

Robert Owen

Department of Physics and Astronomy
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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:

Computational 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 Vortexes 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 Vortexes 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 Vortexes 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 Vortexes 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:

Numerical Relativity and the Gravitational Waves from Black Hole Mergers

Physics Colloquium

Case Western Reserve University

November 17, 2016

Computational General Relativity and the Detection of Gravitational Waves from Black Hole Collisions

Physics Colloquium

John Carroll University

September 29, 2016

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:

Detection and Analysis of Gravitational Waves from Colliding Black Holes

Public talk to the Akron Physics Club
October 24, 2016

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 tendicity

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

Physice 310: Classical Mechanics

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.

Student 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 Gravito-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, 2016, 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).