Nesar Ramachandra

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Current position

Computational Scientist, Argonne National Laboratory, Aug, 2021 - Present.

Professional experience

1. Postdoctoral Researcher - Cosmological Physics and Advanced Computing Group, Argonne National Laboratory, Aug, 2018 - Aug, 2021.

2. Associate Fellow - Kavli Institute for Cosmological Physics, University of Chicago, March, 2019 - Present

3. Fellow - Kavli Summer Program on Astrophysics, University of California, Santa Cruz, June, 2019 - Aug, 2019.

4. Graduate researcher - Cosmological Physics and Advanced Computing (CPAC) Group, Argonne National Laboratory, Jan, 2018 - Aug, 2018.

5. HEP-Center for Computational Excellence Fellow - High Energy Physics Division, Argonne National Laboratory, June, 2017 - Aug, 2017.

6. Graduate Research Assistant - Department of Physics and Astronomy, University of Kansas, Aug, 2013 - June, 2017.

7. Research Scholar - Tata Institute of Fundamental Research Centre for Interdisciplinary Science, Hyderabad, India, Jan, 2013 - July, 2013.

8. Research scholar - Indian Institute of Astrophysics, Bangalore, India, Jan 2012 - Jan 2013.

Academic background

Ph.D. (Hons.) Physics, University of Kansas, 2018.

> Dissertation title: *Topology, Geometry and Morphology of the Dark Matter web.*
> Adviser: Professor Sergei Shandarin

Integrated M.S. (Hons.) Physics, Birla Institute of Technology and Science (BITS) Pilani, India, 2012.

> Thesis title: *Dynamics of ellipsoidal collapse in a cosmological setting.*
> Adviser: Professor Arun Mangalam, Indian Institute of Astrophysics.

Research interests

Scientific machine learning, Bayesian inference, high-performance computing, astrophysical data analysis, numerical methods, topological and geometrical techniques.

Projects

1. co-PI: SciDAC-5 – Femtoscale Imaging of Nuclei using Exascale Platforms, U.S. Department of Energy.

2. Member: SciDAC-5 – Enabling Cosmic Discoveries in the Exascale Era, U.S. Department of Energy.

3. PI: Artificial Intelligence (AI)-enabled analytics for Cosmology, Laboratory Directed Research and Development (LDRD), Argonne National Laboratory.

4. Co-PI: Deep-Learning Inference for Nuclear Femtography on Exascale Platforms, Swift LDRD, Argonne National Laboratory.

5. Member: L4 Science Team for NASA-SPHEREx mission.

6. Co-PI: Deep Learning-Based Scalable and Robust Strong Gravitational Lensing Characterization Pipeline Using SambaNova, LDRD Expedition Project, Argonne National Laboratory.

7. Co-PI: Automated Model Inference for Cosmological Structure Formation using Reinforcement Learning, Laboratory Directed Research and Development (LDRD), Argonne National Laboratory.

8. Co-lead: Deep Learning to Identify and Deblend Strong Lenses for LSST, Strong Lensing Working group project, LSST-DESC.

9. Co-lead: Synthetic-spectra for sample redshift inference, Photometric Redshifts Working group project, LSST-DESC.

10. Co-lead: LSST-DESC project on power spectra emulators for $f(R)$ Modified Gravity Cosmologies.

11. Member: SciDAC-4 – Inference and Machine Learning at Extreme Scales, U.S. Department of Energy.

Teaching experience

1. *Head Teaching Assistant*, Department of Physics and Astronomy, University of Kansas (2015-2016): Implemented, oversaw and evaluated new teaching strategies for 12 undergraduate courses.

2. *Graduate Teaching Assistant*, Department of Physics and Astronomy, University of Kansas (2014-2015): General Physics II Honors, General Physics II Honors, General Physics I, College Physics I.

3. *Undergraduate Teaching Assistant*, Department of Physics, BITS-Pilani (2011): Theory of Relativity.

Mentorship

1. Summer internship students: Claire Guilloteau (IRAP), Ting-Yun Cheng (University of Nottingham), Kate Storey-Fisher (NYU), Madeline Lucey (University of Texas Austin), Aurora Cossairt (Argonne National Lab).

2. Longer term students: James Butler (University of Chicago), Xiaofeng Dong (University of Chicago), Xin Liu (University of Chicago).

Publications

Under review

1. H. Wang, S. Sreejith, Y. Lin, **N. Ramachandra**, A. Slosar, S. Yoo: Neural Network Based Point Spread Function Deconvolution For Astronomical Applications, Submitted to The Open Journal of Astrophysics, *arxiv:2210.01666*.

2. H. Wang, S. Sreejith, Y. Lin, **N. Ramachandra**, A. Slosar, S. Yoo: Deconvolution of Astronomical Images with Deep Neural Networks, Submitted to the NeurIPS workshop on AI for Science, 2022

3. T. Y. Chen, B. Dey, A. Ghosh, M. Kagan, B. Nord, **N. Ramachandra**: Interpretable Uncertainty Quantification in AI for HEP, Submitted to the Proceedings of the US Community Study on the Future of Particle Physics (Snowmass 2021), *arxiv:2208.03284*.

4. M. Lucey, N. A. Kharusi, K. Hawkins, Y. Ting, **N. Ramachandra**, T. C. Beers, Y. S. Lee, A. M. Price-Whelan, J. Yoon: Over 2.7 Million Carbon-Enhanced Metal-Poor stars from BP/RP Spectra in Gaia DR3, Submitted to the Monthly Notices of the Royal Astronomical Society, *arxiv:2206.08299*.

Peer-reviewed articles

1. **N. Ramachandra**, J. Chaves-Montero, A. Alarcon, A. Fadikar, S. Habib, K. Heitmann: Machine learning synthetic spectra for probabilistic redshift estimation: SYTH-Z, *Monthly Notices of the Royal Astronomical Society*, 2022.

2. A. Hearin, **N. Ramachandra**, M. Becker, J. DeRose: Differentiable Predictions for Large Scale Structure with SHAMNet, *Open Journal of Astrophysics*, 2021.

3. K. Fukami, R. Maulik, **N. Ramachandra**, K. Fukagata, K. Taira : Global field reconstruction from sparse sensors with Voronoi tessellation-assisted deep learning, *Nature Machine Intelligence*, 2021.

4. X. Dong, **N. Ramachandra**, S. Habib, K. Heitmann, M. Buehlmann, S. Madireddy: Physical Benchmarking for AI-Generated Cosmic Web, Accepted at *NeurIPS workshop on AI for Science*, 2021.

5. L. Vazsonyi, P. Taylor, G. Valogiannis, **N. Ramachandra**, A. Ferte, J. Rhodes: Constraining f(R) Gravity with a k-cut Cosmic Shear Analysis of the Hyper Suprime-Cam First-Year Data, *Physical Review D*, 2021.

6. K. Storey-Fisher, M. Huertas-Company, **N. Ramachandra**, F. Lanusse, A. Leauthaud, Y. Luo, S. Huang, X. Prochaska: Anomaly detection in Hyper Suprime-Cam galaxy images with generative adversarial networks, *Monthly Notices of the Royal Astronomical Society*, 2021.

7. Y. Wang, **N. Ramachandra**, E. Salazar-Canizales, H. Feldman, R. Watkins, K. Dolag: Peculiar Velocity Estimation from Kinetic SZ Effect using Deep Neural Networks, Accepted, *Monthly Notices of the Royal Astronomical Society*, 2021.

8. **N. Ramachandra**, G. Valogiannis, M. Ishak, K. Heitmann (for the LSST Dark Energy Science Collaboration): Matter Power Spectrum Emulator for f(R) Modified Gravity Cosmologies, Accepted, *Physical Review D*, 2021.

9. T. Cheng, M. Huertas-Company, C. Conselice, A. Aragón-Salamanca, B. Robertson, **N. Ramachandra**: Beyond the Hubble Sequence – Exploring Galaxy Morphology with Unsupervised Machine Learning, *Monthly Notices of the Royal Astronomical Society*, Volume 503, Issue 3, May 2021, Pages 4446–4465.

10. R. Maulik, T. Botsas, **N. Ramachandra**, M. Lachlan, I. Pan: Latent-space time evolution of non-intrusive reduced-order models using Gaussian process emulation, Accepted, *Physica D: Nonlinear Phenomena*, 2020.

11. K. Storey-Fisher, M. Huertas-Company, **N. Ramachandra**, F. Lanusse, A. Leauthaud, Y. Luo, S. Huang: Anomaly Detection in Astronomical Images with Generative Adversarial Networks, Accepted at *NeurIPS workshop on Machine Learning and the Physical Sciences*, 2020.

12. K. Fukami, R. Maulik, **N. Ramachandra**, K. Fukagata, K. Taira: Probabilistic neural network-based reduced-order surrogate for fluid flows, Accepted at *NeurIPS workshop on Machine Learning and the Physical Sciences*, 2020.

13. R. Maulik, K. Fukami, **N. Ramachandra**, K. Fukagata, K. Taira : Probabilistic neural networks for fluid flow model-order reduction and data recovery, *Physical Review Fluids*, 5, 104401, 2020.

14. M. Lucey, Y. Ting, **N. Ramachandra**, K. Hawkins: From the Inner to Outer Milky Way: A Photometric Sample of 2.6 Million Red Clump Stars, *Monthly Notices of the Royal Astronomical Society*, Volume 495, Issue 3, Pages 3087–3103.

15. L. Bleem *et al.* (incl. **N. Ramachandra**): The SPTpol Extended Cluster Survey, *The Astrophysical Journal Supplement Series*, Volume 247, Number 1.

16. S. Madireddy, N. Li, **N. Ramachandra**, P. Balaprakash, S. Habib: Modular Deep Learning Analysis of Galaxy-Scale Strong Lensing Images, *Machine Learning and the Physical Sciences Workshop at the 33rd Conference on Neural Information Processing Systems (2019)*.

17. N. Libeskind *et al.* (incl. **N. Ramachandra**): Tracing the cosmic web, *Monthly Notices of the Royal Astronomical Society*, Volume 473, Issue 1, Pages 1195-1217.

18. **N. Ramachandra**, S. Shandarin: Dark matter haloes: a multistream view, *Monthly Notices of the Royal Astronomical Society*, Volume 470, Issue 3, p. 3359-3373.

19. **N. Ramachandra**, S. Shandarin: Topology and geometry of the dark matter web: a multistream view, *Monthly Notices of the Royal Astronomical Society*, Volume 467, Issue 2, p.1748-1762.

20. **N. Ramachandra**, S. Shandarin: Multi-stream portrait of the Cosmic web, *Monthly Notices of the Royal Astronomical Society*, Volume 452, Issue 2, p.1643-1653.

Selected talks

1. **N. Ramachandra**: Estimation of Galaxy Redshift with Probabilistic Neural Networks, SIAM Conference on Parallel Processing for Scientific Computing, Seattle, 2022 (remote).

2. **N. Ramachandra**: Astrophysical AI: Issues and lessons learned, Exascale Astronomy AI and benchmarking workshop, Edinburgh, 2020 (remote).

3. **N. Ramachandra**, G. Valogiannis, M. Ishak, K. Heitmann: Matter Power Spectrum Emulator for f(R) Modified Gravity Cosmologies, Science Highlight Plenary talk, LSST-DESC July 2020 Virtual Meeting, 2020.

4. **N. Ramachandra**: Scientific Machine Learning using Astrophysical Simulations, Conference on Data Analysis, Santa Fe, 2020.

5. **N. Ramachandra**: Scientific machine learning with synthetic astrophysical data, Machine Learning Tools for Research in Astronomy Ringberg, Germany, 2019.

6. **N. Ramachandra**: Deep Generative models and Astrophysical Image emulation, Machine Learning in the Era of Large Astronomical Surveys, Santa Cruz, 2019.

7. **N. Ramachandra**, G. Valogiannis, M. Ishak, K. Heitmann: Gaussian Process Emulators for Modified Gravity Summary Statistics, LSST-DESC meeting, Paris, France, 2019 (remote).

8. **N. Ramachandra**, M. Binois, S. Habib, K. Heitmann: Suite of Gaussian Process emulators for cosmological inference problems, Likelihood-free inference workshop, Flatiron Institute, New York, 2019.

9. **N. Ramachandra**, P. Larsen: Cosmic Emulators for next generation surveys, Accurate lensing in the era of precision Cosmology, University of California, Berkeley, 2019.

10. **N. Ramachandra**, S. Habib, K. Heitmann: Cosmological analysis pipelines through Neural Networks, American Physical Society April Meeting, Columbus, Ohio 2018.

11. **N. Ramachandra**: Emulation of the halo mass function, SAMSI Research Triangle Park, North Carolina, 2017

12. **N. Ramachandra**, S. Shandarin: Topology and geometry of the dark matter web, American Physical Society April Meeting, Washington D.C, 2017

13. **N. Ramachandra**, S. Shandarin: The Multi-stream portrait of the cosmic web, American Physical Society April Meeting, Salt Lake City, Utah, 2016.

14. **N. Ramachandra**, S. Shandarin: The Multi-stream structures of the cosmic web, Canadian-American-Mexican Graduate Students Physics Conference at Oaxaca, Mexico, 2015.

Honors & awards

Kavli Summer Program fellowship grant, 2019.

Physics and Astronomy Department Scholarship, University of Kansas, 2018.

Division of Astrophysics Travel grant, American Physical Society, 2018.

Graduate Research travel award, University of Kansas, 2017.

High Energy Physics - Center for Computational Excellence summer fellowship, 2017.

SAMSI Travel grant, Astrophysical population emulation workshop, 2016, 2017.

Division of Astrophysics Travel grant, American Physical Society, 2016.

Graduate Research Competition Award, University of Kansas, 2016.

National Science Foundation, the American Physical Society and the Sociedad Mexicana de Fisica travel grant, CAM conference, 2015.

Junior research fellowship, Council for Scientific and Industrial Research, Government of India, 2012.

Innovation in Science Pursuit for Inspired Research (INSPIRE) fellowship, Department of Science and Technology, Government of India, 2008 - 2012.

Professional service & outreach

Co-organizer: AI, Statistics and Machine Learning Journal Club, Argonne National Laboratory, 2019.

Reviewer: Future Investigators in NASA Earth and Space Science and Technology, FINESST program, 2019-2020.

Co-organizer: Workshop on Advanced Statistical Methods Meet Machine Learning, Argonne National Laboratory, 2018-2019

Referee, The Astrophysical Journal - IOPscience, Monthly Notices of Royal Astronomical Society - Oxford University Press, Astronomy and Computing - Elsevier Publishing, Journal of Cosmology and Astroparticle Physics - IOP Publishing.

President: Society of Physics Students, The University of Kansas chapter, 2015 - 2018.

Founding Member: KUbeSat team - a University of Kansas miniature satellite Mission that won the SPS Chapter Research Award by American Institute of Physics, 2016-2018.

Member: American Physical Society (APS), 2014.

Mentor: Afro-Academic, Cultural, Technological and Scientific Olympics (ACT-SO) initiative by National Association for the Advancement of Colored People (NAACP), 2020-2021.