Siddhartha Gupta

Contact Information

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Personal Details

Nationality: Indian **Sex:** Male **Languages:** Bengali, English, and Hindi **Pronouns:** he/him/his

Academic Training

2019 **PhD in Astrophysics**
Indian Institute of Science & Raman Research Institute, Bangalore, India

2014 **Master of Science in Physics**. CGPA: 9.54/10.
Indian Institute of Technology (IIT), Kharagpur, India.

2012 **Bachelor of Science in Physics**. Marks Obtained: 81.125%
Burdwan Raj College, University of Burdwan, India.

Research Interests

Astrophysical plasma: cosmic ray acceleration, collisionless shocks, and the origin of nonthermal energy.

Galaxy evolution: star clusters - stellar radiation - stellar wind - supernovae, and cosmic ray feedback.

Computational physics: numerical techniques, fluid simulation, and kinetic particle-in-cell simulation.

Research Experience

2024 Sep – present **Princeton University**, NJ, USA.
Associate Research Scholar.
Advisor: Prof. Anatoly Spitkovsky.

2023 Sep – 2024 Aug **Princeton University**, NJ, USA.
Postdoctoral Research Associate.
Advisor: Prof. Anatoly Spitkovsky.

2019 Dec – 2023 Aug **University of Chicago**, IL, USA.
Postdoctoral Scholar.
Advisor: Prof. Damiano Caprioli.

2014 Aug – – 2019 Oct **Indian Institute of Science** (IISc) & **Raman Research Institute** (RRI), Bangalore, India
Doctoral Candidate, Thesis: Thermal and Non-thermal Processes in Young Star Clusters.
Advisors: Prof. Biman Nath (RRI) & Prof. Prateek Sharma (IISc).

2012 Aug – – 2014 Jul **Indian Institute of Technology**, Kharagpur, India.
Masters Thesis: A Modified Newtonian Gravity and Its Applications.
Advisor: Prof. Sayan Kar.

Honors and Awards

2023 Postdoctoral position at Australian National University, Australia (declined).

2023 Postdoctoral position at Gran Sasso Science Institute, Italy (declined).

2019 Postdoctoral position at Ben-Gurion University, Israel (declined).

2019 Postdoctoral Fellowship at Max-Planck Princeton Center for Plasma Physics by MPA, Germany (declined).

2015–2019 Dr. Shyama Prasad Mukherjee Fellowship awarded by the Council of Scientific and Industrial Research by Government of India for securing **All India Rank** 3 in the National Eligibility Test 2014.

2014	Qualified Joint Entrance Screening Test (JEST), **All India Rank** 26.
2014	Qualified Graduate Aptitude Test in Engineering (GATE), **All India Rank** 32.
2014	Selected for the OCES programme at the Bhabha Atomic Research Centre (declined).
2014	**Institute Silver Medal** from Indian Institute of Technology (IIT) Kharagpur for securing 1**st rank** in Master of Science Physics.
2014	**Proficiency award** from IIT Kharagpur for the **Best Project Work** in Master of Science Physics.
2012	Qualified IIT - Joint Admission Test for M.Sc (IIT-JAM), **All India Rank** 62.
2012	**Priya Nath Sinha Memorial Medal and Manoranjan Kundu Prize** for securing 1**st rank** in Bachelor of Science Physics, from the University of Burdwan, India.
2009 –2014	INSPIRE (Innovation in Science Pursuit for Inspired Research) scholarship from the Department of Science & Technology (DST), Government of India.

Computational Skills

Programming	C (outstanding), C++, python (outstanding), fortran, HTML.
Advanced simulation softwares	PLUTO (magnetohydrodynamic), TRISTAN-MP (electron and proton particle-in-cell), SHOBDO (1D two-fluid cosmic ray hydrodynamic code, developed by me), SHAKTI (particle-in-cell code, C and python based, under development).
Visualization packages	GNU plot, Matplotlib, Mathematica, Origin, MYTH (a plotting interface written by me).

Computational Grant/Allocation

Co-PI: 2024 – present	PHY240045 (ACCESS): Kinetic Simulations of High Mach Number Collisionless Shocks: Long-Term Nonlinear Evolution and New Acceleration Mechanisms.
Co-PI: 2020 – present	AST180008 (ACCESS): Ab-initio Simulations of Cosmic Ray Acceleration and Transport.
Co-PI: 2021	Special Summer Allocation, at the Midway Cluster, University of Chicago.

Teaching/Mentoring Experience

Teaching Assistant **Aug – Dec** 2016	Indian Institute of Science, Bangalore, India. Fundamental of Astrophysics (undergraduate + post undergraduate course)
Students	Ivan Jane (University of Michigan, University of Chicago Summer REU programme; June 2022 –), Saikat Das (Graduate student at Indian Institute of Science Bangalore, April 2024 –)

Activities for the Scientific Community

Referee	Astrophysical Journal Letters (ApJL), Astrophysical Journal (ApJ), Monthly Notices of the Royal Astronomical Society (MNRAS), Communications in Computational Physics (CICP).
Developer	Cosmic ray two-fluid MHD module for the PLUTO code; a one-dimensional two-fluid hydrodynamic simulation code: SHOBDO; and electromagnetic particle-in-cell code: SHAKTI.
Conference Organizer	Served as a Local Organizer Committee in "Bubble Big and Small" conference, in June 2018, IISc Bangalore.
Other Activities	Friday Astroplasmas seminar organizer in the Dept of Astrophysical Sciences Princeton University, Volunteering as AstroCoffee host - daily ArXiv paper discussion club at Princeton University.

Selected Schools and Workshops

- "Synergistic approaches to particle transport in magnetized turbulence: from the laboratory to astrophysics" [15-17th April 2024] at Princeton Center for Theoretical Science, Princeton, USA.
- "Coronal Mass Ejection propagation" [31st January 2024] at 42nd Meeting of Astronomical Society of India, Bangalore, India.

- "GIAN" school [4th-16th December 2017] on "Computational Solution of Hyperbolic PDEs for Scientists, Engineers and Mathematicians" at IIT Delhi, India. Instructors: Prof. Dinshaw Balsara (University of Notre Dame, USA), Prof. Praveen Chandrashekar (TIFR-CAM, Bangalore), Prof. Harish Kumar (IIT Delhi).
- "High-performance computing in Astrophysics" [6th March 2017] at 35th Meeting of Astronomical Society of India, Jaipur, India. Instructors: Prof. Prateek Sharma (IISc, Bangalore), Prof. Mahendra Verma (IIT Kanpur).
- "CLOUDY workshop" [21-26 September 2015] at Inter-University Centre for Astronomy & Astrophysics, Pune India. Instructor: Prof. Gary J. Ferland (University of Kentucky).

Selected presentations

- *Contributed Talk*, at Galaxy Clusters & Radio Relics II on "Nonthermal Electrons in Collisionless Shocks: Injection and Acceleration" at Center for Astrophysics | Harvard & Smithsonian, September 3-6, 2024.
- *Seminar*, at Inter-University Centre for Astronomy and Astrophysics on "Nonthermal Particles in Collisionless Shocks: Investigating Injection and Acceleration Mechanisms through Kinetic Plasma Simulations" in Pune, India on February 6, 2024.
- *Contributed Talk*, at the Annual Meeting of "42nd Astronomical Society of India" (ASI) on "From Thermal to Nonthermal: Understanding Electron Acceleration at Nonrelativistic Shocks Using First-principles Simulations" at Bangalore, India, January 31st - February 4th, 2024.
- *Seminar*, on "Unraveling the Secrets of Particle Acceleration in Collisionless Shocks" at International Centre for Theoretical Sciences - TIFR, Bangalore, India, on January 30, 2024.
- **Invited Talk**, at the "Bahcall Lunch" on "Nonthermal particles at Collisionless Shocks" at the Institute for Advanced Study, in Princeton on November 28, 2023.
- Contributed Talk, at the "APS Division of Plasma Physics" on "Ab-initio Simulations of Electron Acceleration at Non-relativistic Collisionless Shocks", in Denver on November 1, 2023.
- *Seminar*, at the "Astroplasmas seminar" on "What Regulates Electron Injection in Diffusive Shock Acceleration" at Princeton University in January 2023.
- *Seminar*, at the "Theoretical High Energy Astrophysics Group" on "Physics of Electron Injection" at Columbia University, New York in January 2023.
- *Seminar*, on "First-principles study of particle acceleration at astrophysical shocks" at Indian Institute of Science in October 2022.
- *Seminar*, on "Electron acceleration at astrophysical shocks" at Raman Research Institute in October 2022.
- **Invited Talk**, at the "Particle Acceleration in Astrophysical Objects (PASTO) 2022" on "Particle acceleration at non-relativistic astrophysical shocks: eligibility to participate in the diffusive shock acceleration" in Italy in September 2022.
- **Invited Talk**, in the "Astrolunch" on "Non-resonant Streaming Instability" at the Hebrew University of Jerusalem Online, on May 3, 2022.
- Contributed Talk, at the "63rd Annual Meeting of the APS Division of Plasma Physics" on "Lepton-driven Bell Instability: linear growth and saturation of the magnetic field" online, in November 2021.
- Contributed Talk, at the "37th International Cosmic Ray Conference" on "Lepton-driven Non-Resonant Streaming Instability" in Berlin, Germany (online), in July 2021.
- Contributed Talk, at the "APS-April meeting" on "Saturation of the Non-Resonant Cosmic Ray Streaming Instability" online, in April 2021.
- **Invited Talk**, at the Max-Planck Institute for Astrophysics on "Star Clusters: Observational Clues and Numerical Modeling" in Garching Germany, in January 2019.
- Contributed Talk, at the "4th CRISM" international conference on "Cosmic Rays from Young Star Clusters" at Grenoble, France, in June 2018.
- Contributed Talk, at the "Bubble Big and Small" international conference on "Cosmic rays from Young Star Clusters" at IISc Bangalore, India, in June 2018.
- Contributed Talk, at the Annual Meeting of "Astronomical Society of India" (ASI) on "Lack of Thermal Energy in Superbubbles: Hint of Cosmic Rays?" at Jaipur, India, in March 2017.

Research Publications

First author

9. **Gupta, Siddhartha**; Caprioli, Damiano; & Spitkovsky, Anatoly, to be submitted (available on request),
"*Theory of electron acceleration at quasi-parallel non-relativistic shocks*"

8. **Gupta, Siddhartha**; Caprioli, Damiano; & Spitkovsky, Anatoly 2024 ApJ, 976 10, arXiv:2408.16071,
"*Electron acceleration at quasi-parallel non-relativistic shocks: a 1D kinetic survey*"

7. **Gupta, Siddhartha**; Caprioli, Damiano; & Spitkovsky, Anatoly 2024, ApJ, 968, 17
"*Return currents in collisionless shocks*"; featured in ApJ YouTube (https://youtu.be/OEdYnshvKPQ).

6. **Gupta, Siddhartha**; Caprioli, Damiano, & Haggerty, Colby 2021, ApJ, 923, 208
"*Lepton-driven nonresonant streaming instability*"

5. **Gupta, Siddhartha**; Sharma, Prateek & Mignone, Andrea 2021, MNRAS, 502, 2733
"*A numerical approach to the non-uniqueness problem of cosmic ray two-fluid equations at shocks*"

4. **Gupta, Siddhartha**; Nath, Biman B.; Sharma, Prateek & Eichler, David 2020 MNRAS 493, 3159
"*Realistic modeling of wind and supernovae shocks in star clusters: addressing 22Ne/20Ne and other problems in Galactic cosmic rays*"

3. **Gupta, Siddhartha**; Nath, Biman B. & Sharma, Prateek 2018 MNRAS 479, 5220
"*Constraining cosmic ray acceleration in young star clusters using multi-wavelength observations*"

2. **Gupta, Siddhartha**; Nath, Biman B.; Sharma, Prateek & Eichler, David 2018 MNRAS 473, 1537
"*Lack of thermal energy in superbubbles: hint of cosmic rays?*"

1. **Gupta, Siddhartha**; Nath, Biman B.; Sharma, Prateek & Shchekinov, Yuri 2016 MNRAS, 462, 4532
"*How radiation affects superbubbles: through momentum injection in early phase and photo-heating thereafter*"

Contributed author

5. Lichko, Emily; Caprioli, Damiano; Schroer, Benedikt; **Gupta, Siddhartha**, submitted to ApJ, arXiv,
"*Understanding Streaming Instabilities in the Limit of High Cosmic Ray Current Density*"

4. Zacharegkas, Georgios; Caprioli, Damiano; Haggerty, Colby; **Gupta, Siddhartha**; Schroer, Benedikt 2024, ApJ, 967, 71,
"*Modeling the saturation of the Bell instability using hybrid simulations*"

3. Diesing, Rebecca; Metzger, Brian D.; Aydi, Elias; Chomiuk, Laura; Vurm, Indrek; **Gupta, Siddhartha**; and Caprioli, Damiano 2023, ApJ, 947, 70
"*Evidence for multiple shocks from the γ-ray emission of RS Ophiuchi*"

2. Bhadra, Sourav; **Gupta, Siddhartha**; Nath, Biman B.; Sharma, Prateek 2022, MNRAS, 510, 5579
"*Cosmic rays from massive star clusters: a close look at Westerlund 1*"

1. Jana, Ranita; **Gupta, Siddhartha**; Nath, Biman B 2020, MNRAS, 497, 2623
"*Role of cosmic rays in the early stages of galactic outflows*"

Conference Proceedings

3. **Gupta, Siddhartha**; Caprioli, Damiano; & Spitkovsky, Anatoly 2023, PoS ICRC2023, 396
"*What regulates electron injection in diffusive shock acceleration?*"

2. Caprioli, Damiano; Zacharegkas, Georgios; Haggerty, Colby C; **Gupta, Siddhartha**; & Schroer, Benedikt 2023, PoS ICRC2023
"*The saturation of the Bell instability and its implications for cosmic ray acceleration and transport*"

1. **Gupta, Siddhartha**; Caprioli, Damiano; & Haggerty, Colby 2021, PoS ICRC2021, 484
"*Nonresonant streaming instability driven by leptons*"