


Dr. Rafael S. de Souza

Senior Lecturer in Astrophysics and Astrostatistics, University of Hertfordshire


Founder and Co-Chair, Cosmostatistics Initiative (COIN) Chair, ISI Astrostatistics Interest Group


Astrostatistics • Machine Learning for Surveys • Galaxy Evolution • Scientific Software

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Academic Summary

- Research Areas** – Astrostatistics and machine-learning methods for large astronomical surveys, with applications to galaxy evolution, Galactic structure, time-domain astronomy, cosmology, and scientific software.
- Publications** – Author or co-author of 130+ scholarly outputs, including peer-reviewed articles, invited reviews, software records, reports, book chapters, and a PROSE-award-winning book. Full publication list appears at the end of this CV.
- Research Funding** – Principal investigator on competitive research awards totalling more than \$1M, including CAS Talents, CNPq, Shanghai Talents, NSFC, FAPESP, and MTA funding.
- Leadership** – Founder and Co-Chair of the Cosmostatistics Initiative (COIN), an international network of 80+ researchers across academia and industry; Chair of the Astrostatistics Interest Group of the International Statistical Institute.
- Mentoring** – Supervision of PhD, MSc, and undergraduate research projects, including student work leading to peer-reviewed publications, software packages, and international collaborations.

Positions

- 2023 – ... – **Senior Lecturer**, Centre for Astrophysics Research, University of Hertfordshire, UK.
- 2024 – ... – **Adjunct Associate Professor**, University of North Carolina, Chapel Hill, NC, USA.
- 2020 – 2022 – **Associate Professor**, Shanghai Astronomical Observatory, CAS, Shanghai, China.
- 2017 – 2020 – **Postdoctoral Fellow** University of North Carolina, Chapel Hill, NC, USA.
- 2014 – 2016 – **Postdoctoral Fellow** Eötvös Loránd University, Budapest, Hungary.
- 2012 – 2014 – **Postdoctoral Fellow** KASI, Daejeon, South Korea.
- 2010 – 2011 – **Postdoctoral Fellow** Kavli-IPMU, Kashiwanoha, Japan.

Education

- 2004 – 2009 – **University of Sao Paulo**, Direct-Entry PhD in Astrophysics
Thesis title: *Origin of Cosmic Magnetic Fields*.
Supervisor: Reuven Opher.
- 1999 – 2004 – **B.Sc. Astronomy** Federal University of Rio de Janeiro.
Thesis title: *Cosmic Acceleration*.
Supervisor: Ioav Waga

Research Interests

- Astrostatistics** – Statistical and machine-learning methodology for survey-era astronomy, with emphasis on interpretable inference, robust segmentation, low-rank structure, uncertainty-aware classification, and reproducible software pipelines.
- Galaxy and Stellar Systems** – Data-intensive studies of galaxy evolution, IFU data cubes, extragalactic globular clusters, nuclear star clusters, and Galactic structure traced by young stellar objects and open clusters.

Research Interests (continued)

- Scientific Software – Reusable R and Python software for astronomical inference and image/spectral analysis, including SPECTRALUNMIX, SAGUI, CAPIVARA, GALMOSS, GALMASK, and QRPCA.

Research Highlights

- Scientific Software – Led the development of dozens statistical and machine-learning software packages in R and Python (e.g. SPECTRALUNMIX, SAGUI, CAPIVARA, GALMOSS, QRPCA), deployed in galaxy surveys, IFU data analysis, and scalable astronomical data-processing pipelines.
- Statistical Inference – Co-developed the first likelihood-free inference framework applied to cosmology, establishing early simulator-driven inference workflows that anticipated modern simulation-based inference approaches in astrophysics.
- Astrostatistics – Co-authored invited review articles in the *Annual Review of Statistics and Its Application* and the *Notices of the American Mathematical Society*.
- Galactic Structure – Co-led the discovery of a previously unresolved high-pitch-angle structure in the Milky Way's spiral arms, the identification of COIN-Gaia open clusters, and the construction of one of the largest catalogues of young stellar objects (SPICY) in the inner Galactic midplane.
- Nuclear Astrophysics – Developed the first hierarchical Bayesian framework for inferring nuclear reaction cross sections and S-factors in Big Bang nucleosynthesis, achieving state-of-the-art precision.
- Time-Domain Astronomy – Contributed to the development and deployment of data-driven methods for time-domain astronomy, including alert-stream analysis, active-learning strategies, and broker-integrated science modules for ZTF and LSST science.

Prizes, Awards, and Competitive Fellowships

Major Competitive Research Funding

- 2025 – 2029 – **Hyperspectral Image Segmentation at Scale** — \$200,000; CNPq (Brazil). [PI]
- 2021 – 2023 – **CAS Talents Programme** — \$800,000; Chinese Academy of Sciences. [PI]
- **MESCAL: Multidimensional Exploration of Stellar Clusters via Automated Learning** — \$32,000; National Science Foundation of China. [PI]
- 2017 – 2020 – **Shanghai Talents Programme** — \$120,000; Shanghai Municipality. [PI]
- 2014 – 2016 – **MTA Fellowship** — \$50,000; Hungarian Academy of Sciences. [PI]

Honours, Awards, and Visiting Appointments

- 2024 – 2025 – **FAPESP Visiting Professorship** — \$50,000; University of São Paulo.
- 2016 – 2017 – **FAPESP Visiting Professorship** — \$50,000; University of São Paulo.
- 2022 – **Excellence in Research Award**; Shanghai Astronomical Observatory.
- 2018 – **PROSE Award** — Best Book in Cosmology and Astronomy.
- 2017 – **Marie Skłodowska-Curie Fellowship**; AstroFit Programme, Italy.
- 2016 – **International Astrostatistics Association Award** — Best Paper in Astrostatistics.
- 2014 – **Excellence in Research Award**; Korean Astronomy and Space Science Institute.

Leadership Roles

- 2014 – ... – Founder & Co-Chair, Cosmostatistics Initiative (COIN) International research network of ~80+ researchers across academia and industry. Designed and led a distributed, project-driven team-science model coordinating multi-institution collaborations across major surveys and infrastructures (e.g. LSST, DES, Fink), integrating statistical methodology, software development, and astrophysical applications.
- 2017 – ... – Led international research programmes in astrostatistics, machine learning, and cosmology, coordinating teams across multiple institutions and securing competitive funding from CAS, FAPESP, and CNPq (total funding > \$1M).
- 2015 – ... – Led the development of dozens of open-source scientific software packages for large-scale astronomical data analysis, forming interoperable tools adopted in survey science and data-intensive workflows.
- 2014 – ... – Established and coordinated international collaborations across Europe, Asia, and the Americas, integrating expertise in statistics, computer science, and astrophysics within large-scale scientific initiatives.

Teaching and Supervision Activities

PhD Supervision

- 2025-2029 – Niranjana Prashanth, *Project title: Globular Cluster Spectral Deconvolution in Data-Cubes*, University Federal of Rio Grande do Sul
- Suresh Parekh, *Project title: GPU-accelerated Spectral Fitting*, University Federal of Rio Grande do Sul
- Andressa Wille, *Project title: Sub-galactic Star-formation across cosmic time*, University Federal of Rio Grande do Sul
- 2024-2027 – Simran Singh, *Project title: Dynamical Mapping of Star Formation in the Solar Neighborhood*, University of Hertfordshire
- Mittal Shree Hari, *Project title: The role of the Cosmic Web in the evolution of galaxies*, University of Hertfordshire
- 2016-2020 – Maria Luiza Dantas, *Thesis title: UV bright red-sequence galaxies: a comparative study between UV upturn and UV weak systems*, University of Sao Paulo

Master Supervision

- 2022-2024 – Mi Chen, *Project title: GPU-accelerated galaxy profile fitting*, Shanghai Astronomical Observatory
- 2021-2023 – Quanfeng Xu, *Project title: Low-rank factorization with GPU acceleration*, Shanghai Astronomical Observatory
- Zihao Mu, *Project title: Effects of galaxy morphology on Quenching of galaxies*, Shanghai Astronomical Observatory

Undergraduate Supervision

- 2025– 2027 – Bruna Lima, *SED-based multi-imaging segmentation of galaxy bars*
- 2021– 2024 – Yash Gondhalekar, *Image segmentation and masking*, Research packaged published.
- 2021–2022 – Peng Chen, *Low-Rank data denoising and reconstruction*, Research packaged published.
- 2019 – Renan dos Santos Barbosa, *Uncertainty aware principal Components*, Research published in peer-reviewed paper. [Remote student from University of Sao Paulo]
- Tan Hong Kiat, *MCMC analysis of ${}^7\text{Be}(n, p){}^7\text{Li}$* . Research published in peer-reviewed paper. [Exchange student from University of Singapore]
- 2018 – Yeoh Jun Kai, *Nucleosynthesis simulation visualizations*. [Exchange student from University of Singapore]

Courses Taught

- 2023-2024, Sem A – *Statistical and Analysis* [master-level class] 30 students

Teaching and Supervision Activities (continued)

- *Machine Learning and Neural Networks* [master-level class] 3000 students
- 2024, Sem B – *Machine Learning and Neural Networks* [master-level class] 300 students
- 2023, Sem C – *Research Methods in Data Science* [master-level class] 250 students

Professional Affiliations and Services

- Projects – COIN, MAUVE, FINK, LSST, J-PAS
- Referee – A&A; MNRAS; Nature; New Astronomy Reviews; PRL; PASP; ApJ; ApJL; ApJS; A&C.

Selected Media

- May 14, 2025 – *AI-powered algorithm Capivara unmasks hidden structures in galaxies by analyzing their spectral fingerprints*, <https://phys.org/news/2025-05-ai-powered-algorithm-capivara-unmasks.html>
- Jul 27, 2022 – *An interview by overleaf*, <https://www.overleaf.com/blog/an-interview-with-rafael-s-de-souza>
- Aug 17, 2021 – *Astronomers Find a 'Break' in One of the Milky Way's Spiral Arms*, NASA Press Release, <https://www.nasa.gov/feature/jpl/astronomers-find-a-break-in-one-of-the-milky-way-s-spiral-arms>
- Dec 1, 2020 – *Mapping stellar nurseries in the Milky Way*, Phys.org, <https://phys.org/news/2020-12-stellar-nurseries-milky.html>

Recent Selected Talks

- 2026 – SED-based galaxy segmentation, BlueMUSE Workshop, Stockholm, Sweden.
- 2025 – Spectral-based galaxy segmentation, LSST LATAM, Mexico City, Mexico.
- 2024 – Galaxy classification at scale, Instituto Nacional de Pesquisas Espaciais (INPE), Brazil.
- 2023 – Astrostatistics and machine learning, Kavli Institute for Cosmology, Cambridge, UK.

References

- Prof. Christian Iliadis – University of North Carolina at Chapel Hill ✉ iliadis@physics.unc.edu
- Dra Emille E. O. Ishida – L'Université Clermont Auvergne ✉ emille.ishida@clermont.in2p3.fr
- Prof. Ana L. Chies-Santos – Universidade Federal do Rio Grande do Sul ✉ ana.chies@ufrgs.br
- Prof. Eric Feigelson – Penn State University ✉ e5f@psu.edu
- Prof. Alan Heavens – Imperial College London ✉ a.heavens@imperial.ac.uk
- Prof. Jogesh Babu – Penn State University ✉ babu@psu.edu

Publications

Book – Prose Awards Winner

- 1 Hilbe, J. M., **de Souza, R. S.**, & Ishida, E. E. O. (2017, May). *Bayesian Models for Astrophysical Data Using R, JAGS, Python, and Stan*, Cambridge University Press.
doi 10.1017/CBO9781316459515

Papers

- 99 **de Souza, R. S.** (2026). Powerspectr: An r package for radial power spectrum estimation. *Research Notes of the AAS*, 10(4), 80.
doi 10.3847/2515-5172/ae5b93
- 98 **de Souza, R. S.**, Wille, A., Shenoy, S., Patil, A. A., Krone-Martins, A., Chies-Santos, A. L., ... Durgesh, R. (2026). SAGUI: SED-based Segmentation of Multi-band Galaxy Images – Application to JADES in GOODS-South. *arXiv e-prints*, arXiv:2604.18812.
doi 10.48550/arXiv.2604.18812. [X:2604.18812](#)
- 97 **de Souza, R. S.**, Coelho, P., P, N., Chies-Santos, A. L., & Riffel, R. (2026b). Spectralunmix: A torch-based regularized non-negative matrix factorization. *Research Notes of the AAS*, 10(3), 56.
doi 10.3847/2515-5172/ae5107
- 96 Azevedo, G. M., Chies-Santos, A. L., Riffel, R., Perez, I., Ferrari, F., **de Souza, R. S.**, ... Bidaran, B. (2026). Galaxy interactions in void substructures: Morphology and stellar populations of two triplets from cavity. *A&A*, 706, A194.
doi 10.1051/0004-6361/202556280
- 95 Dage, K. C., Darc, P., Pessi, T., Durgesh, R., Shenoy, S., Nakazono, L., ... Tahmasebzadeh, B. (2025). AT2022zod: An Unusual Tidal Disruption Event in an Elliptical Galaxy at Redshift 0.11. *arXiv e-prints*, arXiv:2512.02136.
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doi 10.48550/arXiv.2512.15670. [X:2512.15670](#)
- 93 Schweder-Souza, N., Chies-Santos, A. L., **de Souza, R. S.**, Dage, K. C., Bonatto, C. J., Caso, J. P., ... Gschwend, J. (2025). The contribution of the color space in LSST-like photometry for the selection of extragalactic globular cluster candidates. *arXiv e-prints*, arXiv:2512.17644. [X:2512.17644](#)
- 92 **de Souza, R. S.**, & Chies-Santos, A. L. (2025). Modeling globular cluster counts with bayesian latent models. *Research Notes of the AAS*, 9(11), 293.
doi 10.3847/2515-5172/ae1973
- 91 **de Souza, R. S.**, Ishida, E. E. O., & Krone-Martins, A. (2025). A brief history of inference in astronomy. *Notices of the American Mathematical Society*, 72(10), 1137–1145. Feature article.
doi 10.1090/noti3267
- 90 Sitzia, T., Campagnaro, T., Ciolli, M., Pettenella, D., ..., **de Souza, R. S.**, & Iacopino, S. (2025). Comparing forest expansion (1930s–present) by invasive and native trees in relation to climatic, socio-economic, and landscape variables. *Ecological Indicators*, 178, 113961.
doi https://doi.org/10.1016/j.ecolind.2025.113961
- 89 Dantas, M. L. L., Smiljanic, R., Romano, D., Guiglion, G., Magrini, L., Tissera, P. B., & **de Souza, R. S.** (2025). Probing the Origins II: Unravelling Lithium Depletion and Stellar Motion: Intrinsic Stellar Properties Drive Depletion, Not Kinematics. *Astronomy & Astrophysics*, 699, A173.
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- 86 Ye, R., Shen, S., **de Souza, R. S.** Xu, Q., Chen, M., Chen, Z., Ishida, E. E. O., ... Durgesh, R. (2025). From Galaxy Zoo DECaLS to BASS/MzLS: detailed galaxy morphology classification with unsupervised domain adaption. *Monthly Notices of the Royal Astronomical Society*, 537(2), 640–649.
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- 85 Malz, A. I., Dai, M., Ponder, K. A., Ishida, E. E. O., ..., **de Souza, R. S.**, ... The Cosmostatistics Initiative. (2025). Are classification metrics good proxies for SN Ia cosmological constraining power? *A&A*, 694, A130.
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- 81 Chen, M., **de Souza, R. S.**, Xu, Q., Shen, S., Chies-Santos, A. L., Ye, R., ... Cong, Y. (2024). Galmoss: A package for GPU-accelerated Galaxy Profile Fitting. *Astronomy and Computing*, 47, 100825.
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Science Fiction

- Dec 29, 2022 – **A Journey into the Void**, Rafael S. de Souza – "Captain Jameson travels to the Great Attractor in search of answers but instead finds a Lovecraftian cosmic horror that reveals the true nature of the universe to him."
- Dec 12, 2022 – **The City of Endless Time**, Rafael S. de Souza – *In a dystopian city where time travel has revolutionized education, babies are placed into Universities and returned as adults. Still, the rapid population growth strains the city's infrastructure and leads to chaos and despair* <https://www.wattpad.com/story/329017604-the-city-of-endless-time>
- Apr 14, 2022 – **Beyond the Rainbow**, Xuenan Cao & Rafael S. de Souza – "The story reflects the daily reality of apathy, stimulant abuses, and toxic competitions." <https://www.wattpad.com/story/307604331-beyond-the-rainbow>