

Jesús M. Rueda-Becerril — Ph.D.

Astrophysicist – Data Scientist – ML Engineer

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Education

Ph.D. in Physics

Universitat de València, Spain

Oct. 2011 – Jul. 2017

Excellent *cum laude*.

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

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

M.Sc. in Physics

Universidad Michoacana de San Nicolás de Hidalgo, Mexico

Aug. 2009 – Sep. 2011

ADVISOR: Prof. José A. Cervera

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

B.Sc. in Physics

Universidad Autónoma del Estado de México, Mexico

Aug. 2004 – Dec. 2008

“Dr. Juan Josafat Pichardo” Award

ADVISOR: Prof. Francisco S. Guzmán

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

Experience

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

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

Miscellaneous: Git (GitHub, Bitbucket), \LaTeX , 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](#).
- [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](#).
- [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](#)

- [6] Murguía-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](#)
- [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](#).
- [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](#).
- [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](#).
- [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](#).
- [1] Guzmán, F. S. & **Rueda-Becerril, J. M.** *Spherical boson stars as black hole mimickers*, *Phys. Rev. D* **80**, 084023 (2009), [arXiv: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 Grisolia* 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

Wind and Spores

Aug 2024 – Present

Open Source Code for Dispersion of Spores in Hilly Terrains

[GitHub](#)

- Simulate the dispersion of spores in hilly terrains in R and C++.

Tleco

Jan 2024 – Sep 2024

Open Source Code for Simulation of Relativistic Particles Radiation

[GitHub](#)

- Tleco stands for both *in the fire* and *rise* in the nahuatl language.
- Numerical code that simulates particles in relativistic plasma, and the rise of radiation from accelerating particles.
- Consists of both Rust functions and Python functions previously built in the Fortran code *Paramo*.

Paramo

Oct 2018 – Apr 2022

Open Source Code for Radiative Transfer Simulations in Relativistic Astrophysics

[GitHub](#)

- Independently developed this code for distributed settings to perform HPC simulations of radiative transfer in relativistic astrophysics.
- Optimized the code with OpenMP to reduce simulation time from 2 minutes to 5 seconds.
- Researched and applied mathematical concepts of machine learning (gradient descent) to adjust the parameters of the code to classify observations from NASA telescopes.
- This code has been used for at least 5 scientific publications and also for graduate pedagogical purposes.
- Developed data analysis and data visualization tools in Python.

Co-Founder, Mexican Scientists Abroad

Aug 2019 – Feb 2021

Group of Mexican Scientists narrowing the gap between science and common knowledge

[Homepage](#)

- Collaborated with a group of multidisciplinary scientists to develop Python scripts for [statistically modeling and forecasting the COVID-19 outbreak](#) in Mexico.
- Wrote [blogposts](#) and [infographics](#) for non-technical Spanish-speaking populations to reduce the spread of 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

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 weakly 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=0TJiKg7k0PI>

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]

Graduate student, Department of Physics and Astronomy, Purdue University

Mentoring

2018 – 2019

Thermodynamics (Graduate Level)

Instituto de Física y Matemáticas, Universidad Michoacana de San Nicolás de Hidalgo

Guest Lecturer

Jun 2018

Professional Development

High Performance Computing on Frontera

Jason Allison et al., TACC, Austin, TX, USA, May 20, 27 and June 3, 2021

Lecture

Writing Winning Grants

Dr. Lauren Broyles, Purdue University, West Lafayette, IN, USA, November 7, 2019

Lecture

XSEDE HPC Workshop: Summer Boot Camp

John Urbanic, Purdue University, West Lafayette, IN, USA, June 3 – 6, 2019

Workshop

Data Analysis and Machine Learning with Python

Dr. Alejandro Torres, Universitat de València, Burjassot, Spain, February 7 – 16, 2017

Workshop

Numerical Relativity Simulations of BBH Coalescence Using the Einstein Toolkit

Dr. Vassilios Mewes, Universitat de València, Burjassot, Spain, July 6 – 7, 2016

Workshop

No. of hours: 8

The Universe in the Light of PLANCK and BICEP2

Prof. Nick Mavromatos, Universitat de València, Burjassot, Spain, May 23 – 16, 2014

Lecture series

No. of credits: 2

Dark Matter

Prof. Alejandro Ibarra, Universitat de València, Burjassot, Spain, September 23 – 27, 2013

Lecture series

No. of credits: 2

International Cargèse School on Cosmic Accelerators

Institut d'Études Scientifiques de Cargèse, Cargèse, France, April 23 – May 8, 2013

Summer school

Introduction to C++ Programming

Dr. Jacek Generowicz, Universitat de València, Burjassot, Spain, April 9 – 12, 2012

Workshop

No. of credits: 6

Numerical Relativistic Astrophysics

Prof. Luciano Rezzolla, Universitat de València, Burjassot, Spain, March 27 – April 4, 2012

Lecture series

No. of hours: 9

Fortran for Scientific Computing

HLRS, University of Stuttgart, Stuttgart, Germany, Mar. 5 – 9, 2012

Workshop

No. of hours: 33

Certifications and Credentials

Data Analyst with Python

Complete

Data Manipulation, Data Visualization, Importing & Cleaning Data

DataCamp

Exploratory Data Analysis, Statistics, Sampling, Hypothesis Testing, Python, Pandas, Matplotlib, Seaborn

Data Scientist Professional with Python

Python Programming, Data Science, Data Communication, Machine Learning

DataCamp

Data Analysis, EDA, Supervised Learning, Unsupervised Learning, SQL, Python, Pandas, Matplotlib, Seaborn, Scikit-Learn

Machine Learning Scientist with Python

Machine Learning, NLP, Deep Learning, Image Processing, Big Data

DataCamp

Mathematical Foundations of Machine Learning

Udemy, [Credential ID: UC-605df108-ae80-4297-8c8f-6bc15b967511](#)

Python for Statistical Analysis

Udemy, [Credential ID: UC-e8557ac8-13f9-41bf-ab46-f196a041b725](#)

Outreach

Los más rápidos y los más furiosos (*The Fastest and the Most Furious*)

Online talk

Community of Undergraduate Physics Students, Juárez Autonomous University of Tabasco

September 4, 2020

Tabasco, Mexico

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

Online talk

Community of Undergraduate Physics Students, Juárez Autonomous University of Tabasco

August 14, 2020

Tabasco, Mexico

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

Blog post

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

May 29, 2020

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

Blog post

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

May 25, 2020

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

Blog post

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

April 5, 2020

Collaborator with the data analysis/modeling

Annual Department of Physics and Astronomy Poster Event

Posters (3) presentation

Department of Physics and Astronomy, Purdue University

November 13, 2019

West Lafayette, IN, USA

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

Panelist

Department of Physics and Astronomy, Purdue University

April 10, 2019

West Lafayette, IN, USA

Annual Department of Physics and Astronomy Poster Event

Poster presentation

Department of Physics and Astronomy, Purdue University

November 14, 2018

West Lafayette, IN, USA

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

Talk

Facultad de Ciencias, Universidad Autónoma del Estado de México

March 11, 2009

Toluca, Mexico

Synergetic Activities

X Scientific Meeting of the Spanish Astronomical Society

Valencia, Spain

Organizing contributor, 14–16 December, 2012

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