ANNUAL REPORT 2002-2003

WOOSTER

PHYSICS

THE COLLEGE OF WOOSTER

www.wooster.edu/physics

Note from the Chair

Please enjoy the seventh Annual Report from The College of Wooster Department of Physics. It has been another busy year.

We are very excited to welcome our two new faculty members, Dr. Susan Lehman, Clare Boothe Luce Assistant Professor of Physics and Dr. Lowell Boone, Visiting Assistant Professor of Physics.

Dr. Jacobs was named a Fellow of the American Physical Society, an honor bestowed on less than one-half of one percent of the members of the APS each year. According to the award letter, "It is a recognition by your peers of your outstanding contributions to physics." The citation reads, "For contributions to the understanding of critical phenomena in liquids, and for substantial mentoring of undergraduate students engaged in research."

Physics did well at graduation this year where Jeff Moffitt '03 was awarded the Notestein prize for highest scholarship and Ryan Hartschuh '03 was awarded the Galpin Award for general excellence. (Jeff also spoke on behalf of the class of 2003, the second physics major in the last three years to do so.)

Tom Spears '04 became the third physics major in eight years to win a Goldwater scholarship, while Jeff Moffitt '03 and Amy Lytle '03 both won National Science Foundation Graduate Fellowships. Go team!

This was the second year of our Physics Club's outreach program, and we made six presentations in local schools. In addition, the club won a 2003 Marshall W. White award to purchase equipment to enhance its presentations.

We successfully renewed our NSF REU grant for another four years, and this summer we enjoyed our 10th summer REU program, which has now involved 80 students from 23 colleges and universities in 12 states.

Our majors were well represented at the March meeting of the APS in Austin Texas, where they gave six different presentations. This summer, they are doing research at the University of Rochester, OSU, and Fermilab, as well as Wooster.

Judy has done an excellent job transitioning our intro physics lab from G3 all-in-ones running Mac OS 9 to 17-inch G4 iMacs running Mac OS X. And, as always, Jackie has done a wonderful job creating this report.

Best wishes to all and keep in touch!

John Lindner

Contents

Class of 2003

Back: Dan Brubaker, Ryan Hartschuh, Nick Hanson
Front: Becky Urban, Christie Egnatuk, Brad Lignoski, Clinton Braganza, Jeff Moffitt

Daniel Wilson Brubaker
Bucyrus, Ohio
Plans:
Teaching Certification
Ashland University

Clinton Ignatius Braganza
Daressalaam, Tanzania
Plans: Grad School
Kent State Liquid Crystal Institute

Christine Marie Egnatuk
Physcs/Math double major
Albion, Michigan
Plans: Undergraduate courses
in preparation for medical school
University of Michigan

Nicholas Jonathan Hanson
Chagrin Falls, Ohio
Plans: Employment

Ryan Douglas Hartschuh
Akron, Ohio
Plans: Grad School
The University of Akron

Bradley Dean Lignoski
Beaver Falls, PA
Plans: Employment

Jeffrey Randolph Moffitt
New Concord, Ohio
Plans: Grad School
University of California, Berkeley

Rebecca Jane Urban
Delaware, Ohio
Plans: Grad School
Georgia Institute of Technology

John Lindner

Professor and Chair of Physics

Teaching

Fall Semester:	Astronomy of the Solar System
	Electricity and Magnetism
	1 lab section of Foundations of Physics
Spring Semester:	Introduction to Quantum Field Theory
	1 lab section of Foundations of Physics

Advised all 7 Junior I.S. computer simulations using the Mac OS X native development environment
Advisor for four Senior Independent Study projects

Areas of Current Research

- Cellular automata
- Celestial mechanics
- Use of disorder and noise to regularize extended nonlinear systems
- Computer visualization

Professional Meetings Attended

- March meeting of the American Physical Society, Austin TX. Co-authored two posters and one oral presentation with students (see "Student Research")
- Keynote Speaker, Innovative Science Teaching: Enhancing Learning with Technology, DePauw University, May 2003

Other Activities

- Presented invited talks at Wooster:

  "Time Machines"
  Faculty at Large, 25 February

  "CoW CPP: The College of Wooster Computational Physics Project"
  Workshop on Teaching, Technology, and Collaboration, 21 September

- Interviews by print, radio, and TV media as a technical expert on space debris with regard to the Columbia accident, including *The Washington Post, USA Today, LA Times, Houston Chronicle, Orlando Sentinel,* and the *Wooster Daily Record*
- Filmed a segment of Wooster's *Campus Close-Up*
- Served as advisor to the Physics Club and Chair of the Physics Department
- Served on the College Scholar Exam Committee and as Chair of the Copeland Fund for Independent Study
- Co-PI, NSF-REU program, Condensed Matter and Nonlinear Dynamics at Wooster, 2003-2007

Dr. Lindner was recently promoted to Professor of Physics. Congratulations!

Shila Garg

Professor of Physics and Dean of the Faculty

Teaching

Spring Semester: Foundations of Physics
Second reader for two Senior I.S. projects

Areas of Current Research

- Dielectric Properties of a Binary Nematic Mixture

Professional Meetings Attended/Papers Presented

- Association of American Colleges and Universities meeting, Seattle WA, January 2003 moderated a round table discussion on "what approaches really work in assessing the success of our students? the success of our institutions?"
- Invited talk,"Properties of Liquid Crystals" James Madison University, July 2003
- Center for Academic Integrity conference, Charlottesville VA, October 2002

Administrative Duties

- Chair: Educational Policy Committee, International Education Committee, Faculty Research and Development Comittee, Upperclass Programs Committee, Academic Standards Committee
- Co-Chair: First Year Living and Learning Project, Honor Code Committee, Kauke Renovation Committee
- Member: Executive Staff, Financial Advisory Committee, Committee on Committees, Teaching Staff and Tenure, Research and Study Leaves, Computing and Information Technology, Student Evaluation of Courses, Enrollment Management, Information Literacy, Hewlett Mellon Advisory Committee, Luce Awards Advisory Committee, Lilly Steering Committee, Orientation, and Galpin Prize

Dean Garg also directed plans for automating the assignments of First Year students to First Year Seminars using a computer algorithm.

Other Activities

- American Physical Society Committee on Education, 2002-2005
- Member of subcommittee to explore the initiative to develop a program to reform science education in South Central Asia and former Soviet Union central Asian nations.
- Reviewer for NSF Graduate Research Fellowship and NSF Nanotechnology in Undergraduate Education programs
- Attendance at GLCA Dean's Council, Ann Arbor MI, March 2003
- Ohio Five Deans' meetings at Kenyon, Oberlin, Ann Arbor, and Wooster
- Q&A column for *The Daily Record* on the College's Independent Study program
- Science Round Table presentation, November 2002
- Co-PI, NSF-REU program, Condensed Matter and Nonlinear Dynamics at Wooster, 2003-2007

Donald Jacobs

Victor J. Andrew Professor of Physics

Teaching

Fall Semester:	First Year Seminar *"Predictability in an Unpredictable World"* Modern Physics and lab
Spring Semester:	Thermal Physics Junior Independent Study and labs

Advisor for four Senior Independent Study projects

Areas of Current Research

- Phase transitions in binary fluid mixtures, polymer-solvent systems, living polymers, biological proteins
- Self-organized criticality

Professional Meetings Attended/Papers Presented *student co-author

- 15th Symposium on Thermophysical Properties, Boulder CO, June 2003
  D.T. Jacobs, Nithya L. Venkataraman*, Clinton I. Braganza*, Ryan D. Hartschuh*, Christopher J. Locke*, and Andy Brinck*
  "Critical phenomena in an eight-arm polystyrene in methylcyclohexane"
- GLCA Complex System Studies Workshop, Kalamazoo MI, February 2003
  Rebecca Urban*, Rachel Costello*, Kelle Cruz*, Christie Egnatuk*, Matt Krivos*, Tim Sir Louis*, Hanna Wagner* and D.T. Jacobs
  "Self-Organized Criticality in Bead Piles" (co-presented by Urban & Jacobs)

Publications Appearing

- Clinton I. Braganza* and D.T. Jacobs, "Turbidity of the Liquid-Liquid Mixture Perfluoroheptane and 2,2,4-Trimethylpentane Near the Critical Point" *Journal of Chemical Physics* **117**, 9876-9879 (2002)
- Rachel M. Costello*, K.L. Cruz*, Christie Egnatuk*, D.T. Jacobs, Matthew C. Krivos*, Tim Sir Louis*, Rebecca J. Urban*, and Hanna Wagner*, Self-Organized Criticality in a Bead Pile" *Physical Review E*, **67**, 041304 (1-9) (2003)

Other Activities

- Associate Editor for *American Journal of Physics*, reviewed articles for several other journals
- Awarded a $50,000 grant from the Petroleum Research Fund, 2003-2005
- Teaching Staff and Tenure Committee

Dr. Jacobs has been elected a Fellow of the American Physical Society, 2002 (Chemical Physics)

"For contributions to the understanding of critical phenomena in liquids, and for sustained mentoring of undergraduate students engaged in research"

Each new fellow is elected after careful and competitive review and recommendation by a fellowship committee on the unit level, additional review by the APS Fellowship Committee and final approval by the full APS Council. Only 1/2 of 1% of the total APS membership is selected for Fellowship in the Society each year.

Alice Churukian

Juliana Wilson Thompson
Visiting Assistant Professor

Dr. Churukian has accepted a tenure track position at Concordia College in Moorhead MN and has moved to Fargo ND. BEST WISHES ALICE!

Teaching

Fall Semester:	Foundations of Physics
	1 lab section of Foundations of Physics
	Classical Mechanics
Spring Semester:	General Physics
	2 lab sections of General Physics
	Math Methods
	Second reader for 3 I.S. projects

Areas of Current Attention

- Developing a single concept survey to be used during the second semester of introductory physics courses
- Developing new experiments to make the weekly labs of algebra and calculus based introductory physics courses match more closely with concepts in the lecture

Professional Meetings Attended/Papers Presented

- 127th National Conference of the American Association of Physics Teachers, Madison WI, August 2003
- International School of Physics Enrico Fermi Course: Research on Physics Education, Varenna Italy, July 2003
- Winter Meeting of the American Association of Physics Teachers, Austin TX, January 2003, presented "A Single Concept Survey for Second Semester Physics"

Rick Batman

Visiting Instructor

Teaching

Fall Semester:	General Physics
	2 lab sections of General Physics
	Astronomy of Stars & Galaxies
Spring Semester:	Physics Revolutions
	1 lab section of Foundations of Physics
	Astronomy of Stars & Galaxies
	Second reader for two Senior I.S. projects

Professor Batman also served as advisor to the Physics Club's Outreach program. We wish him all the best as he continues work on his dissertation and teaches part-time at University of Akron.

New Faculty for 2003-2004

Susan Lehman

Clare Boothe Luce Assistant Professor

B.A. Goshen College
1993
M.S., Ph.D.
U of North Carolina
1996, 1999

Research Interest:
Solid-state physics; optoelectronics

Lowell Boone

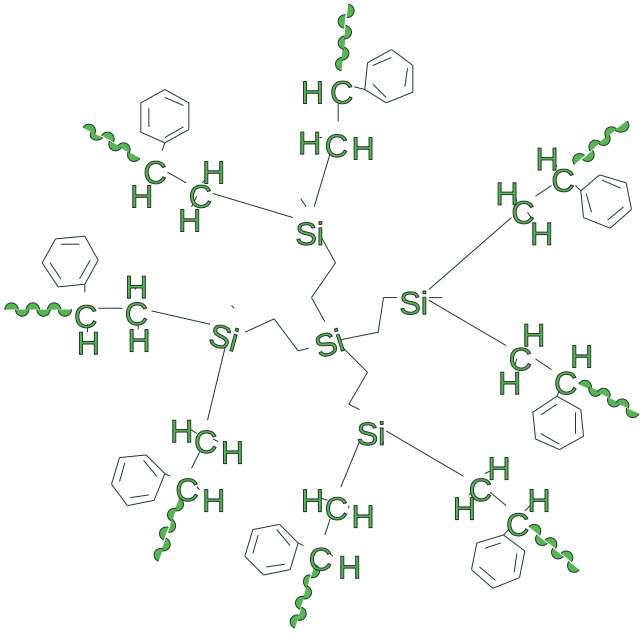
Visiting Assistant Professor

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

Research Interest:
High-energy astrophysics

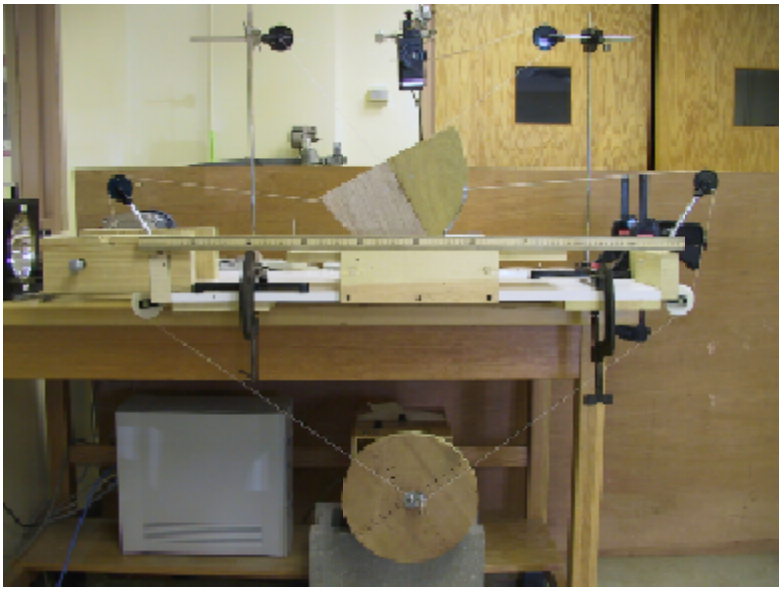
Senior Independent Study

Clinton Braganza
Advisor: Donald Jacobs
The Turbidity of 8-Arm Polystyrene in Methylcylochexane in the One-Phase Region Near the Critical Solution Point: A Small Step in Determining the Effects of Polymer Architecture on Critical Amplitudes



An experiment was designed to determine the effect of polymer architecture on the correlation length amplitude ξ_o. This amplitude was obtained by fitting a theoretical function based on Ornstein-Zernike theory to turbidity data of 8-arm polystyrene (M_w = 282 400) in methylcyclohexane close to the critical solution point. The correlation length amplitude obtained was 1.044 ± 0.068 nm, this value seems to be within the experimental error of data available for linear polystyrene in methylcyclohexane for the same molecular weight of polystyrene. It was also found that the star architecture did not affect the critical composition as expected.

Daniel Brubaker
Advisor: John Lindner
A Mechanical System Designed to Exhibit Bistable Stochastic Resonance



A bistable mechanical device was built to exhibit Stochastic Resonance (SR) in the first element and Noise Enhanced Propagation (NEP) in an array of coupled similar elements. The first element was studied while forced at a fixed frequency and amplitude. Four different realizations of noise were applied to the bistable element by shaking its base with wheels of four different offsets. The standard deviation of the noise applied to the rocker was not correlated to the offset of the wheel. The phenomenon of stochastic resonance was not observed in the data collected due to an inherent flaw in the noise generation mechanism. Plans for an improved mechanical system are presented.

Jeff Moffitt

Advisor: John Lindner

Self-Erasing Perturbations of the Abelian Sandpile Automata

The early to mid 1980s was the time of the first cellular automata revolution. Though von Neumann had formulated the concept 30 years earlier, this period produced the greatest advances in our understanding of cellular automata (CA), particularly in regards to the modeling of physical systems. It was during this time that automata whose behavior approximated solutions to certain differential equations were found. This was also the time of the cellular vacuum and digital mechanics, suggestions that CA could describe fundamental physics in ways that differential equations could not. However compelling these proposals may be, we currently do not have the understanding of general CA to produce automata whose behavior subsume all of modern physics. In short, CA have yet to displace differential equations as the backbone of our understanding of fundamental physics. However, we attribute this fact not to any inherent limitations in CA, but simply to the difference between the centuries of understanding we have of differential equations as opposed to the decades for CA.

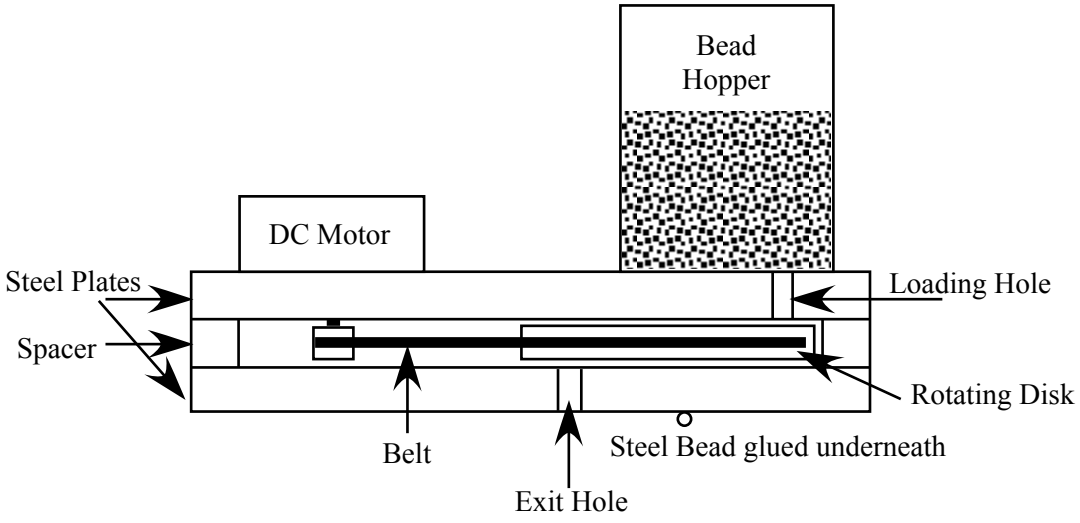
We contribute to the growing body of CA knowledge in this thesis by investigating a novel phenomenon on a certain self-organizing cellular automata, the Abelian scalar sandpile. We find that there exists a wide class of *global* perturbations that can be made to the attracting states of any Abelian scalar sandpile such that the natural *local* dynamics of the automaton completely remove these perturbations. We term such perturbations self-erasing perturbations (SEP) and provide both a general form and an understanding of why such a phenomenon exists. By using SEP to elucidate certain aspects of the general Abelian scalar sandpile, we suggest its abilities as a conceptual tool. We also demonstrate possible applications of this phenomenon in data protection and encryption. Finally, the generality of this work is suggested by the discovery of a related CA that demonstrates a SEP phenomenon as well.

Becky Urban

Advisor: Donald Jacobs

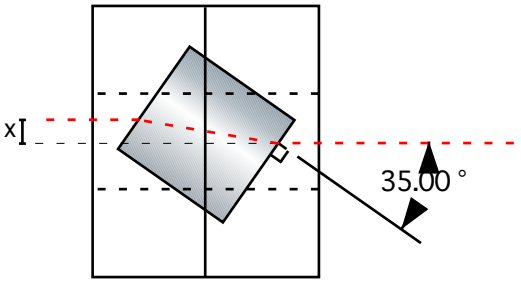
Dynamics of a Steel Bead Pile Exhibiting Self-Organized Criticality

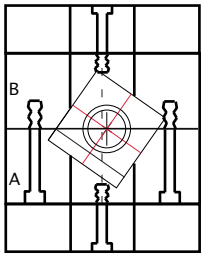
The theory of self-organized criticality is a way to explain complex dynamical systems near their critical points. This experiment examined a pile of steel beads perturbed by the addition of beads onto its apex. The distribution of avalanches with respect to their size was compared to a power-law description. A power-law with an exponent of -1.5, the mean-field value, is characteristic of SOC. The height from which the beads were dropped was varied. The drop height was kept constant throughout each data run. The heights used were 0.5 cm, 0.6 cm, 1.5 cm, and 3.0 cm. The resulting avalanche distributions were not found to be as expected. Instead of following a pure power-law or a power-law combined with an exponential, the distributions were found to follow a power-law with an average exponent of -1.77 ± 0.07 for avalanches between the sizes of 1.94 and 128. However, there appeared to be an increased probability of large avalanches occurring. When a straight line with a slope of -1.5, the mean-field exponent value, was added to the avalanche distribution graphs, there was a decreased probability of intermediate avalanche sizes occurring.

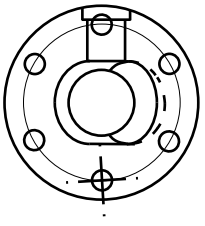


Ryan Hartschuh
Advisor: Donald Jacobs
Measuring the Coexistence Curve of 8-Arm Star Polystyrene in Methycyclohexane

A new experimental setup was designed and developed to measure the refractive index of an 8-arm star polystyrene-methylcyclohexane solution in the one and two-phase regime. This particular system of branched polymer in a weak solvent has not yet been thoroughly studied as it pertains to critical phenomena and universality class. For the first time, photodiode linear arrays (position sensitive detectors) were used to detect refracted light position. A three-state copper thermostat was used to control the temperature of the sample, which was contained in a glass cell of path length 20 mm at 35° incident to the incoming beam. Substantial effort was focused towards designing, developing, testing, and calibrating the setup. When applied to the critical system of concern, preliminary data were collected, analyzed, and used to plot the coexistence curve, in refractive index and volume fraction, of the one-phase and the upper phase, but the accuracy of the data was questionable. Much was learned in terms of using the new experimental setup and quantifying error, but suggestions for improvement are discussed that may lead to an effective means of measuring the coexistence curve of 8-arm star polystyrene in methylcyclohexane.

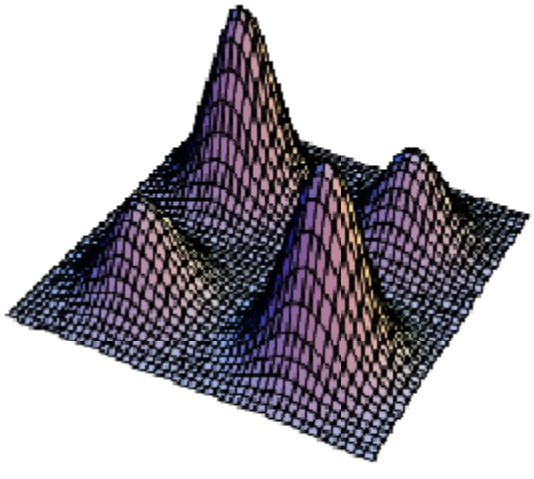






Brad Lignoski
Advisor: John Lindner
Decoherence, the Classical Appearance of the Quantum World and Quantum Evolution

The motivation for this project was the provocative new theory of the quantum evolution of life proposed by McFadden and others. To understand the theory, one must first understand how the world appears classical though it is governed by quantum rules. Decoherence theory provides an observer-free alternative to the controversial "wave function collapse" postulate. This thesis provides an illuminating introduction into decoherence theory and its possible application to the origin and evolution of life.



Christie Egnatuk

Advisors: John Lindner (Physics) and John Ramsay (Mathematics)

Kaluza-Klein Theory

Kaluza-Klein Theory attempts to unify electromagnetism and General Relativity by adding an extra dimension. The fifth dimension is considered to be compact, uncoupled and rolled into a circle at every point in space. Expanding Einstein's field equations to 4+1 dimensions results in Einstein's equations for gravity along with Maxwell's equations of electromagnetism. The split in the Ricci Scalar of 4+1 dimensions between the classical General Relativity in a vacuum and the Maxwell field equations is known as the "Kaluza-Klein miracle". The momentum in the fifth dimension is the electric charge of the particle. Since the fifth dimension is compact, charge must be quantized.

Theodor Kaluza

$$\hat{R} = R + \frac{1}{4} F_{\mu\nu} F^{\mu\nu}$$

Oskar Klein

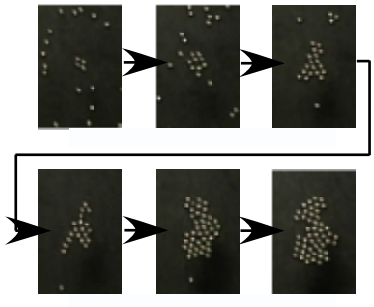
Nick Hanson

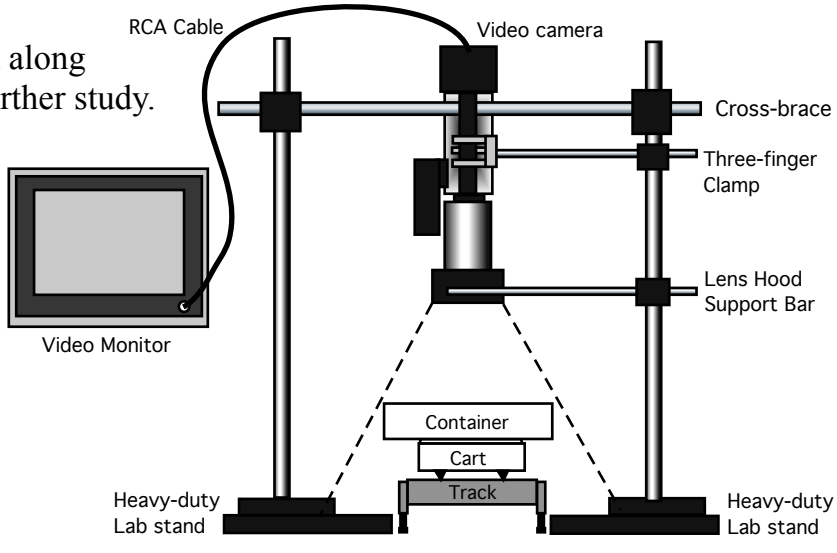
Advisor: Donald Jacobs

Two-Dimensional Clustering Transitions in Vibro-Fluidized Hard Spheres

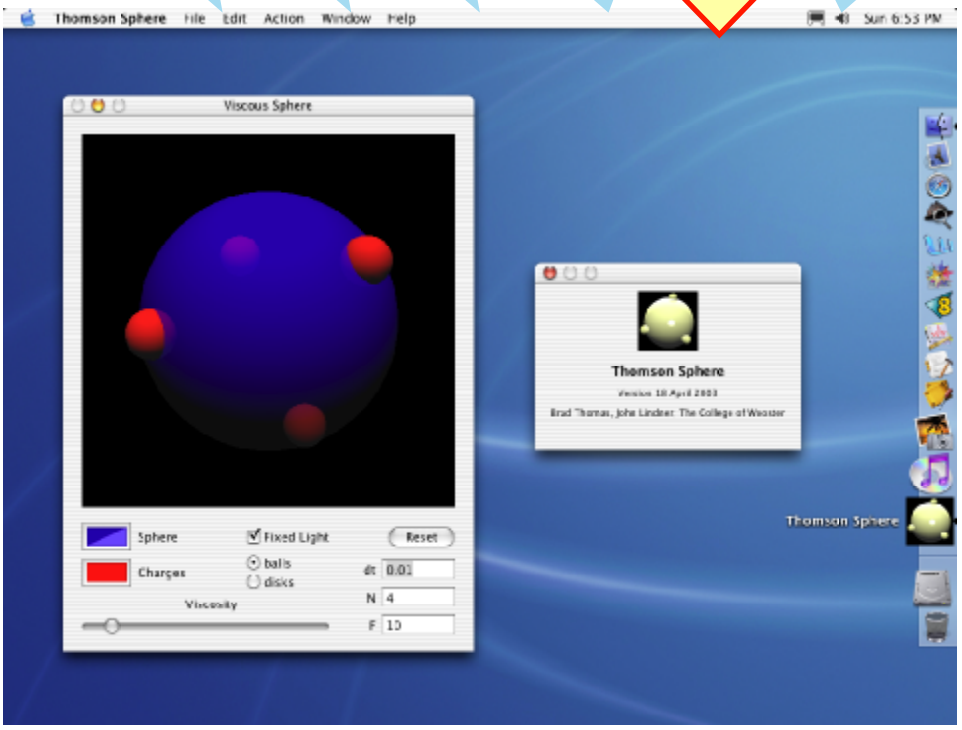
An investigation of the clustering transitions of a vibro-fluidized granular material in two-dimensions was conducted. Steel ball bearings, 1 mm in diameter, were placed in a rectangular Plexiglas container and oscillated horizontally with a mechanical vibrator that was powered by a function generator. Covering fractions between 0.01 and 0.15 were studied. The system exhibited three phases; the gas, clustered, and networked phases. Transitions between the phases were observed by visual inspection of the system. A phase diagram of the system was constructed, however no direct correlation was found between the covering fraction of particles and the acceleration amplitudes at which phase transitions occurred. Electrostatic effects greatly interfered with accurate measurements of the phase transitions. Clustering of particles was observed, and the nature of the cluster growth process was determined to vary with the rate of at which the acceleration amplitude of the system was quenched. Video of a "charged cloud" of particles was recorded and analyzed. Velocity distributions of the particles in the charged cloud showed that the velocities of the particles, and subsequently the granular temperature of the system, were anisotropic.

The results of this investigation are presented along with possible improvements and routes for further study.





Junior Independent Study

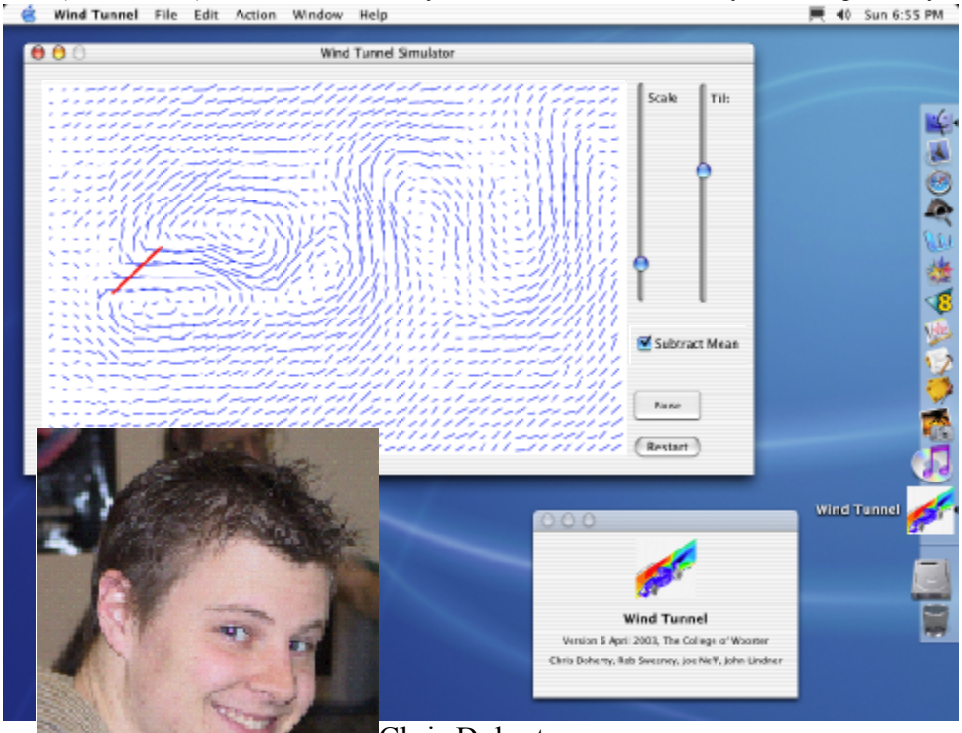


Brad Thomas

Computer Simulation:
Thomson Sphere

Self-Designed:
The Propagation of an Electrical Current through a Granular Medium

Abstract: By passing an electrical current through a container of steel shot, we study the dynamics and conductivity of a granular medium. With a four wire connection we study the systems electrical resistance while varying volume of shot as well as pressure applied to the surface. Data sets with low volumes of 1000 ml, 1500 ml, and 2000 ml of shot produce resistance vs. pressure plots that follow an exponential decay. However, the system with greatest volume of shot, 2500 ml, returned a plot that does not follow this same decay, suggesting that there are interactions within the system that cause an insensitivity to external pressure. The two lowest resistances, (.016+/–.002)kΩ and (.018+/–.002) kΩ, were returned by the 2000 ml and 2500 ml systems respectively, each under a pressure of (32.13+/–0.01) Pa.

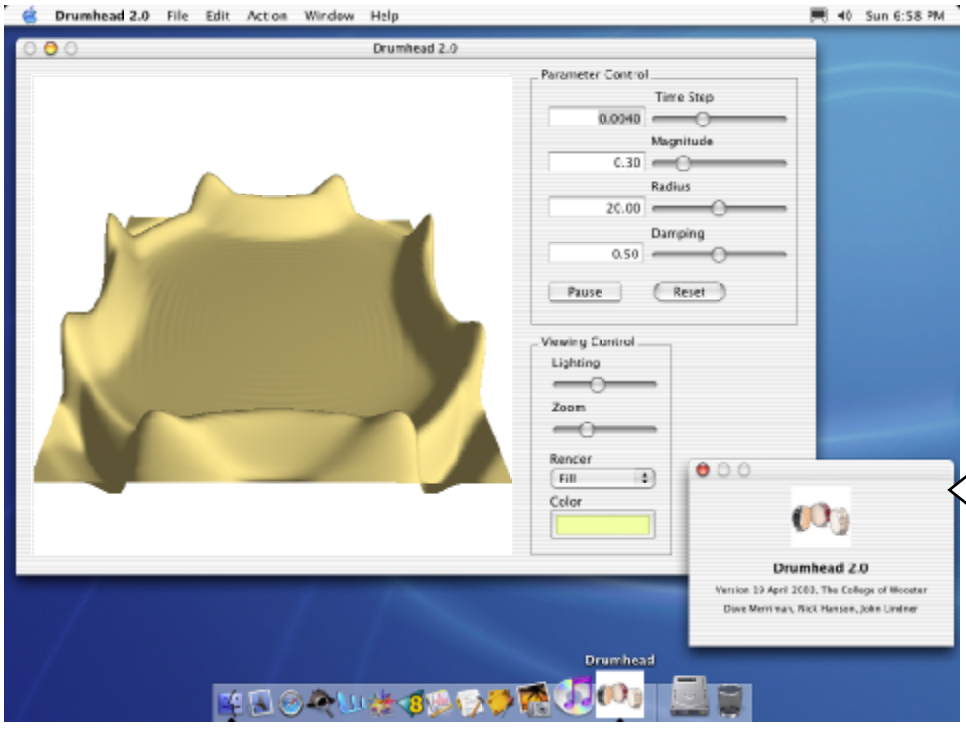


Chris Doherty

Computer Simulation:
Wind Tunnel

Self-Designed:
The Collision Investigation

Abstract: To directly visualize compression wave propagation through a sphere, a computer simulation is created. Particles arranged on an octagonal lattice are connected to each other with virtual springs, representing intermolecular forces. The simulation propels the ball toward a stationary object with some initial speed. During the collision with the obstacle, the particles are compacted, and then extended by the virtual spring forces. This motion causes compression waves to travel through the sphere in a manner predicted by the theory. The compression wave propagation through the ball is very similar to what would be expected in the collision of an elastic spherical solid. In order to observe vibrations in the balls, a physical collision experiment is also performed, which found no vibration in the spheres.

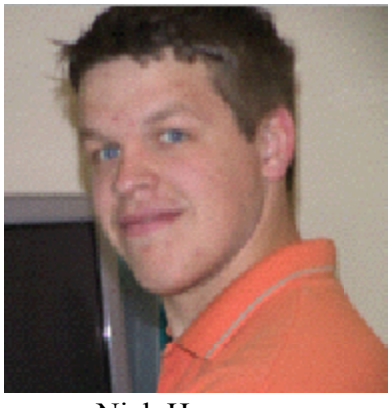


Dave Merriman

Computer Simulation:
Drumhead

Self-Designed:
Heavy Metal Mayhem
(characterizing guitar and amp)

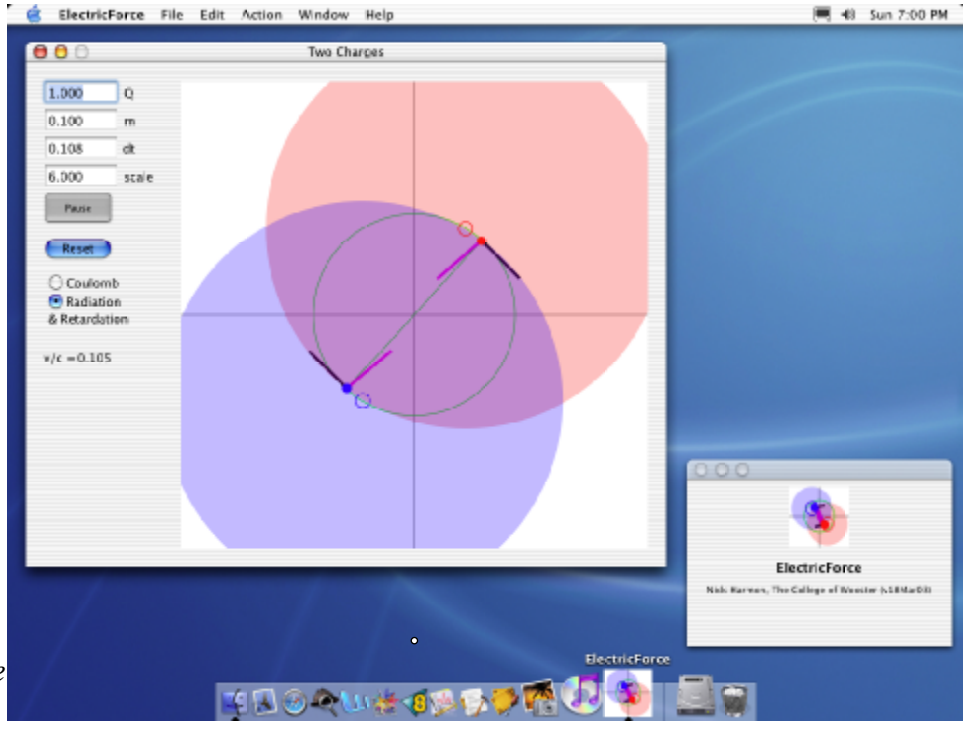
Abstract: The differences between a pure sine wave produced by a function generator and a vibrational frequency produced by a guitar string were investigated, along with nonlinear properties that affect distortion in an amplifier. An oscilloscope allowed for a qualitative comparison of the two signals, as many observations were made from an oscilloscope's main and XY plot features. The use of a FFT spectrum analyzer allowed for a quantitative analysis, by comparing corresponding Fourier transforms to one another. The sine wave produced by the function generator yielded a signal where only the fundamental was significant, or audible. However, the vibrations produced by the guitar string are composed of a complex superposition of frequencies. The reason for this complex superposition has not been fully investigated, but would be interesting to further examine. It can be concluded, however, that the harmonic structure of the vibrations produced by the guitar string are much different than those of a "pure" sine wave produced by the function generator.



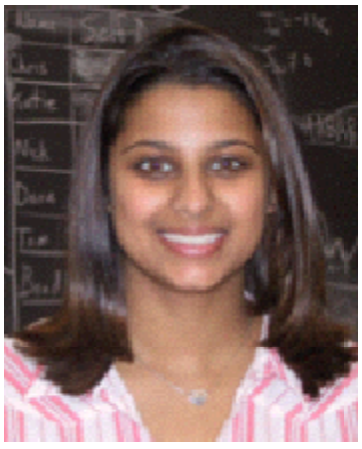
Nick Harmon

Computer Simulation:
Electric Force

Self-Designed:
Single Slit Diffraction and the Heisenberg Uncertainty Principle

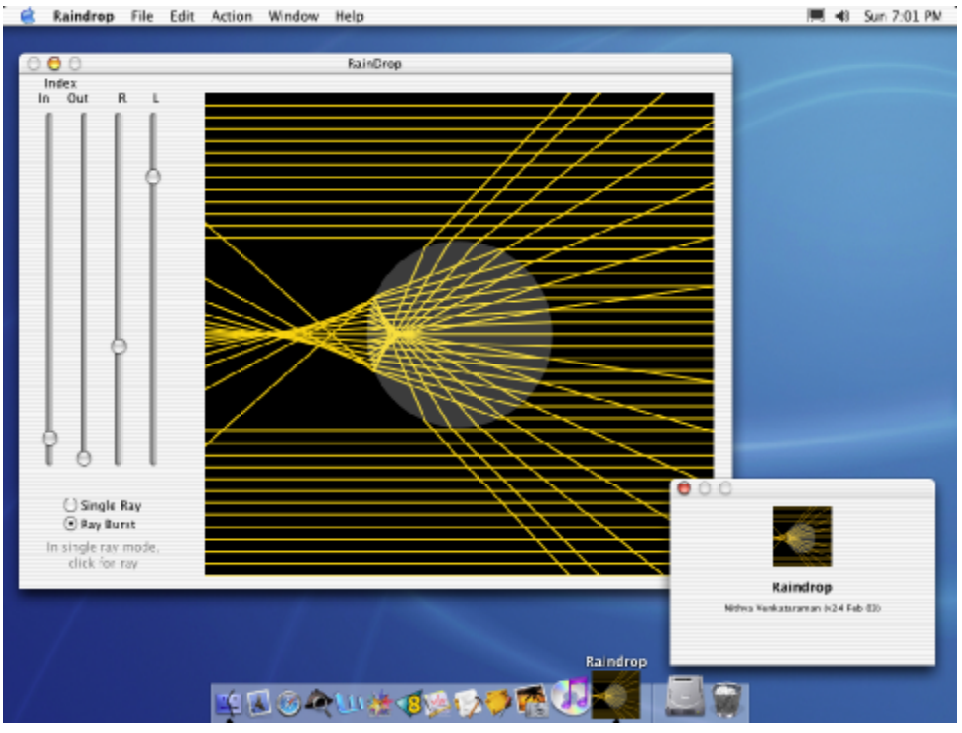


Abstract: In this experiment, single slit diffraction was used as an analog for the Heisenberg Uncertainty Principle (HUP). The goal was to conduct a single slit diffraction experiment in which uncertainties could correspond to the $\Delta x \Delta p$ of the HUP. Further analysis was conducted on the data for the four slits used (0.50, 0.20, 0.16, 0.08 mm). Most of the diffraction patterns agreed well with the theory of Huygens and Frensel.



Nithya Venkataraman

Computer Simulation:
Raindrop



Self-Designed:
The Observation of Crystalline Structures of Evaporated 8-arm Polystyrene in Methylcyclohexane

Abstract: The purpose of this experiment was to observe the structures of evaporated 8-arm polystyrene in methylcyclohexane using an optical microscope and atomic force microscopy. The 5 mm cell containing 8-arm star polystyrene with a molecular weight of 282,400 and methylcyclohexane was observed under the optical microscope. The structures that were observed were dark tail-like spike structures and streetscape structures. The growth rate of the dark tail-spikes resulted in an exponential growth that had a limit and would cease to grow. Streetscape structures located on the slides of evaporated 8-arm polystyrene and methylcyclohexane were observed under the AFM to analyze the topography of the material. The streetscape structures resulted from trenches that were 300 nm deep and 900 nm wide. With few similarities between the streetscape structures of the slides compared to the 5 mm cell, the data could not be applied to that of the 5 mm cell. In the future, observations on the growth can be continued and the limit at which the polymer stops growing can be determined.

10 Most Beautiful Physics Experiments
According to a poll of physicists in Physics World
Listed below chronologically with rankings

(7) Eratones' measurement of Earth's circumference

(2)* Galileo's experiment on falling objects

(8) Galileo's experiments with rolling balls down inclined planes

(4) Newton's decomposition of sunlight with a prism

(6) Cavendish's torsion-bar experiment

(5) Young's light-interference experiment

(10) Foucault's pendulum

(3) Millikan's oil-drop experiment

(9) Rutherford's discovery of the nucleus

(1)† Young's double-slit experiment applied to the interference of single electrons

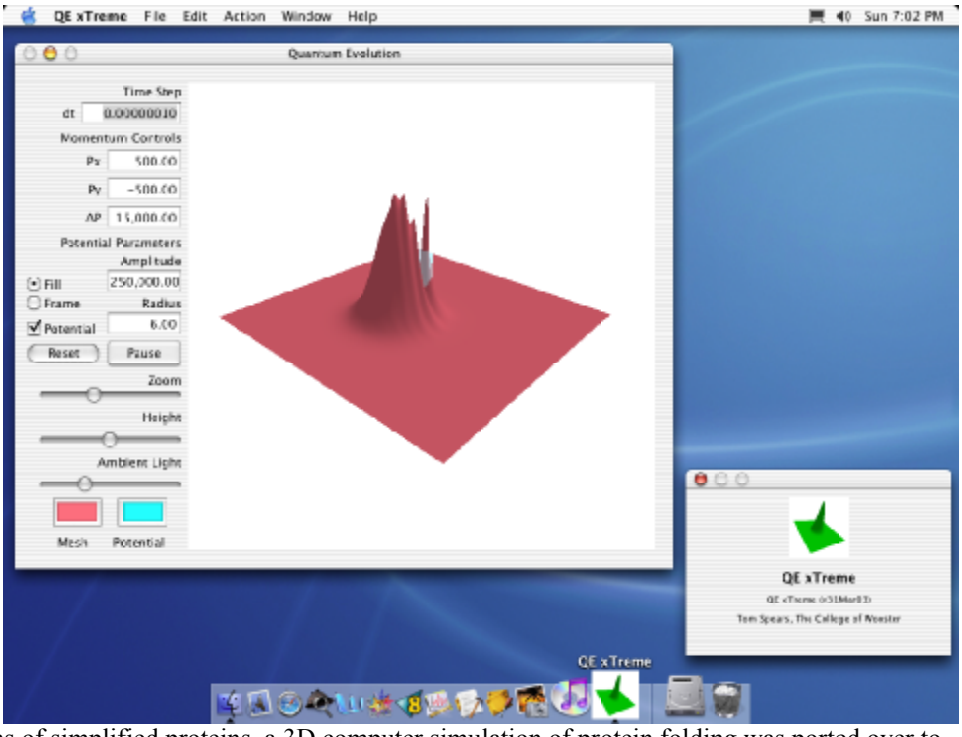
**Definitively performed by astronaut David Scott on Moon in 1971*

†First performed by Claus Jönsson of Tubingen University in 1961

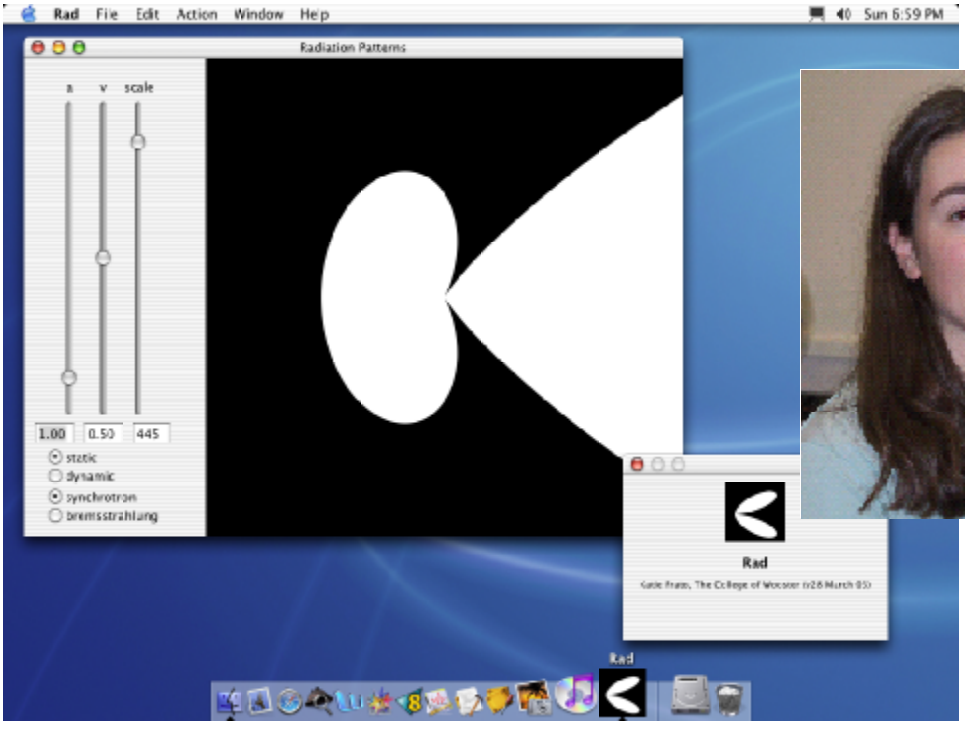
Tom Spears

Computer Simulation:
QE xTreme

Self-Designed:
Monte Carlo Protein Folding Using Annealing Algorithms



Abstract: To find low energy conformations of simplified proteins, a 3D computer simulation of protein folding was ported over to OpenGL and the Cocoa environment. An experiment mode was added to the simulation to allow the user to alter the temperature of the environment the protein resides in as a function of time. This annealing is designed to guide the protein quickly to a low energy conformation reliably. The results of the testing revealed that the annealing algorithm was superior to constant temperature folding but was not successful in producing identical conformations.



Katie Frato

Computer Simulation:
Rad(iation) Patterns

Self-Designed:
Determination of the Effective Diameter, Polydispersity, and Average Molecular Weight of an Unknown Polymer Using Static and Dynamic Light Scattering

Abstract: In this investigation, the effective diameter, polydispersity and average molecular weight of an unknown polymer in the solution phase is characterized using static and dynamic light scattering.

Static light scattering was conducted using 13 scattering angles between 30° and 150° and five different dilutions of the polymer in THF. Photon correlation spectroscopy was conducted for all of five concentrations. Static light scattering data resulted in Zimm plots with a parabolic shape, which were fit using both linear and 2nd order polynomial forms to extrapolate KC/R_θ to zero scattering angle. The linear extrapolation resulted in a molecular weight of $(1.88+/-0.28)\times10^6$g and the quadratic extrapolation resulted in a molecular weight of $(6.19+/-0.82)\times10^5$g. There was a 67.1% difference between the molecular weights determined by the two extrapolation techniques. Dynamic light scattering gave an average effective diameter of 113.0nm+/–9.9nm and an average polydispersity of 1.222+/–0.013. It appears that significant error was introduced into the experiment through dust contamination. Future experiments using these methods should filter solvents before sample preparation in order to reduce error.

Physics Club

Officers

President: Jeff Moffitt
Vice President: Tom Spears
Secretary: Becky Urban
Treasurer: Ryan Hartschuh
Advisor: John Lindner

Wooster
Physics

We're not nerds!
I can prove it
with this equation:

$$-\frac{\hbar^2}{2m}\nabla^2\Psi + V\Psi = i\hbar\frac{\partial}{\partial t}\Psi$$

T-shirt design by Brad Thomas

Events

Fall Semester
Aug 2002: Physics Table at Scot's Spirit Day
Sept 2002: Organizational Meeting
Sept 2002: Pizza and Dessert Night
Oct 2002: Summer Research Talks
Nov 2002: Great Lake Science Center & Dinner
Dec 2002: Senior I.S. Research Presentations

Spring Semester
Jan 2003: Lecture by Rellen Hardtke
"The Search for Gamma-Ray Burst Neutrinos from the Earth's South Pole"
Jan 2003: Lecture by Bonnie Valant-Spaight
"Fundamentally Incomplete: Pushing the Boundaries of the Standard Model of Particle Physics"
Jan 2003: Lecture by Susan Lehman
"Cavity Ring-down Spectroscopy: Detecting Nanomoles of Water to Improve Growth of Nanoscale Devices"
Mar 2003: Lecture by Jackie Milingo "Planetary Nebulae and Their Role in the Chemical Evolution of Our Galaxy"
Apr 2003: Lecture by Paul Bloom
"Measurements of Branching Fractions and Charge-Parity Violating Asymmetries in B Meson Decays to $\eta' K$"
Apr 2003: Taylor Bowl 14
Apr 2003: Lecture by Don Driscoll "Cryogenic Dark Matter Search"
Apr 2003: Junior I.S. Computer Simulation Presenations + Pizza & Pop
May 2003: Dr. Garg's Indian Dinner

Taylor Bowl XIV

Great turnout . . . but we lost!

Physics 107.7	Math/CS 117.7

The Physics Club received a 2003 Marshall W. White Award for their proposal "Electrifying Elementary Students with Electromagnetism." The award was used to purchase equipment and accessories to illustrate magnetic induction and other aspects of electromagnetism as part of the Physics Club's outreach program. Funds for the award come from the income in the Sigma Pi Sigma Trust Fund. The awards, which were first made in 1975, were named in honor of Dr. Marshall W. White for his long years of service to Sigma Pi Sigma. Authors of the proposal were (from left) Becky Urban, Jeff Moffitt, Ryan Hartschuh, and Tom Spears. This year's outreach program made six presentations in local schools.

Student Research

Research Experience for Undergraduates 2003
front: Dr. Jacobs, Elizabeth Baker, Dr. Garg, Kathleen McCreary
back: Greg Dallinger, Joe Vanfossen, Seth Hopper, Adam Cohen, Dr. Lindner, Katherine Olaksen, Andy Brink, Dr. Greer (not pictured: Dr. Glassey)

Projects

Elizabeth Baker (Bucknell University '06)
Advisor: Donald Jacobs
Self-Organized Criticality: Cliff Phenomena

Andy Brinck (CoW '05)
Advisor: Donald Jacobs
The Turbidity and Correlation Length of 8-Arm Polystyrene in Methylcyclohexane

Adam Cohen (Bucknell University '06)
Advisor: Donald Jacobs
The Automated Measurement of the Coexistence Curve of 8-Arm Star Polystyrene in Methylcyclohexane

Greg Dallinger (CoW '05)
Advisor: Wingfield Glassey
Computational Study of the Oxidation of CO on the Pt(111) Surface

Seth Hopper (Earlham College '04)
Advisor: John Lindner
Vector & Parallel Processing in Computational Physics

Kathleen McCreary (CoW '06)
Advisor: Shila Garg
Dielectric Properties of a Nematic Binary Mixture

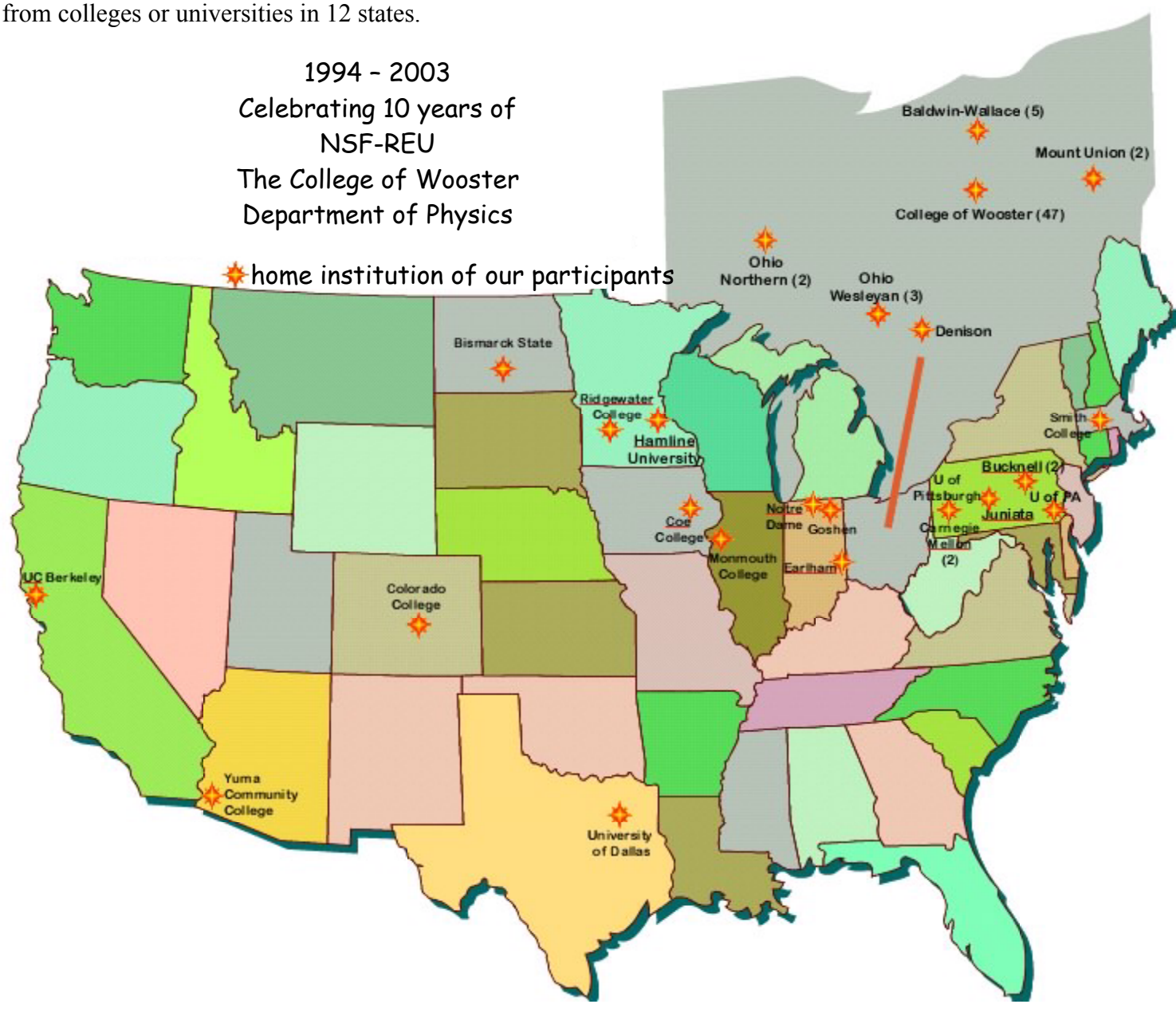
Katherine Olaksen (CoW '06)
Advisor: John Lindner
Chaotic Sphere: Two Particles Interacting on a 2D Spherical Universe

Joe Vanfossen (Baldwin-Wallace College '04)
Advisor: John Lindner
Self-Erasing Perturbations: BTW Scalar Sandpiles and Superpiles

Our department has been awarded a four-year $268,000 grant from the National Science Foundation (NSF) to continue our Research Experience for Undergraduates (REU) program.

The REU Site, "Condensed Matter and Nonlinear Dynamics at Wooster," began this year and will continue through the summer of 2006. Principal investigator John Lindner and co-principal investigator Shila Garg were joined by Don Jacobs and Wingfield Glassey, assistant professor of chemistry.

Our NSF-REU program is now in its tenth year. It brings at least eight students to campus each summer for ten weeks of scientific research and has contributed to 18 scientific papers in peer-reviewed journals, all of them co-authored by REU students. It has also resulted in 39 presentations at regional, national, and international professional conferences, almost all by REU students. In addition, it has involved about 80 students from colleges or universities in 12 states.



This year an ethics component was introduced as part of the REU program. Dr. Sandra Greer, Professor of Chemical Engineering at the University of Maryland College Park, presented a public lecture entitled "Truth, Justice, and the Scientific Way: Ethical Issues of a Working Scientist." Later that day, she led a discussion workshop for our eight REU students that included case studies on data recording and adequate laboratory notebook documentation, attribution and collaboration, under-represented groups in science, as well as ethics of animal and human subjects.

Off-Campus Summer Research

Tom Spears '04 spent his summer at Fermi National Accelerator Lab in Batavia, Illinois updating LabVIEW VIs that run the ionization profile monitors on the booster and main injector to allow advanced error handling measures. The main injector systems were combined into one VI that would run on all three systems.
Katie Frato '04 worked in the department of biochemistry and biophysics at the University of Rochester Medical Center. Her research involved expressing the Vif (viral infectivity factor) protein of HIV for eventual structural determination by x-ray crystallography.
Nick Harmon '04 did his summer research at Ohio State University doing quality control for muon detectors that will be used at Stanford Linear Accelerator Center.
Austin Carter '05 also spent the summer at Ohio State using vertical channel construction to optimize response of polymeric field effect transistors.

National Meeting of the American Physical Society , Austin TX, March 2003

Dr. Lindner accompanied six students to the Austin APS Meeting, five of whom gave poster presentations and one (Jeff Moffitt) gave an oral presentation on his Senior Independent Study research.

Brad Thomas, John Lindner, Scott Hughes, David Miller and K. Wiesenfeld, *The Flux Creep Automaton*
Nithya Venkataraman, Christopher Locke and D.T. Jacobs, *The correlation length of an eight-arm polystyrene in methylcyclohexane near the critical point*
David Merriman and Shila Garg, *Investigating the Elastic Properties of N4 Through Freedericksz Transitions*
Jeff Moffitt, Patrick Macdonald and John Lindner, *Self-erasing perturbations of Abelian sandpiles*
Christine Leidel, Nick Harmon and John Lindner, *Optimal Exit: Solar Escape as a Restricted Three-Body Problem*

On the rooftop of the Austin Convention Center, from left:
Becky Urban, Christine Leidel, Dr. Lindner, Dave Merriman Nithya Venkataraman, Brad Thomas

Jeff Moffitt presenting his research in a session of Pattern Formation and Spatio-Temporal Chaos.

Alumni Spotlight

Andy Martin ‘95

Andy and his wife live in Rocky River OH about 20 miles west of Cleveland. He is a pilot with American Eagle and hopes to start school again this fall. He is shown here at Chicago’s O’Hare Airport. Says Andy, “It’s amazing where a physics degree can take you.”

Doug Iams ‘84

After Wooster, Doug spent two years at Lockheed in Sunnyvale CA as a satellite rocket booster jockey, then obtained a master’s degree in optics from the University of Arizona. He then returned to the Silicon Valley and took a position as a metrologist with a company that makes disks for hard disk drives. In addition to his measurement duties, he also did some polish and anneal development and some failure analysis. After ten years, he was transferred to Santa Rosa CA, but unfortunately the company was forced to shut down the division. Doug is taking classes at Sonoma State to keep his mind fresh while he waits for the economy to pick up.

Lauren Ault ‘01

Lauren is living in Boston and recently earned her Ed.M. from “that place in Boston” (aka Harvard) with teaching certification in physics. She taught math this summer and hopes to land a teaching job at a Boston High School. In her spare time, she plays horseshoes, sometimes with Chris Templeman ‘01.

Karl Crandall '91

Karl has left the Naval Research Labs to go into the IT industry. He ended up at the Office of Foreign Disaster Assistance, one of several offices in the US Agency for International Development. Just recently he spent a month in Kuwait supporting a group of sixty Disaster Response Specialists in their attempt to assess and respond to the possible humanitarian crisis in Iraq. His role there was as an acting communication officer, making sure that the DART (Disaster and Assessment Response Team) stayed in constant communication with Washington DC by email and phone. Karl found the experience very exciting and rewarding.

Josh Fagans '93

Josh lives in Redwood City, California with his wife Emily and young son Connor. Josh reports that Connor is more interested in biology than physics at this point. :) Josh is the head of Apple Computer's iPhoto group and even gets to attend regular meetings with Steve!

Priyavadan Mamidipudi '95

Pri recently received his Ph.D. from the University of South Florida and has moved to the DC metro area. He is working for a small company called Optical Air Data Systems which specializes in developing air data sensors.

Salman Saeed '96

Salman successfully defended his dissertation last summer and has received his Ph.D. in chemical physics from Kent State University.

Peter Hourigan ‘93

This is Peter’s seventh year working at the Oxford Academy boys boarding school in Westbrook CT. He lives on the campus with his wife Elizabeth (Murray) Hourigan ‘95. Peter serves as the Dean of Faculty, a full time math teacher, and co-technology chair. The school features one-on-one classroom instruction and caters to students facing academic challenges. In the past several years, three graduates of Oxford Academy have enrolled at The College of Wooster. Peter and Lizzie are expecting to travel to China later this year to complete the adoption of their first child.

Erich Ippen ‘92

Erich has been a visual effects creator for George Lucas’ Industrial Light and Magic for the past five years. His most recent credit was on *Hulk*, and he will be starting work on *Star Wars Episode III* in the fall. He and his wife Chandra recently became the parents of a baby boy, Raiden Arthur Ippen.

Erica Bramley Montbach ‘97

Erica successfully defended her thesis and just received her Ph.D. in chemical physics from Kent State University. She is employed as a research scientist for Eastman Kodak in Rochester NY.

Zakir Thaver ‘01

Zakir has just returned from Pakistan and is working as a technical consultant for Granada Television in New York City.

Contact Us

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jlindner@wooster.edu (John Lindner)
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djacobs@wooster.edu (Don Jacobs)
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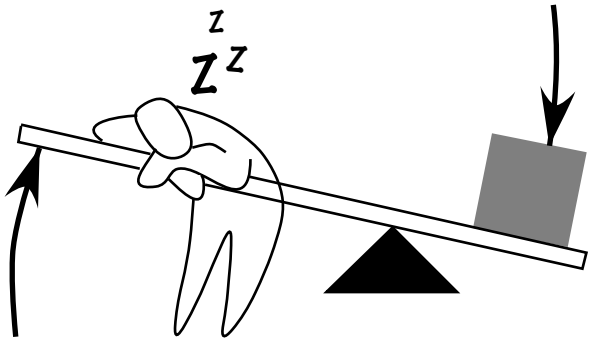
www.wooster.edu/physics

Simple Machines

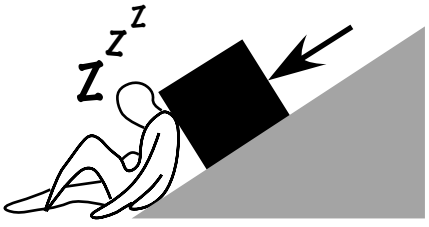
Early humans had to rely on muscle alone in their daily work. With the advance of civilization, the burden was lightened by the discover of these labor-saving devices:

THE LOAFER



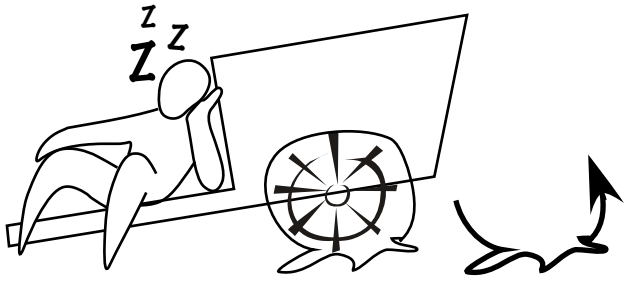
Force exerted by load raises end of lever to convenient height for resting.

THE DISINCLINED PLANE



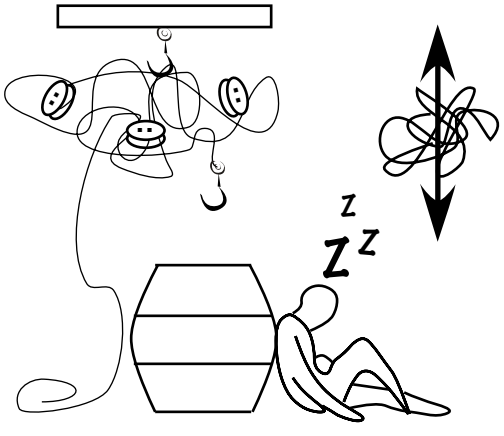
Downward force of load provides support to lean against.

THE FLAT TIRE



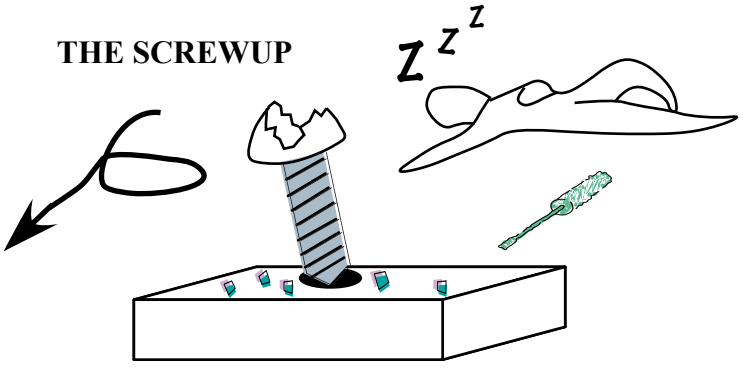
Useless wheel prevents moving load; might as well take a nap.

THE BLOCKED TACKLE



As ropes are hopelessly tangled, the load cannot be lifted.

THE SCREWUP



After ruining the screw, the job might as well be given up.

Thus, the Law of Conversation of Energy is demonstrated.

From: *Science Made Stupid*, Tom Weller, Houghton Mifflin 1985

Jackie the Administrative Assistant's Advice Column for Physics Majors

Be sure to tell Dr. Garg at least once during your Wooster career that you are changing your major from physics to communications, just to get a rise out of her.

Don't stick your tongue on the Van de graaff generator.

Don't ever nod off during a guest lecture. Dr. J will make a mental note of it.

Do not wait until I.S. Monday to print out your thesis. Murphy's Law *will* apply.

Do not ever throw paper into a wastebasket instead of a recycling bin. You will go to hell for sure.

Don't fall asleep in the cushy leather chairs in the reading room. "Someone" will write on you with a Sharpie marker or hide your backpack in the magazine rack.

See Jackie frequently for relationship advice or gossip.

Be nice to Judy—she is the only one who can find anything.

Make fun of the math people – a lot. You'll feel better.

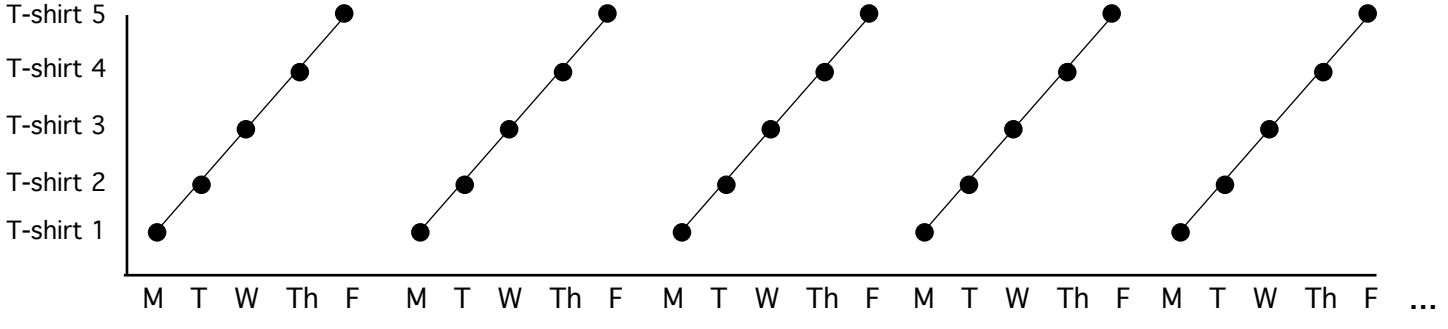
Don't ask Tom Spears if he is related to Brittney – he isn't.

Ask Jackie lots of favors (she'll do anything for a student).

Do not call Jackie "Mrs. Middleton". That is her mother-in-law.

After you leave Wooster, come back to visit and tell Jackie how wonderful she is compared to the nasty secretary at your graduate school.

Keep track of what t-shirt Dr. Lindner wears each day of the week, then plot your data.
By the end of the semester, you willl have a nice graph like this:

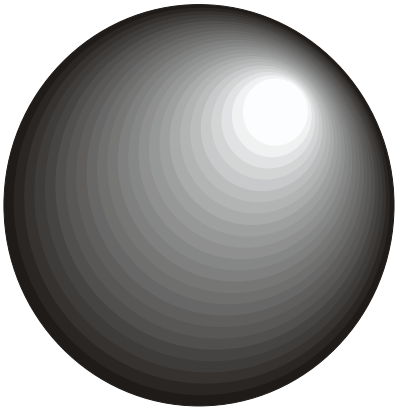


What!!! No error bars! That's unacceptable!
—Dr. J

History of the Atom

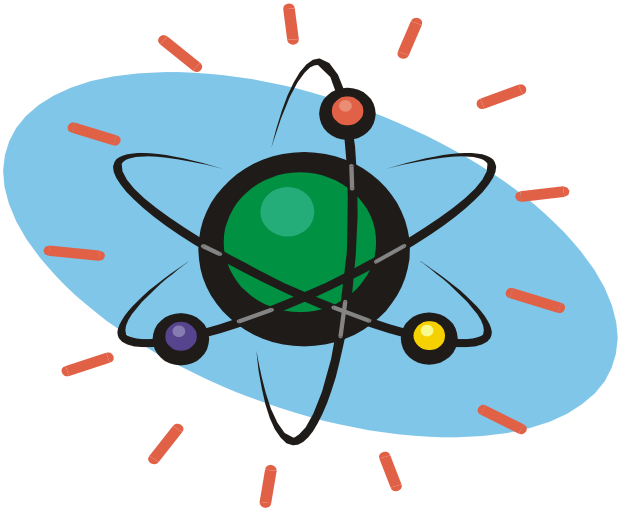
DEMOCRITUS' ATOM

The earliest theories held that the atom was hard, round, and indivisible, like a Lowry meatball.



RUTHERFORD'S ATOM

In the 20th century it was discovered that atoms consisted of three smaller particles. This was still tolerable and made a nice graphic symbol for corporate logos.



MODERN ATOM

Our modern picture of the atom has little lines zinging off (to represent the hundreds of subatomic particles that have been discovered), and is represented as a blur (on account of Heisenberg's Uncertainty Principle, which says that you can't tell where anything is).

Adapted from *Science Made Stupid*