

# Jesús M. Rueda-Becerril — Ph.D.

Astrophysicist – Data Scientist

☎ +1 (765) 430-2330 • ✉ [jm.ruebe@gmail.com](mailto:jm.ruebe@gmail.com) • 🌐 [altjerue.github.io](https://altjerue.github.io)  
in [jeruebe](#) • 🔄 [altjerue](#) • 📦 [DataCamp](#) • 🆔 0000-0003-1988-1912  
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## Profile

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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

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### 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

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### Spatial Data Scientist

*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.

May 2025 — Present

### Independent Research/Open-Source Developer

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

Jan 2024 — May 2025

### Software Engineer (Remote)

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

Apr 2022 – Jan 2024

- 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

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**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<sup>A</sup>T<sub>E</sub>X, MPI, OpenMP, OpenACC, HDF5, Mathematica, Maple, Docker, Jenkins, Splunk, Jira, Kafka, Visit, Paraview, Job Scheduling (SLURM, PBS)

## Publications

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**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] 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](#)
- [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

### 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

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**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

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### 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

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### 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

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**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

## Thermodynamics (Graduate Level)

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

Mentoring

2018 – 2019

Guest Lecturer

Jun 2018

## Professional Development

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### 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

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### Gen AI Intensive

Generative AI

[Kaggle](#)

### Data Scientist Professional with Python

Python Programming, Data Science, Data Communication, Machine Learning

[DataCamp](#)

### Machine Learning Scientist with Python

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

[DataCamp](#)

### Mathematical Foundations of Machine Learning

Python Programming, Data Science, Statistics, Machine Learning

[Udemy](#)

### Python for Statistical Analysis

Python Programming, Data Science, Data Communication, Machine Learning

[Udemy](#)

## Outreach

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

Community of Undergraduate Physics Students, Juárez Autonomous University of Tabasco

Online talk

September 4, 2020

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](https://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](https://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](https://mexiciencia.github.io/post/covid19)  
Collaborator with the data analysis/modeling

**Blog post**  
April 5, 2020

**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

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**X Scientific Meeting of the Spanish Astronomical Society**  
*Organizing contributor, 14–16 December, 2012*

**Valencia, Spain**

## Other activities

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**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

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**Spanish:** Native proficiency

**English:** Full professional proficiency

**Catalan:** Intermediate