Wooster Physics

THE COLLEGE OF

WOOSTER

Annual Report 2004-2005

Contents

Student assistant Nathan Utt follows every safety precaution while working with holographic chemicals. OSHA would be proud!

Greetings from the chair

Our department continues to be actively engaged in research with undergraduates. Our summer research program, which is in its 12th year of funding from NSF, had 4 faculty and 10 students (two funded by a Petroleum Research Fund grant). In this program, we focus on budding scientists (after their first or second year of college) and those off-campus students who do not have an opportunity to do research at their home institutions. In addition to training them to be full collaborators in our ongoing research programs, we also build a research community through group oral and poster presentations, picnics, canoeing, and meals at faculty homes. New this year was the opportunity for the students to live and cook together in a College house. Other students did summer research at other institutions including Columbia University and Sandia National Labs. By the time our students are seniors, most have experienced research in the summer that provides them with the tools and perspective to successfully conduct sophisticated Senior I.S. projects.

Jackie and Judy continue to provide superb support for our academic and summer programs. Judy's ability to find most anything in the Department and her savvy in making it work allow our labs and outreach to proceed smoothly. Jackie's ability as an administrative assistant is legend as she accomplishes so much, including the production of this newsletter. The science departments share a new staff person, Ron Tebbe, a machinist who has done a wonderful job assisting our faculty and students with projects.

We continue to be blessed with excellent students. One of our recent graduates, Ryan Hartschuh '03, was recently awarded an NSF graduate fellowship and attends the University of Akron's polymer science program. Ryan makes the third Wooster physics student in the past six years who has received such a fellowship.

Our introductory sequence was the largest it has been in over a decade due to a large number of First Year students. Many of those were involved in this summer's research program, and we hope to involve others next summer. The interest in physics remains strong and our Modern Physics course will be very large this fall.

Our faculty, which included Susan Lehman and Lowell Boone in their second year here, leave replacement Leo Pantelidis and myself, enjoyed the challenges and energy our students bring. Lowell led an active Physics Club that, among other accomplishments, won the bowling challenge with Math/Computer Science. Our outreach program to elementary and middle school children remains strong and was guided by Susan. John Lindner is returning from his research leave at Georgia Tech and will resume duties as Department Chair. Shila Garg, Dean of the Faculty, remains active in the Department by advising a Senior I.S. thesis this past year and teaching a section of Foundations this fall.

I find it difficult to accept that this fall will begin my 30th year on the faculty. The students and a wonderfully collegial department have kept me thinking I am a junior faculty member. I know many of you as a result and always rejoice in hearing how and what you are doing. Please keep us informed.

All the best,

Don Jacobs aka "Dr. J"

Faculty

Lowell M. Boone

Visiting Assistant Professor of Physics

B.A. (Literature) UC Santa Cruz 1992
M.S., Ph.D. (Physics) UC Santa Cruz 1998, 2002

Fall 2004
- Physics 121: Astronomy of Stars & Galaxies
- Physics 203 Laboratory (2 sections)
- Physics 304: Electricity and Magnetism

Spring 2005
- Physics 102: General Physics
- Physics 102 Laboratory (1 section)
- Physics 208: Math Methods
- Junior. I.S. numerical simulation advisor

Senior I.S. advisor for Andy Brinck
(Comparison of High and Low Flux States of the Microquasar XTE J1748-288)

Dr. Boone has been a member of the Department since 2003. He served as a member of the College Scholar Committee, Goldwater Scholarship Committee, and the Howard Hughes Medical Institute Steering Committee. He also was advisor to the Physics Club and organized the Department's colloquium series. He served as a referee for the *Astrophysical Journal*, wrote review questions for Educational Testing Service exams, and reviewed a chapter of a textbook on computer simulation methods for Addison Wesley. In September, Dr. Boone presented a poster "Applying the Discrete Correlation Function" at the 8th meeting of the High Energy Astrophysics Division of the American Astronomical Society. In July, Dr. Boone attended the Ultra-Relativistic Jets in Astrophysics (URJA) conference in Banff, Alberta, Canada. He is a member of the American Astronomical Society (High Energy Astrophysics Division), the Astronomical Society of the Pacific, and the Wayne County Astronomical Society.

Since when does Dr. Boone study granular material?

Lowell and Barbara welcomed new family member Collin Calhoun Boone on February 26, 2005.

John F. Lindner

Professor of Physics

B.S. Vermont 1982
Ph.D. California Institute of Technology 1988

John Lindner spent the 2004-2005 academic year as Visiting Scientist at the Georgia Institute of Technology in Atlanta Georgia. Working with physicists in Atlanta and San Diego, his research centered on three projects involving noise and nonlinear dynamics.

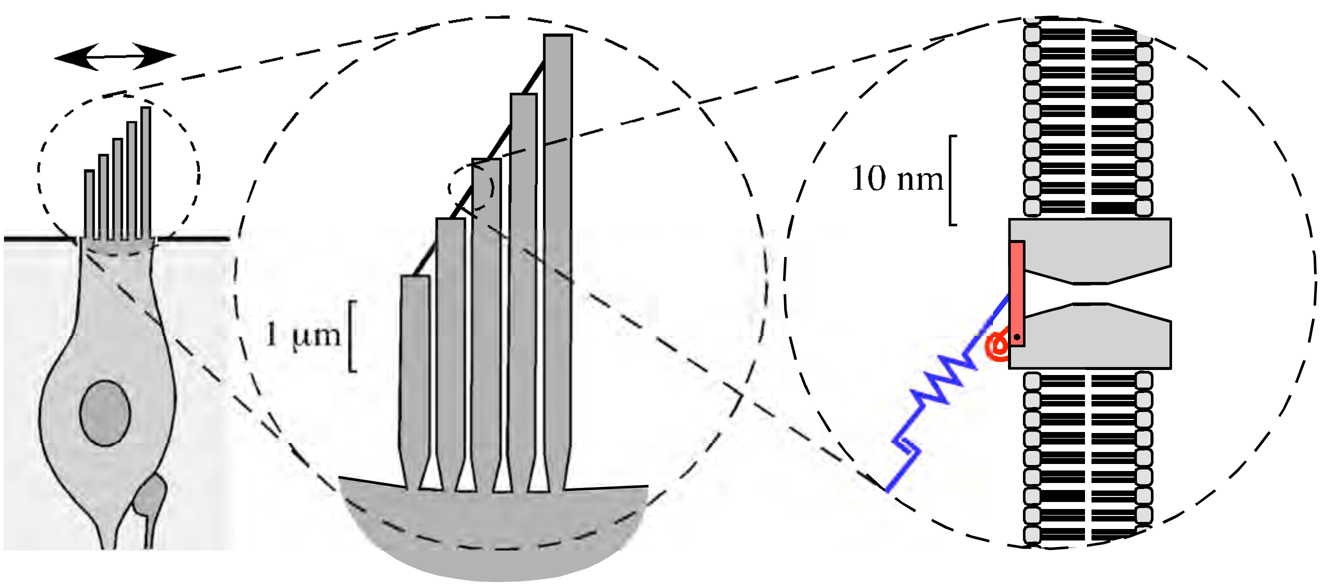
One project involved creating a computer model of inner ear hair cells (see below), which supports the hypothesis that noise plays a constructive and functional role in hearing, a phenomenon call stochastic resonance. A second project created a numerical rate model of array-enhanced stochastic resonance, which elucidates a phenomenon discovered on his first Georgia Tech sabbatical in 1994-1995. A third project studied how noise and coupling can induce oscillations and spatiotemporal patterns in undriven arrays of bistable elements. Papers on all three projects are in various stages of preparation and submission.

Hiking the Abel Tasman coast track, New Zealand, April 2005

Publications appearing:

Magnetic Avalanches: Josephson, Bean, Bak
K. Wiesenfeld, J. Lindner, *Physica A*, volume 340, pages 617-624 (2004)

Dr. Lindner reviewed manuscripts for many journals, including: Physical Review Letters, Physical Review E, Chemical Physics Letters, and Chaos: An Interdisciplinary Journal of Nonlinear Science.



Susan Y. Lehman

Clare Boothe Luce Assistant Professor of Physics


Frozen pizza, anyone?

B.A. Goshen 1993
M.S., Ph.D. North Carolina, Chapel Hill 1996, 1999

Fall 2004
- Physics 203: Foundations of Physics
- Physics 203 Laboratory (1 section)
- Physics 220: Electronics
- Physics 220 Laboratory

Spring 2005
- Physics 204: Foundations of Physics
- Physics 204 Laboratory (1 section)
- Physics 303: Modern Optics

Senior I.S. advisor for:
Austin Carter
(Ballistic Electron Emission Microscopy of InAs/GaAs Quantum Dots)
and
Dan Utley
(Measuring the Reflectivity of Semiconductor Mirrors Using Light-Intensity Ring-Down in a Half-Symmetric Resonator)

Dr. Lehman has been with our Department since 2003. This past year, she served as coordinator for the Society of Physics Students' science outreach program, on the Women's Studies Curriculum Committee, Upperclass Programs Committee, 2005 Forum Planning Committee, Dean of Admissions Search Committee, and as Admissions Liaison for the Physics Department. She accompanied seven students to the 2005 National Meeting of the American Physical Society, where she participated in a workshop on introductory physics teaching. She gave an invited lecture at John Carroll University entitled "Quantum Dots: The Next Big Thing?" and a Faculty at Large Lecture at Wooster titled "Plenty of Room at the Bottom: Nanotechnology and Quantum Dots." She is the recipient of two equipment grants from The William H. Wilson Fund. Dr. Lehman is a member of the American Physical Society and the Materials Research Society.

This past summer, Dr. Lehman attended the Electronic Materials Conference in Santa Barbara, CA in June and ACCGE 16 (the 16th American Conference on Crystal Growth and Epitaxy) in Big Sky, Montana in July.

Donald T. Jacobs

Victor J. Andrew Professor of Physics

Mount Rainier

B.A., M.A. University of South Florida 1971, 1972
Ph.D. Colorado 1976

Fall 2004

- First Year Seminar
  "Patterns in Nature: Chaos, Complexity, & Networks"
- Physics 101: General Physics
- Physics 205L: Modern Physics Laboratory

Spring 2005

- Physics 302: Thermal Physics
- Physics 401: Junior Independent Study

Senior I.S. advisor for:
Mark Lightfoot
(Measuring the Coexistence Curve of 8-Arm Star Polystyrene in Methylcyclohexane)

"Dr. J" has been at Wooster since 1976. He served as Chairperson during 2004-2005 in the absence of Dr. Lindner. He also served on the College's Financial Advisory Committee and the Taskforce on Faculty Workload. Dr. Jacobs is the recipient of a $50,000 grant from the Petroleum Research Fund to study "Universal Amplitude Relations in Complex Systems near their Critical Point". He accompanied seven undergraduates to the March National Meeting of the American Physical Society in Los Angeles, and two of his research students gave poster presentations. He was an invited speaker at the Mid-Atlantic Meeting on Thermodynamics (Thermo 2005) at the University of Maryland College Park this past April.

Grandpa Don has been enjoying his first grandchild, Brianna.

Leonidas Pantelidis

Merton M. Sealts Visiting Assistant Professor of Physics

Diploma National and Kapodistrian University of Athens (Greece) 1995
Ph.D. MIT 2003

Fall 2004

- Physics 101 laboratory (2 sections)
- Physics 122: Astronomy of the Solar System
- Physics 205: Modern Physics

Spring 2005

- Physics 102 Laboratory (1 section)
- Physics 110: Physics Revolutions
- Physics 122: Astronomy of the Solar System
- Physics 204 Laboratory (1 section)

Dr. Pantelidis served as advisor to the College's section of Pi Sigma Alpha. We wish him all the best as he begins a tenure-track appointment at Hanover College in Hanover, Indiana.

Shila Garg

Professor of Physics
Dean of the Faculty

B.S. Madras (India) 1970
M.S. Sussex (U.K.) 1972
Ph.D. Kent (U.K.) 1975

Senior I.S. advisor for:
Saleh Satti
(Phase Transitions and Dielectric Anisotropy in Nematic Binary Mixtures: Comparing 7CB and MBBA Mixtures to 5CB and MBBA Mixtures)

Judith Elwell

Laboratory Technician

Judy has enjoyed working with the Department since 1980. A highlight of this past year was a visit from her two grandsons, Justin and Adam. They helped in setting up the computers and labs for the coming semester.

Jackie Middleton

Administrative Assistant

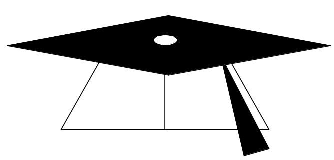
Jackie has been administrative assistant to the Departments of Physics, Mathematics, and Computer Science since 1989. She is also assistant to the Physics Department's NSF-REU program and the Math Department's Applied Mathematics Research Experience. She serves as secretary to the College's Support Staff Committee.

Class of 2005

Austin Roberts Carter
Columbus, OH
Graduate School, Physics
The Ohio State University

Andy Patrick Brinck
Cincinnati, OH
Graduate School, Astrophysics
Ohio University

Mark Allen Lightfoot
Avon Lake, OH
Employment



Daniel Lee Utley
Beachwood, OH
5th year at CoW, Music Education

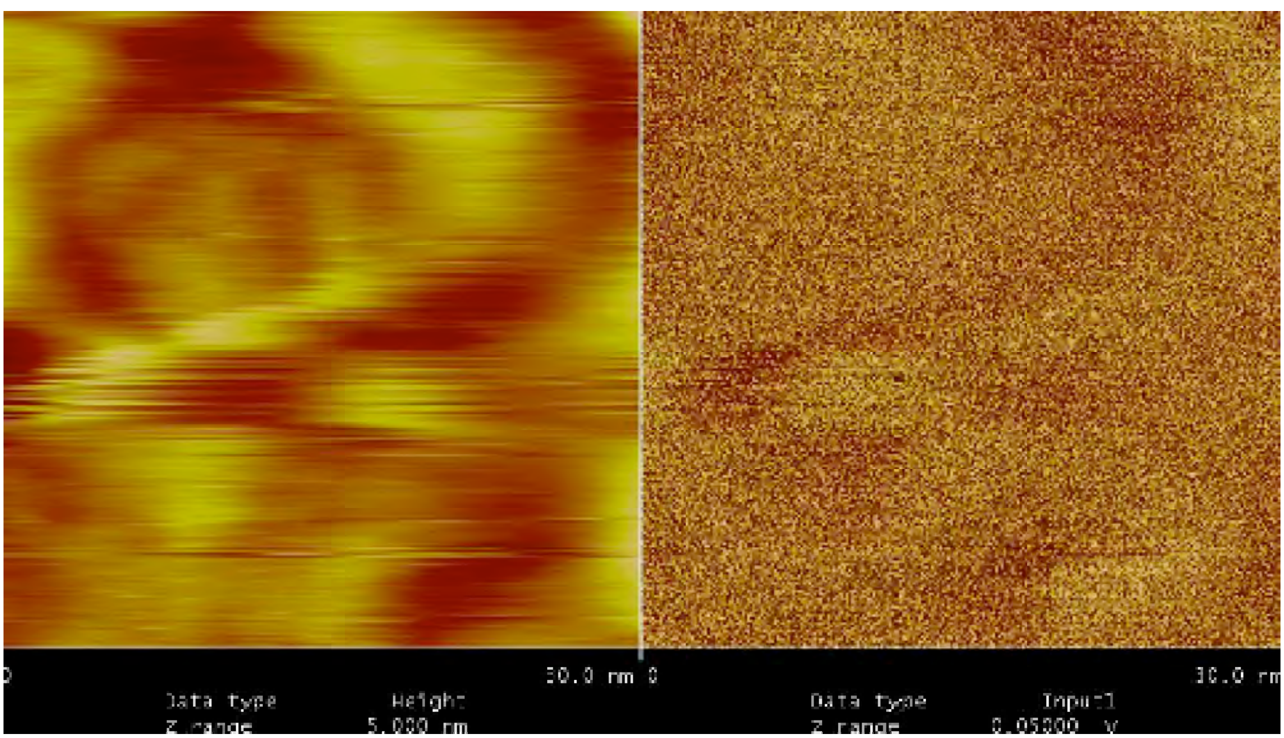
Saleh Abdel Moneim Satti
Ghana, West Africa
Employment

Senior Independent Study

Investigation of InAs/GaAs Quantum Dots with a Ballistic Electron Emission Microscope

Austin R. Carter
Advisor: Susan Lehman

A scanning tunneling microscope (STM) was converted to a ballistic electron emission microscope (BEEM). STM/BEEM images were taken of a variety of conductive and non-conductive samples including an InAs/GaAs quantum dot BEEM sample. For small scans with high scan rates, changes in the BEEM images directly correlate to sample features such as topography and subsurface electronic properties. It was qualitatively determined that the degree to which these BEEM images correlate to a feature depends on the tip bias. Small tip biases less than 1000 mV produce relatively flat BEEM images while large tip biases produce BEEM images heavily correlated to sample features. Improvements to the amplification of the BEEM current as well as suggestions for future ballistic electron emission spectroscopy measurements are described.

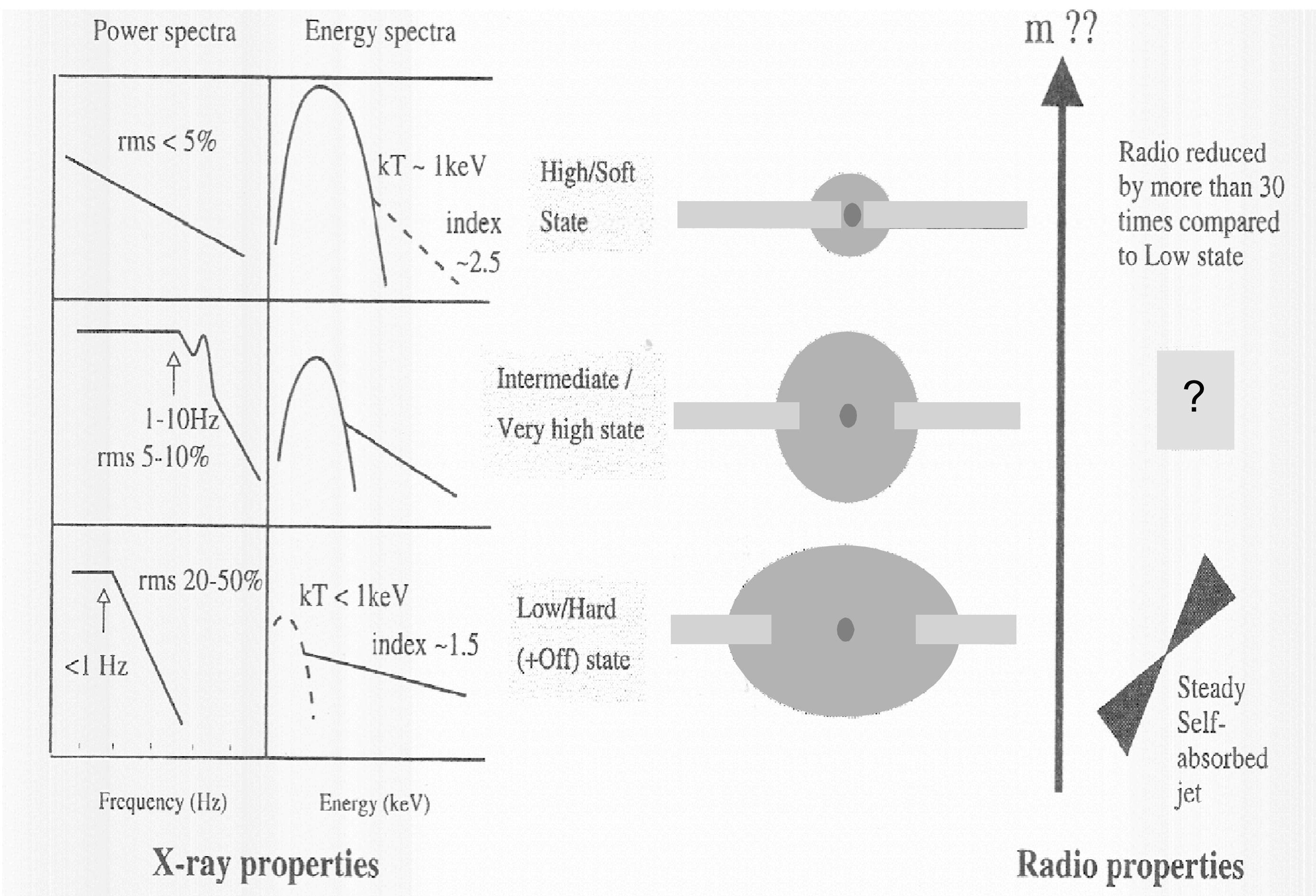


STM and BEEM images taken with parameters: Size=30 nm, V_o=+3000 mV, Scan Rate=51.9 Hz, IG=0.3, PG = 0.6, I_{set}=1 nA. The preamplifier operated off the battery and used 6 dB/octave high and low pass filters set at 0.03 Hz and 0.3 Hz respectively. The preamplifier was AC coupled in low noise mode with a gain of 5 x 10^5. Changes in the BEEM image correlate directly to changes in the STM image.

Comparison of High and Low Flux States of the Microquasar XTE J1748-288

Andy P. Brinck
Advisor: Lowell Boone

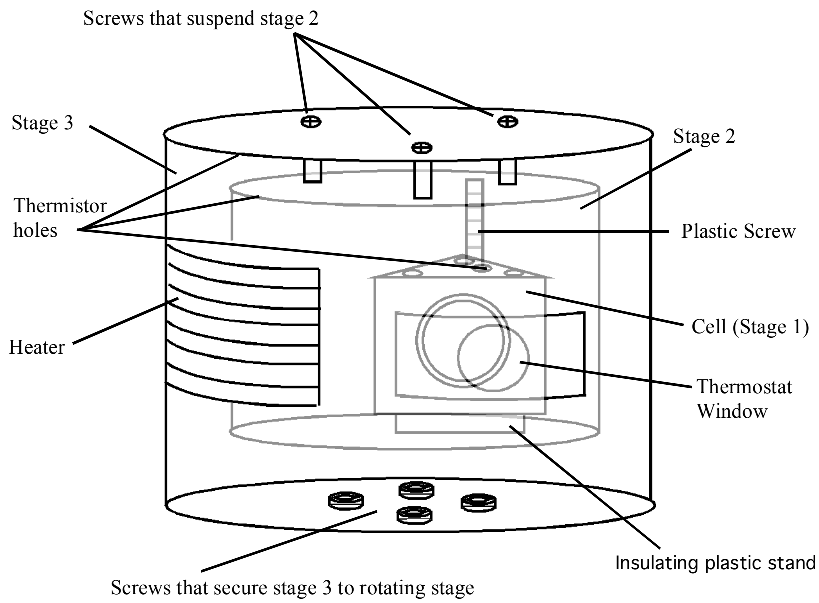
RXTE spectral data for the microquasar XTE J1748-288 was retrieved and reduced using HEASOFT programming tools. The spectral files from the Proportional Counter Array (2-60 keV) and the High Energy X-ray Timing Explore (60-250 keV) were combined in the X-ray spectral fitting and analysis program XSPEC. Within XSPEC a model was created to account for the thermal and non-thermal emissions produced from radiation processes within the extreme environments of black holes. This model was then fit to a high and low flux state spectra in order to verify theoretical predictions of radiation process in microquasars.



Measuring the Coexistence Curve of 8-Arm Star Polystyrene in Methylcyclohexane

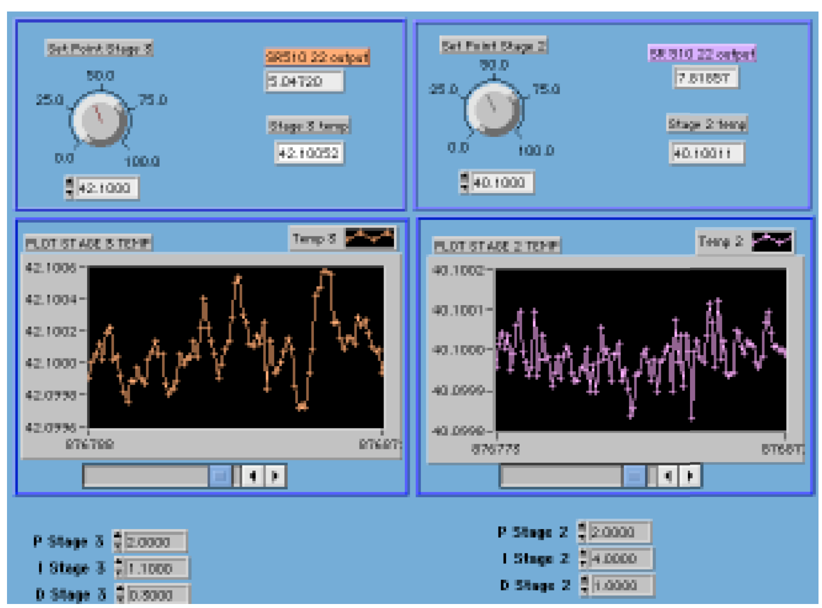
Mark A. Lightfoot
Advisor: Donald Jacobs

Advances were made on an existing experiment that will enable the measuring of the coexistence curve of eight-arm star polystyrene in methylcyclohexane to determine the coexistence curve amplitude B. An automated measurement of the minimum deviated angle in each phase provides the refractive index and thus the composition in each phase. By exploring temperatures from a few milliKelvins to ten Kelvin below the critical temperature, the shape of the coexistence curve will be determined and compared to a simple power law of amplitude B and exponent β. The exponent should be independent of molecular weight while the amplitude should vary as a power-law in molecular weight. Preliminary data were obtained using refractive index as the order parameter. Strange behavior near the critical temperature prevented an accurate analysis. Still the data were fit to a power law equation where the β exponent was held constant at its value for the 3D Ising model (0.326) to show how much the data agree with universality theory.



A generalized diagram of the assembled thermostat

The front panel for the temperature control program, Temp.Control.5.1.vi



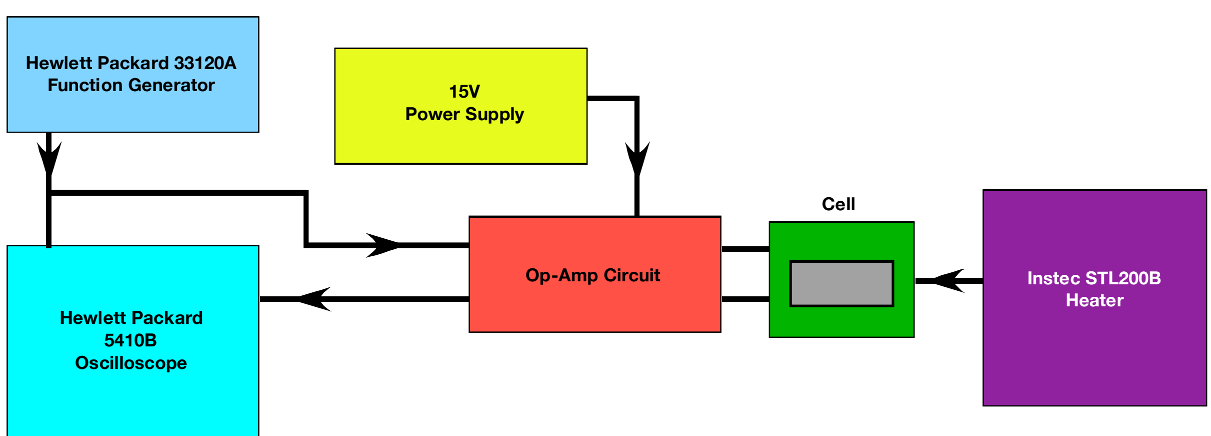
Eventually, results for one molecular weight (228,000) can be compared to published values for a smaller molecular weight (74,000) and to the results for a linear polystyrene in the same solvent.

Phase Transitions and Dielectric Anisotropy in Nematic Binary Mixtures: Comparing 7CB and MBBA Mixtures to 5CB and MBBA Mixtures

Saleh Satti
Advisor: Shila Garg

Nematic liquid crystals 4-n-heptyl-4'-cyanobiphenyl (7CB) and 4-methoxybenzylidene-4-butylanaline (MBBA) were mixed at various molar concentrations. The phase transition temperatures were measured using a phase transition set-up that recorded through a digital video camera any qualitative change in the liquid crystal phase as the temperature was altered. In addition to the isotropic-nematic phase transition, there was another phase transition that was observed and recorded for certain concentrations. By using the 'glass plate test', and by qualitatively comparing a sample picture of this new phase to others already documented, it was concluded that the two mesogens produced a smectic G phase for some concentrations.

The cells with various mixtures were then modeled as capacitors in parallel to a resistor in order to measure the epsilon perpendicular and parallel values. For both values it was found that there was a linear increase as the molar concentration of 7CB increased; however, the difference of the two values (delta epsilon) showed no linear properties. Both the phase transition values and the epsilon values of these mixtures were compared to those of 4-n-pentyl-4'-cyanobiphenyl (5CB) and 4-methoxybenzylidene-4-butylanaline (MBBA). It was found that the phase transition temperatures and epsilon perpendicular values of the 4-n-heptyl-4'-cyanobiphenyl and 4-methoxybenzylidene-4-butylanaline mixtures were larger, however their epsilon parallel, and thus the delta epsilon values were less.

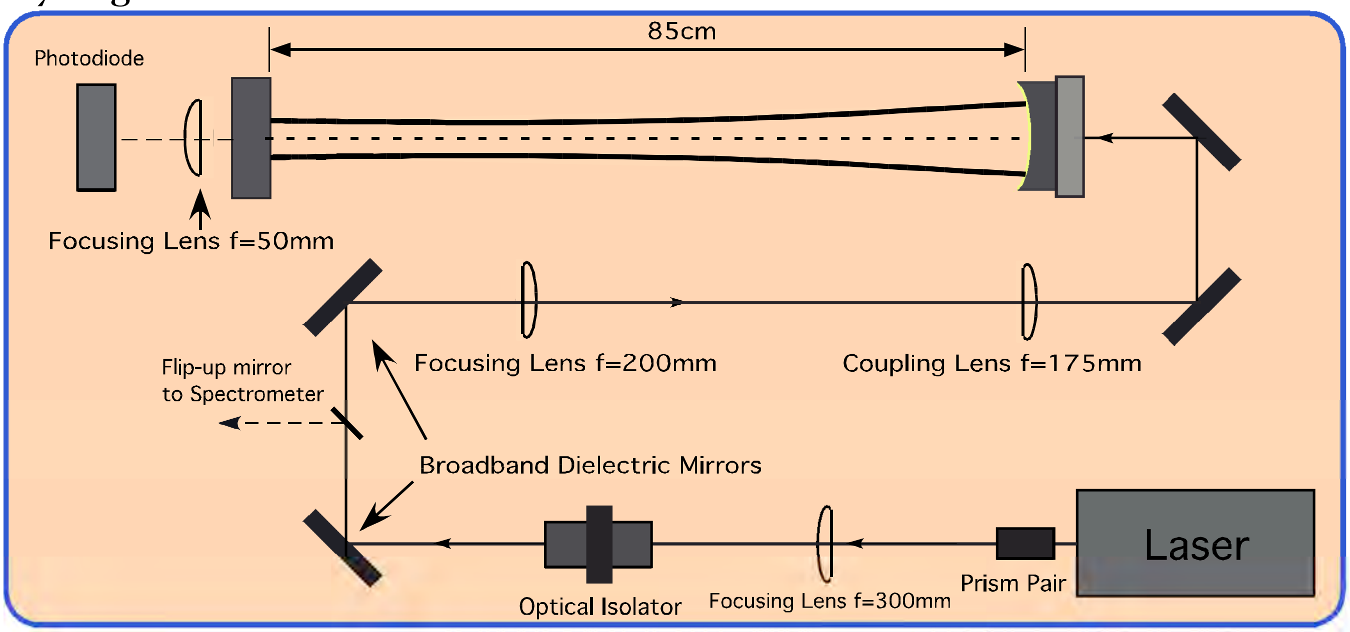


Set-up for deriving epsilon values

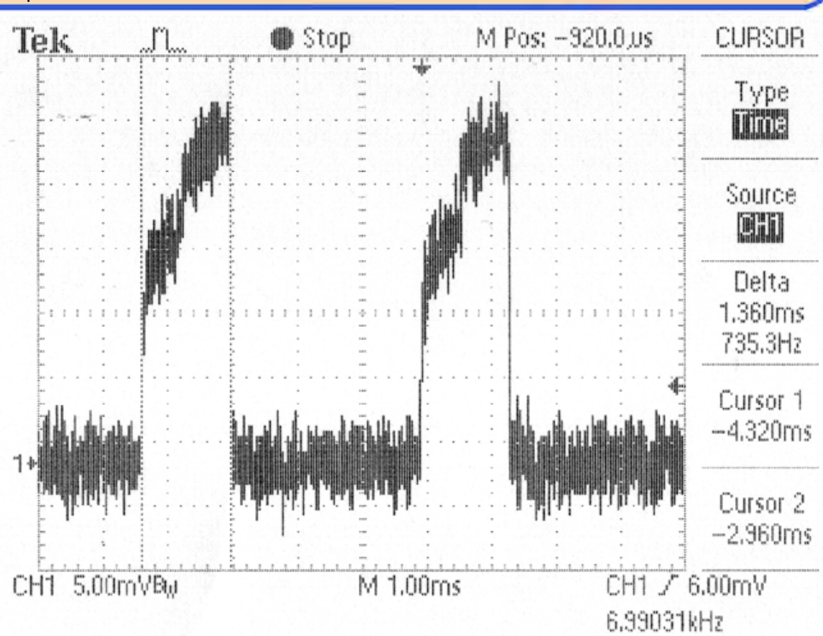
Measuring the Reflectivity of Semiconductor Mirrors Using Light Intensity Ring-Down in a Half-Symmetric Resonator

Daniel Utley
Advisor: Susan Lehman

This Independent Study is the first step into semiconductor mirror research at The College of Wooster. As a result of the initial research on this project, the foundation for future work has been established. Through the assembly of an optical resonator cavity, we have gained a greater understanding of the characteristics of our laser and the sensitivity of a new optical system. A light signal from the optical cavity was detected and the cavity was likely very close to resonance conditions. At the present time, achieving successful resonance is dependent on obtaining several new components which will allow for more accurate cavity alignment.



This oscilloscope trace illustrates the periodic shifts in intensity observed as the laser wavelength was tuned slightly shorter than ~983 nm. 983 nm produces a peak intensity output from the laser.



Junior Independent Study

Jeremy Hohertz, Andrew Kindschuh, Danny Shai, Katherine Olaksen, Kathy McCreary, Angie Triplett

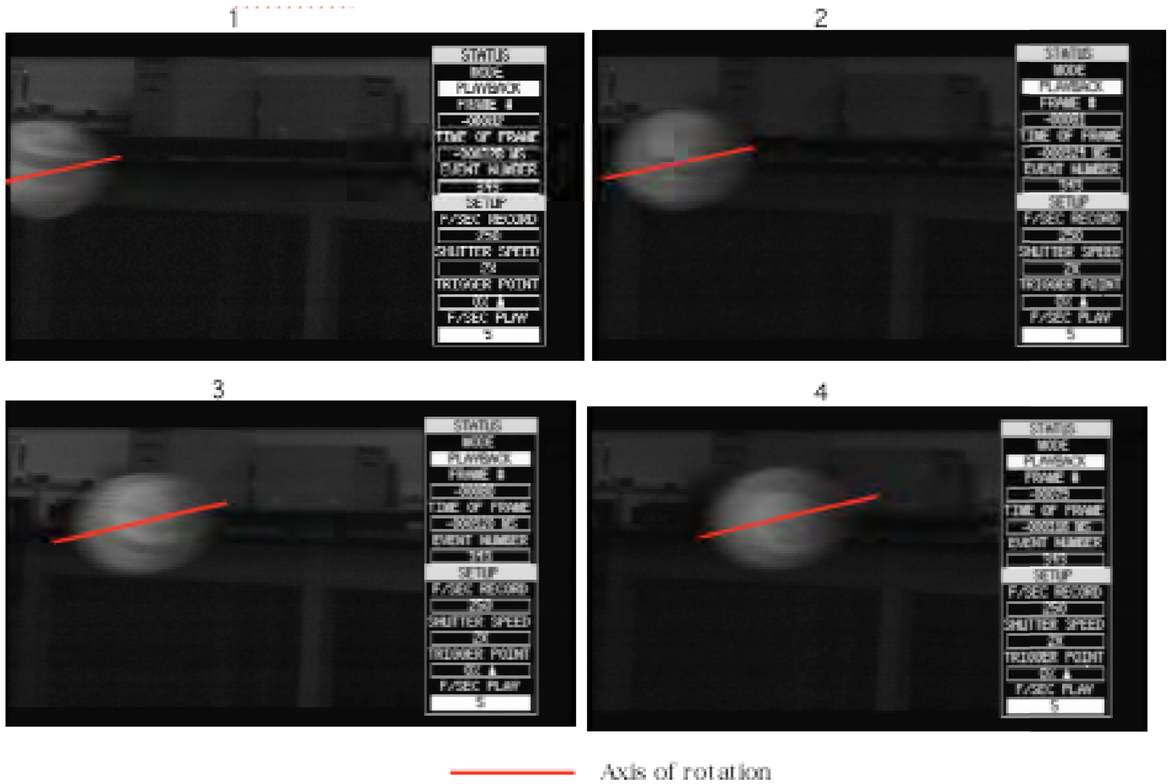
This year's Junior I.S. requirements included one self-designed experiment (details on following pages) with a proposal and a serious literature review, at least one project from each of the areas of Mechanics, E&M, Optics & Quantum Mechanics, and Thermal Physics, one experiment using computer data acquisition, and a numerical simulation.

The numerical simulations were advised by Dr. Lowell Boone. Katherine simulated a monoenergetic ideal gas to test the pressure-temperature predictions of kinetic theory in two and three dimensions. Kathy used a Huygens approach to constructing the two-dimensional diffraction patterns produced by an arbitrary aperture. Jeremy simulated the confinement and eventual escape of a charged particle embedded within a system of tangled magnetic fields. Danny modeled the response of a physical circuit to an alternating EMF in an effort to understand and reproduce chaotic behavior. Angie studied the pair correlation function for a one dimensional polymer chain and found that its functional form depends strongly on the spatial dimensions in which the polymer is allowed to relax. Andrew studied how the flow of liquid through a randomly porous three-dimensional material depends on the geometry of the system.

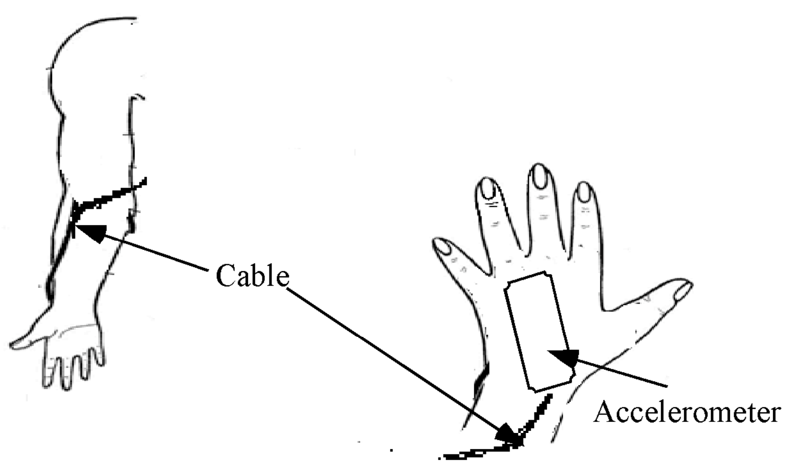
Finding the Spin of a Softball Pitch

Angie Triplett

In this experiment, rise and drop ball softball pitches were examined by using a three dimensional accelerometer and a high-speed camera. The drop ball's data unfortunately was too unclear to make any assumptions as to what the angular velocity is and how the different forces affect the flight of the ball. As for the rise ball, a constant angular momentum was found when using a high-speed camera, which showed that there was no torque acting upon the ball. There was an angular velocity of 65±10 rad/s and velocity of 3.1 m/s for the seam of the ball, though. The velocity for the center of mass was also calculated to be 9.69 ± 0.49 m/s. The forces acting upon the ball were the Magnus force of 0.396N, the gravitational force of –1.94N and the viscous force of 1.58 x 10^{-4} N.



Consecutive frames over a time of 12 ms. Notice how the seam rotates about the line representing the axis of rotation.

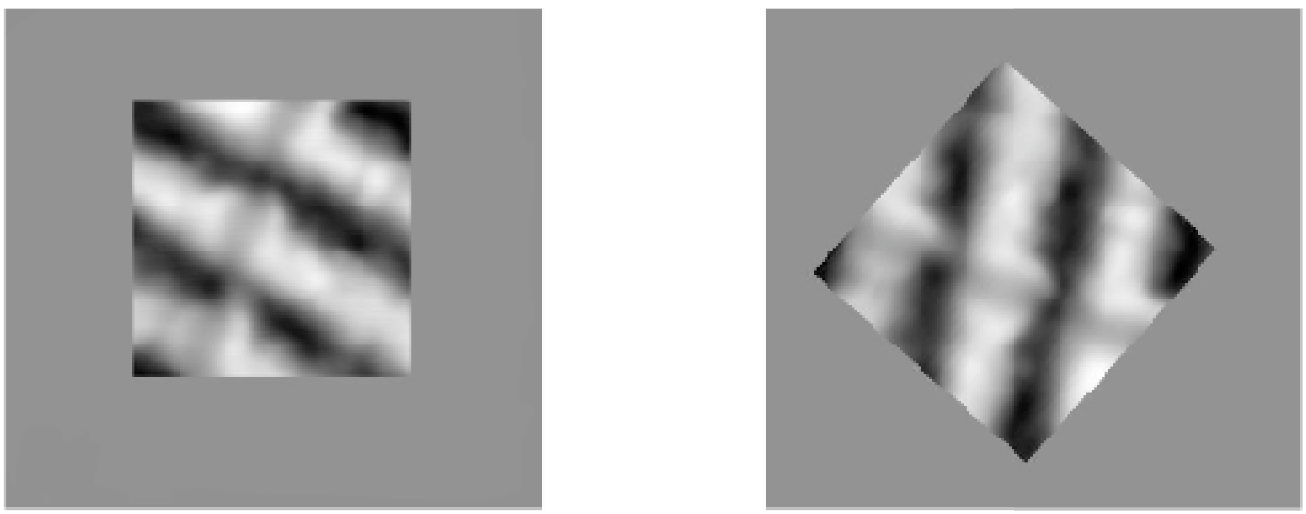


How the accelerometer was attached to the hand

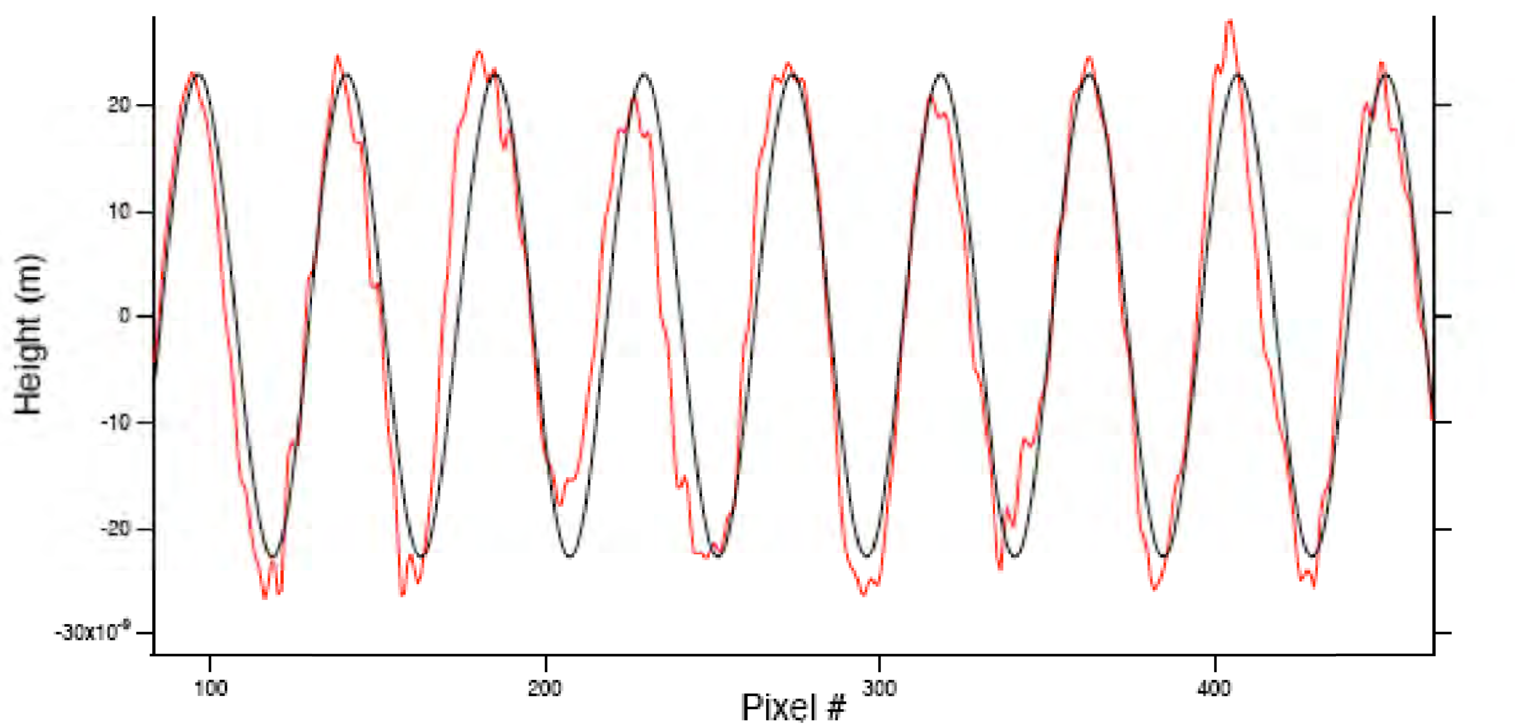
Investigation of a Blazed Reflection Grating

Danny Shai

A reflection grating was studied via two different experimental measurement techniques. Initially, the diffractive properties of the grating were used to determine an average line spacing of 2401 ± 6 L/mm. Then, atomic force microscopy was used to measure the same value. The average spacing as calculated through atomic force microscopy is 2351 ± 51 L/mm. Both of these values are in near agreement with the accepted value of 2400 L/mm. In addition, the blaze angle of the grating was measured to be 12.4 ± 0.4˚. This value is also in near agreement with the calculated value of 17.5˚.



AFM scan (a) before and (b) after the rotation was implemented



A sine wave fitted to the cross-section of a scan

A Study of the Motion of a Free Falling Shuttlecock

Kathy McCreary

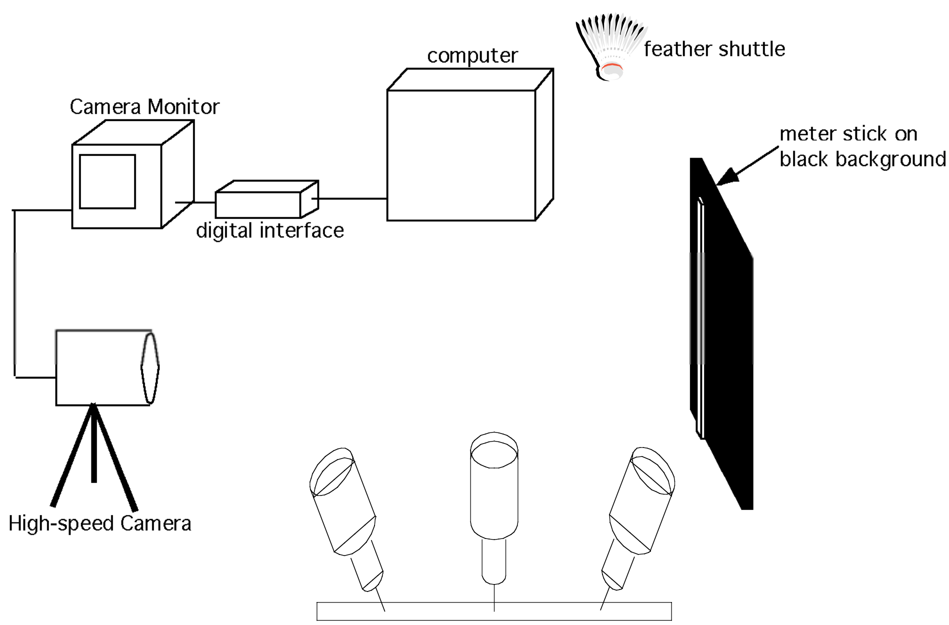
In order to conclusively determine whether the resistive force on a feather shuttlecock in free fall is proportional to the velocity or the velocity squared, more data needs to be collected and analyzed after the shuttle has fallen larger distances. From the current data, the velocity of the shuttle after falling approximately two meters has been measured. Data acquired for the shuttle after falling three meters should be sufficient to distinguish between a resistive force proportional to velocity or velocity squared. Using the current data, if the resistive force is assumed to be proportional to the velocity squared $\left(F_{res} = kmv^2\right)$, the data of position graphed with respect to velocity should fit the equation

$$x(v) = \frac{v_T^2}{2g}\ln\left[g\left(1-\left(\frac{v}{v_T}\right)^2\right)\right] + \frac{v_T^2}{2g}\ln(g)$$

The collected data of position versus instantaneous velocity was fit to this equation with the aid of *Igor*, in order to find a terminal velocity value of 6.96 ± 0.07 m/s. If, on the other hand, the resistive force is assumed to be proportional to the velocity, the position graphed with respect to velocity will fit the equation

$$x(v) = -\frac{v \cdot v_T}{g} - \frac{v_T^2}{g}\ln\left[g\left(1-\frac{v}{v_T}\right)\right] + \frac{v_T^2}{g}\ln(g)$$

The terminal velocity value resulting from this model is 11.59 ± 0.17 m/s, which intuitively seems very large for the speed of a shuttlecock.

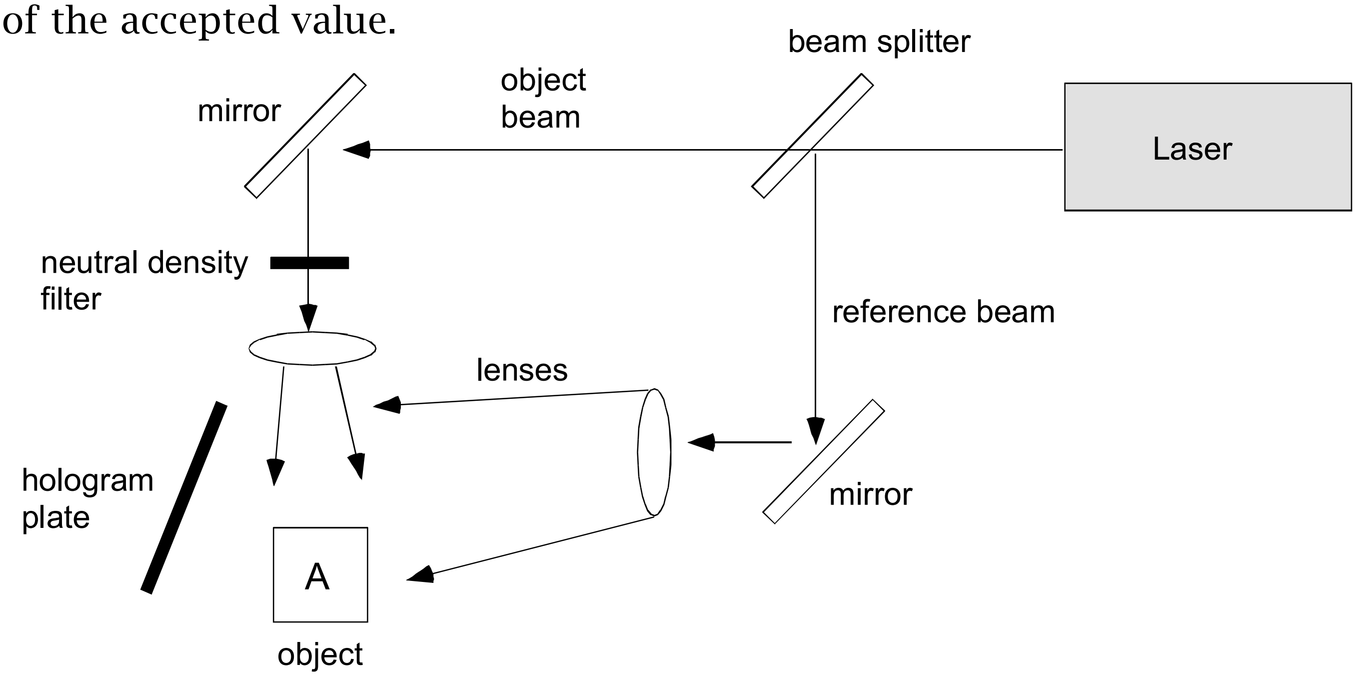


High-speed camera set-up

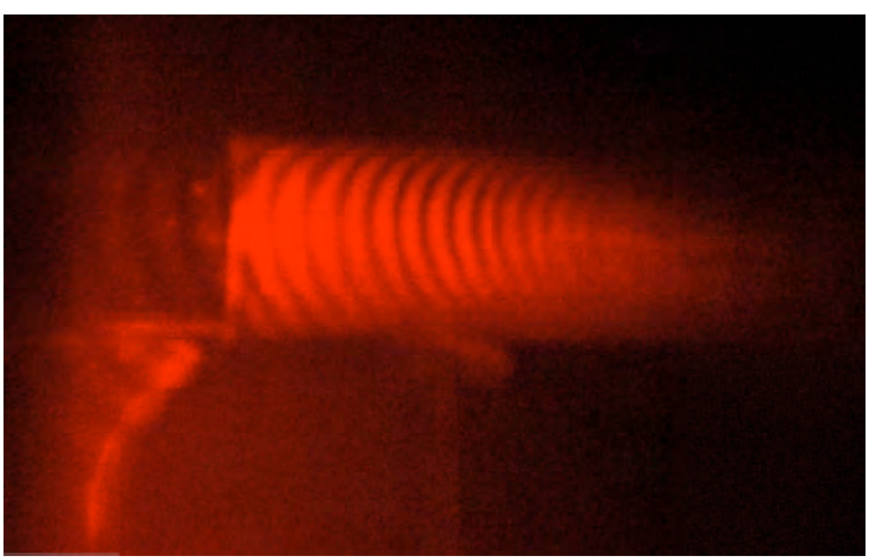
Thermal Expansion of Yellow Brass (66 Cu: 34 Zn)

Jeremy Hohertz

Double exposure holographic interferometry was used to determine the coefficient of thermal expansion (standard value α = 2.02 x 10^{-5} C^{-1}) for yellow brass (66 Cu: 34 Zn). By cooling the unlacquered part of a trombone tuning slide, and allowing it to return to room temperature, a double exposure hologram was taken that recorded the change in size on the order of visible light wavelengths (632.8 x 10^{-7} cm from a He-Ne laser). The coefficient of thermal expansion was found to be α = (2.144 ± 0.064) x 10^{-5} C^{-1}, which is within two standard deviations of the accepted value.



General set-up for the experiment. A beam of light from the laser is split by a beam splitter into a reference beam (right) and object beam (left). The neutral density filter used in this experiment was rated at (OD 0.3), and each lens has a 60x magnification.

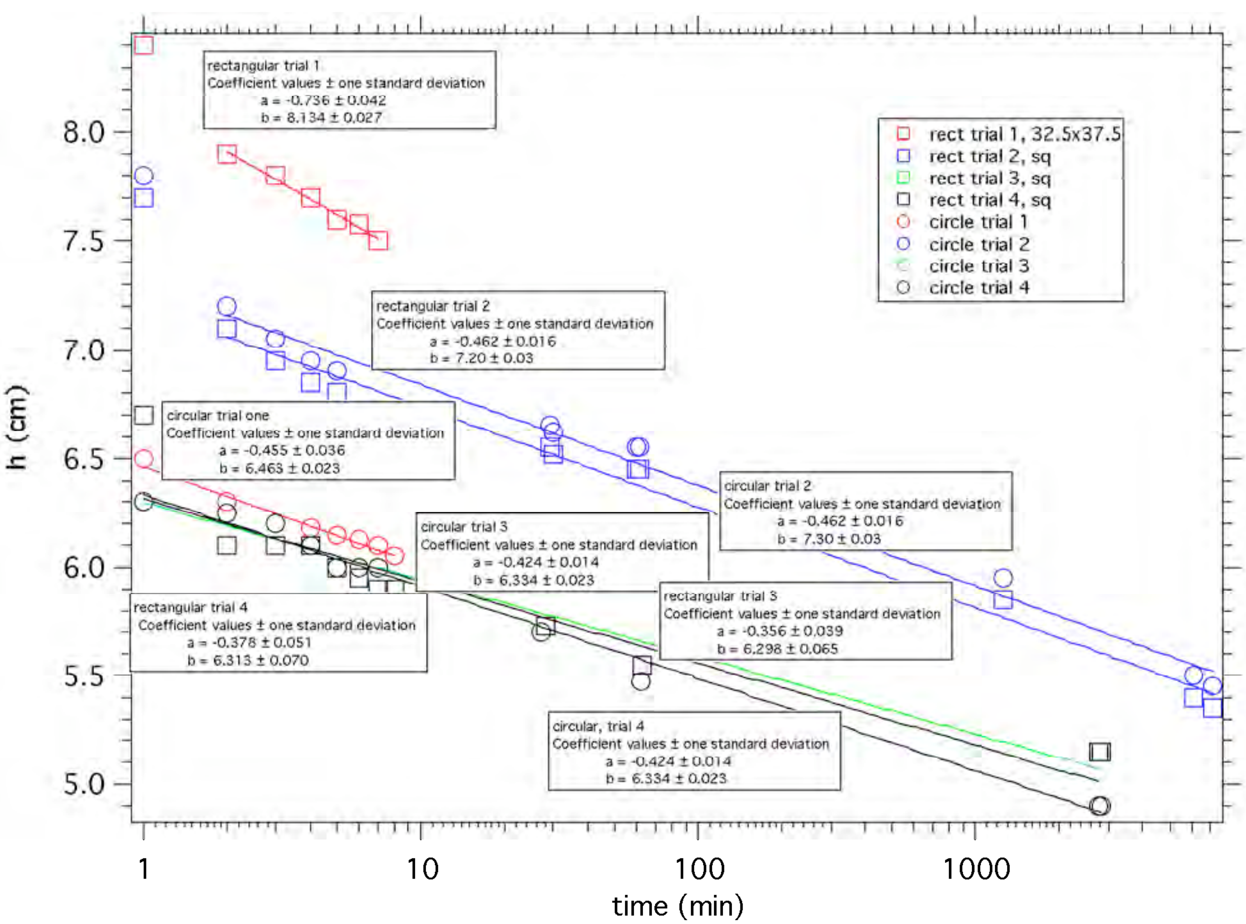


This photograph of the hologram shows concentric rings moving along the length of the object. This is due to the uneven cooling; the right side of the object was cooled more than the left side.

Log based compression of a thin sheet crumpled under constant force

Andrew Kindschuh

A reproduction of the results for the temporal behavior (found by Matan and Williams) of a crumpled thin Mylar sheet compressed under a constant force was sought, but not found, and a comparison was made between crumpled thin sheets of similar size, but dissimilar shape. A mass is placed on top of a plastic disk on top of the crumpled material confined in a cylinder. The vertical location of the disk is monitored over time. The formula B + Alog(T) was determined to fit the compression data gathered, and good reproducibility was found for the constant A in the equation. For mylar sheets, A was found to be –0.455 ± 0.036 cm, –0.462 ± 0.016 cm, –0.424 ± 0.014 cm, and –0.424 ± 0.014 cm for circular sheets under a constant force of 1.96 N; –0.736 ± 0.042 cm, –0.462 ± 0.016 cm, –0.356 ± 0.039 cm, and –0.378 ± 0.051 cm for a rectangular sheet of the same size compressed under the same force. Aluminum gave a value of –0.784 ± 0.033 cm for a sheet of the same size compressed under a much larger force of 5.88 N.

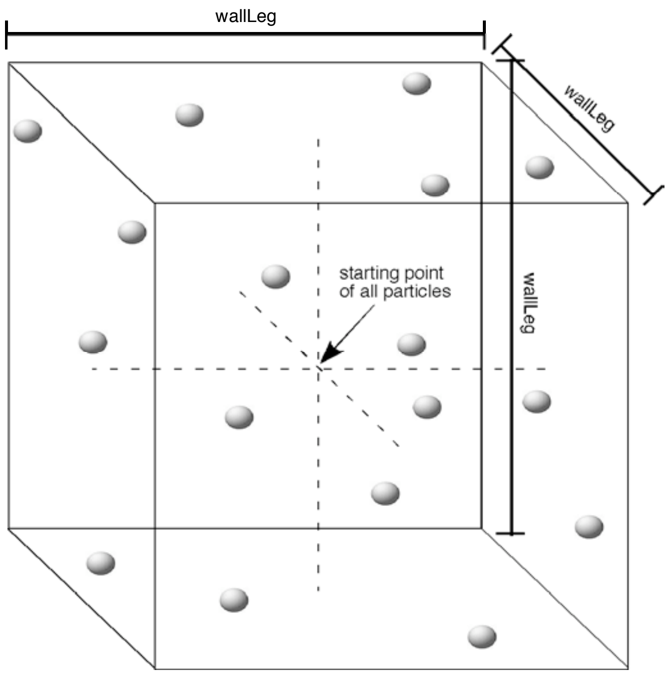


Height (cm) versus time (min) at constant pressure and all points were curve fit to the formula H = A log(t) + B

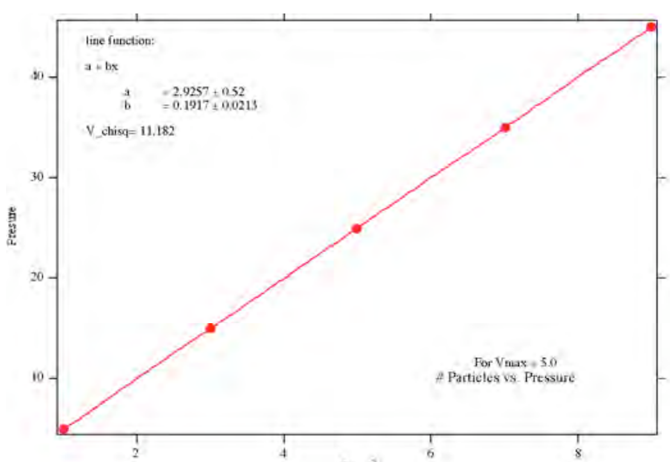
Simulation Verifying the Ideal Gas Law

Katherine Olaksen

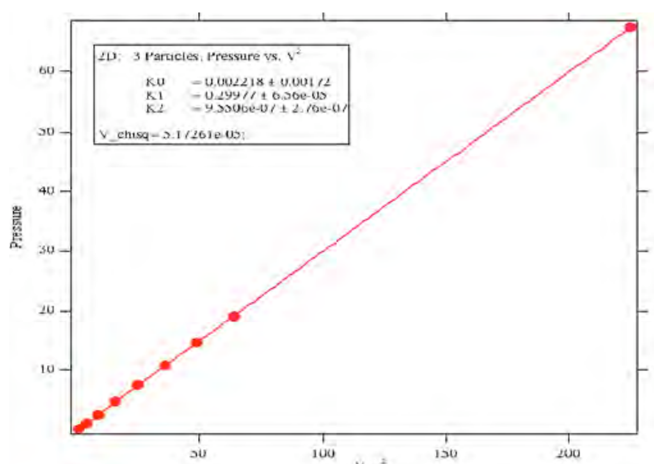
A simulation of mono-energetic gas released in a cubic chamber was done in an attempt to illustrate the Ideal Gas Law. The particle movement is simulated and the pressure experienced by the chamber due to the gas is calculated. The intention was to demonstrate a quadratic correlation between the net velocity of the particles and the pressure exerted on the box. This relation was successfully demonstrated.



This is what the program simulates at its start. All particles disperse from the center randomly. They interact with the walls of the cube but not each other.



This graph demonstrates the linear relationship between the velocity and pressure.



This graph demonstrates the relationship between the velocity and pressure in 2D.

Awards & Honors

The Arthur H. Compton Prize in Physics

Austin Roberts Carter

Established in 1928 by members of the class of 1913 in honor of Dr. Compton, who received the Nobel Prize in Physics in 1927. Awarded to the senior physics major attaining the highest standing in that subject

The Mahesh K. Garg Prize in Physics

Austin Roberts Carter

Awarded annually to an upperclass physics major who has displayed interest in and potential for applying physics beyond the classroom

The Joseph Albertus Culler Prize in Physics

Stephen Thomas Poprocki

Established in 1942, recognizes excellence in the field of physics and is awarded to the first- or second-year student who has attained the highest rank in general college physics

The William A. Galpin Award for General Excellence in College Work

Austin Roberts Carter (2nd)

Awarded annually to two men and two women in the senior class who may be adjudged outstanding personalities from the point of view of scholarship, social and religious leadership, and athletic ability

The Laub Foundation Scholarship

Kathleen Michelle McCreary

Established by The Laub Foundation of Rocky River, Ohio, and awarded to students in good academic standing who come from Northeastern Ohio

Latin Honors

Austin Roberts Carter
Summa cum laude

Daniel Lee Utley
Cum laude

Phi Beta Kappa

Austin Roberts Carter

Daniel Lee Utley

Physics Club

Officers:
President: Austin Carter
Vice President: Dan Utley
Treasurer: Kathy McCreary
Secretary: Jeremy Hohertz

Colloquium Series:

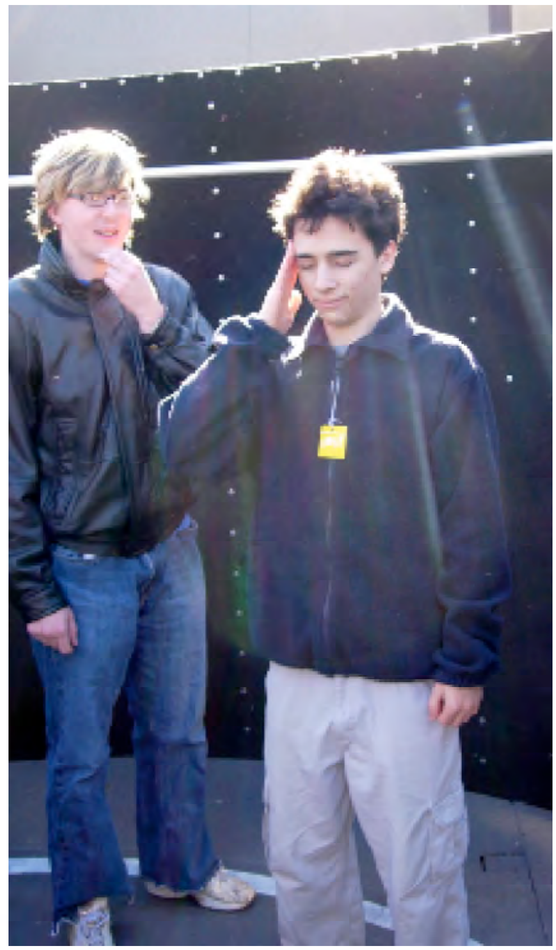
Corbin Covault, CWRU
New Connections in High Energy Astrophysics
September 30, 2004

Sergio DeSouza-Machado, UMBC
(College of Wooster '88)
Infrared Remote Sounding of the Earth's Atmosphere
October 21, 2004

Wooster Student Researchers
A Festival of Research
December 7, 2004

Markus Böttcher, Ohio University
The most violent active galaxies in the Universe
March 10, 2005

Ryan Hartschuh, Collaborative Center in Polymer Photonics, University of Akron
(College of Wooster '03)
Spectroscopic Techniques for Characterization of Nanostructured Materials
April 28, 2005



John & Stephen cope with loose brain data after a spin on the Rotor at COSI

No wonder we won Taylor Bowl this year!

Activities:

Scot Spirt Day
September 2004

Pizza &
Liquid Nitrogen Ice Cream Night
October 2004

Trip to COSI
November 2004

Taylor Bowl
April 2005

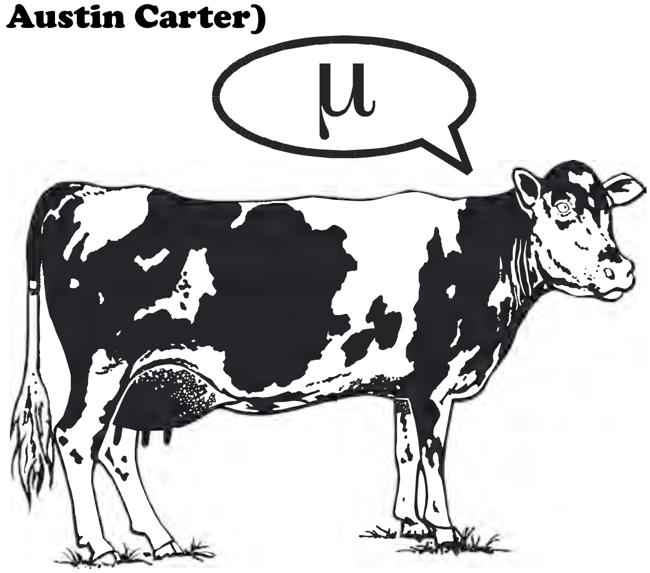
Taylor Bowl XVI

Physics 112.69
Math 108.70

Physics Club president Austin Carter led the way to victory with a high score of 199. During the week leading up to Taylor Bowl, several physics majors sported T-shirts saying "Da Loves Physics", in reference to the Math Club president DaPeng Hu's year long taunting of the Physics Club's bowling abilities. Da was a good sport, however, and even donned a Da Loves Physics shirt himself (*after* hurling it across the room).

Physics Club T-Shirt
(design by Austin Carter)

C.O.W.
PHYSICS
2005



Outreach

from left:
Nathan Utt, Danny Tremblay,
Sarah Suddendorf, Austin Carter

Advisor:
Susan Lehman

Students at
Wooster Township elementary
show their enthusiasm for physics.

19 November 2004
Cornerstone Elementary 4th grade
THEME: Pressure and Air

28 January 2005
Cornerstone Elementary 4th grade
THEME: Pressure and Air

17 February 2005
Wooster Township Elementary 3rd grade
THEME: Pressure and Air

25 February 2005
Wooster Township Elementary 3rd grade
THEME: Electricity & Magnetism

1 April 2005
Kean Elementary 5th grade
THEME: Electricity & Magnetism

15 April 2005
Mount Eaton Elementary 4th grade
THEME: Pressure and Air

29 April 2005
Wooster Township Elementary 4th grade
THEME: Pressure and Air

The fourth year of the Physics Club's outreach program was very successful, offering an electricity and magnetism demonstration in addition to the pressure and air demonstration done in previous years. A trip to Mount Eaton Elementary School, located in the heart of Amish country of Wayne County, was the highlight of the year. The young students were quite intrigued by the fact that Nathan Utt plans to use his physics degree to become an engineer of farm equipment. The teacher of the class, Lindsey Howell (CoW '04), is very proud that her class passed the science section of the Ohio proficiency test this year, the first class to do so at Mount Eaton in at least seven years!

B-Wiser

Each summer, the College hosts the **Buckeye Women in Science** camp for young women of junior high age. The camp is funded in part by the Ohio Space Grant Consortium. The Physics Department provides a program of physics demonstrations on one evening of the camp. Judith Elwell sets up the demos and our summer research students explain the physics to the campers. Susan Lehman served as faculty coordinator this year. It is an evening of fun and learning for both campers and students.

This year's demonstrations included:

Moon Cratering

Campers learned about craters on the Moon and then dropped balls into containers of flour and paint powder to create their own craters. They studied how the speed of impact affects the size of the craters.

Holography

Starting with the diffraction of light, we explained how holograms are different from regular photographs using holograms made by CoW students. The rotating cylindrical holograms, white light holograms and the hologram of a phone with a working magnifying glass in the hologram were big hits with the campers.

Reflection

This demo used a red, green, and yellow laser and a corner cube to explain how light can get trapped inside materials by total internal reflection. TIR is also why diamonds have so much sparkle and how fiber optic communication works.

Sound

Sound is a wave with different frequencies which we can hear. We used a microphone and *DataStudio* to show the campers the different sets of frequencies present in different types of sounds, such as talking, singing, and various musical instruments. We used a trombone to play a scale and to show the students how the pitch we hear relates to the frequency of the sound.

Spectral Lines

Campers learned about light as a wave and used transmission diffraction gratings to see how the grating spread the white light from an incandescent light bulb into the rainbow. Then, using the gratings on light from different gas lamps (including hydrogen, helium, and neon), they saw how each gas has its own spectral "fingerprint" of certain colors so that we can identify it. We explained how this is used to determine composition of stars. Campers got to keep their piece of grating so that they can continue their spectral investigations at home.

Lightyears in the Movies

We used the beginning sequence of the movie *Contact* and the short DVD of *Powers of Ten* to try to gain some understanding of vast dimensions. We used these movies and a scale model of the solar system to increase understanding of the distances involved within the atom, the solar system, the galaxy and the universe, and how much empty space there is in each of these systems.

Campers made Moon craters out of flour & paint powder.

Kelly Patton '08 is full of hot air for the sound demo.

National Meeting
American Physical Society
Los Angeles, CA, March 2005

Dr. Lehman, Dan Utley, Mark Lightfoot, Angie Triplett, Austin Carter, Stephen Poprocki, Danny Shai (also accompanied by Don Jacobs)

Poster Presentations (*undergraduate co-author)

Angie Triplett, Nithya Venkataraman*, and D.T. Jacobs, "Correlation length of a near-critical, eight-arm star polystyrene in methylcyclohexane"*

Stephen Poprocki, Leann Erbsen*, and Susan Lehman, "Detection and Analysis of Quantum Dots from Atomic Force Microscope Images"*

Mark Lightfoot and D.T. Jacobs, "Coexistence curve of a near-critical, eight-arm star polystyrene in methylcyclohexane"*

Daniel Shai and John Lindner, "Precession of nearly circular orbits in the Newtonian 2-body problem perturbed by constant positive curvature"*

Summer Research

Los Angeles, CA, March 2005

1. Dr. Lehman
2. Kelly Patton (CoW '08)
3. Christine O'Brien (College of DuPage)
4. Sarah Suddendorf (CoW '07)
5. Danny Tremblay (CoW '07)
6. John Gamble (CoW '08)
7. Lisa May Walker (Dickinson College)
8. Dr. Jacobs
9. Ruth Shewmon (MIT)
10. Kirsten Larson (CoW '08)
11. Mark Wellons (CoW '08)
12. Megan Miller (Wells College)
13. Dr. Boone
14. Dr. Garg

It wasn't all work and no play for the 2005 summer research group. In addition to research, library training, software tutorials, and ethics workshops, fun activities included a canoe trip, COSI science museum, weekly picnic lunch, weekly video of the PBS series *Rough Science*, ice skating, and cookouts at faculty homes.

Summer research students "balance" hard work with lots of fun.

Projects

John Gamble (funded by NSF-REU)
Dielectric Permittivity in Binary Nematic Mixtures
Advisor: Shila Garg

Kirsten Larson (funded by NSF-REU)
The Search for Microquasars in High Galactic Latitudes
Advisor: Lowell Boone

Megan Miller (funded by NSF-REU)
Self-Organized Criticality and the Energy Dissipation Model as Observed in a Bead Pile
Advisor: Donald Jacobs

Christine O'Brien (funded by NSF-REU)
Modeling Magnetic Confinement of a Relativistic Particle
Advisor: Lowell Boone

Kelly Patton (funded by NSF-REU)
A Study of Quantum Dots through Atomic Force Microscopy
Advisor: Susan Lehman

Ruth Shewmon (funded by NSF-REU)
Using Heat Capacity to Observe Non-critical Phase Transitions of the Binary Fluid Mixture Triethylamine-Water
Advisor: Donald Jacobs

Sarah Suddendorf (funded by Petroleum Research Fund of the American Chemical Society)
Turbidity and Correlation Length Amplitude of 8-Arm Star Polystyrene in Methylcyclohexane Near the Critical Point
Advisor: Donald Jacobs

Danny Tremblay (funded by NSF-REU)
Measuring Ultra High Reflectivities Using Light Intensity Cavity Ring-down
Advisor: Susan Lehman

Lisa May Walker (funded by NSF-REU)
Searching for Microquasars using the INTEGRAL Satellite
Advisor: Lowell Boone

Mark Wellons (funded by Petroleum Research Fund of the American Chemical Society)
Measuring the Coexistence Curve of an 8-Arm Star Polystyrene in Methylcyclohexane
Advisor: Donald Jacobs

Off-Campus Summer Research

Stephen Poprocki '07 worked on the DZero and ATLAS projects at Nevis Labs through Columbia University. His project involved using artificial neural networks to detect bottom quark jets. The mass of the Z boson was calculated by using the neural network to detect Z bosons decaying to bottom and anti-bottom quark pairs.

Angie Triplett '06 did research at the Advance Materials Laboratory of Sandia National Labs. Her concentration was on the synthesis and characterizations of nanostructured titania. Using aerosol assisted assembly to form hollow and solid titania particles and their photocatalytic properties, she compared the percentage of arsenic removal in drinking water to the commercial titania P25 particles.

Kathy McCreary '06 did summer research at North Carolina State University. She studied SiO_2 at thicknesses of approximately 1.5 nm, which exhibits a direct tunneling current of 1A/cm2. In order to reduce direct tunneling through the gate stack of a metal oxide semiconductor field effect transistor, MOSFET, and in turn further decrease device dimensions, a proposed solution is to use stacked gate dielectric materials with high dielectric constants. High-k materials allow a physically thicker film to be used, while the equivalent oxide thickness may be much smaller (less than 1 nm). Kathy used Remote Plasma Enhanced Chemical Vapor Deposition to produce MOSFETS composed of high-k materials. $(HfO_2)_{0.8}(SiO_2)_{0.2}$ were stacked with Al_2O_3 samples at a variety of thicknesses. These samples were analyzed and found to have reduced fixed charge compared to previous composition.

Physics Phun with Magnetic Poetry

Give a physicist a list of words, a flexible magnetic sheet from the craft store, spray adhesive, and scissors, and it's INSTANT FUN! Both students and faculty have been having a blast creating nonsensical phrases from Jackie's homemade magnet poetry using the words on the opposite page. Here's a sampling of our creative juices at work:

Jackie's kilt's gravitational chamber fluctuates and quarks Tootsie Rolls.

If they analyze Dr. Lindner's dynamics, sophomore students are excited.

Dr. Boone uses polymer magnetism for Taylor Bowl.

Experiment with a Lowry pizza perturbation.

Do interfering chemists and mathematicians matter?

Dr. Jacobs uses nuclear caffeine to experiment with condensed radioactive fluids.

Dr. Lehman has a Junior Einstein in her geek chamber.

Senior I.S. puts senior students in a variable chaos pattern.

Taylor has physicist and mathematician nerds within its lattice.

Judy analyzes molecular refraction with electronic slide rule technology.

A physics professor was famous for his animated lectures. He was tall and thin with wild hair and an excited expression. In lecture he would throw himself from the top of desks and toss frisbees to students in the back row to illustrate various principles.

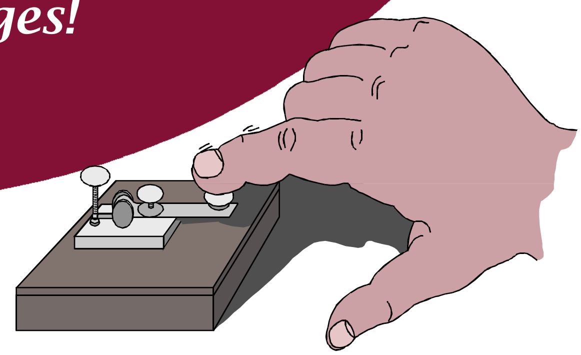
One day in class he was spinning on an office chair holding weights in each hand when he lost his balance and tumbled into the first row. He promptly apologized to his class for going off on a tangent.

dirty	fusion	within	Dr. Jacobs	do	because	fluid	and	is	is		
pattern	atoms	Einstein	beam	Senior I.S.	variable	tensor	is	is			
gravitational	black hole	superconductor	physicist	radioactive	ed	ed					
boiling	biological	acoustic	chemical	gauge	cosmology	ed	ed				
Dr. Lindner	beside	condensed	quark	visible	state	d	d	d			
refraction	matter	mathematician	these	polymer	light	are	are				
moves	relativity	cloud	fluctuates	statistical	dynamics	a	a	a			
lecture	pulsar	professor	excited	order	turbidity						
lattice	wave	applied	graviton	nuclear	nonlinear	s	s	s			
momentum	optical	lepton	technology	she	time						
that	hadron-neutrino	proton	in	industry	second						
chamber	chaos	mass	fiery	put	science	coherent					
accelerator	they	with	experiment	you	Dr. Lehman						
each	physics	molecular	integrate	I	we	Dr. Boone					
analyze	interference	perturbation	magnetism	observe	ultimate						
if	uses	compare	the	are	of	first	for	then			
has	those	electronic	it	this	an	to	he	bowl			
Junior I.S.	Wooster	Jackie	E&M	tootsie roll	Judy	gluon					
CoW	kilt	students	Taylor	slide rule	geek	nerd					
faculty	pizza	caffeine	First Year	Sophomore	Junior	Senior					
Scots	Lowry	ask	like	cry	tell	see					
want	or	Dr. Garg	go	something	try	s	s	s			
chemist	the	the	and	and	an	an	ing	ing	ing		
my	our	your	nano	his	?	?	her	'	'	'	'

Alumni Spotlight is on hiatus this year as we try out a NEW and EASY method for you to update us. Simply visit:

http://www.wooster.edu/physics/Alumni/

and click on "Alumni Update Form".
It only takes a few minutes, and you can select if and where your update is published.
Let's fill these pages!



Of course, email or snail mail updates are always welcome too!

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