Steven Dorsher

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Education

Massachusetts Institute of Technology *August 2000 - May 2004*
Bachelor of Science, Physics. Overall GPA: 4.6 / 5.0
Thesis on statistical feasibility of measuring dark matter and dark energy using gravitational lensing of galaxies.

The Ohio State University *August 2004 - August 2006*
Master of Science, Plan C, Astronomy Overall GPA: 3.810 / 4.000
Publication on the statistics of exoplanets.

University of Minnesota, Twin Cities *August 2006 - July 2013*
Master of Science, Plan C, Physics Overall GPA: 3.652 / 4.000
Five publications on neutrinos, statistics of gravity gradient noise, and data analysis of gravitational waves.

Louisiana State University, Baton Rouge *June 2014 - December 2017*
Master of Science, Plan C, Physics Overall GPA: 3.784 / 4.000
Thesis on computing black hole orbits by numerically solving a general relativistic differential equation.

Career Objective

To make an impact in a field where I can harness aspects of my training as a computational physicist in data analysis and numerical simulation to benefit the company, my colleagues, and society.

Technical Strengths

Programming	Physics & Astronomy
Data Analysis	Black Holes & Gravitational Waves
Numerical Methods of Scientific Computing	Particle Physics
Python, C++, FORTRAN, Matlab, C	Teaching & Tutoring
Pandas & SQL	

Research Experience

Louisiana State University, Baton Rouge **6/2014 - 9/2017**
Center for Computational Physics *Numerical Relativity – Black Hole Orbits in C++, FORTRAN, and Python*

- Helped design an object-oriented framework for simulating an Extreme Mass Ratio black hole binary orbit, where a stellar mass black hole orbiting a supermassive black hole loses energy due to the self-force generated by the interaction of the stellar mass's curved spacetime wit the background spacetime of the supermassive black hole, causing the stellar mass black hole to spiral inward. I simulated the scalar self-force approximation to this problem on a Schwarzschild background using the discontinuous Galerkin method for the spatial grid, in 3+1D with multipole moments for the higher spatial dimensions. The simulation was in C++, based on the SelfForce1D FORTRAN code in the Blackhole Perturbation Toolkit and the Einstein Toolkit.

- Tested convergence of the generalized wave equation solver for sinusoidal and Gaussian waves as a function of lm-mode and DG-order.

- Confirmed that the behavior of the C++ code I wrote matched the expected theoretical values of the quasinormal modes and exponential tails of the ring-down post-black-hole-merger for a Gaussian perturbation modeling that post-merger state on a curved spacetime.
- Numerically evolved self force loops using the DG-differential equation solver as a step toward implementing more generic orbits. Obtained round-off error precision between my C++ code and the existing FORTRAN code.
- Ran the FORTRAN code which acted as a model for my C++ code and produced plots of the geodesic evolution of the orbit with the self-force backreaction turned on.
- For existing data from the FORTRAN code, extrapolated a finite number of lm-modes to a sum of infinite modes, using a variety of techniques, as a function of starting DG-order. Determined the DG-order at which round-off noise takes over, so no incremental improvement can be gained by increasing resolution to higher DG-order.
- Documented this work in a 70+ page MSc thesis, which became the basis for my Masters degree.

Louisiana State University, Baton Rouge **12/2015 - 1/2017**
LIGO Scientific Collaboration *Prototype Gravitational Wave Event Candidate Database*

- Collaborated in a small interdepartmental effort to select a database design for a prototype upgraded database to store events that could be either environmental or gravitational wave candidates for the LIGO gravitational wave detector.
- Installed HBase in standalone mode on my laptop.
- Implemented a few simple standard queries using the Java API with MapReduce.
- Documented my work in a short summary document.

University of Minnesota, Twin Cities **9/2008 - 1/2011**
LIGO Scientific Collaboration *Gravitational Waves Data Analysis in MATLAB*

- Helped calculate statistics for the STAMP gravitational wave transient search based upon cross-correlations of frequency-time maps and pattern recognition algorithms.
- Wrote data analysis software in Matlab based on a statistical modification of the radon transform to look for line-like gravitational wave event candidates on a spectrogram of a statistic based on the coherence between the two LIGO detectors, in MATLAB.
- Helped implement tests of this software using trial waveforms. Was able to demonstrate parameter recovery.
- Wrote section V.B of Thrane et al.

University of Minnesota, Twin Cities **9/2008 - 1/2011**
LIGO Scientific Collaboration *Gravity Gradient Noise Statistics– Analytical and in MATLAB*

- Improved a simulation of the gravity gradient noise due to isotropic seismic waves in an underground interferometric gravitational wave detector. Included seismic P waves and implemented the differential arm mode contribution in the interferometer.
- Analytically calculated the gravity gradient noise in an underground gravitational wave detector due to isotropic seismic S and P waves. Introduced a plane boundary such as the surface of the Earth.
- Calculated coherence as a function of distance for seismometer data from Homestake Mine to determine if it was a suitable site for a future underground gravitational wave detector.

University of Minnesota, Twin Cities **6/2008 - 8/2008**
Summer Research Fellowship *Theoretical Particle Physics – Analytical Computation*

- Calculated a component of the muon magnetic moment due to electromagnetic interactions to tree level using symmetry considerations.

University of Minnesota, Twin Cities **8/2007 - 6/2008**
NOνA and MINOS Neutrino Detectors *Experimental Particle Physics*

- Ran analyses of avalanching photodiodes to verify their suitability for the NOνA neutrino detector. Produced a plot of temperature versus breakdown voltage.
- Manually classified particle tracks in the MINOS neutrino detector.

The Ohio State University, Columbus **6/2004 - 1/2006**
OGLE-III exoplanet transit candidates *First Exoplanet Statistics in FORTRAN*

- Computed the first exoplanet statistics by simulating two lines of sight in the galaxy as well as the statistical effect of transits on the brightness of stars to determine the number of stars that passed magnitude cuts for potential OGLE-III transit candidates. Extended this simulation from a preliminary outline of the simulation provided by advisor.
- Categorized planets by two categories related to the depth of the transit, in order to create proportions of Hot Jupiters and Very Hot Jupiters in the galaxy.
- Wrote a very preliminary draft of a section of the publication that resulted.

Massachusetts Institute of Technology, Cambridge **1/2003 - 5/2014**
Center for Space Research *Cosmology Feasibility Study – Computational Statistics in C*

- Performed a Monte Carlo simulation in C to determine whether or not strong gravitational lens systems could be used to measure cosmological parameters based on measurements of the Einstein ring radii and one dimensional velocity dispersions of the lensing galaxies. Determined that assuming an singular isothermal spherical lensing galaxy, this technique gave marginal improvements over current state-of-the art measurement techniques at the time.
- Determined that assuming an axisymmetric lensing galaxy, this technique gave marginal improvements over current state-of-the art measurement techniques at the time.
- Considered the effect of making the central lensing galaxies oblate or prolate.
- Qualitatively considered the effect of introducing triaxiality in the central lensing galaxies. Concluded the method was not feasible as compared to other methods available at the time based upon Einstein Ring Radii.
- Wrote the undergraduate thesis Using gravitational lens geometry to measure cosmological parameters.

Projects

Newtonian Three Body Problem Numerical Simulation **8/2018 - 1/2022**
This project's purpose was to investigate phenomena related to orbits of three stars or planets in Newtonian gravity. The simulation in python numerically evolved a differential equation to produce these orbits. To verify them, it checked convergence of the simulation with step size, tested conservation of energy and momentum, and performed fits to the orbits based on known solutions in the case of two body orbits. Following that, it evolved an orbit for a binary star system with a distant planet to produce a plot of the energy transfer between the planet and the binary star system over the course of one orbit. This was then compared to the literature, determining that the specific result was novel, but that it was consistent with existing similar results.

Fractional Calculus Algorithm For Integration and Differentiation **7/2012 - 8/2013**
This project's purpose was to develop a novel low storage fractional calculus algorithm for fractional integration and differentiation, then to simulate it to test feasibility in C++. In this project, it was found that the constant phase bandwidth was improved over similar algorithms by two orders of magnitude. A first author publication was submitted, but not published.

Image of a Black Hole **5/2016**
This project's purpose was to produce a 48 x 48 pixel image of a black hole using parallel processing techniques in mpi4py in python. Ray tracing of the light of the stars in the galaxy was used to produce the image, by computing the relativistic geodesics along which they traveled.

Teaching Experience

Tutor.com **8/2020 - present**
Professional Tutor *Math, Physics, and Astronomy*

- Initially tutored algebra II, trigonometry, pre-calculus, calculus, calculus BC, and algebra and calculus based physics.
- Now only tutoring both varieties of calculus, both varieties of physics, as well as astronomy.

Varsity Tutors **1/2020 - 5/2020**
Professional Tutor *Math, Physics, Astronomy, and Engineering Tutor*

- Tutored recurring students at scheduled hours remotely by video, voice, and whiteboard in calculus, multivariable calculus, physics, and electrical engineering.

Unaffiliated **4/2019 -1/2020**
Volunteer Tutor *Physics and Calculus in Assorted Groups on Facebook*

- Volunteered on a few Facebook groups where I answered questions, often from students, several hours a day. Topics were mostly calculus, higher math, astronomy (especially black holes), and a little bit of general physics.

Louisiana State University, Baton Rouge, Physics **2/2017 - 5/2017; 8/2017 - 12/2017**
Teaching Assistant Grader for Upper Level and Graduate Courses in Physics Grader for Graduate General Gourses in Physics

- Graded Graduate Quantum Mechanics, Graduate Classical Mechanics twice, and Undergraduate Computational Physics.
- Held office hours for some of these classes
- Prepared and taught a one hour review session in Graduate Quantum Mechanics.

Louisiana State University, Baton Rouge, Physics **6/2015 - 12/2015; 5/2017 -8/2017**
Teaching Assistant *Tutor for General Physics*

- Tutored students on a walk-in basis for introductory physics courses.

Louisiana State University, Baton Rouge, Physics **1/2015 - 5/2015**
Teaching Assistant *Led General Physics Lab*

- Lead a classroom of 30 students in electromagnetism, optics, circuitry, and spectroscopy labs.
- Graded lab reports weekly.

Louisiana State University, Baton Rouge, Physics **8/2014 - 12/2014**
Teaching Assistant *Graded and Assisted in Physics Majors Introductory Lab*

- Assisted in teaching physics, statistics, and lab technique concepts through the Socratic method in a small group setting.
- Helped troubleshoot lab technique, analysis, and equipment problems.
- Graded and gave feedback on lab notebooks both in person and on paper.

Louisiana State University, Baton Rouge, Physics **6/2014 - 8/2014**
Teaching Assistant *Temporary Outreach Coordinator, Monitoring Progress of REU's*

- Monitored the research progress of 30 high school, college, and high school teacher researchers in the summer REU program at the Center for Computation and Technology and in the LA-SIGMA materials science program in the physics department, using knowledge of physics and computing to make judgments and write reports. Reported and discussed these summaries with two professors supervising these REU researchers.
- Helped everyday events run smoothly through coordination with food delivery, audio-visual, purchasing, event lists, facilities, and the organizers of the weekly meetings and summer camps.

University of Minnesota, Twin Cities, Physics **2/2011 - 5/2011**
Teaching Assistant *Lab Development – Introductory College Physics I*

- Developed constant velocity motion, uncertainty, and distortion of the camera lab material for the Introductory College Physics I lab manual.
- Wrote a preliminary draft of the constant velocity motion and uncertainty lab to replace the existing Lab 0.

University of Minnesota, Twin Cities, Physics **5/2007 - 12/2007; 8/2008 - 5/2009**
Teaching Assistant *Introductory College Physics I for Majors & II for Non-Majors*

- Instructed introductory physics classes based on University of Minnesota physics department guidelines.
- Led cooperative group laboratory and discussion sections of thirty students.
- Graded homework, papers, lab reports, and exams.
- Tutored for all introductory University of Minnesota physics classes at office hours.

The Ohio State University **8/2005 - 5/2006**
Teaching Assistant *Assisted in Lecture for General Astronomy I & II*

- Developed and presented review material to a class of more than 100 students prior to each exam.
- Presented planetarium shows for both students and the public.
- Selected exam questions from a question bank.
- Tutored at office hours.
- Proctored exams.

Academic Achievements

- University Fellowship, The Ohio State University, 2004 - 2005
- University Fellowship, University of Minnesota, 2006 - 2007
- Summer Research Fellowship, University of Minnesota, 2008

Primary Publications

- Using Gravitational Lens Geometry to Measure Cosmological Parameters
  S. Dorsher; Undergraduate Thesis
  Massachusetts Institute of Technology; 2004; (Status: Passed, eprint)
- Frequency of Hot Jupiters and Very Hot Jupiters Toward the Galactic Bulge and Carina
  A. Gould, et al.; ActaAstron.56:1-50; 2006 (Status: Published)
- The NOνA Technical Design Report
  D. S. Ayres, et al.; 2007 (Status: Published)
- Simulation of underground gravity gradients from stochastic seismic fields
  J. Harms, et al.; Phys.Rev.D 80 122001; 2009; (Status: Published)
- Gravity-Gradient Subtraction in 3rd Generation Underground Gravitational-Wave Detectors in Homogeneous Media; J Harms, et al; 2009; (Status: eprint)
- Characterization of the seismic environment at the Sanford Underground Laboratory, South Dakota
  Class.Quant.Grav. 27 225011; 2010; (Status: Published)
- Long gravitational-wave transients and associated detection strategies for a network of terrestrial interferometers; E. Thrane, et al.; Phys.Rev.D83:083004; 2011; (Status: Published)
- An efficient broadband deep memory algorithm for computing fractional order operator
  S. Dorsher, G. Bohannan; (Status: Unpublished)
- Strategies for Computing the Scalar Self-Force on a Schwarzschild Background
  S. Dorsher; Master's Thesis, Plan C
  Louisiana State University; 2017 (Status: Passed, eprint)