Jesús M. Rueda-Becerril — Ph.D.

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Profile

I am a trained astrophysicist with experience in industry. I have expertise in programming, data science, data analysis, and problem-solving and I am creative, innovative, and analytical. I enjoy working both individually and collaboratively and I am an effective communicator in both English and Spanish. I have extensive experience debugging, testing, and maintaining sophisticated code in scientific and business arenas. I have strong programming skills in multiple languages like Python, Fortran, C/C++, Shell, Java, SQL, and I am experienced in managing version control systems (e.g., git). Additionally, I have experience in high-performance computing (HPC) and data science and a strong foundation in data analysis, machine learning, and statistical modeling. In my free time, I like to catch up with the most recent discoveries about the mysteries of our universe and I am an avid climber.

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
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 processing and extensive quantitative analysis in SQL on client databases to extract pivotal insights, which enabled the company to update and select clients and accounts for smooth synchronization across Oracle EBS and Enterprise databases.
- Developed using Java, Bootstrap, Kafka, PL/SQL, and deployed to OpenShift.
- Collaborated with stakeholders to assess product needs and optimized the design of services and features for the infrastructure of QTC+ Process.
- Developed Java Kafka consumers, which allowed for the streamlined transfer of large volumes of client data across databases.
- Developed a Java TestNG integration testing service for Kafka consumers to run recursive regression tests and ensure optimal performance of the Kafka consumers.
- Created Splunk dashboards and alerts for data analysis and traffic and error monitoring, which facilitated greater visibility of product performance among developers throughout the company.
- Investigated and compiled technical procedures and documentation from the company's repository for Kafka consumers, including operations and user manuals, allowing future users to utilize the products more efficiently.
- Developed Python testing script that would assert the billing system of a client after switching off the billing-system filter, allowing for more robust data maintenance.

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.
- Conducted the benchmarking and scalability of `PatchworkMHD` in order to identify performance optimization opportunities.
- Mentored and collaborated with a graduate student to apply the mathematical concepts of gradient descent to adjust the parameters of the open-source HPC 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 that I 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 HPC Fortran 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.

Technical Skills

Programming Languages: Fortran, Python, Shell Scripting, C/C++, R, Java, Julia, SQL (PL/SQL, PostgreSQL)

Python Ecosystem: Numpy, Pandas, Matplotlib, Scipy, Astropy, Scikit-learn, Assertpy, Jupyter

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

Research Scientist: Fellowships: 4 Federal from Mexico, 1 from Spain; Grants: 1 from NASA; Publications: 3 first author, 6 co-author, 6 Conference Proceedings.

Projects

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.

Publications

Articles

[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.

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=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] — **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

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

Python Fundamentals
DataCamp, Statement of Acomplishment #403,521

Data Manipulation with Python
DataCamp, Statement of Acomplishment #409,710

Importing & Cleaning Data
DataCamp, Statement of Acomplishment #409,699

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

French: Basic

German: Basic

Portuguese: Basic