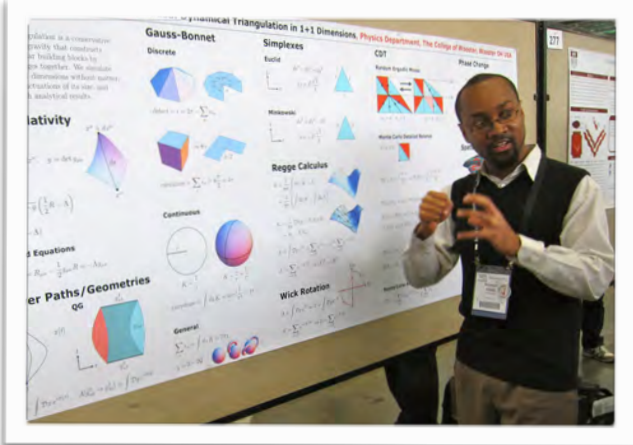


Wooster Physics



Norman Israel '12 presents his research on causal dynamical triangulation at the National APS meeting in Boston.

2011 – 2012

www3.wooster.edu/physics

Greetings!

Wooster Physics Veterans & Friends,

The 2011-2012 academic year was an exciting and eventful one for the department.

Don Jacobs retired from the College in December after 36 years of teaching, research, and service. For me, Dr. J is and always will be a model for combining teaching and research in a career. He is a superb teacher and one of the best researchers to devote his entire career to an undergraduate institution. His contributions to the College are enormous. He grew Wooster's Physics Department from its near-death experience in the 1970s into one of the best small physics departments in the country. I will miss his wisdom and advice in both small and large matters.

Our new tenure-track professor of physics Cody Leary began setting up an innovative lab in quantum optics. One year visiting professor of physics Nicole Moore replaced Susan Lehman who enjoyed a one year sabbatical. Thanks to our astronomer Karen Lewis, this spring, Astronomy Table on Wednesdays in Kittredge alternated with Physics Table on Mondays in Lowry, as we now have both an Astronomy Club and a Physics Club. Manon Grugel-Watson completed her fifth year as Lab Coordinator and Adjunct



Instructor, so she has now been at the College longer as staff than she was as a student!

With a record number of 15 juniors, we split Jr I.S. into a fall and a spring section for the first time ever. The 11th year of our elementary school outreach program included creating four half-hour training videos for our demonstrations. We had a great turnout at our 23rd annual Taylor Bowl. Our 4th annual Science Day in Taylor Hall was a big success.

The department was well represented at the March meeting of the American Physical Society in February (sic) in Boston, including three students and two professors. This was at least the 15th consecutive March APS meeting that Wooster students have attended and presented their research.

Our 19th annual summer research program involved eight students on campus working on a wide range of projects with three professors. In addition, Shila Garg, back from being Dean and Provost of the College, worked with two other Wooster students at Kent State University.

I thank Jackie Middleton for her great work this year and for preparing this 16th annual report.

Alumni please email us or visit if you're in the area -- we love to hear how you're doing!

John Lindner, Czar of Physics

Contents

- Class of 2012
- Honors & Awards
- Senior Independent Study
- Junior Independent Study
- Physics Club
- Colloquia
- Faculty & Staff
- Patriot Award & Robot Mania
- APS Meeting & Summer Research
- Off-Campus Research & Study Abroad
- Alumni News
- History



Alyse Marquinez '12, Milo Carpenter '13 and Deepika Sundarraman '14 with their robot "Dolly Llama"

Class of 2012

front: Sarah Beth Loder, Margaret Raabe, Alyse Marquinez

back: Matt Damon, Patrick Butler, Norman Israel,

Katsuo Maxted, David Simpson,

Saif Ahmad, Kemal Ramic

below: Larry Markley



Mohammad Saif Ahmad

Kingston Jamaica
Major: Physics & Mathematics

Future plans: Saif will be attending graduate school in nuclear physics at George Washington University in Washington DC.

Sarah-Beth Loder

Chardon Ohio
Major: Chemical Physics

Future plans: Sarah-Beth will be the first environmental sustainability coordinator at The College of Wooster.

Margaret Raabe

Columbus Ohio
Major: Physics

Future plans: Margaret will be pursuing a graduate degree in biomedical engineering at The Ohio State University.

Patrick Butler

Lakewood Ohio
Major: Physics

Future plans: employment

Larry Markley

Orrville Ohio
Major: Physics

Future plans: Larry plans to do additional coursework in computer science at The University of Akron.

Kemal Ramic

Zenica Bosnia and Herzegovina
Major: Physics & Mathematics

Future plans: Kemal will attend Rennselaer Polytechnic Institute to study nuclear engineering.

Matt Damon

Glenshaw Pennsylvania
Major: Physics

Future plans: Matt hopes to find a position coaching basketball.

Alyse Marquinez

Hudson Ohio
Major: Physics & Political Science

Future plans: Alyse has been awarded an internship at ABS Materials, Wooster.

David Simpson

Gilroy California
Major: Chemical Physics

Future plans: David will study graduate physics at Clarkson University in Potsdam, New York.

Norman Israel

St. Mary Jamaica
Major: Physics & Mathematics

Future plans: Norman will be entering the physics PhD program at Ohio University.

Katsuo Maxted

Wauseon Ohio
Major: Physics

Future plans: Katsuo will begin graduate studies in aerospace engineering at University of Cincinnati.

CLASS OF 2012



above: Saif Ahmad proudly wears the colors of Jamaica at Wooster's 142nd commencement ceremony.

College & Department Honors & Awards



above: David Simpson happily accepts his diploma...are those Old Gold sneakers he is wearing?

Joseph Albertus Culler Prize in Physics

Awarded to the first- or second-year student who has attained the highest rank in general college physics

Danielle Shepherd '14

Latin Honors

Summa cum laude

Margaret Raabe '12

Arthur Compton Prize

Awarded to the senior physics major attaining the highest standing in that subject

Norman Israel '12 and Margaret Raabe '12

Phi Beta Kappa

Margaret Raabe '12

Andrew Blaikie '13

Departmental Honors

Norman Israel '12

Margaret Raabe '12

Mahesh K. Garg Prize in Physics

Awarded to an upper-class physics major who has displayed interest in and potential for applying physics beyond the classroom

Lorenzo Dumanças '13 and Tyler Rhoades '13

David A. Guldin Award

Awarded to the top student-athlete in the graduating class

Margaret Raabe '12

Center for Entrepreneurship's 3rd Annual Competition

Social entrepreneurship category "Chnooze It," a philanthropic alarm clock that uses cloud-source technology to direct small donations to charity every time a student hits the snooze button on the alarm clock.

Kemal Ramic '12 and Saif Ahmad '12



Senior Independent Study

Katsuo Maxted

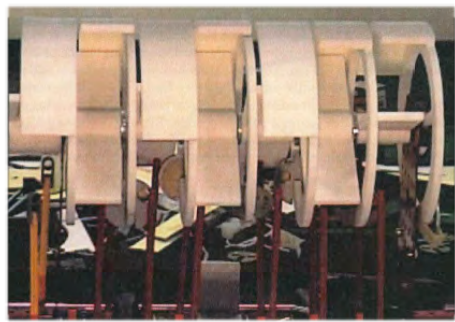
Physics

Advised by John Lindner

A Cyclic Aero-mechanical Array of One-way Coupled Oscillators

Abstract: One-way coupling of multi-stable elements produces novel phenomena. For example, a one-way coupled cyclic array of an odd number of bistable elements spontaneously forms solitary waves that propagate forever. Although such behavior appears to violate both energy and momentum conservation, it has been experimentally observed in hydro-mechanical and electrical arrays with externally powered coupling. This thesis describes the design, construction, and operation of a new and simpler aero-mechanical array that exhibits such phenomena. The array is designed in *Mathematica* and printed in ABS plastic by Shapeways. Its simplicity may make practical two-dimensional mechanical arrays where solitary waves propagate at different speeds in different directions.

Side view of the plastic array in motion



Alyse Marquinez

Physics & Political Science

Advised by John Lindner (Physics) and Bas Van Doorn (Political Science)

The Rocket Science behind the Political Science: Comparing Space Visions of the Presidents from 1993-2011 and the Rocket Technology That Helped Characterize Them

Abstract: This project discusses the influences on a president's national space vision and investigates rocket design aspects. Throughout the last several presidencies, each new president has cancelled space programs of the previous president leaving NASA, particularly, without the ability to achieve long-term goals. This small-N, comparative case study examines Presidents W. Clinton, G. W. Bush, and B. Obama's space visions through speech analysis and interview. Shepsle and Weingast's Distributional Politics theory and Allison's Bureaucratic Politics model of decision making guide this discussion. The mathematical computation program *Mathematica* was then used to simulate rocket staging, differences between liquid hydrogen and RP-1 as rocket fuels, and the differences between solid and liquid fuels. This paper concludes that the best science of the day is not always the first choice of presidents and their administrations and that a combination of political models would best describe the decision making process undergone for space policy. In addition, it is shown that rocket features have both advantages and disadvantages but a multi-staged hydrogen rocket launch vehicle may be the most desirable.



Alyse Marquinez '12 sports her custom-made "Rocket Scientist" t-shirt at the I.S. Monday celebration.

David Simpson

Chemical Physics

Advised by Donald Jacobs, Nicole Moore (Physics) and Karl Feierabend (Chemistry)

Analysis of the Correlation Length Amplitude of Nitrobenzene and Dodecane Binary-Fluid Solution

Abstract: The correlation length amplitude was determined through light scattering measurements for a mixture of nitrobenzene and dodecane. The objective was to determine the validity of the values presented by An *et al.* and Utt *et al.* The light scattering was done by taking measurements of the intensity of a laser beam as it passed through the sample at temperatures close to the critical temperature. The critical temperature was determined to drift upwards with time, indicating an extremely small contamination, most likely water. For the testing period the critical temperature was determined to have a value of $28.783 \pm 0.005^\circ\text{C}$. The scattering intensity data near the critical temperature was used to calculate the turbidity as a function of the reduced temperature. After producing a graph of the turbidity as a function of temperature, a correlation length amplitude was calculated by fitting the data. The value for the correlation length amplitude was found to be $0.207 \pm 0.004 \text{ nm}$, which does not



agree with any previous results. This result does not resolve the discrepancy of the data sets or prove that two-scale-factor universality is still valid.

Depiction of cell at critical temperature. A meniscus forms in the center between the dodecane rich upper phase and nitrobenzene rich lower phase.

Senior Independent Study

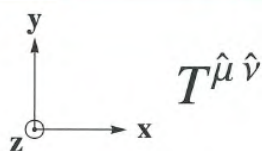
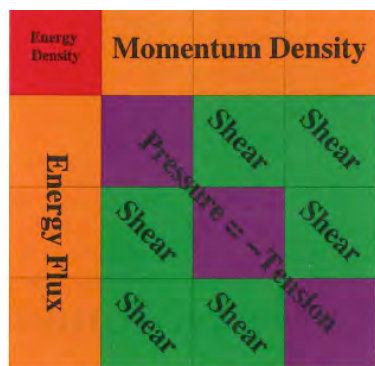
Larry Markley

Physics

Advised by John Lindner

Perturbing Spacetime

Abstract: Our main endeavor in this project is to elucidate the connection between “source” and “field” of gravity, that is between the Stress-Energy-Momentum (SEM) tensor and spacetime curvature in Einstein’s general relativity. To do this we run the typical process of working with Einstein’s field equations, $G_{\mu\nu} = \kappa T_{\mu\nu}$, in “reverse”. This essentially means that we specify the curvature and then derive the SEM. We visualize the curvature with geodesics and the SEM with arrays of contour plots. As an example, we compute the SEM to create an artificial gravity field aboard a starship.



Color coded SEM tensor

Matt Damon

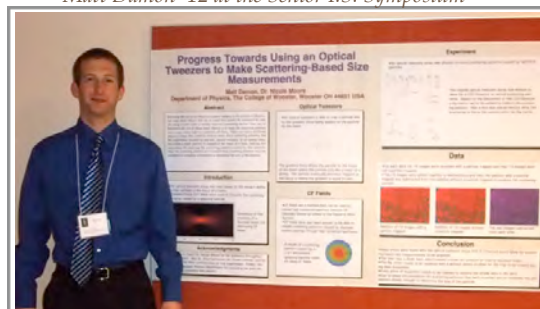
Physics

Advised by Nicole Moore

Progress Toward Using an Optical Tweezer to Make Scattering-based Size Measurements

Abstract: Knowing the size of an object is a crucial weapon in the arsenal of physics, but what about objects that are so small they cannot be measured by simply using a meter stick or another physical measuring device? One way to determine the size of these small objects is to study the scattering patterns they create when light is scattered off them. There are many different physical setups that could be used to study these scattering patterns, but this experiment focused on just one, optical tweezers. In an optical tweezers setup, a small particle is trapped at the focus of a laser, making this setup ideal for studying the scattering patterns caused by that particle. Once the scattering patterns are recorded these scattering patterns must be compared to computer simulations to determine the size of the particle. The computer simulations were created using Complex Focus (CF) fields because CF fields allowed for multiple simulations to be created with all variables held constant, except the size of the particle. The experimental scattering pattern could then be compared to the CF field simulation and whichever simulation the experimental scattering pattern matched the best determined the size of the particle. Determining the size of particles with an optical tweezers setup was the ultimate goal of this experiment, but this goal was not achieved for various reasons. Instead this experiment will provide vital experience for future experiments.

Matt Damon '12 at the Senior I.S. Symposium



Kemal Ramic

Physics & Mathematics

Advised by Karen Lewis (Physics) and James Hartman (Mathematics)

Monte Carlo Simulations of the Clumpy Torus in Active Galactic Nuclei

Abstract: It has been observed that approximately 10% to 30% of AGNs show no X-ray absorption, whereas the optical spectrum suggests significant obscuration. One possible explanation is that the obscuring medium consists of dense clumps. In the model, using Monte Carlo simulations, I conduct a study to check whether the clumpiness of the torus is a possible reason for the mismatch in optical and X-ray spectrums. For a variety of torus configurations I have found that there is no mismatch in the number of the clumps intersected between the lines of sight originating in the X-ray and optical regions. If time variability is assumed I found that, due to clumpiness, it is not possible to change the spectrum of AGN galaxy from absorbed to unabsorbed, but clumps could be responsible for more mild variations in the spectra. If the X-ray and optical spectra are not simultaneously observed there exists some level of disagreement on the degree of obscuration.



3D rendering of the clumps distribution from the model. The chosen inclination angle is the intermediate inclination angle.

Senior Independent Study

Mohammad Ahmad

Physics & Mathematics

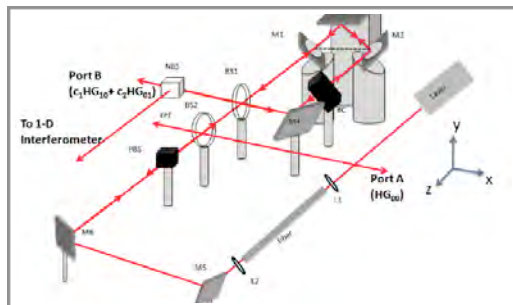
Advised by Cody Leary (Physics) and Pamela Pierce (Mathematics)

Parity-based Measurement and Control of the Spatial Wave Function of Photons

Abstract: The experiment involved parity based measurement and control of the spatial wave functions of photons. To achieve this the theory was developed for a 1-dimensional parity based interferometer. This interferometer was capable of taking a laser beam input that consisted of a specific solution set of Hermite-Gaussian modes and span of this solution set as well. The resulting theory was then modeled for several types of input beams and simulated for several special cases. The mathematical relationships governing the interferometer were exploited and simplified to establish a general matrix with complex entries that would model the output of any beam input to the interferometer. It was then proven that this governing matrix was unitary.

The modeled interferometer was then built and the results of multiple input beams were analyzed through the theory and simulations that were built based off of the general interferometer matrix. By analyzing certain properties of beams that were input to the interferometer one could in effect determine certain properties of the photons that could not otherwise be measured without losing the usefulness of the photon. By tweaking parameters within the interferometer one could also change the output of the interferometer

without changing the input beam. This is changing the spatial wave function of the photon. In this respect the experiment achieved its purpose although much can still be done to optimize the interferometer set up and effectively learn more about the input beams.



Schematic of the 2-dimensional parity sorter. The Hg_{00} mode is removed at port A, while the pure first-order mode leaves port B. Using a non polarizing cube beam splitter (NBS) this mode was redirected to the 1-D interferometer.

Margaret Raabe

Physics

Advised by Cody Leary

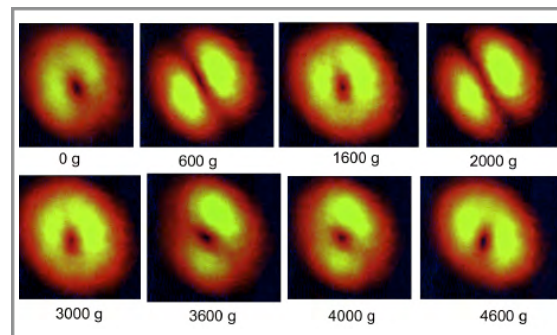
Manipulation of a Photon's Wave Function in Optical Fibers

Abstract: A method was developed to manipulate a photon's spatial wave function inside an optical fiber. This method involved placing physical stress on the fiber and utilized a phase-stable Sagnac interferometer that acts as a two-dimensional (2D) parity sorter. An out-of-plane Sagnac interferometer was successfully designed and built that sorts laser modes that exit the fiber based on their two-dimensional spatial symmetry into two separate ports. By comparing measured results to theoretical predictions, it was shown that this sorter can successfully separate modes with even 2D spatial parity into one output port and modes with odd 2D spatial parity into a

separate output port. This condition is necessary in order to isolate the first-order Hermite-Gauss (HG) modes that are desired to study.

It was shown that by imparting physical stress on an optical fiber, one is able to transfer orbital angular momentum (OAM) to a laser mode's orthogonal components while it is propagating inside the fiber. This essentially induces a phase shift ϕ on the propagating mode. The result from this is a different mode exiting the fiber than enters the fiber. A phase shift (ϕ) of $\pi/2$ and π were successfully

induced on an incident HG_{10}^{+45} mode. When this mode underwent a phase shift of $\pi/2$, it was output from the fiber as a Laguerre-Gauss (LG) mode. Using this device, one can manipulate any first-order mode input with a given Bloch sphere latitude (θ) to exist with any phase ϕ with a given amount of stress. Most analysis was performed qualitatively by comparing measured data to theoretical data. The next step in furthering this research would be to develop a more quantitative method of analysis and improve the current crushing device to ensure more repeatability in results.



Crushing sequence for a fiber with about a 12 cm crushing length.

Senior Independent Study

Norman Israel

Physics & Mathematics

Advised by John Lindner (Physics) and John Ramsay (Mathematics)

Quantum Gravity: Exploring the Causal Dynamical Triangulation Approach

Abstract: Quantum Gravity is an attempt to unify the current understanding of the microworld (governed by quantum mechanics) with the current understanding of the macroworld (governed by general relativity). This thesis provides a brief overview of the problem of quantum gravity, including conceptual as well as technical overviews of general relativity and quantum mechanics. It explores a conservative approach to quantizing gravity known as Causal Dynamical Triangulation (CDT). CDT constructs spacetime from triangular-like building blocks known as simplexes. Combining quantum mechanics and general relativity by a sum-over-geometries, CDT demonstrates that microcausality implies classical global spacetime. This thesis focuses on a bare 1+1 dimensional universe. It converts the Einstein-Hilbert action of general relativity (from which one can recover the Einstein Field Equations using the principle of least action) from continuous to discrete form using the Gauss-Bonnet theorem, which is rigorously developed. This thesis proves a version of the theorem on two dimensional Euclidean polyhedra and sketches a proof on Pseudo-Riemannian spaces. Finally, it describes the design, construction, and operation of a computer simulation of a bare 1+1 dimensional CDT universe. It uses the simulation to find a critical value for the cosmological constant and computes the corresponding fluctuations in the spatial size of the universe, which it compares with analytical results.

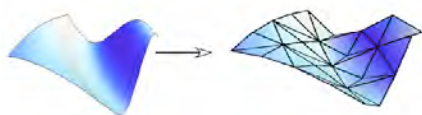


Diagram showing triangulation of a surface

Sarah-Beth Loder

Chemical Physics

Advised by Sarah Schmidtke (Chemistry) and Karen Lewis (Physics)



Experimentally and computationally determining the theoretical aqueous pK_a of three UV-absorbing benzophenone derivatives

Abstract: UV-absorbers are common pharmaceuticals used in many cosmetics today. Water insolubility makes them easy to incorporate into oil-based lotions, providing protection from harmful UVA and UVB light. The acid dissociation constant, pK_a , is one value that can be used to understand the properties and intermolecular interactions of a molecule. This value can be determined by several methodologies, both in lab and on the computer. pK_a 's are generally reported in aqueous solution, although it cannot directly be determined for water-insoluble molecules.

Experimentally using a combination of binary solvent systems and spectrophotometric titrations, the acidity constant was found using the Benesi-Hildebrandt method. Computationally, the structures of the protonated and deprotonated species were optimized using density functional theory methods, B3LYP/6-31+G(d,p), and implicit solvation, CPCM model. These computations yield pK_a values unrealistically high, but may be brought into a more accurate range with the addition of multiple explicit waters for stabilization. Experimental results produced pK_a 's of 13.7 for oxybenzone, 12.8 for dioxybenzone and 13.7 for sulisobenzene with standard errors under 0.05.

Patrick Butler

Physics

Advised by Karen Lewis

Air Drag and External Ballistics

Abstract: I will apply my knowledge of air drag to ballistics, in an attempt to do an in-depth study of the drag force. Many ballistic tests have been performed within much higher ranges of velocity, such as military applications, while many others have been performed at much lower speeds, such as an athlete throws a ball through the air. For this procedure, I will attempt focus on the intermediate range of velocities, trying to bridge the gap between both ranges of velocity.

I will perform this procedure with a custom built air cannon to launch the projectile. As with many projects that are built from scratch, the majority of this study will be about simply calibrating and understanding the apparatus. Before the air drag can be determined, several ways for measuring velocity and the motion of the projectile will need to be devised and put into practice. Unfortunately, due to constraints on the precision of the apparatus, this project will not be able to gain much depth into examining the drag of an object moving through the air, but I will develop a procedure for studying such drag. Data will be collected and the procedure will be proven effective, to a degree, but more time will be needed to gather a considerable amount of data and conclude the study. One value in particular which this study will focus on is the coefficient of drag, which is both unknown and unique for the projectile studied. Despite a large error on the final value of the coefficient of drag, a reasonable range which it may exist within will be identified. Even if the results of this study are limited, I believe the work done here will make a much more thorough and complete ballistics test possible, given that more time is committed to this project.



The air cannon

Junior Independent Study

Due to the size of the junior class, this year marked the first time in our memory that we offered Junior Independent Study in both the fall and spring semesters.

Self-Designed Projects

Theresa Albon

Plantar Force Distribution for Increasing Heel Height within Women's Shoes



Tyler Rhoades

Exploring Electromagnetic Acceleration of Rail Guns

Michael-Erik Ronlund

Modeling Brownian Motion with Elastic Collisions

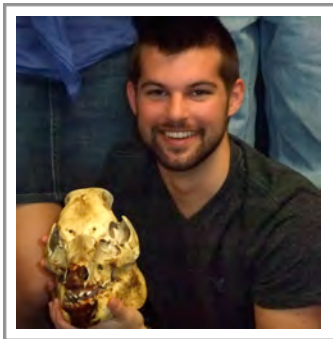
Syne Salem

Chaos in the Stadium: Quantum Billiards

Andrew Sopher

Force Induced on the Brain by Heading Soccer Balls

Andrew used a pig skull to calculate the force of a vertically dropped soccer ball.

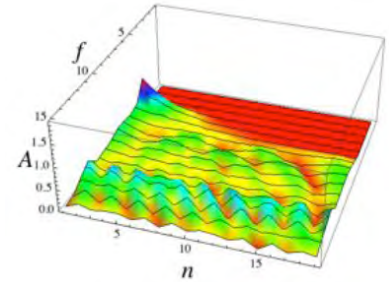


Phillip Wales

Effect of the Orientation of a Magnetic Field on the Resistance of a YBCO Superconductor

Daniel Axe

Observing Sound Waves in a One-dimensional Acoustical Metamaterial Superconductor



Tom Gilliss

Simulating a Magnetized Bead Pile

Lily Christman

Modeling Geophysical Waves with Gelatin

Duncan Price

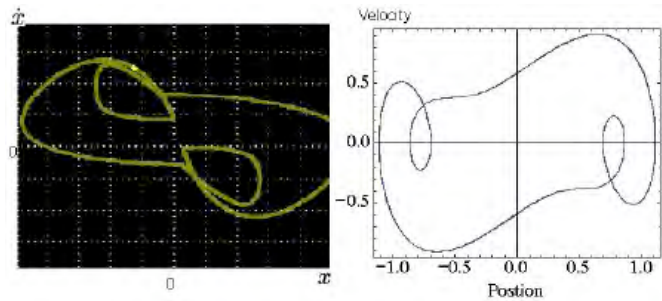
Shear-Thickening Fluid

Andrew Blaikie

The Gravitational Potential Between Two Line Segments

Matt Schmitthenner

Modeling the Duffing Equation with an Analog Computer



Karl Smith

Querying Qubits Creates Quantum Computers

Sam Mermall

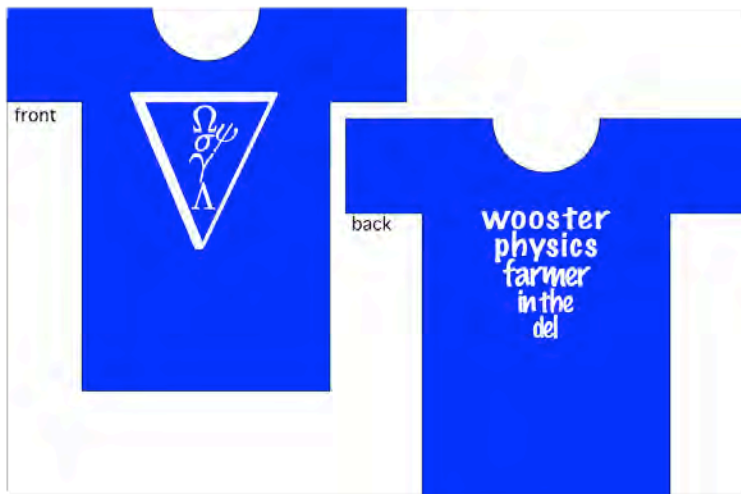
Three-dimensional Motion Tracking from Stereo Video

Lorenzo Dumancas

Stochastic Resonance in a Bistable Mechanical System

Physics Club

President: *David Simpson '13*
 Vice President: *Lorenzo Dumancas '13*
 Secretary: *Larry Markley '12*
 Treasurer: *Andrew Blaikie '13*
 Faculty Advisor: *John Lindner*



Events

- 2011 September 2: Scot Spirit Day
- 2011 September 15: Pizza and Liquid Nitrogen Ice Cream night
- 2011 September 28: General Meeting
- 2011 October 26: General Meeting and group photo
- 2011 November 9: Outreach Training: Air Pressure
- 2011 November 12: Great Lakes Science Center Trip
- 2011 November 16: Outreach Training: Electricity & Magnetism
- 2012 January 25: General Meeting
- 2012 February 2: Outreach Forces & Motion Video Shoot
- 2012 February 16: Outreach Pressure Video Shoot
- 2012 March 28: General Meeting
- 2012 April 12: E & M Video Shoot
- 2012 April 19: Light & Sound Video Shoot
- 2012 April 21: Community Science Day
- 2012 April 22: Taylor Bowl 23 (Math/CS=105.5; Physics=95.1)



The Physics Club undertook a major project this past year when they made videos of each of their elementary school physics demonstrations. These videos will be used in future years to train students who wish to participate in our elementary school outreach program. In the photo above, Joseph Smith '15 and Amanda Steinhebel '15 presented Electricity and Magnetism at Community Science Day after watching the new training video, and they nailed it!



Michael-Erik Ronlund '13 enjoyed playing with the electric discharge ball at the Great Lakes Science Center.

Astronomy Club

President: *Andrew Blaikie '13*
 VP/Treasurer: *Syne Salem/Lorenzo Dumancas*
 Faculty Advisor: *Karen Lewis*

Events

- 2011 September 2: Scot Spirit Day
- 2011 October 7-8: Astronomy Club Overnight Observing
- 2011 November 18: Astronomy Club Observing
- 2012 February 11: Astronomy Club Cleveland Natural History Museum Trip
- 2012 April 21: Community Science Day



At Community Science Day, Andrew Blaikie '13 helps some eager young astronomers locate the paper cutout of an astronaut on the exit sign down the hall. (It was raining outside, what can we say?)

Colloquia

Fall Semester

Kevin Cavicchi, University of Akron

Research in Polymer Engineering

Asad Khan, CTO, Kent Displays Inc.

Physics and Science at Wooster: From Graduate School to Consumer Products and Beyond

Edward Caner, Case Western Reserve University

Physics Careers and Entrepreneurship in Northeast Ohio and Beyond

Brian Arbic, University of Michigan

Predicting the Maelstrom: Physics of the Ocean

Wooster Physics Juniors & Seniors, Rounds 1-4

Fall Independent Study Presentations

Physics Colloquium

Predicting the maelstrom: The physics of the ocean
by **Dr. Brian Arbic**
Assistant Professor, Physical Oceanography and Ocean Modelling
Department of Earth and Environmental Sciences
University of Michigan

Thursday, October 27
11:00 am
Taylor 111

I will briefly describe the highly interdisciplinary and socially relevant field of Earth and Environmental Sciences. I will then briefly discuss opportunities for graduate study in EES at the University of Michigan. Then I will discuss my specific sub-discipline, physical oceanography, and the kinds of ocean-related problems I work on, all of which require a strong quantitative background in subjects such as physics, mathematics, and computer science.

Spring Semester

Antal Jákli, Liquid Crystal Institute, Kent State University

Current Trends in Liquid Crystal Research

Joe Van Fossen, Kent State University (Wooster REU 2003)

Heavy Ion Collisions-A Trillion Degrees in the Shade

Jan Kmetko, Kenyon College

Wiggle, Jiggle, Dance and Giggle: Brownian Motion of Particles in Confined Geometries

Aaron Santos, Oberlin College

Coarse-grained Models of Nanoparticles: An Attempt to Make Nano-LEGOs

John Feldmeier, Youngstown State

Cosmic Castaways

Wooster Physics Juniors

Spring Independent Study Presentations

Department of Physics Spring 2012 Colloquium Series

Cosmic Castaways

John Feldmeier
Department of Physics & Astronomy
Youngstown State University

Thursday April 19
11:00 am Taylor 111

Most stars in the universe lie within galaxies. However, an unlucky fraction of stars are actually formed within galaxies, then are flung away from their original homes to roam the spaces between the galaxies. These cosmic castaway stars tell us much about galaxy's form and change over time. I will also show some scenes from an upcoming digital movie about these lonely stars.

Faculty

John Lindner

Chairperson and The Moore Professor of Astronomy

At Wooster since 1988

PhD Caltech 1989; BS University of Vermont 1982



discussed Wooster's leading research on the 3 -body problem of celestial mechanics.

Senior Independent Study

Dr. Lindner advised four senior I.S. projects this past year:

Norman Israel (Physics & Math)

Quantum Gravity: Exploring the Causal Dynamical Triangulation Approach

Larry Markley (Physics)

Perturbing Spacetime

Katsuo Maxted (Physics)

A Cyclic Aero-mechanical Array of One-way Coupled Oscillators

Alyse Marquez (Physics & Political Science)

The Rocket Science behind the Political Science: Comparing Space Visions of the Presidents from 1993-2011 and the Rocket Technology That Helped Characterize Them

Teaching

IDPT First Year Seminar: Science, Theism, & the Nature of Reality

Physics 205 Modern Physics Laboratory

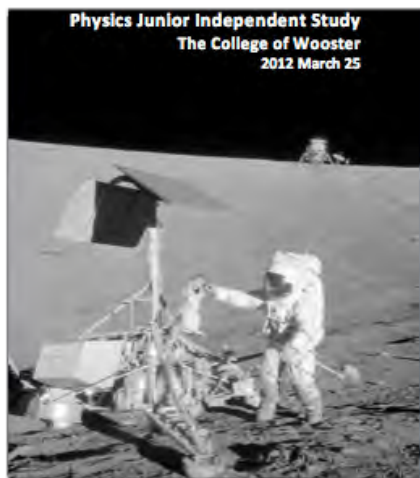
Physics 399 Selected Topics: Nonlinear Dynamics

Physics 401 Junior Independent Study

Dr. Lindner rewrote the Physics Jr. I.S. lab manual, modernizing it for the 21st century. The previous 1980s version was a hodgepodge of documents, including photocopies of equipment manufacturers' instructions, with hand-written page numbers. The revised version is a single 135-page Word document that can easily be incrementally improved in the future.

Research

Areas of current research: *Celestial mechanics, general relativity, nonlinear dynamics of one-way arrays, practical knots*



Team Physics enjoyed a HUGE turnout for Taylor Bowl XXIII.



In addition to serving as Department Chair and advisor to the Physics Club, Dr. Lindner traveled to Boston with undergraduates Norman Israel '12 and Karl Smith '13, where they presented posters on simulations of practical knots and quantum gravity at the March 2012 meeting of the American Physical Society. He was also the invited Muller Prize speaker at Ohio Wesleyan University, where he

Fun in the vertical kaleidoscope at Great Lakes Science Center



Faculty

Cody Leary

Assistant Professor of Physics

At Wooster since 2011

MS, PhD Oregon 2004, 2010; BS Puget Sound 2003

Teaching

Physics 203 & 204 Foundations of Physics

Physics 205 Modern Physics

Physics 220 Electronics laboratory

Physics 350 Quantum Mechanics

For his quantum mechanics course, Dr. Leary created material to supplement the main course textbook, emphasizing a group-theoretical, symmetry-based approach to quantum mechanics. No undergraduate textbook currently approaches quantum mechanics from this point of view.

Dr. Leary attended the Conference on Lasers and Electro-Optics/Quantum Electronics and Laser Science in May 2012 (San Jose, CA). His work with collaborators Dashiell L. Vitullo and M.G. Raymer at the University of Oregon and Siddharth

Ramachandran at Boston University on the spin-orbit interaction of photon in optical fibers was presented at the Frontiers in Optics: Laser Science XXVII Conference in October 2011 (San Jose, CA). He gave an invited talk at Oberlin College in March entitled "Measurement, control, and collisions of photon spatial wave



functions" where he presented results recently obtained at Wooster by his Senior I.S. students.

Senior Independent Study

Dr. Leary advised two senior I.S. projects this past year:

Mohammad Saif Ahmad (Physics & Math)

Parity-based Measurement and Control of the Spatial Wave Function of Photons

Margaret Raabe (Physics)

Manipulation of a Photon's Wave Function in Optical Fibers

Research

Areas of current research: *Parity-based measurement and control of transverse quantum states of light, bimodal two-photon interference, quantum entanglement, spin-orbit interaction of electrons and photons in cylindrical geometries*

Publication

Dashiell L. Vitullo, M. G. Raymer, Cody C. Leary, Siddharth Ramachandran, "Photonic Spin-Orbit Interaction in Few-Mode-Optical Fiber," in the proceedings of the Frontiers in Optics: Laser Science XXVII Conference, San Jose, CA, 2011.



Isn't there a law against using your child for air table experiments?



Dr. Leary and son Connor anxiously await to receive a serving of liquid nitrogen ice cream.

Faculty

Karen Lewis

Assistant Professor of Physics

At Wooster since 2010

PhD Penn State 2005; BS Physics & Mathematics, University of Wisconsin 1999



Teaching

Physics 101 (2 sections) & 102 General Physics & laboratories

Physics 208 Math Methods for Scientists

One new technique that Dr. Lewis employed this year is called “Just in Time Teaching” in which students answer several conceptual questions about the assigned reading that are graded primarily for effort. After reading the responses, Dr. Lewis tailored how she would spend class time. Dr. Lewis felt that this technique helped students to be better prepared for class.

Dr. Lewis was the advisor to the newly formed Astronomy Club. The Club met weekly for Astronomy Table. During the year they had five observing events for the club, including one overnight camping trip to the Wayne

Dr. Lewis traveled to Chile in October for viewing time on the Very Large Telescope at the Paranal Observatory.



National Forest, and they organized one public event on March 31st to view Venus, Mars, Jupiter, and Saturn.

Dr. Lewis attended *AGN Winds in Charleston* at the College of Charleston (SC) in October, a workshop dedicated to the physical characteristics of AGN accretion disk winds - the structure, ionization state, kinematics, energetics, driving mechanism and their interaction with their environments. She gave colloquia at John Carroll University and Youngstown State University and was the colloquium organizer for the department. She attended the American Astronomical Society meeting in June to present the results of the Monte Carlo simulations of the dusty torus in AGN that she and Kemal Ramic ('12) worked on this year. In July she participated in the Sagan Summer Workshop at California Institute of Technology: *Working with Exoplanet Light Curves*.

Senior Independent Study

Dr. Lewis advised two senior I.S. projects this past year:

Kemal Ramic (Physics & Math)

Monte Carlo Simulations of the Clumpy Torus in Active Galactic Nuclei

Patrick Butler (Physics)

Air Drag and External Ballistics

Research

Areas of current research: analysis of Active Galactic Nuclei (AGN) found in the XMM-Newton Slew Survey; also AGN that have unusual double-peaked emission lines.



Dr. Lewis and the Astronomy Club do a little a night sky viewing with our Celestron Omni XLT120 refracting telescope, donated by David H. Gunning.

Faculty

Nicole Moore

Visiting Assistant Professor of Physics

At Wooster since 2011

PhD Rochester 2009; BS Harvey Mudd 2003



Teaching

Physics 101 & 102 General Physics laboratories

Physics 203 Foundations of Physics laboratory

Physics 110 Physics Revolutions (both semesters)

Physics 301 Mechanics

Physics 303 Modern Optics

Research

Dr. Moore's research centers on highly focused fields, particularly the sort of field that results from a beam passing through a high numerical aperture (NA) lens

system. This type of field is present in many systems of current interest, including (but not limited to) optical tweezers, confocal microscopes, photolithography, and laser-confined inertial fusion.

Dr. Moore attended the International Commission for Optics Triennial Meeting in Puebla, Mexico, and gave a talk titled "Mie Scattering of High Numerical Aperture Fields".

Dr. Moore will begin a tenure-track position at Elmhurst College (IL) this fall.

Senior Independent Study

Dr. Moore advised two senior I.S. projects this past year:

Matt Damon (Physics)

Progress toward Using an Optical Tweezer to Make Scattering-based Size Measurements

David Simpson (Chemical Physics)

Analysis of the Correlation Length Amplitude of Nitrobenzene and Dodecane Binary-Fluid Solution

Shila Garg

William F. Harn Professor of Physics

At Wooster since 1987

PhD Kent (UK) 1975; BS Madras (India) 1970;
MS Sussex (UK) 1972

After serving as the Dean of Faculty and Interim Provost for eight years, Dr. Garg is again becoming a regular fixture in the Physics Department.

Research

Dr. Garg is continuing her liquid crystal research in collaboration with Kent State University. There are several new molecules synthesized by chemists at Kent State University that need characterizing to understand the intrinsic, basic physical properties, as well as to see if they are suitable for display applications. The properties being investigated are: phase transitions, elastic constants, viscosity and dielectric constants. Dr. Garg wrote and successfully obtained a *Research Opportunity Award* from NSF for \$33,916. She wrote this proposal as a supplement to an existing award to Dr. Antal Jakli of the Liquid Crystal Institute at Kent State University.



She attended the National Meeting of the American Physical Society in Boston last March, and she gave a talk entitled "Phase Transitions in Binary Mixtures of Liquid Crystals" at the Physics Department of Marietta College.

Publication

Tsang-Min Huang, Kathy McCreary*, Shila Garg, Thein Kyu, "Induced Smectic B phase in Binary Nematic Liquid Crystal Mixture of 5CB and MBBA" *Journal of Chemical Physics*, 134, 124508 (2011).

Part of this work was done by Kathy McCreary '06 and Dr. Garg during summer 2007 and continued by Huang for his doctoral thesis.

Special Projects

Dr. Garg has also been spending a lot of time researching the conditions to introduce/enhance liberal arts education in India and the Middle East. She accompanied President Grant Cornwell and Peg Cornwell on their two-week long trip to India. They visited four cities where they held alumni socials, meetings with alumni, parents and friends, and school visits. As a result of this trip, they established an Alumni Leadership group in India.

Faculty

Donald Jacobs

Victor J. Andrew Professor of Physics

At Wooster since 1976

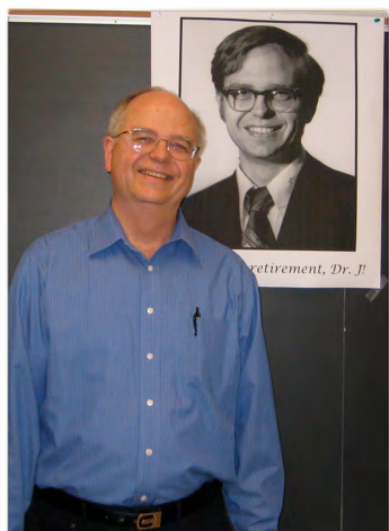
PhD Colorado 1976; BA, MA South Florida 1971, 72

Teaching

Physics 220 Electronics for Scientists & laboratory

Physics 400 Junior Independent Study (fall semester)

Everyone in the Department of Physics dreaded the arrival of December 2011, because that brought about the retirement of Dr. Jacobs. We hosted a wonderful open house/reception in his honor and welcomed many, many of Dr. Jacobs' colleagues, former students, current students, and friends. "Dr. J" cookies were served and we even had a candy Buckeye "bead pile" at the critical angle of repose! The department presented Dr. Jacobs with a bound memory book of photos, anecdotes, cards and good wishes.



Senior Independent Study

Dr. Jacobs advised one senior I.S. project in the fall semester:

David Simpson (Chemical Physics)

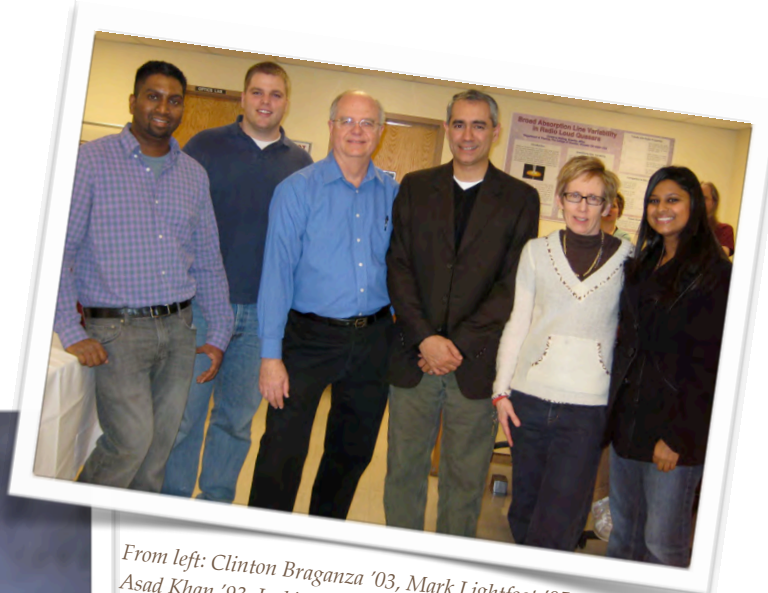
Analysis of the Correlation Length Amplitude of Nitrobenzene and Dodecane Binary-Fluid Solution

Publications (*student co-author)

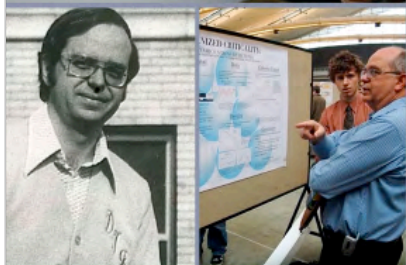
- Hosanna Odhner* (REU 2010) and Donald Jacobs, "Refractive index of liquid D2O for visible wavelengths", *Journal of Chemical and Engineering Data* 57 (1) pp 166-168 (2012).

- S.Y. Lehman, Elizabeth Baker*, Howard A. Henry*, Andrew J. Kindschuh*, Larry C. Markley*, Megan B. Browning*, Mary E. Mills*, R. Michael Winters IV* and D.T. Jacobs, "Avalanches on a Conical Bead Pile: Scaling with Tuning Parameters", *Granular Matter* (to appear 2012).

Happy trails to you...



From left: Clinton Braganza '03, Mark Lightfoot '05, Dr. J, Asad Khan '93, Jackie Middleton, Nithya Venkataraman '04



Wooster's Don Jacobs

Physics at Taylor Hall 1976-2011



Faculty

Susan Lehman

Clare Boothe Luce Associate Professor of Physics

At Wooster since 2003

MS, PhD North Carolina 1996, 99; BA Goshen 1993

On Sabbatical 2011-2012

The highlight of Dr. Lehman's research leave was her visit to the Vienna University of Technology (Vienna, Austria) as a Guest Professor. The focus of the visit was research in collaboration with colleagues at the Institute for Solid State Electronics, and she also taught a brief graduate seminar course on *Ballistische Elektronenmikroskopie auf Nanostrukturen* (Ballistic Electron Microscopy of Nanostructures).

In January, Dr. Lehman presented an invited talk entitled "Ballistic Electron Emission Microscopy Investigation of InGaAs Quantum Dots and Wetting Layer," for the Quantum Electronics and Photonics Division of the Physical Measurement Laboratory, National Institute of Standards and Technology, Boulder, CO. She also attended the Conference on the Physics and Chemistry of Surfaces and Interfaces in Santa Fe, NM. This summer, Dr. Lehman



advised a project in the College's Applied Mathematics Research & Experience program (AMRE) which involved modeling tension in wound polyester film.

Research

Dr. Lehman's current research interests include: investigation of semiconductor nanostructures, in particular GaN nanowires, using ballistic electron microscopy and other scanning probe techniques; study of avalanching and critical behavior in granular materials; and understanding the structure and swelling behavior of Osorb®, a nanomechanically tensioned silica glass; development and formal testing of an active-learning module on simple harmonic motion and oscillations for upper-level mechanics courses.

While in Vienna, Dr. Lehman took time to visit the Austrian physicist Ludwig Boltzmann's grave. Notice his famous formula for entropy is engraved at the top of the stone.



Staff

Manon Grugel-Watson

Laboratory Coordinator and Adjunct Instructor

at Wooster since 2007



Jackie Middleton

Administrative Coordinator

at Wooster since 1989

Alyse Marquinez (Class of 2012 & 3rd Class Petty Officer, United States Coast Guard)

and

The Employer Support for the Guard and Reserve

presented

The Patriot Award

to: Dr. Karen Lewis, Dr. Susan Lehman, Dr. Jeffrey Lantis (Political Science), Dr. Don Jacobs and Dr. Jennifer Bowen (Mathematics)

The National Committee for Employer Support of the Guard conducts an awards program designed to recognize employers who support a strong National Guard and Reserve force. Employers qualify for recognition when they

practice leadership and personnel policies that support employee participation in the Guard and Reserve. Alyse, a double major in physics and political science, nominated five of her Wooster professors, all of whom received a Patriot Award at a ceremony held in November.



Robot Mania

The students in Don Jacobs' Electronics for Scientists class used Lego Mindstorms NXT robot kits to interface a new sensor to the microprocessor "brick" that controls the robot. The software to read the sensor and run the motors on the robot was written in LabVIEW. The goal was to have the students use the hardware knowledge of analog and digital electronics along with using LabVIEW software for interfacing signals to a computer and determining the response. Here are the creative ideas our Electronics students came up with:

TeaBot: Cup of tea? This robot inserts a heating element into a cup of water, heats the water to a selectable temperature (measured by the robot) then turns off the heat while inserting a teabag for two minutes. Tea is ready! (Phil Wales & Lorenzo Dumancas)

Ryan the Ryno: Using two microphones, this robot rotates to locate its foe, plays the opening notes from Beethoven's V, and then fires a ball at the foe. The robot resembles a rhinoceros with its ball shooting snout. (Laura Haldane, Tom Wood, & Katsuo Maxted)

Waiter-Bot: Keeping a tray level while your robot goes up and down a ramp becomes "easy" by interfacing an accelerometer to the tray so the robot can constantly correct for any tilt. (Matt Schmitthenner & Theresa Albon)

Dolly Llama: This llama shaped robot could measure the spring constant of a spring by using a potentiometer and measuring the voltage as the robot stretched the spring. (Milo Carpenter, Alyse Marquinez & Deepika Sundarraman)

Shell-Con 3000: The classic con of placing an object beneath an inverted shell with two others empty and then rotating all three quickly makes you wish that you could see through the



shells. This robot does that by using a magnetodiode to sense which shell contains a small magnet as the object. (Sam Mermall & Duncan Price)

Gary the Beat Counter: This robot becomes a nurse by using a microphone with a stethoscope to measure a person's heart rate. (Ian Wilson, Andrew Sopher, & Tyler Rhoades)

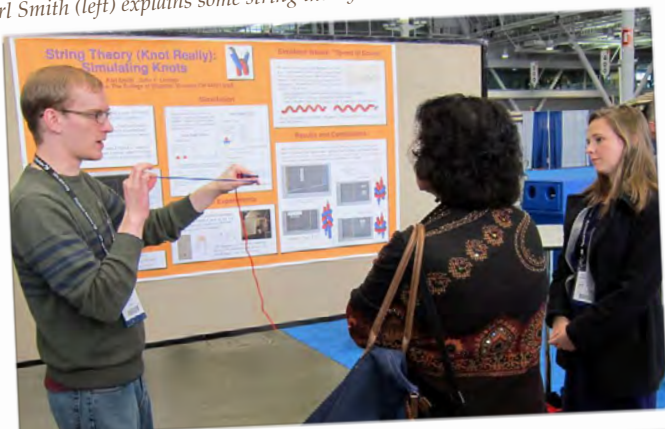
Hyperion: Solar Tracker: Want your solar array to track the sun? This robot would locate a light source with a photodiode, move towards it and then unfurl a solar panel to use the resulting power to light up a set of LEDs in the shape of a tree. (Daniel Axe, Matt Damon & Matthew Lambert)

National Meeting of the American Physical Society, Boston, MA

February 2012 (leave it to some physicists to hold the March meeting in February!)

Theresa Albon*, Paul Edmiston and Susan Lehman, *Investigation of Forces Exerted During the Expansion of Nanomechanically Tensioned Organosilica Materials*

Karl Smith (left) explains some string theory to Dr. Garg and Theresa Albon.



Karl Smith* and John Lindner, *String Theory (Knot Really)*

Norman Israel* and John Lindner, *Pure Quantum Gravity Simulation in 1+1 Dimensions Using Causal Dynamical Triangulation*

*student presenter/ co-author

Summer Research

Aero Mechanical Array of One-Way Coupled Oscillators
Prakrit Shrestha '14 (advised by John Lindner)

ξ . *Body Problem*

Philip Wales '13 (advised by John Lindner)

The Journey Around a Sphere: The Creation of an Optical Rotator
Brian Maddock '15 (advised by Cody Leary)

The Magic 'U' Box: Bimodal-Ou-Mandel Interference in an Interferometric Optical System
Deepika Sundarraman '14 (advised by Cody Leary)

Stochastic Resonance in a Mechanical System
Elliot Wainwright '15 (advised by John Lindner)

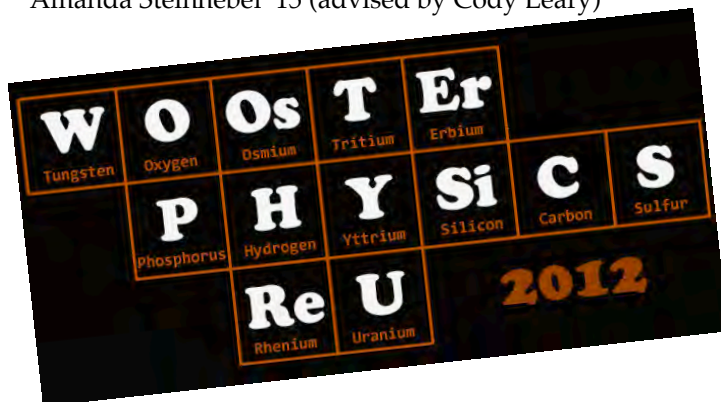
Astrophotography, Image Processing, and the College Observatory
Jairaj Ranchod '15 (advised by Karen Lewis)

The Ultimate Shield: Perturbing Spacetime
Duncan Price '13 (advised by John Lindner)



1-Dimensional Photonic Parity Sorting Through Interacting Interferometers

Amanda Steinhebel '15 (advised by Cody Leary)



Off-Campus Summer Research



Matt Schmitthenner '13 worked with Dr. Shila Garg at **Kent State University's Liquid Crystal Institute**. His work focused on three basic properties of a new family of liquid crystals — elastic, optical, and electrical — in an effort to characterize them and determine their suitability for applications.

Theresa Albon '13 also worked with Dr. Garg at LCI looking at a mechanical model of bent wire, or staples, in U, V, or H shapes to determine how they entangle and untangle in order to better understand how the process occurs at a microscopic level in a liquid crystal system.

Lorenzo Dumancas '13 had an REU experience at the **National High Magnetic Field Laboratory** at Florida State in Tallahassee writing a program to simulate magnetic fields. Specifically, the program calculates magnetic field distributions along a user-specified path for wire-wound magnets similar to those built at the National High Magnetic Field Laboratory. The program was written in Fortran and Java and uses the vector potential of a wire filament and superposition techniques to simulate the fields. The actual computation is handled in a Fortran subroutine that Lorenzo expanded upon and Java was used to create a user-friendly GUI.

Lily Christman '13 spent the summer working at **Stanford University** through Incorporated Research Institutions for Seismology (IRIS). She examined electromagnetic data for anomalous signals that could potentially be precursors to earthquakes.

Andrew Blaikie '13 had a summer research experience at the University of Rochester where he was part of the international collaboration with the T2K (Tokai to Kamioka) long base-line neutrino oscillation experiment in Japan.

Danielle Shepherd '14 worked in the Math Department's AMRE program studying Knot Theory. Her team created a digital catalogue of over 50 Klein links. In addition, they investigated connections between the invariants of torus links and Klein links with the goal of further understanding the effects of the construction.

Tom Gilliss '13 participated in **Auburn University's** REU program in Micro / Nano-Structured Material, Therapeutics, and Devices.



Lorenzo Dumancas '13 issuing the annual "Taylor Bowl Challenge" to the Math/CS folks. His outfit defies all reasonable explanations.

Study Abroad

Lily Christman '13 spent the first semester of 2011-12 in New Zealand. She took some very interesting classes, many on subjects focusing on New Zealand, like the geology of New Zealand and New Zealand politics. She piled into tiny rental cars with friends and traveled around the South Island on the weekends. Her favorite area was the West Coast. She hiked on Fox Glacier in crampons and ran through a rock formation called Pancake Rocks in the pouring rain.

Syne "Soona" Salem '13 spent the second semester at the American University of Beirut, Lebanon.

Prakrit Shrestha '14 spent the second semester in Edinburgh, Scotland. Although he didn't take any courses in his major (mainly because the science building was too far from his apartment and the rest of the school and he would have had to take a bus everyday to get to class. It was quite unfortunate, especially since Dr. Higgs is from Edinburgh) but he took two computer science courses, German, and philosophy. He enjoyed his academic experience, and it was interesting to see how they have lectures with hundreds of students and the entire grade depends on the final exam



Lily Christman '13 (physics major and geology minor as well as the Physics Cub's "ambassador" to New Zealand), shows off her CoW Physics t-shirt at Fox Glacier.

(quite a lot of pressure for the last month). He traveled a lot in the UK; some of the highlights were: 100th anniversary of Titanic in Belfast, Harry Potter's studio tour in London, Lion King Broadway, and just visiting the highlands and all the castles. Prakrit reports "Scotland is a very cold and windy place, but it is filled with history – I felt like I was living in a black and white movie."

Tom Gillis '13 spent a semester at the Danish Institute for Study Abroad in Copenhagen, Denmark. He said Copenhagen was incredible and found time to take a two-



Prakrit Shrestha '14, the Physics Cub's "ambassador" to Scotland, takes in the breathtaking view of the Scottish Highlands while sporting his Wooster Physics Farmer in the Del shirt.



Tom Gillis '13 at a remnant of the Berlin Wall

week travel break to visit other places in Europe. He also enjoyed packing everyone into his tiny apartment for a makeshift Thanksgiving dinner.

Karl Smith '13 also spent his semester abroad in Copenhagen. While there, he visited the historical part of the Niels Bohr Institute at the University of Copenhagen.

Alumni News

Austin Carter '05 has received his Ph.D. in physics from The Ohio State University and has accepted a position at Wright Patterson Air Force Base within the NASIC (National Air and Space Intelligence Center).

Chris Templeman '01 owns a small product design and technology development company in the Boston area. Templeman Automation has been moving into the area of open source electronics as a basis for low cost biology education and field laboratory tools. Specifically they are designing a low cost thermocycler for DNA amplification, a PCR machine.

Jon Rosch '07 is finishing up his Ph.D. in optics from the College of Optics and Photonics at the University of Central Florida. He married Laura Herb '09 in October 2011. In October 2012, he begins a position at Intel as Senior Packaging Engineer doing R&D for fabrication/characterization of organic films.

Henry Timmers '09 has passed his oral examinations and is now a Ph.D. candidate in physics at the University of Arizona.



Ingrid Thvedt '11 spent the last year teaching English in Taiwan.

Mark (Madhujit) Ghosh '99 is employed by the Sherwin Williams Company in Cleveland where he leads a team of Java back end and front end developers in maintaining the company's collection of web properties.

Bryan Prusha '98 has worked for Apple Computer for over 12 years. He posted this sentiment on Facebook last October. -->



Bryan Prusha Yeah, everybody's having a tough time. We all owe our careers and inspiration to him.
22 minutes ago · Like

Nick Hanson '03/Matt Krivos '02 both work in Cleveland for a wind energy development company: juwi Wind, LLC.

Stephen Poprocki '07 has received his PhD in physics from Cornell University. His thesis was titled "Search for WZ+ZZ production with MET + jets with b enhancement at CDF" (Collider Detector at Fermilab). He has accepted a post-doctoral position at Cornell in particle physics.



Heather Moore '10 teaches physics at Robert E. Lee High School in Fairfax County, Virginia.

Dave Merriman '00 is a Product Engineer for Sage Products, a worldwide leader in disposable healthcare products. Dave and his wife Jackie welcomed their second daughter, Devon Fiona, in July 2011.

Tom Spears '04 recently graduated from the University of Chicago with a Ph.D. in physics.

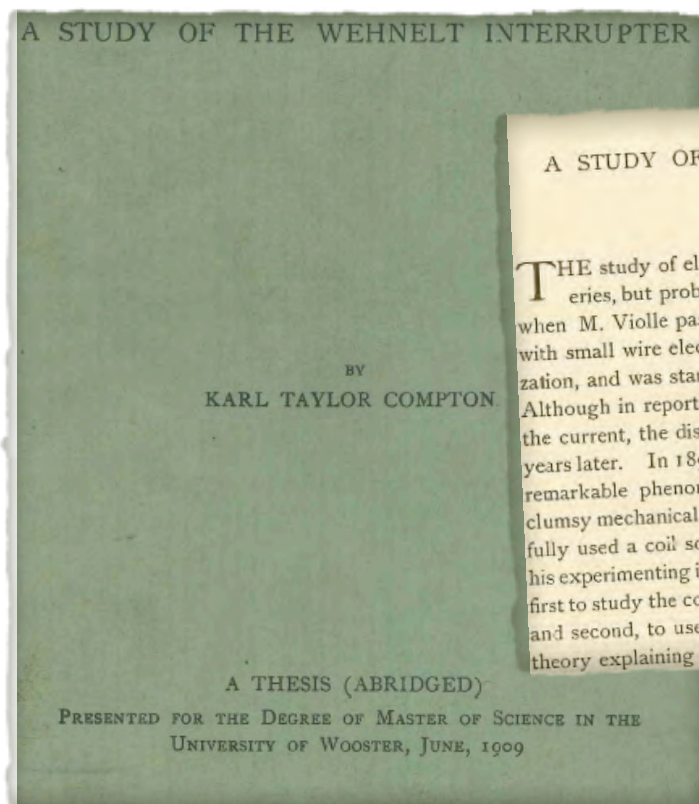
Derek Somogy '02 has joined the law firm of Wood Herron & Evans in Cincinnati. He supports the firm's patent practice in the mechanical arts.

Katherine Olaksen '06 is an MBA student at Cornell University's S.C. Johnson Graduate School of Management. She is also an Operation Excellence intern at Harvest Power. Harvest enables communities to produce renewable energy and high-value soil, mulch and organic fertilizer products from organic materials.

Angie Triplett '06 received her Ph.D. in mechanical engineering from the University of Akron and has accepted a position at National Technical Systems (NTS) in Dana Point, California, part of the largest worldwide network of independent testing laboratories, providing engineering services to a range of industries in both the defense and commercial sectors.

A Little Bit of History...

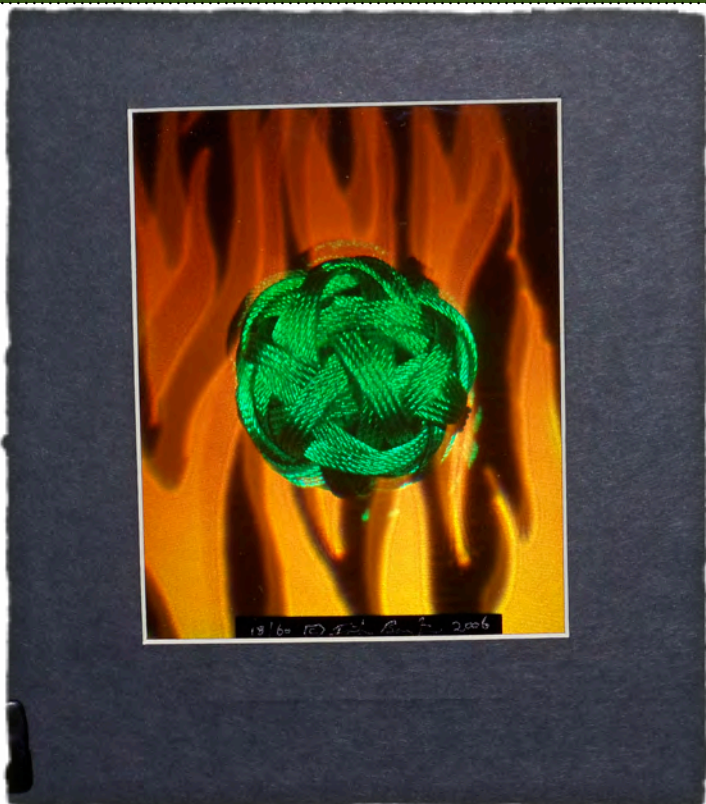
It is amazing what one can find in the Physics Department by standing on a chair and looking on tops of shelves. Jackie recently came across Karl (brother of Arthur) Compton's Master's degree thesis from 1909.



A STUDY OF THE WEHNELT ELECTROLYTIC INTERRUPTER.

BY KARL TAYLOR COMPTON.

THE study of electrolysis has led to many unlooked for discoveries, but probably few if any of these were more strange than when M. Violle passed a large current through an electrolytic cell with small wire electrodes, for the purpose of studying their polarization, and was startled by a regular succession of sharp explosions. Although in reporting this he ascribes the noise to interruptions of the current, the discovery was not put to practical use until seven years later. In 1899 Dr. Wehnelt conceived the idea of utilizing this remarkable phenomenon in an electrolytic device, to replace the clumsy mechanical circuit breaker of the Ruhmkorff coil, and successfully used a coil so equipped in wireless telegraphy. The result of his experimenting is the Wehnelt interrupter. It will be our purpose, first to study the conditions which affect the action of this instrument; and second, to use the results of this investigation in formulating a theory explaining its action.



Hologram

The Physics Department obtained a multicolour reflection hologram of a beautifully designed steel ball created at Inaki Beguiristain's studios in Essex, England. The ball consists of 16 individual pieces of stainless steel rigging rope. In the background is a projected pattern of flames. Stop by Taylor Hall sometime and view the hologram in all its splendor in a display case on the first floor!

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