

# The Dilated Times

The newsletter of the Drew University Society of Physics Students

Spring 2005 Volume 15 Number 2

Editor: Jackie Haynicz

## SPS Zone Meeting at TCNJ

On February 26<sup>th</sup> students and faculty from Drew's physics department traveled to the Society of Physics Students Zone meeting held at The College of New Jersey (TCNJ). The event was co-hosted by Drew, and provided a chance to meet physics students from other schools. The day was filled with lectures, student presentations, a tour of TCNJ's facilities, and an informative panel of guest physicists currently employed in various industries.



Tina talks about our SPS chapter at lunch

still being researched. This was followed with a presentation by Dr. Gary White, the Director of SPS and Sigma Pi Sigma. His humorous and informative presentation centered on the theme of the world year of physics; why this year, why Einstein, and what one can do with a physics degree in our day and age. Witnessing Dr. White's remarkable enthusiasm for Einstein's work helped give the audience a more appreciative idea of why 2005 has been declared the World Year of Physics.

After Dr. White's presentation, Sean Elmes of TCNJ and our own Tina Aragona gave presentations on research projects they had done. Sean's involved the use of a piezoelectric metal fiber to make "muscles" for robots, and Tina presented her work on binary stars (See "Tina Does an REU", The Dilated Times Vol. 15, No. 1).

The assembled meeting then broke for lunch, which was held in one of the TCNJ physics labs. During lunch, Dr. Fenstermacher encouraged representatives from each college to tell the group what their chapter of SPS had done recently. Lunch was followed by a tour of TCNJ's physics facilities. The group was led by students from TCNJ's physics department through the optics lab, new

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## Einstein's Miraculous Year



The World Year of Physics 2005 celebrates the one hundredth anniversary of Albert Einstein's so-called "annus mirabilis," the year during which he wrote five papers that changed physics irrevocably. What did he do and how did he do it?

The answer to the first question is easy; it is a matter of historical record. The second question is much more difficult. Certainly Einstein was a man of high intelligence, unusual physical insight, and unshakeable self-confidence. But what is remarkable is that he was only twenty-six at the time, still a graduate student and a

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*Disappointed you can't endow a faculty chair?  
Or buy a wing in a new science hall?  
How about a lab stool?*



*Imagine a student next year sitting in your named lab chair in advanced lab!*

This unique opportunity comes to you as the physics department boldly embarks on its lab stool initiative to upgrade the 37 year old lab stools in the electronics, introductory, and advanced physics labs. Over the next year new, more ergonomic laboratory seating will replace our current stools, each task chair providing a place for your name and year (or an honoree) on an engraved plaque. Put a check in the mail to become the first on your block to take advantage of this exceptional offer. Your Drew contribution can go directly to the needs of the physics department. Chair orders will begin this spring.

\*\*\*\*\*

Name: \_\_\_\_\_ Year: \_\_\_\_\_  
Address: \_\_\_\_\_  
E-mail: \_\_\_\_\_

To endow a laboratory chair, send this coupon and a tax-deductible check for \$200 (yes, lab stools actually cost this much) for each chair made out to "Drew University Department of Physics", and mail to:

Dr. Bob Fenstermacher, Department of Physics, Drew University, Madison, NJ 07940

# A Fresh(man's) Perspective on the Drew Physics Experience

Around this time last year, I timidly walked the corridors of the Hall of Sciences for the very first time. I was in a tour group with a bunch of other high school seniors, and I lingered in the back as my guide rambled on about the greatness of the RISE program. I remember peeking into a lecture hall at the rows of desks with disappointment as my guide explained that introductory science classes were sometimes rather large in comparison to the other classes offered at Drew. I also remember wandering through a laboratory, wondering if I'd ever feel confident enough to actually accomplish anything in such a professional looking room. I stood in the hall, and being very intimidated by the serious atmosphere around me, began to rethink my decision to pursue physics as (gulp!) a major.

A month later, everything was finalized, and it was inevitable that if I wanted to study physics, I would be skulking around the Drew laboratories trying to avoid directing attention to myself, praying I wouldn't break anything. But then, a curious thing happened. I got a personal greeting card in the mail from a girl who at that time was a senior in the physics program. She had actually taken the time to send me a card (handwritten I might add!) welcoming me to the program, and telling me how much fun it was to be a physics major. As I sat there in surprise, an email popped up from some very distinguished and scary sounding guy from Drew- Dr. Fenstermacher. I nervously read the email, and also to my surprise, found myself smiling as I read. This guy Dr. Fenstermacher sounded so nice and down to earth! The head of the department was actually excited that I was interested in physics and glad I was coming to Drew!

After the email and the card, I wasn't quite so nervous about pursuing physics, but as I walked into Dr. Supplee's intro physics class, I still felt like the butterflies in my stomach had

somehow gotten a sugar high and decided to throw a party. As I perched on the edge of my seat, I began to look around. The room had about half the number of kids my high school physics class had! "So much for large classes..." I said to myself with a grin. Later on in the class, Dr. Supplee jumped onto the desk in the front of the room and in a loud voice declared, "And we will NOT be concerning ourselves with significant figures in this class!" I laughed and realized how far off my preconceived notion of stuffy physics professors had been.

Later that week, it was time for the dreaded three (three?!) hour lab. In high school, my teacher gave us labs with hardly any directions at all, and nothing on the lab tables, saying that in college we'd be completely on our own for lab so we'd better get used to it. I walked into the room, and to my relief, everything we needed was provided. This year, I wouldn't have to pull an airtrack out of a box from the closet and figure out by chance how to set it up! We actually have lab manuals, and are given an introduction to each lab by the professor! By the time the first month had gone by, I felt like a pro.

By the end of the first semester, Dr. S had cooked hamburgers on a grill for all the physics majors at the fall barbeque at Dr. F's house. And I had opened presents at a holiday party and watched my professors play with all kinds of toys. I had sat on Dr. F's basement floor in a giant circle of fun-loving, laughing people who just happened to be into physics, and made tacos. And I had watched as Dr. S perilously swung a flimsy bucket full of water over his head- tempting fate not once but three times! A semester later and the dreaded world of Drew physics is my home. And as for stuffy professors? Impossible classes? Feeling lost in the crowd? I can't believe I'd ever associated that with physics!

Laura Barclay '08

## SPS Zone Meeting

(Continued from page 1)

planetarium, and two separate observatories.

When the group reconvened, Dr. F led a panel discussion (entitled "Life after the BA/BS in Physics") with four guest physicists, including Dr. Amy Perkins (Drew '94). Members of the audience were given the opportunity to ask questions on everything from succeeding in graduate school to actually finding a career with a degree. For any student seriously considering a degree in physics or graduate school thereafter, this was a wonderfully educative discussion.

The day ended with some brief student presentations. Nate Woodward presented his summer work on the diffraction efficiency of organic polymer films (See "Nate Does DSSI", The Dilated Times Vol. 15, No. 1), and students from other schools presented on a myriad of other topics. This concluded the Zone meeting, which was a n and informative day for all.

David Newby '08

## Physics 11 Dr. Supplee Quotes:

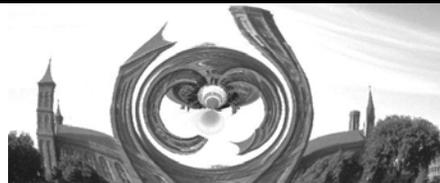
"I tend to go non-linear on people who make up forces."

"Don't call Omega 'w'. It makes it sound like you haven't gone to school."

(Solving a differential equation:)  
Prof. Supplee: "What's wrong?"  
Laura Barclay (Points at her paper):  
"I don't understand where this came from"

Prof. Supplee: "What do you mean?? It came from your pencil!"

"I sometimes wonder how intellectual history might've played out differently if the Greeks had air hockey."



The Castle on the Mall in Washington, D.C viewed normally and through the gravitational lens of a black hole with the mass of Saturn over the middle

## Tina Says Goodbye to Drew

Every year, the senior physics majors write a sort of Senior Goodbye article for the Dilated Times. Past students have discussed plans for the future and favorite memories from their years as physics majors at Drew. And now, I find that it is time to write my own goodbye...which, I must admit, feels a bit odd at the moment. In part, the feeling comes from that fact that, while I realize I will be graduating in month, I don't think it has truly hit me that my time here at Drew is ending. Of course, life doesn't stop simply because change is looming around the corner. I am just as busy with schoolwork and clubs as ever, leaving me little time to dwell on the future, although I'm beginning to form some ideas about the direction I would like to go in the years ahead.

Still, it has been odd to attend SPS events and think "This is the last time I will ever do this." I can still remember when I was a freshman and unsure about attending SPS events, not sure if I belonged there. That feeling quickly faded once I attended my first holiday Taco party. The grab bag in a way served as the ultimate icebreaker, as everyone compared gifts and attempted to make them work. The Orbitron was the popular item that year, and I still have mine sitting in my desk at home. Over the next four years, I had the opportunity to get to know physics majors in the classes above and below me. The small department at Drew has created a group which transcends grade levels. We are not so much majors in the class of '05, '06, or any other year, but simply physics majors. Classes are small enough that the entire group can meet for study sessions.

There is a real sense of camaraderie among many of the majors, and I will be sad to leave this friendly group.

I will also be sad to have finished my physics classes at Drew University. We have some truly wonderful professors here. They are always ready to help students both inside and outside the classroom, be it homework help or advice on REU applications and plans after college. Through the classes I have taken with them, I have learned a great deal. Knowing more about physics has changed the way in which I see the world. Life is richer as I apply my knowledge of physics to understanding the world around me, and regain a sense of wonder which has been fading since I was a child. The Junior/Senior physics seminar has been giving me a new perspective on the role of science and scientists with respect to the wider world. Again, my ideas and way of looking at the world are developing as I consider questions to which I had previously devoted relatively little attention. None of this would be possible without the wonderful professors which make up our department.

I am not yet sure what I will be doing over the next year, so that the near future still seems rather distant at times. I do know that I would like to attend graduate school after a year or so, but those decisions still lie a bit farther ahead. I do know, however, that the four years I have spent at Drew as a physics major have had a positive impact on my life which will never fade. In the end, I would simply like to say thank you to all the professors I have had over the past four years, for all the help you have given me. And so, goodbye, for now.  
Tina Aragona '05

## Students' Plans for a Physics-y Summer



### Nate to Lehigh:

This summer I will be participating in a Research Experience for Undergraduates program at Lehigh. Under the direction of Dr. Dierolf I will spend ten weeks working in his optics lab. The subject of my research will utilize optical detection of magnetic resonance, electron paramagnetic resonance, optical detection of charge transport, ultrasonic attenuation, Raman and IR spectroscopy, luminescence spectroscopy, quantum transport, and a broad range of theoretical methods. I am extremely excited to experience a physics lab outside of Drew and am sure that this will be a great summer!

Nathaniel Woodward '06

### Jackie to Kansas:

There's no place like home? This summer I will be strapping on my magic red shoes and driving twenty hours west to Kansas State University, where I will be working with Professor N. Sanjay Rebellon on a project in physics education research. I do not yet know what my specific topic will be, but I am excited to learn about the field in general to help me decide whether I should pursue education research in my graduate studies. Also, since I have never even set foot west of Indiana, living in Kansas for ten weeks should be an interesting experience. Hopefully they have heard of vegetarian food?

Jackie Haynicz '06

### Paul Goes Nowhere

This summer I will be a counselor for the New Jersey Governor's School in the Sciences at Drew. When not being wine and dined at Chez Commons, I will be living with the students, helping organize activities, and assisting in classes and labs. While I do not know what project I will be assigned to yet, I am certain that it will have something to do with science. I am looking forward to working with this program this summer.

Paul-Michael Huseman '07

### Dr. Supplee's Mechanics "Test Question":

I'll give you a multiple choice. It a) violates Newton's Third Law, or b) does something else.

### Show off your Physics Style!

Drew Physics t-shirts featuring Maxwell's equations are available for \$10.

Get yours from Dr F. now by e-mailing him at [rfenster@drew.edu](mailto:rfenster@drew.edu).

Or, become a physics major and you'll get one for free!

### Elizabeth Plays with Legos

This summer, I have been invited to participate in iGEM, the 2<sup>nd</sup> annual competition of genetically engineered machines. iGEM is a challenge to "design and build a genetically encoded finite state machine." I'll be working with Dr. Ron Weiss of Princeton University, first going through a crash course in synthetic biology, a relatively new field, and then working with a small group to create a machine using BioBricks or bits of spare DNA. Biological legos, here I come!

Elizabeth Bendler '06

## Einstein's Miraculous Year

(Continued from page 1)

junior clerk working in the Swiss patent office to support a young wife and child. We can only marvel at the astounding outpouring of creativity that marked his truly memorable year.

Actually, the year was only six months, extending from March 17 to September 27. Between those two dates, Einstein submitted the manuscripts of the five papers to the *Annalen der Physik*, the leading German physics journal. Four were published in 1905 and one in 1906.

The March paper bore the modest title, "On a Heuristic Point of View about the Creation and Conversion of Light." In the introduction Einstein argued that light was not a continuous wave but consisted of "energy quanta." He was not unaware of the potential impact of the paper; he informed a colleague that it was "very revolutionary." Einstein gave three applications of the theory, the most prominent of which was the photoelectric effect, the emission of electrons from a metal surface activated by a beam of light. The phenomenon had been discovered in 1887 by Heinrich Hertz but had not been previously understood. Einstein's explanation was stunningly simple and totally successful. In 1921 he received the Nobel Prize "for his services to Theoretical Physics, and especially for his discovery of the photoelectric effect." (The Swedish Academy was worried about not awarding him the prize for the theory of relativity, but the opposition against relativity was strong at the time.)

On April 30 Einstein completed his doctoral dissertation, which was published the following year. For his thesis he first submitted a recently completed paper on relativity. It was rejected, because it "seemed a little uncanny to the decision-making professors." So he submitted the April paper because it was not speculative and was directly connected to experiment. The subject was determining the size of molecules in solutions from knowledge of the liquid's viscosity and rate of diffusion. Einstein applied his analysis to a solution of sugar dissolved in water. He was able to determine Avogadro's number to within a factor of three, and his result for the size of sugar molecules agreed with other estimates of molecular dimensions. His thesis was accepted in the summer of 1905 and he became Dr. Einstein. Interestingly enough, while it did not have the impact of the other 1905 papers, it was the most frequently cited work.

The dissertation served as the basis for a paper finished in May on Brownian motion. In this paper, Einstein stated that, "On the assumption of the molecular theory of heat, bodies of the order of 1/1000 mm suspended in liquids must carry out an observable random movement, which is generated by thermal motion." Einstein later said that he had written the paper without knowing that observations of Brownian motion were already long familiar, dating back to the 1820's, when the English botanist Robert Brown studied the zigzag motion of pollen particles in fluids. At the end of the paper, Einstein made a very specific prediction of the mean horizontal distance a particle of a given size would move in one minute at room temperature. The verification was provided in a series of experiments by the French physicist Jean Baptiste Perrin, who received the Nobel Prize for the work in 1926. The importance of Einstein's paper was that it yielded compelling evidence for the existence of atoms. The skeptics of atomism – there were many – caved in, one by one.

In June and September Einstein submitted for publication his landmark papers on the special theory of relativity. His "Relativtheorie" arose from a conflict:

Galilean relativity and Newton's laws of motion assert the equivalence of all inertial frames of reference (systems in uniform motion), whereas Maxwell's electromagnetic theory implies the existence of a privileged reference frame. Something had to give; Einstein chose Maxwell over Newton. The concept of absolute time upon which Newtonian kinematics is based had to be abandoned. The Galilean transformations between the coordinates of two inertial frames had to be replaced by Lorentz transformations that had been introduced earlier with an entirely different interpretation. Einstein found that he had to make a daring assumption, that the speed of light is a universal constant, independent of any reference frame. The radical consequences of this are time dilation and length contraction. Einstein said, "My thinking generated a state of psychic tension in me that, after seven years of vain searching, was resolved by relativizing the concepts of time and length." The special theory provided philosophers with material for reflection on the new views of space and time, though Einstein cautioned them that relativity did not imply relativism.

During the summer of 1905, Einstein wrote to his friend Conrad Habicht, "One more consequence of the paper on electromagnetism has also occurred to me. The principle of relativity, in conjunction with Maxwell's equations, requires that mass be a direct measure of the energy contained in a body; light carries mass with it. A noticeable decrease of mass should occur in the case of radium. The argument is amusing and seductive; but for all I know the Lord might be laughing over it and leading me around by the nose." The reference, of course, is to his most famous equation,  $E=mc^2$ . It is the central result of the last of the 1905 papers. The conclusion that radiation has inertial mass strengthened Einstein's belief in the hypothesis that light quanta possess particle-like properties.

Einstein was always way ahead of his time. His particle theory of light predated quantum mechanics by twenty years. Predictions of special relativity were confirmed decades later in cosmic ray observations and high-energy accelerator experiments. And  $E=mc^2$  foreshadowed the discovery of nuclear fission by thirty-four years.

In his later work Einstein forecasted stimulated emission in lasers and anticipated a new state of matter, the Bose-Einstein condensate. His monumental general theory of relativity, published in 1916, predicted the gravitational red shift and the bending of light in curved spacetime.

It all started in 1905. Einstein himself admitted that it was a pretty good year for him. He said, "A storm broke loose in my mind." Indeed it did.

Dr. Carter



Dr. Ashley Carter, who once wished Einstein a happy birthday!



## Women in Physics



In January, Harvard University President, Larry Summers, made headlines when giving a speech attempting to explain the gender-gap between tenured science professors at Harvard and other top universities. He stated three main reasons for this gap: “1) women are just not so interested as men in making the sacrifices required by high-powered jobs, 2) men have more ‘intrinsic aptitude’ for high-level science, 3) women may be victims of old-fashioned discrimination.” Naturally, the second comment caused great controversy; the president of one of the most respected universities in the country feels that women are naturally less capable than men in math and science.

At first glance, this claim could appear credible because science and math historically have been male-dominated fields. Statistics show that in 2003, men nearly dominated the field of physics with males holding 90 percent of physics faculty positions and earning 82 percent of doctoral degrees in the United States. Is the reason for this really an intrinsic difference between male and female brains or are there other factors that play a role?

It is true that many studies have been done that show there are indeed differences between the male and female brain. The biggest misconception about these studies is that men have bigger brains, and therefore, they are smarter. The male brain is on average about 10% larger than the female brain, but there is no data suggesting size predicts intelligence. Also, men are on average 8% bigger and taller than women, and taking this into account, there is only about a 2%

difference in brain size. Although much progress is being made in the study of gender difference in the brain, most scientists are still not able to tell the difference between male and female brains simply by looking at them. Sociologist, Dr. Rachel Ivie points out, “While women earned only 18 percent of PhD’s in the US in 2003, that is far higher than 1970, when the percentage was 2.4. If it’s differences in innate ability, I don’t know what innate abilities would have changed so quickly.”

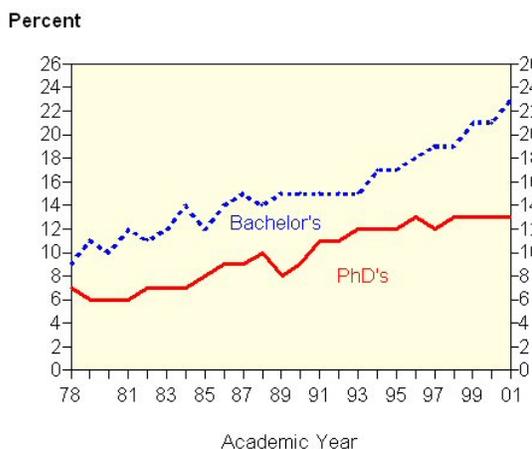
This leads to the question of what is responsible for this gap if it isn’t the brain. As a female, I can see many possible causes. As early as grammar school, girls are deterred from math and the sciences, which are generally seen as male fields. Even if girls manage to keep an interest in science through high school, when they reach college they may feel very intimidated entering a male-dominated major. They may feel that they automatically have to do tens times better than the men just to prove that they are equal.

Even though men are in the majority, it is important to realize that the women who do enter physics succeed. Also, this large gender gap is not seen everywhere. In countries such as France and Turkey, women make up more than a quarter of all PhDs in physics. Being a female physics major at Drew is definitely a unique experience because, currently, women dominate the major. I hope that at universities where men dominate the major, women interested in physics are not afraid to succeed.

### Sources:

Ripley, Amanda. "Who Says A Women Can't Be Einstein." *Time* 07 Mar. 2005: 51-60.

Chang, Kenneth. "Women in Physics Match Men in Success." *The New York Times* 22 Feb. 2005.



AIP Statistical Research Center: Enrollments and Degrees Report

Percent of PhD's and bachelor's degrees in physics earned by women, 1978-2001.

## Dr. McGee the Chemist?

During spring break I left the gray and cold east coast for sunny San Diego, where I attended the American Chemical Society national meeting. The meeting was held in the San Diego Convention Center, which is located in center city San Diego, and which had beautiful views of the nearby Coronado Island. The ACS is the largest scientific society in the world, and this was quite evident from the enormous crowds that filled the meeting rooms and exhibition halls. The meeting also had a large number of participants from industry, which is quite different from typical physics meetings.

Now, it may seem odd to be a physicist at an ACS meeting. However, I was presenting a poster describing some very interesting optical phenomena in blended polymer films, and so the project reflected a diverse range of researchers including chemists, physicists, and materials engineers. The films are made by mixing a highly colored dipolar molecule with an inert polymer. Applying an electric field and a laser-induced intensity grating to the film causes dipolar alignment, which can then be used to set up dynamic diffraction gratings in the film. The synthetic work was performed by Drew chemistry major Anthony Caruso along with Victoria Campbell and Padma Gopalan from the University of Wisconsin Department of Materials Engineering. The optical characterization was done here at Drew with physics major Nate Woodward. After the poster presentation, I got together with my University of Wisconsin collaborators to discuss the next phase of this research (another advantage of attending professional meetings), which will hopefully lead to publication of our results. The poster, “Study of chromophore orientation and photorefractive effects in branched electro-optic chromophores,” is hanging in the Hall of Science along the physics corridor, so check it out and see what a physics major does in his or her spare time.

Dr. McGee

### Physics Quotations:

“Ours is longer.” -Jackie, about TCNJ’s telescope

“Some of you are probably very good poker players.” - Dr. S

Christina Conzentino '05.5



# A New Physics 11 Demo: Tuning Jim's Bass Guitar



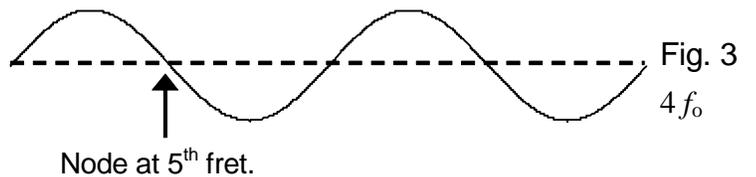
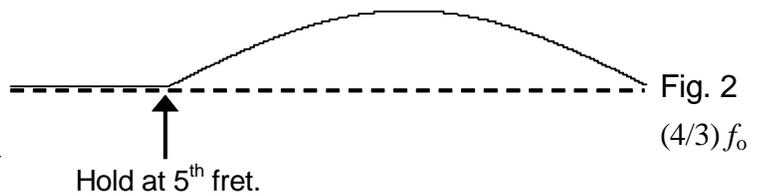
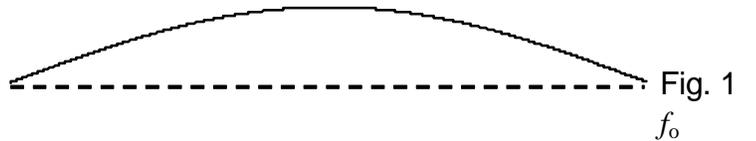
Neighboring strings on a bass guitar are tuned so that the two strings have frequencies with a ratio of about 4 to 3. That is, if the lower string has frequency  $f_0$ , the higher neighboring string has frequency  $(4/3)f_0$ . Simple ratios like this are common in western popular music. We seem to like simple frequency ratios like 2 to 1 (an octave), or 3 to 2, or 4 to 3.

There are a number of ways to quickly check tuning. One widely used method for checking that neighboring strings have a frequency (pitch) ratio of  $f_0$  to  $(4/3)f_0$  is this: Fret the lower-pitched string so that it is only  $3/4$  of its full length. Length and pitch have an inverse relation, so reducing the length to  $3/4$  of the whole string raises the pitch by a factor of  $4/3$  (Fig. 2 versus Fig. 1). So the fretted pitch should match the higher string played unfretted, both at  $(4/3)f_0$ . If it doesn't, I need to tune. But hey!... How do I know where the  $3/4$  mark is? Use a ruler? Of course not. These clever bass makers have put a piece of metal on the neck so I know where to push! I use the fifth fret. Each fret is a half-step, which (in equal tempered tuning) raises the pitch by a factor of  $2^{1/12}$ . Because pitch and length are inversely related, that's the same as saying that each fret I go up multiplies the string length by a factor of  $2^{-1/12}$ . So going up five frets, multiplies the string length by  $(2^{-1/12})^5 = 2^{-5/12} = 0.7942$ . Well, for my purposes that's definitely close enough to  $3/4$ .

Now, here's a more precise (and cooler) way to check relative tuning: I don't push the string to the fifth fret; I just lightly touch the string at the fifth fret location, then pluck with my other hand. This lets the whole string vibrate, but the string has a node where my finger stopped the vibration at the 5<sup>th</sup> fret (Fig. 3). Because the fifth fret is  $3/4$  of the way from the bridge (and  $1/4$  of the way from the other "nut" end), the string vibrates in four segments. This makes its pitch 4 times its fundamental ( $4f_0$ ). Now, can I make the higher string

vibrate at  $4f_0$  too, for comparison? Sure: Its natural frequency (unfretted) is  $(4/3)f_0$ , so just triple that by making it vibrate in 3 segments. That is, I force a node  $1/3$  of the way down the string, which is  $2/3$  of the way from the bridge. The node (again caused by a light touch) should be at the 7<sup>th</sup> fret, because  $2^{-7/12} = 0.6674$ , which is close enough to  $2/3$ .

Summary: The fourth harmonic of the lower string is the exact same pitch as the third harmonic of the higher, neighboring string. This makes for a fun, easy, and precise way to check that my bass is in tune.



Dr. Supplee

## Letter to the Editor

Hi,  
This isn't really a Physics quote, but it is interesting and is said to come from an interesting source. Back in 1985, I was given the following quote by Jay Keyworth.

"Don't ask scientists (read: physicists) about practicality; scientists are trained to question interminably. If you want to know what can be done, ask engineers. Engineers are trained to do things."

I was told that this is a quote from Edward Teller.

VR,  
Ned Woisard '50

## Congratulations!

### 2005 ΣΠΣ Inductees:

Christina Conzentino  
Jackie Haynicz  
Nathiel Woodward

### Phi Beta Kappa Members:

Tina Aragona  
Jackie Haynicz

### 2005-2006 Society of Physics Students Leadership Awardee:

Jackie Haynicz

## Physics Quotations

"His name is Hans Bethe? Did he have something to do with beta decay?" -Nate

"You have an infinite set of these funny things." -Dr. Carter

"What did T.S. Eliot mean when he said April is the cruelest month?" - Dr. Carter

"I thought he was talking about taxes." - Nate

"Differential equations and discrete are girly math." -Dr. Surace

$$E=mc^2$$

## Young Albert E. and the Miracle Year

$$E=mc^2$$

Listen my friends, and shortly you'll hear; Why 1905 was a miracle year. For that was the time that a young patent clerk; By the name of Albert Einstein did incredible work

Now this is a story that comes in three parts; And the beginning, of course, is the best place to start. But how it begins, I confess I don't know; So I made up a lie, and here's how it goes.

One Al was walking and stopped to look down; At a puddle that spread in his way on the ground; As he studied the muck and the mud, Albert found; That his mind wandered back to the motion of Brown.

A small bit of dust or pollen or fluff; Would dance in the water, if 'twas tiny enough. Some thought that the motions were signs of life; But old Reverend Brown had proved that's not right.

"The way the dust jiggles and wriggles and writhes;" Al said, "it's no wonder some think it's alive." He sat and he pondered the micro-commotion; What could possibly lead to this Brownian motion?

Well, he thought and he thought and he thought a bit more; He thought till the thoughts made his thinking parts sore. And with a little statistics and persistence galore; He thought of an answer not thought of before.

"It's molecule," cried Albert, "too small to see; That are bumping the bits, that's what it must be. And if water has molecules then so has that tree; And this rock and that bird, and yes, you and me."

Well, molecules and atoms at last were confirmed; And solid-state texts were rewritten or burned. 'Twas a wondrous discovery, thought not without peer; And it's hardly enough for a miracle year.

Now photons, like atoms, were once speculation; Since light comes in waves with well-known undulations. But when light fell on metals and started a current; Though the theories were clear, the experiments weren't.

Turn up the brightness and more electrons emerge; While it's the color of light makes their energy surge. How could this be? Albert knew it was wrong; If light was a wave as we'd thought all along.

He thought and he thought and he thought a bit more; He thought till the thoughts made his thinking parts sore. And with a little deduction and persistence galore; He thought of an answer not thought of before.

Light is sometimes a wave, that much is true; But at other times it's a particle too. And the same goes for atoms and marbles and pigs; It's just hard to tell when things get too big.

'Twas a wondrous discovery and now he was near. Yes, it's almost enough for a miracle year.

One day Al was dreaming and thought if he might; Travel as fast as his photons of light. What strange things would happen, what wonders there'd be; If he could approach the speed of light:  $c$ .

He thought and he thought and he thought a bit more; He thought till the thoughts made his thinking parts sore. And with a little deduction and persistence galore; He thought of an answer not thought of before.

Now light speed is constant, experiment showed; If you move very quickly or move very slow. But if light speed is constant, it's time that must change. The answer's the answer no matter how strange.

This one little notion, while modest enough; Led to a whole bunch of powerful stuff. From time dilation to lengths that contract; To the source of the sunshine and cloud chamber tracks.

And to Albert's most famous discovery of all; A simple equation that most folks recall;  $E=mc^2$  made the fact plain; That energy and matter are one and the same.

And now, there you have it, the case is quite clear; Why 1905 was a miracle year. For in five famous papers and less than twelve months; Einstein came up with some fabulous stuff!



Written by James R. Riordon, American Physical Society  
Submitted by Evan Kimberly '08



Every- one gravitated toward Newton, but he just kept moving around at a constant velocity and showed no reaction.

Einstein thought it was a relatively good time.

Ohm spent most of the time resisting Ampere's opinions on current events.

### At the Physics Party

Volta thought the social had a lot of potential.

The Curies were there and just glowed the whole time.

Compton was a little scatter-brained at times.

Hertz went back to the buffet table several times a minute.



For Schrodinger this was more a wave function rather than a social function.

Watson and Crick danced the Double Helix, while Fermat sang, 'Save the Last Theorem for me.'

Rontgen saw through everybody.

<http://www.physlink.com/Fun/PhysicsParty.cfm>

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# Upcoming Events:

## April 16: Spring Saturday

Check out the SPS table for fantastic physics demonstrations!  
Relax afterwards with exciting physics bowling!

## April 26: Physics Banquet

Come see the induction of new  $\Sigma\Pi\Sigma$  members!

## May 9: SPS Spring Picnic

Join us for food and fun at Dr. F's as we celebrate the end of classes!

## May 21: Commencement, 10:30 AM

Come by the physics table after the ceremony!

Don't forget to visit the physics department website at: <http://depts.drew.edu/phys/>

# The Dilated Times

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*Address Correction Requested*

inside...

Einstein's Miraculous Year, SPS Zone Meeting, Senior Goodbye, Summer Plans, Chair Fundraiser and more!

Contributors: Tina Aragona, Laura Barclay, Elizabeth Bandler, Dr. Ashley Carter, Christina Conzentino, Jackie Haynicz, Paul-Michael Huseman, Evan Kimberly, Dr. Dave McGee, David Newby, Dr. Jim Supplee, Nathaniel Woodward

2005  
Celebrate the World  
Year of Physics!

