

## Ian Ruchlin

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## Curriculum Vitae

### Research Interests

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General relativity; numerical relativity; black hole initial data and evolution; highly spinning black holes; gravitational waves; strong gravity; neutron stars; magnetohydrodynamics.

My primary research focus involves generating accurate numerical simulations of the inspiral and merger phases of orbiting black holes and neutrons stars. In particular, I am interested in exploring the extreme limits of general relativity in the regime of near-extremal intrinsic angular momentum, strong magnetic fields, and fluids with nuclear densities. In addition to probing the peculiarities of nonlinear gravity theory, I generate astrophysical gravitational waveforms for use in gravitational wave detection experiments.

### Education

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2010/09–2015/08	Ph. D. Astrophysical Sciences and Technology, Rochester Institute of Technology, Rochester, NY, USA.
2007/09–2010/05	B. Sc. Physics, Syracuse University, Syracuse, NY, USA.
2007/09–2010/05	B. Sc. Mathematics, Syracuse University, Syracuse, NY, USA.

### Employment

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2015/09—Present	Postdoctoral Research Associate, Department of Mathematics, West Virginia University.
2011/06–2016/08	Graduate Research Associate, Center for Computational Relativity and Gravitation, Rochester Institute of Technology.
2010/09–2011/05	Graduate Teaching Assistant, College of Science, Rochester Institute of Technology.
2008/02–2010/08	Laboratory Assistant, Cryogenic Dark Matter Search, Syracuse University.

### Publications

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1. **Ian Ruchlin**, James Healy, Carlos O. Lousto, and Yosef Zlochower (2015). Gravitational Radiation and orbital dynamics of highly spinning black-hole binaries. In preparation for Physical Review D.
2. James Healy, **Ian Ruchlin**, Carlos O. Lousto, and Yosef Zlochower (2015). High Energy Collisions of Black Holes Numerically Revisited. Submitted to Physical Review D. arXiv:1506.06153
3. **Ian Ruchlin**, James Healy, Carlos O. Lousto, and Yosef Zlochower (2015). New Puncture Initial Data for Black-Hole Binaries: High Spins and High Boosts. Submitted to Physical Review D. arXiv:1410.8607

4. **I. Ruchlin** and R. W. Schnee (2012). Calculating a confidence interval on the sum of binned leakage. Nuclear Instruments and Methods in Physics Research Section A. Volume 664, Issue 1, Pages 336–340. arXiv:1106.6296

## Grants & Fellowships

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- American Physical Society Travel Grant (APS April Meeting Travel Grant, 2015/04).
- Graduate Student Research and Creativity Grant (Rochester Institute of Technology Grant, 2014/12).
- New York Space Grant/Astrophysical Sciences & Technology Fellowship (Rochester Institute of Technology, 2013/08–2014/05).
- New York Space Grant/Astrophysical Sciences & Technology Fellowship (Rochester Institute of Technology, 2011/08—2012/05).
- Astrophysical Sciences and Technology Travel Grant (Rochester Institute of Technology Grant, 2011/11).
- Graduate Student Research and Creativity Grant (Rochester Institute of Technology Grant, 2011/11).
- Chancellor's Scholarship (Syracuse University Merit Scholarship, 2007/08—2010/05).
- Student Grant (Syracuse University Financial Aid Grant, 2007/08–2010/05).

## Presentations

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- “Modeling Dynamical Black Holes With Spin Parameters Larger than 0.999.” Talk presented at APS April Meeting, 2016/04.
- “Celebrating 100 Years of Einstein's General Relativity.” Talk presented to the Astronomy Section of the Rochester Academy of Sciences, 2015/06.
- “Puncture Initial Data for Highly Spinning Black-Hole Binaries.” Talk presented at 18<sup>th</sup> East Coast Gravity Meeting, 2015/05.
- “Puncture Initial Data for Highly Spinning Black-Hole Binaries.” Talk presented at APS April Meeting, 2015/04.
- “Simulating Highly Spinning Black Hole Binaries.” Talk presented at 7<sup>th</sup> RIT Graduate Research and Creativity Symposium, 2015/02.
- “Puncture Initial Data for Black Hole Binaries with Nearly Extremal Spins.” Talk presented at 24<sup>th</sup> Midwest Relativity Meeting, 2014/11.
- “Puncture Initial Data for Black Hole Binaries with Nearly Extremal Spins.” Talk presented at 17<sup>th</sup> East Coast Gravity Meeting, 2014/05.
- “A New Look at the Early Universe through the Cosmic Background.” Talk presented to the Astronomy Section of the Rochester Academy of Sciences, 2014/05.
- “Simulating Highly Spinning Black Hole Binaries.” Talk presented at 6<sup>th</sup> RIT Graduate Research and Creativity Symposium, 2014/04.
- “Puncture Initial Data for Highly Spinning Black Hole Binaries.” Talk presented at 16<sup>th</sup> East Coast Gravity Meeting, 2013/06.
- “Spinning Black Holes in Numerical Relativity.” Talk presented at The College at Brockport Masters Graduate Research Conference, 2013/04.
- “The Dance of Highly Spinning Black Hole Binaries.” Poster presented at Rochester Institute of Technology's President's Roundtable, 2013/03.
- “Initial Data for Black Hole Binaries.” Talk presented at Rochester Institute of Technology Astrophysical Sciences & Technology Research Talks Jamboree, 2012/10.
- “Solving initial data for black hole binaries in trumpet slicing with spectral methods.” Talk presented at 15<sup>th</sup> East Coast Gravity Meeting, 2012/04.
- “Solving black hole binary trumpet initial data with spectral methods.” Talk presented at 21<sup>st</sup> Midwest Relativity Meeting, 2011/11.

- “Solving black hole binary trumpet initial data with spectral methods.” Talk presented at Rochester Institute of Technology Astrophysical Sciences & Technology Research Talks Jamboree, 2011/10.
- “Black-Hole Binary Initial Data.” Talk presented at Rochester Institute of Technology Center for Computational Relativity and Gravitation Lunch Seminar, 2011/10.
- “Multi-bin Confidence Intervals and Dark Matter Detection.” Talk presented at Rochester Institute of Technology Astro Lunch Seminar, 2011/09.
- “Calculating Confidence Intervals on Leakage.” Talk presented at Rochester Institute of Technology Astrophysical Sciences & Technology Research Talks Jamboree, 2010/10.
- “Confidence Intervals on Misclassification.” Poster presented at Syracuse University Mayfest, 2010/04.
- “Calculating Confidence Intervals in Multi-bin Binomial Data.” Poster presented at Syracuse University Physics Undergraduate Research Day, 2008/11.

## Research & Teaching Experience

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- Highly spinning black hole binary inspiral and merger simulations using full numerical relativity.
  - Constructed new initial data allowing near-extremal spins and arbitrary momenta, reduced initial spurious radiation content by an order of magnitude, performed long duration numerical evolutions, and extracted accurate gravitational waveforms (arXiv:1410.8607).
  - Measured gravitational wave energy emitted in the high momentum head-on collisions of black holes (arXiv:1506.06153).
- Statistical modeling of binomial rare-event searches in the context of direct dark matter detection experiments (arXiv:1106.6296).
- Wrote lesson plans and presented several lectures for Prof. Manuela Campanelli’s undergraduate multivariable and vector calculus course and graduate general relativity course, and Prof. Zachariah Etienne’s undergraduate integral calculus course and graduate numerical solutions to partial differential equations course.
- Worked three quarters (one academic year) as a teaching assistant, tutor, and grader for the courses University Physics II (calculus based rotational mechanics and harmonic oscillators), University Physics III (calculus based electricity and magnetism), and Matrices and Boundary Value Problems (introduction to linear algebra and partial differential equations).

## Outreach

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- Designed a computer applet to simulate gravitational lensing on a live stream from a webcam, and produced signage for the cosmology exhibit at the Museum of Science and Technology, Syracuse, NY, USA 2010/07.
- Designed and 3D printed models showing various spacetime embedding diagrams for the “Celebrating 100 Years of Einstein’s General Relativity” exhibit at the Imagine RIT 2015 innovation and creativity festival. Interacted with visitors ranging from young children to seniors, and explained basic concepts of length and time in the context of general relativity using posters, 3D models, and an interactive computer program.
- Gave public, hour-long lectures to a nonexpert audience, organized by the Astronomy Section of the Rochester Academy of Sciences, on various astrophysics topics including cosmic microwave background cosmology, dark matter detection, gravitational lensing, gravitational waves, black holes, and science history.

## References

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**Carlos O. Lousto**, Ph. D.  
Ph.D. Dissertation Advisor  
Professor of Mathematical Sciences  
Rochester Institute of Technology  
1-585-475-2219  
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**Manuela Campanelli**, Ph. D.  
Director, Center for Computational  
Relativity and Gravitation  
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