

Shalabh Gautam

Postdoctoral Fellow,
BIMSA-YMSC Joint Program

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Citizenship: India

Research Interests

Numerical Relativity (NR), Mathematical Relativity, General Relativity, Numerical Analysis.

Academic Appointments

- Apr 2025 – **Postdoctoral Fellow**, General Relativity and Partial Differential Equations (PDEs) Group, **Yanqi Lake Beijing Institute of Mathematical Sciences and Applications (BIMSA)**, Beijing, China.
- Apr 2025 – **Postdoctoral Fellow**, Analysis, PDE and Dynamical Systems Group, **Yau Mathematical Science Centre (YMSC)**, Tsinghua University, Beijing, China.
- Jan 2022 – **Postdoctoral Fellow**, Astrophysical Relativity Group, **International Centre for Theoretical Sciences, ICTS**, Bengaluru, India.

Education

- Aug 2015 – **Inter University Center for Astronomy and Astrophysics (IUCAA)**, Pune, India,
Dec 2021 PhD in Physics.
Research Scholar, Gravitational Waves Group
Thesis Advisors: *Prof. David Hilditch & Prof. Sukanta Bose*
Thesis Title: *Towards Einstein Field Equations in Spherical Symmetry on Hyperboloidal Slices: A Generalized Harmonic Gauge Formalism*
- May 2016 – **IUCAA Graduate School**, Thesis Title: *Action at a Distance in Cosmology and Curved Spacetimes*
July 2016 Thesis Advisor: *Prof. Jayant V. Narlikar*
- 2012 – 2015 **University of Delhi**, M. Sc. Physics.
Thesis Title: *Magnetic Fields in Early Universe*
Thesis Advisor: *Prof. T. R. Seshadri*
- 2009 – 2012 **University of Delhi**, B. Sc. Honours Physics.

Awards and Fellowships

- Aug 2024 Travel Support from the Center of Mathematical Sciences and Applications, Harvard University, Boston, United States (waived).
- Aug 2024 Travel Support from the Institute for Computational and Experimental Research in Mathematics (ICERM) at Brown University, United States to attend the SpECTRE Community Workshop 2024 at Providence. Amount USD 3145.82.
- July 2023 Travel Support from Astrophysical and Cosmological Relativity Group, Albert Einstein Institute, Max Planck Institute for Gravitational Physics, Potsdam.
- July 2023 International Travel Support from the Infinity on a Gridshell Workshop at the Niels Bohr Institute, University of Copenhagen, Denmark. Amount EUR 2450.

- June 2023 Travel Support from Department of Mathematics, University of Valencia.
- June 2023 ICTS Knowledge Exchange Grant, amount INR 150,000.
- July 2022 Travel Support from the Relativity and Gravitation Group, University of the Balearic Islands (UIB), Spain.
- July 2022 Infosys-TIFR Leading Edge Travel Grant, amount INR 200,000.
- May 2022 **Honorable mention** in the **best talk competition** by postdocs in the Atlantic General Relativity Meeting 2022, prize money CND 150.
- 2017 – 2021 University Grants Commission (UGC) India Senior Research Fellowship.
- 2015 – 2017 UGC India Junior Research Fellowship.

Publications and Preprints

- 1 Edgar Gasperin, **Shalabh Gautam**, David Hilditch, Alex Vañó-Viñuales. “The Hyperboloidal Numerical Evolution of a Good-Bad-Ugly Wave Equation”. *Class. Quantum Grav.* 37 035006 (2020), <https://doi.org/10.1088/1361-6382/ab5f21>, <https://arxiv.org/abs/1909.11749>
- 2 **Shalabh Gautam**, David Hilditch, Alex Vañó-Viñuales, Sukanta Bose. “Summation by Parts and Truncation Error Matching on Hyperboloidal Slices”. *Phys. Rev. D* 103, 084045 (2021), <https://doi.org/10.1103/PhysRevD.103.084045>, <https://arxiv.org/abs/2101.05038>.
- 3 Christian Peterson, **Shalabh Gautam**, Inês Rainho, Alex Vañó-Viñuales, David Hilditch. “3D Evolution of a Semilinear Wave Model for the Einstein Field Equations on Compactified Hyperboloidal Slices”. *Phys. Rev. D* 108, 024067 (2023), <https://doi.org/10.1103/PhysRevD.108.024067>, <https://arxiv.org/abs/2303.16190>.
- 4 Christian Peterson, **Shalabh Gautam**, Alex Vañó-Viñuales, David Hilditch. “Spherical Evolution of the Generalized Harmonic Gauge Formulation of General Relativity on Compactified Hyperboloidal Slices”. *Phys. Rev. D* 110, 124033 (2024), <https://doi.org/10.1103/PhysRevD.110.124033>, <https://arxiv.org/abs/2409.02994>.
- 5 **Shalabh Gautam**, Akash Maurya. “A General Summation-by-Parts Framework for a given Conservation Law: Tests with Linear Hyperbolic Systems on Static Backgrounds”. **In Preparation.**
- 6 **Shalabh Gautam**, Anuraag Reddy. “Summation-by-Parts on Hyperboloidal Slices: 3D Minkowski Case”. **In Preparation.**

Invited Talks

- Aug 22, 2024 **IDEA Talk Series:** “Inference-Data-Experiments-Analysis (IDEA)” Talk Series at Tata Institute for Fundamental Research (TIFR), Mumbai, with the topic “Numerical Relativity: Current Techniques and Future Directions”.
- Aug 13, 2024 **General Relativity Seminar:** Center of Mathematical Sciences and Applications, Harvard University, Boston, United States. <https://cmsa.fas.harvard.edu/event/compactified-hyperboloidal-evolution-in-numerical-relativity/>
- July 19, 2023 **Group Seminar:** Astrophysical and Cosmological Relativity Group, Albert Einstein Institute, Max-Planck Institute for Gravitational Physics, Potsdam-Golm.
- June 21, 2023 **Group Seminar:** Valencia Virgo Group, Department of Astronomy and Astrophysics and Department of Mathematics, University of Valencia.
- Feb 06, 2023 **Invited Seminar:** NR community call, Caltech (Online). <https://github.com/sxs-collaboration/nr-community-call/wiki>
- Oct 12, 2022 **Group Seminar:** GRIT, CENTRA, Instituto Superior Técnico (IST), Lisboa, Portugal.
- July 20, 2022 **Group Seminar:** Relativity and Gravitation Group, University of the Balearic Islands (UIB), Spain

- Sep. 24, 2021 **Group Seminar:** Astrophysical Relativity Group, International Centre for Theoretical Sciences (ICTS), Tata Institute of Fundamental Research (TIFR), Bengaluru, India
- Jan 20, 2021 **Group Seminar:** Illinois Relativity Group, Department of Physics, University of Illinois at Urbana-Champaign, US.
- July 27, 2020 **Invited Colloquium:** Astrophysics and Cosmology Group, Department of Physics and Astrophysics, University of Delhi, India.

Conference Presentations

- July 01 – 02, 2024 **Plenary Talk:** *Constraint Equations on Hyperboloidal Slices in Generalized Harmonic Gauge Formulation.* July 02, 2024. Virtual Infinity Workshop 2024. <https://hyperboloid.al/event/virtual-24/>.
- July 10 – 13, 2023 **Plenary Talk:** *Compactified Hyperboloidal Evolution in Numerical Relativity.* July 10, 2023. Infinity on a Gridshell. Niels Bohr Institute, University of Copenhagen, Denmark. <https://hyperboloid.al/event/copenhagen-23/>, <https://strong-gr.com/infinity-on-a-grid-shell/>.
- SXScon 2024 **Lightening Talk:** *Compactified Hyperboloidal Evolution in Numerical Relativity.* Aug 08, 2024. Simulating Extreme Spacetimes with SpEC and SpECTRE. ICERM at Brown University, Providence, United States https://icerm.brown.edu/topical_workshops/tw-24-ses/.
- ASI 2024 **Oral Presentation:** *Compactified Hyperboloidal Evolution in Numerical Relativity.* Jan 31 – Feb 04, 2024. 42nd meeting of the Astronomical Society of India. Indian Institute of Science (IISc), Indian Space Research Organisation (ISRO) and Jawaharlal Nehru Planetarium (JNP), Bengaluru. <https://www.astron-soc.in/asi2024/>.
- ICGC 2023 **Oral Presentation:** *Compactified Hyperboloidal Evolution in Numerical Relativity.* Dec 08, 2023. 10th International Conference on Gravitation and Cosmology: New Horizons and Singularities in Gravity, Dec 06 – 09, 2023. Indian Institute of Technology (IIT) Guwahati, India. <https://indico.cern.ch/event/1268737/>.
- IAGRG 2022 **Contributed Talk:** *Spherical Einstein Field Equations on Hyperboloidal Slices.* Dec 19, 2022. 32nd meeting of Indian Association for General Relativity and Gravitation. IISER Kolkata, India. <https://www.iiserkol.ac.in/~iagrg32/>.
- FNR2022 **Oral Presentation:** *Some Ongoing Efforts for Evolving Einstein Field Equations on Hyperboloidal Slices.* July 25, 2022. Frontiers in Numerical Relativity 2022, University of Jena, Germany. <https://indico.tpi.uni-jena.de/event/224/>.
- GR23 **Oral Presentation:** *Some Ongoing Efforts for Evolving Einstein Field Equations on Hyperboloidal Slices.* July 05, 2022. 23rd International Conference on General Relativity and Gravitation, Beijing, China.
- 12th Iberian GW meeting **Contributed Talk:** *Some ongoing Efforts for Evolving Einstein Field Equations on Hyperboloidal Slices.* June 08, 2022. 12th Iberian Gravitational Waves Meeting 2022, Braga, Portugal. <https://indico.cern.ch/event/1141427/>.
- Atlantic GR22 **Contributed Talk:** *Spherical Einstein Field Equations on Hyperboloidal Slices.* May 18, 2022. Atlantic General Relativity Meeting 2022.
- CERS12 **Oral Presentation:** *Some Ongoing Efforts for Evolving Einstein Field Equations on Hyperboloidal Slices.* Feb. 23, 2022. 12th Central European Relativity Seminar, Budapest. <https://cers.univie.ac.at/cers12/index.html>.
- EREP2021 **Contributed Talk:** *Some Ongoing Efforts for Evolving Einstein Field Equations on Hyperboloidal Slices.* Sep. 16, 2021. Spanish-Portuguese Relativity Meeting.
- MG16 **Talk in parallel session:** *Some Ongoing Efforts for Evolving Einstein Field Equations on Hyperboloidal Slices.* July 05, 2021. Sixteenth Marcel Grossmann Meeting. <https://www.icra.it/mg/mg16.html>.
- BritGrav21 **Conference Talk:** *Some Ongoing Efforts for Evolving Einstein Field Equations on Hyperboloidal Slices.* April 14, 2021. <https://sites.google.com/view/britgrav21>.

- GR22 – **Oral Communications:** *Massive Klein-Gordon Field on Hyperboloidal Slices*. July 10, 2019. Amaldi13 22nd International Conference on General Relativity and Gravitation and 13th Edoardo Amaldi Conference on Gravitational Waves, Valencia, Spain. <https://www.gr22amaldi13.com/>.
- LIMMA **Poster Presentation:** *Massive Klein-Gordon Field on Hyperboloidal Slices*. Jan 15 – 18, 2019. Conference on Multi-messenger Astronomy in the Era of LIGO-India, Khandala, India. <https://www.gw.iucaa.in/limma2019/>.
- IAGRG 2019 **Oral Communications:** *Decay Rates of the Massive Klein-Gordon Fields along the Future Null direction and their evolution on Hyperboloidal Slices*. Jan 03, 2019. Indian Association for General Relativity and Gravitation, BITS Pilani, Hyderabad Campus, India. <https://universe.bits-pilani.ac.in/hyderabad/iagrg/iagrg>.

Teaching and Mentorship

- Fall 2023 – Present Supervising Anuraag Reddy, a masters student from IISER Pune, on a research project in NR via the S N Bhatt Memorial Excellence Fellowship program at ICTS.
- Fall 2023 – Present Co-supervising Akash Maurya, a graduate student at ICTS, along with Prayush Kumar for his PhD thesis.
- 24 July – 04 Aug 2023 Teaching Assistant (TA) in the ICTS Summer School on Gravitational-Wave Astronomy 2023. <https://www.icts.res.in/program/gws2023>
- Spring 2023 Mentored Akash Maurya, ICTS, for a semester long research project that he credited as a part of his graduate school.
- Spring 2022 TA in the topical course on Introduction to Numerical Relativity given by Prof. Prayush Kumar at ICTS.
- June 2020 TA in Summer School 2020 at IUCAA in the course on Introduction to General Relativity given by Prof. Sukanta Bose at IUCAA.
- Fall 2017 TA in a course on Fluid Dynamics given by Prof. Sukanta Bose at IUCAA.

Organising Services

- Jan–Feb, 2024 Scientific Organizing Committee of the online conference “**Predictability in General Relativity: celebrating the contributions of Prof. Yvonne Choquet-Bruhat**”, 28-29 Feb 2024, organized jointly by the Raman Research Institute (RRI), Bengaluru, and ICTS under the aegis of the Indian Association for General Relativity and Gravitation (IAGRG). <https://www.icts.res.in/program/pgr>.
- July, 2024 Local Organizing Committee (LOC) of the **ICTS Summer School on Gravitational-Wave Astronomy**, 01 – 12 July 2024. <https://www.icts.res.in/program/gws2024>.
- May–Aug, 2023 LOC of the **ICTS Summer School on Gravitational-Wave Astronomy**, 24 July – 04 August 2023. <https://www.icts.res.in/program/gws2023>.
- Mar–Apr, 2023 Screening committee of the applications for the ICTS Long Term Visiting Students Program for undergraduate and masters students 2023. <https://www.icts.res.in/academic/long-term-visiting-student-program>
- Jan–Mar, 2023 Screening committee of the applications for the ICTS SN Bhatt memorial Summer Internship programme for undergraduate and masters students 2022-2024. <https://www.icts.res.in/academic/summer-research-program>.
- May 2022 – Present Group meeting organizer in the Astrophysical Relativity Group at ICTS.
- July 2019 – Feb 2020 Group meeting organizer in the Gravitational Waves Group at IUCAA.
- Dec. 2018 Served in the Local Organizing Committee (LOC) of **Newton-Bhabha meeting** at IUCAA.
- PAX-IV 2018 Served in the LOC of the “**Physics and Astrophysics at the eXtreme (PAX-IV)**” meeting at IUCAA, Pune, India. <https://www.gw.iucaa.in/pax4/>

Outreach and Services

- 4 Assisting ICTS on various outreach activities, that involve demonstrating various phenomena using table-top experiments.
- 3 Participated in the IUCAA Gravitational Waves Group events on National Science Days 28(-29) February every year from 2016 until 2020. This involved Poster Presentations, Explaining General Relativity using Table-top experiments, Instrument demonstrations etc.
- 2 Participated in the organizing committee for the Science Quiz as a part of National Science Day activities at IUCAA in 2018 and 2020.
- 1 Gave a Public Lecture on “100 years of testing General Relativity” on 28 Feb. 2019 as a part of National Science Day activities at IUCAA with the help of colleagues.

Skills

Programming Working Knowledge in C, C++, Fortran, Python (numpy, matplotlib, scipy), Mathematica, Linux OS, Git and SVN.

Language English (fluent, and an official language throughout my education from elementary school), Hindi (native)

References

- 1 **Prof. Lars Andersson**, Professor, BIMSA, Beijing, China.
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- 2 **Prof. David Hilditch**, Assistant Professor, GRIT, CENTRA, Técnico, Lisboa, Portugal.
david.hilditch@tecnico.ulisboa.pt
- 3 **Prof. Prayush Kumar**, Assistant Professor, ICTS, Bengaluru, India.
prayush@icts.res.in
- 4 **Prof. Sukanta Bose**, Professor, Department of Physics and Astronomy, Washington State University, Pullman, WA, United States.
sukanta@wsu.edu
- 5 **Dr. Alex Vañó-Viñuales**, Postdoctoral Fellow FCT, GRIT, CENTRA, Técnico, Lisboa, Portugal.
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