2024** (*Young Scientists Journal science podcast*)
URL: <https://www.youngscientistsjournal.com/podcast/episode/1aaf8292/episode-15-the-journey-of-a-young-physicist-an-interview-with-arpan-dey>
- **Interview with An Aspiring Physicist – by Aaradhana Umesh, 2023** (*Travelling through Pages, YouTube*)
URL: https://youtu.be/x_Zvn9IVOSO
- **Young Author Arpan Dey talks about his book Our Physics So Far, 2021** (*The Literature Times*)
URL: <https://www.theliteraturetimes.com/young-author-arpan-dey-talks-about-his-book-our-physics-so-far-a-journey-through-spacetime-consciousness-and-the-fundamental-nature-of-reality>
- **'Dey'light at the end of a quantum tunnel as teen physicist Arpan explores consciousness – by Darshana Ramdev, 2022** (*Global Indian*)
URL: <https://www.globalindian.com/youth/story/global-indian-exclusive/deylight-at-the-end-of-a-quantum-tunnel-as-teen-physicist-arpan-explores-consciousness>
- **All that Matters is Physics – by Hasini Lakshminarayanan, 2022** (*The First Step*)
URL: <https://www.arpandey.net/exclusive-interview-the-first-step>
- **The Fundamental Domain of the Modular Group – Spectrum 2025** (*St Xavier's College, Kolkata*)
Slides: https://drive.google.com/file/d/1uno_URMCs1AkV0G1DM8IIBjw6NRUklox
- **Emergence and Consciousness – Summer Opportunity of Academic Research 2023, Laney Graduate School** (*Emory University, Atlanta*)
Slides: https://docs.google.com/presentation/d/1GneY_hgzPwnpEfJEwCC8-elplVCVpt8RnWXyITsI7n4

COURSES AND CERTIFICATES

- **Summer Research Program 2025 – Institute of Mathematical Sciences**
<https://drive.google.com/file/d/1uxVql8qrkpikHf0ZpqkyOmsh73GIqFV4>
- **Summer Research Fellowship Program 2024 – The Three National Science Academies**
<https://drive.google.com/file/d/1WJL2zSACZ0DBclqpy0Dv9VhA98y2MTq0>
- **Summer Internship Program 2024 – Physical Research Laboratory**
<https://drive.google.com/file/d/1j75TsuS0wD4YXhuV93r1BGldiSGJmaL9>
- **Physics behind Biology: International Colloquium 2025 – St. Xavier's College (Autonomous), Kolkata**
https://drive.google.com/file/d/1IL_r5ErP-oOFyatK6nMYJQWzOHVs4Oau
- **Summer Opportunity for Academic Research 2023 – Laney Graduate School – Emory University**
<https://drive.google.com/file/d/1FjobvYBJ-EL0oBn30OXWu36sWd6byznP>
- **Top 100 Innovators – Student Innovation Challenge 2020 – Smartcircuits Innovation Pvt. Ltd.**
<https://drive.google.com/file/d/1YvspMZ96eQ65Thf8x-zpnJ4YkIs6vTq7>

- **Oral Presentation, Quantum Foundations Summer School 2025 – Bhaktivedanta Institute, Kolkata and Centre for Development of Advanced Computing, Patna**
https://drive.google.com/file/d/1oBL_DLF-EK2SLvV0NNZ6MQzWgdICJiWX
- **The Unknowable and the Counterintuitive: International Exchange Program on Science and Religion 2024 – Santa Clara University, California; St. Xavier's College (Autonomous), Kolkata**
<https://drive.google.com/file/d/17gJxogT5uOt6qLX1p55A-Vj9p7WZD-LF>
- **Young Member (2020-2022) – The New York Academy of Sciences**
<https://www.credly.com/badges/cc3a3d4a-6164-4baf-b5dd-09cee1cb8ac1>
- **Editorial Board Member, Horizon 2025 – St. Xavier's College (Autonomous), Kolkata**
https://drive.google.com/file/d/146I8_2VcUOAkWHGszOuxqlolxxBNCUEr
- **Research Mentor, Xaverian Astronomical Society 2025 – St. Xavier's College (Autonomous), Kolkata**
<https://drive.google.com/file/d/1zhCcX1KrBz5ptWsXqTiMzw5uoo1g1aJY>
- **Introduction to Complexity 2024 – Santa Fe Institute**
<https://www.complexityexplorer.org/courses/185-introduction-to-complexity/certificates/4053598210.pdf>
- **Particle Physics: An Introduction – University of Geneva – Coursera, 2021**
<https://www.coursera.org/account/accomplishments/certificate/KUFWDBP8AUYY>
- **Understanding Modern Physics I: Relativity and Cosmology – The Hong Kong University of Science and Technology – Coursera, 2023**
<https://www.coursera.org/account/accomplishments/certificate/VDDYH2WPG37N>
- **Understanding Modern Physics II: Quantum Mechanics and Atoms – The Hong Kong University of Science and Technology – Coursera, 2023**
<https://www.coursera.org/account/accomplishments/certificate/A5MW98UAAZC5>
- **Understanding Modern Physics III: Simplicity and Complexity – The Hong Kong University of Science and Technology – Coursera, 2023**
<https://www.coursera.org/account/accomplishments/certificate/LWTTR5323LDJ>

SKILLS AND INTERESTS

- **Areas of Interest in Physics** – Quantum mechanics, Statistical mechanics, Nonlinear dynamics, Biological physics, Complex systems
- **Hard skills** – LaTeX, Python, LTSPICE, Gnuplot, Scientific writing, Academic writing, Editing
- **Soft skills** – Research, Science communication, Popular science, Creativity and innovation, Conflict resolution, Team management, Paper presentation, Public speaking
- **Interests beyond academics** – Writing, songwriting, music production
- **Languages** – English (Full professional proficiency), Hindi (Limited working proficiency), Bengali (Native or bilingual proficiency)