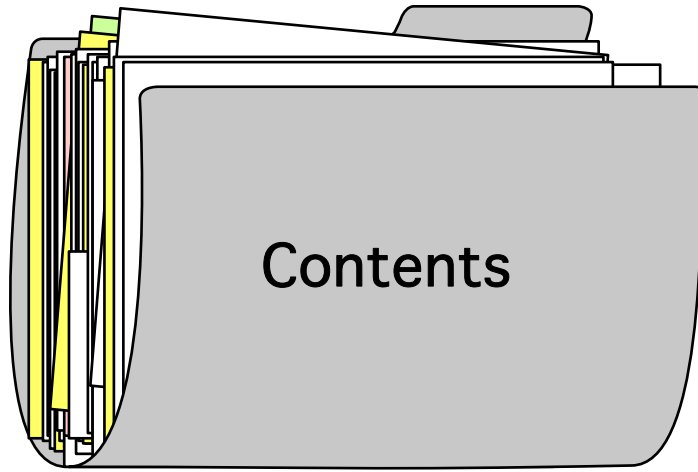




THE COLLEGE OF
WOOSTER



Department of Physics
Annual Report
2000-2001

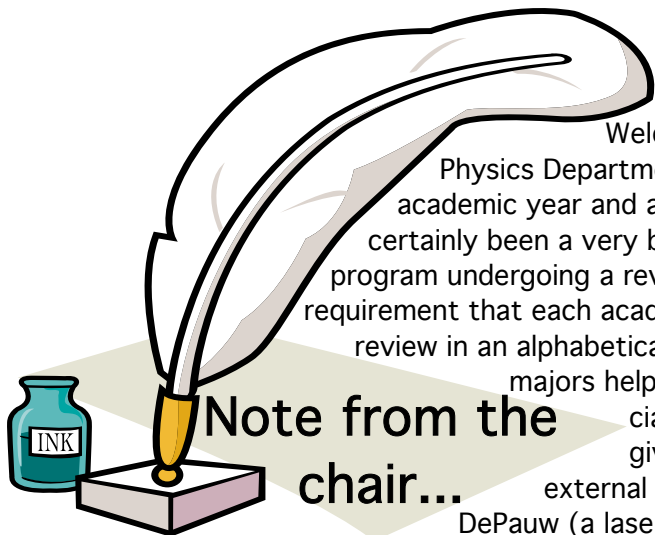


Note from the Chair
Class of 2001
Faculty & Staff
Senior Independent Study
Junior Independent Study
A Glimpse at the Past (I.S.)
Recognition of Physics Majors
Alumni News
Research Experience for Undergraduates
Physics Club
Conferences
Dr. Garg Goes to China
Fractal Dimension of Broccoli?

On the cover:

For his Junior Independent Study self-designed experiment, Dave Miller studied chaotic light scattering. He stacked three or four large reflecting globes (lawn ornaments!) on top of one another and illuminated them simultaneously with different colored lights. As seen on the cover, the result was an infinite hall of mirrors effect, except with curved rather than flat mirrors.

The set of all incident light rays is the union of subsets of rays which exit the reflecting globes in different directions. These exit basins have fractal boundaries. Furthermore, they exhibit the Wada property: any initial condition which is on the boundary of one exit basin is also simultaneously on the boundary of all the other exit basins.



Welcome to the fifth Annual Report from the Physics Department. I hope you enjoy reading about the past academic year and all that has gone on in the department. It has certainly been a very busy year for us, especially with our curricular program undergoing a review. This review is part of The College's requirement that each academic department and program undergoes a review in an alphabetical manner. Our alumni as well as our current

majors helped us define our goals for the review. I appreciate many thoughtful comments that were given to us by you through our survey. Our external reviewers were Neal Abraham, VPAA at DePauw (a laser physicist who had taught at Bryn Mawr for many years) and Peter Collings (a liquid crystal physicist at

Swarthmore College). They spent two days on campus during February and spent a lot of time talking to various groups of faculty and students. They had access to our course syllabi, data on our students and alumni and the elaborate self-study that the department prepared. Our reviewers had many positive comments about our program and were impressed with our students' accomplishments. As a result of this process, we are currently looking at the rigor of our upper-level courses and the suitability of our introductory sequences to our audience. In addition, we were advised to acquire some 'state-of the art' equipment for our upper level labs. We were fortunate that our subsequent grant application to ALDEN Trust (a private foundation) was successful and we were awarded \$100,000 to purchase a scanning probe microscope. It will be installed later this year, in time for Junior Independent Study.

Our upper-class majors have been very successful in getting summer research positions, after going through our REU program in their first and second years. Two of our REU students and two seniors presented posters at the March APS meeting at Seattle. As is our tradition, we also discovered the local cuisine during our trip. Two other sophomores presented at other national conferences. Our SPS section has been very active and has hosted many fun events. Our majors are about to launch an outreach program in the grade schools at Wooster. You can read about it in our next report.

We wish Bram Boroson, who was with us as a half-time visiting faculty, all the best as he continues his teaching career at Claremont College, CA. Ryan Culler has joined us as an adjunct professor to teach additional astronomy courses. This year all four of us are in the department, with no one on leave. My faculty colleagues have been very productive with excellence in teaching and research and being visible in the larger scientific community. Jackie is now our administrative assistant and continues to excel in all she does. Judy's duties continue to expand as the department is going high-tech with all the lab equipment. She is doing an excellent job of keeping up with this growth.

Thank you for your continued interest in the department and drop us a line when you can to tell us about how you are doing. Or better yet, stop by and see us if you are in the neighborhood.

Sincerely,

Shila Garg
Chair



Zakir



Rachel Mary, Lauren, Chris, Amy, Scott, Drew

The Class of 2001



Lauren K. Ault

Concord, OH

Plans: Americorp Program, Boston, MA

Rachel Mary Costello

Greensburg, PA

Plans: Graduate school, University of Utah

Andrew Mark Bouchard

Fort Kent, ME

Plans: Return to CoW to earn teaching certificate

Scott Brandon Hughes

Grafton, OH

Plans: Graduate school, Washington University

Amy Louise Lytle

Westfield Center, OH

Plans: Graduate school, University of Colorado at Boulder

Christopher Lewis Templeman

Berea, OH

Plans: Scientist, Physical Sciences, Inc.
Boston, MA

Zakir Zulfikar Thaver

Karachi, Pakistan

Plans: Employment

Physics Faculty



Donald T. Jacobs

Victor J. Andrew Professor of Physics
BA, MA South Florida 1971, 1972
PhD Colorado 1976



Shila Garg

Professor and Chair of Physics
BS Madras (India) 1970
MS Sussex (U.K.) 1972
PhD Kent (U.K.) 1975



John Lindner

Associate Professor of Physics
BS University of Vermont 1982
PhD California Inst of Technology 1988



Jennifer Goetz

Clare Boothe Luce Asst Professor of Physics
BS Binghamton 1992
MA University of Rochester 1995
PhD University of Rochester 1999



Bram Boroson

Visiting Assistant Professor of Physics
BA Oberlin 1989
PhD University of Colorado 1995

Shila Garg taught Modern Physics and lab as well as Modern Optics in the fall semester of 2000. In the spring, she taught Thermal Physics, Junior Independent Study, and a section of General Physics lab. Her current research is concentrating on:

1. Focal Conic Domain Growth in Smectic A Liquid Crystal subjected to an Electric Field
2. Phase Transitions in a Binary Nematic Mixture
3. Liquid Crystalline Behavior of DNA
4. Pattern Formation in Liquid Crystals Due to Nonlinear Flow

In January of 2001, Dr. Garg attended the CUR Executive Board Meeting in Washington, D.C. In the spring, she chaired a session on Physics Education at the Ohio section of the American Physical Society meeting at Kent State. She also presented a paper “Undergraduate Research in Physics as a Capstone Experience: Framework and Strategies”. She accompanied four students to the national meeting of the American Physical Society in Society in Seattle, where she presented a paper titled “Phase Transitions in a Nematic Binary Mixture” at the liquid crystal oral session. She was co-author of another paper presented with the president of CUR, Toufic Hakim, on “Undergraduate Research in Physics as an Educational Tool”. In June, Dr. Garg made a trip to Beijing, China to attend a conference on Pattern Formation in Nonlinear Complex Systems. She presented a paper entitled “Nucleation and Growth Dynamics of Focal Conic Domains”. While in Beijing, Dr. Garg began setting up a possible NSF-REU program with the Chinese Institute of Physics (see “Dr. Garg Goes to China”). In June, Dr. Garg attended the CUR Executive Board and Councilors’ meeting at Elon University, NC. She was a reviewer for NSF’s Graduate Research Fellowship program and was an external reviewer for a physics department at an Ohio university. She also reviewed grant proposals for NSF (DMR) and U.S. Civilian Research and Development Foundation.

Donald Jacobs was on research leave in the fall semester and was awarded a Henry Luce III Fund for Distinguished Scholarship which provided him release time from teaching in the spring semester. In one month’s time, Dr. Jacobs published three articles in the Journal of Chemical Physics. One resulted from a collaboration with Dr. Sandra Greer and her students at the University of Maryland College Park:

Krishna Pendyala, Xiangyun Gu, Kevin P. Andrews, Karen Gruner, D.T. Jacobs, and S.C. Greer, “Living Poly(alpha-methylstyrene) near the polymerization line: VIII. mass density, viscosity, and surface tension in tetrahydrofuran” J. Chem. Phys. 114, 4312 (2001).

The other two articles were from collaborations with students:

A.W. Nowicki, Madhujit Ghosh, S.M. McClellan, and D.T. Jacobs, “Heat Capacity and Turbidity Near the Critical Point of Succinonitrile-Water” J. Chem. Phys. 114, 4625 (2001).

E.R. Oby and D.T. Jacobs, “Heat Capacity of the Liquid-Liquid Mixture Perfluoroheptane and 2,2,4-Trimethylpentane Near the Critical Point” J. Chem. Phys. 114, 4918 (2001).

Dr. Jacobs has become an associate editor for The American Journal of Physics, the most widely circulated physics journal in the world. This peer-reviewed journal contains articles of particular interest to undergraduate physics faculty and programs. At a recent Gordon Conference on the Chemistry and Physics of Liquids in Holderness, New Hampshire, Dr. Jacobs’ poster on his research in self-organized criticality was selected as one of the five best posters, which awarded him the opportunity to present his research to the entire conference group.

Jennifer Goetz taught General Physics and labs in the fall semester along with a First Year Seminar entitled "First Contact: Possibilities and Consequences". The course examined the possibility of extra-terrestrial life within and beyond our solar system by looking at current scientific evidence for life on other planets, as well as explored the consequences of our first contact with that life and our first contact with a more advanced civilization through historical, fictional and futuristic accounts. Readings included:

The Rape of Shavi by Buchi Emecheta

Aliens: Can We Make Contact with Extraterrestrial Intelligence? Andrew J. H. Clark & David H. Clark

The Search for Life on Other Planets, Bruce Jakosky

The Sparrow, Mary Doria Russell

In the spring, Dr. Goetz taught Astronomy as well as Foundations of Physics and its two lab sections. She attended the 197th meeting of the American Astronomical Society in January. She presented a research talk entitled "Stardust" as part of the Faculty Research Luncheon series. Dr. Goetz organized the summer B-Wiser junior high physics program where she created hands-on activities, such as moon cratering with balls and sand. She was the advisor to Pursuing Scientific Interests (PSI, formerly Women in Science) here on campus. With John Lindner, Dr. Goetz received Hewlett Mellon funds to acquire a telescope and supporting hardware to further develop a new course in experimental astronomy. The new telescope is a Meade 12" LX200 Schmidt-Cassegrain. This summer, Dr. Goetz traveled to the Haystack Radio Observatory with her two REU students, Christian Clerc and Dan Brubaker, and acquired some useful data.

John Lindner taught Foundations of Physics, its two lab sections, and Electromagnetism in the fall semester. In the spring, he taught General Physics and one lab section, as well as Nonlinear Dynamics. He also advised all six Junior I.S. computer simulations. Dr. Lindner had three publications appearing:

J. Mason, J. Lindner, J. Neff, A. Bulsara, W. Ditto, M. Spano

"Pulse Enhanced Stochastic Resonance"

Physics Letters A, volume 277, pages 13-17 (November 2000)

J. Lindner, J. Mason, J. Neff, B. Breen, A. Bulsara, W. Ditto

"Noninvasive Control of Stochastic Resonance"

Physical Review E, volume 63, 041107 (2001)

J. Lindner, B. Breen, M. Wills, A. Bulsara, W. Ditto

"Monostable Array Enhanced Stochastic Resonance"

Physical Review E, volume 63, 051107 (2001)

Publications accepted:

J. Lindner, K. Wiesenfeld

"The Pendulum Automaton"

International Journal of Bifurcation and Chaos, (TBA 2001)

* Three of these four publications were co-authored with current or former Wooster students Joe Neff '93 and Meghan Wills '02.

Dr. Lindner served on two Ph.D. committees at Georgia Tech, gave three invited talks on campus and with Jennifer Goetz, he submitted to President Hales a detailed proposal to build a Wooster astronomical observatory.

Bram Boroson taught Astronomy and Math Methods in the fall semester, and Cultural Physical Science in the spring. He also taught a course in the Math Department, Math in Contemporary Society. He had five publications in the past year:

Testing Hydrodynamic Models of LMC X-4 with Ultraviolet and X-ray Spectra, 2001, Astrophysical Journal, 550, 919, Boroson, B., Kallman, T., Blondin, J.M., and Owen, M.P.

Discovery of Millihertz Ultraviolet Quasi-periodic Oscillations in Hercules X-1, 2000, Astrophysical Journal, 545, 399, Boroson, B., O'Brien, K., Horne, K., Kallman, T., Still, M., Boyd, P.T., Quintrell, H., Vrtilik, S.D.

Atmospheric Reflection during an Anomalous Low State of Hercules X-1; 2001, Astrophysical Journal, 554, 352, Still, M., O'Brien, K., Horne, K., Boroson, B., Titarchuk, L.G., Engle, K., Vrtilik, S.D., Quintrell, H., and Fiedler, H.

RXTE Observations of Hercules X-1 during the 1998 July Short High State; 2001, Astrophysical Journal, 553, 776, Still, M., O'Brien, K., Horne, K., Hudson, D., Boroson, B., Vrtilik, S.D., Quintrell, H., Fiedler, H.

Multiwavelength Studies of Hercules X-1 during Short High and Anomalous Low States: On-again, Off-again, 2001, Astrophysical Journal, 549, 552, Vrtilik, S.D, Quintrell, H., Boroson, B., Still, M., Fiedler, H., O'Brien, K, and McCray, R.

Dr. Boroson presented an astronomy program to the residents of Smithville Western Nursing Home in Wooster (he played a little piano too!). Dr. Boroson will become Assistant Professor of Physics at the Joint Science Center of the Claremont Colleges (California) in the coming academic year. Good luck, Bram!

Physics Staff



Judith Elwell

Lab Technician since 1981

Judy celebrated her 20th year with the College this year. One of the biggest changes during this time has been the introduction of computers into the general labs. She has enjoyed the work involved with them. Besides enjoying her work, she likes to visit her three daughters who live in various parts of the country and her two grandsons.

Jackie Middleton

Administrative Assistant since 1989

“The best part about my job is interacting with the students. They are so energetic and full of mischief! They keep me feeling young.” Jackie’s oldest son Gabe becomes a College of Wooster First Year this fall. Caleb, a high school sophomore, attends Smithville High School and plays varsity football. Jackie’s husband Randy is an electrician at CoW. Jackie enjoys walking, reading, and crossword puzzles.



Senior Independent Study

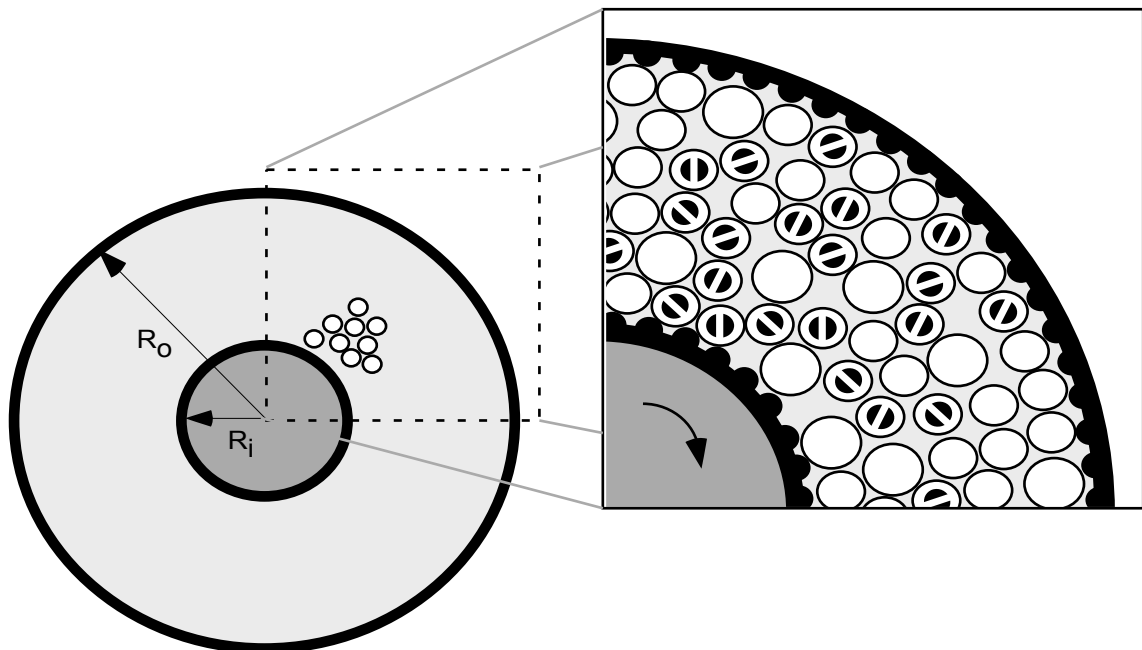
Kinematics of granular material in a two-dimensional Couette shearing cell

by Christopher Templeman

Advisor: Shila Garg

Abstract:

An investigation of the kinematics of granular material in 2D Couette shearing cell was conducted. A bimodal distribution of rigid cylindrical disks (1400 0.939 ± 0.002 cm diameter and 237 1.248 ± 0.001 cm diameter) were placed between an inner rotating wheel and a stationary outer ring. The system exhibited two states; a transient and a steady state. Observations of the local order of the system were made during the transient and video data acquisition was used to study the steady state. When the disks were sheared, a shear band existed adjacent to the rotating wheel that set up a velocity profile. In the steady state the azimuthal velocity profile was found to be reproducible and was fit to the equation, $v_{\theta}(r/d) = \tilde{A}_0 \exp[A_1(r/d)]$, where r was the width of the shearing cell, d was the diameter of a small disk and \tilde{A}_0 and A_1 were experimentally determined to be 0.006 ± 0.002 and 1.08 ± 0.12 respectively. The substrate under the disks was changed to determine the effect of the substrate friction on the kinematics of the disks. The three substrates used had coefficients of static friction of 0.41 ± 0.09 , 0.37 ± 0.02 , 0.23 ± 0.05 . There was no correlation found between changing the substrate and the kinematics of the system. The system behaved in a like manner with all the substrates. The results of this investigation are presented along with possible improvements and routes for further study.



Schematics of shearing cell where R_o is 24.5 cm and R_i is 10.0 cm. A magnified view of the shearing cell packed with disks is on the right.

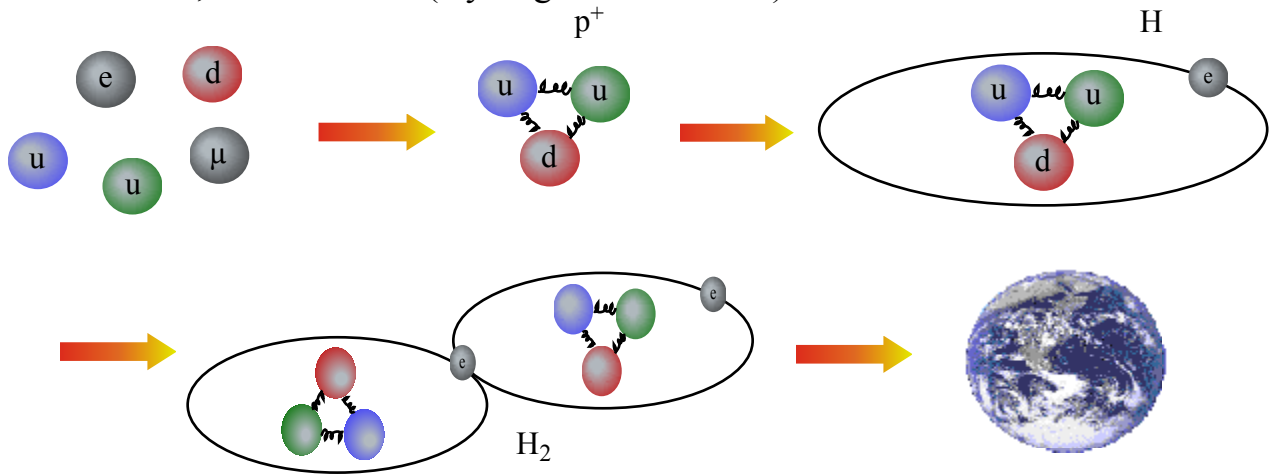
Cosmological Nucleosynthesis

by Lauren Ault

Advisor: John Lindner

Abstract:

Using undergraduate physics and without resorting to numerical simulations the ratio of primordial H to He created in the Big Bang has been calculated and is in reasonable agreement with experimental results. The temperatures of critical events that led up to cosmological nucleosynthesis are fully derived. The conversion factor for the temperature-to-time scale is also derived and used to outline a timeline of the events that occurred at the beginning of the universe. At a time of 0.1 ms from the Big Bang and temperature of 10^{10} K, the weak interaction froze out of GUT and the proton-neutron ratio became constant. At 2 minutes and 10 seconds at a temperature of 10^9 K, the Deuterons formed. Finally, at approximately 300,000 years and 3700 K, neutral atoms (Hydrogen and Helium) were formed.



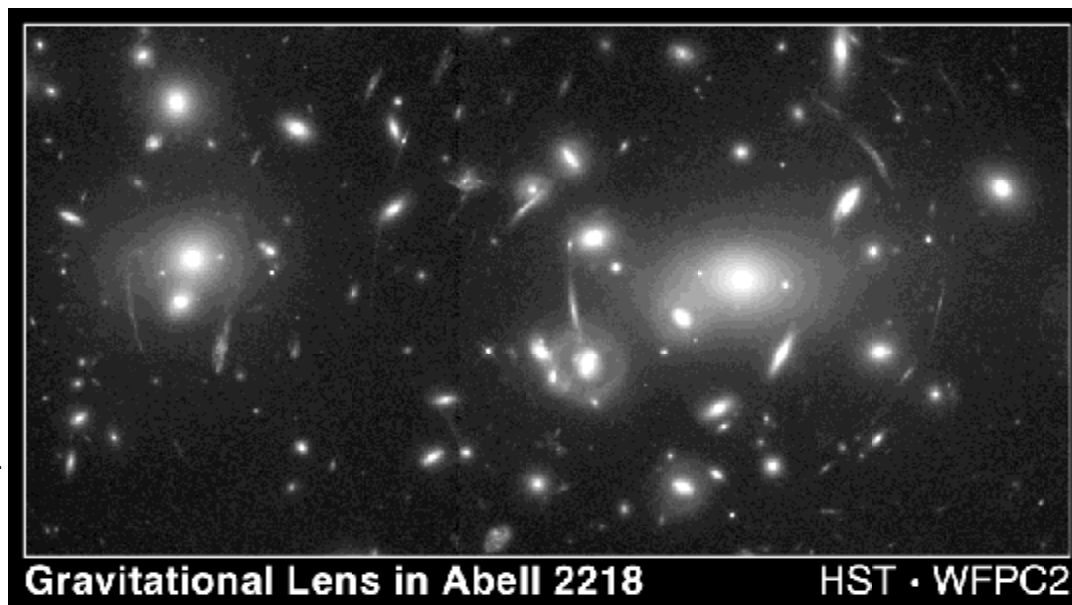
Abstract:

Three computer simulations written in C++ have been created to model the visual appearance of a star, a star field, and an accretion disk in the vicinity of a Schwarzschild black hole in three-dimensional space. The models allow for flexibility in the placement of the objects and the observer in relation to the black hole. The programs attempt to illustrate basic gravitational lensing effects to give insight into the theory.

Visualization of Objects in the Vicinity of Black Holes

by Rachel Mary Costello

Advisor: John Lindner



Gravitational Lens in Abell 2218

HST · WFPC2

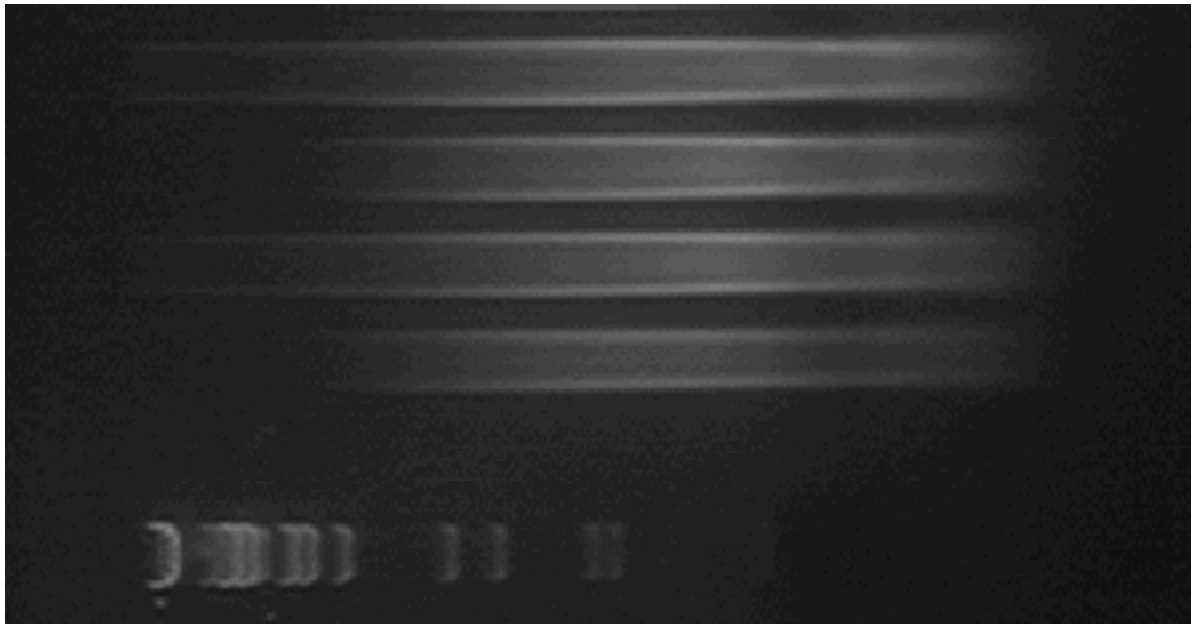
A Structural and Optical Study of Evaporated Droplets Containing DNA

by Amy Lytle

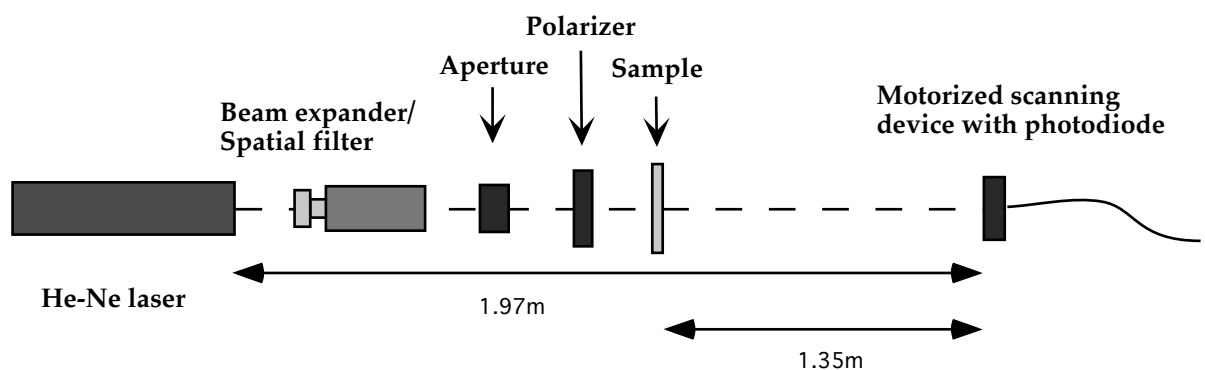
Advisor: Shila Garg

Abstract:

Droplets of sonicated calf thymus DNA in a Tris-EDTA solution, with a range of fragment lengths from 300-2000 bp, were evaporated on a glass substrate. DNA forms several liquid crystalline phases with increasing concentration before reaching the completely evaporated crystalline phase, so the droplets are birefringent both during and after evaporation. Dynamics within the droplet during evaporation due to contact line pinning and the majority of the evaporation occurring at the edge cause an outward radial flow of material in the droplet. The evaporated droplets consequently possess a raised ring at the edge, smaller concentric rings further in, and a depression in the center. In this study, the effects of varying temperature, vapor pressure, and induced alignment at the substrate on the microscopic and macroscopic structure of the droplets were investigated. Due to the characteristic rings and central well, the evaporated droplets possess lensing and diffraction properties. The diffraction pattern in the Fraunhofer regime was measured and compared to an initial model of the droplet structure as sets of multiple slits separated by an opaque obstacle. Parameters for the theory were measured using optical microscopy.



Chromosomal calf thymus DNA was suspended in a buffer solution and then sonicated to a mixture of lengths ranging from 300-2000 bp, determined by low percentage agarose gel electrophoresis.



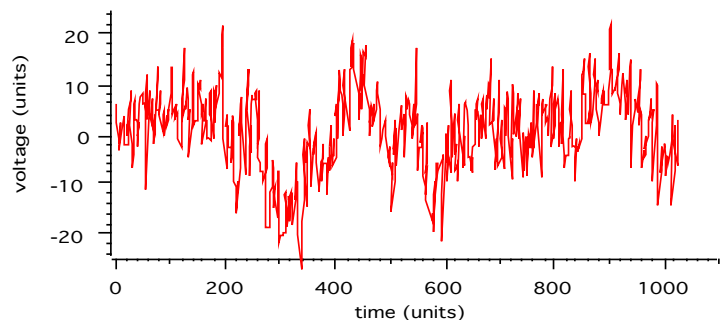
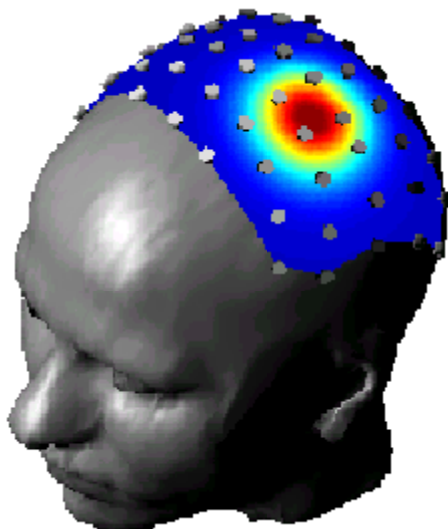
Chaos in the Brain: A Nonlinear Time Series Analysis of Electroencephalograms

by Zakir Thaver

Advisor: Shila Garg (Sem. I) and John Lindner (Sem. II)

Abstract:

Following the experimental verification that a single neuron can generate chaos in neural activity, chaotic behavior in the macroscopic activity of the brain, which is essentially a set of neurons connected in a network, was anticipated. The electroencephalogram (EEG) is a crude measure of the electrical activity of the billions of neurons in the brain, and is considered to represent its macroscopic state. EEG Data from a young subject with eyes open and closed was analyzed using *Chaos Data Analyzer*, Professional version (CDA). The correlation dimension and Lyapunov exponents were calculated for all the EEG data using optimal embedding dimensions and time delays. The results for the EEG data from the young subject with eyes open from electrode 1 (Channel 1) placed according to the International 10-20 System were compared with the corresponding results for Random and Chaotic data (from the Duffing equation). The correlational length (time) τ for the EEG data was more than that for the Random data but less than that for Duffing data, showing more correlation between temporal neighbor than the former but less than the latter. The correlation dimension D_c for EEG data was less than Random data but more Duffing data suggesting that EEG is not merely noise. More trend in separation was observed in the case of EEG data than Random data, but less than Duffing data. Specifically, while the largest Lyapunov exponent λ for Random data was found to tend to zero, that for Duffing and EEG were found to be positive indicating their chaotic nature. Moreover, for all the EEG data sets analyzed, the largest Lyapunov exponents λ were found to be positive. The results, within experimental error, suggest that the EEGs have significant chaotic character. The human brain can therefore be considered to be a giant nonlinear dynamic system, and hence can be modeled by nonlinear dynamic invariants.



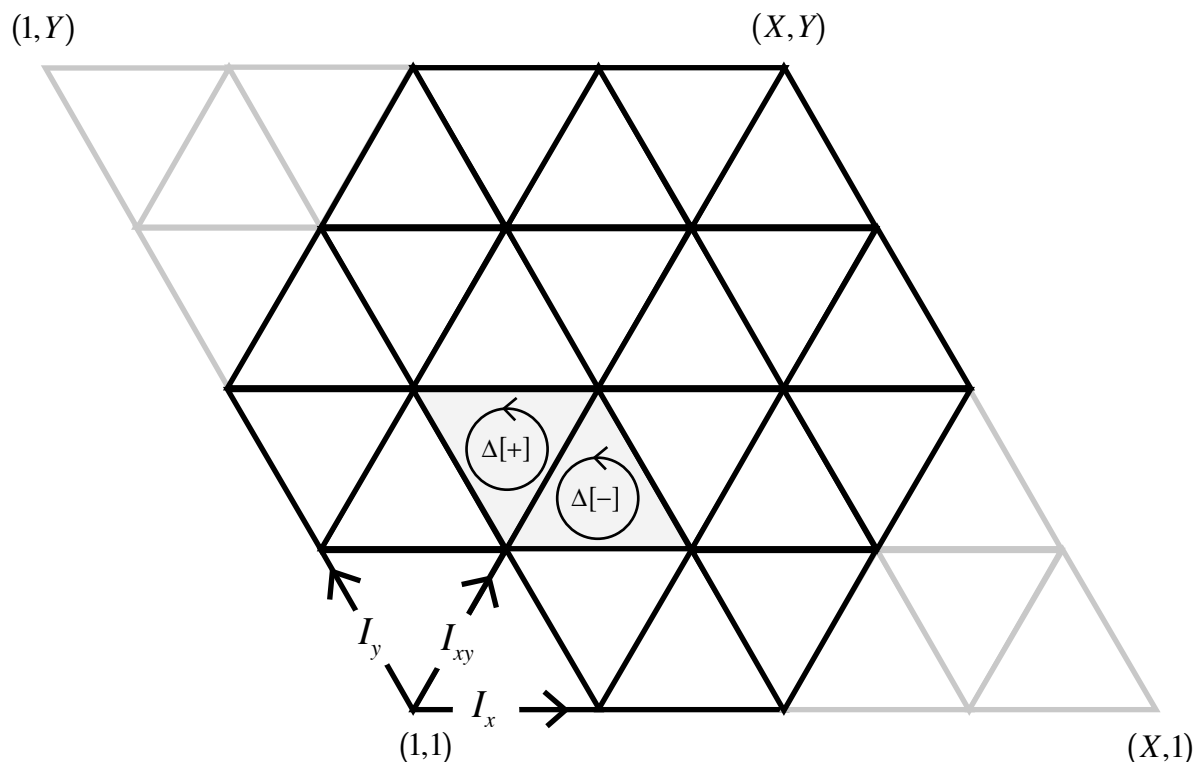
An Investigation Using Cellular Automata and Differential Equations to Model Magnetic Flux Creep Through a Type II Superconductor, Represented by an Array of Coupled Josephson Junctions, Using a Standard Square Lattice, as Well as a Non-traditional 6-Fold Symmetric Lattice

by Scott Hughes

Advisor: John Lindner

Abstract:

An investigation was done to simulate magnetic flux creep in two-dimensional granular superconductors using both 4-fold and 6-fold symmetric lattices as models. The superconductor was first modeled as an array of resistively shunted Josephson junctions evolving according to a set of ordinary differential equations (ODEs). If the magnetic field increases slowly, we achieve the separation of time scales needed to convert the equations to a simple cellular automaton (CA). Comparing the ODE and CA methods of evolution showed that the two are equivalent. The CA, however, provides a more stylized version of the complex dynamics of the system and evolves much faster than the ODEs. Statistics on the avalanches that occurred in the CA versions (equivalent to the vector sand pile problem) showed the 6-fold version displayed much richer dynamics than the 4-fold version. While avalanching with effectively period 1, the 4-fold lattice is not nearly as complex as the 6-fold lattice, whose avalanches have an extremely large period that seems to increase as the size of the array increases.



The 6-fold lattice representing a granular superconductor. The underlying structure is still a square array, skewed to create the visual pattern we need, and with the corners cut off to yield a symmetric hexagon.

Junior Independent Study

I learned many things in Jr IS in addition to writing papers and designing one's own experiment, such as:

- *How to be an Igor Pro.*
- *The security cameras really are checked, so don't do anything you wouldn't want to be caught on tape.*
- *The most important lesson is: Do NOT mess with the seniors and their IS's.*

Seriously, I really feel that Jr IS helped me immensely in writing, organizing, and researching technical papers, and the computer simulation project was invaluable. I've used that knowledge every day this summer.

— Dave Miller '02 and 2001 REU Summer Researcher

This year's self-designed Junior I.S. experiments:

Sara Connolly — “Hydraulic Jumps”

Hydraulic jumps are one of the most common physical phenomenon. They are seen around the world in rivers, lakes and even in the ocean. Most commonly though, they are known for being found in kitchen sinks. Hydraulic jumps rely on flow rate and water depth for their production. These effects are studied in this experiment and a basic theory of equations that could be applied are given.

Giovanni Cueto — “The Rate of Optical Readout on a Compact Disk”

Information on a compact disk is stored as a series of bumps and flat areas along a helical path. An optical reading device involving a laser light is used to read the information imprinted on a spinning disk. As the optical reading device moves radially outwards, the angular frequency of the spinning motor decreases to ensure a constant reading rate of information. Though the laser is moving normal to the spinning motion of the disk, the spinning motion of the disk suggests that the reading rate of the laser is the linear velocity of which the helical path is swiped by the laser. The maximum linear velocity of $1.65 \text{ m/s} \pm 31.74\%$, and the minimum linear velocity is $1.43 \text{ m/s} \pm 36.82\%$, with % discrepancies of 15.52% and 16.00% from the range of literature values.

Matt Krivos — “Optical Properties of CT-DNA”

Droplets of CT-DNA were videotaped, between a cross polarizer, as they fell through mineral oil. A bright light was shined through the first polarizer in order to see if the CT-DNA droplets had any liquid crystal optical properties. The droplets did not act completely theoretical but there is reason to believe they did display anisotropic properties.

Christopher Locke — “Phase Transitions of Mixtures of the Nematic Liquid Crystals 5CB and MBBA Using Microscopic Techniques”

The goal of this experiment was to study the temperatures at which the phase transitions of mixtures of the liquid crystals MBBA and 5CB took place. This was achieved using a microscope and computer software. The mixtures were composed of molar ratios BBA and 5CB in the following ways: 1:1, 1:2, 1:3, 1:4, 2:3 (MBBA:5CB). All ratios underwent phase transitions from the liquid phase to the nematic. Only the 1:1 mixture underwent a third transition, from the nematic to the smectic phase.

David J. Miller — “Chaotic Light Scattering in Scatterers with 4 and 8 Exit Modes”

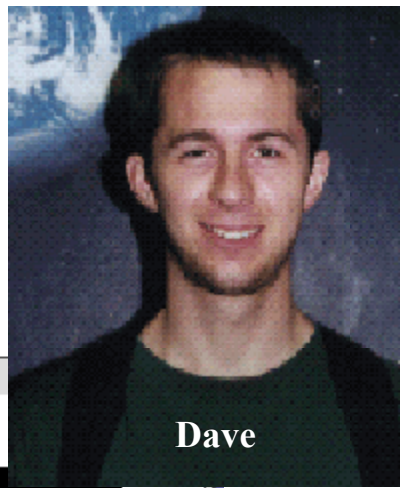
A replication of a simple experimental setup originally done by the University of Maryland Chaos Group uses large reflective spheres to demonstrate chaotic light scattering. The optical limitations of the experimental setup are overcome with a computer simulation of the same experiment. A new arrangement of spheres is created and observed to share several properties with the original. Among these, the Wada Property was observed to occur in both chaotic scatterers.

Rob Sweeney — “Using Double-Exposure Interferometry to Measure Thermal Expansion in Aluminum”

In this experiment, a hologram was taken of a soda can at room temperature. Then 100 mL of hot water was poured into the can at room temperature and the same plate was exposed again. The interference pattern produced was to be used to measure how much the can had expanded due to the heat, but it was concluded that the thermal expansion is too minute for the interference pattern to be workable. It was concluded that double exposure interferometry using red coherent light is an ineffective way to measure thermal expansion.

Junior I.S. Computer Simulations

Chaotic Scattering



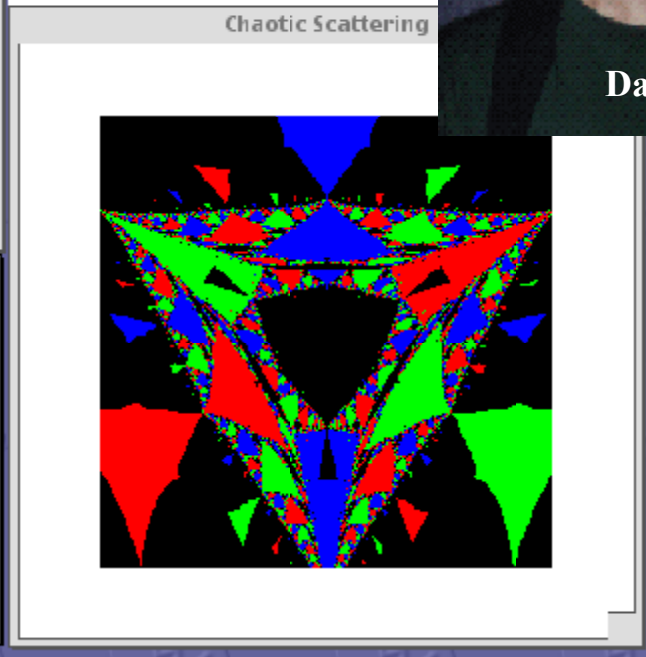
Dave

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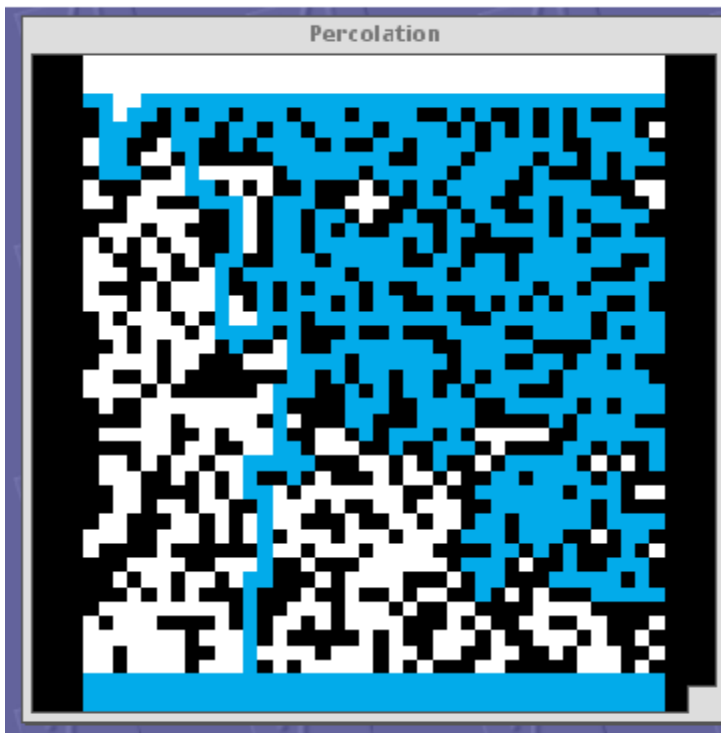


Chaotic Scattering
Version of 3 April 2001



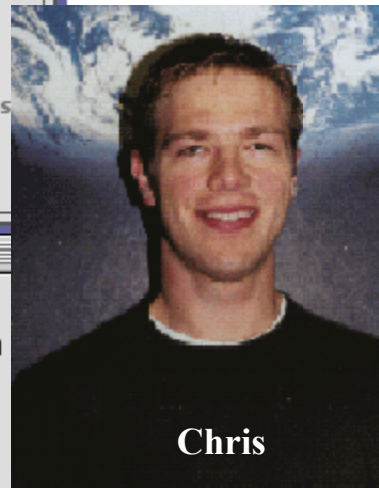
Dave Miller
John Lindner

Department of Physics
The College of Wooster
Wooster OH 44691 USA




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Chris

PERCOLATION
Version of 19 February 2001

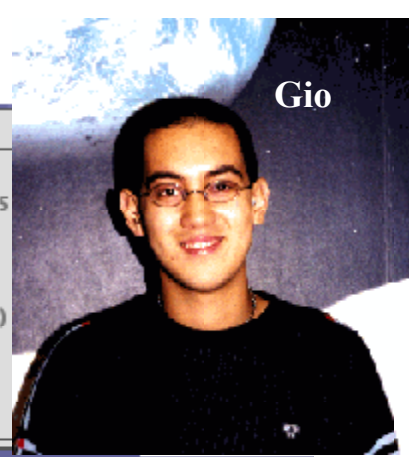


Chris Locke
Erica Bramley
John Lindner

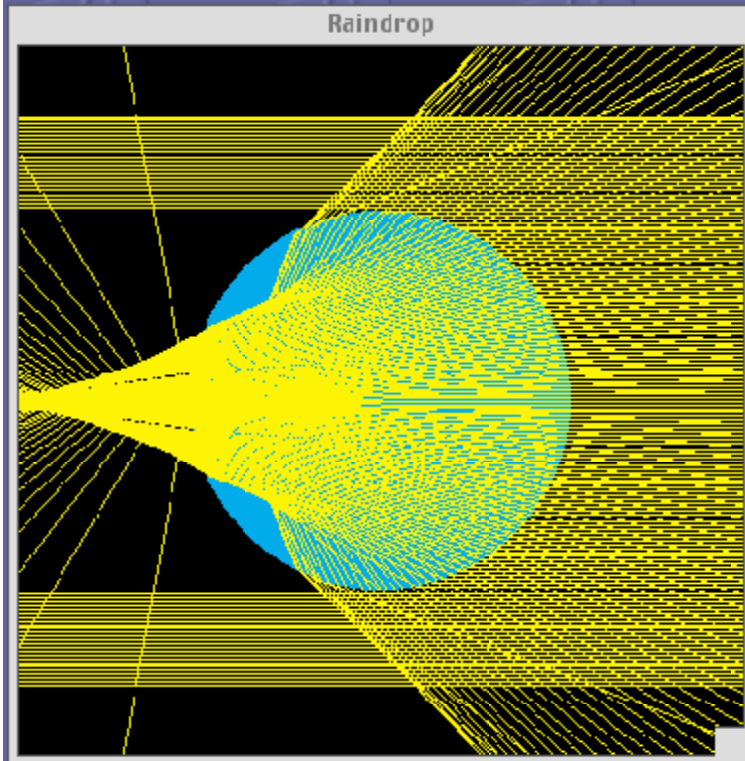
Department of Physics
The College of Wooster
Wooster OH 44691 USA

Percolation

Raindrop



Gio



Parameters

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n(in)

n(out)

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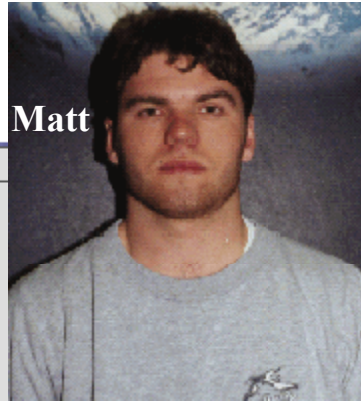
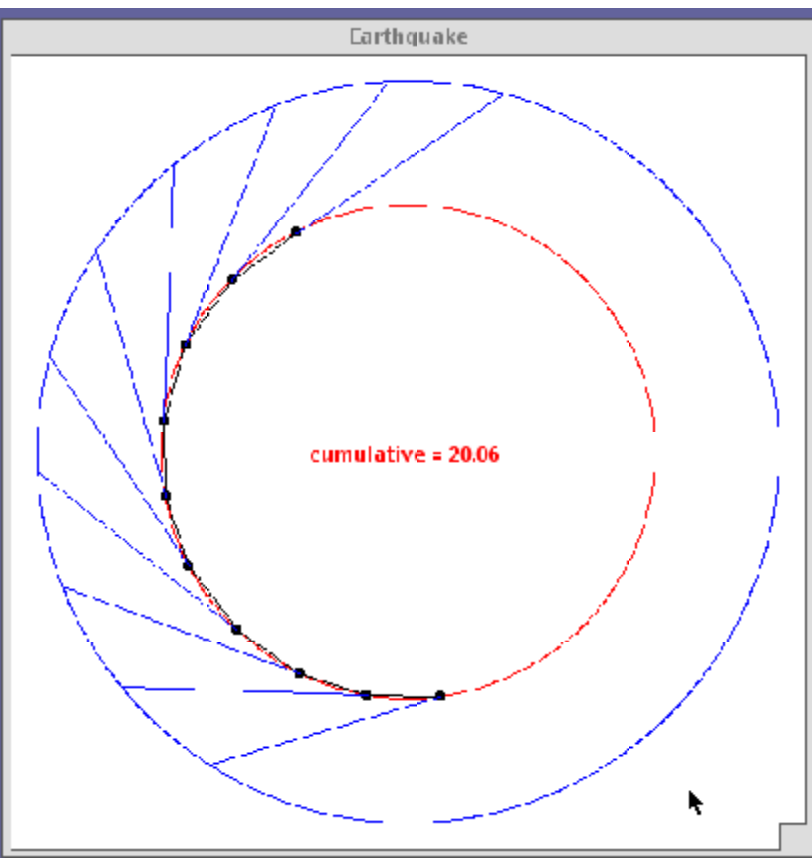
About

Raindrop
Version of 30 March 2001



**Giovanni Cueto
John Lindner**

Department of Physics
The College of Wooster
Wooster OH 44691 USA



Matt

Parameters

masses

relative V

initial Δx


max friction

50% friction V

Record n points

[Reset]

FARTHQUAKE
Version of 8 March 2001



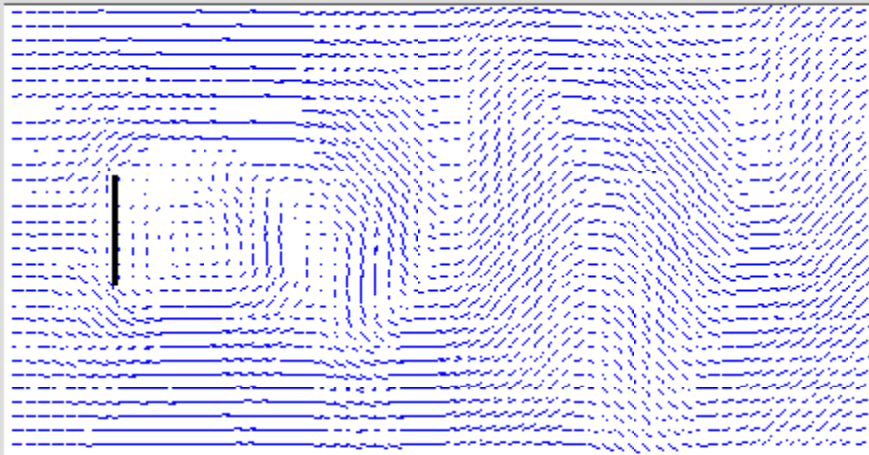
**Matt Krivos
Tim SirLouis
John Lindner**

Department of Physics
The College of Wooster
Wooster OH 44691 USA

EARTHQUAKE

Hexagonal Lattice Gas

Hexagonal Lattice Gas



$l = 13469, Re = 180.7$

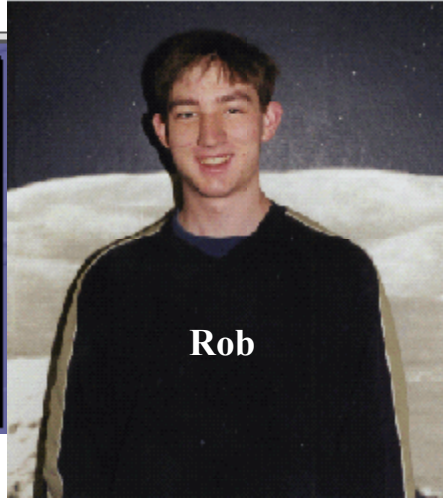
Parameters

delay (in ticks)
 # updates/display
 spatial scale
 velocity scale

Hexagonal Lattice Gas Wind Tunnel
Version of 3 March 2001



Rob Sweeney
Joe Neff
John Lindner
Department of Physics
The College of Wooster
Wooster OH 44691 USA

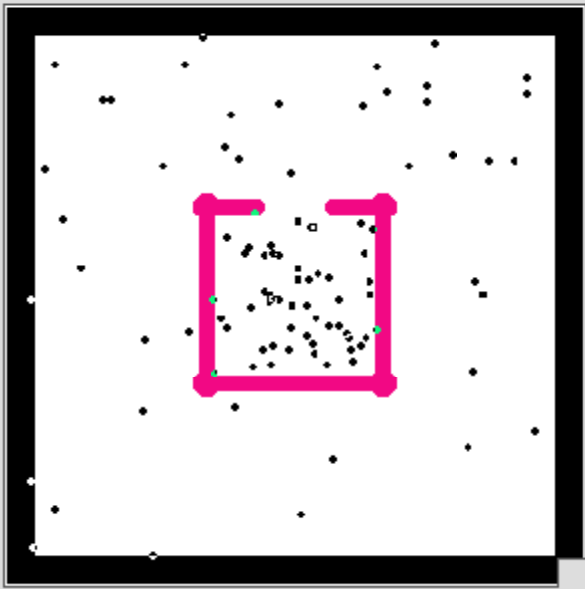


Rob



Sara

Diffusion



Parameters

Atoms
 Bottle Size
 Time Step

Diffusion
Version of 26 March 2001



Sara Connolly
John Lindner

Department of Physics
The College of Wooster
Wooster OH 44691 USA

Diffusion

A Glimpse at the Past



minus 10 years ...

Senior Independent Study 1991

- | | |
|----------------------|--|
| Richard C. Bailey | A Study of Electro-Optic Properties of Polymer Dispersed Liquid Crystals as a Function of Sample Curing Time |
| Mark L. Bricker | A Dynamic Light Scattering Study of a Nematic Liquid Crystal in the Presence of a Magnetic Field |
| Alice D. Churukian | Chaos in a Dripping Water Faucet |
| Karl A. Crandall | Determining the Bend Elastic Constant of the Liquid Crystal Di-Heptyl-Alkyl Azoxybenzene (Using Freedericksz Transition) |
| Douglas A. Halverson | A New Method for the Experimental Investigation of Self-Organized Criticality |
| Andrew O. Mellinger | Multiple Time Dimensions |
| Victor T. Norton | The Belousov-Zhabotinskii Reaction: a computer simulated study of bromate oscillators and autocatalysis |
| Jonathan F. Partee | Adiabatic Calorimetry Measurement of the Heat Capacity of Triethylamine-Water Near the Critical Point |
| Thomas M. Taczak | BumperPool: A New Region for Chaotic Billiards |

minus 5 years ...

Senior Independent Study 1996

- | | |
|--------------------|--|
| Darwin Keith-Lucas | η : An experiment measuring the turbidity of the binary fluid methanol-cyclohexane: determining the elusive exponent η |
| Ali Özgenç | The Kinetics of Fatty Acid and Phospholipid Solid Self Assembly |
| Salman Saeed | Frequency Dependence of the Modulated Phase in 5CB |
| Cyrus Screwvala | The Chaotic Tumbling of Hyperion: Moon of Saturn |

Recognition of Physics Majors

The Elias Compton Freshman Prize, established in 1926, honors the first Dean of The College of Wooster, and recognizes academic excellence in the first-year class. The prize is awarded to the student who has achieved the highest standing in scholarship during the first year.

Jeffrey R. Moffitt '03, New Concord, OH

The Joseph Albertus Culler Prize in Physics, 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.

Jeffrey R. Moffitt '03

The Mahesh K. Garg Prize in Physics is awarded annually to an upper-class physics major who has displayed interest in and potential for applying physics beyond the classroom.

Andrew M. Bouchard '01, Fort Kent, Maine

The Jonas O. Notestein Prize, established in 1923, honors Dr. Notestein who taught Greek and Latin at Wooster from 1873 to 1928. The prize is awarded to the student who is graduated with the highest scholarship for the whole college course.

Amy Louise Lytle '01, Medina, Ohio

Speaker for the Class of 2001

Amy Louise Lytle '01



The Arthur H. Compton Prize in Physics honors Dr. Compton who received the Nobel Prize in Physics in 1927. The prize is awarded to the senior physics major attaining the highest standing in that subject.

Amy Louise Lytle '01

Scott Brandon Hughes '01, Grafton, OH



Alumni News

Karen McEwen Farthing '90 received two M.S. degrees from Northwestern University in 1993/1994, the first in applied mathematics and the second in environmental engineering. After the birth of daughter Meghan in 1996, Karen's husband Josh Farthing '92 was diagnosed with leukemia and passed away in January, 1998. Karen now attends the Eden Theological Seminary in St. Louis. This past summer she had an internship at the United Church of Christ national offices in Cleveland. She is the project coordinator for 65 Eden students, faculty, and staff. This year, Karen will be a student pastor at Kirkwood United Church of Christ in Kirkwood, Missouri. Even though she is not doing physics, Karen says that Wooster was a great preparation for the ministry by showing her that one could be a rational person, involved in science, and still have a strong faith.

Darwin Keith-Lucas '96 is an industrial designer for Porter-Cable/Delta, a power tool manufacturer in Jackson, Tennessee. He designs the shape of the tool, color, texture and material use. He also deals with button placement, balance, and ergonomics. When he designs, he starts with user interviews and lots of sketches. He then models his design in Alias/Studio-the same software used to make the movie Toy Story. Darwin reports that physics has been very useful in his job!

Shoaib Zaidi '89 lives in Poughkeepsie, New York, and works as a metrology engineer at Infineon Technologies. He received his Ph.D. in electrical engineering and computer engineering from the University of New Mexico in 1998. He says that Wooster's 3/2 engineering program was great training.

Thane Norton '91 lives in Portland, Oregon in a 1915 arts and crafts bungalow that he shares with his wife Johanna Norton (née Salmon '93) and Mac Daddy the cat. He works as a software engineer at Lacie in Hillsboro where he is in charge of Lacie's transition to Mac OSX. He and Johanna spend a lot of time with another Wooster physics alum, Andrew Mellinger '91, and his wife Susan (née Salmon '94).

John Cuff '94 received his dual master's degree from the University of South Florida in 2000. He is now working towards his Ph.D. in applied physics in the area of laser ablation.

Anna Ploplis Andrews '87

Anna is a product developer in the plastics division of Ferro Corporation in Independence, Ohio. She develops new plastics using her background in physics and polymer thermodynamics. Her job involves taking a new product from conception to market launch and interacting with a variety of professionals in science, business, and communications. Current interests include nanotechnology and novel resins for plastic films.

Kevin Andrews '87

Kevin is a research and development chemist with Metromedia Technologies, Inc. in Wooster. Kevin has been with MMT for seven years, working to characterize inks and coatings used to print super wide format graphics. Recently, Kevin is project lead for a new high resolution printing system. Kevin's job as project lead involves directing a group of engineers, scientists, and technicians to develop, design, prove, and deliver for manufacture a new printing system.

Anna and Kevin live in Medina and have two human children: Gwynneth (5) and Ethan (17 months). They also have two canine children: Snitter (>16) and MacLeod (9).

Salman Saeed '96

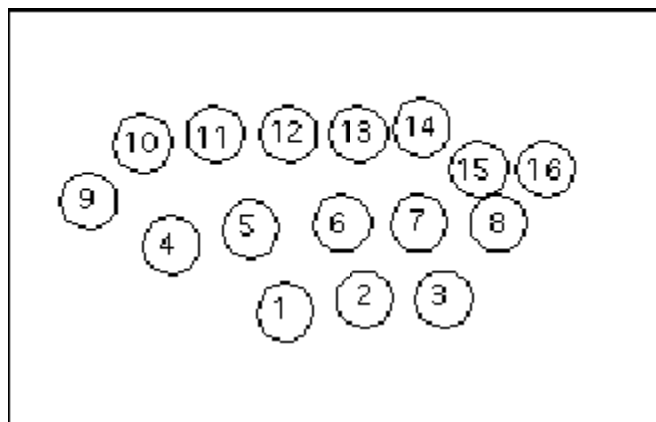
Salman is now working as a project engineer at Three-Five systems (<http://www.threefive.com>) in Tempe, Arizona. He is also in his final year of the Ph.D. program at the Liquid Crystal Institute Kent State University. He is completing the remainder of his research and Ph.D. thesis remotely and hopes to be done by the end of this year. At Three-Five systems he is working on their Brillian line of microdisplays which are essentially liquid crystal on silicon (LCOS) devices used for projection displays and head mounted displays. His work involves computer modeling of the LCOS optics and optimizing the displays.

Andrew Mellinger '91

Andrew has lived in Portland, Oregon since October of 1993. For the past five years, he has worked for a small software company (<http://www.criticalpath.com>) that does project based software on contract to large companies. The company also does hardware support and custom applications in any major language. Andrew is married to Susan (Salmon) Mellinger '94. Visit Andrew at <http://www.crashbox.com>.



Research Experience for Undergraduates 2001



1. Shila Garg
2. Anna LaRue
3. Bram Boroson
4. Dave Merriman
5. Amy Lytle
6. Jenn Goetz
7. Clinton Braganza
8. Nick Harmon
9. Don Jacobs
10. Ryan Hartschuh
11. Dave Miller
12. Dan Brubaker
13. Tom Spears
14. John Lindner
15. Corey Casto
16. Christian Clerc

PROJECTS:

Dan Brubaker '03 (advised by Jenn Goetz)

An Investigation of OMC-2 at Microwave Wavelengths

Clinton Braganza '03 (advised by Don Jacobs)

The Correlation Length of a Critical Mixture of Perfluoroheptane and 2,2,4-trimethylpentane

Corey Casto '03 (Ohio Wesleyan) (advised by Bram Boroson)

Spectral Variability in LMCX-4 Caused by the Hatchett-McCray Effect

Christian Clerc '04 (University of Dallas) (advised by Jenn Goetz)

Observations of the 44 GHz Methanol Maser $7_0 \rightarrow 6_1 A^+$ Transition in the Molecular Cloud W75N

Nick Harmon '04 (advised by John Lindner)

Modeling of the Circular Planar Restricted Three-Body Problem

Ryan Hartschuh '03 (advised by Don Jacobs)

The Heat Capacity of Triethylamine-Water: Testing Yang-Yang Theory

Anna LaRue '04 (Smith College) (advised by Shila Garg)

Exploring Neutral Dielectric Anisotropy in a Binary Liquid Crystal Mixture

Amy Lytle '01 (advised by Don Jacobs)

Turbidity in a Binary Fluid Mixture: Measuring the Critical Exponent η

Dave Merriman '04 (advised by Jenn Goetz & John Lindner)

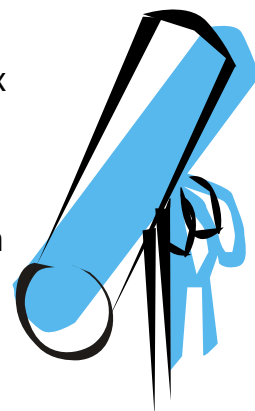
The Long and Circuitous Route to the Procurement of an Observatory for the Department of Physics: A View of Prospects in Three Space

David J. Miller '02 (advised by John Lindner)

Using Cellular Automata and Differential Equations to Model Magnetic Flux Creep Through a Type II Semiconductor

Tom Spears '04 (advised by Shila Garg)

Phase Transitions, Dielectric Anisotropy and Intermolecular Interactions in Binary Mixtures of the Nematic Liquid Crystals 5CB and MBBA



ELSEWHERE . . .

Jeff Moffitt '03 spent the summer at Cornell University in an REU program. He wrote code to control a series of circuit boards that will be placed around the Cornell accelerator. These boards will process the signals from a set of capacitor pickups that monitor the position of the electron and positron beams in the accelerator.

Christie Egnatuk '03 did research at the University of Colorado Boulder, where she worked on thin film deposition. She grew permalloy films and looked at their optical properties.

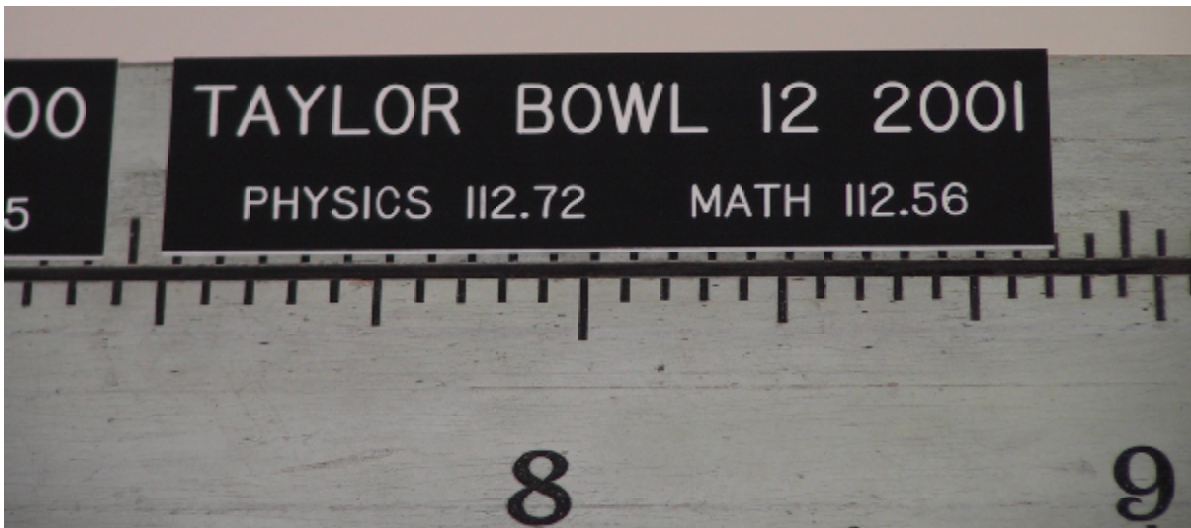
Sara Connolly '02 spent her summer doing liquid crystal research with Kent State University's chemistry department. Her project involved the design of a liquid crystal that has the characteristics of the organic compound perylene and was titled "Synthesis and Properties of Discotic Liquid Crystals".

Josh Martin '02 did his summer research at Kent State's Liquid Crystal Institute where he worked on the building of electro-convection diffractive devices.

Derek Somogy '02 spent the spring semester at the University of Adelaide in Australia. He completed his Junior I.S. requirement by taking a course in experimental physics. He also studied the history of Australian indigenous people.

Nick Hanson '03 worked

Physics Club



PHYSICS RULES!!!!!!!!!!!!!!

NEWS!

The College of Wooster Physics Club had not won Taylor Bowl since 1997. . .



but 2001 was the year they redeemed themselves. The giant slide rule now hangs in its rightful home on the first floor of Taylor Hall. Congratulations Seth Kerechanin '03 who had the highest score of 188.

Physics Club Officers 2000-01

President Lauren Ault Vice-President Amy Lytle
Treasurer Scott Hughes Secretary Rachel Costello
Advisor John Lindner

Events 2000-01

Thu 7 Sep 2000: Organization Meeting

Wed 14 Sep 2000: Pizza & Dessert Night

Tue 19 Sep 2000: Summer Research Symposium

Tue 14 Nov 2000: Lecture by Bram Boroson

"The Care and Feeding of Neutron Stars"

Sat 18 Nov 2000: Columbus Science Museum & Dinner

Tue 28 Nov 2000: Senior I.S. Research Presentations

Mon 22 Jan 2001: General Meeting

Thu 5 Apr 2001: General Meeting

Thu 12 Apr 2001: Sunspot Gazing

Sun 22 Apr 2001: Canoeing at Mohican

Mon 23 Apr 2001: Taylor Bowl 12

Mon 30 Apr 2001: Shapley Lecture by Rocky Kolb

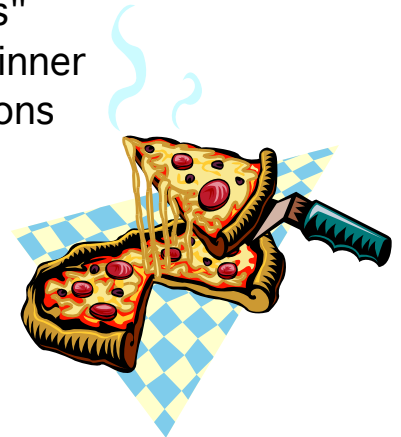
"The Quantum and the Cosmos"

Tue 1 May 2001: Lecture by Rocky Kolb

"The Alarming Phenomenon of Particle Creation in the Early Universe"

Fri 4 May 2001: Spring Senior I.S. Posters, Pizza, & Pop

Thu 10 May 2001: Indian Dinner at Dr. Garg's house



Conferences

C. Templeman* and S. Garg, "Two-Dimensional Granular Couette Shearing Cell" Nat'l Meeting/American Physical Society (March 2001).

A. Lytle** and S. Garg, "A Structural and Optical Study of Evaporated Droplets Containing DNA" Nat'l Meeting/American Physical Society (March 2001).

C. Egnatuk* and D.T. Jacobs, "Self-Organized Criticality in a Bead Pile" Nat'l Meeting/American Physical Society (March 2001).

E. Oby* and D.T. Jacobs, "Heat Capacity of the Liquid-Liquid Mixture Perfluoroheptane and 2,2,4-Trimethylpentane Near the Critical Point" Nat'l Meeting/American Physical Society (March 2001).

B. Boroson and R. Hartschuh♦, "The First FUSE View of an X-Ray Binary: LMC X-4" 197th Annual Meeting of the American Astronomical Society, San Diego CA (January 2001).

S. Hughes§, J.R. Sowell, D.S. Hall, and R.M. Williamon, "An Investigation of Period Changes for Four RS CVn Stars: UV Psc, YY Gem, CG Cyg, and XY Uma" 197th Annual Meeting of the American Astronomical Society, San Diego CA (January 2001).

J. Moffitt* and D. Ludwigsen, "Self-sustained oscillation as a function of blowing pressure in a one mass lip reed model" 140th Meeting of the Acoustical Society of America (December 2000). Awarded "Best Student Paper in Musical Acoustics"

* REU research at College of Wooster

** Senior I.S. research

♦ Sophomore research

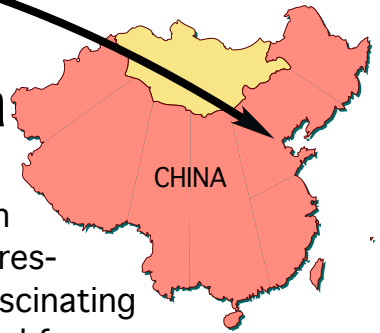
§ REU research at Georgia Institute of Technology



Christie Egnatuk, Emily Oby, Dr. Garg, Amy Lytle, and Chris Templeman at the National Meeting of the American Physical Society in Seattle.



Dr. Garg Goes to China



I was in Beijing this summer to attend a conference on "Pattern Formation in Nonlinear Complex Systems" and to present a paper. China with its rich traditions and history is a fascinating country to visit. Since I was going to China anyway, I applied for a 'development grant' from the National Science Foundation to explore the possibility of setting up an International Research Experience for Undergraduates site. My initial plan and contact were at the Physics Department of University of Peking. However, while I was at the conference, I met scientists from the Institute of Physics (I.O.P) which is part of the Chinese Academy of Sciences. The I. O. P. was the local host for the conference as well and there were some excellent papers presented by their faculty.

I visited the I.O.P. and was very impressed with their facilities as well as their exciting array of research projects in material physics, optics and nonlinear physics. They are well equipped and several of their physicists have been trained in Europe and the U.S. They have regular international visitors and collaborations. The one point that concerned me was the lack of a presence of undergraduates. The I.O.P has only graduate students and post docs. However, the facilities and the ease of communication with the people at the I.O.P. convinced me that it would be easier to establish the first phase of the project at this location. Our contact person there is Dr. Meiyong Hou who received her Ph.D. at Stanford University and currently works on granular materials.

Subsequent to my visit, I applied for a grant from NSF to set up a "Wooster-Beijing International REU site." If funded, this will start a new era in our efforts to promote undergraduate research. The plan would be to select students who have already participated in our REU program and thus are trained in various research skills. We will give them an intensive orientation program to prepare them for this experience. In the first summer, we will send four students and in the subsequent summers we will send eight students. I am very excited about this program for all the possibilities it offers our students.

First and foremost, this is an excellent opportunity for undergraduates to participate in a high quality strong research program. In addition, in the early stages of their careers, students' exposure to international scientific collaborations can be very valuable and better prepare them for a more global scientific workforce. Our students will have an opportunity to interact with their peers in another culture and to understand the issues that are important to them. An international REU experience can train our students to be leaders of the next generation and to take major roles in global cooperation. We'll keep you posted on the success of our proposal!

Talk about enthusiasm.....

Some of the students in Dr. Lindner's Nonlinear Dynamics course were so excited by their study of fractals that they decided to apply their newly gained knowledge to their favorite green vegetable! Thanks to Jeff Moffitt and Dan Brubaker '03s for providing the scientific world with this long awaited data!



Fractal Dimension

1.202 +/- 0.002

We've told you what we've
been doing ...

now,
we want to hear from you!

**STAYIN'
IN
TOUGH!**

Send email telling us what you are up to:

sgarg@wooster.edu
jmiddleton@wooster.edu
jlindner@wooster.edu
djacobs@wooster.edu
jgoetz@wooster.edu

or write us at:

Department of Physics
The College of Wooster
Wooster OH 44691

Visit us:
www.wooster.edu/physics

