Uddipan Banik
Curriculum Vitae

PERSONAL DETAILS

Affiliation	**Zel'dovich (Postdoctoral) Fellow, Perimeter Institute for Theoretical Physics,** Waterloo, Canada (Sept 1, 2026 - Present)
Concurrent appointments	**Visiting Scientist, Plasma Science and Fusion Center (PSFC), Massachusetts Institute of Technology** (2025 - Present)
Past appointments	**Bezos Member (Postdoctoral Fellow) in Astrophysics, Institute for Advanced Study, Princeton** (2023-26) **Multi-Messenger Plasma Physics Center (Postdoctoral) Fellow, Department of Astrophysical Sciences, Princeton University** (2023-26)
Office address	Office 329, Perimeter Institute, 31 Caroline Street N., Waterloo, Ontario N2L 2Y5, Canada
Email	ubanik@perimeterinstitute.ca, uddipanbanik@ias.edu, banikuddipan@gmail.com
Other links	ADS, Google Scholar, ORCID

EDUCATION

PhD Astrophysics (2023) Yale University
Thesis advisor: Prof. Frank C. van den Bosch
Dissertation title: "Pushing the Frontiers of Non-equilibrium Dynamics of Collisionless and Weakly Collisional Self-gravitating Systems"
M.Phil Astrophysics (2020) Yale University
M.Sc Astrophysics (2020) Yale University
BS Physics (2017) Indian Institute of Technology (IIT) Kanpur Cumulative GPA (CGPA): 9.5/10
Department Rank 1

AWARDS & FELLOWSHIPS

- Awarded the ***Yakov B. Zel'dovich Fellowship*** by Perimeter Institute for Theoretical Physics (2026).
- Awarded the 2024 ***Dirk Brouwer Memorial Prize*** by the Department of Astronomy at Yale University for a contribution of unusual merit to astronomy in the PhD thesis.
- Awarded the ***Tinsley award*** for the best graduate student paper in Yale Astronomy for the year 2021.
- Awarded the 2023 ***Junior Fellowship*** of the ***Simons Society of Fellows*** (declined).
- Awarded the ***General Proficiency Medal*** for the best academic performance and securing Department Rank 1 among all graduating students of 2017 batch in the Department of Physics, IIT Kanpur.
- Awarded the ***Academic Excellence Awards*** for outstanding academic performance in BS Physics in the years 2014-15 and 2015-16 at IIT Kanpur.
- Awarded the ***INSPIRE Fellowship*** by the Department of Science and Technology, Government of India over all 4 years of the BS Program in Physics at IIT Kanpur.

RESEARCH INTERESTS

1. **Astrophysical fluids and plasmas**
   - **Magnetohydrodynamics (MHD)** - Magnetorotational instability (MRI), large-scale dynamo in sheared rotational flows, solar and stellar dynamo simulations with AthenaK/Athena++, dynamo cycles and the butterfly diagram, MHD turbulence, non-ideal effects, magnetic reconnection, finite-time singularities
   - **Plasma kinetic theory** - linear and quasilinear relaxation of kinetic plasmas (waves and instabilities, Landau damping, cyclotron damping, collisionless relaxation),plasma echo, Vlasov turbulence (wave-wave and wave-particle interactions, cascades), non-thermal particle acceleration, collisionless shocks, magnetic reconnection, coherent (BGK holes, plasmoids) and intermittent structures, coronal temperature inversion, solar wind, cosmic rays
2. **Galaxy formation and evolution, Galactic dynamics & Cosmology**
   - **Relaxation of galaxies, dark matter halos and globular clusters** - linear and quasilinear relaxation of self-gravitating systems (Landau damping, phase-mixing, collisionless relaxation, dynamical friction, core-stalling), non-perturbative methods and N-body simulations for non-linear relaxation phenomena (violent relaxation, virialization, particle trapping), resonant relaxation, core-collapse, gravothermal catastrophe, tidal disruption, galaxy mergers
   - **Relaxation of galactic disks** - secular evolution, radial migration and heating, angular momentum transport by bar and spiral arm, phase-space spirals, bending and breathing waves, warps

- **Impact of dark matter models** (Cold dark matter (CDM), e.g., WIMP, Fuzzy dark matter, Self-interacting dark matter (SIDM), Dissipative dark matter, etc.) **on structure formation and secular evolution of galaxies**- dynamical friction in cored vs cuspy galaxies, diffusion of stellar streams and heating of stellar disks by dark matter substructure, non-linear structure formation, violent relaxation and the origin of universal halo profiles (NFW profile and the prompt cusp)

3. Black holes
   - **Gravitational collapse and black hole formation** - formation of virialized halos and trapped surfaces (Einstein-Boltzmann and Einstein-Euler problems), gravothermal core collapse and black hole formation in SIDM, dark matter spikes around black holes
   - **Inspiral and merger of black hole binaries** - gravitational waves (GW), loss-cone dynamics, binary hardening, three-body capture and ejection, dephasing of GW (due to gas, dark matter spikes, etc.)
   - **Extreme plasma around black holes** - Launching (Blandford-Znajek process) and stability of black hole jets, non-thermal particle acceleration and radiation in the black hole magnetosphere, active galactic nuclei (AGNs)
   - **Strong gravitational lensing** - distortion of lensing arcs by free-floating (primordial and galactic) black holes
4. Particle Physics & Quantum Field Theory
   - **Quantum many-body theory** - developing a Lorentz covariant framework for evolving relativistic many-particle states (Schwinger-Tomonaga equation for QED), quantum BBGKY (Martin-Schwinger) hierarchy, quantum kinetic theory (Kadanoff-Baym equation)
   - **Non-thermality and chaos in quantum many-body systems** - relaxation to thermal and non-thermal states, quasi-periodicity, ergodicity and chaos, entanglement, critical phenomena

PUBLICATIONS

Submitted manuscripts

- **"Non-linear dynamo waves in magnetized shear flows: a candidate mechanism for the solar cycle"** (arXiv:2609.30367)
  Uddipan Banik
  Submitted to *Physical Review E*
- **"On the origin of the solar dynamo cycle"**
  Uddipan Banik
  Submitted to *Nature*
- **"Nonlinear MRI dynamo waves: origin of magnetic cycles in accretion disks"**
  Uddipan Banik, George N. Wong, Bindesh Tripathy, Jeremy Goodman, Eliot Quataert, Jonathan Squire, James M. Stone and Amitava Bhattacharjee
  Submitted to *The Astrophysical Journal*
- **"A Boltzmann–Poisson theory for violent relaxation in cold dark matter: origin of prompt cusps and NFW halos"**
  Uddipan Banik, Scott Tremaine, Frank C. van den Bosch, Sachiet Kapur and Kaushik Bhattacharya
  Submitted to *Physical Review D*
- **"Wave interference as the origin of the cyclic magnetorotational dynamo in accretion disks: insights from weakly nonlinear theory and local shearing box simulations"** (arXiv:2605.02996)
  Uddipan Banik, Amitava Bhattacharjee and James M. Stone
  Submitted to *Physical Review Research*
- **"Non-thermal particle acceleration in multi-species kinetic plasmas: universal power-law distribution functions and temperature inversion in the solar corona"** (arXiv:2601.03344)
  Uddipan Banik and Amitava Bhattacharjee
  Submitted to *Physics of Plasmas* (special topic: invited papers from the 67th annual meeting of APS-DPP)
- **"Universal power-law distribution functions in an electromagnetic kinetic plasma: implications for the inverted temperature profile in the solar corona"** (arXiv:2508.08361)
  Uddipan Banik and Amitava Bhattacharjee
  Submitted to *The Astrophysical Journal Letters*

First author refereed publications

- **"Collisionless relaxation to equilibrium distributions in cold dark matter halos: Origin of the Navarro-Frenk-White profile"** (arXiv:2506.02104)
  Uddipan Banik and Amitava Bhattacharjee
  Physical Review D, 112, 123009, December 3, 2025

- **"Universal non-thermal power-law distribution functions from the self-consistent evolution of collisionless electrostatic plasmas"** (arXiv:2408.07127)
  Uddipan Banik, Amitava Bhattacharjee and Wrick Sengupta
  The Astrophysical Journal, Volume 977, Number 1, 91, December 5, 2024
  Featured in the Institute Letter, Spring 2025
- **"Relaxation of weakly collisional plasma: Continuous spectra, discrete eigenmodes, and the decay of echoes"** (arXiv:2402.07992)
  Uddipan Banik and Amitava Bhattacharjee
  Physical Review E, 110, 045204, October 17, 2024
- **"A Comprehensive Perturbative Formalism for Phase Mixing in Perturbed Disks. II. Phase Spirals in an Inhomogeneous Disk Galaxy with a Non-responsive Dark Matter Halo"** (arXiv:2303.00034)
  Uddipan Banik, Frank C. van den Bosch and Martin D. Weinberg
  The Astrophysical Journal, Volume 952, Number 1, 65, July 18, 2023
- **"A Comprehensive Perturbative Formalism for Phase Mixing in Perturbed Disks. I. Phase Spirals in an Infinite, Isothermal Slab"** (arXiv:2208.05038)
  Uddipan Banik, Martin D. Weinberg and Frank C. van den Bosch
  The Astrophysical Journal, Volume 935, Number 2, 135, August 23, 2022
- **"Dynamical Friction, Buoyancy and Core-Stalling. I. A Nonperturbative Orbit-based Analysis"** (arXiv:2112.06944)
  Uddipan Banik and Frank C. van den Bosch
  The Astrophysical Journal, Volume 926, Number 2, 215, February 25, 2022
- **"A Self-consistent, Time-dependent Treatment of Dynamical Friction: New Insights Regarding Core Stalling and Dynamical Buoyancy"**(arXiv:2103.05004)
  Uddipan Banik and Frank C. van den Bosch
  The Astrophysical Journal, Volume 912, Number 1, 43, May 3, 2021
- **"A fully general, non-perturbative treatment of impulsive heating"** (arXiv:2010.06632)
  Uddipan Banik and Frank C. van den Bosch
  Monthly Notices of the Royal Astronomical Society, Volume 502, Issue 1, March 2021, Pages 1441–1455
- **"Constraining the mass density of free-floating black holes using razor-thin lensing arcs"** (arXiv:1811.00637)
  Uddipan Banik, Frank C. van den Bosch, Michael Tremmel, Anupreeta More, Giulia Despali, Surhud More, Simona Vegetti and John P McKean
  Monthly Notices of the Royal Astronomical Society, Volume 483, Issue 2, February 2019, Pages 1558–1573
- **"Self-gravitating fluid systems and galactic dark matter"** (arXiv:1606.07875)
  Uddipan Banik, Dipanjan Dey, Kaushik Bhattacharya and Tapobrata Sarkar
  General Relativity and Gravitation 49, Article number: 116 (2017)

Co-authored refereed publications

- **"Not all cores are equal: Phase-space origins of dynamical friction, stalling and buoyancy"** (arXiv:2511.11804)
  Shashank Dattathri, Frank C. van den Bosch, **Uddipan Banik**, Martin Weinberg, Priyamvada Natarajan, Zhaozhou Li and Avishai Dekel
  The Open Journal of Astrophysics, Volume 9, September 7, 2026
- **"The Dipole Instability in Gravitational N-body Systems: A Natural Explanation for Lopsidedness and Off-Centered Nuclei in Galaxies"** (arXiv:2505.23905)
  Shashank Dattathri, Frank C. van den Bosch, Martin D. Weinberg, **Uddipan Banik**
  The Astrophysical Journal, Volume 993, Number 1, 150, Oct 30, 2025
- **"Exact results in Floquet coin toss for driven integrable models"** (arXiv:1705.03662)
  Utso Bhattacharya, Somnath Maity, **Uddipan Banik** and Amit Dutta
  Physical Review B 97, 184308, May 2018

Codes

- **"VENUS"**: Vlasov-Einstein NUmerical Solver code in C++ (OpenMP & MPI parallelized, GPU-accelerated), equipped with Einstein-Vlasov, Einstein-Boltzmann, Vlasov-Poisson and Boltzmann-Poisson (CDM and SIDM) modules, for the numerical simulation of non-linear structure formation (virialized halos and black holes) in weakly collisional self-gravitating systems.
- **"Stellar dynamo solvers for AthenaK and Athena++"**: Developed an anelastic MHD solver in AthenaK and Athena++ for stratified, shearing simulations and used it to simulate a solar dynamo with sustained magnetic polarity reversals and meridional circulation resembling solar observations. Developing a fully compressible low-Mach

MHD solver in AthenaK for stratified magnetoconvection.

- **"QKIN"**: Quantum KINetic Solver code in C++ (OpenMP & MPI parallelized) for evolving many-body quantum states, with the aim to investigate the relaxation of weakly coupled bosonic and fermionic systems (e.g., degenerate fermions in compact objects, dilute plasmas) towards thermal and non-thermal steady states.
- **"NP-impulse"**: Publicly available code in Python to compute the (non-perturbative) energy transfer and mass loss in impulsive encounters of galaxies and dark matter halos

Publications in preparation

- **"Self-similar profiles in Einstein-Vlasov systems: from virialized halos to black holes"**
  Uddipan Banik, Scott Tremaine, Frank C. van den Bosch, Sachiet Kapur and Kaushik Bhattacharya
- **"Numerical solution to the Einstein-Vlasov system in spherically symmetric gravitational collapse"**
  Uddipan Banik, Sachiet Kapur, Kaushik Bhattacharya, Frank C. van den Bosch and Scott Tremaine
- **"Numerical solution to the Einstein-Boltzmann problem: core-collapse and black hole formation in self-interacting dark matter"**
  Uddipan Banik, Frank C. van den Bosch, Chris Hamilton, Abdelaziz Hussein, Lina Necib, Scott Tremaine, Sachiet Kapur and Kaushik Bhattacharya
- **"A self-consistent quasilinear theory for non-thermal particle acceleration in magnetized plasmas"**
  Uddipan Banik, Robert J. Ewart, Alexander A. Schekochihin and Amitava Bhattacharjee
- **"How fast do supermassive black hole binaries form in galaxy mergers?"**
  Kavish Sardana, **Uddipan Banik**, Shashank Dattathri and Frank C. van den Bosch
- **"Dynamical Friction, Buoyancy and Core-Stalling. II. Inspiral vs libration"**
  Kavish Sardana, **Uddipan Banik**, Shashank Dattathri and Frank C. van den Bosch
- **"Self-gravitating response of galactic disks and the Gaia snail"**
  Chris Hamilton, **Uddipan Banik** and Shaunak Modak

MEDIA HIGHLIGHTS

- ***Beyond Boltzmann***: Featured in the Institute Letter, Spring 2025, for explaining the origin of non-thermal power-law distribution functions in kinetic plasmas (Banik et al. 2024).
- ***"Pushing the Frontiers" of Galaxy Relaxation***: Featured in the IAS and Princeton news for being awarded the 2024 ***Dirk Brouwer Memorial Prize*** by the Department of Astronomy at Yale University for a contribution of unusual merit to astronomy in the PhD thesis, "Pushing the Frontiers of Non-equilibrium Dynamics of Collisionless and Weakly Collisional Self-gravitating Systems".
- ***Institute Instances***: Interviewed about life and work at the IAS.

TECHNICAL SKILLS

- **Code development**: Developed VENUS and QKIN for kinetic calculations and an anelastic MHD solver in AthenaK and Athena++ for solar dynamo simulations; developing a fully compressible low-Mach MHD solver in AthenaK for stratified magnetoconvection. Experience with Einstein-Vlasov, Einstein-Boltzmann, Vlasov-Poisson, Boltzmann-Poisson, Fokker-Planck, hydrodynamic, and MHD solvers.
- **Numerical simulations**: Experience developing and running MHD simulations in AthenaK and Athena++ for accretion-disk and solar/stellar dynamo problems, and Vlasov-Maxwell solvers (Gkeyll) and Particle-in-cell/PIC simulations (Tristan) for modeling particle acceleration in kinetic plasmas. Experience with N-body simulations (GADGET, gyrfalcON, RAMSES, REBOUND) for modeling the relaxation of galaxies and dark matter halos. Experience with parallel programming and GPU acceleration (using the CUDA toolkit).
- **Artificial Intelligence (AI) & Machine Learning**: Experience in AI/ML programming and research, including neural network fundamentals, TensorFlow-based modeling, and applied use of large language models (LLMs), Codex/GPT and AI agents in research and software development workflows.
- **Computer programming**: Proficient in Python, C and C++. Proficient in HPC computing on the IAS Apollo and Typhon clusters and Perimeter's Symmetry cluster. Working knowledge of Mathematica, MATLAB, Bash shell script, AWK. Acquainted with HTML.
- **Software**: Proficient in Git, developing codes with documentation.
- **Data analysis**: Analyzed astrometric data from Gaia and radio interferometric data from CHIME.
- **Analytical theory**: Proficient in perturbation theory, linear and quasilinear theories, weak turbulence theory, closure theory (BBGKY hierarchy), theory of dynamical systems (resonance and chaos), near-integrable Hamiltonian systems (e.g., restricted three body problem), secular theory, asymptotic analysis, analytic continuation, real and complex analysis, operator algebra, differential geometry, group theory (Lie groups).

MENTORING, TEACHING & OUTREACH

Mentoring

Graduate students

- **2023-26**: **Currently co-advising graduate student Shashank Dattathri** from **Yale University**, with my PhD supervisor Prof. Frank van den Bosch, on their **PhD thesis project** probing the secular dynamics (dynamical friction, buoyancy and core-stalling) of black holes in cored galaxies as well as binary supermassive black hole mergers in galaxy mergers using a combination of secular theory and N-body simulations (gyrfalcON). So far, the project has culminated in papers I and II.
- **2024-26**: **Currently advising graduate student Abdelaziz Hussein** from the **Department of Physics, MIT** on a project regarding the computation of transport coefficients (viscosity and conductivity) for inelastic collisions from kinetic theory, with application to the modeling of (1) structure formation in dissipative dark matter and (2) ionization and recombination in poorly ionized plasmas (e.g., in the warm neutral interstellar medium).
- **2025-26**: **Currently co-advising graduate student Sachiet Kapur** from the **Department of Physics, IIT Kanpur**, with Prof. Kaushik Bhattacharya, on a project regarding the investigation of virialized halo and black hole formation in cold dark matter and self-interacting dark matter using the VENUS code. Publications are in preparation.
- **2024-25**: **Co-advised graduate student Nicholas Pham**, with Prof. Amitava Bhattacharjee, Dr. Wrick Sengupta and Dr. James Juno, on their **PhD thesis project** in the **Department of Astrophysical Sciences, Princeton University** on the evolution of coherent structures (BGK holes and plasmoids) in collisionless/kinetic plasmas (solar wind, supernova shocks, pulsar and black hole magnetosphere).
- **2024-26**: **Currently mentoring graduate student Amir Siraj** as part of the **graduate student mentoring program** in the Department of Astrophysical Sciences, Princeton University.

Undergraduate students

- **2025-26**: **Currently co-advising undergraduate student Amrita Sahu**, with Prof. Romain Teyssier, as part of their **Program in Applied and Computational Mathematics (PACM)** project in the **Department of Astrophysical Sciences, Princeton University**, on the investigation of how the NFW profile emerges from the violent relaxation of CDM halos using idealized N-body simulations (particle-mesh RAMSES code).
- **2024**: **Advised undergraduate student Jake Grodner** as part of their **junior project** and the **Undergraduate Summer Research Program (USRP)** project in the **Department of Astrophysical Sciences, Princeton University**, on non-thermal particle acceleration and the emergence of power-law tails in collisionless plasmas using the Gkyell 2.0 Vlasov-Maxwell solver.
- **2023-26**: **Currently advising undergraduate student Kavish Sardana** from the **Indian Institute of Science Education and Research (IISER) Mohali, India**, on a project investigating supermassive black hole mergers in merging galaxies using N-body simulations (GADGET and gyrfalcON). Publications are in preparation.
- **2025**: **Co-advised undergraduate student Malik Booker**, with Prof. Romain Teyssier, as part of the **USRP** in the **Department of Astrophysical Sciences, Princeton University**, on the violent relaxation of CDM halos using N-body simulations (RAMSES code).
- **2024**: **Co-advised undergraduate student Thomas Bizien** from Université Paris-Saclay, with Prof. Amitava Bhattacharjee, for their **summer project** on the relaxation of weakly collisional plasmas and the plasma echo using a Vlasov-Poisson (Gkeyll) solver in the **Department of Astrophysical Sciences, Princeton University**.
- **2023-24**: **Advised undergraduate student Milind Sarkar** from IISER Mohali, India, on a project investigating dark matter accumulation around black holes and the resulting enhancement in gamma ray emission from dark matter annihilation using a combination of analytical theory and N-body simulations (GADGET).
- **2022**: **Mentored Astronomy undergraduate students** as part of the **Astro Sibs Undergraduate Mentorship Program** at the **Department of Astronomy, Yale University**.

Teaching and outreach

- **2017-20**: Acted as a **Teaching Fellow** in the courses, **ASTR130 (*Origin & Search For Life In The Universe*)** taught in Fall 2017 and Fall 2018 and **ASTR170 (*Introduction to Cosmology*)** taught in Spring 2018 and Spring 2020 at **Yale University**.
  - Took tutorial sessions and did one-on-one mentoring of undergraduate students.
  - Prepared assignment and examination questions and graded answer sheets.
- **2017**: Acted as an **Academic Resource Person** in the **Orientation cum Selection Camp** at the **Homi Bhabha Center for Science Education (HBCSE), Tata Institute of Fundamental Research (TIFR)**, Mumbai, India for the 48^{th} **International Physics Olympiad**.
  - Designed practice and examination questions.

- Did one-on-one mentoring of high school students.
- **2016**: Acted as a theory question grader and a **member of the Academic Team** at the 10^{th} **International Olympiad on Astronomy and Astrophysics**, Bhuvaneshwar, India, 2016.
- **2015**: Acted as a theory question grader and a **member of the Academic Team** at the 46^{th} **International Physics Olympiad**, Mumbai, India, 2015.
- **2014-15**: Acted as an **Academic Mentor** at the **Counseling Service, IIT Kanpur**, Kanpur, India.
  - Took tutorial and remedial sessions for undergraduate level physics courses: PHY102 (Introductory Classical Mechanics), PHY103 (Classical Electrodynamics) and PSO201 (Quantum Physics).
- **2014-15**: Taught physics and mathematics to high school students from marginalized backgrounds in and around the campus of IIT Kanpur as part of **voluntary service** at ***Prayas*** ('Initiative'), an endeavour of the **Presidential Council, Students' Gymkhana, IIT Kanpur**.
- **2024**: **Spoke at the Astronomy podcast series astrO** on galaxy collisions, dynamical friction and dark matter. This podcast series is aimed at getting high school students interested in astronomy and encouraging them to pursue astrophysics research in future.
- **2026**: Gave the **USRP Colloquium** on 'Gravity, magnetism and the growth of cosmic structure' in the **Department of Astrophysical Sciences, Princeton University**.

MAJOR POSITIONS OF RESPONSIBILITY

Organizational

- **Organized the IAStrophysical Waves workshop** at the Institute for Advanced Study on January 13 - 17, 2025, aimed at uniting different research communities who exploit common techniques to study waves in astrophysical systems: stars, planets, galaxies and gaseous disks.
- **Organized the Astrophysics seminar series at the Institute for Advanced Study** for the academic year 2024-25.
- Acted as Board-member and Cultural Secretary of SAGA, the South Asian Graduate and Professional Association at Yale University from 2018 till 2021. The organization is dedicated to propagating awareness about South Asian culture and socio-political issues through lectures, panel discussions and other interactive social events.

Academic Service

- Reviewer for the Monthly Notices of the Royal Astronomical Society (MNRAS), The Astrophysical Journal (ApJ), Astronomy & Astrophysics (A&A), Proceedings of the National Academy of Sciences (PNAS) and Astrophysics and Space Science (Springer Nature) journals.

CONFERENCES, SEMINARS & WORKSHOPS

Conferences, seminars & meetings

Invited Talks

"Non-thermal particle acceleration in multi-species kinetic plasmas: universal power-law distribution functions and temperature inversion in the solar corona"

- 22^{nd} **International Congress on Plasma Physics**, Hyderabad, India (**December 6-11, 2026**)
- 68^{th} **Annual Meeting of the APS Division of Plasma Physics (DPP)**, Chicago, Illinois, USA (**November 2-6, 2026**)
- **AAPPS-DPP2026 Annual Conference**, Busan, South Korea (**October 11-16, 2026**)

"A self-consistent quasilinear theory for non-thermal particle acceleration in magnetized plasmas"

- **The Thermodynamics of Collisionless Plasmas workshop**, EPFL, Switzerland (**October 5–7, 2026**)

"How dark matter halos get their cusps"

- **Cosmology Seminar, Perimeter Institute for Theoretical Physics**, Waterloo, Ontario, Canada (**September 29, 2026**)

"Collisionless relaxation to equilibrium distributions in cold dark matter halos: Origin of the Navarro-Frenk-White profile"

- **Division on Dynamical Astronomy (DDA) Meeting of the American Astronomical Society (AAS)**, Chicago, Illinois, USA (**June 22-26, 2026**)

"Magnetorotational dynamo cycles in accretion disks: insights from weakly nonlinear theory and local shearing box simulations"

- **Midwest Magnetic Fields Workshop 2026**, Florida Institute of Technology, Melbourne, Florida, USA (**May 18-22, 2026**)

"Universal power-law distribution functions in an electromagnetic kinetic plasma: implications for the inverted temperature profile in the solar corona"

- **American Physical Society (APS) Division of Plasma Physics (DPP) Meeting 2025**, Long Beach, California, USA (**November 17-21, 2025**)
- **Journal of Plasma Physics (JPP) Colloquium** (**October 16, 2025**)
  Click here for my talk.

"From secular evolution to violent relaxation"

- **Dynamix** (Dissipation Yields Novel Astrophysical Mechanisms, Interactions and eXtreme phenomena) workshop, University of Cambridge, Cambridge, UK (**June 4, 2025**)

"Non-thermal power-law distribution functions in collisionless plasmas: a potential solution to the solar coronal heating problem"

- **ASTRONUM 2025** conference (the 17th International Conference on Numerical Modeling of Space Plasma Flows), University of Wisconsin Madison, Madison, Wisconsin, USA (**July 14, 2025**)

"The origin of the universal non-thermal distribution function in collisionless plasmas"

- **Kinetic Experiments Meeting**, Plasma Science and Fusion Center (PSFC), MIT, Cambridge, Massachusetts, USA (**April 16, 2025**)
- **Plasma Theory Seminar, University of Oxford**, Oxford, UK (**March 12, 2025**)
- **Plasma Theory Seminar, PSFC, MIT**, Cambridge, Massachusetts, USA (**March 3, 2025**)

"A theory for collisionless relaxation to universal attractors in plasmas and self-gravitating systems"

- **Monday Afternoon Talk, MIT**, Cambridge, Massachusetts, USA (**Dec 16, 2024**)

"A perturbative response theory for the ringing of disks: phase-mixing, phase-spirals and beyond"

- **Waves in the Milky Way disk** conference, Shanghai, China (**Sept 8, 2024**)

"Quasilinear relaxation of collisionless plasmas and self-gravitating systems"

- **Interconnections between the Physics of Plasmas and Self-gravitating Systems** workshop, Kavli Institute for Theoretical Physics, University of California Santa Barbara, California, USA (**June 20, 2024**)

"The relaxation of collisionless and weakly collisional many-body systems with long range interactions"

- **Astrophysics Seminar, Inter-University Centre for Astronomy and Astrophysics (IUCAA)**, Pune, India (**October 27, 2023**)
- **Department of Astronomy and Astrophysics Seminar, Tata Institute of Fundamental Research (TIFR)**, Mumbai, India (**October 31, 2023**)
- **Astrophysics and Relativity Seminar, International Center for Theoretical Sciences (ICTS)**, Bengaluru, India (**November 2, 2023**)
- **Cosmology Seminar, Department of Physics, Indian Institute of Technology (IIT) Kanpur**, Kanpur, India (**November 9, 2023**)

"Kinetic theory of collisionless self-gravitating systems"

- **Cosmology Seminar, Perimeter Institute for Theoretical Physics**, Waterloo, Ontario, Canada (**July 10, 2023**) Click here for my talk.

"Pushing the frontiers of gravitational encounters and collisionless dynamics"

- **Cosmology Seminar, Perimeter Institute for Theoretical Physics** (**November 22, 2022**)
- **Cosmology Seminar, Kavli Institute for Particle Astrophysics and Cosmology (KIPAC)**, **Stanford University**, Stanford, California, USA (**October 31, 2022**)
- **Special Cosmolunch, Hebrew University of Jerusalem**, Jerusalem, Israel (**October 27, 2022**)
- **Galaxy Evolution Seminar, Department of Physics, University of Oxford**, Oxford, UK (**October 13, 2022**)

- **Theory Lunch Meeting, Institute for Astronomy, The University of Edinburgh**, Edinburgh, UK (**October 12, 2022**)
- **Astrophysics Seminar, Observatoire astronomique de Strasbourg**, Strasbourg, France (**October 7, 2022**)
- **Cosmology Seminar, Max Planck Institute for Astrophysics, Garching**, Germany (**October 4, 2022**)
- **Kavli Galaxy Evolution Seminar, Institute of Astronomy, University of Cambridge**, Cambridge, UK (**September 30, 2022**)
- **Astrophysics Seminar, University of Surrey**, Guildford, UK (**September 29, 2022**)
- **Astrophysics Seminar, Department of Astronomy and Astrophysics, Columbia University**, New York City, New York, USA (**September 22, 2022**)
- **Astrophysics Seminar, Institute for Advanced Study**, Princeton, New Jersey, USA (**September 8, 2022**)
  Click here for my talk.

"A Self-consistent, Time-dependent Treatment of Dynamical Friction: New Insights Regarding Core Stalling and Dynamical Buoyancy"

- **Astrophysics Seminar, Observatoire astronomique de Strasbourg**, Strasbourg, France (**June 18, 2021**)
- Prof. Wyn Evans's group meeting, **Institute of Astronomy, University of Cambridge**, Cambridge, UK (**April 23, 2021**)
- **Special Cosmolunch, Hebrew University of Jerusalem**, Jerusalem, Israel (**March 22, 2021**)

Talks & Posters

"Collisionless relaxation to equilibrium distributions in cold dark matter halos: Origin of the NFW profile"

- **American Physical Society (APS) Global Summit 2026**, Denver, Colorado, USA (**March 15-20, 2026**)

"Relaxation of weakly collisional plasmas: decaying echoes and transition to the fluid limit"

- **Synergistic approaches to particle transport in magnetized turbulence: from the laboratory to astrophysics** workshop, Princeton Center for Theoretical Science, Princeton University, Princeton, New Jersey, USA (**April 15, 2024**)

"Pushing the frontiers of gravitational encounters and collisionless dynamics"

- **RandoAstro, Canadian Institute for Theoretical Astrophysics (CITA), University of Toronto**, Toronto, Ontario, Canada (**December 1, 2022**)
- **CCA Dynamics Community Meeting, Center for Computational Astrophysics (CCA), Flatiron Institute**, New York City, New York, USA (**November 17, 2022**)
- Dr. Andrew Benson's group meeting, **Carnegie Observatories**, Pasadena, California, USA (**October 18, 2022**)
- **Galaxy Coffee, Max Planck Institute for Astronomy, Heidelberg**, Germany **October 6, 2022**
- **SEGAL (Secular Evolution of GALaxies) Collaboration Seminar, Institut d'Astrophysique de Paris**, Paris, France (**September 21, 2022**)
- **Astrophysics Brown Bag Lunch Talk, Kavli Institute for Astrophysics and Space Research, Massachusetts Institute of Technology**, Cambridge, Massachusetts, USA (**September 12, 2022**)
- **Dissertation Talk**:
  240th **Meeting of the American Astronomical Society**, Pasadena, California, USA (**June 12-16, 2022**)

"Phase-space spirals as probes of perturbed, out-of-equilibrium disk galaxies"

- 53rd **Annual DDA (Division on Dynamical Astronomy) Meeting of the American Astronomical Society, Center for Computational Astrophysics, Flatiron Institute**, New York City, New York, USA (**April 25-28, 2022**)

"Perturbation and phase-mixing in the Milky Way disk: the origin of phase-space spirals"

- **Local Local-Group Group (L2G2) Meeting, Center for Computational Astrophysics, Flatiron Institute**, New York City, New York, USA (**November 11, 2021**)

"A Self-consistent, Time-dependent Treatment of Dynamical Friction: New Insights Regarding Core Stalling and Dynamical Buoyancy"

- 238th **Meeting of the American Astronomical Society** (**June 7-9, 2021**)

"A fully general, non-perturbative treatment of impulsive heating"

- 237th **Meeting of the American Astronomical Society** (**January 10-15, 2021**)

"Constraining the mass density of free-floating black holes using razor-thin lensing arcs"

- **BLAST (BLack Holes Across Space & Time) Workshop**, **Black Hole Initiative, Harvard University**, Cambridge, Massachusetts, USA (**December 17, 2021**)
- **Supermassive Black Holes: Environment and Evolution** conference, Corfu, Greece (**June 19-22, 2019**)

"Dynamical friction, core-stalling and merging of Lagrange points"

- **Poster**: **2019 Santa Cruz Galaxy Workshop, University of California Santa Cruz**, Santa Cruz, California, USA (**August 5-9, 2019**)

Workshops & summer schools

- **January 4 - March 11, 2027**: Invited to participate in the **Cosmic Rays in Astrophysical Systems: From the Sun to Galaxies and Beyond** program, **KITP, UCSB**, Santa Barbara, California, USA
- **June 16 - July 7, 2024**: **Interconnections between the Physics of Plasmas and Self-gravitating Systems** workshop, **KITP, UCSB**, Santa Barbara, California, USA
- **August 1-7, 2022**: **N3AS Summer School in Multi-Messenger Astrophysics**, **University of California Santa Cruz**, Santa Cruz, California, USA
- **June 28 - August 13, 2021**: **Big Apple Dynamics Summer School**, **Center for Computational Astrophysics (CCA), Flatiron Institute**, New York City, New York, USA
  - Worked with Prof. Martin D. Weinberg on developing the theory for the perturbative response of disk galaxies and their post-perturbation relaxation/equilibration via phase-mixing (phase-space spirals).
  - Presented my work at the **2021 CCA Big Apple Dynamics School Symposium**.
- **Summer 2016**: **IUAC Summer Program, Inter-University Accelerator Center (IUAC)**, New Delhi, India
  - Worked on the pulse-shape discrimination and time of flight analysis of neutron and gamma-ray signals from radioactive sources measured with liquid organic scintillation detectors.
- **Summer 2014-15**: **National Initiative on Undergraduate Science (NIUS) Program, HBCSE, TIFR**, Mumbai, India
  - Worked with Dr. Anwesh Mazumdar on the asteroseismology of red giant stars, specifically on constraining the core composition, rotation rates and ages of red giant stars observed by the Kepler space telescope using mixed mode oscillations.

EXTRACURRICULAR ACTIVITIES

- Proficient in Hindustani Classical Music (North Indian). Performed onstage at classical music concerts. Performed onstage at musical events such as Musical Extravaganza, Galaxy college festival and Antaragni inter-college festival as member of the Music Club, IIT Kanpur.
- Proficient in chess. Participated in chess tournaments.
- Written essays on philosophy and social issues.
- Performed military drills as part of the National Cadet Corps (NCC), the youth wing of the Indian Armed Forces, at IIT Kanpur.