Milton Ruiz

Research Scientist · Relativistic Astrophysics

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Summary

Research Scientist in the Department of Physics at the University of Illinois at Urbana-Champaign studying compact objects mergers in magnetized environments, including binary black holes in gaseous disks, black hole–neutron star, neutron star binaries, and exotic objects such as ergostars. The goal of my research is to predict and correlate observable gravitational-waves and electromagnetic signatures from these events. Also, strongly interested in alternative theories of gravity and mathematical aspects of numerical relativity.

Work Experience

Research Scientist — *Urbana, Illinois*

Department of Physics,
University of Illinois at Urbana-Champaign (UIUC) — *Aug 2016 -*

Postdoctoral Research Associate — *Urbana, Illinois*

Department of Physics,
UIUC — *2013 - 2016*

CPAN Postdoctoral Research Associate — *Palma de Mallorca, Spain*

Spanish National Center for Particle, Astroparticle and Nuclear Physics,
Universitat de les Illes Balears — *2011 - 2013*

Postdoctoral Research Associate — *Jena, Germany*

Theoretisch-Physikalisches Institut,
Friedrich-Schiller-Universität — *2009 - 2010*

Education

Ph.D. Physics — *Mexico City, Mexico*

National Autonomous University of Mexico (UNAM) — *April, 2009*

- Dissertation: *Axial symmetry, Gravitational Waves and Boundary Conditions*
  Advisor: Miguel Alcubierre
  Field: Numerical Relativity

Master of Science (Physics) — *Mexico City, Mexico*

UNAM — *June, 2006*

Bachelor of Science (Physics) — *Bogota, Colombia*

National University of Colombia — *June, 2003*

- Dissertation: *Exact Solution of the Einstein's Equations*

Major Collaborations

CONACYT Thematic Network:
Black Holes & Gravitational Waves — *México, México*

2017 -2019

LISA Consortium:
Numerical Relativity & Analytical Relativity –Waveform modeling for MBHBs group — *Urbana, Illinois*

July 2018 –

Honors & Awards

2015-2016	**Fellowship for Basic Research**, Colombian Ministry of Education	*Bogota, Colombia*
2011-2013	**Fellowship for advance research**, Spanish National Center for Astroparticle and Nuclear Physics	*Madrid, Spain*
2005-2009	**Fellowship for PhD studies**, Mexican Ministry of Education	*Mexico City, Mexico*
2000-2004	**Fellowship for B.S. studies**, Colombian Ministry of Education	*Bogota, Colombia*

Research Stays

Friedrich-Schiller-Universität — *Jena, Germany*
Theoretisch-Physikalisches Institut — *June-July 2008*

Louisiana State University — *Louisiana, US*
Center for Computational and Technology — *June - Aug 2006*

Teaching Experience

Guest Lecturer — *Graduate level*
Industrial University of Santander — *Bucaramanga, Colombia, 2015*
- Lecture: *Advanced Topics in General Relativity*

Teaching Assistant — *Undergraduate level*
Theoretisch-Physikalisches Institut, Friedrich-Schiller-Universität — *Jena, Germany, 2010*
- Lecture: *Numerische Relativitaetstheorie (Numerical Relativity)*

Teaching Assistant — *Undergraduate level*
Theoretisch-Physikalisches Institut, Friedrich-Schiller-Universität — *Jena, Germany, 2009*
- Lecture: *Allgemeine Relativitaetstheorie (General Relativity)*

Teaching Assistant/Grader — *Undergraduate level*
Department of Physics, UNAM — *Mexico City, Mexico, 2006-2007*
- Lecture: *General Relativity*

Teaching Assistant/Grader — *Graduate level*
Department of Physics, UNAM — *Mexico City, Mexico, 2005*
- Lecture: *Classical Mechanics*

Teaching Assistant/Grader — *Graduate level*
Department of Physics, UNAM — *Mexico City, Mexico, 2005*
- Lecture: *Quantum Mechanics*

Student Advising

2016-2018	**Abid Khan, graduate student**, UIUC	*Urbana, Illinois*
2015 -	**Lunan Sun, graduate student**, UIUC	*Urbana, Illinois*
2018 -	**Illinois Relativity Group REU Team: Guangkuo Liu, Minh Nguyen, Kyle Nelli**, UIUC	*Urbana, Illinois*
2019 -	**Illinois Relativity Group REU Team: Samuel Qunell, Michael Mudd**, UIUC	*Urbana, Illinois*

Seminar and Conference Organizer

Theoretical Astrophysics and General Relativity Seminar — *Urbana, Illinois*
Weekly seminar — *Jan 2017 - Dec 2017*

First Symposium of Relativistic Astrophysics — *Bucaramanga, Colombia*
Industrial University of Santander — *June 10-12, 2015*

Theoretical Astrophysics and General Relativity Seminar
Weekly seminar
Urbana, Illinois
Aug 2013 - May 2014

Theoretical Astrophysics and General Relativity Journal Club
Weekly seminar
Urbana, Illinois
2013-2015

Grants/Allocations

Studies in Theoretical Astrophysics and General Relativity
co-PI, High-End Computing resources NASA (s2057)
Awarded: 4,291,380 SBUs
2018-2021

Studies in Theoretical Astrophysics and General Relativity
Co-PI, XSEDE Resource Allocation System (MCA99S008)
Awarded: 3,404,828.0 SUs
2019-2020

"Gravitational and Electromagnetic Signatures of Compact Binary Mergers: General Relativistic Simulations at the Petascale
Co-PI, Blue Waters Allocation (ILL joh)
Awarded: 750,000 node-hours ($ 465,500 USD)
2018-2019

Black Hole Formation on Cosmological Space-times
PI, Industrial University of Santander/Colciencias
Awarded: $ 16,500 USD
2014-2015

Signatures of Compact Binary Mergers
Co-PI, Blue Waters Allocation (ILL joh)
Awarded: 500,000 node-hours
2017-2018

Studies In Theoretical Astrophysics and General Relativity
Co-PI, Resource Allocation System (MCA99S008)
Awarded: 3,000,000 SUs ($145,539.34 USD)
2017-2018

Gravitational and Electromagnetic Signatures of Compact Binary Mergers: General Relativistic Simulations at the Petascale
Co-PI, Blue Waters Allocation (ILL joh)
Awarded: 990,000 node-hours
2016-2017

Compact Object Binary Mergers: Simulations in Full General Relativity
Co-PI, XSEDE Resource Allocation System (PHY100053)
Awarded 4,069,156 SUs ($145,539.34 USD)
2014-2015

Gravitational and Electromagnetic Signatures of Compact Binary Mergers: General Relativistic Simulations at the Petascale
Co-PI, Blue Waters Allocation (ILL joh)
Awarded: 610,000 node-hours
2013-2014

Electromagnetic Signatures of Neutron Star Binaries
PI, Mare Nostrum BSC Allocation (FI-2011-3-0017)
Awarded: 120,000 core-hours ($18,895.45 €)
2011-2012

Peer Reviewer/Referee

- Classical and Quantum Gravity
- Monthly Notices of the Royal Astronomical Society
- Physical Review D
- Physical Review Letters
- The Astrophysical Journal

Invited Talks/Panelist

Stellar compact mergers as progenitors of gravitational waves & short-gamma ray bursts — *Aveiro, Portugal*
Online seminar at Mathematics and Physics Department of Aveiro University — *Dec 9, 2020*

Black hole-neutron star and binary neutrons star mergers: Progenitors of sGRBs — *Rocher institute of technology, Rochester, NY, US*
TCAN on Binary neutron star workshop — *July 7-10, 2020*

Community Astrophysics Science with the Einstein Toolkit Code — *Guadalajara, Mx*
University of Guadalajara — *Nov 20-24, 2017*

Multimessenger astronomy: The new era of gravitational waves and electromagnetic Signatures — *Jeju, Korea*
Collaborative Conference on Gravitational Waves — *May 22-26, 2017*

Gravitational Waves, a New Observational Window on the Universe — *Bogotá, Col*
Physics Colloquium, National university of Colombia — *May 16-19, 2016*

Numerical relativity at the University of Santander — *Barranquilla, Col*
Celebrating One Hundred Years of the General Relativity — *Nov 4-6, 2015*

Numerical Solutions of the Einstein's field Equations — *Bucaramanga, Col*
First Symposium on Relativistic Astrophysics — *June 10-12, 2015*

The Cactus code and Numerical Relativity — *Bogotá, Col*
National Astronomical Observatory, National university of Colombia — *Dec 16-20, 2006*

Contributed Talks

Black hole-neutron star and binary neutrons star mergers: Progenitors of sGRBs — *University of Notre Dame, IN, US*
30th Annual Midwest Relativity Meeting — *Oct 21-23, 2020*

Spinning binary neutron star mergers: Effects of the spin on jet outflows — *Allendale, Michigan, US*
29th Midwest Relativity Meeting — *Oct 4-5, 2019*

Effects of spin on magnetized binary neutron star mergers and jet launching — *Denver, Colorado, US*
APS April Meeting — *April 13-16, 2019*

GW170817, General Relativistic Magnetohydrodynamic Simulations, and the Neutron Star Maximum Mass — *Wisconsin-Milwaukee, US*
28th Midwest Relativity Meeting — *Oct 12-13, 2018*

Accretion Disks Around Supermassive Binary Black Holes: GRMHD Simulations of Postdecoupling and Merger — *Chicago, Il, US*
12th International Lisa Symposium — *July 8-13, 2018*

GW170817, General Relativistic Magnetohydrodynamic Simulations, and the Neutron Star Maximum Mass — *Columbus, Ohio, US*
APS April Meeting — *April 14-17, 2018*

GRMHD simulations of prompt-collapse neutron star mergers: the absence of jets — *Ann Arbor, Michigan, US*
27th Midwest Relativity Meeting — *Oct 12-14, 2017*

Binary neutron star mergers as engines of short gamma-ray bursts: delayed vs. prompt collapse
APS April Meeting
Washington, DC, US
Jan 28-31, 2017

MHD simulations of NSNS mergers in full GR: the role of the initial B field on the emergence of sGRB jets
APS April Meeting
Salt Lake City, Utah, US
April 16-19, 2016

Relativistic simulations of black hole-neutron star coalescence: the jet emerges
25th Midwest Relativity Meeting
Evanston, Il, US
Oct 1-3, 2015

Numerical Relativity: From Vacuum to Matter Spacetimes
The 1st Colombia-ICRANet Julio Garavito Armero Meeting
Bogotá-Bucaramanga, Col
Nov 23-27, 2015

Black Hole-Neutron Star Coalescence as engines that power sGRBs
Second Workshop on Astronomy
Bogotá, Col
July 27-31, 2015

Relativistic simulations of black hole-neutron star coalescence: the jet emerges II
APS April Meeting
Baltimore, Maryland, US
April 11-14, 2015

Gravitational Waves as Probes of Dark Matter Spikes around Massive Black Holes
Theoretical Astrophysics and General Relativity Seminar
Urbana, Il, US
Sep 3, 2014

General relativistic corrections to the pulsar spin-down luminosity
APS April Meeting
Savannah, Georgia
April 5-8, 2014

I-Love-Q Relations in Neutron Stars and their Applications to Astrophysics, Gravitational Waves and Fundamental Physics
Theoretical Astrophysics and General Relativity Seminar
Urbana, Il, US
Feb 2, 2014

Initial boundary value problem of the Z4c formulation of General Relativity
23th Midwest Relativity Meeting
Evanston, Il, US
Oct 25-26, 2013

The Initial Value Problem in General Relativity
CoCoNuT Meeting
Palma de Mallorca, Spain
Nov 26-28, 2012

High Order Outer Boundary Conditions for the Z4c Formulation
Workshop on Numerical and Mathematical Relativity
Oppurg, Germany
Oct 11-13, 2012

Magnetospheres of compact objects in Force-Free Plasma
2nd Iberian Gravitational Wave meeting
Barcelona, Spain
Feb 15-17, 2012

Constraint Preserving Boundary Conditions for the Z4c Formulation
Workshop on Computational General Relativity
Province, Rhode Island, US
May 20-22, 2011

Constraint Preserving Boundary Conditions for the Z4c Formulation of General Relativity
19th International Conference on General Relativity and Gravitation
Mexico City, Mx
Oct 25-27, 2010

Refereed Publications

Black hole-neutron star coalescence: effects of the neutron star spin on jet launching and dynamical ejecta mass
M. Ruiz, V. Paschalidis, A. Tsokaros, S. L. Shapiro
Phys. Rev. D in press
ArXiv:2011.08863
2020

Gravitational Waves from Disks Around Spinning Black Holes: Simulations in Full General Relativity
E. Wessel, V. Paschalidis, A. Tsokaros, **M. Ruiz**, S. L. Shapiro
ArXiv:2011.04077
Submitted to PRD
2020

Magnetic Ergostars, Jet Formation and Gamma-Ray Bursts: Ergoregions versus Horizons
M. Ruiz, A. Tsokaros, S. L. Shapiro, Kyle Nelli, Sam Quell
Phys. Rev. D 102, 104022
2020

GW190814: Spin and equation of state of a neutron star companion
A. Tsokaros, **M. Ruiz**, S. L. Shapiro
Astrophys. J. 905, 48
2020

Ergostar models: where do they reside?
A. Tsokaros, **M. Ruiz**, S. L. Shapiro
Phys. Rev. D 101, 064069
2020

Prospects for Fundamental Physics with LISA
E. Barausse et al.
Gen. Rel. Grav. 52, 81
2020

Magnetohydrodynamic Simulations of Binary Neutron Star Mergers in General Relativity: Effects of Magnetic Field Orientation on Jet Launching
M. Ruiz, A. Tsokaros, S. L. Shapiro
Phys. Rev. D 101, 064042
2020

The great impostors: Extremely compact, merging binary neutron stars in the mass gap posing as binary black holes
A. Tsokaros, **M. Ruiz**, L. Sun, S. L. Shapiro, K. Uryu
Phys. Rev. Lett. 124, 071101
2019

Dynamically stable ergostars exist: General relativistic models and simulations
A. Tsokaros, **M. Ruiz**, L. Sun, S. L. Shapiro, K. Uryu
Phys. Rev. Lett. 123, 231103
2019

Enabling real-time multi-messenger astrophysics discoveries with deep learning
E. Huerta et al.
Nature Reviews Physics 1, 600
2019

Effect of spin on the inspiral of binary neutron stars
A. Tsokaros, **M. Ruiz**, V. Paschalidis, S. L. Shapiro, K. Uryu
Phys.Rev. D100, 024061
2019

Are fast radio bursts the most likely electromagnetic counterpart of neutron star mergers resulting in prompt collapse?
V. Paschalidis, **M. Ruiz**
Phys. Rev. D100, 043001
2019

Effects of spin on magnetized binary neutron star mergers and jet launching
M. Ruiz, A. Tsokaros, V. Paschalidis, S. L. Shapiro, K. Uryu
Phys.Rev. D99, 084032
2019

Magnetic Braking and Damping of Differential Rotation in Massive Stars
L. Sun, **M. Ruiz**, S. L. Shapiro
Phys.Rev. D99, 064057
2019

Constant circulation sequences of binary neutron stars and their spin characterization
A. Tsokaros, K. Uryu, **M. Ruiz**, S. L. Shapiro
Phys. Rev. D98, 124019
2018

Jet launching from binary black hole-neutron star mergers: Dependence on black hole spin, binary mass ratio and magnetic field orientation
M. Ruiz, A. Tsokaros, S. L. Shapiro
Phys. Rev. D98, 123017
2018

Simulating the Magnetorotational Collapse of Supermassive Stars: Incorporating Gas Pressure Perturbations and Different Rotation Profiles
L. Sun, **M. Ruiz**, S. L. Shapiro
Phys. Rev. D98, 103008
2018

Disks Around Merging Binary Black Holes: From GW150914 to Supermassive Black Holes
A. Khan, V. Paschalidis, **M. Ruiz**, S. L. Shapiro
Phys. Rev. D97, 044036
2018

GW170817, General Relativistic Magnetohydrodynamic Simulations, and the Neutron Star Maximum Mass
M. Ruiz, S. L. Shapiro, A. Tsokaros
Phys. Rev. D 97, 021501R
2018

The initial boundary value problem for free-evolution formulations of General Relativity
D. Hilditch, **M. Ruiz**
Class. Quan. Grav. 35 015006
2018

GRMHD simulations of prompt-collapse neutron star mergers: the absence of jets
M. Ruiz, S. L. Shapiro
Phys. Rev. D 96, 084063
2017

Magnetorotational Collapse of Supermassive Stars: Black Hole Formation, Gravitational Waves and Jets
L. Sun, V. Paschalidis, **M. Ruiz**, S. L. Shapiro
Phys. Rev. D 96, 043006
2017

Gravitational wave content and stability of uniformly, rotating, triaxial neutron stars in general relativity
T. Tsokaros, **M. Ruiz**, V. Paschalidis, S. L. Shapiro, L. Baiotti, K. Uryu
Phys. Rev. D 95, 124057
2017

Binary neutron star mergers: a jet engine for short gamma-ray bursts
M. Ruiz, R. Lang, V. Paschalidis,S. L. Shapiro
Astrophys. J. Lett. 824, L6
2016

Relativistic simulations of black hole-neutron star coalescence: the jet emerges
V. Paschalidis, **M. Ruiz**, S. L. Shapiro
Astrophys. J. Lett. 806, L14
2015

Accretion disks around binary black holes of unequal mass: GRMHD simulations of postdecoupling and merger
R. Gold, V. Paschalidis, **M. Ruiz**, S. L. Shapiro, Z. B. Etienne, H. Pfeiffer
Phys. Rev. D 90, 104030
2014

The Pulsar spin-down luminosity: simulations in general relativity
M. Ruiz, V. Paschalidis, S. L. Shapiro
Phys. Rev. D 89, 084045
2014

Almost-Killing conserved currents: a general mass function
M. Ruiz, C. Palenzuela, C. Bona.
Phys. Rev. D 89, 025011
2014

Induced scalarization in boson stars and scalar gravitational radiation
M. Ruiz, J. C. Degollado, M. Alcubierre, D. Nunez, M. Salgado
Phys. Rev. D 86, 104044
2012

The role of the ergosphere in the Blandford-Znajek process
M. Ruiz, C. Palenzuela, F. Galeazzi, C. Bona.
Mon. Not. R. Aston. Soc. 423
2012

Constraint preserving boundary conditions for the Z4c formulation of general relativity
M. Ruiz, D. Hilditch, S. Bernuzzi
Phys. Rev. D 83, 024025
2011

Dynamic transition to spontaneous scalarization in boson stars
M. Alcubierre J. C. Degollado, D. Nunez, **M. Ruiz**, M. Salgado
Phys. Rev. D 81, 124018
2010

Multipole expansions for energy and momenta carried by gravitational waves
M. Ruiz, M. Alcubierre, D. Nunez, R. Takahashi
Gen. Rel. Grav. 40, 2467
2008

Regularization of spherical and axisymmetric evolution codes in numerical relativity
Gen. Rel. Grav. 40, 159
M. Ruiz, M. Alcubierre, D. Nunez
2008

Outer boundary conditions for Einstein's field equations in harmonic coordinates
Class. Quant. Grav. 24, 6349
M. Ruiz, O. Rinne, O. Sarbach
2007

Conference Publications

Gravity and Light: Combining Gravitational Wave and Electromagnetic Observations in the 2020s
FERMILAB-PUB-19-169-AE
R. Foley et al.
2019

Deep Learning for Multi-Messenger Astrophysics: A Gateway for Discovery in the Big Data Era
arXiv:1902.00522
G. Allen et al.
2019

Regularization of spherical and axisymmetric codes in numerical relativity
Rev. Mex. Fis. 53, 144
M. Ruiz, M. Alcubierre, D. Nunez
2007

Computer Skills

Operating Systems: UNIX, Linux, Windows, Mac OS X

Programming Language: FORTRAN, C, C++

Graphics and Image Processing: Mathematica, Microcal Origin, SM, Gnuplot, VIsIt, Python

Document Preparation LaTeX, Microsoft Office, Open/Libre Office

Other: Bash scripting, Basic system administration

Languages

Spanish (native speaker)

English

Primary References

Professor Miguel Alcubierre
Departamento de Gravitación y Teoría de Campos
Instituto de Ciencias Nucleares
UNAM
Mexico City, Mexico
malcubi@nucleares.unam.mx
+55 562-33-371 Ext. 3371

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Theoretisch-Physikalisches Institut
Friedrich-Schiller-Universitaät Jena
Jena, Germany
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Professor Vasileios Paschalidis
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University of Arizona
Tucson, Arizona, US
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Department of Physics
University of Illinois at Urbana-Champaign
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slshapir@illinois.edu
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