

Atul Kedia

Postdoctoral Research Scholar
Department of Physics
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Positions

- 2024- **Postdoctoral Research Scholar**, *North Carolina State University*, Department of Physics.
2022-24 **Postdoctoral Research Associate**, *Rochester Institute of Technology*, Center for Computational Relativity and Gravitation.

Education

- 2016-22 **Ph.D.**, *University of Notre Dame*, Physics, Dissertation title "[Relativistic Matter in Neutron Star Mergers and Big Bang Nucleosynthesis](#)", Advisor: Prof. Grant Mathews.
2016-20 **M.S.**, *University of Notre Dame*, Physics.
2012-16 **B.Tech.**, *Indian Institute of Technology Bombay*, Engineering Physics with Honors.
Exchange Semester - Spring 2015 at *University of Toronto*.

Research publications

- [18] **AK**, R. O'Shaughnessy, L. Wade, et al., Exploring hidden priors when interpreting gravitational wave and electromagnetic probes of the nuclear equation of state, [arXiv:2405.17326 \[astro-ph.HE\]](#) (2024).
- [17] E. Sanger, S. Roy, ..., **AK**, et al., Tests of General Relativity with GW230529: a neutron star merging with a lower mass-gap compact object, [arXiv:2406.03568 \[gr-qc\]](#) (2024).
- [16] Abac, et al., Observation of Gravitational Waves from the Coalescence of a 2.5-4.5 M_{\odot} Compact Object and a Neutron Star, *Astrophys. J. Lett.* **970**, L34 (2024).
- [15] Y. Peng, M. Ristic, **AK**, et al., Kilonova Light-Curve Interpolation with Neural Networks, *Phys. Rev. Res.* **6**, 033078 (2024).
- [14] C. Fryer, A. Hungerford, ..., **AK**, et al., The Effect of the Velocity Distribution on Kilonova Emission, *Astrophys. J.* **961**, 9 (2024).
- [13] M. Ristic, R. O'Shaughnessy, ..., **AK**, Interpolated kilonova spectra models: Examining the effects of a phenomenological, blue component in the fitting of AT2017gfo spectra, *Phys. Rev. Res.* **5**, 043106 (2023).
- [12] **AK**, M. Ristic, R. O'Shaughnessy, et al., Surrogate light curve models for kilonovae with comprehensive wind ejecta outflows and parameter estimation for AT2017gfo, *Phys. Rev. Res.* **5**, 013168 (2023).
- [11] **AK**, H.I. Kim, I.-S. Suh, G.J. Mathews, Binary neutron star mergers as a probe of quark-hadron crossover equations of state, *Phys. Rev. D* **106**, 103027 (2022).
- [10] Y. Zlochower, S.R. Brandt*,...*, **AK***, et al., The Einstein Toolkit (Version: [The "Riemann" release, ET_2022_05](#)), (2022, May 31). (*=co-second authors)
- [9] **AK**, G.J. Mathews, H.I. Kim, I.-S. Suh, Binary neutron star mergers of quark matter based nuclear equations of state, *EPJ Web of Conf.* **260**, 11004 (2022).
- [8] M. Kusakabe, **AK**, G.J. Mathews, N. Sasankan, Distribution function of nuclei from e^{\pm} scattering in the presence of a strong primordial magnetic field, *Phys. Rev. D* **104**, 123534 (2021).

- [7] **AK**, N. Sasankan, G.J. Mathews, M. Kusakabe, Simulations of multicomponent relativistic thermalization, [Phys. Rev. E 103, 032101 \(2021\)](#).
- [6] G.J. Mathews, I.S. Suh, N.Q. Lan, **AK**, Conformally flat, quasi-circular numerical simulations of the gravitational wave chirp from binary neutron star merger GW170817, [arXiv:2103.05082 \[gr-qc\] \(2021\)](#).
- [5] Z. Etienne, S.R. Brandt*,...*, **AK***, et al., The Einstein Toolkit (Version: [The "Lorentz" release, ET_2021_05](#)), (2021, May 31). (*=co-second authors)
- [4] N. Sasankan, **AK**, M. Kusakabe, G.J. Mathews, Analysis of the multicomponent relativistic Boltzmann equation for electron scattering in big bang nucleosynthesis, [Phys. Rev. D 101, 123532 \(2020\)](#).
- [3] G.J. Mathews, **AK**, et al, Cosmological solutions to the Lithium problem, [JPS Conf. Proc. 31, 011033 \(2020\)](#), [Mem. S.A.It. Vol. 91, 29-34 \(2020\)](#).
- [2] S.R. Brandt, B. Brendal*,...*, **AK***, et al., The Einstein Toolkit (Version: [The "Turing" release, ET_2020_05](#)), (2020, May 30). (*=co-second authors)
- [1] P. Sarkar, S. Majumdar, B. Pandey, **AK**, S. Sarkar, The many scales to cosmic homogeneity: Use of multiple tracers from the SDSS, [arXiv:1611.07915 \[astro-ph.CO\] \(2016\)](#).

Talks and Presentations

- June 2024 "Kilonova dependence on ejecta morphology and composition (+ nucleosynthesis dependence on nuclear input)" Towards a consistent approach for nuclear structure and reactions: microscopic optical potentials, ECT*, Trento, Trentino-Alto Adige, Italy **(invited)**.
- June 2024 "Inferences from Multi-messenger Neutron star observations" 2024 Frontiers in Nuclear Astrophysics Meeting, South Bend **(invited)**.
- April 2024 "Exploring tension between gravitational wave and electromagnetic probes of the nuclear equation of state" at the American Physical Society (APS) April Meeting, Sacramento.
- October 2023 "Kilonova dependence on Ejecta morphology and composition" at California State University, Fullerton Department of Physics Colloquium **(invited)**.
- July 2023 "Neutron star merger ejecta estimation from kilonova light curve (surrogates)" at the N3AS Summer School for Multi-Messenger Astrophysics, University of California Santa Cruz.
- May 2023 Poster titled "Ejecta of neutron star mergers estimated via kilonova light curve models" at the CeNAM Frontiers in Nuclear Astrophysics, Michigan State University.
- April 2023 "Neutron star merger ejecta estimation with kilonova light curve surrogates" at the APS April Meeting, Minneapolis.
- March 2023 "Multi-messenger Astrophysics: Gravitational waves of quark matter EOSs and ejecta parameter estimation with Kilonova modelling" at the Center for Computational Relativity and Gravitation (CCRG) Seminar, Rochester Institute of Technology. **(invited)**
- June 2022 "Neutron star merger gravitational waves for quark matter equation of state" at the North American Einstein Toolkit Workshop, University of Idaho (Hybrid).
- April 2022 "Postmerger evolution of neutron star mergers as a probe of quark matter equation of state" at the APS April Meeting, New York City.
- November 2021 "Neutron star mergers of quark matter based equations of state" at the Midwest Relativity meeting, University of Illinois Urbana-Champaign (Hybrid).
- October 2021 "Binary neutron star mergers of quark matter based equations of state" at the APS - DNP Fall meeting (Virtual).
- July 2021 "Binary neutron star initial data creation using LORENE" at the North American Einstein Toolkit Workshop (Virtual). **(invited)**

- July 2021 "Binary neutron star mergers of quark matter based equations of state" at the North American Einstein Toolkit Workshop (Virtual).
- July 2021 "Binary neutron star mergers of quark matter based equations of state." at the 16th Marcel Grossmann meeting (Virtual).
- April 2021 "Binary neutron star mergers and the nuclear equations of state." at APS April Meeting (Virtual).
- April 2021 Poster titled "Monte-Carlo simulations of multi-specie relativistic thermalization for Big bang nucleosynthesis." at APS April Meeting (Virtual).
- November 2020 "Monte-Carlo simulations of multi-specie relativistic thermalization and Analysis of Boltzmann Equation for Big bang nucleosynthesis" at APS-DNP Fall meeting (Virtual).
- October 2020 "Full GR simulations of Neutron star binaries at large separations" at Midwest Relativity Meeting (Virtual).
- September 2020 "Relativistic thermodynamics in Big Bang Nucleosynthesis" at University of Notre Dame Astrophysics Seminar. (Virtual)(**invited**)
- April 2019 "Relativistic electron scattering and Big Bang Nucleosynthesis" at APS April Meeting.
- Dec 2018 Poster titled "Relativistic particle scattering and Big Bang Nucleosynthesis" at College of Science and Engineering - Joint Annual Meeting 2018.
- Oct 2018 "Relativistic particle scattering and Big Bang Nucleosynthesis" at the Biophysics group led by Prof. Vural at iCeNSA, University of Notre Dame. (**invited**)
- Oct 2018 "Relativistic particle scattering and Big Bang Nucleosynthesis" at Interplay between Particle and Astroparticle physics 2018 hosted by University of Cincinnati.
- April 2018 Poster titled "Proton distribution function during Big Bang Nucleosynthesis" at APS April Meeting.
- June 2017 "Probing homogeneity of the Cosmos using Quasars" at Fourth Azarqui School of Astronomy.
- Nov 2016 Poster titled "Probing homogeneity of the Cosmos using Quasars" at GPS Annual Conference.

Awards, Grants and Scholarships

- May 2023 Travel Support by CeNAM Frontiers in Nuclear Astrophysics (\$450).
- April 2023 Travel award by American Physical Society (APS)-Division of Astrophysics (DAP) to present at APS April meeting (\$600).
- April 2022 Travel award by APS-Division of Gravitational Physics (DGRAV) and DAP to present at APS April meeting (\$300×2).
- October 2021 Downes Memorial Award of Notre Dame (\$100).
- June 2021 Recipient of the Center of Research Computing Graduate Award for Computational Science and Visualization 2021 (\$1000 and a plaque) at Notre Dame.
- April 2021 Travel award by APS-DAP to present at APS April meeting (\$110).
- April 2021 Travel award by Graduate Student Union (GSU) of University of Notre Dame to present at APS April meeting (\$149).
- April 2020 Travel award by GSU to attend APS April meeting (\$500).
- April 2019 Travel award by APS-DAP to present at APS April meeting (\$500).
- April 2019 Travel award by GSU to present at APS April meeting (\$350).
- May 2018 Full funding support from organizers to attend Neutron Star Merger summer school at FRIB, Michigan State University.
- April 2018 Travel award by APS-Division of Nuclear Physics to present at APS April meeting (\$400).

- Sept 2017 Full funding support from organizers to attend Midwest Theory Get-Together at Argonne National Laboratory.
- July 2017 Partial funding support to attend National Nuclear Physics Summer School at University of Colorado Boulder (registration, accommodation, and meals).
- June 2017 Partial Funding support from organizers to attend Fourth Azarqui School of Astronomy, on Nuclear Astrophysics and Astroparticle physics at Sicily, Italy (registration, accommodation, and meals).
- October 2014 Full tuition scholarship to attend University of Toronto as a semester exchange for spring 2015(\approx \$14000).
- 2012 All India Rank 673 in IIT-JEE among approx. 500 thousand examinees (99.8 percentile) and AIEEE rank 842 among approx. 1.2 million examinees (99.9 percentile).
- 2011 Qualified National Standard Examination in Physics (NSEP), being in the top 1% among 43,000 examinees across India. Invited for Indian National Physics Olympiad (INPhO) 2012 by the Homi Bhabha Centre for Science Education (HBCSE).

Professional memberships

- 2022-present Laser Interferometer Gravitational-Wave Observatory (LIGO) Scientific Collaboration (www.ligo.org)
- 2018-present American Physical Society (www.aps.org)

Services and Outreach

- 2023-present Reviewer for the Astrophysical Journal and Stephen Hawking Postdoctoral Fellowship offered by the Engineering and Physical Sciences Research Council of UK Research and Innovation (UKRI).
- 2024 Session Chair for the session on "High Energy and Particle Astrophysics" at the APS April Meeting 2024.
- 2023-24 Hosted speakers for CCRG weekly seminar series at RIT.
- 2023 Reviewer of [RePrimAnd](#) for the LIGO-CBC-ExtremeMatter working group.
- 2023 In rapid parameter estimation team of LIGO for three weeks during the fourth observing run O4, and conducted analyses for over 8 significant observations including several BBH observations and a mass-gap BH-NS observation [GW230529](#).
- 2022 Popular science magazine *New Scientist* published an article on my Ph.D. research paper Phys. Rev. D 106, 103027 (2022). Article: K. Padavic-Callaghan, "Gravitational waves could reveal the existence of quark matter", *New Scientist*, Issue 3411 (2022), newscientist.com/article/2344898-gravitational-waves-could-reveal-the-existence-of-quark-matter/.
- 2020-22 Member of the Einstein Toolkit community, and contributor to the the May 2022 release "[Riemann](#)", the May 2021 release "[Lorentz](#)", and the May 2020 release "[Turing](#)".
- 2020 Session Chair for the session on "Physics of Neutron Stars and Black Holes" at the [Midwest Relativity Meeting 2020](#).
- 2020 Member of the Local Organizing Committee for the Midwest Relativity Meeting 2020.
- 2024 Volunteer for North Carolina Science Olympiad State Tournament Astronomy high school competition.
- 2019-20 Physics Department Representative at the [Graduate Student Union, University of Notre Dame](#).
- 2017-18 Graduate International Students committee member at the Physics Department, University of Notre Dame.

- March 2017, Judge for high school and elementary school students' physics projects at the Northern Indiana Regional Science & Engineering Fair(NIRSEF).
- 2016-18 Volunteer for Our Universe Revealed events and Stargazing events at the University of Notre Dame.

Student collaborators

- 2023- Sara Rosborough : Rochester Institute of Technology, PhD student; *Project:-* AGN reverberation spectra estimation via RIFT parameter estimation code and BELMAC.
- 2023- Wei Sun : University of Notre Dame, PhD student; *Project:-* Equation of state study via numerical relativity simulations of neutron star merger.
- 2023- Amelia Henkel : University of New Hampshire, PhD student; *Project:-* Employing kilonova models for multi-messenger inference using the GEMMA (GW-EM MMA) framework.
- 2023- Yinglei Peng : University of Rochester, Undergraduate student (co-mentor); *Project:-* A kilonova light curve model using Neural Network. Talk recording on YouTube "[Kilonova light curves using autoencoders](#)" Channel: [Center For Computational Relativity and Gravitation](#)

Teaching Experience

- Summer 2019 Instructor of Record for Physics 2 Electromagnetism labs at the Department of Physics and Astronomy, Indiana University South Bend.
- 2017-2021 Delivered five lectures as part of Teaching Practicum for graduate students at Notre Dame.
- General Relativity for Prof. Mathews (April 2021)
 - Engineering Physics I for Prof. Howk (Feb 2019) (x2)
 - Math Methods for Physics II for Prof. Vural (March 2018)
 - Elementary Cosmology for Prof. Jessop (Jan 2017)
- 2016-2021 Teaching Assistant in the Physics department for:
- Special and General Relativity (spring 19, 20, 21)
 - Graduate Classical Mechanics (fall 18)
 - Particles and Cosmology (spring 18)
 - Descriptive Astronomy (fall 17)
 - Elementary Cosmology (fall 17, 21)
 - Physics 1 : Mechanics course Lead tutor (fall 19)
 - Physics 1 : Mechanics course tutor (summer 17, 18, spring 20, fall 21)
 - Physics 1 : Mechanics lab for pre-med students (fall 16, spring 18)
 - Physics 2 : Electromagnetism course tutor (summer 18, fall 18, 20 spring 19), received Course Instructor Feedback composite score of upto 5.0/5.0.
 - Physics 2 : Electromagnetism lab for pre-med students (spring 17, summer 17)
 - Physics 2 : Electromagnetism lab for engineering students (fall 20)
- 2015 Teaching Assistant for online course on Engineering physics by IIT Bombay and *Teach 10k Teachers* for physics teachers at engineering colleges in India.

Skill Set

Softwares :- PRISM (nucleosynthesis network), TALYS (Hauser-Feshbach), RIFT (parameter estimation), RePrimAnd (TOV solver), Einstein Toolkit (numerical relativistic hydrodynamics), LORENE (neutron star initial data), MATLAB, Mathematica, and \LaTeX .

Programming Languages :- Python (extensive experience), Bash scripts (extensive experience), C, C++, and Arduino.

Operating Systems :- Windows (primarily using Ubuntu through WSL), Ubuntu (Linux) (primarily via WSL in the recent years), Red Hat Enterprise Linux, High Performance Computing (HPC) systems such as HTCondor and the Open Science Grid (OSG).

Languages :- Fluent in English and Hindi. Novice in French, German, and Bengali.

References

Prof. Richard O'Shaughnessy

Associate Professor

Center for Computational Relativity and Gravitation, Rochester Institute of Technology

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Prof. Grant Mathews

Professor of Physics & Astronomy, Director of Center for Astrophysics, University of Notre Dame

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Webpage - physics.nd.edu/people/faculty/grant-j-mathews/

Dr. Ryan Wollaeger

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Email - wollaeger@lanl.gov

Webpage - ccsweb.lanl.gov/astro/index.html

Dr. Christopher L. Fryer

Past-Director, Computational Physics & Methods, Los Alamos National Laboratory

Email - fryer@lanl.gov

Webpage - ccsweb.lanl.gov/astro/index.html