Rafael S. de Souza, Senior Lecturer in Data Science

Chair: The Cosmostatistics Initiative

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Professional Experience

2023 – ... **Senior Lecturer,** Centre for Astrophysics Research, University of Hertfordshire, UK.
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 **Ph.D. Astrophysics** University of Sao Paulo.
Thesis title: *Origin of Cosmic Magnetic Fields.*
Advisor: Reuven Opher.

1999 – 2004 **B.Sc. Astronomy** Federal University of Rio de Janeiro.
Thesis title: *Cosmic Acceleration*.
Advisor: Ioav Waga

Awards

2022 **Excellence in research**, by Shanghai Astronomical Observatory.
2018 **Prose Award**, Best book in Cosmology and Astronomy.
2017 **Marie Skıodowska-Curie fellowship**, by AstroFit.
2016 **International Astrostatistics Association Award**, Best paper in Astrostatistics.
2015 **MTA fellowship**, by Hungarian Academy of Sciences.
2014 **Excellence in research**, by Korean Astronomy and Space Science Institute.

Research Grants

2022 – 2025 **CAS Talents** Total amount: $800,000. [PI.] Chinese Academy of Sciences
2021 – 2024 **MESCAL:** *Multidimensional Exploration of Stellar Clusters via Automated Learning* Total amount: $32,000. [PI.] National Science Foundation of China
2017 – 2020 **Shanghai Talents** Total amount: $120,000. [PI.] Shanghai Municipality
2016 – 2017 **FAPESP Visiting Professorship** Total amount: $50,000. [PI.] University of Sao Paulo

Research Areas

Statistics	Hierarchical Bayesian Models, non-parametric regression, mixture models, likelihood-free inference, copulas, generalized linear and non-linear models, symbolic regression, spatial models, low-rank approximations, sparse models, denoising, optimal transport and information theory.
Machine Learning	Supervised, unsupervised and active learning, convolutional neural networks, variational auto-encoders, generative models, large language models, manifold learning, graph theory, information visualization.
Galactic Astrophysics	Open Clusters, young stellar objects, variable stars.
Extra-galactic Astrophysics	Extra-galactic Globular Clusters, Nuclear Star Clusters, Galaxy Evolution, IFS data.
Cosmology	Type Ia Supernova Cosmology, cosmic web, large-scale structures, cosmological simulations.
Nuclear Astrophysics	Bayesian estimation of nuclear reaction cross sections, astrophysical S-factors.

Coding Skills

- R, Python, Torch, LaTeX, Stan, JAGS, SQL, Keras, Ti*k*Z …

Science Fiction

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`

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

In the Media

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 Ways 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`

Dec 2, 2020 — *Mapeando viveros estelares en la Vía Láctea*, europapress, `https://www.europapress.es/ciencia/astronomia/noticia-mapeando-viveros-estelares-via-lactea-20201202111012.html`

In the Media (continued)

Jun 26, 2017 — *Astronomia: Computação Galáctica*, Folha de S.Paulo, https://mensageirosideral.blogfolha.uol.com.br/2017/06/26/astronomia-computacao-galactica/

Apr 28, 2015 — *As primeiras supernovas do Universo (The first supernovae in the Universe)*, Folha de S.Paulo, https://mensageirosideral.blogfolha.uol.com.br/2015/04/28/as-primeiras-supernovas-do-universo/

Professional Service

The Cosmostatistics Initiative	Chair (2014 – . . .)
International Astrostatistics Association	Vice-President (2016 – 2023)
Panel member	PhD Defense: Czech Technical University in Prague (2021), University of Sao Paulo, (2020); MS Defense: University of Lisbon (2021), University of Houston (2017)
Meetings	Scientific Organizing Committee: Annual COIN Residence Program (2014 – present); European Week of Astronomy and Space Science, Prague, Czech Republic (2017)
Journal Review	Astronomy and Astrophysics; Monthly Notices of the Royal Astronomical Society; Nature; New Astronomy Reviews; Physical Review Letters; Publications of the Astronomical Society of Australia; The Astrophysical Journal; The Astrophysical Journal Letters; The Astrophysical Journal Supplement Series; Astronomy and Computing.

(Co-) Supervision Activities

Graduate Students

MS 2022– — Mi Chen, *Project title: "Fitting galaxy profiles in GPUs"*,

MS 2021– — Quanfeng Xu, *Project title: " Low-rank factorization with GPU acceleration"*, Research packaged published.

Zhihao Mu, *Project title: "Effects of galaxy morphology on Quenching of galaxies".*

PhD 2016- 2020 — Maria Luiza Dantas, *Thesis title: "UV bright red-sequence galaxies: a comparative study between UV upturn and UV weak systems".*

Undergraduate Students

2021– — Yash Gondhalekar, *Image segmentation and masking*, Research packaged published.

Peng Chen, *Low-Rank data denosing and reconstruction*, Research packaged published.

2019, Summer — 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* $^7Be(n,p)^7Li$. Research published in peer reviewed paper. [Exchange student from University of Singapore]

2018, Summer — Yeoh Jun Kai, *Nucleosynthesis simulation visualizations.* [Exchange student from University of Singapore]

Talks

Selected Invited Talks

Jun 30, 2021	*Astrostatistics and the pathway to interdisciplinarity*, National Observatories of China Colloquium, Beijing, China
Jul 26, 2019	*The Cosmostatistics Initiative: How to Catalize Interdisciplinarity*, ESO Workshop: Artificial Intelligence in Astronomy, Garching, Germany
Sep 02, 2018	*A review of Statistical methods in the Gaia Era*XXX IAU General Assembly, Vienna, Austria
Jul 28, 2018	*A review of Generalized Linear models in Astronomy* Joint Statistical Meetings Vancouver, Canada
Jun 14, 2018	*Astrostatistics* MIAPP, The Extragalactic distance scale in the Gaia era, Munich, Germany
Jun 28, 2017	*Probabilistic Approach for Galaxy Classification*European Weak of Astronomy and Astrophysics Prague, Czech Republic
Jul 26 , 2015	*The Cosmostatistics Initiative* World Statistics Congress, Rio de Janeiro, Brazil
May 07, 2014	*Analysis of Multidimensional Astronomical Datasets* Bayes Forum-Max Planck Institute for Astrophysics, Garching, Germany
Jan 10, 2014	*Probing the Pop-III IMF* Kyung Hee University, Suwon, South-Korea
June 09, 2013	*Detectability of the Pop-III stars* Chungnam National University, Daejeon, South-Korea
April 19, 2011	*Cosmic Explosions* Hong Kong University, Clear Water Bay, Hong Kong

Selected Invited Tutorials

Dec 18 – 21 2017	*Bayesian Workshop* ESA/Estec, Noordwijk, Netherlands
Jul 12 – 13 , 2016	*Bayesian Methods for Astrophysics* Univ. Fed. Rio Grande do Sul, Porto Alegre, Brazil
May 22 – 24, 2016	*Bayesian Methods for Astrophysics* Astronomical Data Analysis Summer School, Chania, Greece

References

Prof. Christian Iliadis	University of North Carolina at Chapel Hill	iliadis@physics.unc.edu
Prof. Eric Feigelson	Penn State University	e5f@psu.edu
Prof. Alan Heavens	Imperial College London	a.heavens@imperial.ac.ukw
Prof. Jogesh Babu	Penn State University	babu@psu.edu
Prof. Ricardo Vilalta	University of Houston	vilalta@cs.uh.edu
Prof. Benedetta Ciardi	Max Planck Institute for Astrophysics	ciardi@mpa-garching.mpg.de

Publications

Citations: ∼ 2700
h-index: 30 i10 index: 46

Books

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

Journal Articles

81 Kuhn, M. A., Hillenbrand, L. A., Connelley, M. S., Rich, R. M., Staels, B., Carvalho, A. S., … Kasliwal, M. M. (2024). The 2022-2023 accretion outburst of the young star V1741 Sgr. MNRAS, *529*(3), 2630–2646.
10.1093/mnras/stae205. :2401.09522

80 Zanatta, E. J. B., Sanchéz-Janssen, R., **de Souza, R. S.**, Chies-Santos, A. L., & Blakeslee, J. P. (2024). NSCs from groups to clusters: A catalogue of dwarf galaxies in the Shapley Supercluster and the role of environment in galaxy nucleation. *arXiv e-prints*, arXiv:2403.14847. :2403.14847

79 Xu, Q., Shen, S., **de Souza, R. S.**, Chen, M., Ye, R., She, Y., … Durgesh, R. (2023). From Images to Features: Unbiased Morphology Classification via Variational Auto-Encoders and Domain Adaptation. MNRAS, *526*(4), 6391–6400.
10.1093/mnras/stad3181. :2303.08627

78 Azevedo, G. M., Chies-Santos, A. L., Riffel, R., Gomes, J. M., Lassen, A. E., Benedetti, J. P. V., … Xu, Q. (2023). Spatially resolved self-consistent spectral modelling of jellyfish galaxies from MUSE with FADO: trends with mass and stripping intensity. MNRAS, *523*(3), 4680–4692.
10.1093/mnras/stad1641. :2306.00049

77 Malz, A. I., Dai, M., Ponder, K. A., Ishida, E. E. O., Gonzalez-Gaitain, S., Durgesh, R., … Cosmostatistics Initiative, T. (2023). Are classification metrics good proxies for SN Ia cosmological constraining power? *arXiv e-prints*, arXiv:2305.14421.
10.48550/arXiv.2305.14421. :2305.14421

76 Kuhn, M. A., Benjamin, R. A., Ishida, E. E. O., **de Souza, R. S.**, Peloton, J., & Veneri, M. D. (2023). Repeating Outbursts from the Young Stellar Object Gaia23bab (=SPICY 97589). *Research Notes of the American Astronomical Society*, *7*(3), 57.
10.3847/2515-5172/acc4c9. :2303.09409

75 Dálya, G., Bleuzé, S., Bécsy, B., **de Souza, R. S.**, & Szalai, T. (2023). Constraining Supernova Physics through Gravitational-Wave Observations. *arXiv e-prints*, arXiv:2302.11480.
10.48550/arXiv.2302.11480. :2302.11480

74 Kuhn, M. A., Saber, R., Povich, M. S., **de Souza, R. S.**, Krone-Martins, A., Ishida, E. E. O., … Zhou, X. (2023). Spectroscopic Confirmation of a Population of Isolated, Intermediate-mass Young Stellar Objects. AJ, *165*(1), 3.
10.3847/1538-3881/ac9314. :2206.04090

73 Biswas, B., Ishida, E. E. O., Peloton, J., Moller, A., Pruzhinskaya, M. V., **de Souza, R. S.**, & Muthukrishna, D. (2023). Enabling the discovery of fast transients: A kilonova science module for the Fink broker. *A&A*, *677*, A77.
10.1051/0004-6361/202245340

72 S. de Souza, R., Thorp, S., Galbany, L., E. O. Ishida, E., González-Gaitán, S., Schmitz, M., … Peters, C. (2023). A graph-based spectral classification of type ii supernovae. *Astronomy and Computing*, *44*, 100715.
https://doi.org/10.1016/j.ascom.2023.100715

71 Iliadis, C., Palanivelrajan, V., & **de Souza, R. S.** (2022). Bayesian Estimation of the S Factor and Thermonuclear Reaction Rate for ^{16}O(p,γ)^{17}F. Phys. Rev. C, *106*, 055802.
10.1103/PhysRevC.106.055802

70 Zhang, Y., **de Souza, R. S.**, & Chen, Y.-C. (2022). Sconce: A cosmic web finder for spherical and conic geometries. MNRAS, *517*(1), 1197–1217.
10.1093/mnras/stac2504. :2207.07001

69 Chies-Santos, A. L., **de Souza, R. S.**, Caso, J. P., Ennis, A. I., de Souza, C. P. E., Barbosa, R. S., … Angulo, R. E. (2022). J-PLUS: A catalogue of globular cluster candidates around the M81/M82/NGC3077 triplet of galaxies. MNRAS, *516*(1), 1320–1338.
10.1093/mnras/stac2002. :2202.11472

68 Kuhn, M. A., Hillenbrand, L. A., Connelley, M. S., Karambelkar, V. R., Fremling, C., Lee, E., … Ishida, E. E. O. (2022). Photometric and spectroscopic evidence for the EX Lup nature of the ongoing outburst from V1741 Sgr. *The Astronomer's Telegram*, *15721*, 1.

67 Dálya, G., Díaz, R., Bouchet, F. R., Frei, Z., Jasche, J., Lavaux, G., … Raffai, P. (2022). Glade+: An extended galaxy catalogue for multimessenger searches with advanced gravitational-wave detectors. MNRAS, *514*(1), 1403–1411.
10.1093/mnras/stac1443. :2110.06184

66 Delli Veneri, M., **de Souza, R. S.**, Krone-Martins, A., Ishida, E. E. O., Dantas, M. L. L., & Kennamer, N. (2022). How have astronomers cited other fields in the last decade? *Research Notes of the AAS*, *6*(6), 113.
10.3847/2515-5172/ac74c7

65 Gondhalekar, Y., **de Souza, R. S.**, & Chies-Santos, A. L. (2022). galmask: A Python package for unsupervised galaxy masking. *Research Notes of the AAS*, *6*(6), 128.
10.3847/2515-5172/ac780b. :2206.06787

64 Chen, P., & **de Souza, R. S.** (2022b). Yonder: A python package for data denoising and reconstruction. *Research Notes of the AAS*, *6*(3), 51.
10.3847/2515-5172/ac5c57

63 **de Souza, R. S.**, Quanfeng, X., Shen, S., Peng, C., & Mu, Z. (2022b). Qrpca: A package for fast principal component analysis with gpu acceleration. *Astronomy and Computing*, *41*, 100633.
https://doi.org/10.1016/j.ascom.2022.100633

62 Villarroel, B., Pelckmans, K., Solano, E., Laaksoharju, M., Souza, A., Dom, O. N., … Ward, M. J. (2022). Launching the vasco citizen science project. *Universe*, *8*(11).
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61 Moscoso, J., **de Souza, R. S.**, Coc, A., & Iliadis, C. (2021). Bayesian Estimation of the D(p,γ)^{3}He Thermonuclear Reaction Rate. ApJ, *923*(1), 49.
10.3847/1538-4357/ac1db0. :2109.00049

60 Zanatta, E. J. B., Sánchez-Janssen, R., Chies-Santos, A. L., **de Souza, R. S.**, & Blakeslee, J. P. (2021). A high occurrence of nuclear star clusters in faint Coma galaxies, and the roles of mass and environment. *Monthly Notices of the Royal Astronomical Society*, *508*(1), 986–998.
10.1093/mnras/stab2348

59 Kuhn, M. A., **de Souza, R. S.**, Krone-Martins, A., Castro-Ginard, A., Ishida, E. E. O., Povich, M. S., & Hillenbrand, L. A. (2021). SPICY: The Spitzer/IRAC Candidate YSO Catalog for the Inner Galactic Midplane. ApJS, *254*(2), 33.
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10.1093/mnras/staa3204. :2005.08583

57 **de Souza, R. S.**, Krone-Martins, A., Carruba, V., Domingos, R. C., Ishida, E. E. O., Aljbaae, S., … Barletta, W. (2021). Probabilistic modeling of asteroid diameters from gaia dr2 errors. *Res. Notes AAS*, *5*, 199.
https://doi.org/10.3847/2515-5172/ac205e

56 **de Souza, R. S.**, & S. Berger, G. (2021). Fallopian tube anatomy predicts pregnancy and pregnancy outcomes after tubal reversal surgery. *Statistical Methods in Medical Research*, *30*(8), 2004–2014. PMID: 34232836.
10.1177/09622802211023543

55 Feigelson, E. D., **de Souza, R. S.**, Ishida, E. E. O., & Jogesh Babu, G. (2021). 21st Century Statistical and Computational Challenges in Astrophysics. *Annual Review of Statistics and Its Application*, *8*(1), 493–517.
10.1146/annurev-statistics-042720-112045

54 Kuhn, M. A., Benjamin, R. A., Zucker, C., Krone-Martins, A., **de Souza, R. S.**, Castro-Ginard, A., … Hillenbrand, L. A. (2021). A high pitch angle structure in the sagittarius arm. *A&A*, *651*, L10.
10.1051/0004-6361/202141198

53 Molino, A., Costa-Duarte, M. V., Sampedro, L., Herpich, F. R., Sodré, J., L., Mendes de Oliveira, C., … Abramo, L. R. (2020). Assessing the photometric redshift precision of the S-PLUS survey: the Stripe-82 as a test-case. MNRAS.
10.1093/mnras/staa1586. :1907.06315

52 **de Souza, R. S.**, Kiat, T. H., Coc, A., & Iliadis, C. (2020). Hierarchical Bayesian Thermonuclear Rate for the ^{7}Be(n,p)^{7}Li Big Bang Nucleosynthesis Reaction. *The Astrophysical Journal*, *894*(2), 134.
10.3847/1538-4357/ab88aa

51 Dantas, M. L. L., Coelho, P. R. T., **de Souza, R. S.**, & Gonçalves, T. S. (2020). UV bright red-sequence galaxies: how do UV upturn systems evolve in redshift and stellar mass? MNRAS, *492*(2), 2996–3011.
10.1093/mnras/stz3609. :1908.06775

50 Boucaud, A., Huertas-Company, M., Heneka, C., Ishida, E. E. O., Sedaghat, N., **de Souza, R. S.**, … Collaboration COIN. (2020). Photometry of high-redshift blended galaxies using deep learning. MNRAS, *491*(2), 2481–2495.
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49 Villarroel, B., Soodla, J., Comerón, S., Mattsson, L., Pelckmans, K., López-Corredoira, M., … Ward, M. J. (2020). The Vanishing and Appearing Sources during a Century of Observations Project. I. USNO Objects Missing in Modern Sky Surveys and Follow-up Observations of a Missing Star. AJ, *159*(1), 8.
10.3847/1538-3881/ab570f

48 Kennamer, N., Ishida, E. E. O., Gonzalez-Gaitan, S., **de Souza, R. S.**, Ihler, A. e., Ponder, K., … Galbany, L. (2020). Active learning with resspect: Resource allocation for extragalactic astronomical transients. *2020 IEEE Symposium Series on Computational Intelligence (SSCI)*, 3115–3124.
10.1109/SSCI47803.2020.9308300

47 Mendes de Oliveira, C., Ribeiro, T., Schoenell, W., Kanaan, A., Overzier, R. A., Molino, A., … et al., d. (2019). The Southern Photometric Local Universe Survey (S-PLUS): improved SEDs, morphologies and redshifts with 12 optical filters. MNRAS, *489*, 241–267.
10.1093/mnras/stz1985. :1907.01567

46 Moews, B., & **de Souza, R. S.** and Ishida, E. E. O. and Malz, A. I. and Heneka, C. and Vilalta, R. and Zuntz, J. (2019). Stress testing the dark energy equation of state imprint on supernova data. *Phys. Rev. D*, *99*, 123529.
10.1103/PhysRevD.99.123529

45 Cantat-Gaudin, T., Krone-Martins, A., Sedaghat, N., Farahi, A., **de Souza, R. S.**, R. S., … Trindade, A. M. M. (2019). Gaia DR2 unravels incompleteness of nearby cluster population: new open clusters in the direction of Perseus. *A&A*, *624*, A126.
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44 Hattab, M. W., **de Souza, R. S.**, Ciardi, B., Paardekooper, J.-P., Khochfar, S., & Dalla Vecchia, C. (2019). A case study of hurdle and generalized additive models in astronomy: the escape of ionizing radiation. MNRAS, *483*, 3307–3321.
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43 **de Souza, R. S.**, Iliadis, C., & Coc, A. (2019a). Astrophysical S-factors, thermonuclear rates, and electron screening potential for the ^{3}He(d,p)^{4}He. *ApJ*, *872*(1), 75.
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41 González-Gaitán, **de Souza, R. S.**, Krone-Martins, A., Cameron, E., Coelho, P., Galbany, L., … for the COIN collaboration. (2019). Spatial field reconstruction with INLA: Application to IFU galaxy data. MNRAS, *482*(3), 3880–3891.
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40 Ishida, E. E. O., Beck, R., Gonzalez-Gaitan, S., **de Souza, R. S.**, Krone-Martins, A., Barrett, J. W., … for the COIN collaboration. (2019). Optimizing spectroscopic follow-up strategies for supernova photometric classification with active learning. MNRAS, *483*(1), 2–18.
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39 Dálya, G., Galgóczi, G., Dobos, L., Frei, Z., Heng, I. S., Macas, R., … **de Souza, R. S.** (2018). GLADE: A galaxy catalogue for multimessenger searches in the advanced gravitational-wave detector era. MNRAS, *479*, 2374–2381.
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37 Vilalta, R., Ishida, E. E. O., Beck, R., Sutrisno, R., **de Souza, R. S.**, & Mahabal, A. (2017). Photometric redshift estimation: An active learning approach. *2017 IEEE Symposium Series on Computational Intelligence (SSCI)*, 1–8.
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10.1109/SSCI.2016.7849951

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doi 10.1093/mnras/stw1459. ⌘:1603.06256

31 Sasdelli, M., Ishida, E. E. O., Vilalta, R., Aguena, M., Busti, V. C., Camacho, H., … Mazzali, P. A. (2016). Exploring the spectroscopic diversity of Type Ia supernovae with DRACULA: a machine learning approach. MNRAS, *461*, 2044–2059.
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29 **de Souza, R. S.**, Hilbe, J. M., Buelens, B., Riggs, J. D., Cameron, E., Ishida, E. E. O., … Killedar, M. (2015). The overlooked potential of generalized linear models in astronomy - III. Bayesian negative binomial regression and globular cluster populations. MNRAS, *453*, 1928–1940.
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27 **de Souza, R. S.**, & Ciardi, B. (2015a). AMADA-Analysis of multidimensional astronomical datasets. *Astronomy and Computing*, *12*, 100–108.
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