

# Robert Owen

Department of Physics and Astronomy  
Oberlin College  
Oberlin, OH 44074

Office: Wright 210  
Phone: (440) 775-8566  
Email: rowen@oberlin.edu

## Education:

---

Ph.D. Physics, California Institute of Technology, 2007.

*Dissertation:* Topics in numerical relativity: the periodic standing-wave approximation, the stability of constraints in free evolution, and the spin of dynamical black holes

*Committee:* Lee A. Lindblom (chair), Kip S. Thorne, Curt J. Cutler, Kenneth G. Libbrecht

B.S. Physics, University of Utah, 2001.

## Employment:

---

Assistant Professor: Oberlin College, Department of Physics and Astronomy, Fall 2012–Present.

Research Associate: Cornell University, Center for Radiophysics and Space Research, 2007–2012.

Postdoctoral Scholar: Caltech, Theoretical Astrophysics Group, Summer 2007.

## Research Interests:

---

Theoretical astrophysics and general relativity, particularly interactions in systems with black holes and neutron stars. Modeling such systems for application to gravitational-wave astrophysics. The interface of numerical relativity with continuum mathematics: numerical methods, systems of partial differential equations. Mitigating gauge ambiguity in the analysis and interpretation of numerical relativity simulations.

## External Funding:

---

*Spin and Horizon Multipoles in Numerical Relativity, and the Visualization of Dynamical Spacetimes*

Cottrell College Science Award, Research Corporation for Science Advancement

Funded at \$55,000 for two years, starting July 1, 2015

*MRI: Acquisition of a high-performance computing cluster to enhance undergraduate research and education in the sciences at Oberlin College*

PI: Michael Moore, co-PIs: Matt Elrod, Aaron Goldman, Robert Owen, Manish Mehta

National Science Foundation

Funded at \$486,256, starting September 1, 2014

## Publications:

---

Nearly extremal apparent horizons in simulations of merging black holes

*Geoffrey Lovelace, Mark A. Scheel, **Robert Owen**, Matthew Giesler, Reza Katebi, Bela Szilagyi, Tony Chu, Nicholas Demos, Daniel A. Hemberger, Lawrence E. Kidder, Harald P. Pfeiffer, Nousha Afshari*

**Classical and Quantum Gravity**, 32, 065007 (2015); arxiv:1411.7297

A catalog of 174 high-quality binary black-hole simulations for gravitational-wave astronomy

*Abdul H. Mroue, Mark A. Scheel, Bela Szilagyi, Harald P. Pfeiffer, Michael Boyle, Daniel A. Hemberger, Lawrence E. Kidder, Geoffrey Lovelace, Sergei Ossokine, Nicholas W. Taylor, Anil Zenginoglu, Luisa T. Buchman, Tony Chu, Evan Foley, Matthew Giesler, **Robert Owen**, Saul A. Teukolsky*

**Phys. Rev. Lett.** 111, 241104 (2013); arxiv:1304.6077

Visualizing Spacetime Curvature via Frame-Drag Vortices and Tidal Tendexes III. Quasinormal Pulsations of Schwarzschild and Kerr Black Holes

*David A. Nichols, Aaron Zimmerman, Yanbei Chen, Geoffrey Lovelace, Keith D. Matthews, **Robert Owen**, Fan Zhang, Kip S. Thorne*

**Phys. Rev. D** 86, 104028 (2012); arxiv:1208.3038

Visualizing Spacetime Curvature via Frame-Drag Vortices and Tidal Tendexes II. Stationary Black Holes

*Fan Zhang, Aaron Zimmerman, David A. Nichols, Yanbei Chen, Geoffrey Lovelace, Keith D. Matthews, **Robert Owen**, Kip S. Thorne*

**Phys. Rev. D** 86, 084049 (2012); arxiv:1208.3034

A Geometric Approach to the Precession of Compact Binaries

*Michael Boyle, **Robert Owen**, Harald P. Pfeiffer*

**Phys. Rev. D** 84, 124011 (2011); arxiv:1110.2965

Visualizing Spacetime Curvature via Frame-Drag Vortices and Tidal Tendexes I. General Theory and Weak-Gravity Applications

*David A. Nichols, **Robert Owen**, Fan Zhang, Aaron Zimmerman, Jeandrew Brink, Yanbei Chen, Jeffrey D. Kaplan, Geoffrey Lovelace, Keith D. Matthews, Mark A. Scheel, Kip S. Thorne*

**Phys. Rev. D** 84, 124014 (2011); arxiv:1108.5486

Frame-Dragging Vortices and Tidal Tendexes Attached to Colliding Black Holes: Visualizing the Curvature of Spacetime

***Robert Owen**, Jeandrew Brink, Yanbei Chen, Jeffrey D. Kaplan, Geoffrey Lovelace, Keith D. Matthews, David A. Nichols, Mark A. Scheel, Fan Zhang, Aaron Zimmerman, Kip S. Thorne*

**Phys. Rev. Lett.** 106, 151101 (2011); arxiv:1012.4869

Degeneracy Measures for the Algebraic Classification of Numerical Spacetimes

***Robert Owen***

**Phys. Rev. D** 81, 124042 (2010); arxiv:1004.3768

## The Final Remnant of Binary Black Hole Mergers: Multipolar Analysis

*Robert Owen***Phys. Rev. D** 80, 084012 (2009); arxiv:0907.0280

## Binary-Black-Hole Initial Data with Nearly-Extremal Spins

*Geoffrey Lovelace, Robert Owen, Harald P. Pfeiffer, Tony Chu***Phys. Rev. D** 78, 084017 (2008); arxiv:0805.4192

## Constraint Damping in First-Order Evolution Systems for Numerical Relativity

*Robert Owen***Phys. Rev. D** 76, 044019 (2007); arxiv:gr-qc/0703145

## A New Generalized Harmonic Evolution System

*Lee Lindblom, Mark A. Scheel, Lawrence E. Kidder, Robert Owen, Oliver Rinne***Class. Quant. Grav.** 23, S447; arxiv:gr-qc/0512093

## The Periodic Standing-Wave Approximation: Nonlinear Scalar Fields, Adapted Coordinates, and the Eigenspectral Method

*Benjamin Bromley, Robert Owen, Richard H. Price***Phys. Rev. D** 71, 104017 (2005); arxiv:gr-qc/0502034

## Optimal Constraint Projection for Hyperbolic Evolution Systems

*Michael Holst, Lee Lindblom, Robert Owen, Harald P. Pfeiffer, Mark A. Scheel, Lawrence E. Kidder***Phys. Rev. D** 70, 084017 (2004); arxiv:gr-qc/0407011

## The Periodic Standing-Wave Approximation: Overview and Three Dimensional Scalar Models

*Zeferino Andrade, Christopher Beetle, Alexey Blinov, Benjamin Bromley, Lior M. Burko, Maria Cranor, Robert Owen, Richard H. Price***Phys. Rev. D** 70, 064001 (2004); arxiv:gr-qc/0310001

## Presentations:

### Invited Talks:

## Gravitational Waves and Computational General Relativity

Physics Colloquium

Denison University

March 4, 2016

## An Entirely New Kind of Astronomy

Physics Colloquium

College of Wooster

February 11, 2016

Simulating Colliding Black Holes in Computational General Relativity

Physics Colloquium

Kenyon College

December 5, 2014

Also presented at Ohio Northern University, April 16, 2015

Wormholes, Black Holes, and the Structure of Spacetime: the Science of *Interstellar*

Physics Colloquium

Oberlin College

November 6, 2014

Vortex/Tendex Structure of Anisotropic Cosmologies

GWPAC Seminar

California State University, Fullerton

January 24, 2014

Visualizing black hole dynamics through the vorticity and tendicity of spacetime

Physics Colloquium

Oakland University

March 28, 2013

Spacetime Vorticity, Tendicity, and the Near-Field Structure of Dynamical Black Holes

Gravitation Theory Seminar

University of Maryland

February 20, 2013

The Computation and Interpretation of Binary Black Hole Spacetimes

NANOGrav Science Seminar

Webcast to members of the NANOGrav pulsar timing collaboration

December 3, 2012

Physical Interpretation of Numerical Spacetimes

Special Session on Modern Relativity

Fall Eastern Sectional Meeting, American Mathematical Society

Rochester Institute of Technology

September 22, 2012

Exploring Black Hole Collisions by Computational Simulation

Physics Colloquium

Oberlin College

February 15, 2012

Characterizing Precession in Binary Sources of Gravitational Waves

CCRG Lunch

Rochester Institute of Technology

February 3, 2012

Exploring the Dynamics of Spacetime through Frame-Drag Vorticity and Tidal Tendicity

Fundamental Theory Seminar

Penn State Institute for Gravitation and the Cosmos

January 13, 2012

Algebraic Classification of Numerical Black Hole Spacetimes

Caltech Tapir Seminar

September 3, 2008

Public Outreach and Other Less-Technical Talks:

---

A Universe From an Idea

Public address commemorating the 100th anniversary of General Relativity

Presented at 15th annual Bryce Canyon Astronomy Festival

June 18, 2015

When Hollywood Gets the Science Right

On the science of the movie *Interstellar*

Presented at 15th annual Bryce Canyon Astronomy Festival

June 19, 2015

The Life and Work of a Theoretical Physicist

Presented to students at Alta High School, Sandy, Utah

January 9, 2015

Wormholes, Black Holes, and the Structure of Spacetime: the Science of *Interstellar*

Presented to the Astronomy Club of Akron, October 2014

Presented also at *Dark Ranger Telescope Tours*, an astronomy-related public outreach organization in southern Utah, January 13, 2015

Computational Physics in Teaching and Research

Talk at a *Computational Modeling Showcase* sponsored by Oberlin's CLEAR Center

May 8, 2014

Black Holes, Neutron Stars, Gravitational Waves, and the Dawn of Multimessenger Astronomy

Presented to the Astronomy Club of Akron

May 24, 2013

Presented to the Black River Astronomical Society

November 6, 2013

The Structure of Space and Time

Describing special and general relativity to members of the Oberlin community

Presented at the Studio Gallery and Lyceum, Oberlin OH

April 29, 2013

Simulating Black Hole Collisions in Computational General Relativity

Semi-technical talk to the Oberlin chapter of Sigma Xi

Oberlin College

March 13, 2013

Contributed Talks:

Defining and calculating spin on deformed apparent horizons

2015 April Meeting of the American Physical Society

Baltimore, MD, April 14, 2015

A subtlety with the demodulation of waveforms from precessing binaries

2012 April Meeting of the American Physical Society

Atlanta, GA, March 31, 2012

Tidal Tendency, Frame-Drag Vorticity, and Black Hole Superkicks

14th Eastern Gravity Meeting

Princeton University, June 3, 2011

Further interpretation and application of frame-drag vorticity and tidal tendency

2011 April Meeting of the American Physical Society

Anaheim, CA, April 30, 2011

Petrov Classification in Numerical Relativity

2010 April Meeting of the American Physical Society

Washington, DC, February 13, 2010

A Multipolar Analysis of Black Hole Ringdown

12th Eastern Gravity Meeting

Rochester Institute of Technology, June 15, 2009

Multipolar analysis of a binary black hole merger

2009 April Meeting of the American Physical Society  
Denver, CO, May 4, 2009

Approximate Killing Vectors on Deformed Two-Spheres

23rd Pacific Coast Gravity Meeting  
California Institute of Technology, March 17, 2007

Constraint Damping in the KST Evolution Systems

2006 April Meeting of the American Physical Society  
Dallas, TX, April 23, 2006

Constraint Damping in the KST Evolution Systems

22nd Pacific Coast Gravity Meeting  
University of California, Santa Barbara, March 4, 2006  
*Awarded GGR Prize, for best student talk of the conference*

An Extension of the KST Evolution Systems for Numerical Relativity

21st Pacific Coast Gravity Meeting  
University of Oregon, March 25, 2005

Optimal Constraint Projection for Symmetric-Hyperbolic Systems

20th Pacific Coast Gravity Meeting  
California Institute of Technology, March 27, 2004

Numerical Issues with Relativistic Periodic Orbits

2002 April Meeting of the American Physical Society  
Albuquerque, NM, April 20, 2002

## Teaching Experience:

---

Fall Semester 2012–present: Teaching duties as Assistant Professor of Physics at Oberlin College.  
Courses taught include:

Physics 054: Musical Acoustics

Physics 110, lecture and workshop/lab sections: introductory calculus-based mechanics course

Physics 290: Computational Modeling

Physics 311: Electricity and Magnetism

Physics 321: Introduction to General Relativity

Fall Semester 2010: *Senior Staff* for Physics 2213 at Cornell University

Introductory calculus-based course on thermodynamics, statistical mechanics, electricity and magnetism.

Oversaw TAs, wrote homework solutions, wrote exam problems, led recitation sections, graded, and handled some course logistics.

2003-2004: *Teaching Assistant* for Physics 236 at Caltech

Advanced graduate-level course in general relativity and numerical relativity, taught by Kip Thorne and Lee Lindblom

Wrote homework solutions, graded, handled student questions, and judged oral exams.

2002-2003: *Grader* for Physics 1 at Caltech

Introductory calculus-based course on mechanics, electricity, and magnetism, taken by all first-year Caltech undergraduates.

Graded homework sets and exams

2000-2002: *Teaching Assistant* for Physics 2210 and 2220 at the University of Utah

Introductory calculus-based courses on mechanics, electricity, and magnetism.

Led recitation sections and collaborative-learning sections, and graded homework and exams.

## Undergraduate Research Projects Supervised:

---

Elizabeth Garbee

*Computational characterization of quasilocal spin angular momentum*

Graduated Oberlin College, 2014. Now in graduate school at Arizona State University.

Ben Lemberger

*Algebraic Speciality and Gravity-Electromagnetism in Bianchi Type IX*

Graduated Oberlin College, 2014, with highest honors. Now in graduate school at the University of Wisconsin, Madison.

Zach Mark

*The Quasinormal Modes of the Kerr-Newman Spacetime in the Small Charge Limit*

Graduated Oberlin College, 2014, with high honors. Now in graduate school at the California Institute of Technology.

Dan Laufer

*Mathematical details of quasilocal angular momentum in general relativity*

Graduated Oberlin College, 2015. Now in graduate school at University College, London.

Gabe Fishel

*Discontinuous Galerkin Finite-Element simulations for computational acoustics and astrophysics*

Graduated Oberlin College, 2016.

H. Perry Hatchfield

*Cosmic Strings and Filaments: Femtolensing and Accretion in Cylindrically Symmetric Spacetime*

Graduated Oberlin College, 2015, with high honors. Now in graduate school at The University of Connecticut.



## Media Attention:

---

*'Gravity lines' trace warped space-time*, by David Shiga

New Scientist, issue 2809 (April 23, 2011), page 14.

*When Black Holes Collide*, by Shannon Palus

Discover Magazine, September 2011 issue, page 13.

Warped Space-Time Around Black Holes Visualized, by Stephanie Pappas

LiveScience.com, syndicated to various media outlets.

Research also described online in posts at NewScientist.com, MSNBC.com, Discovery.com, Universe Today, Astronomy.com, and elsewhere (links embedded in pdf).

Last updated: May 31, 2016