Arka Banerjee

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Research Positions

- **Indian Institute of Science Education and Research (IISER)**, Pune, India
  Assistant Professor of Physics, March 2022 – present.
- **Fermilab**, Batavia, Illinois, USA
  Schramm Fellow in Theoretical Astrophysics, Dec 2020 - Feb 2022.
- **Kavli Institute for Particle Astrophysics and Cosmology**, Stanford University, USA
  KIPAC Postdoctoral Fellow, Sep 2017 - Dec 2020.

Education

- **University of Illinois, Urbana-Champaign**, USA
  Ph.D. in Physics, 2017.
  Advisor: Neal Dalal
  Dissertation: "Cosmological Signatures of Fundamental Physics"
- **Tata Institute of Fundamental Research**, India
  M.Sc. in Physics, 2011.
  Advisor: Amol Dighe
  Dissertation: "Onset of Nonlinear Neutrino Oscillations in Core Collapse Supernovae"
- **St. Stephen's College**, India
  B.Sc. in Physics, 2008.

Honors and Awards

- Science and Engineering Research Board (SERB) India - Startup Research Grant (2023)
- UIUC University Fellowship (Fall 2016, Spring 2013)
- Outstanding Teaching Award, UIUC (Spring 2016, Fall 2012, Spring 2012)
- Kamla Bajaj Award for Best Student in Physics Honours, St. Stephen's College (2008)

Mentoring Experience

- **PhD Students:**
  - Eishica Chand, IISER Pune (2022 – present)
  - Vikhyat Sharma, IISER Pune (2022 – present)
  - Yash Koushal, IISER Pune (2023 – present)
- **Graduate student supervision for research projects:**
  - Adrian Bayer, UC Berkeley.
  - Ethan Nadler, Stanford University.

  - Andrew Eberhardt, Stanford University
  - Yunchong Wang, Stanford University
  - Sean McLaughlin, Stanford University
  - Nickolas Kokron, Stanford University
  - Dhayaa Anbajagane, University of Chicago

- **Master Thesis Students:**
  - Kaustubh Gupta, IISER Pune (2024)
  - Kwanit Gangopadhyay, IISER Pune (2023)

- **Undergraduate Research Students:**
  - Jacob Stanton, Brown University
  - Harrsh Goyal, IISER Pune
  - Subhankar Datta, IISER Pune
  - Saptarshi Pandey, IISER Pune
  - Om Hebbar, IISER Pune
  - Anargha Mondal, IISER Pune

Conferences and Workshops Organized

- Pune-Mumbai Cosmology and Astro-Particle Meetings, IISER-Pune, IUCAA, TIFR, IIT-Bombay (2023 – present)
- Less Traveled Path to Dark Matter, ICTS Bangalore (March 2023)
- Workshop on Nearest Neighbor Distributions in Cosmology, Stanford University (Jan 2021)
- KIPAC Hack Day, Stanford University, May 2019.
- Local Group Meeting (Stanford, UC Berkeley, UC Davis) on Local Group Science, Stanford University, November 2019.

Publications

[1] Kwanit Gangopadhyay, Arka Banerjee, and Tom Abel. "Geometric Interpretations of the k-Nearest Neighbour Distributions". In: *arXiv e-prints*, arXiv:2502.07713 (Feb. 2025), arXiv:2502.07713. DOI: 10.48550/arXiv.2502.07713. arXiv: 2502.07713 [astro-ph.CO].

[2] Zhuoyang Zhou et al. "High-energy Neutrino Source Cross-correlations with Nearest-neighbor Distributions". In: ApJ 979.2, 194 (Feb. 2025), p. 194. DOI: 10.3847/1538-4357/ad924c. arXiv: 2406.00796 [astro-ph.HE].

[3] William R. Coulton, Tom Abel, and Arka Banerjee. "Small-scale signatures of primordial non-Gaussianity in k-nearest neighbour cumulative distribution functions". In: MNRAS 534.3 (Nov. 2024), pp. 1621–1633. DOI: 10.1093/mnras/stae2108. arXiv: 2309.15151 [astro-ph.CO].

[4] Eishica Chand et al. "Boosting HI-Galaxy Cross-Clustering Signal through Higher-Order Cross-Correlations". In: *arXiv e-prints*, arXiv:2410.21225 (Oct. 2024), arXiv:2410.21225. DOI: 10.48550/arXiv.2410.21225. arXiv: 2410.21225 [astro-ph.CO].

[5] Shany Danieli et al. "Merian: A Wide-Field Imaging Survey of Dwarf Galaxies at z~0.06-0.10". In: *arXiv e-prints*, arXiv:2410.01884 (Oct. 2024), arXiv:2410.01884. DOI: 10.48550/arXiv.2410.01884. arXiv: 2410.01884 [astro-ph.GA].

[6] Delon Shen et al. "Aemulus ν: Precision halo mass functions in wνCDM cosmologies". In: *arXiv e-prints*, arXiv:2410.00913 (Oct. 2024), arXiv:2410.00913. DOI: 10.48550/arXiv.2410.00913. arXiv: 2410.00913 [astro-ph.CO].

[7] Kaustubh Rajesh Gupta and Arka Banerjee. "Spatial clustering of gravitational wave sources with k-nearest neighbour distributions". In: MNRAS 531.4 (July 2024), pp. 4619–4639. DOI: 10.1093/mnras/stae1424. arXiv: 2404.01428 [astro-ph.CO].

[8] Arhum Ansari et al. "Time Non-locality in Dark Matter and LSS". In: *arXiv e-prints*, arXiv:2406.17025 (June 2024), arXiv:2406.17025. DOI: 10.48550/arXiv.2406.17025. arXiv: 2406.17025 [astro-ph.CO].

[9] Arka Banerjee et al. "Primordial magnetic relics and their signatures". In: *arXiv e-prints*, arXiv:2406.08728 (June 2024), arXiv:2406.08728. DOI: 10.48550/arXiv.2406.08728. arXiv: 2406.08728 [astro-ph.CO].

[10] Yifei Luo et al. "The Merian survey: design, construction, and characterization of a filter set optimized to find dwarf galaxies and measure their dark matter halo properties with weak lensing". In: MNRAS 530.4 (June 2024), pp. 4988–5005. DOI: 10.1093/mnras/stae925. arXiv: 2305.19310 [astro-ph.GA].

[11] Vidhya Ganesan et al. "Hint of dark matter-dark energy interaction in the current cosmological data?" In: *arXiv e-prints*, arXiv:2403.14247 (Mar. 2024), arXiv:2403.14247. DOI: 10.48550/arXiv.2403.14247. arXiv: 2403.14247 [astro-ph.CO].

[12] Kate Storey-Fisher et al. "The Aemulus Project. VI. Emulation of Beyond-standard Galaxy Clustering Statistics to Improve Cosmological Constraints". In: ApJ 961.2, 208 (Feb. 2024), p. 208. DOI: 10.3847/1538-4357/ad0ce8. arXiv: 2210.03203 [astro-ph.CO].

[13] Susmita Adhikari et al. "Constraints on Dark Matter Self-Interactions from weak lensing of galaxies from the Dark Energy Survey around clusters from the Atacama Cosmology Telescope Survey". In: *arXiv e-prints*, arXiv:2401.05788 (Jan. 2024), arXiv:2401.05788. DOI: 10.48550/arXiv.2401.05788. arXiv: 2401.05788 [astro-ph.CO].

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[15] Arka Banerjee et al. "Nonthermal warm dark matter limits from small-scale structure". In: Phys. Rev. D 108.4, 043518 (Aug. 2023), p. 043518. DOI: 10.1103/PhysRevD.108.043518. arXiv: 2305.15736 [astro-ph.CO].

[16] Joseph DeRose et al. "Aemulus ν: precise predictions for matter and biased tracer power spectra in the presence of neutrinos". In: J. Cosmology Astropart. Phys. 2023.7, 054 (July 2023), p. 054. DOI: 10.1088/1475-7516/2023/07/054. arXiv: 2303.09762 [astro-ph.CO].

[17] Zhongxu Zhai et al. "The Aemulus Project. V. Cosmological Constraint from Small-scale Clustering of BOSS Galaxies". In: ApJ 948.2, 99 (May 2023), p. 99. DOI: 10.3847/1538-4357/acc65b. arXiv: 2203.08999 [astro-ph.CO].

[18] Arka Banerjee and Tom Abel. "Tracer-field cross-correlations with k-nearest neighbour distributions". In: MNRAS 519.4 (Mar. 2023), pp. 4856–4868. DOI: 10.1093/mnras/stac3813. arXiv: 2210.05140 [astro-ph.CO].

[19] Ethan O. Nadler et al. "Symphony: Cosmological Zoom-in Simulation Suites over Four Decades of Host Halo Mass". In: ApJ 945.2, 159 (Mar. 2023), p. 159. DOI: 10.3847/1538-4357/acb68c. arXiv: 2209.02675 [astro-ph.CO].

[20] Arka Banerjee et al. "Signatures of Light Massive Relics on non-linear structure formation". In: MNRAS 516.2 (Oct. 2022), pp. 2038–2049. DOI: 10.1093/mnras/stac2128. arXiv: 2202.09840 [astro-ph.CO].

[21] Alex Drlica-Wagner et al. "Report of the Topical Group on Cosmic Probes of Dark Matter for Snowmass 2021". In: *arXiv e-prints*, arXiv:2209.08215 (Sept. 2022), arXiv:2209.08215. DOI: 10.48550/arXiv.2209.08215. arXiv: 2209.08215 [hep-ph].

[22] Yunchong Wang, Arka Banerjee, and Tom Abel. "Detection of spatial clustering in the 1000 richest SDSS DR8 redMaPPer clusters with nearest neighbor distributions". In: MNRAS 514.3 (Aug. 2022), pp. 3828–3843. DOI: 10.1093/mnras/stac1551. arXiv: 2112.04502 [astro-ph.CO].

[23] Susmita Adhikari et al. "Astrophysical Tests of Dark Matter Self-Interactions". In: *arXiv e-prints*, arXiv:2207.10638 (July 2022), arXiv:2207.10638. DOI: 10.48550/arXiv.2207.10638. arXiv: 2207.10638 [astro-ph.CO].

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[25] Adrian E. Bayer, Arka Banerjee, and Uroš Seljak. "Beware of fake ν 's: The effect of massive neutrinos on the nonlinear evolution of cosmic structure". In: Phys. Rev. D 105.12, 123510 (June 2022), p. 123510. DOI: 10.1103/PhysRevD.105.123510. arXiv: 2108.04215 [astro-ph.CO].

[26] Joy Bhattacharyya et al. "The Signatures of Self-interacting Dark Matter and Subhalo Disruption on Cluster Substructure". In: ApJ 932.1, 30 (June 2022), p. 30. DOI: 10.3847/1538-4357/ac68e9. arXiv: 2106.08292 [astro-ph.CO].

[27] Arka Banerjee, Nickolas Kokron, and Tom Abel. "Modelling nearest neighbour distributions of biased tracers using hybrid effective field theory". In: MNRAS 511.2 (Apr. 2022), pp. 2765–2781. DOI: 10.1093/mnras/stac193. arXiv: 2107.10287 [astro-ph.CO].

[28] Keith Bechtol et al. "Snowmass2021 Cosmic Frontier White Paper: Dark Matter Physics from Halo Measurements". In: *arXiv e-prints*, arXiv:2203.07354 (Mar. 2022), arXiv:2203.07354. DOI: 10.48550/arXiv.2203.07354. arXiv: 2203.07354 [hep-ph].

[29] Marcelo A. Alvarez et al. "Snowmass2021 Computational Frontier White Paper: Cosmological Simulations and Modeling". In: *arXiv e-prints*, arXiv:2203.07347 (Mar. 2022), arXiv:2203.07347. DOI: 10.48550/arXiv.2203.07347. arXiv: 2203.07347 [astro-ph.IM].

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[31] Alejandro Aviles et al. "Clustering in massive neutrino cosmologies via Eulerian Perturbation Theory". In: J. Cosmology Astropart. Phys. 2021.11, 028 (Nov. 2021), p. 028. DOI: 10.1088/1475-7516/2021/11/028. arXiv: 2106.13771 [astro-ph.CO].

[32] Ethan O. Nadler et al. "The Effects of Dark Matter and Baryonic Physics on the Milky Way Subhalo Population in the Presence of the Large Magellanic Cloud". In: ApJ 920.1, L11 (Oct. 2021), p. L11. DOI: 10.3847/2041-8213/ac29c1. arXiv: 2109.12120 [astro-ph.CO].

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[35] Adrian E. Bayer, Arka Banerjee, and Yu Feng. "A fast particle-mesh simulation of non-linear cosmological structure formation with massive neutrinos". In: J. Cosmology Astropart. Phys. 2021.1, 016 (Jan. 2021), p. 016. DOI: 10.1088/1475-7516/2021/01/016. arXiv: 2007.13394 [astro-ph.CO].

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[37] Francisco Villaescusa-Navarro et al. "The Quijote Simulations". In: ApJS 250.1, 2 (Sept. 2020), p. 2. DOI: 10.3847/1538-4365/ab9d82. arXiv: 1909.05273 [astro-ph.CO].

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[39] Arka Banerjee et al. "Weighing neutrinos with the halo environment". In: J. Cosmology Astropart. Phys. 2020.6, 032 (June 2020), p. 032. DOI: 10.1088/1475-7516/2020/06/032. arXiv: 1907.06598 [astro-ph.CO].

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[41] Ke Fang et al. "A Cross-correlation Study of High-energy Neutrinos and Tracers of Large-scale Structure". In: ApJ 894.2, 112 (May 2020), p. 112. DOI: 10.3847/1538-4357/ab8561. arXiv: 2002.06234 [astro-ph.HE].

[42] Andrew Eberhardt et al. "Investigating the use of field solvers for simulating classical systems". In: Phys. Rev. D 101.4, 043011 (Feb. 2020), p. 043011. DOI: 10.1103/PhysRevD.101.043011. arXiv: 2001.05791 [physics.comp-ph].

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[44] Thomas McClintock et al. "The Aemulus Project IV: Emulating Halo Bias". In: *arXiv e-prints*, arXiv:1907.13167 (July 2019), arXiv:1907.13167. DOI: 10.48550/arXiv.1907.13167. arXiv: 1907.13167 [astro-ph.CO].

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[46] Keith Bechtol et al. "Dark Matter Science in the Era of LSST". In: BAAS 51.3, 207 (May 2019), p. 207. DOI: 10.48550/arXiv.1903.04425. arXiv: 1903.04425 [astro-ph.CO].

[47] Jason Rhodes et al. "The End of Galaxy Surveys". In: BAAS 51.3, 114 (May 2019), p. 114.

[48] Alex Drlica-Wagner et al. "Probing the Fundamental Nature of Dark Matter with the Large Synoptic Survey Telescope". In: *arXiv e-prints*, arXiv:1902.01055 (Feb. 2019), arXiv:1902.01055. DOI: 10.48550/arXiv.1902.01055. arXiv: 1902.01055 [astro-ph.CO].

[49] Arka Banerjee et al. "Reducing noise in cosmological N-body simulations with neutrinos". In: J. Cosmology Astropart. Phys. 2018.9, 028 (Sept. 2018), p. 028. DOI: 10.1088/1475-7516/2018/09/028. arXiv: 1801.03906 [astro-ph.CO].

[50] Francisco Villaescusa-Navarro et al. "The Imprint of Neutrinos on Clustering in Redshift Space". In: ApJ 861.1, 53 (July 2018), p. 53. DOI: 10.3847/1538-4357/aac6bf. arXiv: 1708.01154 [astro-ph.CO].

[51] Lucas F. Secco et al. "Probing Self-interacting Dark Matter with Disk Galaxies in Cluster Environments". In: ApJ 860.1, 32 (June 2018), p. 32. DOI: 10.3847/1538-4357/aac271. arXiv: 1712.04841 [astro-ph.GA].

[52] Arka Banerjee et al. "Tests of neutrino and dark radiation models from galaxy and CMB surveys". In: J. Cosmology Astropart. Phys. 2018.1, 022 (Jan. 2018), p. 022. DOI: 10.1088/1475-7516/2018/01/022. arXiv: 1612.07126 [astro-ph.CO].

[53] Lucas Secco et al. "The Morphology of Disk Galaxies in Galaxy Clusters with Dark Matter Self-Interactions". In: *APS April Meeting Abstracts*. Vol. 2018. APS Meeting Abstracts. Jan. 2018, K15.006, K15.006.

[54] Arka Banerjee and Neal Dalal. "Simulating nonlinear cosmological structure formation with massive neutrinos". In: J. Cosmology Astropart. Phys. 2016.11, 015 (Nov. 2016), p. 015. DOI: 10.1088/1475-7516/2016/11/015. arXiv: 1606.06167 [astro-ph.CO].

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Talks and Presentations

- "Cosmology with nonlinear structure formation: Simulations and Statistics" - Presidency University, Dec 2022.
- "Cosmology with nonlinear structure formation: Simulations and Statistics" - HRI Physics Colloquium, Sep 2022.
- "Cosmology with nonlinear structure formation: Simulations and Statistics" - IISER Pune Physics Colloquium, Aug 2022.
- "Nearest Neighbor distributions: a new approach to cosmological clustering" - Vipolze Berkeley Workshop, July 2022.
- "Cosmology with nonlinear structure formation: Simulations and Statistics" - IUCAA Colloquium, May 2022.
- "Nearest Neighbor distributions: a new approach to cosmological clustering" - Yale Astronomy Colloquium, Sep 2021.
- "Cosmological clustering and Nearest Neighbor Distributions" - University of Waterloo Astro Seminar Series, May 2021.

- "k-Nearest Neighbor distributions: new statistical measures for cosmological clustering" - Survey Science Meeting, UChicago, Jan 2021.
- "Modeling structure formation in the era of precision cosmology" - IMSc Chennai, Nov 2020.
- "Modeling structure formation in the era of precision cosmology" - IISER Pune, Oct 2020.
- "k-Nearest Neighbor distributions: new statistical measures for cosmological clustering" - KIPAC tea talk, Stanford University, Aug 2021.
- "Weighing neutrinos with the Large Scale Structure of the Universe" - ICTS, Bangalore, March 2020.
- "Weighing neutrinos with the Large Scale Structure of the Universe" - IISC, Bangalore, March 2020.
- "Signatures of Dark Matter Self-Interactions in the Milky Way" - Local Group Meeting, Stanford, Nov 2019.
- "Signatures of Self-Interacting dark matter on cluster density profile and subhalo distributions" - Cosmic Controversies Conference, Chicago, Oct 2019.
- "Signatures of Self-Interacting dark matter on cluster density profile and subhalo distributions" - LSST Dark Matter Workshop, U. Chicago, Aug 2019.
- "Signatures of Self-Interacting dark matter on cluster density profile and subhalo distributions" - New York University, June 2019.
- "Massive neutrinos and environmental scale dependence" - Cosmology Seminar, ICTS Bangalore, Jan 2019.
- "Imprints of massive neutrinos on Large Scale Structure" - IMSC Chennai, Jan 2019.
- "Cosmology with massive neutrinos" - INPA Seminar, Lawrence Berkeley Laboratory, Oct 2018.
- "Massive Neutrinos and the Environmental Scale Dependence of Halo Bias" - Nonlinear Universe Conference, Smartno, July 2018.
- "Reducing Noise in Cosmological N-body simulations with neutrinos" - KIPAC Tea, SLAC, Jan 2018.
- "Reducing Noise in Cosmological N-body simulations with neutrinos" - Cosmology Lunch, Princeton University, Dec 2017.
- "Imprints of massive neutrinos on Large Scale Structure" - Cosmology Seminar, UC Davis, Oct 2017.
- "Cosmological effects of massive neutrinos" - IIT Bombay, Aug 2017.
- "Void biasing in the presence of massive neutrinos" - LBL, Apr 2017.
- "Simulating nonlinear structure formation with massive neutrinos" - KIPAC, Stanford University, Mar 2017.
- "Cosmological structure formation with massive neutrinos" - IPMU, Tokyo, Feb 2017.

- "Simulating nonlinear structure formation with massive neutrinos" - CCAPP, Ohio State University, Jan 2017.
- "Large scale biasing of voids in the presence of massive neutrinos" - University of Pennsylvania, Aug 2016.
- "Simulating cosmologies with textitfast particles" - Santa Fe Cosmology Workshop, July 2014.

Teaching Experience

- Cosmology (2025)
- Introductory Quantum Mechanics (2024)
- Mathematical Methods for Physics II (2023)
- Electricity and Magnetism, IISER Pune (2022, 2023, 2024)
- Introduction to Mechanics, IISER Pune (2022)
- Teaching Assistant: Quantum Mechanics and Statistical Physics, UIUC (2012-2016)
- Teaching Assistant: Special Relativity and Math Applications, UIUC (2012)

Professional Service

- Referee for JCAP, PRD, ApJ, ApJ Letters, MNRAS

Computing Skills and Experience

- Programming Languages: C, C++, Python, Mathematica, LaTeX
- Extensive experience in cluster computing and parallel computing

References

Prof. Tom Abel	Stanford University
Prof. Risa Wechsler	Stanford University
Prof. Neal Dalal	Perimeter Institute
Prof. Andrey Kravtsov	University of Chicago