North Carolina Section of the American Association of Physics Teachers

Spring 2014 Meeting
Appalachian State University
April 11th - 12th, 2014

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# Schedule of Events

## Friday, April 11

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>4:30PM-6:00PM</td>
<td>Walk-in Department Tours</td>
<td>Those who are able to arrive early are invited and encouraged to visit the Physics and Astronomy Department. Student and faculty guides will be available to conduct tours.</td>
</tr>
<tr>
<td>5:30PM-8:00PM</td>
<td>Registration</td>
<td>Registration is located in the Solarium of the Plemmons Student Union.</td>
</tr>
<tr>
<td>6:30PM-6:45PM</td>
<td>Welcome</td>
<td>Welcoming remarks by meeting organizers. (Solarium).</td>
</tr>
<tr>
<td>6:45PM-7:30PM</td>
<td>Dinner</td>
<td>Buffet style dinner. (Solarium) Dinner tickets may be purchased at time of registration. Complimentary beer will be provided by staff of the Appalachian State Fermentation Science program and the Ivory Tower Brewery.</td>
</tr>
<tr>
<td>7:30PM-8:30PM</td>
<td>Plenary Speaker</td>
<td>Dr. Charles Falco from the University of Arizona will be our plenary speaker. (Solarium) The title of Dr. Falco’s presentation will be The History of Art; The Science of Optics.</td>
</tr>
<tr>
<td>8:45PM-9:45PM</td>
<td>Rankin Science Observatory</td>
<td>A tour and hands-on observation session will take place at the Rankin GoTo Laboratory on Campus. The Rankin Science Observatory (RSO) is our on-campus teaching facility that has 15 eleven-inch Celestron GoTo telescopes for introductory astronomy labs and a 16” DFM scope for our advanced observational astronomy courses.</td>
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## Saturday, April 12

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
<th>Description</th>
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<tbody>
<tr>
<td>8:00AM-10:00AM</td>
<td>Registration</td>
<td>(Solarium, Plemmons Student Union.)</td>
</tr>
<tr>
<td>8:00AM-9:00AM</td>
<td>Breakfast</td>
<td>Complimentary continental breakfast (Solarium, Plemmons Student Union).</td>
</tr>
<tr>
<td>8:50AM-9:00AM</td>
<td>Official Welcome</td>
<td>Comments by Dr. Anthony Calamai, Dean of the College of Arts and Sciences at ASU (Solarium, Plemmons Student Union).</td>
</tr>
<tr>
<td>9:00AM-9:30AM</td>
<td>Opening Presentation</td>
<td>Dr. Beth Cunningham, Executive Officer of AAPT. “AAPT Building Better Physics Educators” (Solarium, Plemmons Student Union).</td>
</tr>
</tbody>
</table>
## Schedule of Events

### Saturday, April 12 (continued)

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>9:30AM-10:00AM</td>
<td>Coffee Break</td>
<td>(Rough Ridge and Beacon Heights Rooms, Plemmons Student Union).</td>
</tr>
</tbody>
</table>
| 10:00AM-11:30AM| Invited and contributed papers (Edwards, Birchard, Hubisz, Belloni, and Dhansar) | Dr. Emily Edwards
Quantum Physics, the Next 100 Years,
Followed by contributed papers.
(Rough Ridge, Plemmons Student Union.) |
| 10:00AM-11:30AM| Invited and contributed papers (Falvo, Dooling, Carnaghi, Caton, Ehret) | Dr. Mike Falvo, UNC-Chapel Hill
Cell Mechanics and Protein Physics,
Followed by contributed papers.
(Beacon Heights, Plemmons Student Union.) |
| 11:30AM-12:00PM| Transition to CAP Building                      | We will transition to the Physics & Astronomy Department in the CAP Building for the remainder of the meeting. |
| 11:45AM-1:15PM | Lunch                                           | A complimentary boxed lunch will be served (CAP Building, rooms 216 and 110). |
| 11:45PM-12:00PM| Poster Setup                                    | Poster presenters can set up their posters (CAP Building, 2nd floor).        |
| 12:00PM-1:00PM | Posters                                         | Contributed posters will be presented in the Physics & Astronomy Department (CAP Building, 2nd floor). |
| 1:00PM-1:45PM  | Business Meeting                                | NCS-AAPT business meeting in the Physics & Astronomy Department (CAP Building, Room 150). |
| 1:45PM-2:45PM  | Workshops and Panel Discussion                  | Workshops (CAP 108, Physics Demo Workshop; CAP 110, Amplitude Modulated Laser) and a Panel Discussion, “Physics Careers” (CAP 112) will be held concurrently. |
| 2:45PM-3:00PM  | Coffee Break                                    | Complimentary coffee and snacks will be offered. (CAP Building, outside Room 150). |
| 3:00PM-4:00PM  | Share-a-thon, Awards, and Closing Remarks       | Physics & Astronomy Department (CAP Building, Room 150).                     |
| 5:30PM-10:00PM | Dark Sky Observatory Tour                       | Walk-in tours and observation activities at the Dark Sky Observatory (DSO) which is located about 40 minutes (20 miles) from ASU, near the Blue Ridge Parkway. DSO has five telescopes for used research programs. The largest instrument there is the 32” DFM Engineering telescope. |
Dr. Charles Falco will be our plenary speaker, giving a talk on *The History of Art; The Science of Optics* - Discoveries about Renaissance paintings resulting from a collaboration with the renowned artist David Hockney. (Friday, 7:30PM, Solarium)

Charles Falco is a holds joint appointments in Optical Sciences and Physics at the University of Arizona, where he holds the UA Chair of Condensed Matter Physics. He is a Fellow of the American Physical Society, the Institute of Electrical and Electronics Engineers, the Optical Society of America, and the SPIE has published more than 250 scientific manuscripts, most of which are related to various physical properties of thin film materials, co-edited two books, has seven U.S. patents, and has given more than 400 invited talks on his research at conferences, research institutions, and cultural organizations in 27 countries. However, in addition to his scientific research, in 1998 he was co-recipient of an award from the AICA for his work as co-curatorial of the Solomon R. Guggenheim museum’s “The Art of the Motorcycle,” for which he also wrote the exhibition catalog’s introductory essay and bibliography. With over 2 million visitors in New York, Chicago, Bilbao, and the Guggenheim Las Vegas, it was by far the most successful exhibition of industrial design ever assembled, and is the 5th most attended museum exhibition of any kind. More recently, a collaboration with the artist David Hockney that found artists of such repute as van Eyck, Bellini and Caravaggio used optical projections in creating portions of their work has resulted in widespread coverage in the popular media, including an hour-long BBC special and a segment on CBS ‘60 Minutes’, and over 150 invited talks and public lectures on this topic in 21 countries.

Dr. Mike Falvo, Department of Physics and Astronomy, University of North Carolina - Chapel Hill will be giving a talk on *Protein Physics and Cell Mechanics*. (Saturday, 10:00-10:35AM, Beacon Heights)

Dr. Falvo received his undergraduate degree in Physics from the University of Illinois, Urbana-Champaign and his M.S and Ph.D. in physics from UNC-CH. His research interests include the study of nanoscale mechanical and electronic phenomena in contexts ranging from engineered electromechanical devices to biological systems. His current work focuses primarily in the area of nanoscale biophysics. In one project, he and his colleagues investigate the mechanical properties of the molecule fibrin, a protein that makes up the fibers that form blood clots. Another project focuses on understanding the mechanical operation of biological cilia. Falvo has taught and created several classes at UNC-CH including a First Year Seminar on nanoscience for which he received funding from the National Science Foundation. He is a recipient of campus-wide UNC-CH teaching award (SUTA), and is member of the UNC Academy of Distinguished Teaching Scholars. Falvo is also active in outreach and education efforts aimed at exposing nanoscience and nanotechnology concepts to middle and high school students. He recently completed a Math Science Partnership Project with Durham Public Schools that provided monthly professional development workshops for K-8 teachers focusing on physical science content knowledge.
Dr. Beth Cunningham, the Executive Officer of AAPT, will present AAPT: Building Better Physics Educators. (Saturday, 9:30AM, Solarium)

Beth is the Executive Officer of the American Association of Physics Teachers. She earned a Bachelor of Science degree, a Master of Arts degree, and a Doctor of Philosophy from Kent State University. After receiving her doctorate, Beth was a post-doctoral fellow at the Hormel Institute at the University of Minnesota. She taught for one year in the physics department at Gettysburg College immediately following her post-doctoral fellowship. In 1989 she joined the physics department at Bucknell University as an assistant professor, attaining full professor in 2002. She was named associate dean of the faculty in the College of Arts and Sciences in 2000. As a faculty member she involved students actively in her research and ran a Research Experiences for Undergraduate site. In 2006, she was appointed as Provost, Dean of the Faculty, and Professor of Physics at Illinois Wesleyan University. As provost, Beth initiated a strategic curricular review and revitalized departmental reviews to enhance academic programs. At AAPT since 2011, Beth provides leadership on a number of physics education initiatives including providing professional development opportunities for high school teachers of physics, supporting physics educators in higher education through workshops for new faculty and topical conferences, and the PhysTEC project to increase the number and quality of high school physics teachers. As a long time member of AAPT, she enjoys working closely with many members to improve physics teaching and learning at all levels. She has assisted AAC&U Project Kaleidoscope in developing STEM faculty leaders and CUR to incorporate undergraduate research into the curriculum. Beth’s current interests include the structure and function of phospholipid membranes, physics education research, and increasing the participation of underrepresented groups in physics.

Dr. Emily Edwards, giving a talk on Quantum Physics, the Next 100 Years, is from the Joint Quantum Institute, a collaboration between the University of Maryland and the National Institute of Standards and Technology (NIST). (Saturday, 10:00-10:35AM, Rough Ridge)

Emily Edwards received a Bachelor’s in both Physics and Chemistry from Appalachian State University in 2002 and a Ph.D. in Physics from University of Maryland in 2009. Her thesis work focused on constructing an apparatus to study disordered ultracold quantum gases. She joined Christopher Monroe’s Trapped Ion Quantum Information group as a postdoc and did quantum simulations using atomic ions. She is currently the Director of Outreach at the Joint Quantum Institute. Her role is to convey the research to the public through science writing, graphics, photography, and demonstrations.
Plenary Talks

**Topic:** The Science of Optics; The History of Art  
**Presenter:** Charles M. Falco  
**Affiliation:** University of Arizona, Tucson  
**Time/Location:** Friday, 7:30-8:30PM, Solarium  
**Abstract:** Recently, renowned artist David Hockney observed that certain drawings and paintings from as early as the Renaissance seemed almost “photographic” in detail. Following an extensive visual investigation of western art of the past 1000 years, he made the revolutionary claim that artists even of the prominence of van Eyck and Bellini must have used optical aids. However, many art historians insisted there was no supporting evidence for such a remarkable assertion. In this talk I show a wealth of optical evidence for his claim that Hockney and I subsequently discovered during an unusual, and remarkably productive, collaboration between an artist and a scientist. I also discuss the imaging properties of the “mirror lens” (concave mirror), and some of the implications this work has for the history of science as well as the history of art (and the modern fields of machine vision and computerized image analysis). These discoveries convincingly demonstrate optical instruments were in use -- by artists, not scientists -- nearly 200 years earlier than commonly thought possible, and account for the remarkable transformation in the reality of portraits that occurred early in the 15th century.(for more information see http://fp.optics.arizona.edu/ssd/art-optics/index.html)

Acknowledgments: This work was done in collaboration with David Hockney. We gratefully acknowledge David Graves (London), Ultan Guilfoyle (Guggenheim), Martin Kemp (Oxford U.), Masud Mansuripur (U. Arizona), José Sasián (U. Arizona), Richard Schmidt (Los Angeles), and Lawrence Weschler (The New Yorker) for a variety of valuable contributions to our efforts.

**Topic:** Building Better Physics Educators  
**Presenter:** Beth A. Cunningham  
**Affiliation:** American Association of Physics Teachers  
**Time/Location:** Saturday, 9:00-9:30AM, Solarium  
**Abstract:** The American Association of Physics Teachers (AAPT) has as its mission to enhance the understanding and appreciation of physics through teaching. Science, specifically physics, education has become increasingly important as the need for a technically proficient workforce and knowledgeable populace grows. The major activities of AAPT for supporting the development of highly qualified high school and university physics educators will be discussed.
Talks (10:00-11:30AM, Beacon Heights)

**Topic:** Protein Physics and Cell Mechanics  
**Presenter:** Mike Falvo  
**Affiliation:** University of North Carolina - Chapel Hill  
**Time:** 10:00-10:35AM  
**Abstract:** There is increasing emphasis in the biological sciences on the importance of a biophysical perspective. Researchers are looking at individual proteins, protein assemblies, organelles, and cells as mechanical actors in the complex machinery of the nano-biological world. Though we tend to think of proteins as biochemical actors on the stage of biology, they also perform amazing feats of mechanics, acting as motors, structural beams, springs, shock absorbers etc. For some of us, the physics of proteins can be more interesting than the biochemistry! To be relevant and successful, this kind of research requires expertise in multiple areas including biology, physics, and materials science; in some projects even expertise in applied mathematics, engineering and computer science is crucial. In this presentation I will give an overview of several projects in which I work as a member of a multi-disciplinary team of researchers - sometimes in a leading and sometimes in a supporting role. These projects attack biophysical questions in contexts ranging from blood clotting, to mucus clearance in the lung, to cell division and motility. As a physicist with experience in Atomic Force Microscopy and nanoscale force measurement techniques, my interests are in assessing the mechanical properties and operation of proteins, protein assemblies and cells. I will present results from a project focusing of fibrin fibers, the fibrous scaffold of blood clots. Progress will also be presented for another project investigating the mechanical operation of cilia, a microscale machine ubiquitous in biology. Finally, a project in which polymer physics is applied to models of cell division will be discussed. Weaved into the discussion of the scientific results, I will describe the experience of working with collaborators who speak different disciplinary languages, and at times even have differing views of the scientific process.

**Topic:** Computational Model of a Weak Spring in Uniform Circular Motion  
**Presenter:** Tom Dooling\(^1\)  
**Co-authors:** Matthew Carnaghi\(^2\), Jeff Regester\(^3\), and Aaron Titus\(^2\)  
**Affiliation:** \(^1\)University of North Carolina at Pembroke, \(^2\)High Point University, \(^3\)Greensboro Day School  
**Time:** 10:40-10:50AM  
**Abstract:** A computational model of a weak spring spinning in a circle has been written using Easy Java Simulations (EJS). The model calculates the spring extension in its quasi-static state. The model takes into account the spring mass, spring constant, rate of rotation, air resistance, and gravity. The model demonstrates the “Principle of Locality”. When the center of the spring is released, the outer end of the spring continues to move on its original circular path. This continues until a wave from the released end makes its way to the outer end. This phenomenon has been seen in real physical systems and was the motivation for making the computer model. The basic math behind the model will be covered and the model itself will be demonstrated under different initial conditions.
**Topic:** Video Analysis of a Weak Spring in Uniform Circular Motion  
**Presenter:** Matthew Carnaghi\(^1\)  
**Co-authors:** Tom Dooling\(^2\), Jeff Regester\(^3\), and Aaron Titus\(^1\)  
**Affiliation:** \(^1\)High Point University, \(^2\)University of North Carolina at Pembroke, \(^3\)Greensboro Day School  
**Time:** 10:52-11:02AM  
**Abstract:** Video analysis was used to measure the motion of a weak spring released from uniform circular motion, and results were compared to a computational model of the spring. It was found that the free end of the spring continues in uniform circular motion after the fixed end is released and before the spring fully collapses. The collapsing spring qualitatively follows the behavior predicted by the model. The collapsed portion of the spring and the stretched portion of the spring are along straight lines which intersect at an elbow or “kink”. As the spring collapses, this kink propagates down the stretched portion of the spring. We measured the equilibrium length of the spring, the time for the spring to collapse, the kink angle, and the kink speed. In this talk, the videos will be presented and results will be compared to predictions from the computational model.

**Topic:** The Brown Mountain Lights: a Scientific Investigation  
**Presenter:** Daniel B. Caton  
**Affiliation:** Appalachian State University  
**Time:** 11:04-11:14AM  
**Abstract:** The Brown Mountain Lights (BMLs) are an Earth-light phenomenon reported in the Linville Gorge area of North Carolina. We have been investigating the BMLs for over 15 years, trying to understand the physics involved in any light sources. We have investigated and dismissed the commonly found reports that they were seen by the Cherokees or by 1770s surveyor William Gerard de Brahm. After ruling out the vast majority of modern reports as misidentified natural or manmade lights, we feel that any real sightings, especially close-up encounters, may be of ball lightning, a poorly understood phenomenon in itself. We run two cameras, imaging Brown Mountain and the Gorge all night on every precipitation-free night. Images are posted to the Web in real time and to YouTube the next day. We hope to add a third camera to image from Wisemans View, with data pushed to the Web via long distance wi-fi.

**Topic:** A Few Techniques to Increase Retention of Women in STEM Programs  
**Presenter:** Rebecca Stamilio Ehret  
**Affiliation:** Edgecombe Community College  
**Time:** 11:16-11:26AM  
**Abstract:** STEM programs need to increase women and increase retention of students, both female and male. Simple techniques will be presented to increase retention of females in STEM courses. In addition to reaching, engaging, and retaining female students, implementing these techniques has also increased retention of male students. A retention plan for women in STEM, created by the author, has been recognized nationally by the Institute for Women in Trades, Technology, & Science (IWTTS) and will be discussed. Although this has been an ongoing personal project, recent funding for this project was made in part by the National Science Foundation (NSF).
**Talks (10:00-11:30AM, Rough Ridge)**

**Topic:** Quantum Physics, the Next 100 Years  
**Presenter:** Emily Edwards  
**Affiliation:** Joint Quantum Institute  
**Time:** 10:00-10:35AM  
**Abstract:** The birth of quantum mechanics kicked off a physics revolution in the early 20th century. When the theory was around 90 years old, mathematicians showed that a computational device based on quantum mechanics promised unprecedented capabilities for solving certain problems. Physicists, armed with this knowledge, are developing novel and practical quantum-based devices. While a full-scale quantum computer does not yet exist, the race for this technology has generated a vibrant research field. I will discuss recent developments, with a focus on research at the Joint Quantum Institute, where my role is to communicate quantum science to the general public and non-specialists.

**Topic:** The Sun in a Flash: A Quick and Easy Solar Imaging Lab  
**Presenter:** Mariah Birchard  
**Co-author:** David Sitar  
**Time:** 10:40-10:50AM  
**Affiliation:** Appalachian State University  
**Abstract:** The goal of this project was to test different cameras attached to an optical solar telescope to determine which would yield the best image of the Sun. This was accomplished by using a Coronado SolarMax II double stacked 60mm Hydrogen-Alpha solar telescope and three different cameras with similar pixel size and aspect ratios. The cameras used were an Orion StarShoot, which is an inch and quarter CCD eyepiece camera and two cell phone cameras: an iPhone 4s and a Nokia Lumia 521, which were both hand held to the back end of an actual 20mm eyepiece inserted into the Coronado. Surprisingly, the results showed that the Nokia 521 cell phone captured the best image compared to the other two cameras. This presentation will illustrate the imaging procedures, the results obtained and conclude with how using a cell phone can easily be adapted to a solar lab exercise or small classroom activity.

**Topic:** Physics Prior to the 16th Century  
**Presenter:** John L. Hubisz  
**Affiliation:** North Carolina State University Physics Department  
**Time:** 10:52-11:02AM  
**Abstract:** Many folks think and many textbooks seem to agree that physics began with Galileo, or perhaps Kepler. I will provide a bit of history that clearly shows that both Galileo and Kepler “stood on the shoulders” of a rich heritage of scientists.
Talks (10:00-11:30AM, Rough Ridge)

**Topic:** Writing Electronic Books with Interactive Curricular Material  
**Presenter:** Mario Belloni  
**Co-authors:** Wolfgang Christian and Kristen Thompson  
**Affiliation:** Davidson College  
**Time:** 11:04-11:14AM  
**Abstract:** With the rise of tablets, such as the iPad, the past few years has seen an increase in the demand for quality electronic textbooks. Unfortunately, most of the current offerings do not exploit the accessibility and interactivity that electronic books can deliver. For astronomy and physics electronic textbooks, support for typesetting of equations (MathML) and interactive simulations (JavaScript) are necessary. In this talk, we will discuss how our curriculum development projects (Physlets, Easy Java/JavaScript Simulations, and Open Source Physics) are merging with the EPUB electronic book format. Specifically we will discuss the EPUB format and how we are taking an iterative approach to producing interactive electronic books for astronomy and physics.  
This work was supported, in part, by an Innovation Grant from Davidson College.

**Topic:** The Art of Teaching: Thermodynamics 101  
**Presenter:** Mookesh Dhanasar  
**Mentors:** William Edmonson, Frederick Ferguson, and Aaron Titus  
**Affiliation:** North Carolina Agricultural and Technical State University  
**Time:** 11:16-11:16AM  
**Abstract:** This paper looks at some of the challenges and teaching methods used in an undergraduate “Introduction to Thermodynamics” class with 101 students. It consists of students from the Mechanical, Civil and Architectural Engineering Departments. This is an essential fact as you do not only have a large number of students, but also students with different paths/trajectories. It is important to consider these facts, because, at the end of the day, you want to be as fair as possible to all of your students without compromising the integrity of the principles being taught. These facts are taken into account when preparing class lectures, assigning homework, designing examinations, and encouraging class engagement and discussions. We will look at how homework are assigned and used to promote learning and motivation, how exams are designed to be as fair as possible to students with different learning styles, and present data on student class performance.
Title: Feline Statistics
Presenter: Patricia E. Allen
Affiliation: Appalachian State University
Abstract: Teaching statistics to life sciences students or upper level physics majors contains many challenges because of terminology and the connections between theory and application. Statistics associated with the domestic cat, both owned and feral, highlight the strengths and limitations of small and large number statistical practices. The effect of initial conditions and assumptions on animal control policies or estimating annual costs of pet ownership shows how statistics can support or dispute claims made by commercial or governmental agencies. Examples of using feline statistics in the classroom will be provided.

Title: Band of Solar Gypsies
Presenters: Angela Blatchley and Andrew Eagle
Co-Author: David Sitar
Affiliation: Appalachian State University
Abstract: The Appalachian State University Academy of Science’s solar outreach corps, funded by the National Science Foundation, connects with individuals by bringing telescopes to those who may be unable to experience the field of astronomical sciences. The program extends to all ages, creating a unique atmospheric blend of historical, observational, and the future of solar astronomy. The focus is to provide an opportunity for the public to observe the Sun using different technologies including a heliostat and sundial, along with parabolic mirrors that capture the Sun’s energy to display the power radiated. In addition to these historical apparatuses, we demonstrated techniques of viewing the Sun safely in different wavelengths, using telescopes equipped with white-light and Hydrogen-alpha filters. We were able to successfully communicate the complexity of solar surface features by giving a forty-five minute PowerPoint presentation defining the mechanics, then having an hour long guided tour at each of the solar viewing stations.

Title: Development of Infrared Transmitter and Receiver Unit for Use in Middle School Science
Presenter: Fredric W. Booth
Co-Author: William D. Brandon
Affiliation: University of North Carolina at Pembroke
Abstract: The purpose of this project was to develop an infrared transmitter and receiver unit to demonstrate the transmission of music through infrared light. The unit had to be relatively simple to assemble. The unit must also be capable of accepting both mono inputs (such as from a digital note recording device) and stereo inputs (such as from a computer output). Another consideration was the transmitter unit had to be independent from the receiver unit. After prototyping and a few modifications to the design, the finished product worked quite well. The units will become a valuable teaching tool for middle school science education.
Title: Principles of Economical PC-Based Laser Transmission and Reception of Audio Frequencies  
Presenter: Fredric W. Booth  
Co-Authors: Austin M. Griffin and William D. Brandon  
Affiliation: University of North Carolina at Pembroke  
Abstract: Incorporating PC-based electrical parameters into electronic device design leads to economically integrated systems. After all, exploiting (hacking) ubiquitous devices can lower the cost of just about any technology. This project focuses on maximizing simplicity in design and minimizing the expense of PC-driven laser diode transmitters and photodiode receivers. Two simple schemes describing electro-optical sound modulation and detection, each costing less than ten dollars per unit, provide simple, inexpensive, user-friendly, and very popular demonstration modules.

Title: Nanoscale Thermal Analysis of Organic Semiconductors  
Presenter: Jesse Brown  
Co-Authors: Kyle Kelley¹, Cortney Bougher¹, Brad Conrad¹, Patrick Heaphy², Chris Cholison², Susan Spenser², Jeremey Cody², and Tonya Coffey¹  
Affiliation: ¹Appalachian State University and ²Rochester Institute of Technology  
Abstract: Organic materials are solid yet flexible materials that can be deposited by solution or roll-to-roll ink printing technologies. Mass production of flexible photovoltaics on plastic or glass sheets would result in huge cost reductions over silicon devices, making organic electronics important economically, strategically, and environmentally. The active component of organic solar cells, the bulk heterojunction (BHJ), is usually made by the blending of two different types of semiconductors in the film: those that transport either electrons or holes well. We study BHJs with localized high charge mobilities and advantageous phase separation morphologies to improve organic solar cells performance through systematically varying annealing times and temperatures to influence phase separation, local crystallinity, and macroscopic crystallization. We examined DiPSQ[OH]2-PCBM blends fabricated at RIT. Our research uses atomic force microscopy (AFM), which measures topography, in conjunction with a Nanoscale Thermal Analysis (NanoTA) system from Anasys Instruments.

Title: A Parallel Computational Model of 2-Body Planetary Orbits  
Presenter: Samuel T. Castle  
Co-Author: Wolfgang Christian  
Affiliation: Davidson College  
Abstract: The study of two-body orbits is a common practice with many realistic applications and examples, yet the ability to accurately model the interactions of large, dynamic planets via computer simulation remains an area of current research. We propose a computational model based strictly on fundamental physical forces between numerous spherical particles. We show that our model is a valid representation of the natural world by confirming the conservation of energy, linear momentum, and angular momentum in closed systems. Using our model, we investigate the development of tidal locking between two planets over the course of many orbits. In future research, we intend to study large-scale collisions with our model, eventually examining the popular giant impact hypothesis - the conjecture that a long-ago collision between the Earth and another planet detached a chunk of mass from the Earth to form the moon.
Title: The Public Nights Program at Appalachian State University’s Dark Sky Observatory  
**Presenter:** Daniel B. Caton  
**Affiliation:** Appalachian State University  
**Abstract:** We have completed two and a half years of public nights at our Dark Sky Observatory’s 32-inch telescope and the adjacent Jo & Don Cline Visitor Center. Our monthly public nights are composed of two groups of 30-60 visitors each that arrive for 1.5-hour sessions. Shorter summer nights limit us to one session. We use two large (70-inch) flat panel displays in the Center for a brief pre-observing PowerPoint discussion and to entertain visitors while they await their turn at the telescope’s eyepiece. One of the displays runs a version of Microsoft’s Worldwide Telescope or Kinect. While the facility is fully ADA compliant, with eyepiece access via a DFM Engineering Articulated Relay Eyepiece, and a wheelchair lift if needed, we have only had one occasion to use this capability. We present some of our experiences in this poster and encourage readers to offer suggestions.

Title: Driven to Distraction: Does the Infamous Earth Shadow Distractor Divert Student Attention?  
**Presenter:** Daniel B. Caton  
**Affiliation:** Appalachian State University  
**Abstract:** The cause of the Moon’s phases is a concept that is known to be a problem for astronomy students, with many thinking incorrectly that they are caused by the shadow of the Earth. I repeat this question from the first exam in the two-semester Introductory Astronomy course, through the final exam of the second semester, for a total of eight appearances. It occurred to me that the inclusion of the shadow distractor in these multiple choice questions may actually reinforce the misconception by repeatedly distracting the student to the familiar but wrong answer. I am running an experiment to see if this is happening. I give different forms of the question to half the class for all regular exams after the first one, with half the class not getting the shadow distractor. I then offer the shadow distractor to the whole class for the two semesters’ final exams.

Title: A Simple Method to Verify Faraday Rotation in Air  
**Presenter:** Alex C. Foster  
**Co-Authors:** Lynn R. Wardell, Austin M. Griffin, and William D. Brandon  
**Affiliation:** University of North Carolina at Pembroke  
**Abstract:** The ongoing evolution and increasing sensitivity of magneto-optical polarimetric measurement techniques continue to attract attention. In exploring various high precision measurement schemes, we attempted to measure the Faraday rotation in air using a straight-forward phase sensitive detection technique suitable for an undergraduate lab activity. The method involves using a lock-in amplifier to measure light intensity modulation induced by an alternating current magnetic field. Encountering intrinsic signal-to-noise ratios approaching the ideal detection limits of the experiment prevented the magnitude of the rotation from being extracted from the data. Nevertheless, the data indicated the presence of Faraday rotation - as verified by a consistent and reproducible increase in signal with interaction length and magnetic field strength.
Title: Using Openstaxcollege.org Physics for Pre-Medicine Students  
Presenter: Don Franklin  
Affiliation: Spelman College and Mercer University  
Abstract: This online textbook allows for the Professor to start with Medical Applications of Physics and Nuclear Medicine. That way the students see physics as a value rather than a “hurdle” to jump on their way to a medical career. This format allows for the building of information from the previous science courses that the student has taken. After this introduction, it is easier to follow the interdisciplinary needs of today’s students.

Title: A Proportional-Integral Current Controller for Laser Diode Stabilization  
Presenter: Austin M. Griffin  
Co-Authors: Lynn R. Wardell and William D. Brandon  
Affiliation: University of North Carolina at Pembroke  
Abstract: In order to investigate current feedback control of p-n junction devices, a PI (proportional-integral) laser diode current controller was designed, built and tested. A laser diode output beam is split and the reflected portion of the beam is used for feedback control via a photodiode. The signal is processed, in analog form, by an op-amp network to modulate the laser. The amplitudes of the proportional and integral feedback circuits are then tuned to minimize the standard deviation of the laser diode intensity. Several direct methods of laser diode stabilization are compared to each other and to the final working version of the PI controller. The feedback design lends itself quite naturally to other applications in addition to laser diode stabilization.

Title: User Friendly Diode I-V Characteristic Module  
Presenter: Austin M. Griffin  
Co-Authors: Lynn R. Wardell and William D. Brandon  
Affiliation: University of North Carolina at Pembroke  
Abstract: In meeting the objectives of a project assignment in an introductory electronics course, a nearly fool-proofed device (i.e. a robust module) allowing the user a quick and straightforward method to obtain I-V characteristics of various selected diodes was designed, constructed, and tested. Designed to maximize robustness while minimizing cost (< $15), the USB powered unit contains a variety of both signal and light emitting diodes. Data may be acquired in a hands-on fashion, without the overhead associated with conventional testing and measuring equipment. For the sake of instructional convenience, such a device can be seamlessly integrated into an online, homework, or “make-up” lab activity – assuming the student has a voltmeter.
Title: Exploring Eratosthenes in High School Astronomy  
Presenter: Thomas Hefner  
Affiliation: Eastern Guilford High School  
Abstract: There are recorded attempts to measure the size of the earth dating back to at least the time of Eratosthenes in the third century BCE. A first year high school astronomy class attempted to reproduce the results of Eratosthenes in a similar manner using the angle of the sun by measuring the lengths of shadows cast by ring stands commonly found in a high school chemistry class. A separate class near Miami, FL recorded data in a similar manner to determine the sun angle at their location. The polar circumference of the earth was then determined using the difference in the two angles. Besides the direct science and mathematics lesson involved, the activity also involved the use of various media to produce a memorable activity. This culminated in a 23-minute video produced in a humorous style that is being used to promote astronomy at the school.

Title: Simple Interactive 3D Visualization of Electric Fields in Introductory Physics  
Presenter: Michael Hester  
Co-Authors: Joe Heafner, Matthew Fisher, Steven Lee, Stephanie Moore, Mark Piotrowski, and Michael Wilkins  
Affiliation: Catawba Valley Community College  
Abstract: In this poster, we present a suite of open source simulations and accompanying library developed with VPython (http://vpython.org) for visualizing electric fields of common charge distributions found in introductory calculus-based physics. The simulations use a custom library called mandipy3 that abstracts most of the computation into functions with easy to remember names and calling parameters. The mandipy3 library may be an appropriate option for classes in which students are not expected to learn detailed programming or for classes in which students have mastered the introductory programming and want a quicker way to develop simple, interactive visualizations.

Title: Exploring Charge Dependence of the Strong Force by Modeling Neutron-Proton Scattering  
Presenter: Jason Howard  
Co-Author: Deepshikha Shukla  
Affiliation: University of North Carolina at Greensboro  
Abstract: In nature, we find four fundamental forces: the strong, weak, electro-magnetic, and gravitational. The strong force, as the name implies, is the strongest at nuclear range. The strong force in the low energy regime is mediated by the pion. The strong nuclear force is largely charge-independent, but this symmetry is broken in nature as evidenced, for example, by the existence of \( \pi^0 \) and \( \pi^\pm \) with different masses. To explore charge-independence breaking, we examined the phase-shifts in neutron-proton scattering. To analyze the differences in the two scattering processes, an effective NN potential was created to match phase shifts for the charged pion exchange in neutron-proton scattering. These phase-shifts were obtained from the PWA-Nijm93 (www.nn-online.org). This potential was then used to predict phase shifts for neutron-proton scattering with only neutral pion exchange.
Posters

Title: Using the Spectral Method to Relate Quantum Half Wells
Presenter: Steven Keller
Co-Author: Mario Belloni
Affiliation: Davidson College
Abstract: It is common practice in quantum mechanics to use the eigenfunctions of a given potential well as the basis for a superposition of states to construct wave packets. Less often, the eigenfunctions of one well are used as the basis for determining (via the spectral method) the eigenfunctions of a different, but related, quantum well. In order to better understand these two methods, we consider how two “half wells” (potential wells with one infinite boundary at x=0) are related. The two half wells we consider are the linear potential of the so-called quantum “bouncer” and the half harmonic oscillator (HHO). Specifically, we use bouncer eigenfunctions as a basis for the HHO eigenfunctions and the HHO eigenfunctions as the basis for the bouncer eigenfunctions. We will demonstrate this method and evaluate its effectiveness in terms of computational time and overall accuracy.

Title: Physics in Non-Inertial Reference Frames
Presenters: Junjie Liao and Amiras Simeonides
Co-Author: Aaron Titus
Affiliation: High Point University
Abstract: This project focused on creating classroom-friendly videos of motion in non-inertial reference frames where fictitious forces are required in order to apply Newton’s laws. To explore motion in a linearly accelerating frame, we attached a camera to a fancart which accelerated down a track, and we recorded video of a neighboring fan cart accelerating down a parallel track at a lower rate. To explore motion in a rotating frame, we attached a camera to a rotating turntable and rolled a steel ball across the turntable. We collected data on the ball’s motion from one video camera in the rotating reference frame and from a second camera in the lab frame. We analyzed the videos from each experiment using the video analysis software Tracker to determine mathematical models for each force. We created simulations of the motion in each frame in VPython. Results from both the video analysis and the corresponding computational models will be compared and discussed.

Title: “Finding Physics” to Impact Student Learning and Increase their Recognition of the Relevance of Physics outside the Classroom
Presenter: James R. Perkins
Co-Author: Judith A. Beck
Affiliation: University of North Carolina at Asheville
Abstract: The “Finding Physics” project is designed to improve our introductory students’ critical thinking skills and combat the common misconception that the course content is unrelated to their lives or career interests. First, students present visual evidence of examples of physics they have encountered in their everyday lives, the popular media, or their other courses. They ask a quantitative question related to each example, determine what assumptions and data are necessary to model the problem, and subsequently solve it using the knowledge and skills they are developing in class. Finally, students reflect on their answers and communicate their results to their peers. We have collected data from student self-assessments of learning gains and attitudes for a total of four semesters of the project, including both algebra- and calculus-based introductory sequences. Overall, students report a positive impact on their learning, their recognition of the relevance of physics, and their critical thinking skills.
Title: EJS and the Arduino
Presenter: Aidan Rogowski
Co-Author: Wolfgang Christian
Affiliation: Davidson College
Abstract: The Easy Java Simulations (EJS) modeling tool has recently been extended to support data acquisition and experiment control. Using inexpensive Arduino and Phidget single board microcontrollers, EJS can precisely control motors, servos, sensors, and TFT screens attached to the board. This poster describes a simple Arduino-based project to control the temperature of a thermal mass with a heater. The heater and temperature sensor are connected to an Arduino that is controlled by an EJS program through a serial connection. We describe how the Arduino+EJS combination is a versatile tool that can collect, analyze, and display data in real time for a wide range of laboratory and teaching goals.

Title: Fluorescence Decay Measurement Apparatus
Presenters: Al Scher and Scott Dickerson
Co-Authors: Anthony G. Calamai, Jennifer L. Burris, Brooke C. Hester
Affiliation: Appalachian State University
Abstract: The characteristics of ruby (Al₂O₃:Cr) are observed when excited by electromagnetic radiation. It is well known that rubies fluoresce when exposed to visible light. After the electrons of the chromium atoms in ruby become excited from the ground state to the 2E metastable state by the incoming light, the chromium electrons decay and return to the ground state within the lifetime \( \tau \). When the decay occurs, light is emitted causing the ruby to fluoresce. During this process, we determine an average decay lifetime by measuring the rapid decrease in intensity of the fluorescence with time. This poster presents a fluorescence decay measurement apparatus that is being developed for use in the senior capstone course in the Physics & Astronomy Department at Appalachian State University.

Title: Introducing Research Problems in Theoretical Physics to Undergraduate Students - My Experience
Presenter: Deepshikha Shukla
Affiliation: University of North Carolina at Greensboro
Abstract: It is often perceived that theoretical physics research is complicated and hence inaccessible to undergraduate students. This rarely means that undergraduate students are not interested in such research, especially if there is an associated computational aspect. There are few examples of the success of such research. My belief is that it is up to the faculty to make such projects accessible to students. Here I present a different perspective on making theoretical research possible in an undergraduate institution. I focus on the techniques and skills and how they may be translated to different research areas in Physics. With basic grounding in calculus and computational techniques, these skill-sets can be used across many fields. I have two students working on “Low-energy Nuclear Physics” and a third one on “Physics of Protein Folding”. I will present my experience with these projects and how such an approach will better prepare our undergraduates.
Title: Single Photon Interference as an Undergraduate Pedagogical Resource  
Presenter: Jacob Simmonds  
Co-Authors: Wolfgang Christian and Timothy Gfroerer  
Affiliation: Davidson College  
Abstract: Undergraduate teaching of quantum mechanics has tended to remain a largely theoretical area with few experimental examples. New methods are being developed to display these concepts, particularly by Dr. Beck and the Department of Physics at Whitman College, and these demonstrational experiments may be critical for undergraduate classes. We demonstrate that any undergraduate school can build and perform these experiments in a cost-effective manner and produce results that display several core quantum mechanical properties. We display that single photons behave as classical waves by interfering with themselves while traversing an interferometer. Our experiment involves the ideas of quantum entanglement and non-locality through measuring the coincidence counts of the downconverted signal and idler photons, which further immerses students in these theoretical concepts.

Title: A Low Cost Approach to Educational and Experimental Laser Construction  
Presenter: Jackson Spell  
Co-Authors: Wolfgang Christian  
Affiliation: Davidson College  
Abstract: This poster describes the construction of a He-Ne laser using a laser tube with Brewster angle windows and off the shelf components for the optical cavity. This low power laser can be used in a wide variety of experiments at all levels of instruction. For example, the laser can produce different longitudinal and transverse modes and it can produce different wavelengths by changing the mirrors. The system is inexpensive, and its construction is a useful hands-on exercise that teaches the principles of laser physics.

Title: Exploring Physics at the Nanoscale  
Presenter: Krithika Venkataramani  
Affiliation: University of North Carolina at Wilmington  
Abstract: “There is plenty of room at the bottom” was the opening line of a talk by the famous physicist and visionary, Richard Feynman, in 1959, describing the then elusive world of matter at very small (nano) scale. Half-a-century later, Feynman’s vision has indeed come true with the advent of Nanoscience and Nanotechnology. A study funded by the NSF predicts that by 2020, six million nanotechnology workers will be needed worldwide with two million in the USA alone. Many efforts are currently underway to engage students in exploration of nanoscience topics in high school and undergraduate institutions using affordable bench-top state of the art nanoprobes. I will present in my poster various aspects of nanoscience and physics at the nanoscale; current state of nanoscience research; and finally, some successful initiatives undertaken by universities to integrate hands-on nanoscience activities in their existing curriculum.
Workshops

**Topic:** Physics Demo Workshop  
**Presenters:** Tyler Foley, Matt Pegram, Ian Newsome  
**Affiliation:** Appalachian State University  
**Location:** CAP Building, Room 108  
**Abstract:** This workshop will introduce the participants to several unique and exciting physics demonstrations. Upon completion of the 30 minute discussion, participants will be invited to come forward and interact with the demonstrations presented. Demonstrations presented will include but are not limited to aluminum can crusher, ping pong cannon, gravity well, and shampoo fountain. The aluminum can crusher demonstrates the power of eddy currents by tearing apart a soda can with magnetic fields. The ping pong cannon uses negative vacuum pressure to propel a ping pong ball. The gravity well models gravitation interactions using weighted balls and a large spandex sheet. The shampoo soap fountain uses falling soap and a laser to demonstrate static electric effects, total internal reflection and the Kaye effect. These demos and several more shall be presented.

**Topic:** Amplitude Modulated Laser (Make and Take Option)  
**Presenters:** W.D. Brandon  
**Affiliation:** UNC-Pembroke  
**Location:** CAP Building, Room 110  
**Abstract:** The amplitude modulated (AM) laser design used in this workshop strives for the most economical audio laser transmission and reception possible. Participants will assemble and test their own final product consisting of a robust USB powered and PC (or iPhone/MP/3/etc.) AC driven, sound modulated laser device with transmitter and receiver of surprisingly high fidelity. Always “a hit” as a demo item, the laser may be incorporated into a variety of lab activities, outreach, and demonstrations – and described at different levels. The workshop is free but the cost to keep an AM laser transmitter and receiver is $8.00 to cover the expense of the parts.
# Event Locations

<table>
<thead>
<tr>
<th>Event Site</th>
<th>Days</th>
<th>Parking</th>
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<tbody>
<tr>
<td>Pleemmons Student Union</td>
<td>Friday and Saturday</td>
<td>College Street Parking Deck</td>
</tr>
<tr>
<td>263 Locust Street</td>
<td></td>
<td>(free after 5pm Friday and all day Saturday)</td>
</tr>
<tr>
<td>Boone, NC 28608</td>
<td></td>
<td>(Long. 81°40’46.77” W</td>
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<tr>
<td>#54 on the campus map</td>
<td></td>
<td>Lat. 36°12’56.96” N)</td>
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<tr>
<td>(Long. 81°40’41.43” W</td>
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<tr>
<td>Lat. 36°12’52.01” N)</td>
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</tr>
<tr>
<td>Physics &amp; Astronomy Department</td>
<td>Friday and Saturday</td>
<td>Rivers Street Parking Deck</td>
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<tr>
<td>CAP Science Building</td>
<td></td>
<td>(Parking validated Friday for Department Tours, free Saturday)</td>
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<tr>
<td>525 Rivers Street</td>
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<td>461 Rivers Street</td>
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<tr>
<td>Boone, NC 28608</td>
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<td>Boone, NC 28608</td>
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<td>#31 on the campus map</td>
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<td></td>
<td>(Long. 81°40’50.89” W</td>
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<td>Lat. 36°12’45.43” N)</td>
<td></td>
<td>Lat. 36°12’42.84” N)</td>
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<tr>
<td>-OR- CAP Parking Lot</td>
<td></td>
<td>(unavailable before 5pm on Friday, free otherwise)</td>
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<tr>
<td>The lot is located behind the CAP Science Building.</td>
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<td>(Adjacent to #30 on the campus map.)</td>
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<tr>
<td>Rankin Science Observatory (RSO)</td>
<td>Friday</td>
<td>Rivers Street Parking Deck</td>
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<tr>
<td>Rankin Science Building</td>
<td></td>
<td>(paid Friday, free Saturday)</td>
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<tr>
<td>572 Rivers Street</td>
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<td>461 Rivers Street</td>
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<td>Boone, NC 28608</td>
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<td>Lat. 36°12’50.27” N)</td>
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<td>Lat. 36°12’42.84” N)</td>
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<tr>
<td>Dark Sky Observatory (DSO)</td>
<td>Saturday</td>
<td>Free parking is available at DSO</td>
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<td>see <a href="http://dso.appstate.edu/sites/dso.appstate.edu/files/Directions.pdf">http://dso.appstate.edu/sites/dso.appstate.edu/files/Directions.pdf</a></td>
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### Handicap/Disability Parking

Please contact the organizing committee at ncsaapt@appstate.edu if you need accessible parking.

### Detailed Directions to Registration Desk

If you are arriving after 5pm on Friday or on Saturday morning, the easiest way to get to the registration desk is to use the following physical address for your GPS: 375 W King St, Boone, NC 28607. Click here for a Google Map. This is the address of the First Baptist Church in Boone, which sits on the corner of King Street and College Street. Turn onto College Street. After about a tenth of a mile you will come to a very small roundabout. On the right side, there will be the College Street Parking Deck. Parking is available here for free after 5pm on Friday and all day Saturday.

Once you exit the parking deck on foot, there will be student volunteers and an abundance of signs to guide you to the Student Union and then to the registration desk. The walk from the Parking Deck to the registration desk is about 3-5 minutes.
Local Organizing Committee

Michael Briley
Jennifer Burris
Brooke Hester
Karl Mamola
David Sitar

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