

# Siddhartha Gupta

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## 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:** kinetic theory, cosmic ray acceleration, 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 **1st 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 **1st 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 – 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/Mentoring Experience

- Teaching Assistant** Indian Institute of Science, Bangalore, India.  
**Aug – Dec 2016** 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 Contributions** 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 Non-thermal: 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  
“*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  $^{22}\text{Ne}/^{20}\text{Ne}$  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*”

### Second author

3. Diesing, Rebecca; **Gupta, Siddhartha**; submitted to ApJ, arXiv  
“*Nonthermal Signatures of Radiative Supernova Remnants II: The Impact of Cosmic Rays and Magnetic Fields*”
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*”

### Contributed author

3. Lichko, Emily; Caprioli, Damiano; Schroer, Benedikt; **Gupta, Siddhartha**, submitted to ApJ, arXiv,  
“*Understanding Streaming Instabilities in the Limit of High Cosmic Ray Current Density*”
2. Zacharegkas, Georgios; Caprioli, Damiano; Haggerty, Colby; **Gupta, Siddhartha**; Schroer, Benedikt 2024, ApJ, 967, 71,  
“*Modeling the saturation of the Bell instability using hybrid simulations*”
1. 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  $\gamma$ -ray emission of RS Ophiuchi*”

### 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*”