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Jesús M. Rueda-Becerril

PhD

Last Updated: September 13, 2020

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 at the Universitat de ValènciaI developed high programming skills in several languages such as Python, R, Fortran, C/C++, Shell and version control systems like Git. 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) in the *internal shocks* model.

I am currently a postdoctoral fellow at the Department of Physics and Astronomy 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 my mentor Prof. Dimitrios Giannios, and the members of his research group.

Interests

High-energy astrophysics — Transients — Relativistic jets — Numerical astrophysics

Professional Experience

Postdoctoral Fellow
Department of Physics and Astronomy, Purdue University, USA *Oct. 2018 – Present*
Mentor: Prof. Dimitrios Giannios
- Creator and developer of the code `Paramo`
  - Numerical Fokker-Planck equation solver
  - Numerical non-thermal radiation processes: synchrotron and inverse Compton
  - Numerical Klein-Nishina radiative cooling
- Mentoring graduate students
- External Compton spectrum and evolution in the context of γ-ray burst afterglows [4]
- Connection between the baryon loading and the so-called *blazar sequence* [5].
- Turbulence as acceleration process in blazars using `Paramo` (work in progress)
- Simulations of accretion around galactic isolated black holes using `HARM` (work in progress)
- Radiative cooling in relativistic outflows using `Paramo` (work in progress)

Postdoctoral Fellow
Instituto de Física y Matemáticas, Universidad Michoacana de San Nicolás de Hidalgo, Mexico *Jan. – Sep. 2018*
Mentor: Prof. Francisco S. Guzmán
- Trained graduate students on computational tools, e.g., HDF5. `https://github.com/altjerue/howto_HDF5`
- Mentored graduate students.
- Developed a Python script to treat large number of output images from the numerical code `GRTRANS` for Machine Learning analysis.
- Developed the visualization tool `SAPytho` for spectral evolution. `https://github.com/altjerue/SAPyto`

Graduate research assistant
Departament d'Astronomia i Astrofísica, Universitat de València, Spain *Oct. 2011 – Jul. 2017*

Supervisors: Prof. Miguel A. Aloy & Dr. Petar Mimica
- Applied the *internal-shocks* model in the context of blazar flares to identify the signature of the magnetization in their SEDs. Our results were contrasted with data from the *Fermi* LAT Second AGN Catalog database [2].
- Developed numerical technique to calculate (cyclo-)synchrotron emission from non-, trans-, and ultra-relativistic charged particles. Calculations applied to the *internal-shocks* model of blazar flares [3].

Graduate research assistant
Instituto de Física y Matemáticas, Universidad Michoacana de San Nicolás de Hidalgo, Mexico *Aug. 2009 – Sep. 2011*
Supervisor: Prof. José A. Cervera
- Developer of a SPH code to evolve a hydrodynamical system with TOV initial conditions.

Undergraduate research assistant
Facultad de Ciencias, Universidad Autónoma del Estado de México, Mexico *Sep. 2008 – May 2009*
Supervisor: Prof. Francisco S. Guzmán
- Developer of numerical null geodesic equation solver for analytical and numerical metrics [1]
- Priced with the *Lic. Juan Josafat Pichardo Cruz* award.

Education

Ph.D. in Physics **Universitat de València, Spain**
Supervisors: Prof. Miguel A. Aloy & Dr. Petar Mimica. *Oct. 2011 – Jul. 2017*
Thesis: *Numerical treatment of radiation processes in the internal shocks of magnetized relativistic outflows*.
Honors: Excellent *cum laude*.

M.Sc. in Physics **Universidad Michoacana de San Nicolás de Hidalgo, Mexico**
Supervisor: Prof. José A. Cervera *Aug. 2009 – Sep. 2011*
Thesis: *Study of TOV stars with the SPH method*

B.Sc. in Physics **Universidad Autónoma del Estado de México, Mexico**
Supervisor: Prof. Francisco S. Guzmán *Aug. 2004 – Dec. 2008*
Thesis: *Numerical solution of null geodesics for the generation of gravitational lenses produced by spherically-symmetric and static spacetimes*

Publications

Articles

[5] **Rueda-Becerril, J. M.**, Harrison, A. O. & Giannios, D. *Baryon loading of blazar jets independent of accretion rate, not so their luminosity*, (2020), submitted for review to MNRAS 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*, (2020)

4. **Rueda-Becerril, J. M.**, Harrison, A. O. & Giannios, D. *The blazar sequence revised*, (2020)

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 – Present: **Fellowship** from the Mexican Federal Government for a postdoctoral stay abroad 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 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

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

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*

Graduate Thermodynamics course — **Class Substitution**
Dr. James P. Edwards, IFM, Universidad Michoacana de San Nicolás de Hidalgo — *2018*

Technical Skills

Programming Languages: Fortran, Python, Shell Scripting, C/C++

Scientific Code Experience: `SPEV` (Mimica et al. 2009), `GRTRANS` (Dexter 2016), `HARM` (McKinney et al. 2012)

Scientific Code Development: `SPEV` [2, 3], `PARAMO` [5]

High Performance Computing: OpenMP, MPI, OpenACC

Tools: HDF5, version-control systems, Jupyter, gnuplot, Paraview

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 saying the truth?*) — **Talk**
Facultad de Ciencias, Universidad Autónoma del Estado de México — *March 11, 2009*
Toluca, Mexico

Professional development

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

Synergetic Activities

X Scientific Meeting of the Spanish Astronomical Society — **Valencia, Spain**
Organizing contributor, 14–16 December, 2012

Volunteering

Científicos Mexicanos en el Extranjero
Member & Co-Founder — *Sep. 2019 – Present*
We are a group of Mexican scientists collaborating with mexican research centers. We're committed with society, intending to narrow down the gap between science and the common knowledge.
Homepage: https://mexiciencia.github.io

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: professional working proficiency
French: Basic
German: Basic
Portuguese: Basic

References

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