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 performe 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 Astrophysics:
- Numerical solutions of the radiation transport equation
- 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

Department of Physics and Astronomy, Purdue University — **West Lafayette, IN, USA**
Posdoctoral Researcher — *2018–Present*

Instituto de Física y Matemáticas, Universidad Michoacana de San Nicolás de Hidalgo — **Morelia, Mexico**
Posdoctoral Researcher — *2018*

Education

Departament d'Astronomia i Astrofísica, Universitat de València — **Valencia, Spain**
Ph.D. in Physics, Distinction Cum Laude — *2011–2017*
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`

Instituto de Física y Matemáticas, Universidad Michoacana de San Nicolás de Hidalgo — **Morelia, Mexico**
M.Sc. in Physics — *2009–2011*

Facultad de Ciencias, Universidad Autónoma del Estado de México — **Toluca, Mexico**
B.Sc. in Physics — *2004–2009*

Computer skills

Proficient: Unix (Linux, macOS), Fortran (fixed and free format), OpenMP, Python (2, 3), R, RStudio, Shell, GNUMake, HDF5, Git, GitHub, Mathematica, LaTeX, 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*

PLUTO: Mignone A. et al., 2007, ApJS, 170, 228 — *http://plutocode.ph.unito.it*

HARM: Gammie, C. F., McKinney, J. C., & Toth, G. 2003, ApJ, 589, 444 — *https://github.com/atchekho/harmpi*

BHAC: Porth, O. et al., 2017, Comput. Astrophys., 4, 1 — *https://bhac.science*

Publications

Articles

4. 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).

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). `10.1093/mnras/stx476`.

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). `10.1093/mnras/stt2335`.

1. 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`.

Proceedings

3. **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

Influence of the magnetic field on the spectral properties of blazars in the internal shocks scenario
Rueda-Becerril, J. M., *Mimica, P., Aloy, M. A., Extreme-Astrophysics in an Ever-Changing Universe* *2014*
Ierápetra, Greece, June 16–20

Numerical study of broadband spectra caused by internal shocks in magnetized relativistic jets
Rueda-Becerril, J. M., *Mimica, P., Aloy, M. A., XXXIV Biennial meeting of the Royal Spanish Society of Physics* *2013*
Valencia, Spain, July 15–19

Poster Sessions

Numerical simulations of the internal shock model in magnetized relativistic jets of blazars
Rueda-Becerril, J. M., *Mimica, P., Aloy, M. A., Swift: 10 years of Discovery* *2014*
Rome, Italy, December 2–5

Numerical study of broadband spectra caused by internal shocks in magnetized relativistic jets of blazars
Rueda-Becerril, J. M., *Mimica, P., Aloy, M. A., The Innermost Regions of Relativistic Jets and Their Magnetic Fields* *2013*
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

Astrophysics Seminar at Purdue University **West Lafayette, IN, February 4**
Morphology of the spectra from numerical simulations of the internal shocks model for blazars *2019*

Weekly coloquium of the DATA group of the Institute of Astronomy, UNAM **Mexico City, Mexico, June 19**
Numerical simulations of the internal shocks model in magnetized relativistic jets of blazars *2018*

Weekly coloquium of the Institute of Physics and Mathematics, UMSNH **Morelia, Mexico, March 2**
Numerical treatment of nonthermal radiation in the internal shocks model for blazars *2018*

IVICFA's Fridays: Computation in Physics **Paterna, Spain, October 17**
Numerical simulations of the internal shock model in magnetized relativistic jets of blazars *2014*

Professional development

Writing Winning Grants **Purdue University**
Dr. Lauren Broyles *Nov 7, 2019*
West Lafayette, IN. No. of hours: 8

XSEDE HPC Workshop: Summer Boot Camp **Purdue University**
John Urbanic *Jun 3–6, 2019*
West Lafayette, IN. No. of hours: 20

Using Python to Access Web Data
University of Michigan on Coursera *Sep 5, 2017*
Certificate earned on September 5, 2017

Data Analysis and Machine Learning with Python **Universitat de València**
Dr. Alejandro Torres *Feb 7–16, 2017*
Burjassot, Spain. No. of hours: 8

The Universe in the light of PLANCK and BICEP2 **Universitat de València**
Prof. Nick Mavromatos *May 23–16, 2014*
Burjassot, Spain. No. of credits: 2

Dark Matter **Universitat de València**
Dr. Alejandro Ibarra *Sep 23–27, 2013*
Burjassot, Spain. No. of credits: 2

International Cagèse School on Cosmic Accelerators
Institut d'Études Scientifques de Cargèse *Apr 23–May 8, 2013*

Cargèse, France

Introduction to C++ Programming — **Universitat de València**
Dr. Jacek Generowicz — *Apr 9–12, 2012*
Burjassot, Spain. No. of credits: 6

Numerical Relativistic Astrophysics — **Universitat de València**
Prof. Luciano Rezzolla — *Mar 27–Apr 4, 2012*
Burjassot, Spain. No. of hours: 9

Fortran for Scientific Computing — **HLRS, University of Stuttgart**
Uwe Küster & Ralf Schneider — *Mar 5–9, 2012*
Stuttgart, Germany. No. of hours: 33

Research experience

Department of Physics and Astronomy, — **West Lafayette, IN, USA**
Postdoctoral Researcher — *2018–Present*

- 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*.

Instituto de Física y Matemáticas, Universidad Michoacana de San Nicolás de Hidalgo — **Morelia, Mexico**
Postdoctoral Research Associate — *2018*

- Took part in instructive and training activities for graduate students.
- Participation in the weekly group meetings for monitoreeing the progress of graduate students.
- Set the fundamentals for a numerical tool for the evolution of particles which solves numerically the Fokker-Planck equation.

Universitat de València — **Burjassot, Spain**
Graduate research assistant — *2011–2017*

- 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 magnetobremsstrahlung 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 magnetobremsstrahlung 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.

Universidad Michoacana de San Nicolás de Hidalgo — **Morelia, Mexico**
Graduate research assistant — *2010–2011*

- 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.

Universidad Autónoma del Estado de México — **Toluca, Mexico**
Graduate research assistant — *2008–2009*

- 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.

Universidad Autónoma del Estado de México **Toluca, Mexico**
Undergraduate research assistant *2007–2008*
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.

Mexican Academia of Science **Morelia, Mexico**
Undergraduate research assistant *25 Jun– 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.

Universidad Autónoma del Estado de México **Toluca, Mexico**
Undergraduate researcher assistant *2005–2008*
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 elecric 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

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

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 Grisolía* awarded by the Council of Education, Research, Culture and Sport of the Valencian Comunity.

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

Annual Department of Physics & Astronomy Poster Event — **Purdue University**
Presentation of three posters — *2019*
November 13, West Lafayette, IN

Post-Doc Panel Q&A: What happens when we complete our PhDs? — **Purdue University**
Zhang, H., Clark, M., ***Rueda-Becerril, J. M.****, & Kathirgamaraju, A.* — *2019*
April 10, West Lafayette, IN

Annual Department of Physics & Astronomy Poster Event — **Purdue University**
Presentation of a poster — *2018*
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 — *TOEFL certified.*

Catalan: Basic

French: Basic

German: Basic

References

Prof. Dimitrios Giannios
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West Lafayette, IN 47907, USA
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+1 (765) 494-5194

Prof. Miguel Ángel Aloy
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