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# Jesús M. Rueda-Becerril

*Postdoctoral Researcher*

*Last Updated: January 28, 2019*

## 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  $\gamma$ -ray bursts, in collaboration with Prof. Dimitrios Giannios.

## 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

- 2017–Present **Postdoctoral Researcher**, *Department of Physics & Astronomy, Purdue University, West Lafayette, IN, USA.*
- 2017 **Postdoctoral Researcher**, *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.*  
 Supervisor: Prof. José Antonio González Cervera  
 Thesis title: *Study of TOV stars with the SPH method*
- 2004–2009 **B.Sc. in Physics**, *Facultad de Ciencias, Universidad Autónoma del Estado de México, Toluca, Mexico.*  
 Supervisor: Prof. Francisco S. Guzmán Murillo  
 Thesis title: *Numerical solution of null geodesics for the generation of gravitational lenses in spherically symmetric space-times*

## Computer skills

- Proficient Unix (Linux, macOS), Fortran (fixed and free format), OpenMP, Python (2, 3), R, RStudio, Shell, Makefile, HDF5, Git, Mathematica, L<sup>A</sup>T<sub>E</sub>X, Atom (text editor), Emacs, gnuplot, grace, GitHub
- Intermediate C, C++, Julia, Jupyter, MPI, SageMath, OpenOffice, Microsoft Office, iWork, Elisp, DOT, TikZ/PGF, yEd, GeoGebra
- Basic HTML, Jekyll, Matlab, Maple, Java, Swift, Perl, SQL, Java

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## Publications

### Articles

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.

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## Meetings and conferences

### Oral presentations

- 2018 **Rueda-Becerril, J. M.**, *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, 19 June.
- 2018 **Rueda-Becerril, J. M.**, *Numerical treatment of nonthermal radiation in the internal shocks model for blazars*, Weekly colloquium of the Institute of Physics and Mathematics, UMSNH, Morelia, Mexico, 2 March.
- 2014 **Rueda-Becerril, J. M.**, Mimica, P., Aloy, M. A., *Numerical simulations of the internal shock model in magnetized relativistic jets of blazars*, IVICFA’s Fridays: Computation in Physics, Paterna, Spain, 17 October.
- 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: Time-Domain Astronomy in the 21st Century, Ierápetra, Greece, 16–20 June.
- 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, 15–19 July.

### Poster presentations

- 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, 2–5 December.

- 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, 10–14 June.
- 2007 **Rueda-Becerril, J. M.**, Leyte González, R., García Santibañez, F., Rosendo-Francisco, P., *Analysis of the superficial structure of graphite samples submitted to an electric arc*, L National Physics Meeting, Boca del Río, Mexico, 29 October–2 November.
- 2006 **Rueda-Becerril, J. M.**, Leyte González, R., García Molina, N., Rosendo-Francisco, P., *Modifications on the superficial structure of graphite samples*, XLIX National Physics Meeting, San Luis Potosí, Mexico, 16–19 October.
- 2005 **Rueda-Becerril, J. M.**, Gómez Díaz, A., Rosendo-Francisco, P., *Studies of microwave effects of graphite samples*, XLVIII National Physics Meeting, Guadalajara, Mexico, 17–21 October.

#### Attendance only

- 2016 CoCoNuT Meeting 2016, Burjassot, Spain, 14–16 December
- 2008 LI National Physics Meeting, Zacatecas, Mexico, 20–24 October

#### Organization

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

### Professional development

- 5 Sep 2017 **Using Python to Access Web Data**, *University of Michigan on Coursera*.  
Certificate earned on September 5, 2017
- 7–16 Feb 2017 **Data Analysis and Machine Learning with Python**, *Universitat de València*, Burjassot, Spain.  
No. of hours: 8
- 23–16 May 2014 **The Universe in the light of PLANCK and BICEP2**, *Universitat de València*, Burjassot, Spain.  
No. of credits: 2
- 23–27 Sep 2013 **Dark Matter**, *Universitat de València*, Burjassot, Spain.  
No. of credits: 2
- 23 Apr–8 May 2013 **International Cargèse School on Cosmic Accelerators**, *Institut d'Études Scientifiques de Cargèse*, Cargèse, France.
- 9–12 Apr 2012 **Introduction to C++ Programming**, *Universitat de València*, Burjassot, Spain.  
No. of credits: 6
- 27 Mar–4 Apr 2012 **Numerical Relativistic Astrophysics**, *Universitat de València*, Burjassot, Spain.  
No. of hours: 9
- 5–9 March 2012 **Fortran for Scientific Computing**, *High Performance Computing Center Stuttgart*, Stuttgart, Germany.  
No. of hours: 33
- Jun 2006 **Advanced Summer School**, *CINVESTAV*, Ciudad de México, Mexico.
- Aug 2006 **Advanced Summer School**, *Instituto de Física of the Universidad de Guanajuato*, León, Mexico.

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## Research experience

- 2017–Present **Postdoctoral Researcher**, *Department of Physics & Astronomy*, West Lafayette, IN, USA.
- Development of the code **Paramo**: a numerical tool which solves the Fokker-Planck equation by making use of an implicit method.
- 2017 **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 magnetobremssstrahlung 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 magnetobremssstrahlung 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– 24 Aug 2007 **Undergraduate research assistant**, *Mexican Academia of Science*, Morelia, Mexico.

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.

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## Awards and Scholarships

2017–present **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.

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## Outreach

- 2009 **Rueda-Becerril, J. M.**, *¿Decía Einstein la verdad? (Was Einstein saying the truth?)*, oral presentation at the weekly colloquium of Physics students: *Café Ciencias*, Toluca, Mexico, 11 March.

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## 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

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## Languages

Spanish Native speaker  
English Proficient  
Catalan Basic  
French Basic  
German Basic

*TOEFL certified.*

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## References

### **Prof. Miguel Ángel Aloy**

Departament d'Astronomia i Astrofísica  
Universitat de València  
Edificio de Investigación  
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46100 Burjassot, Valencia, Spain  
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### **Prof. Francisco S. Guzmán**

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### **Dr. Petar Mimica**

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