# Jesús M. Rueda-Becerril — Ph.D.

Astrophysicist – Data Scientist

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## Education

**Ph.D. in Physics** **Oct. 2011 – Jul. 2017**

*Universitat de València, Spain* 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** **Aug. 2009 – Sep. 2011**

*Universidad Michoacana de San Nicolás de Hidalgo, Mexico*

Advisor: Prof. José A. Cervera

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

**B.Sc. in Physics** **Aug. 2004 – Dec. 2008**

*Universidad Autónoma del Estado de México, Mexico* *"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**: 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), 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] 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 Grisolía* awarded by the Council of Education, Research, Culture and Sport of the Valencian Comunity, 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

**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 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=0TJiKg7kOPI

**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] — **Mentoring**
*Graduate student, Department of Physics and Astronomy, Purdue University* — *2018 – 2022*

**Amanda O. Harrison** [5] — **Mentoring**
*Graduate student, Department of Physics and Astronomy, Purdue University* — *2018 – 2020*

**Hao Zhang** [4] — **Mentoring**
*Graduate student, Department of Physics and Astronomy, Purdue University* — *2018 – 2019*

**Thermodynamics (Graduate Level)** — **Guest Lecturer**
*Instituto de Física y Matemáticas, Universidad Michoacana de San Nicolás de Hidalgo* — *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 Cagèse School on Cosmic Accelerators**
*Institut d'Études Scientifques 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

**5-Day Gen AI Intensive** **Kaggle**
*Generative AI*

**Data Analyst with Python** **DataCamp**
*Data Maniputalion, Data Visualization, Importing & Cleaning Data*

**Data Scientist Professional with Python** **DataCamp**
*Python Programming, Data Science, Data Communication, Machine Learning*

**Machine Learning Scientist with Python** **DataCamp**
*Machine Learning, NLP, Deep Learning, Image Processing, Big Data*

**Mathematical Foundations of Machine Learning** **Udemy**
*Python Programming, Data Science, Statistics, Machine Learning*

**Python for Statistical Analysis** **Udemy**
*Python Programming, Data Science, Data Communication, Machine Learning*

## 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

**Catalan**: Intermediate