Siddhartha Gupta

Contact Information

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Personal Details

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

Academic Training

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

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

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

Research Interests

Astrophysical plasma: kinetic theory, cosmic rays, 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 Associate Research Scholar, Princeton University, NJ, USA.
Advisor: Prof. Anatoly Spitkovsky.

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

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

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

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

Honors and Awards

2015-2019 Dr. Shyama Prasad Mukherjee Fellowship by the Council of Scientific and Industrial Research by the Government of India for securing **All India Rank** 3 in the National Eligibility Test (Total examinees $\approx$ 10k).

2014 Qualified Joint Entrance Screening Test (JEST), **All India Rank** 26 (Total examinees $\approx$ 5k).

2014 Qualified Graduate Aptitude Test in Engineering (GATE), **All India Rank** 32 (Total examinees $\approx$ 10k).

2014 **Institute Silver Medal** from 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 (Total examinees $\approx$ 5k).

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 (Total examinees $\approx$ 1k).

2009-2014 **INSPIRE** scholarship from the Department of Science and Technology (DST), Government of India, for being in the **top** 1**%** of Class 12 examination in the West Bengal Board of Higher Secondary Education (Total examinees $\approx$ 755k).

Academic Offers (Declined)

2023 Postdoctoral position at Australian National University, Australia.

2023 Postdoctoral position at Gran Sasso Science Institute, Italy.

2019 Postdoctoral position at Ben-Gurion University, Israel.

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

2014 Selected for the OCES programme at the Bhabha Atomic Research Centre.

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-I: 2024 – present	PHY240045 (ACCESS): Kinetic Simulations of High Mach Number Collisionless Shocks: Long-Term Nonlinear Evolution and New Acceleration Mechanisms.
Co-PI: 2020 – 2024	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 Experience

Teaching Assistant **Aug – Dec** 2016	Fundamentals of Astrophysics (undergraduate + graduate course with 90 students). at Indian Institute of Science, Bangalore, India

Mentoring Experience

Undergraduate Student Co-supervisor	– Jahnavi Murthy Padukone (Princeton University; June 2025 –), – Jake Grodner (Princeton University; January – April 2025), – Ivan Jane (University of Chicago REU programme; June – August 2022),
Graduate Student Co-supervisor	– Saikat Das (Indian Institute of Science Bangalore, from April 2024; PhD expected in 2028)

Synergistic activities

Referee	Astrophysical Journal Letters (ApJL), Astrophysical Journal (ApJ), Monthly Notices of the Royal Astronomical Society (MNRAS), Communications in Computational Physics (CICP).
Membership	Life member of the Astronomical Society of India.
Computational Tool Development	1) Cosmic ray two-fluid MHD module for the PLUTO code; 2) a one-dimensional two-fluid hydrodynamic code: SHOBDO; and 3) electromagnetic particle-in-cell code: SHAKTI.
Conference Organizer	1) Served as a Local Organizing Committee in “Bubble Big and Small” conference at IISc, in June 2018, 2) Co-organizing a conference scheduled to take place at the Princeton Center for Theoretical Science from February 23 to 25, 2026.
Public Outreach	Served as a volunteer at the Open Day events during 2014–2019 at IISc Bangalore.
Other Contributions	Astroplasmas seminar organizer in the Dept of Astrophysical Sciences, Princeton University, Volunteering as AstroCoffee host - daily ArXiv paper discussion club at Princeton University.

Selected presentations

September 12, 2025	***Invited Talk***, at the "Magnetic Fields and Cosmic Rays across Diverse Scales: What's Next" conference in CfA | Harvard & Smithsonian in Cambridge, Massachusetts, USA.
July 18, 2025	*Contributed Talk*, at the "39th International Cosmic Ray Conference" in Geneva, Switzerland.
June 7, 2025	*Contributed Talk*, at the Galaxies and related topics, at Raman Research Institute, India (online).
April 1, 2025	***Invited Talk***, at The Center for Cosmology and AstroParticle Physics, The Ohio State University.
January 22, 2025	*Seminar*, at Indian Institute of Technology Indore, India.
January 17, 2025	*Seminar*, at Indian Institute of Astrophysics, Bangalore, India.
January 15, 2025	*Seminar*, at Indian Institute of Technology Kanpur, India.
January 6, 2025	*Seminar*, at Indian Institute of Technology Kharagpur, India.
September, 2024	*Contributed Talk*, at Galaxy Clusters and Radio Relics II at CfA | Harvard and Smithsonian, USA.
February 6, 2024	*Seminar*, at Inter-University Centre for Astronomy and Astrophysics in Pune, India.
February 2, 2024	*Contributed Talk*, at the Annual Meeting of "42nd Astronomical Society of India" at Bangalore, India.
January 30, 2024	*Seminar*, at International Centre for Theoretical Sciences - TIFR, Bangalore, India.
November 28, 2023	***Invited Talk***, at the "Bahcall Lunch" at the Institute for Advanced Study, Princeton.
November 1, 2023	*Contributed Talk*, at the "APS Division of Plasma Physics" in Denver, USA.
January, 2023	*Seminar*, at the "Astroplasmas seminar" in Princeton University.
January, 2023	*Seminar*, at the "Theoretical High Energy Astrophysics Group" at Columbia University, New York.
October, 2022	*Seminar*, at Indian Institute of Science, Bangalore, India.
October, 2022	*Seminar*, at Raman Research Institute, Bangalore, India.
September, 2022	***Invited Talk***, at the "Particle Acceleration in Astrophysical Objects (PASTO)" in Italy.
May 3, 2022	***Invited Talk***, in the "Astrolunch" at the Hebrew University of Jerusalem (Online).
November, 2021	*Contributed Talk*, at the "63rd Annual Meeting of the APS Division of Plasma Physics" online.
July, 2021	*Contributed Talk* at the "37th International Cosmic Ray Conference" in Berlin, Germany (online).
April, 2021	*Contributed Talk*, at the "APS-April meeting" online.
September, 2019	*Contributed Talk*, at the "From Gas to Stars: The Links between Massive Star and Star Cluster Formation" in York, UK.
January, 2019	***Invited Talk***, at the Max-Planck Institute for Astrophysics in Garching Germany.
June, 2018	*Contributed Talk*, at the "4th CRISM" conference at Grenoble, France.
June, 2018	*Contributed Talk*, at the "Bubble Big and Small" conference at IISc Bangalore, India, in June 2018.
March, 2017	*Contributed Talk*, at the Annual Meeting of "Astronomical Society of India" (ASI) at Jaipur, India.

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).

Research Publications

Journal articles

Including 9 first-author papers, 3 second-author papers with students and postdocs, and 3 contributing-author papers.

300+ citations; i10-index: 11

15. **Gupta, Siddhartha**; Caprioli, Damiano; Spitkovsky, Anatoly, under review, arXiv:2506.09134,
"*Speed-dependent threshold for electron injection into diffusive shock acceleration*"
14. Diesing, Rebecca; **Gupta, Siddhartha** 2025, ApJ, 980, 167
"*Nonthermal signatures of radiative supernova remnants II: the impact of cosmic rays and magnetic fields*"
13. Lichko, Emily; Caprioli, Damiano; Schroer, Benedikt; **Gupta, Siddhartha**; 2025, ApJ, 980, 240
"*Understanding streaming instabilities in the limit of high cosmic-ray current density*"
12. **Gupta, Siddhartha**; Caprioli, Damiano; & Spitkovsky, Anatoly 2024, ApJ, 976 10
"*Electron acceleration at quasi-parallel non-relativistic shocks: a 1D kinetic survey*"
11. **Gupta, Siddhartha**; Caprioli, Damiano; & Spitkovsky, Anatoly 2024, ApJ, 968, 17
"*Return currents in collisionless shocks*"; featured in ApJ YouTube (https://youtu.be/OEdYnshvKPQ).
10. Zacharegkas, Georgios; Caprioli, Damiano; Haggerty, Colby; **Gupta, Siddhartha**; Schroer, Benedikt 2024, ApJ, 967, 71,
"*Modeling the saturation of the Bell instability using hybrid simulations*"
9. 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*"
8. 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*"
7. **Gupta, Siddhartha**; Caprioli, Damiano, & Haggerty, Colby 2021, ApJ, 923, 208
"*Lepton-driven nonresonant streaming instability*"
6. **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*"
5. Jana, Ranita; **Gupta, Siddhartha**; Nath, Biman B 2020, MNRAS, 497, 2623
"*Role of cosmic rays in the early stages of galactic outflows*"
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*"

Conference Proceedings

4. Diesing, Rebecca; **Gupta, Siddhartha**; Guo, Minghao; Kim, Chang-Goo; Stone, James; Caprioli, Damiano; 2026, PoS ICRC2025, 34
"*How cosmic rays reshape their accelerators?*"

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*"

In preparation

Below is a list of works in preparation, in the order they will be submitted.

6. Saikat, Das; **Gupta, Siddhartha**; Prateek Sharma
"*Impact of cosmic ray distribution on the growth and saturation of streaming instabilities*"

5. Sun, Xiaochen; **Gupta, Siddhartha**; Spitkovsky, Anatoly
"*Recipes for particle injection in MHD-PIC simulations: self-regulation and acceleration*"

4. **Gupta, Siddhartha**; Spitkovsky, Anatoly; et al.
"*Seedless acceleration: thermal particle injection by low-Mach number shocks in a weakly magnetized hot plasma*"

3. **Gupta, Siddhartha**
"*Positron acceleration in nonrelativistic shocks and its implications for Galactic cosmic rays*".

2. **Gupta, Siddhartha**
"*SHAKTI: a new user-friendly tool for studying plasmas from first-principles*".

1. **Gupta, Siddhartha**; Sharma, Prateek & Mignone, Andrea
"*A cosmic ray magnetohydrodynamic module for the PLUTO code*".