PHELIPE DARC

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Keywords: Multi-messenger astronomy, Gravitational waves, Kilonovae, Time-domain astronomy, Simulation-based inference, Machine learning

EDUCATION

Centro Brasileiro de Pesquisas Físicas (CBPF) — Rio de Janeiro, Brazil — Sep. 2023 – (Anticipated) May 2027
Ph.D. in Physics (advisor: Clecio R. Bom)

Centro Brasileiro de Pesquisas Físicas (CBPF) — Rio de Janeiro, Brazil — Mar. 2022 – Aug. 2023
M.Sc. in Physics (advisor: Clecio R. Bom)
Thesis: *The Use of Deep Learning for Automated Transient Identification*

Universidade Federal do Rio de Janeiro (UFRJ) — Rio de Janeiro, Brazil — Jan. 2017 – Oct. 2021
B.Sc. in Physics

RESEARCH EXPERIENCE

Positions

CIERA, Northwestern University | Visiting Researcher (host: C. D. Kilpatrick) — Dec. 2025 – May 2026

- Developed `KilonovaSCORER` for kilonova candidate ranking in the TROVE GW follow-up program.
- Contributed to `TEGLON`: code refactoring, documentation, AGN-host searches for BBH mergers, efficiency analysis.

LAB-IA, CBPF | Research Scientist (graduate student since Mar. 2022) — Jun. 2026 – present

- Lead developer of `WHISPER`, an agentic AI system for LSST transient prioritization and bulk bayesian model comparison on GPUs.
- Simulation-based inference for kilonova and GRB afterglow modeling (NeurIPS ML4PS 2023, 2024).
- Scaling Relations from Neutron Star Merger Simulations with Symbolic Regression (NeurIPS ML4PS 2025).
- Supernova Type I/II spectral classifier (1D CNN + BiLSTM).
- Contributed to the dark-siren H_0 analysis and to the ADSS and AI-Scope platforms.

LNCC + Lemobs | Research Intern — Jan. 2022 – Aug. 2023

- Used BERTimbau (Portuguese-BR BERT) classifier for phrases describing medical conditions.

Instituto de Física, UFRJ | Undergraduate Researcher (CNPq-funded) — Jan. 2018 – Aug. 2021

- Quasars as standard candles via X-ray–UV luminosity relation; cosmological parameters from SNe Ia with MCMC.

Collaborations

ARANDU | Science Team Member — May. 2026 – present

- Alert broker for Roman time-domain science (PIs: A. Mahabal, C. R. Bom).

TROVE | Science Team Member — Dec. 2025 – present

- Tool for Rapid Object Vetting and Examination (integrated `KilonovaSCORER` into TROVE)

COIN (Cosmostatistics Initiative) | Member — Sep. 2025 – present

- Co-led an archival ZTF search for IMBH tidal disruption events in star-cluster hosts: broker cross-matching, alert filtering, visual inspection, theoretical modeling and Bayesian model comparison (2 papers submitted to PASP).
- Contributed to the SAGUI galaxy-segmentation project.

Rubin LSST TVS Science Collaboration | Member — Mar. 2025 – present

- Contributed to two collaboration white papers on AI for time-domain astronomy: conceptualization, pipeline design, writing and review.

FINK Broker | Member Oct. 2023 – present

- Ran GPU processing of broker alerts at CBPF with the CATS light-curve classifier.

DESGW Collaboration | Member Dec. 2022 – Aug. 2023

- Developed and integrated a CNN real/bogus classifier into the search pipeline; real-time candidate vetting in O4.

S-PLUS Collaboration (STEP) | Member Jun. 2022 – present

- Led the long-term T80-South follow-up of the BBH events S231206cc and S240413p: AGN-prioritized observing, candidate visual inspection, spectroscopic SMBH-mass estimates, flare modeling and detection-efficiency analysis.
- Developed DeepSTEP, a deep-learning transient identifier.

OBSERVING EXPERIENCE

T80-South (S-PLUS/STEP) | transient search and GW follow-up observations 2022 – present
NEWFIRM near-infrared imager | NEWFIRM Infrared Survey for Transients 2025 – present
SOAR/Goodman | spectroscopy for S240413p 2025 – present

PRESENTATIONS & TALKS

Invited Talk | AAS2027 – Optimizing the search for electromagnetic counterparts to gravitational wave events with TEGLON, Salt-lake city, USA Jan. 2027 (scheduled)
Invited Talk | SAMBA – Symbolic AI and Machine Learning in Baixada Santista, Santos, Brazil Nov. 2026
Talk | 21st S-PLUS Collaboration Meeting, Paraty, Brazil Aug. 2026
Invited Talk | ICTP Advanced School on Uncertainty and Robustness of DL Models for Science, Trieste: Intelligent Agents and Physical Modeling of Explosive Transients in the Rubin Era Jul. 2026
Poster | ICTP Advanced School on Uncertainty and Robustness of DL Models for Science, Trieste: *Intelligent Agents and Physical Modeling of Transients in the Rubin Era* (Best Poster Award) Jul. 2026
Talk | Scientific AI for Physics Workshop Nov. 2025
Talk | Annual Meeting of the Brazilian Astronomical Society (SAB) Oct. 2025
Poster | NeurIPS 2025, ML4PS Workshop, San Diego, USA Dec. 2025
Poster | NeurIPS 2024, ML4PS Workshop, Vancouver, Canada Dec. 2024
Contributed Talk | CBPF Annual Academic Meeting, Rio de Janeiro Nov. 2024
Talk | FINK Brazil meeting: *Simulation-based inference applied to Kilonova SED modeling* May 2024
Poster | NeurIPS 2023, ML4PS Workshop, New Orleans, USA Dec. 2023
Talk | CBPF Artificial Intelligence Workshop, Rio de Janeiro Dec. 2023
Talk | Dark Energy Survey Fall Collaboration Meeting (DESGW workshop) Oct. 2023
Poster | XLVI Annual Meeting of the Brazilian Astronomical Society (SAB) Oct. 2023
Talk | São Paulo Advanced School on Multi-Messenger Astrophysics May 2023
Talk | XVI Computational Modeling Conference, LNCC Jun. 2022

PUBLICATIONS

Refereed | 11 papers, 4 first-author (ApJ, ApJL, PRD, PASP, MNRAS, Astron. Comput.)
Workshop papers | 3 first-author, peer-reviewed (NeurIPS ML4PS) 2023 – 2025
Other | 5 submitted (2 second-author), 2 in preparation, 8 GCN Circulars
Citations | 128 , h-index 7 (Google Scholar); full list on the following pages 2023 – 2026

DEVELOPED SOFTWARE & COMPUTATIONAL SKILLS

Software | `WHISPER` (lead), `KilonovaSCORER` (lead), `DeepSTEP` (lead), `TEGLON` (contributor), AI-Scope and ADSS (contributor)
Methods | Simulation-based inference (NPE, NLE, sequential-NPE), MCMC, nested sampling, deep learning, symbolic regression, Agentic-AI, foundational model
Tools | Python, JAX, PyTorch, TensorFlow/Keras, scikit-learn, XGBoost, GPU computing

TEACHING & MENTORING

Research mentor | Lilian Rodrigues, undergraduate, LAB-IA/CBPF: ML for difference-imaging artifact removal — May 2026 – present

Teaching Assistant | Digital Signal Processing and Experimental Modern Physics, UFRJ — Feb. – Dec. 2020

Teaching Assistant | Physics classes for visiting high-school students and school visits, LADIF, UFRJ — Feb. 2019 – Mar. 2020

PUBLIC OUTREACH

Science Communicator | Annual Meetings of SBPC: Belém, PA (2024); 77th, Recife, PE (2025, 64 h) — 2024 – 2025

Science Communicator | LITCOM-AI / LAB-IA educational science videos — Dec. 2024 – present

Science Communicator | Semana Nacional de Ciência e Tecnologia (MCTI), Brasília, representing CBPF — Nov. 2024

PUBLICATION LIST

∗ Selected publications

First-author, refereed

- **Darc**, **P.**, Bom, C. R., Santos, A., Panda, S., Rodríguez-Ramírez, J. C., Kilpatrick, C. D., Mendes de Oliveira, C., Kanaan, A., Ribeiro, T., and Schoenell, W. (Aug. 2026). "Searching for Binary Black Hole Merger Emission in AGN Disks: Optical and Spectroscopic Follow-up of S240413p". In: Phys. Rev. D 114, p. 043039. DOI: 10.1103/1c1b-d4m1. arXiv: 2603.26972.

- ∗ **Darc**, **P.** and Kilpatrick, C. D. (Aug. 2026). "`KilonovaSCORER`: Prior-predictive Scoring of Kilonovae for Real-time Multimessenger Follow-up". In: PASP 138.8, p. 084502. DOI: 10.1088/1538-3873/ae8e00. arXiv: 2604.22994.

- ∗ **Darc**, **P.**, Bom, C. R., Kilpatrick, C. D., Souza Santos, A., Fraga, B., Rodríguez-Ramírez, J. C., Coulter, D. A., Mendes de Oliveira, C., Kanaan, A., Ribeiro, T., Schoenell, W., and Lacerda, E. A. D. (Sept. 2025). "Long-term Optical Follow-up of S231206cc: Multimodel Constraints on BBH Merger Emission in AGN Disks". In: Phys. Rev. D 112, p. 063019. DOI: 10.1103/6rg8-2xxz. arXiv: 2506.02224.

- ∗ **Darc**, **P.**, Bom, C. R., Fraga, B., and Kilpatrick, C. D. (Aug. 2024). "Kilonova Spectral Inverse Modelling with Simulation-based Inference: An Amortized Neural Posterior Estimation Analysis". In: ApJ 971.1, p. 82. DOI: 10.3847/1538-4357/ad53c7. arXiv: 2311.09471.

Co-authored, refereed

- Coulter, D. A., **P. Darc**, Kilpatrick, C. D., Foley, R. J., McGill, P., Wyatt, S. D., and Hausen, R. (Oct. 2026). "`Teglon`: A Pixel-level Pipeline for Galaxy-Informed Gravitational-wave Follow-up Planning and Efficiency Analysis". In: Publications of the Astronomical Society of the Pacific 138.10, p. 104507. DOI: 10.1088/1538-3873/aead23. URL: http://dx.doi.org/10.1088/1538-3873/aead23.

- Vieira, N., Franz, N., Subrayan, B., et al. (Aug. 2026). "Search for a Counterpart to the Subsolar Mass Gravitational-wave Candidate S251112cm". In: ApJ 1007.2, p. 116. DOI: 10.3847/1538-4357/ae877c. arXiv: 2603.17009. (**Darc, P.**: 14th of 52 authors).

- de Souza, R. S., Wille, A., Shenoy, S., Patil, A. A., Krone-Martins, A., Chies-Santos, A. L., Boehm, C., Rosa, R. R., Pessi, T., Ishida, E. E. O., Dage, K. C., Nakazono, L., **Darc**, **P.**, and Durgesh, R. (June 2026). "SAGUI: SED-based Segmentation of Multiband Galaxy Images – Application to JADES in GOODS-South". In: MNRAS 549.4. DOI: 10.1093/mnras/stag1062. arXiv: 2604.18812.

- Teixeira, G., Kilpatrick, C. D., Bom, C. R., Santos, A., **Darc**, **P.**, Auchettl, K., Álvarez-Candal, Á., Foley, R. J., Humire, P. K., Piro, A. L., Rojas-Bravo, C., Mendes de Oliveira, C., Kanaan, A., Ribeiro, T., and Schoenell, W. (Feb. 2026). "SN 2022acko and the Properties of Its Red Supergiant Progenitor: Direct Detection, Light Curves, and Nebular Spectroscopy". In: ApJ 998.1, p. 123. DOI: 10.3847/1538-4357/ae27a0.

- Franz, N., Subrayan, B., Kilpatrick, C. D., et al. (Nov. 2025). "Optimizing Kilonova Searches: A Case Study of the Type IIb SN 2025ulz in the Localization Volume of the Low-significance Gravitational Wave Event S250818k". In: ApJL 994.2, p. L45. DOI: 10.3847/2041-8213/ae17a8. (**Darc, P.**: 17th of 57 authors).

- Bom, C. R., Alfradique, V., Palmese, A., Teixeira, G., Santana-Silva, L., Santos, A., and **Darc**, **P.** (Oct. 2024). "A Dark Standard Siren Measurement of the Hubble Constant Following LIGO/Virgo/KAGRA O4a and Previous Runs". In: MNRAS 535.1, pp. 961–975. DOI: 10.1093/mnras/stae2390.

- Santos, A., Kilpatrick, C. D., Bom, C. R., **Darc**, **P.**, Herpich, F. R., Lacerda, E. A. D., Sartori, M. J., Alvarez-Candal, A., Mendes de Oliveira, C., Kanaan, A., Ribeiro, T., and Schoenell, W. (Feb. 2024). "The S-PLUS Transient Extension Program: Imaging Pipeline, Transient Identification, and Survey Optimization for Multimessenger Astronomy". In: MNRAS 529.1, pp. 59–73. DOI: 10.1093/mnras/stae466.

- Teixeira, G., Bom, C. R., Santana-Silva, L., Fraga, B. M. O., **Darc**, **P.**, Teixeira, R., Wu, J. F., Ferguson, P. S., Martínez-Vázquez, C. E., Riley, A. H., Drlica-Wagner, A., Choi, Y., Mutlu-Pakdil, B., Pace, A. B., Sakowska, J. D., and Stringfellow, G. S. (2024). "Photometric Redshifts Probability Density Estimation from Recurrent Neural Networks in the DECam Local Volume Exploration Survey Data Release 2". In: Astronomy and Computing, p. 100886. DOI: 10.1016/j.ascom.2024.100886.

First-author workshop papers (NeurIPS ML4PS, peer-reviewed)

- **Darc**, **P.**, Bom, C. R., Kilpatrick, C. D., Fraga, B. M. O., and Teixeira, G. S. M. (Dec. 2025). "Symbolic Regression Is All You Need: From Simulations to Scaling Laws in Binary Neutron Star Mergers". In: *Machine Learning and the Physical Sciences Workshop, 39th Conference on Neural Information Processing Systems (NeurIPS 2025)*. arXiv: 2511.08784.

- **Darc**, **P.**, Bom, C. R., Teixeira, G., Kilpatrick, C. D., Sherman, N., Portes de Albuquerque, M., and Russano, P. (Dec. 2024). "Multi-Wavelength Analysis of Kilonova Associated with GRB 230307A: Accelerated Parameter Estimation and Model Selection Through Likelihood-Free Inference". In: *Machine Learning and the Physical Sciences Workshop, 38th Conference on Neural Information Processing Systems (NeurIPS 2024)*. URL: https://openreview.net/forum?id=IkeW6z9t2d.

- **Darc**, **P.**, Bom, C. R., Fraga, B. M. O., and Kilpatrick, C. D. (Dec. 2023). "Simulation Based Inference of BNS Kilonova Properties: A Case Study with AT2017gfo". In: *Machine Learning and the Physical Sciences Workshop, 37th Conference on Neural Information Processing Systems (NeurIPS 2023)*. URL: https://neurips.cc/virtual/2023/76182.

Submitted / preprints

- Bom, C. R., Fraga, B. M., Sabogal, M. A., Bernui, A., **Darc**, **P.**, and Schwarz, G. (June 2026). "Physics-guided Discovery of Dynamical Dark-Energy Equations of State through Iterative AI Reasoning". arXiv: 2606.19427.

- Bom, C. R., Mahabal, A., Bianco, F., and **Darc**, **P.** (June 2026). "Toward Decision-aware AI for LSST-scale Time-domain Astronomy". arXiv: 2606.05285. (Rubin LSST Transients and Variable Stars Science Collaboration white paper; 28 authors).

- Dage, K. C., Durgesh, R., Kovács-Stermeczky, Z. V., Shenoy, S., **Darc**, **P.**, Pessi, T., Nakazono, L., Pessi, P. J., Sett, S., Kar Chowdhury, R., Boehm, C., Chies-Santos, A. L., de Souza, R. S., Ishida, E. E. O., Krone-Martins, A., Patil, A. A., Rosa, R. R., and Wille, A. (2026). "ZTF Constraints on Tidal Disruption Events in 100,000 Local Volume Star Clusters". submitted to PASP. (for the COIN collaboration).

- Dage, K. C., **Darc**, **P.**, Pessi, T., Durgesh, R., Shenoy, S., Nakazono, L., Boehm, C., Chies-Santos, A. L., de Souza, R. S., Kovacs-Stermeczky, Z. V., Bahramian, A., Bidaran, B., Ishida, E. E. O., Krone-Martins, A., Patil, A. A., Rosa, R. R., Wille, A., Plotkin, R. M., and Tahmasebzadeh, B. (Dec. 2025). "A Search for Intermediate Mass Black Hole Tidal Disruption Events in Globular Clusters with the Zwicky Transient Facility". submitted to PASP. arXiv: 2512.02136.

In preparation

- **Darc**, **P.** et al. (2026). "GPU accelerated Bayesian Model Comparison of the ZTF Bright Transient Survey with `WHISPER`". in preparation.

- Rubin LSST Transients and Variable Stars Science Collaboration (2026). "Artificial Intelligence Across Time-Domain Astronomy: The Rubin LSST Transients and Variable Stars Science Collaboration Perspective". in preparation. (incl. **Darc, P.**: pipeline design, writing, review).

GCN Circulars

- Santos, A., Bom, C. R., Kilpatrick, C. D., Santana-Silva, L., **Darc**, **P.**, Teixeira, G., Mendes de Oliveira, C., and STEP Collaboration (Jan. 2026). "GRB260114A: STEP/T80S optical limits". In: GCN Circ. 43416.

- Santos, A., Bom, C. R., Kilpatrick, C. D., Santana-Silva, L., **Darc**, **P.**, Teixeira, G., Mendes de Oliveira, C., and STEP Collaboration (Aug. 2025). "EP250827a: STEP/T80S Confirmation of fading optical counterpart". In: GCN Circ. 41580.

- Santos, A., Bom, C. R., Kilpatrick, C. D., Santana-Silva, L., **Darc**, **P.**, Teixeira, G., Mendes de Oliveira, C., and STEP Collaboration (Aug. 2025). "GRB250812a: STEP/T80S Indication of slow decay of afterglow". In: GCN Circ. 41346.

- Santos, A., Bom, C. R., Kilpatrick, C. D., Santana-Silva, L., **Darc**, **P.**, Teixeira, G., Mendes de Oliveira, C., and STEP Collaboration (Aug. 2025). "LIGO/Virgo/Kagra S250818k: STEP/T80N upper limits on 2025ulz". In: GCN Circ. 41501.

- Santos, A., Bom, C. R., Kilpatrick, C. D., Santana-Silva, L., **Darc**, **P.**, Teixeira, G., Mendes de Oliveira, C., and STEP Collaboration (Mar. 2025). "GRB250322A: STEP/T80S optical limits". In: GCN Circ. 39847.

- Santos, A., Santana-Silva, L., Bom, C. R., Kilpatrick, C. D., **Darc**, **P.**, Mendes de Oliveira, C., and STEP Collaboration (Aug. 2024). "EP240807a: STEP/T80S optical limits". In: GCN Circ. 37108.

- Santos, A., Bom, C. R., Kilpatrick, C. D., Santana-Silva, L., **Darc**, **P.**, Mendes de Oliveira, C., and STEP Collaboration (June 2024). "EP240617a: STEP/T80S optical limits". In: GCN Circ. 36707.
- Bom, C. R., Santos, A., Kilpatrick, C. D., Santana-Silva, L., **Darc**, **P.**, Mendes de Oliveira, C., and STEP-GW Collaboration (Apr. 2024). "LIGO/Virgo/KAGRA S240413p: STEP - T80S Search and Candidate Counterpart Identification". In: GCN Circ. 36146.

Thesis

- **Darc**, **P.** (Aug. 2023). "The Use of Deep Learning for Automated Transient Identification". M.Sc. thesis. Rio de Janeiro, Brazil: Centro Brasileiro de Pesquisas Físicas (CBPF). URL: https://phelipedarc.github.io/files/ThesisPhelipe.pdf.