

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 binary 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. I have been supported by grants from the National Science Foundation (NSF) and the National Aeronautics and Space Agency (NASA).

Work Experience

Research Scientist

DEPARTMENT OF PHYSICS,
University of Illinois at Urbana-Champaign (UIUC)

Urbana, Illinois

Aug 2016 -

Postdoctoral Research Associate

DEPARTMENT OF PHYSICS,
UIUC

Urbana, Illinois

2013 - 2016

CPAN Postdoctoral Research Associate

SPANISH NATIONAL CENTER FOR PARTICLE, ASTROPARTICLE AND NUCLEAR PHYSICS,
Universitat de les Illes Balears

Palma de Mallorca, Spain

2011 - 2013

Postdoctoral Research Associate

THEORETISCH-PHYSIKALISCHES INSTITUT,
Friedrich-Schiller-Universität

Jena, Germany

2009 - 2010

Education

Ph.D. Physics

NATIONAL AUTONOMOUS UNIVERSITY OF MEXICO (UNAM)

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

Mexico City, Mexico

April, 2009

Master of Science (Physics)

UNAM

Mexico City, Mexico

June, 2006

Bachelor of Science (Physics)

NATIONAL UNIVERSITY OF COLOMBIA

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

Bogota, Colombia

June, 2003

Major Collaborations

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 THEORETISCH-PHYSIKALISCHES INSTITUT	Jena, Germany June-July 2008
Louisiana State University CENTER FOR COMPUTATIONAL AND TECHNOLOGY	Louisiana, US June - Aug 2006

Teaching Experience

Guest Lecturer INDUSTRIAL UNIVERSITY OF SANTANDER • Lecture: <i>Advanced Topics in General Relativity</i>	Graduate level Bucaramanga, Colombia, 2015
Teaching Assistant THEORETISCH-PHYSIKALISCHES INSTITUT, FRIEDRICH-SCHILLER-UNIVERSITÄT • Lecture: <i>Numerische Relativitaetstheorie (Numerical Relativity)</i>	Undergraduate level Jena, Germany, 2010
Teaching Assistant THEORETISCH-PHYSIKALISCHES INSTITUT, FRIEDRICH-SCHILLER-UNIVERSITÄT • Lecture: <i>Allgemeine Relativitaetstheorie (General Relativity)</i>	Undergraduate level Jena, Germany, 2009
Teaching Assistant/Grader DEPARTMENT OF PHYSICS, UNAM • Lecture: <i>General Relativity</i>	Undergraduate level Mexico City, Mexico, 2006-2007
Teaching Assistant/Grader DEPARTMENT OF PHYSICS, UNAM • Lecture: <i>Classical Mechanics</i>	Graduate level Mexico City, Mexico, 2005
Teaching Assistant/Grader DEPARTMENT OF PHYSICS, UNAM • Lecture: <i>Quantum Mechanics</i>	Graduate level Mexico City, Mexico, 2005

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

WEEKLY SEMINAR

Urbana, Illinois

Jan 2017 - Dec 2017

First Symposium of Relativistic Astrophysics

INDUSTRIAL UNIVERSITY OF SANTANDER

Bucaramanga, Colombia

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, BLUE WATERS ALLOCATION (ILL JOH)

Awarded: 487,000 node-hours

2020-2021

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

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

Invited Talks/Panelist

Full GR simulations of stellar compact mergers: From GW170817 to GW190814

ONLINE SEMINAR AT CERTER FOR ASTROPHYSICS AND GRAVITATION (CENTRA)

Lisbon, Portugal

March 4, 2021

Stellar compact mergers as progenitors of gravitational waves & short-gamma ray bursts

ONLINE SEMINAR AT MATHEMATICS AND PHYSICS DEPARTMENT OF AVEIRO UNIVERSITY

Aveiro, Portugal

Dec 9, 2020

Black hole-neutron star and binary neutrons star mergers: Progenitors of sGRBs

TCAN ON BINARY NEUTRON STAR WORKSHOP

*Rocher institute of technology,
Rochester, NY, US*

July 7-10, 2020

Community Astrophysics Science with the Einstein Toolkit Code

UNIVERSITY OF GUADALAJARA

Guadalajara, Mx

Nov 20-24, 2017

Multimessenger astronomy: The new era of gravitational waves and electromagnetic Signatures

COLLABORATIVE CONFERENCE ON GRAVITATIONAL WAVES

Jeju, Korea

May 22-26, 2017

Gravitational Waves, a New Observational Window on the Universe

PHYSICS COLLOQUIUM, NATIONAL UNIVERSITY OF COLOMBIA

Bogotá, Col

May 16-19, 2016

Numerical relativity at the University of Santander

CELEBRATING ONE HUNDRED YEARS OF THE GENERAL RELATIVITY

Barranquilla, Col

Nov 4-6, 2015

Numerical Solutions of the Einstein's field Equations

FIRST SYMPOSIUM ON RELATIVISTIC ASTROPHYSICS

Bucaramanga, Col

June 10-12, 2015

The Cactus code and Numerical Relativity

NATIONAL ASTRONOMICAL OBSERVATORY, NATIONAL UNIVERSITY OF COLOMBIA

Bogotá, Col

Dec 16-20, 2006

Contributed Talks

Black hole-neutron star and binary neutrons star mergers: Progenitors of sGRBs

30TH ANNUAL MIDWEST RELATIVITY MEETING

University of Notre Dame, IN, US

Oct 21-23, 2020

Spinning binary neutron star mergers: Effects of the spin on jet outflows

29TH MIDWEST RELATIVITY MEETING

Allendale, Michigan, US

Oct 4-5, 2019

Effects of spin on magnetized binary neutron star mergers and jet launching

APS APRIL MEETING

Denver, Colorado, US

April 13-16, 2019

GW170817, General Relativistic Magnetohydrodynamic Simulations, and the Neutron Star Maximum Mass

28TH MIDWEST RELATIVITY MEETING

Wisconsin-Milwaukee, US

Oct 12-13, 2018

Accretion Disks Around Supermassive Binary Black Holes: GRMHD Simulations of Postdecoupling and Merger

12TH INTERNATIONAL LISA SYMPOSIUM

Chicago, Il, US

July 8-13, 2018

GW170817, General Relativistic Magnetohydrodynamic Simulations, and the Neutron Star Maximum Mass

APS APRIL MEETING

Columbus, Ohio, US

April 14-17, 2018

GRMHD simulations of prompt-collapse neutron star mergers: the absence of jets

27TH MIDWEST RELATIVITY MEETING

Ann Arbor, Michigan, US

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

Refereed Publications

Minidisk Dynamics in Accreting, Spinning Black Hole Binaries: Simulations in Full General RelativityV. PASCHALIDIS, J. BRIGHT, **M. Ruiz**, R. GOLD*Submitted to Astrophys. J. Lett.**ArXiv:2102.06712*

2021

Multimessenger Binary Mergers Containing Neutron Stars: Gravitational Waves, Jets, and γ -Ray Bursts. *Invited review for the Research Topic: Neutron Star Physics in the Multi-Messenger Discourse.***M. Ruiz**, S. L. SHAPIRO, A. TSOKAROS*Frontiers Astronomy and Space**Science (in press)**ArXiv:2102.03366*

2021

Gravitational Waves from Disks Around Spinning Black Holes: Simulations in Full General RelativityE. WESSEL, V. PASCHALIDIS, A. TSOKAROS, **M. Ruiz**, S. L. SHAPIRO*Phys. Rev. D 103, 043013*

2021

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 102, 124077*

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 companionA. 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 holesA. TSOKAROS, **M. Ruiz**, L. SUN, S. L. SHAPIRO, K. URYU*Phys. Rev. Lett. 124, 071101*

2019

Dynamically stable ergostars exist: General relativistic models and simulationsA. 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 starsA. 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?	<i>Phys. Rev. D100, 043001</i>
V. PASCHALIDIS, M. Ruiz	2019
Effects of spin on magnetized binary neutron star mergers and jet launching	<i>Phys.Rev. D99, 084032</i>
M. Ruiz, A. TSOKAROS, V. PASCHALIDIS, S. L. SHAPIRO, K. URYU	2019
Magnetic Braking and Damping of Differential Rotation in Massive Stars	<i>Phys.Rev. D99, 064057</i>
L. SUN, M. Ruiz, S. L. SHAPIRO	2019
Constant circulation sequences of binary neutron stars and their spin characterization	<i>Phys. Rev. D98, 124019</i>
A. TSOKAROS, K. URYU, M. Ruiz, S. L. SHAPIRO	2018
Jet launching from binary black hole-neutron star mergers: Dependence on black hole spin, binary mass ratio and magnetic field orientation	<i>Phys. Rev. D98, 123017</i>
M. Ruiz, A. TSOKAROS, S. L. SHAPIRO	2018
Simulating the Magnetorotational Collapse of Supermassive Stars: Incorporating Gas Pressure Perturbations and Different Rotation Profiles	<i>Phys. Rev. D98, 103008</i>
L. SUN, M. Ruiz, S. L. SHAPIRO	2018
Disks Around Merging Binary Black Holes: From GW150914 to Supermassive Black Holes	<i>Phys. Rev. D97, 044036</i>
A. KHAN, V. PASCHALIDIS, M. Ruiz, S. L. SHAPIRO	2018
GW170817, General Relativistic Magnetohydrodynamic Simulations, and the Neutron Star Maximum Mass	<i>Phys. Rev. D 97, 021501R</i>
M. Ruiz, S. L. SHAPIRO, A. TSOKAROS	2018
The initial boundary value problem for free-evolution formulations of General Relativity	<i>Class. Quan. Grav. 35 015006</i>
D. HILDITCH, M. Ruiz	2018
GRMHD simulations of prompt-collapse neutron star mergers: the absence of jets	<i>Phys. Rev. D 96, 084063</i>
M. Ruiz, S. L. SHAPIRO	2017
Magnetorotational Collapse of Supermassive Stars: Black Hole Formation, Gravitational Waves and Jets	<i>Phys. Rev. D 96, 043006</i>
L. SUN, V. PASCHALIDIS, M. Ruiz, S. L. SHAPIRO	2017
Gravitational wave content and stability of uniformly, rotating, triaxial neutron stars in general relativity	<i>Phys. Rev. D 95, 124057</i>
T. TSOKAROS, M. Ruiz, V. PASCHALIDIS, S. L. SHAPIRO, L. BAIOTTI, K. URYU	2017
Binary neutron star mergers: a jet engine for short gamma-ray bursts	<i>Astrophys. J. Lett. 824, L6</i>
M. Ruiz, R. LANG, V. PASCHALIDIS, S. L. SHAPIRO	2016
Relativistic simulations of black hole-neutron star coalescence: the jet emerges	<i>Astrophys. J. Lett. 806, L14</i>
V. PASCHALIDIS, M. Ruiz, S. L. SHAPIRO	2015
Accretion disks around binary black holes of unequal mass: GRMHD simulations of postdecoupling and merger	<i>Phys. Rev. D 90, 104030</i>
R. GOLD, V. PASCHALIDIS, M. Ruiz, S. L. SHAPIRO, Z. B. ETIENNE, H. PFEIFFER	2014

The Pulsar spin-down luminosity: simulations in general relativity	<i>Phys. Rev. D 89, 084045</i>
M. Ruiz, V. PASCHALIDIS, S. L. SHAPIRO	2014
Almost-Killing conserved currents: a general mass function	<i>Phys. Rev. D 89, 025011</i>
M. Ruiz, C. PALENZUELA, C. BONA.	2014
Induced scalarization in boson stars and scalar gravitational radiation	<i>Phys. Rev. D 86, 104044</i>
M. Ruiz, J. C. DEGOLLADO, M. ALCUBIERRE, D. NUNEZ, M. SALGADO	2012
The role of the ergosphere in the Blandford-Znajek process	<i>Mon. Not. R. Aston. Soc. 423</i>
M. Ruiz, C. PALENZUELA, F. GALEAZZI, C. BONA.	2012
Constraint preserving boundary conditions for the Z4c formulation of general relativity	<i>Phys. Rev. D 83, 024025</i>
M. Ruiz, D. HILDITCH, S. BERNUZZI	2011
Dynamic transition to spontaneous scalarization in boson stars	<i>Phys. Rev. D 81, 124018</i>
M. ALCUBIERRE J. C. DEGOLLADO, D. NUNEZ, M. Ruiz, M. SALGADO	2010
Multipole expansions for energy and momenta carried by gravitational waves	<i>Gen. Rel. Grav. 40, 2467</i>
M. Ruiz, M. ALCUBIERRE, D. NUNEZ, R. TAKAHASHI	2008
Regularization of spherical and axisymmetric evolution codes in numerical relativity	<i>Gen. Rel. Grav. 40, 159</i>
M. Ruiz, M. ALCUBIERRE, D. NUNEZ	2008
Outer boundary conditions for Einstein's field equations in harmonic coordinates	<i>Class. Quant. Grav. 24, 6349</i>
M. Ruiz, O. RINNE, O. SARBACH	2007

Conference Publications

Gravity and Light: Combining Gravitational Wave and Electromagnetic Observations in the 2020s	<i>FERMILAB-PUB-19-169-AE</i>
R. FOLEY ET AL.	2019
Deep Learning for Multi-Messenger Astrophysics: A Gateway for Discovery in the Big Data Era	<i>arXiv:1902.00522</i>
G. ALLEN ET AL.	2019
Regularization of spherical and axisymmetric codes in numerical relativity	<i>Rev. Mex. Fis. 53, 144</i>
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

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UNAM

Mexico City, Mexico

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Professor Vasileios Paschalidis

Astronomy and Physics Departments

University of Arizona

Tucson, Arizona, US

vpaschal@email.arizona.edu

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Professor Stuart L. Shapiro

Department of Physics

University of Illinois at Urbana-Champaign

Urbana, IL, US

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