

Jesús M. Rueda-Becerril

PhD

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Profile

Doctor in Astrophysics with high expertise in programming, data analysis and problem solving. I am creative, innovative, analyst and hard worker.

During my PhD studies I developed high programming skills in several languages such as Python, R, Fortran 95, C, Shell and version control tools like Git using platforms such as GitHub and Bitbucket. I worked on developing sophisticated numerical tools which were implemented to simulate blazar flares (prompt high energy radiation from relativistic jets of active galactic nuclei). This has shown my fast learning skill of new programming languages and develop efficient codes to solve the problem posed.

In my present position as a postdoctoral researcher at Purdue University, I am developing numerical tools to perform simulations of high energy processes in relativistic jet scenarios such as blazars and γ -ray bursts, in collaboration with Prof. Dimitrios Giannios and the members of his research group.

Interests

- High energy astrophysics
 - Cosmic rays
 - Particles acceleration processes
 - Relativistic jets: formation, composition, magnetization
 - Active galactic nuclei: blazars, radio galaxies
 - Tidal disruption events
 - Gamma-ray bursts
 - Pulsars
 - X-ray binaries
 - Gravitational waves

- Hydrodynamics
 - Newtonian and (General) Relativistic
 - Magnetic (ideal and resistive)
 - Radiative
 - Numerical methods

- Numerical
 - Numerical solutions of the radiation transport equation
- Astrophysics
 - Plasma modeling via fully-kinetic and hybrid kinetic-fluid simulations
 - PIC simulations
 - Numerical solution of the Fokker-Planck equation
 - Computational hydrodynamics and magnetohydrodynamics
 - Numerical solution to the Einstein equations
 - Numerical solutions to the geodesic equation (timelike and null)
 - Black holes and neutron stars mergers

- Computer Sciences
- Performance, stability, convergence and accuracy of numerical codes
 - Decision-making optimization
 - Machine learning (supervised and unsupervised)
 - Data mining

Employment

- 2018–Present **Postdoctoral Fellow**, *Department of Physics and Astronomy, Purdue University, West Lafayette, IN, USA.*
- 2018 **Postdoctoral Fellow**, *Instituto de Física y Matemáticas, Universidad Michoacana de San Nicolás de Hidalgo, Morelia, Mexico.*

Education

- 2011–2017 **Ph.D. in Physics**, *Departament d’Astronomia i Astrofísica, Universitat de València, Valencia, Spain, Distinction *Cum Laude*.*
Supervisors: Prof. Miguel Ángel Aloy Torás and Dr. Petar Mimica
Thesis title: *Numerical treatment of radiation processes in the internal shocks of magnetized relativistic outflows.*
Access: <http://roderic.uv.es/handle/10550/60003>
- 2009–2011 **M.Sc. in Physics**, *Instituto de Física y Matemáticas, Universidad Michoacana de San Nicolás de Hidalgo, Morelia, Mexico.*
- 2004–2009 **B.Sc. in Physics**, *Facultad de Ciencias, Universidad Autónoma del Estado de México, Toluca, Mexico.*

Computer skills

- Proficient Unix (Linux, macOS), Fortran (fixed and free format), OpenMP, Python (2, 3), R, RStudio, Shell, GNUMake, HDF5, Git, GitHub, Mathematica, L^AT_EX, Atom (text editor), Emacs, gnuplot, grace
- Intermediate C, C++, Julia, Jupyter, MPI, OpenACC, PBS, SageMath, OpenOffice, Microsoft Office, iWork, GitLab
- Basic HTML, Jekyll, Matlab, Maple, Java, Swift, Perl, SQL, Java, IDL, Visit, Paraview

Experience with scientific software

- SPEV Mimica P. et al., 2009, ApJ, 696, 1142 [10.1088/0004-637X/696/2/1142](https://doi.org/10.1088/0004-637X/696/2/1142)
- PLUTO Mignone A. et al., 2007, ApJS, 170, 228 <http://plutocode.ph.unito.it>
- HARM Gammie, C. F., et al., 2003, ApJ, 589, 444 <https://github.com/atchekho/harmpi>
- BHAC Porth, O. et al., 2017, Comput. Astrophys., 4, 1 <https://bhac.science>

Publications

Articles

- Zhang, H., Christie, I., Petropoulou, M., **Rueda-Becerril, J. M.** & Giannios, D. Inverse Compton Signatures of Gamma-Ray Burst Afterglows. *arXiv e-prints* arXiv:1910.14049 (2019).
- 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). [10.1093/mnras/stx476](https://doi.org/10.1093/mnras/stx476).
- 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). [10.1093/mnras/stt2335](https://doi.org/10.1093/mnras/stt2335).
- Guzmán, F. S. & **Rueda-Becerril, J. M.** Spherical boson stars as black hole mimickers. *Phys. Rev. D* **80**, 084023 (2009). [10.1103/PhysRevD.80.084023](https://doi.org/10.1103/PhysRevD.80.084023).

Proceedings

- Rueda-Becerril, J. M.**, Mimica, P. & Aloy, M. A. Numerical simulations of the internal shock model in magnetized relativistic jets of blazars. In *Proceedings of Swift: 10 Years of Discovery (SWIFT 10)*, 159 (Rome, Italy, 2014).

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. In *The Innermost Regions of Relativistic Jets and Their Magnetic Fields*, vol. 61 of *European Physical Journal Web of Conferences*, 02007 (2013). 10.1051/epjconf/20136102007.
1. Mimica, P., Aloy, M. A., **Rueda-Becerril, J. M.**, Tabik, S. & Aloy, C. Numerical simulations of dynamics and emission from relativistic astrophysical jets. In *24th IUPAP Conference on Computational Physics*, vol. 454 of *Journal of Physics: Conference Series*, 012001 (2013). 10.1088/1742-6596/454/1/012001.

Meetings and conferences

Talks

- 2014 **Rueda-Becerril, J. M.**, Mimica, P., Aloy, M. A., *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
- 2013 **Rueda-Becerril, J. M.**, Mimica, P., Aloy, M. A., *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

Poster Sessions

- 2014 **Rueda-Becerril, J. M.**, Mimica, P., Aloy, M. A., *Numerical simulations of the internal shock model in magnetized relativistic jets of blazars*, Swift: 10 years of Discovery. Rome, Italy, December 2–5
- 2013 **Rueda-Becerril, J. M.**, Mimica, P., Aloy, M. A., *Numerical study of broadband spectra caused by internal shocks in magnetized relativistic jets of blazars*, The Innermost Regions of Relativistic Jets and Their Magnetic Fields. Granada, Spain, June 10–14

Organization

- 2012 Contribution to the organization of the X Scientific Meeting of the Spanish Astronomical Society, Valencia, Spain, 14–16 December

Invited Talks and Seminars

- 2019 **Morphology of the spectra from numerical simulations of the internal shocks model for blazars**, *Astrophysics Seminar at Purdue University*, West Lafayette, IN, February 4.
- 2018 **Numerical simulations of the internal shocks model in magnetized relativistic jets of blazars**, *Weekly colloquium of the DATA group of the Institute of Astronomy, UNAM*, Mexico City, Mexico, June 19.
- 2018 **Numerical treatment of nonthermal radiation in the internal shocks model for blazars**, *Weekly colloquium of the Institute of Physics and Mathematics, UMSNH*, Morelia, Mexico, March 2.
- 2014 **Numerical simulations of the internal shock model in magnetized relativistic jets of blazars**, *IVICFA's Fridays: Computation in Physics*, Paterna, Spain, October 17.

Professional development

- Nov 7, 2019 **Writing Winning Grants**, Dr. Lauren Broyles, Purdue University. West Lafayette, IN. No. of hours: 8
- Jun 3–6, 2019 **XSEDE HPC Workshop: Summer Boot Camp**, John Urbanic, Purdue University. West Lafayette, IN. No. of hours: 20
- Sep 5, 2017 **Using Python to Access Web Data**, University of Michigan on Coursera. Certificate earned on September 5, 2017
- Feb 7–16, 2017 **Data Analysis and Machine Learning with Python**, Dr. Alejandro Torres, Universitat de València. Burjassot, Spain. No. of hours: 8

- May 23–16, 2014 **The Universe in the light of PLANCK and BICEP2**, *Prof. Nick Mavromatos*, Universitat de València.
Burjassot, Spain. No. of credits: 2
- Sep 23–27, 2013 **Dark Matter**, *Dr. Alejandro Ibarra*, Universitat de València.
Burjassot, Spain. No. of credits: 2
- Apr 23–May 8, 2013 **International Cargèse School on Cosmic Accelerators**, *Institut d'Études Scientifiques de Cargèse*.
Cargèse, France
- Apr 9–12, 2012 **Introduction to C++ Programming**, *Dr. Jacek Generowicz*, Universitat de València.
Burjassot, Spain. No. of credits: 6
- Mar 27–Apr 4, 2012 **Numerical Relativistic Astrophysics**, *Prof. Luciano Rezzolla*, Universitat de València.
Burjassot, Spain. No. of hours: 9
- Mar 5–9, 2012 **Fortran for Scientific Computing**, *HLRS, University of Stuttgart*, Uwe Küster & Ralf Schneider.
Stuttgart, Germany. No. of hours: 33

Research experience

- 2018–Present **Postdoctoral Researcher**, *Department of Physics and Astronomy*, West Lafayette, IN, USA.
- Participation and interaction with the members of Prof. Dimitrios Giannios Group.
 - Tutoring graduate students with their research projects.
 - Development of the code **Paramo**: a numerical tool which solves the Fokker-Planck equation by making use of an implicit method.
 - Work on a model in which a simple model for the blazars sequence has been proposed. An article is being developed out of this project.
 - A research grant was obtained from the *NASA Fermi Cycle-12 Guest Investigator Program*.
- 2018 **Postdoctoral Research Associate**, *Instituto de Física y Matemáticas, Universidad Michoacana de San Nicolás de Hidalgo*, Morelia, Mexico.
- Took part in instructive and training activities for graduate students.
 - Participation in the weekly group meetings for monitoring the progress of graduate students.
 - Set the fundamentals for a numerical tool for the evolution of particles which solves numerically the Fokker-Planck equation.
- 2011–2017 **Graduate research assistant**, *Universitat de València*, Burjassot, Spain.
- Studied in depth AGNs and blazars, the blazars models, the radiation transfer equation, the kinetic equation.
 - Automatized the launching of simulations, treatment of data and generation of plots for an extensive parameter space study of the internal shocks code developed by Petar Mimica and Miguel A. Aloy in order to find traces left in the spectra due to the magnetization of the shocked shells of plasma.
 - Extracted and interpreted data from the simulations of the main characteristics of blazars SEDs, e.g. Compton dominance, synchrotron and Compton peaks, spectral index.
 - Extracted, cleaned and processed data from the *Fermi* LAT Second AGN Catalog database for the comparison with our simulations.
 - I implemented a routine for a more general distribution of particles (thermal and nonthermal) injected at the shock front to be treated in the original code.
 - I calculated tables with the magnetobremstrahlung emission of charged particles of arbitrary velocity, and the emissivity for isotropic distributions of electrons using a code that I developed from scratch.
 - I implemented the magnetobremstrahlung tables to the original code and performed simulations of the internal shocks scenario for blazars.
 - Interpreted the new SEDs out of the simulations.
 - Wrote and defended a thesis.
 - Contributed to the writing of and coauthored two manuscript for publication in a peer-reviewed journal.
- 2010–2011 **Graduate research assistant**, *Universidad Michoacana de San Nicolás de Hidalgo*, Morelia, Mexico.
- I developed a newtonian and relativistic smoothed-particle hydrodynamics (SPH) codes.
 - I solved the TOV field equations numerically using my RK4 solver.
 - I wrote a routine with the simple predictor-corrector method: Euler method with the trapezoidal rule.
 - I simulated a TOV star using the numerical solution of the TOV field equations as initial conditions of the SPH code and evolved the system using the predictor-corrector routine.
 - Wrote and presented a master thesis with the results obtained.

- 2008–2009 **Graduate research assistant**, *Universidad Autónoma del Estado de México*, Toluca, Mexico.
- Wrote and characterized a fourth-order Runge-Kutta (RK4) solver for analytic and numeric input functions for each stage.
 - I solved the null geodesic equation for two spherically symmetric and static space-times using the RK4 solver: black holes (analytic Christoffel symbols) and boson stars (numeric Christoffel symbols).
 - I simulated and interpreted light trajectories due to curved space-times and characterized such trajectories for gravitational lenses.
 - Wrote and presented a thesis with the results obtained.
 - Contributed to the writing of and coauthored a manuscript for publication in a peer reviewed journal.
- 2007–2008 **Undergraduate research assistant**, *Universidad Autónoma del Estado de México*, Toluca, Mexico.
Internship service project, supervised by Prof. Jorge Orozco Velasco.
- Writing the elliptic equations in finite differences form
 - Characterization of the typical kinds of boundary conditions:
 - Dirichlet
 - Neumann
 - Writing of a code which solves the two-dimensional Laplace equation in Cartesian coordinates with Dirichlet and Neumann boundary conditions.
- 25 Jun– **Undergraduate research assistant**, *Mexican Academia of Science*, Morelia, Mexico.
24 Aug 2007 National program for temporary stays at national research centers for undergraduate science students.
Supervisor: Prof. Francisco S. Guzmán Murillo.
- Numerical solution of the wave equation with finite differences.
 - Numerical solution of Burgers' equation with finite differences.
 - Numerical solution of the general relativistic one-dimensional wave equation in the 3+1 formalism with finite differences.
- 2005–2008 **Undergraduate researcher assistant**, *Universidad Autónoma del Estado de México*, Toluca, Mexico.
Volunteer work in a faculty research project
Supervisor: Prof. Porfirio D. Rosendo-Francisco
- Exposure of graphite samples to microwaves
 - Ultrasonic cleaning of graphite samples.
 - Systematic exposure graphite samples to microwaves (2.45 GHz).
 - Observation of the superficial effects using a metallographic microscope.
 - Characterization of the structures observed.
 - Results presented in a poster at the XLVIII National Physics Meeting, Guadalajara, México, 2005.
 - Exposure of graphite samples to electric arcs
 - Ultrasonic cleaning of graphite samples.
 - Characterization of a Tesla coil.
 - Input current.
 - Output flux of electrons.
 - Controlled handling of a Tesla coil.
 - Systematic exposure of the surface of graphite samples to a perpendicular and tangential electric arc.
 - Observation of surface effects with a metallographic microscope.
 - Characterization of the zones around the contact region.
 - Characterization of the temperature around the contact region.
 - Characterization of the structures which appeared after the exposure.
 - Analysis of X-rays spectra of the samples.
 - Identification of induced families of lattice planes.
 - Results presented in a poster at the XLIX National Physics Meeting, San Luis Potosi, México, 2006.
 - Results presented in a poster at the L National Physics Meeting, Boca del Río, México, 2007.

Research Grants

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

Awards and Grants

- 2018–2020 **Fellowship** from the Mexican Federal Government for a postdoctoral stay abroad awarded by the National Council of Science and Technology (CONACyT).
- 2017 **Grant** from the Mexican Federal Government under the *Program for the Professional Development of Higher Education Institutions*, awarded by the Secretariat of Public Education.

- 2014–2016 **Fellowship** from the Mexican Federal Government to study abroad awarded by the National Council of Science and Technology (CONACyT).
- 2011–2014 **Fellowship** *Santiago Grisolia* awarded by the Council of Education, Research, Culture and Sport of the Valencian Community.
- 2009–2011 **Fellowship** for academic training for MSc studies granted by the Mexican Council of Science and Technology (CONACyT).
- 2009 **Award** *Lic. Juan Josafat Pichardo Cruz*, granted by the UAEMex, for finishing the BSc thesis and graduating within a year after completing the undergraduate credits.
- 25 Jun–24 Aug 2007 **Fellowship** for a temporary stay in a national research center under the XVII summer of scientific investigation program awarded by the Mexican Academia of Science.

Outreach

- 2019 **Presentation of three posters**, *Annual Department of Physics & Astronomy Poster Event*, Purdue University.
November 13, West Lafayette, IN
- 2019 **Round table**, *Post-Doc Panel Q&A: What happens when we complete our PhDs?*, Purdue University.
April 10, West Lafayette, IN
- 2018 **Presentation of a poster**, *Annual Department of Physics & Astronomy Poster Event*, Purdue University.
November 14, West Lafayette, IN

Other activities

- Aug 2007– May 2009 Physics students representative at the Governing Council of the Faculty of Sciences of the Universidad Autónoma del Estado de México

Languages

Spanish	Native speaker
English	Proficient
Catalan	Basic
French	Basic
German	Basic

TOEFL certified.

References

Prof. Dimitrios Giannios
Department of Physics and Astronomy
Purdue University
525 Northwestern Avenue
West Lafayette, IN 47907, USA
✉ dgiannio@purdue.edu
☎ +1 (765) 494-5194

Dr. Petar Mimica
Qindel Group
Valencia, Spain
✉ petar.mimica@gmail.com

Prof. Miguel Ángel Aloy
Departament d'Astronomia i Astrofísica
Universitat de València
Edificio de Investigación
C/ Dr. Moliner s/n
46100 Burjassot, Valencia, Spain
✉ Miguel.A.Aloy@uv.es
☎ +34 963 543 080