

Jesús M. Rueda-Becerril — Ph.D.

Astrophysicist – Data Scientist

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Profile

I am a trained astrophysicist with a strong background in programming, data science, and problem-solving, bringing analytical rigor and innovation to both scientific and industry settings. With expertise in debugging, testing, and maintaining complex code, I have extensive experience working with Python, Fortran, C/C++, Shell, R, and SQL, as well as managing version control systems like Git. My proficiency in high-performance computing (HPC), data analysis, machine learning, and statistical modeling allows me to tackle challenging problems efficiently. A highly adaptable and effective communicator in both English and Spanish, I thrive in both independent and collaborative environments.

Education

Ph.D. in Physics

Universitat de València, Spain

ADVISOR: Prof. Miguel A. Aloy & Dr. Petar Mimica.

THESIS: *Numerical treatment of radiation processes in the internal shocks of magnetized relativistic outflows*

Oct. 2011 – Jul. 2017

Excellent *cum laude*.

M.Sc. in Physics

Universidad Michoacana de San Nicolás de Hidalgo, Mexico

ADVISOR: Prof. José A. Cervera

THESIS: *Study of TOV stars with the SPH method*

Aug. 2009 – Sep. 2011

B.Sc. in Physics

Universidad Autónoma del Estado de México, Mexico

ADVISOR: Prof. Francisco S. Guzmán

THESIS: *Numerical solution of null geodesics for the generation of gravitational lenses produced by spherically-symmetric and static spacetimes*

Aug. 2004 – Dec. 2008

“Dr. Juan Josafat Pichardo” Award

Experience

Spatial Data Scientist

May 2025 — Present

TealWaters

- Lead project to optimize code for topographic terrain modeling and elevation derivative calculation.
- Engineered Python tools for geospatial data processing and analysis, utilizing QGIS for visualization and analysis.
- Utilize Wetland Intrinsic Potential (WIP) tool with random forest for wetland probability mapping in Skykomish watershed.
- Performed EDA, feature engineering, and geospatial data preparation—including multispectral (Sentinel 1/2) processing—for ML/AI land-cover and wetland probability models.
- Share knowledge and results with managers and decision-makers, train team members on WIP tool usage, and collaborate with software engineers and scientific team to transition prototypes into production.

Independent Research/Open-Source Developer

Jan 2024 — May 2025

- Developed scientific codes (Tleco, WindsOfChange), completed ML/AI coursework, and contributed to open-source geospatial and scientific-computing tools.

Software Engineer (Remote)

Apr 2022 – Jan 2024

Paychex, Rochester NY, USA; based in Seattle, WA, USA

- Conducted data preparation, validation, and analysis in SQL from Oracle EBS datasets.
- Developed Java Kafka consumers for the streamlined transfer of large volumes of client data across databases. Developed high quality code using Java, Spring Boot, Kafka, PL/SQL, and deployed into production using Jenkins and OpenShift, following software development best practices.
- Collaborated with stakeholders, other software developers and engineers, and senior leadership to assess product needs and meet code standards for continuous integration model.
- Created Splunk dashboards and alerts for analysis of production data.
- Developed and deployed Python tests to ensure software quality and continuous integration.

Postdoctoral Research Associate

Feb 2021 – Apr 2022

Rochester Institute of Technology, Rochester, NY, USA

- Led a team of specialists on a NSF-sponsored project to upgrade the C code **PatchworkMHD** to perform HPC simulations using state-of-the-art numerical techniques to model supermassive black hole binaries.
- Implemented a new feature (black hole spin) to **PatchworkMHD**, making more realistic binary black hole simulations without impacting runtime.
- Designed the experiments and evaluated state-of-the-art mathematic and numerical algorithms implemented in **PatchworkMHD** by running simulations at *Frontera* supercomputer (TACC, UT at Austin).
- Worked in a detail-oriented manner to successfully benchmark and identify performance optimization opportunities of the scientific code.
- Mentored and collaborated with a graduate student to apply the machine learning algorithm *gradient descent* to adjust the parameters of the open-source code, **Paramo**, to classify observations of blazars (extra-galactic objects) from Fermi-LAT telescope.
- Participated in a multi-institutional collaboration to study binary Neutron Star mergers through HPC simulations, resulting in 2 publications that provided critical breakthrough insights of the physics underlying these events.
- Published 3 co-authored papers and mentored graduate students (2 Ph.D.).

Postdoctoral Research Fellow

Oct 2018 – Nov 2020

Purdue University, West Lafayette, IN, USA

- Developed the open-source code, **Paramo**, a numerical code in Fortran 95 optimized with OpenMP to perform radiative transfer simulations in relativistic astrophysics scenarios.
- Obtained and led a NASA grant to explain the origin and nature of radiation from active galaxies (blazars) using numerical and statistical models for objects observed with NASA Fermi-LAT space telescope. This research helped to unify our understanding of the two main types of blazars, identifying that important physical constraints applied to both objects.
- Developed Python tools to calculate the loss of energy due of high-energy particles due to interactions spectrum and evolution in the context of gamma-ray burst afterglows by developing sophisticated numerical integration, and OpenMP optimized features to **Paramo**.
- Collaborated with a group of multidisciplinary scientists to develop Python scripts for statistically modeling the COVID-19 outbreak in Mexico and helped create scientific infographics and blogposts for Spanish-speaking populations to reduce the spread of misinformation.
- Published 1 first-author and 1 co-authored paper and mentored three graduate students (1 M.S. and 2 Ph.D.).

Postdoctoral Research Fellow

Jan – Sep 2018

Universidad Michoacana de San Nicolás de Hidalgo, Morelia, Michoacan, Mexico

- Developed a Python script that would process images of spinning black holes simulations from the numerical code **GRTrans** to provide an SVM with training data that would later predict radio images of actual black holes.
- Developed an open-source data analysis and visualization tool in Python to provide any user with accessible tools to calculate radiative transfer phenomena (spectra and light-curves) in relativistic astrophysics.
- Organized a workshop to train graduate students in the use of the high-volume data storage tool HDF5.

Graduate Research Assistant

Oct 2011 – Jul 2017

Universitat de València, Burjassot, Valencia, Spain

- Independently developed Shell and Python scripts to build pipelines to run simulation of the radiative transfer code C-SPEV and perform data processing of output datasets in HDFS format, ensuring data quality and integrity for downstream analysis and model fit with observations.
- Developed Python scripts to perform exploratory data analysis on datasets from NASA Fermi-LAT telescope and from the Very Large Baseline Array (VLBA) of the National Radio Astronomy Observatory (NRAO), and build non-linear regression models.
- Independently constructed models from C-SPEV simulations for curve fitting, pattern recognition, and prediction of data from NASA telescopes.
- Conducted multiple analyses to identify patterns in spectra and light-curves that allowed the quantification of magnetization of plasma in blazars.
- Conducted an analysis that identified the importance of including both cyclotron and synchrotron radiation from non-relativistic to ultra-relativistic charged particles in blazar simulations.
- Implemented sophisticated numerical tools and data handling to C-SPEV that could calculate both discrete and continuous spectra from particle distributions with arbitrary shape, without impacting simulation runtime.
- Published 2 first-author papers.

Skills

Programming Languages: Fortran, Python, Shell, C/C++, R, Java, Julia, SQL (PL/SQL, PostgreSQL), Rust, HTML, Markdown, MongoDB

Python Ecosystem: Numpy, Pandas, Matplotlib, Scipy, Astropy, Scikit-learn, Tensorflow, PyTorch, Pytest, Jupyter

Miscellaneous: Git (GitHub, Bitbucket), L^AT_EX, MPI, OpenMP, OpenACC, HDF5, Mathematica, Maple, Docker, Jenkins, Splunk, Jira, Kafka, Visit, Paraview, Job Scheduling (SLURM, PBS)

Publications

Articles

- [9] Davis, Z., **Rueda-Becerril, J. M.**, & Giannios, D. *Tleco: A Toolkit for Modeling Radiative Signatures from Relativistic Outflows*, *ApJ* **976**, 182, (2024), [arXiv:2405.17581](https://arxiv.org/abs/2405.17581).
- [8] Davis, Z., **Rueda-Becerril, J. M.**, & Giannios, D. *Balancing Turbulent Heating with Radiative Cooling in Blazars*, *MNRAS* **513**, 5766–5779, (2022), [arXiv:2201.07790](https://arxiv.org/abs/2201.07790).
- [7] Lopez-Armengol, F. G., Etienne, Z. B., [...], **Rueda-Becerril, J. M.**, [...] *Handing off the outcome of binary neutron star mergers for accurate and long-term postmerger simulations*, *Phys. Rev. D* **106**, 083015, (2022), [arXiv:2112.09817](https://arxiv.org/abs/2112.09817)
- [6] Murguia-Berthier, A., Noble, S., [...], **Rueda-Becerril, J. M.**, [...] *HARM3D+NUC: A New Method for Simulating the Post-merger Phase of Binary Neutron Star Mergers with GRMHD, Tabulated EOS, and Neutrino Leakage*, *ApJ* **919**, 95, (2021), [arXiv:2106.05356](https://arxiv.org/abs/2106.05356)
- [5] **Rueda-Becerril, J. M.**, Harrison, A. O. & Giannios, D. *Blazar jets launched with similar energy per baryon, independently of their power*, *MNRAS* **501**, 4092–4102, (2021), [arXiv:2009.02273](https://arxiv.org/abs/2009.02273).
- [4] Zhang, H., Christie, I., Petropoulou, M., **Rueda-Becerril, J. M.** & Giannios, D. *Inverse Compton Signatures of Gamma-Ray Burst Afterglows*, *MNRAS* **496**, 974–986, (2020), [arXiv:1910.14049](https://arxiv.org/abs/1910.14049).
- [3] **Rueda-Becerril, J. M.**, Mimica, P. & Aloy, M. A. *On the influence of a hybrid thermal–non-thermal distribution in the internal shocks model for blazars*, *MNRAS* **468**, 1169–1182, (2017), [arXiv:1612.06383](https://arxiv.org/abs/1612.06383).
- [2] **Rueda-Becerril, J. M.**, Mimica, P. & Aloy, M. A. *The influence of the magnetic field on the spectral properties of blazars*, *MNRAS* **438**, 1856–1869 (2014), [arXiv:1310.5441](https://arxiv.org/abs/1310.5441).
- [1] Guzmán, F. S. & **Rueda-Becerril, J. M.** *Spherical boson stars as black hole mimickers*, *Phys. Rev. D* **80**, 084023 (2009), [arXiv:1009.1250](https://arxiv.org/abs/1009.1250).

Proceedings.....

5. Rueda-Becerril, J. M. *A numerical approach for radiative cooling in relativistic outflows*, *Astron. Nachr.*, 9th International Workshop on Astronomy and Relativistic Astrophysics: from Quarks to Cosmos **342**, 277–282, (2021), arXiv:2011.13797.
4. Rueda-Becerril, J. M., Harrison, A. O. & Giannios, D. *The blazar sequence revised*, *Astron. Nachr.*, 9th International Workshop on Astronomy and Relativistic Astrophysics: from Quarks to Cosmos **342**, 147–152, (2021), arXiv:2011.13805.
3. Rueda-Becerril, J. M., Mimica, P. & Aloy, M. A. *Numerical simulations of the internal shock model in magnetized relativistic jets of blazars*, *PoS(SWIFT 10)* **233**, 159 (2014), arXiv:1502.07882.
2. Rueda-Becerril, J. M., Mimica, P., Aloy, M. A. & Aloy, C. *Numerical study of broadband spectra caused by internal shocks in magnetized relativistic jets of blazars*, *EPJ Web Conf.* **61**, 02007 (2013), arXiv:1309.4612.
1. Mimica, P., Aloy, M. A., Rueda-Becerril, J. M., Tabik, S. & Aloy, C. *Numerical simulations of dynamics and emission from relativistic astrophysical jets*, *J. Phys.: Conf. Ser.* **42**, 012001 (2013), arXiv:1211.1794.

Research Grants

NASA Fermi Cycle-12 Guest Investigator Program Grant #121077
A simple model to understand the blazar sequence, PI: Giannios, D., Co-I: Rueda-Becerril, J. M. 2019

Grants and Fellowships

Oct. 2018 – Nov. 2020: Fellowship from the Mexican Federal Government for international postdoctoral studies awarded by the National Council of Science and Technology (CONACyT).

Jan. – Sep. 2018: Fellowship from the Mexican Federal Government under the *Program for the Professional Development of Higher Education Institutions*, awarded by the Secretariat of Public Education.

Sep. 2014 – Aug. 2016: Fellowship from the Mexican Federal Government to study abroad awarded by the National Council of Science and Technology (CONACyT).

Oct. 2011 – Jun. 2014: Fellowship *Santiago Grisolía* awarded by the Council of Education, Research, Culture and Sport of the Valencian Community, Spain.

Sep. 2009 – Aug. 2011: Fellowship for MSc studies at the Institute of Physics and Mathematics, Universidad Michoacana de San Nicolás de Hidalgo, granted by the Mexican Council of Science and Technology (CONACyT).

Jun. – Aug. 2007: Fellowship for a temporary stay (3 months) in a national research center under the *XVII summer of scientific investigation program* awarded by the Mexican Academia of Science.

Projects

WindsOfChange Aug 2024 — May 2025
Open Source Code for Spore Dispersion in Hilly Terrains GitHub

- Simulate spore dispersion in hilly terrains using R and C++.

Tleco Jan 2024 — Sep 2024
Open Source Code for Relativistic Particle Radiation Simulation GitHub

- Simulates relativistic plasma particles and radiation rise from accelerating particles.
- Combines Rust and Python functions from the Fortran code **Paramo**.

Paramo Oct 2018 — Apr 2022
Open Source Code for Radiative Transfer in Relativistic Astrophysics GitHub

- Built an HPC-optimized radiative-transfer simulation code (OpenMP; 60× speedup).
- Applied ML techniques (gradient descent) for parameter optimization and implemented Python tools for analysis.
- Used in 5 scientific publications.

Co-Founder, Mexican Scientists Abroad Aug 2019 — Feb 2021
Group of Mexican Scientists bridging science and public knowledge Homepage

- Collaborated on Python scripts for [COVID-19 modeling and forecasting](#) in Mexico.
- Authored [blogposts](#) and [infographics](#) to combat misinformation.

Awards

Marcos Moshinsky Award: for *Best Poster* presented at the IWARA 2020 Video Conference, Mexico City, 6 – 12 September 2020.

Lic. Juan Josafat Pichardo Cruz Award: for finishing and defending a licentiate thesis within a year after completing the undergraduate credits, granted by the Universidad Autónoma del Estado de México, 2009.

Invited Talks

The Role of Machine Learning in Environmental Science

Seminar on Climate Change Ecology, University of Washington, Seattle, WA, USA, March, 2024

Morphology of the spectra from numerical simulations of the internal shocks model for blazars

Astrophysics Seminar, Purdue University, West Lafayette, IN, USA, February 4, 2019

Numerical simulations of the internal shocks model in magnetized relativistic jets of blazars

DATA group weekly Seminar, Instituto de Astronomía, UNAM, Mexico City, Mexico, June 19, 2018

Numerical treatment of non-thermal radiation in the internal shocks model for blazars

Weekly Seminar, Instituto de Física y Matemáticas, Morelia, Mexico, March 2, 2018

Numerical simulations of the internal shock model in magnetized relativistic jets of blazars

IVICFA's Fridays: Computation in Physics, IFIC, Paterna, Spain, October 17, 2014

Meetings and conferences

Contributed Talks.....

Simulations of supermassive binary black holes accretion dynamics in the spinning case

APS April Meeting 2022, New York City, NY, April 9–12, 2022

A numerical approach to the Klein-Nishina corrections of radiative cooling in relativistic outflows

APS April Meeting 2021, April 17–20, 2021

The blazar sequence revised

9th International Workshop on Astronomy and Relativistic Astrophysics, Video Conference, September 6–12, 2020

<https://www.youtube.com/watch?v=BAZNWLNT69M>

Influence of the magnetic field on the spectral properties of blazars in the internal shocks scenario

Extreme-Astrophysics in an Ever-Changing Universe, Ierápetra, Greece, June 16–20, 2014

Numerical study of broadband spectra caused by internal shocks in magnetized relativistic jets

XXXIV Biennial meeting of the Royal Spanish Society of Physics, Valencia, Spain, July 15–19, 2013

Poster Sessions.....

A numerical approach for radiative cooling in relativistic outflows

9th International Workshop on Astronomy and Relativistic Astrophysics, Video Conference, September 6–12, 2020

Marcos Moshinsky Award for Best Poster. <https://www.youtube.com/watch?v=OTJiKg7kOPI>

Numerical simulations of the internal shock model in magnetized relativistic jets of blazars

Swift: 10 years of Discovery, Rome, Italy, December 2–5, 2014

Numerical study of broadband spectra caused by internal shocks in magnetized relativistic jets

The Innermost Regions of Relativistic Jets and Their Magnetic Fields, Granada, Spain, June 10–14, 2013

Teaching & Mentoring Experience

Zachary Davis [8, 9]

Graduate student, Department of Physics and Astronomy, Purdue University

Mentoring

2018 – 2022

Amanda O. Harrison [5]

Graduate student, Department of Physics and Astronomy, Purdue University

Mentoring

2018 – 2020

Hao Zhang [4]	Mentoring
<i>Graduate student, Department of Physics and Astronomy, Purdue University</i>	<i>2018 – 2019</i>
Thermodynamics (Graduate Level)	Guest Lecturer
<i>Instituto de Física y Matemáticas, Universidad Michoacana de San Nicolás de Hidalgo</i>	<i>Jun 2018</i>

Professional Development

High Performance Computing on Frontera	<i>Lecture</i>
<i>Jason Allison et al., TACC, Austin, TX, USA, May 20, 27 and June 3, 2021</i>	
Writing Winning Grants	<i>Lecture</i>
<i>Dr. Lauren Broyles, Purdue University, West Lafayette, IN, USA, November 7, 2019</i>	
XSEDE HPC Workshop: Summer Boot Camp	<i>Workshop</i>
<i>John Urbanic, Purdue University, West Lafayette, IN, USA, June 3 – 6, 2019</i>	
Data Analysis and Machine Learning with Python	<i>Workshop</i>
<i>Dr. Alejandro Torres, Universitat de València, Burjassot, Spain, February 7 – 16, 2017</i>	
Numerical Relativity Simulations of BBH Coalescence Using the Einstein Toolkit	<i>Workshop</i>
<i>Dr. Vassilios Mewes, Universitat de València, Burjassot, Spain, July 6 – 7, 2016</i>	
No. of hours: 8	
The Universe in the Light of PLANCK and BICEP2	
<i>Prof. Nick Mavromatos, Universitat de València, Burjassot, Spain, May 23 – 16, 2014</i>	<i>Lecture series</i>
No. of credits: 2	
Dark Matter	
<i>Prof. Alejandro Ibarra, Universitat de València, Burjassot, Spain, September 23 – 27, 2013</i>	<i>Lecture series</i>
No. of credits: 2	
International Cagèse School on Cosmic Accelerators	
<i>Institut d'Études Scientifiques de Cargèse, Cargèse, France, April 23 – May 8, 2013</i>	<i>Summer school</i>
Introduction to C++ Programming	
<i>Dr. Jacek Generowicz, Universitat de València, Burjassot, Spain, April 9 – 12, 2012</i>	<i>Workshop</i>
No. of credits: 6	
Numerical Relativistic Astrophysics	
<i>Prof. Luciano Rezzolla, Universitat de València, Burjassot, Spain, March 27 – April 4, 2012</i>	<i>Lecture series</i>
No. of hours: 9	
Fortran for Scientific Computing	
<i>HLRS, University of Stuttgart, Stuttgart, Germany, Mar. 5 – 9, 2012</i>	<i>Workshop</i>
No. of hours: 33	

Certifications and Credentials

Gen AI Intensive	Kaggle
<i>Generative AI</i>	
Data Scientist Professional with Python	DataCamp
<i>Python Programming, Data Science, Data Communication, Machine Learning</i>	
Machine Learning Scientist with Python	DataCamp
<i>Machine Learning, NLP, Deep Learning, Image Processing, Big Data</i>	
Mathematical Foundations of Machine Learning	Udemy
<i>Python Programming, Data Science, Statistics, Machine Learning</i>	
Python for Statistical Analysis	Udemy
<i>Python Programming, Data Science, Data Communication, Machine Learning</i>	

Outreach

Los más rápidos y los más furiosos (The Fastest and the Most Furious)	Online talk
<i>Community of Undergraduate Physics Students, Juárez Autonomous University of Tabasco</i>	<i>September 4, 2020</i>

Tabasco, Mexico

Una simulación de la física y la astrofísica (*A Simulation of Physics and Astrophysics*)

*Community of Undergraduate Physics Students, Juárez Autonomous University of Tabasco
Tabasco, Mexico*

Online talk

August 14, 2020

ANITA y la teoría de los universos paralelos (*ANITA and the Theory of Parallel Universes*)

Científicos Mexicanos en el Extranjero, mexiciencia.github.io/post/anita

Blog post

May 29, 2020

¿Qué es el modelo SIR? (*What is the SIR Model?*)

Científicos Mexicanos en el Extranjero, mexiciencia.github.io/post/modelo-sir

Blog post

May 25, 2020

Evolución del brote epidémico de COVID-19 (*Evolution of the COVID-19 Epidemic Outbreak?*)

Científicos Mexicanos en el Extranjero, mexiciencia.github.io/post/covid19

Blog post

April 5, 2020

Collaborator with the data analysis/modeling

Annual Department of Physics and Astronomy Poster Event

Department of Physics and Astronomy, Purdue University

West Lafayette, IN, USA

Posters (3) presentation

November 13, 2019

Post-Doc Panel Q&A: What Happens When we Complete our PhDs?

Department of Physics and Astronomy, Purdue University

West Lafayette, IN, USA

Panelist

April 10, 2019

Annual Department of Physics and Astronomy Poster Event

Department of Physics and Astronomy, Purdue University

West Lafayette, IN, USA

Poster presentation

November 14, 2018

¿Decía Einstein la verdad? (Was Einstein Telling the Truth?)

Facultad de Ciencias, Universidad Autónoma del Estado de México

Toluca, Mexico

Talk

March 11, 2009

Synergetic Activities

X Scientific Meeting of the Spanish Astronomical Society

Organizing contributor, 14–16 December, 2012

Valencia, Spain

Other activities

Aug 2007– May 2009: Representative of the Physics students community at the Governing Council of the Faculty of Sciences of the Universidad Autónoma del Estado de México.

Languages

Spanish: Native proficiency

English: Full professional proficiency

Catalan: Intermediate