Leonardo (Leo) Rosa Werneck

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Professional Summary

Versatile computational astrophysicist with extensive experience in developing and enhancing state-of-the-art numerical codes for simulating compact object mergers, nuclear astrophysics, and multi-messenger signals. Proven track record of spearheading innovative projects, collaborating in multi-institutional research, mentoring graduate students, and securing research funding. Expertise includes general relativistic magnetohydrodynamics, neutrino transport, nuclear reactions, and critical phenomena in gravitational collapse. Research results published in top-tier journals and presented at prestigious scientific conferences.

Highlights

- Led development of major extensions to IllinoisGRMHD, enabling state-of-the-art simulations of compact object systems relevant to nuclear astrophysics.
- Key contributor to the HandOff code, enabling seamless data transfer from the Einstein Toolkit to HARM3D+NUC for physically accurate and long-duration post-merger simulations, critical for studying nucleosynthesis and multi-messenger signals.
- Pivotal role in research on dynamical ejecta from binary neutron star mergers, contributing to the understanding of kilonova and other astrophysical transients.
- Major contributor to the design and development of the GRHayL library, extracting core algorithms from IllinoisGRMHD to create a versatile, infrastructure-agnostic solution.
- Led development of neutrino leakage code NRPyLeakage and currently mentoring students on ongoing development of a M1 closure neutrino transport code.
- Key member of the TCAN collaboration led by Prof. Manuela Campanelli, bridging research from multiple research group across elite US institutions.
- While in a postdoctoral role, secured research funding as Institutional PI for a NASA award exceeding \$640 000, showcasing leadership and the ability to fund and manage large-scale research projects.
- Demonstrated cross-disciplinary adaptability through development of RETINAS, a CUDA-ready real-time image analysis code used by collaborators at Montana State University for high-precision measurements of the gravitational constant G and other fundamental physics experiments.

Education & Research Experience

Postdoctoral Researcher University of Idaho — Moscow, ID, USA	**2021–Present**
Postdoctoral Researcher West Virginia University — Morgantown, WV, USA	**2020–2021**
Visiting Scholar West Virginia University — Morgantown, WV, USA	**2019–2020**

Ph.D. in Computational Astrophysics
University of São Paulo — São Paulo, SP, Brazil
    Advisor: Elcio Abdalla
    Thesis: Aspects of Numerical Relativity: Scalar Fields and Neutron Stars
	July 17, 2020

M.Sc. in Mathematical Physics
University of São Paulo — São Paulo, SP, Brazil
    Advisor: Victor O. Rivelles
  Dissertation: A Gauge Theory for Continuous Spin Particles
	2016

B.Ed. in Physics University of São Paulo — São Paulo, SP, Brazil	**2013**

Peer-Reviewed Publications

Prefix denotes citations in INSPIRE-HEP (⋆: 1–5; ⋆⋆: 6–10; ⋆⋆⋆: 11–15; ⋆⋆⋆⋆: 16–20)

[1] ⋆ Y. Zenati, J. H. Krolik, **L. R. Werneck**, Z. B. Etienne, S. C. Noble, A. Murguia-Berthier, and J. D. Schnittman, *"The Dynamics of Debris Disk Creation in Neutron Star Mergers,"* Astrophys. J. **971**, no.1, 50, arXiv: 2404.03156 [astro-ph.HE] (**2024**).

[2] **L. R. Werneck**, C. Jessup, A. Brandenberger, T. Knowles, C. W. Lewandowski, M. Nolan, K. Sible, Z. B. Etienne, and B D'Urso, *"Cross-correlation image analysis for real-time single particle tracking,"* Rev. Sci. Instrum. **95**, 073708, arXiv: 2310.08770 [physics.optics] (**2024**).

[3] ⋆ Y. Zenati, J. H. Krolik, **L. R. Werneck**, A. Murguia-Berthier, Z. B. Etienne, S. C. Noble and T. Piran, *"Bound Debris Expulsion from Neutron Star Merger Remnants,"* Astrophys. J. **958**, no.2, 161, arXiv: 2306.09464 [astro-ph.HE] (**2023**).

[4] ⋆⋆⋆⋆ **L. R. Werneck**, Z. B. Etienne, A. Murguia-Berthier, R. Haas, F. Cipolletta, S. C. Noble, L. Ennoggi, F. G. L. Armengol, B. Giacomazzo and T. Assumpção, *et al.* *"Addition of tabulated equation of state and neutrino leakage support to IllinoisGRMHD,"* Phys. Rev. D **107**, no.4, 044037, arXiv: 2208.14487 [gr-qc] (**2023**).

[5] ⋆⋆ F. G. L. Armengol, Z. B. Etienne, S. C. Noble, B. J. Kelly, **L. R. Werneck**, B. Drachler, M. Campanelli, F. Cipolletta, Y. Zlochower and A. Murguia-Berthier, *et al.* *"Handing off the outcome of binary neutron star mergers for accurate and long-term postmerger simulations,"* Phys. Rev. D **106**, no.8, 083015, arXiv: 2112.09817 [astro-ph.HE] (**2022**).

[6] ⋆⋆ T. Assumpcao, **L. R. Werneck**, T. P. Jacques and Z. B. Etienne, *"Fast hyperbolic relaxation elliptic solver for numerical relativity: Conformally flat, binary puncture initial data,"* Phys. Rev. D **105**, no.10, 104037, arXiv: 2111.02424 [gr-qc] (**2022**).

[7] ⋆ **L. R. Werneck**, Z. B. Etienne, E. Abdalla, B. Cuadros-Melgar and C. E. Pellicer, *"NRPyCritCol & SFcollapse1D: an open-source, user-friendly toolkit to study critical phenomena,"* Class. Quant. Grav. **38**, no.24, 245005, arXiv: 2106.06553 [gr-qc] (**2021**).

[8] ⋆⋆⋆⋆ A. Murguia-Berthier, S. C. Noble, L. F. Roberts, E. Ramirez-Ruiz, **L. R. Werneck**, M. Kolacki, Z. B. Etienne, M. Avara, M. Campanelli and R. Ciolfi, *et al.* *"HARM3D+NUC: A New Method for Simulating the Post-merger Phase of Binary Neutron Star Mergers with GRMHD, Tabulated EOS, and Neutrino Leakage,"* Astrophys. J. **919**, no.2, 95, arXiv: 2106.05356 [astro-ph.HE] (**2021**).

Preprints

[9] T. P. Jacques, S. Cupp, **L. R. Werneck**, S. D. Tootle, M. C. B. Hamilton, Z. B. Etienne, *"GRoovy: A General Relativistic Hydrodynamics Code for Dynamical Spacetimes with Curvilinear Coordinates, Tabulated Equations of State, and Neutrino Physics,"* *Submitted to Phys. Rev. D.* arXiv: 2412.03659 [astro-ph.HE] (**2024**).

[10] M. D. Duez, C. L. Cadenhead, Z. B. Etienne, B. J. Kelly, and **L. R. Werneck**, *"Toward 2D Dynamo Models Calibrated by Global 3D Relativistic Accretion Disk Simulations,"* *Submitted to Phys. Rev. D.* arXiv: 2404.03156 [astro-ph.HE] (**2024**).

Technical Skills

Programming Languages
Proficient: C, Python
Competent: C++, CUDA, Fortran, Shell Scripting
Familiar: Julia, Mathematica, Matlab

High Performance Computing
Competent: OpenMP, MPI, Slurm, PBS, Spack, conda

UNIX CLI Tools
Competent: git, ssh, awk, sed, grep
Familiar: gdb, valgrind, autoconf, automake, CMake, Meson

Operating Systems & Document Editing
Proficient: Linux, OS X, Windows, LaTeX/Overleaf, Google Workspace, Microsoft Office, Apple iWork

SOFTWARE DEVELOPMENT

IllinoisGRMHD[1]	**2019–Present**

Core developer & maintainer
Einstein Toolkit thorn providing GRMHD for dynamical spacetimes.
– Documented entire code in pedagogical Jupyter notebooks.
– Added support for finite-temperature, microphysical equation of state tables.

Einstein Toolkit[2]	**2019–Present**

Contributor & maintainer
A community-driven software platform of core computational tools to support
research in relativistic astrophysics and gravitational physics.

GRHayL[3]	**2023–Present**

Core developer & maintainer
An open-source, modular, infrastructure agnostic GRMHD library.

NRPy+[4]	**2019–Present**

Core developer & maintainer
Python-based C code generator for Numerical Relativity and beyond.

NRPyLeakage[5]	**2022–Present**

Core developer & maintainer
NRPy+-based neutrino leakage code.
– Lead developer of Einstein Toolkit thorn version of the code, NRPyLeakageET.

NRPyElliptic[6]	**2021–Present**

Core developer & maintainer
Extensible NRPy+-based elliptic solver for Numerical Relativity initial data.
– Lead developer of Einstein Toolkit thorn version of the code, NRPyEllipticET.

NRPyCritCol[7]	**2019–Present**

Lead developer & maintainer
User-friendly, well-documented NRPy+-based code to study critical phenomena.

SFcollapse1D[8]	**2018–Present**

Lead developer & maintainer
C++ code to study critical phenomena of a massless scalar field in 1D.

RETINAS[9]	**2021–Present**

Lead developer & maintainer
CUDA-ready image analysis code for real-time single particle tracking.

[1]: https://github.com/IllinoisGRMHD
[2]: http://einsteintoolkit.org
[3]: https://github.com/GRHayL
[4]: https://nrpyplus.net
[5]: https://github.com/IllinoisGRMHD
[6]: http://github.com/assumpcaothiago/NRPyElliptic
[7]: https://github.com/zachetienne/nrpytutorial
[8]: https://github.com/leowerneck/SFcollapse1D
[9]: https://github.com/leowerneck/RETINAS

GRANTS & FELLOWSHIPS

Institutional Principal Investigator: *Gravitational-Wave Signatures of Massive Black Hole Formation*, NASA LISA Preparatory Science Program.	**2023–Present**

Total funding: **$644,836**; **$78,298** to L. Werneck

Ph.D. Fellowship, CAPES, Brazil	**2016–2020**

Awarded a highly competitive fellowship for top applicants to the Ph.D. program.

M.Sc. Fellowship, CAPES, Brazil	**2013–2016**

Awarded a highly competitive fellowship for top applicants to the M.Sc. program.

Undergraduate Research Fellowship, CNPq, Brazil	**2011–2013**

Awarded a competitive research fellowship for qualified undergraduate students.

Distinguished Talks

2024
- Invited talk, *From Microspheres to Supermassive Stars: An overview of the University of Idaho's Numerical Relativity group's research*, Idaho National Laboratory, ID, USA.
- Invited talk, North American Einstein Toolkit Summer School, *Direct Collapse Black Holes: Gravitational Wave Signatures of Massive Black Hole Formation*, Louisiana State University, LA, USA.
- Selected talk, APS April Meeting, *Binary Neutron Star Mergers on a Moving Mesh*, SAFE Credit Union Convention Center, Sacramento, CA.

2023
- Invited talk, INT 23-2: Astrophysical Neutrinos and the Origin of the Elements, *GRHayL: An Opensource, Modular, Extensible GRMHD Library*, Institute for Nuclear Theory, Seattle, WA.
- Invited talk, North American Einstein Toolkit Summer School, *Tutorial: Einstein Toolkit Simulation Analysis*, Rochester Institute of Technology, NY, USA.
- Selected talk, APS April Meeting, *IllinoisGRMHD: Recent Developments and Future Plans*, Hilton Minneapolis, Minneapolis, MN.

2022
- Invited talk, North American Einstein Toolkit "Working Workshop", *An introduction to NRPy+*, University of Illinois at Urbana-Champaign, IL, USA.
- Invited talk, North American Einstein Toolkit Summer School, *Accurate, long-term binary neutron stars simulations with IllinoisGRMHD and HARM+NUC*, University of Idaho, ID, USA.
- Selected talk, APS April Meeting, *Accurate, long-term binary neutron stars simulations with IllinoisGRMHD and HARM+NUC*, New York Marriott Marquis, NY, USA.

2021
- Poster presentation, Midwest Relativity Meeting, *IllinoisGRMHD+HARM3D: Next-generation binary neutron stars simulations*, University of Illinois at Urbana-Champaign, IL, USA.
- Invited talk, North American Einstein Toolkit Summer School, *NRPy+ tutorial: Maxwell's equations in flat space & ET thorn generation*, University of Illinois at Urbana-Champaign, IL, USA (online event).
- Invited talk, TCAN on BNS Workshop, *IllinoisGRMHD progress update—advanced, tabulated equation of state support,*, Rochester Institute of Technology, NY, USA (online event).
- Selected talk, APS April Meeting, *New, user-friendly codes to study critical collapse*, online event.

2020
- Invited talk, TCAN on BNS Workshop, *IllinoisGRMHD progress update—piecewise polytropic equation of state support,*, Rochester Institute of Technology, NY, USA (online event).

Community Involvement

APS April Meeting Session Chair	**2024–Present**
Peer-review	**2023–Present**
Physical Review D and *Classical and Quantum Gravity*	
College of Science Tailgate Event	**2022–Present**
Physics booth interactive demonstrator, Moscow, ID, USA.	

2023
- Manager for the Einstein Toolkit May 2023 release (codename "Karl Schwarzschild").
- M.Sc. committee member for Joaquín E. L. Salazar, UNIFEI, Brazil (online participation).
- Idaho Science & Engineering Fair, *Natural Sciences & Best in Fair Judge*, Moscow, ID, USA.

2022
- North American Einstein Toolkit Summer School, *Member of Scientific & Local Organizing Committees*, University of Idaho, ID, USA.
- First Einstein Toolkit Hackaton, *NRPy+ mentor; documented several thorns*, online event.

MENTORING

Johnny Tsao, Ph.D. Student — University of Texas at Austin   **2024–Present**
    Moment-based neutrino radiation transport code for the ET.

David Boyer, Ph.D. Student — University of Idaho   **2023–Present**
    TOV solver and moment-based neutrino radiation transport code, both for the ET.

Terrence Pierre Jacques, Ph.D. Student — West Virginia University   **2020–Present**
    GRoovy, a GRHD code in curvilinear coordinates, used in an upcoming publication.

Thiago Assumpção, Ph.D. Student — West Virginia University   **2020–2024**
    NRPyElliptic, a numerical relativity initial data code discussed in Pub. [5].

Gabriel M. Steward, Ph.D. Student — University of Idaho   **2022–2023**
    General Relativity, Numerical Relativity, and a drop-in replacement for GSL's ODE solver.

Federico G. L. Armengol, Ph.D. Student — Rochester Institute of Technology   **2021–2022**
    The HandOff code, discussed in [4].

Lucas Pereira Francisco, Undergraduate Student — University of São Paulo, Lorena   **2020–2021**
    Guided student on how to use SFcollapse1D for their senior thesis.

Amanda Sato, Undergraduate Student — University of São Paulo, Lorena   **2020–2021**
    Guided student on how to use SFcollapse1D for their senior thesis.

TEACHING EXPERIENCE

Engineering Physics III (Phys 213), University of Idaho   **Spring 2024**
– Fluids, waves, oscillations, thermodynamics, and geometric optics.
– Class of 25 students.

Experimental Physics I,[*] University of São Paulo   **1st Semester, 2017–2020**
– Significant figures, uncertainty, various experiments.
– Class of 24–30 students, divided in groups of three.

Experimental Physics II,[*] University of São Paulo   **2nd Semester, 2017–2018**
– Propagation of uncertainty, various experiments.
– Class of 24–30 students, divided in groups of three.

Introduction to Experimental Physics,[*] University of São Paulo   **2nd Semester, 2016**
– Significant figures, uncertainty, various experiments.
– Class of 24–30 students, divided in groups of three.

Substitute Lecturer
– Relativistic Astrophysics (Phys 404/504), University of Idaho   **2024**
– Numerical Methods (Phys 428/528), University of Idaho   **2023**
– General Physics I (Phys 111), University of Idaho   **2022**
– Oscillations and Thermal Physics (Phys 212), West Virginia University   **2020**

Teaching Assistant
– Statistical Data Analysis in Experimental Physics, University of São Paulo   **2016**
– Electricity and Magnetism, University of São Paulo   **2011, 2012**

[*] Course taught in Portuguese as a Ph.D. student, under supervision of a professor.

REFERENCES

1. **Prof.** Zachariah B. Etienne
   Department of Physics
   University of Idaho
   Email: zetienne@uidaho.edu
   Phone: +1 (208) 885-1206
2. **Prof.** Elcio Abdalla (**thesis advisor**)
   Department of General Physics
   University of São Paulo
   Email: eabdalla@if.usp.br
   Phone: +55 (11) 3091-7036
3. **Prof.** Julian H. Krolik
   W.H. Miller III Dept. of Physics & Astronomy
   Johns Hopkins University
   Email: jhk@jhu.edu
   Phone: +1 (410) 516-7926
4. **Prof.** Manuela Campanelli
   School of Mathematics and Statistics
   Rochester Institute of Technology
   Email: manuela@astro.rit.edu
   Phone: +1 (585) 475-7752