the SPS Observer

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Winter 2013–14

Mental Maintenance

WHEN PHYSICS AND LIFE GET HARD, WHAT GETS YOU THROUGH?

SOCIETY OF PHYSICS STUDENTS

One Physics Ellipse
College Park, MD 20740
301.209.3007 (tel)
301.209.0839 (fax)
sps@aip.org
www.spsnational.org

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A Piecewise Continuous Path

LIFE DOESN'T ALWAYS GO AS PLANNED

by Toni Sauncy, SPS Director

My path to physics and, eventually, to teaching was not what most would consider "traditional." I went right from high school to the community college in my small hometown in West Texas, on a full scholarship and with a brilliant plan to be an accountant in the booming regional oil and gas industry. Fortunately, I dropped out of college in my third semester. After leaving school behind, I thought very little about what I wanted to be "when I grew up." Several years later, I decided that I wanted to be a teacher. In a convoluted way, that decision ultimately led me to SPS, because that's what this organization is all about: students.

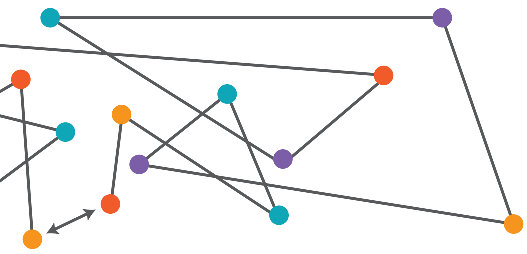
I did not consider dropping out of college to be a huge catastrophe since no one in my family had even finished high school. I was academically clueless. Pregnant and suffering from morning sickness, and dealing with being a single mother, I stopped going to class and thought that they (the nebulous college authority, "they") would realize I was no longer interested in college and simply remove my name from the class rosters. When I received failing grades at the end of the semester, I was shocked and made an angry call to the registrar's office. I was shortly informed that signing up for college courses is a sort of contract and that I was supposed to actually notify "them" of my decision to withdraw. That was academic lesson number one.

It was fortunate that I dropped out of college, not only because I missed out on being an unemployed oil and gas accountant (there was a big downturn in the industry a few months after I dropped out), but also because, frankly, my daughter saved my life. We grew up together. She taught me how to stop being a reckless teenager and start thinking about being an adult. A few years later I was fortunate to find a partner with whom to share my piecewise path. We grew our family with the addition of a son, and I landed a part-time job teaching arts and crafts. It was not until a high school reunion a few years later that I decided to try the whole college thing again. After telling my dropout story, I overheard a former classmate remark, "Oh, that's too bad, because I always thought she was so smart." I cannot say for sure whether my response was anger or embarrassment, but that remark kick-started my return to higher education. I went back to the same community college and re-enrolled in the courses I had failed (except for economics, which is, to this day, marked with an "F" on my transcript). I decided to become a math teacher because

Table of Contents

Volume XLVII, Issue 4 Winter 2013–14

ON THE COVER
In this issue, we explore the academic stresses and social pressure that undergraduates face, and how to give yourself a tune up when it all feels like too much.



the path took an unexpected turn

WHEN I FOUND MY PASSION IN AN OPTICS LAB

I was always "good at math", and teaching is a respectable profession that fit well with having a family. My kick start turned into genuine motivation to make a better life for my children. They watched me to go to school and assumed everyone's mom did homework all the time.

To finish my degree, I had to transfer to a four-year school. Another destined-to-be-a-teacher classmate and I decided to share a daily commute to Texas Tech University in Lubbock, two short hours away (each way). At the suggestion of my classmate, I took on physics as a minor so our schedules would coordinate. I had never taken a physics course before. Ever. I scraped my way through the first two courses in physics, feeling lost and clueless most of the time even though I was an "A" student in math. But I stuck with it. I had a family who needed me to be a working mother as soon as possible. My path took an unexpected turn when I found my passion in an optics lab. Fascinated by the way physics caused me to view the world, I went from being dumbfounded about what the heck a flywheel is to mesmerized by light passing through a diffraction grating. Then someone advised me go to graduate school. I did not even know what that meant. I knew that my professors were called "doctor" but had never actually considered why. During my last semester as an undergraduate math major, we packed up the family and moved to Lubbock, where I started graduate school—in physics. This was a second academic lesson. There is always more to learn.

Graduate school was fantastic. I learned from a masterful research mentor, made lifelong friends, and built up a network of professional support. When I graduated, I chose a tenure track faculty position at an institution where the emphasis was on teaching rather than research, in which I spent 15 or more hours per week with students in a classroom or teaching lab—despite the urging of one of my most cherished mentors to pursue a position as a postdoc. I truly enjoyed my research in graduate school doing experimental solid state physics, and though I have not accomplished great feats of ground-breaking research, I have enjoyed focusing on teaching undergraduate students and guiding their research projects centered around my interest in optoelectronic materials.

Unlike my driving-partner classmate, I never became an official math teacher, but I did become a teacher. My piecewise continuous experience as a student has helped me to be a better educator and mentor. I did loathe my first year in physics, but, eventually, physics drew me in. No matter where (or when) a student falls in love with physics and no matter how many discontinuities may occur along the path, that student can have a profound influence on the world because of the way physics enables one to think.

In this issue of *The SPS Observer*, we deal with those not-so-easy parts of academia and physics. I have seen lots of students encounter the same kinds of challenges I did when I was a student, and there are many ways to navigate those challenges. I know this because of my own experiences, but more importantly because of the stories of the many students with whom I have shared my piecewise continuous path. //

FOR MORE ON THIS TOPIC

See the feature stories starting on page 13.

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ON RECEIVING THE 2013 SPS OUTSTANDING CHAPTER ADVISOR AWARD

Pitching Physics

by Sharon Rosell
Professor of Physics, Central Washington University in Ellensburg

I am very honored to have been selected for the 2013 Outstanding Chapter Advisor Award. But I am only one of hundreds of outstanding advisors across the country—men and women who give of their time to ensure that students have the opportunity to participate in a Society of Physics Students chapter and form friendships and memories that will last a lifetime.

My award is shared with the fine physics program at Central Washington University (CWU), which recognizes the importance of undergraduate research and community outreach. It is a small department that values its students and doesn't hesitate to ask them for help tutoring general physics courses or finding funding for guest speakers. My award also reflects the fine quality of the many students who have participated in Central's SPS chapter over the past 20 years. I may suggest field trips or outreach opportunities or ways to raise funds, but I leave it up to the students to decide which activities to do and how to organize their efforts. I let them lead, and they have done a good job. We have received 17 Outstanding Chapter Awards over the years.

I am humbled that my SPS members want this 60-something-year-old lady to attend their meetings and participate in their fun activities. We have gone go-carting and snow sledding and river rafting. I got to pitch during a kickball game with the chemistry club a few years ago. Some time before that, before I had cataract surgery, I was asked to umpire a baseball game. It was a matchup between the rival physics and chemistry students. I could hardly see the ball! Needless to say, SPS won that game.

Our field trip to TRIUMF Labs in British Colombia was particularly memorable. On the way home, the students and I camped on the shores of Puget Sound in Northern Washington. We watched the green flash as the sun set over the waters. Another time, as we were returning from an outreach event for middle school girls in Yakima, Washington, we stopped along the Yakima River Canyon. My students attempted to show me how to skip stones on the river, until one gave up in frustration, telling me that I threw like a girl.

An annual physics workshop that my SPS students do for a local preschool class is one of the most eagerly awaited events of their school year. On Halloween my chapter entertains children with a shadow board or, this year, with a vortex cannon. They hold water rocket launches, and help with a laser light show the physics department puts on for both school children and for the general public. They do "Expanding Your Horizons" workshops for middle school girls. My SPS students make me proud.

AT LEFT: SPS President DJ Wagner congratulates Rosell (right) on receiving the highest honor SPS awards to advisors at the 2014 Winter Meeting of the American Association of Physics Teachers. Photo by Lydia Quijada.

ABOVE: Rosell works with students at an Expanding Your Horizons in Math and Science conference intended to nurture girls' interests in these subjects. Photos courtesy of Sharon Rosell.

“my SPS students make me proud”

THE CENTRAL WASHINGTON UNIVERSITY SPS CHAPTER received a 2013 SPS Marsh W. White outreach award. Members who participated in the project include (l-r) Ryan Corbin, Hans Berghoff, Sharon Rosell, John Pitts, Trevor Taylor, Anthony Douse, Addison Wenger, Jordache Richardson, Andrew Kerr, Richard Grist, and Christopher Pearce. Photo courtesy of Sharon Rosell.

Receiving the award is especially poignant for me this year because I plan to retire in June. I hope that my SPS chapter continues to thrive, finding even greater things to do in the future. //

MORE INFORMATION

Sharon Rosell received the 2013 SPS Outstanding Chapter Advisor Award at the 2014 Winter Meeting of the American Association of Physics Teachers in Orlando, Florida. This award is the highest recognition given to chapter advisors by SPS. It celebrates an individual who has made exceptional contributions toward promoting student leadership, developing and inspiring a broad spectrum of activities, and inspiring enthusiastic student participation.

To find out more about Rosell and previous recipients of the award, and to learn how to nominate your own advisor, visit: www.spsnational.org/programs/awards/advisor.htm.

Student Voices

QUOTES FROM THE NOMINATORS

“Professor Rosell was a ray of light during my formative years at Central Washington University (CWU). Fortunately, during my second year at CWU, Modern Physics provided a venue for me to get to know Professor Rosell better. Her class built within me a great appreciation of physics and chemistry. It also became apparent that Professor Rosell was a true resource for advice and guidance.”

“I continue to attribute my success to Professor Rosell.”

“Professor Rosell truly cares about her students. She saw beyond my youthful exuberance to my full potential. The advice, counsel, and insight Professor Rosell has shared with me continue to be a source of guidance.”

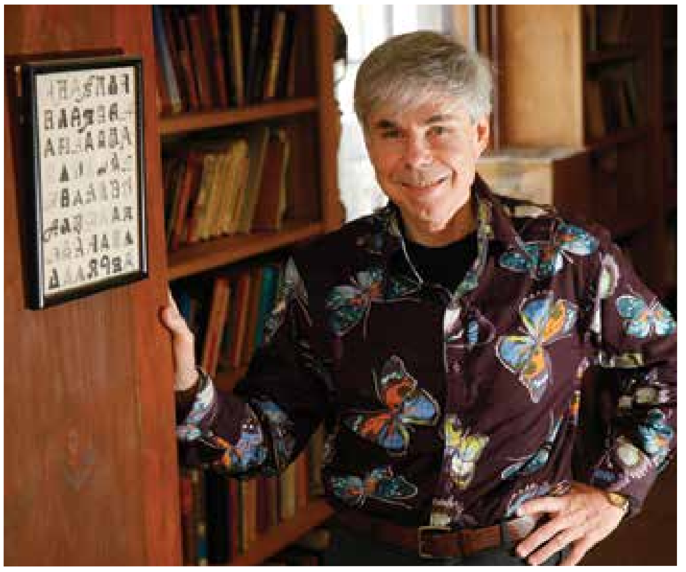
“Leading by example, Professor Rosell showed students the importance of being involved in the local community. It was amazing to me how Professor Rosell could quickly and efficiently adapt her teaching style, form of presentation, and demonstrations to different audiences, age groups, educational levels, and attention spans. It deeply impressed me how easily she could do this, considering how her audiences varied widely from students new to physics to upper-level undergraduate physics majors to preteens being introduced to the possibilities and excitement of science.”

“She captured my interest in [Modern Physics] as no other professor or class ever did or has since. The postulates of Einstein, the theorizations of Niels Bohr, and the revelations of Max Planck were laid bare for us in an easily accessible way. She didn’t just teach a class. She told a story, a tale of how modern science became what it is today … I changed my major to physics ... and have never regretted it”.

Butterflies in the Stomach

HOW BELIEVING IN MYSELF AS A YOUNG SCIENTIST PAID OFF

by Douglas Hofstadter, Professor of Cognitive Science at Indiana University Bloomington



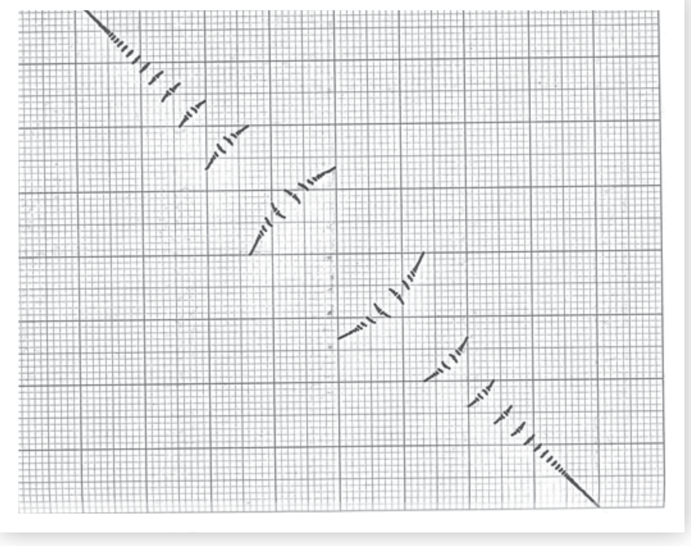
DOUGLAS HOFSTADTER. Photo courtesy of Douglas Hofstadter.

Douglas Hofstadter is a physicist turned cognitive scientist who wrote the Pulitzer Prize-winning book *Gödel, Escher, Bach: An Eternal Golden Braid*. As a student in the 1970s, he discovered a fractal pattern describing the energy spectrum of electrons in atomic lattices in magnetic fields; initially scorned by his advisor, this "Hofstadter butterfly" has very recently been experimentally verified.

In late 1974, as a graduate student at the University of Oregon in Eugene, I accompanied my PhD advisor, the distinguished solid-state physicist Gregory Wannier, on a six-month visit to Regensburg, Germany.

In the early 1960s, I had discovered a family of graphs having a novel and beautiful kind of behavior while researching number-theoretical questions as an undergraduate math major. The main graph, which I dubbed "INT," was continuous at every irrational number but had a jump discontinuity at every rational.

THE INT GRAPH revealed a fractal years before mathematician Benoit Mandelbrot popularized the term "fractal." Image courtesy of Douglas Hofstadter.



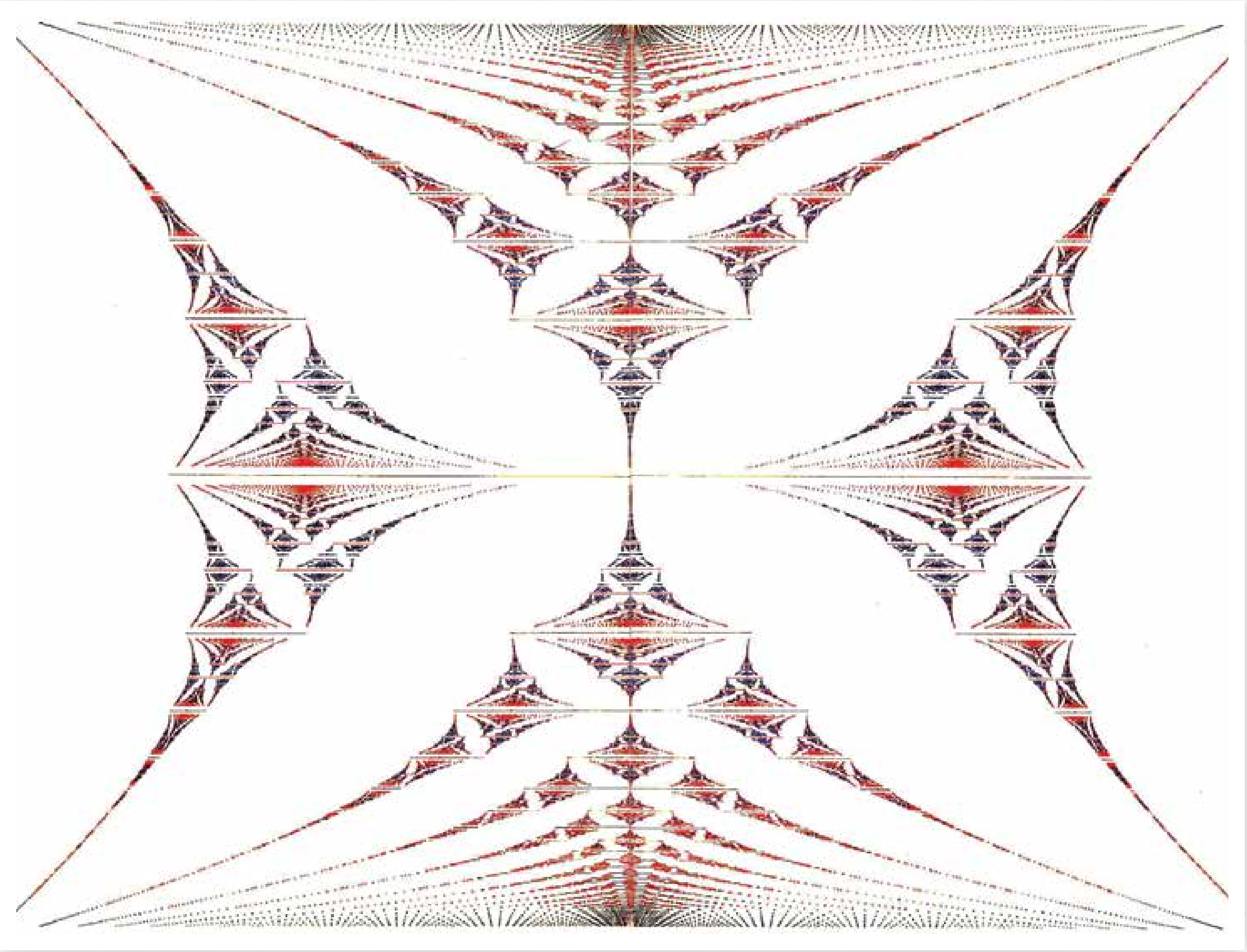
This was very weird. Seen from far away, INT looked like the 45 degree line $y = x$. But if you looked at it more closely, you would see it actually consisted of an infinite number of backslashes. If you looked in greater detail at each backslash, you would see it in turn break up into an infinite number of forward slashes. And so on.

In short, INT consisted of an infinite number of copies of itself (each of which consisted of yet smaller copies, ad infinitum). Today such wild shapes are known as "fractals" and are familiar even to people who have never studied mathematics, but back then this was a totally unfamiliar and wonderfully counterintuitive phenomenon. Thanks to my exploration of the INT family in the early 1960s, such "nested" behavior became part of my most intimate mental makeup.

Fast-forward to the mid-1970s, when I was a physics grad student working on the unsolved problem of the energy spectrum of electrons in a crystal in a uniform magnetic field. Such a situation is characterized by the number of "flux quanta," $hc/2\pi e$, passing through each cell of the crystal lattice.

I had been lured to study this problem by Wannier's strange statement that the problem could be attacked for rational values of this dimensionless quantity but was in principle unsolvable for irrational values. This claim tantalized me, first because I was intimately familiar with number-theoretical functions that acted differently at rationals and irrationals, and second because it struck me as impossible that any physical phenomenon could exhibit such weird behavior. (What would you say to someone who asked you if you prefer keeping your house at rational or irrational temperatures?)

I studied the problem very diligently, soon discovering, to my chagrin, that I was not skilled enough to do the virtuosic kinds of equation manipulations that Wannier and his Regensburg colleagues could do. Out of desperation, I decided to use a small desktop computer to explore the spectrum's numerical behavior. This was not a typical approach for a theoretical physicist back then—the ones I



THE ENERGY OF ELECTRONS IN AN ATOMIC LATTICE can be plotted as the butterflylike Gplot fractal shown here, discovered by Hofstadter. Image by Douglas Hofstadter.

knew never used computers and weren't interested in them.

When I started plotting (by hand, using colored pens) the energy bands whose coordinates the small, slow computer calculated in overnight sessions, I saw, to my astonishment, old familiar patterns of nesting. Even when the graph was plotted very crudely, I could see that it had to be made out of an infinite number of smaller-sized copies of itself. Thanks to my discovery of INT many years earlier, I had a "prepared mind."

The analogy between INT and Gplot (as I called my graph, later dubbed the "Hofstadter butterfly" by other people) was very exciting to me, but when I explained my findings to Wannier, he was bewildered and utterly skeptical. He had never seen anything like INT. The few dozen bands making up the hand-plotted graph I showed him didn't seem to him to exhibit any regularity, so he scornfully called the nesting pattern that I claimed to see "mere numerology." He told me I would be unable to get a PhD for such work; instead, I would have to write a "library thesis" summarizing other people's research.

I WAS SURE MY IDEAS WERE CORRECT, so I persevered

Though deeply hurt by Wannier's harsh words, I was sure my ideas were correct, so I persevered in private. After a few months, I had produced some very detailed graphs of Gplot, including graphs of tiny regions of it, which looked just like the whole thing. Some months after we'd returned to Eugene, I at last showed Wannier these detailed images, and he carefully scrutinized them. All at once, the scales fell from his eyes and he realized that my "numerology" had been right, after all. Eventually he fell deeply in love with the unprecedented self-similar structure I'd discovered (no such thing had cropped up in physics before), becoming a champion of my ideas. He totally forgot that he had voiced any skepticism about what I'd told him in Regensburg. That was most ironic, of course, but I never pointed out the irony to him.

As I look back on this crucial

episode of my life, I see that it typifies situations where one finds oneself pitted against an expert, with the two people holding diametrically opposite opinions. Is there any general recipe for what to do in such a situation? Well, one general approach would be always to kowtow to the expert, to always cave in and convert to the expert's beliefs. I obviously didn't do that.

Another general recipe would be to always insist on one's own ideas, no matter what other people say, no matter how famous or accomplished they might be. This is not a general strategy that I would advise either, even though it's exactly what I did in my story—but in that case, I had very good reasons to do so.

The subtle judgment call that has to be made in such situations of conflict depends on many ineffable factors, such as whether one has ever been in analogous situations before (and I had been, thanks to my deep explorations of INT many years earlier), and the degree to which the expert is really an expert in this domain (Wannier, although undeniably a world expert in solid-state physics, had never studied number theory, which turned out to be crucial to this problem). That Wannier had resorted to terms of scorn to describe my claims revealed that he was mystified by my findings and was in some sense putting up a smokescreen of resistance to them.

My "words of wisdom" thus cannot be put into simple terms, because it would be foolish always to believe in oneself over experts, and yet sometimes one has to do just that. And so, when? When some prior experience from one's past is so profoundly analogous to the current situation that one knows in one's bones that one is onto something deep. That's when one must cling to one's beliefs and not let oneself be bullied into giving up. //

READ MORE

- **To learn more about Hofstadter's butterfly** check out www.nature.com/news/physicists-net-fractal-butterfly-1.13717.

UNG Senior Training for Spot on Olympic Team

by Michael Marshall, Communications Specialist at the University of North Georgia in Gainesville

On a typical Monday at 7 am, many college students are just beginning to stir and prepare for the day's classes. However, Ben Hefner of Gainesville, a senior majoring in physics at the University of North Georgia (UNG), is already on the water, training for a berth with Team USA as a flat water sprint canoeist for the 2016 Summer Olympic Games to be held in Rio de Janeiro, Brazil.

Hefner, a graduate of North Hall High School who recently took second place in the individual 200-meter sprint canoe and third place in the 1,000 meter at the US National Team Trials in Oklahoma City, Oklahoma, will graduate from UNG in spring 2014 and focus the next two years on training. He also took first place in the two-man 1,000-meter sprint canoe with partner Ian Ross.

"Ben is a top athlete; it's very tough to train and go to school, but he is very responsible," said Claudiu Cuir, Hefner's coach and a world champion canoeist from Romania. "He is very strong and can really move through the water. Ben is a little younger than most of his competition, but he has great potential and drive. He spends three months every summer training in Europe with some of my connections."

Hefner began paddling in 2005 on Lake Lanier at the age of 13 at the Lanier Canoe and Kayak Club in Gainesville, where the 1996 Olympic events were held. The following year he won the national championship in the 500-meter and 1,000-meter sprint for his age group.

"I could see that I had a future and set my eyes on making the national team," Hefner said. "In this sport, in order to be competitive at the world championships and to make the Olympic team, I have to compete internationally. My love for the sport and my commitment to excellence fuels my desire to compete."

That commitment includes much more than the early-morning paddles. Hefner follows up his sunrise session with a one-hour weight circuit, a second paddle set at 10 am, and a third paddle set from 4 to 6 pm. He runs in the evenings.

Though he plans to take time off for training and for the Olympics, Hefner plans to attend graduate school later to major in astrophysics or nuclear physics. His ultimate dream is to become an astronaut.

"Ben is very smart and a hard worker, and a member of the UNG Honors Program," said Dr. Richard Prior, head of UNG's Department of Physics and Hefner's academic advisor. "He does a really good job of handling his dual responsibilities as a student and is an excellent athlete. Ben is a leader among our majors as president of the Society of Physics Students, and is well liked by them and the faculty members. Besides being one of our best students, he also works as a lab assistant and tutor for introductory physics classes." //

This story originally appeared at http://ung.edu/news/articles/2013/10/ung-senior-training-for-spot-on-us-olympic-team.php.

BEN HEFNER TAKES THE LEAD during a race at the 2013 USA Canoe/Kayak Sprint Nationals in Oklahoma City, OK. Photo courtesy of Ben Hefner.

Starboard, Starbound

SPS CHAPTER PRESIDENT AIMS FOR THE OLYMPICS AND OUTER SPACE

Photo courtesy of Ben Hefner.

Ben Hefner, a physics major and canoeist at the University of North Georgia (UNG) in Gainesville, plans to compete in the 2016 Olympics and, some day, become an astronaut. He sat down with *The SPS Observer* to talk about his busy life.

Why physics?

I started school as a biology major but quickly decided that physics, the science of everything, was a better fit. I have always had a fondness for the exploration of the unknown. Space is the final frontier, and I would like to one day become an astronaut, which reinforces my decision to go with physics.

How are you involved with your SPS chapter?

I am currently the president of the SPS chapter here at UNG. We organize fundraisers and group activities to strengthen the unity of the department. In addition, we have been promoting undergraduate research and participation in summer programs. I also attended the American Physical Society Southeastern Section meeting last year in Tallahassee, Florida, and plan to attend the meeting again this year.

Do you spend any time in the lab?

I am a TA in the Physics 1 lab and tutor lower-level physics classes. I also do research with Richard Prior; last semester, we worked on calibrating detectors in the department in order to more accurately measure a black body spectrum from the Sun. This semester we are investigating fluctuations in Earth's magnetic field.

How do you balance your schoolwork, your research, and your sport?

I have learned that regardless of how good you are, it is impossible to devote your life to two things at once. I have seen a drop in performance, both in school and in my sport, that is due to my attempt to juggle both. As I devote myself more to my studies, I find myself finishing second or third in races as much as I finish first. I am still a top athlete in the country, but my former dominance over the competition has lessened. So I plan on taking a few years off from school to fully pursue my Olympic dream. After that I will return to academia in order to devote myself totally to my graduate studies.

How do you cope with stress?

I do find myself overwhelmed sometimes. But for the most part, I am able to maintain stability with the support of my family, professors, coach, and friends. Without them, and their willingness to work with me and my busy schedule, I would surely be lost. One of the biggest challenges I have faced in my life was the loss of my father in 2009. With the help of great friends, I was able to rise again and be stronger for it. It has brought my family closer together and only fueled my desire for success in life. Life is too short to squander away without ambition.

If you could visit one place in the solar system, where would it be?

I would probably choose Titan. This is Saturn's largest moon, and the only place in the solar system that may have liquid water on its surface. But really anywhere off world would be cool. //

Regardless of how good you are,

IT IS IMPOSSIBLE TO DEVOTE YOUR LIFE TO TWO THINGS AT ONCE

CHEER BEN ON

Follow his athletic career at the website of the US Olympic Committee, www.teamusa.org/Athletes/HE/Ben-Hefner.

Check out UNG's SPS chapter at https://sites.google.com/site/spsnorthgeorgia/.

Photo courtesy of Patrick Ford.

Mars Man

HOPEFUL ASTRONAUT SIGNS UP FOR A ONE-WAY TRIP TO THE RED PLANET

by Patrick Ford
Class of 2016 at Florida International University in Miami

As far back as I can remember, there was some reason for me to look up at the night sky. I remember my kindergarten science teacher building an inflatable planetarium out of trash bags with glow-in-the-dark constellations taped to the inside. When I was older, I watched the moon through a pair of binoculars my parents gave me and went to observing sessions at the local planetarium.

In college I almost majored in aerospace engineering, but I realized that it'd break my heart to build a rocket or spacecraft and have it take off without me inside. So I decided to major in physics with a minor in astronomy. (My university doesn't have an astronomy major.)

In November 2012 I saw an article about an organization called Mars One. It was planning a one-way trip to Mars and looking for applicants from all over the world. Beginning in 2016, supplies, satellite networks, hydraulic rovers, and modules will be sent to the Red Planet. If everything goes smoothly, a team of four astronauts will take off in September 2022 and arrive roughly in April 2023. Subsequent launches every 26 months will send more teams of four, who will add more modules and expand the base.

YOU DO KNOW THAT'S A
one-way trip, right?

When I heard about this plan, I was reading a sci-fi novel called *Red Mars* by Kim Stanley Robinson about that very same idea: a team of one hundred astronauts leaving the planet on a one-way trip to colonize the Red Planet. I did a lot of research about the project and became very interested in the technical aspects and logistics challenges it posed. Of course I began considering it—how could I not? A chance to go farther from Earth than anyone has ever been before? A chance to set foot on ground that has never been disturbed by humans? It sounded incredible. The organization held a press conference in April, and I completed my application that day. That's when my official "Mission to Mars" began.

The selection process will take place in four rounds, the first of which just ended in September. We submitted our formal applications and answered private questions regarding our thoughts on isolation and fear and how we think we work in groups. I can't even begin to fully comprehend the challenges and sacrifices that lie ahead. Just saying that I'll go is one thing; it will become entirely more real when I'm looking at the rocket and realizing that I'm about to take my last steps on the planet I've known my whole life.

In November I visited the Kennedy Space Center in Orlando, FL, where I got the opportunity to attend a NASA social for the launch of the Mars Atmosphere and Volatile Evolution (MAVEN) probe. When I was there, I asked astronaut John Grunsfeld what the greatest attribute an aspiring astronaut could have. He told me that I should be a jack of all trades and learn to fix many different kinds of systems—even humans. We are fragile beings that need support. I think this is why Mars One so heavily focuses on strong people skills. Mars One will need astronauts who are mentally strong and can deal with all kinds of hardships between each other and within ourselves.

We can expect that someone will regret volunteering for the mission. It's actually a deep fear that I have for myself. What if I get all the way to Mars, and it's not as glorious as I thought it would be? What if I miss my home planet too much? Having strong, deep connections with each other and our families will allow us to support one another when these psychological hardships arise.

To promote the mission, I have been looking for opportunities to reach out to as many students as possible. I've never done anything like this, so it's hard to figure out where to begin building a community.

I've started by giving talks. The mother of a friend of mine, who is an elementary school teacher, asked me if I was interested in coming to her class dressed in my NASA-embossed astronaut Halloween costume. I went to her class with some pictures and models and a presentation about the solar system. I then did a few more talks at some elementary schools, as well as one for a high school, liking it more and more. I tried to avoid technical aspects with the younger ages. With the older high school students, however, I went into specifics about how we know what we know about the universe and where humanity may be heading with more manned missions.

Last month my SPS chapter started PhysTalks, forums for undergraduate students to talk about either their research or something they're very passionate about. The organizer of the PhysTalks reached out to me and asked if I wanted to present something about Mars and Mars One.

Online, I mainly promote my mission through Facebook, but I am also building a website and have a Twitter account I might post articles on. Back in August of this year, a group of Mars One applicants got together in Washington, DC, for the first "Million Martian Meeting"—an event created by the administrators of a group on Facebook called "Aspiring Martians Group." We got to know one another and talk about the issues and ideas that we'll have to think about during our lives on Mars. I also got to meet Bas Lansdorp, CEO of Mars One, who told me that his long-term goal after Mars One was to make something of humanity on another planet.

It's very funny how people react when I explain the mission to them. Some say, "You'd have to be crazy to sign your life away!" Others ask, "You do know that's a one-way trip, right?" Or, "Wait, you never come back? And you're okay with that?"

But to me, this is something that has really shaped the past year of my life. I love the idea of reaching out to the planets around us and doing something a little more permanent than collecting samples and returning. //

"LIKE" PATRICK

Subscribe to his Facebook page at www.facebook.com/patrickthemartian.

FORD HOPES TO ONE DAY TRADE HIS ASTRONAUT COSTUME, shown here, for the real thing. Photo courtesy of Patrick Ford.

SPS wanted to know:

When physics and life get hard, what gets you through?

You told us, on Facebook and Twitter, and we noticed some common themes. Throughout this issue, we bring you words of wisdom from your peers who have been there and found ways to keep going and keep growing.

When physics and life get hard, what gets you through?

A change in perspective. For me, this goes a long way in overcoming the challenges of life and being a student. The right mental perspective and attitude often give rise to new opportunities to grow.

When physics and life get hard, what gets you through?

Relaxing and trying again.

When physics and life get hard, what gets you through?

Holding on with all my strength to my driving passion for both.

When physics and life get hard, what gets you through?

Getting lost in an alternate reality. TV, video games, and movies help me unwind when things get hard, so I can be ready for the next difficult task.

When physics and life get hard, what gets you through?

Remembering my dream. It leads to new modes of satisfaction.

When physics and life get hard, what gets you through?

Sometimes my goals are the only thing that I hold on to.

When physics and life get hard, what gets you through?

"Dr. Who" of course!

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Mental Maintenance

and Inner Unity

by Dwight E. Neuenschwander
Professor of Physics, Southern Nazarene University in Bethany, OK

This article was requested by the editor in light of the theme of this issue. This topic was also discussed in a set of Fall 2004 articles in The SPS Observer under the heading "Sometimes I Feel Like Quitting."[1] Some repetition exists. Perhaps some topics bear repeating.

Every semester, usually between midterms and finals, one or more discouraged students comes into my office, anxiously wanting to talk. Their course work is not going well; they are behind in everything and feel overwhelmed, inadequate, trapped, and discouraged. They want to drop a course and may hint at changing majors or quitting university life. Perhaps they are so burned out that they are tempted to just disappear . . . what a relief if everything would just go away.

I can empathize with these students. I was one of them myself, more than once, as an undergraduate and in graduate school. When I look in the distressed student's eyes, I remember . . .

. . . A student furiously rides his bicycle around and around in a large empty parking lot, like a caged wild animal, lap after mindless lap—at four o'clock in the morning. Trapped for weeks in a downward spiral, frustrated at being unable to work, he feels guilty about trying to relax. He is exhausted but unable to sleep. This cannot go on. Maybe a change of venue would help.

A few months later he transfers to another university. But he brings along the same person he was before. Within six months the solitary student finds himself, late one Friday night, sitting under the stars on a seemingly deserted campus, as everyone else whoops it up at the cafés and bars across the street. The student hears the laughter and music but cannot bring himself to join in. To leave tasks undone makes him feel irresponsible, but if he returns to them he steps back into a prison. So there he sits, pulled between opposite poles of duty and frivolity, trapped in a wearisome pattern grown too familiar. Although he has been in school a long time, somehow he missed the lesson on mental maintenance. Maintenance requires occasional downtime. To keep on going for the long term, a motorcycle engine's oil must be periodically changed. But you can't change the oil while the engine runs at 3000 RPM.

This student soon leaves the new university too, and goes home, the place where, as Robert Frost described, "When you have to go there, they have to take you in."[2] No one at the university seemed surprised by his sudden departure.

He reads *A Christmas Carol* by Charles Dickens.[3] Ebenezer Scrooge's behavior hits close to home. Dickens writes: "Scrooge took his melancholy dinner in his usual melancholy tavern; and having read all the newspapers, and beguiled the rest of the evening with his banker's book, went home to bed. He lived in chambers which had once belonged to his deceased partner. They were a gloomy suite of rooms."

When the Ghosts of Christmas Past and Present help Scrooge step outside of himself, Scrooge sees other possibilities:

> *When this strain of music sounded, all the things that the Ghost had shown him came upon his mind; he softened more and more; and thought that if he could have listened to it often, years ago, he might have cultivated the kindnesses of life for his own happiness with his own hands, without resorting to the sexton's spade that buried Jacob Marley . . .*

Some of us have to learn things the hard way. In university life our most important lessons have nothing to do with courses and majors. The greatest lessons are about ourselves and about life.

Physics never came easy for me; I had to work hard at it. When I was an

In university life our most important lessons have nothing to do with courses and majors. The greatest lessons are about ourselves and about life.

undergraduate, the hard work paid off in predictable ways. In graduate school the stakes were higher, the topics deeper, and the pace faster. I assumed success would come through maximizing time spent in the office. That assumption, combined with my high motivation, lack of natural talent, and excess of stubborn persistence, led to a perfect storm of downward spiral and burnout. The world closed in, a painful form of self-centeredness. Extreme motivation and persistence can be admirable. But doing physics with competence also requires peace of mind. Peace of mind requires mental maintenance. Mental maintenance depends on deliberately taking time to enjoy life, which includes periodically giving the work a rest.[4]

Although I would not want go through those days again, I am grateful for them now. When each despondent student looks

The author is shown sitting behind a 1964 VW Volkswagen bus in Sevier Lake (a salt flat) in western Utah, during a summer in his graduate school years. Out here peace of mind could be found. Why he did not do this more often back then he does not understand now. Photo by Douglas Strickland.

into my office and asks if we can talk, I can say, "I've been there." Most discouraged students are not suicidal, but I don't take that for granted. I have been a faculty member in a building where a student took his own life one beautiful Thursday afternoon. That student, we learned, had withdrawn from the university earlier in the week. The previous Monday a student had come to my office and asked me to sign a withdrawal form. I signed, he left, and I turned back to my desk. Today, if you come to my office to withdraw, you and I are going to have a long conversation, and not just about the course. If you jump ship from my course or the university, that's fine; but I must know where you're jumping to. Not, I pray, down a stairwell. That is never the answer, even if you see no other way out at that moment.

If I may, I would like to offer a few suggestions:

1. Never, never, never make an irreversible decision based on how you feel at the moment. Every year, about a dozen university students out of every 100,000 commit suicide.[5] Before you dive down a stairwell, for once in your life decide to let that intractable problem go. Go ride a bike, go dancing, go to a concert, go TP your professor's house . . . get out of yourself and do something fun. If you are in a no-way-out crisis and have to act now, pack your car and take a spontaneous road trip. You may end up as a coffee shop barista at Lake Tahoe or a guide for a Grand Canyon river trip company, interesting experiences that will give you time to renormalize your mind. If you decide to go back, you can always make the necessary apologies (as I have had to do). At least there will be pieces that can be put back together, and your story will keep going.

2. Do not get so obsessed with the degree of tomorrow that you overlook the joys of being alive today. Henry David Thoreau observed that "the cost of a thing is the amount of what I call life which is required to be exchanged for it."[6] The only reality we genuinely have is this present moment. However pressing the task at hand, take a look—really look—at that gorgeous sunset. We must work for the future and remember the past, but the living takes place right now.

3. Keep things in perspective. Life and physics are too important to be taken too seriously. If your self-worth depends on grades and accolades, that's a self-serving dead end. No matter how good you are, there is always someone better. The only comparison I should be making is against myself: Am I giving it my best, so that I won't be a hack?[7] Being another Richard Feynman is not the measure of success; we already have Feynman. But we need you to be *you*. You have a unique set of experiences and passions and skills to offer. Earning the respect of competent colleagues is the true measure of success.[8] Brilliance is nice, but quality is what counts. And if we never had any difficulties, where would our most colorful stories come from?

4. Setting aside periodic downtime is not goofing off—it's maintenance. Albert Einstein did not have his "miraculous year"[9] in 1905 through relentless nonstop work. He knew how to enjoy life. In 1902, while in graduate school and shortly before he got a job in the Swiss Patent Office, he met two fellows who became lifelong friends: Maurice Solovine and Conrad Habicht. The three comrades began meeting regularly over frugal dinners of sausage and cheese in their apartments to discuss physics and philosophy. Sometimes they took mountain hikes together. They called their three-member society the "Olympia Academy," poking fun at the pomposity of learned societies. Rather than delaying Einstein's immortal work, those sessions of relaxed conversation, with friends at a table or while sitting on a mountain awaiting the sunrise, helped his creativity bloom.[10]

When I look back on it now, I wonder what was so dreadfully important in the office that I could not give it a rest for a couple of hours once or twice a week. Had I done so, I would have returned refreshed to the tasks waiting there, and completed them with effectiveness and genuine joy. I know that to be so because that's what I do now.

5. Nurture your hidden inner selves. Inside every physicist there also lives a musician or an artist, a hiker, or a cyclist. To be a whole, interesting, authentic person, those other selves need space to grow, along with the physicist. Those inner selves teach one another. Samuel Crothers wrote, "As civili-

zation advances and work becomes more specialized . . . what then becomes of the other selves? The answer must be that playgrounds are provided for them outside the confines of daily business. . . . If one has only a little free time at his disposal, he must use that time for the refreshment of his hidden selves. If he cannot have a Sabbath rest of 24 hours, he must learn to sanctify little sabbaths, it may be of ten minutes' length. In them he shall do no manner of work."[11]

6. Strive for excellence, not perfection. When I was a TA, each week I gave a 10-point quiz. One student who I shall call Elisabeth got 10/10 every week—except one week, when the score was only 9. After class the student argued with me for 20 minutes about that one point. The irony of the situation was that I dropped the two lowest quizzes anyway, but for the persistent student, this argument was not about the quiz average—the student's ego demanded nothing less than perfect scores across the board. That's a crushing burden to carry around.

7. Notice that most of our difficulties are self-inflicted. When I walked out of graduate school, my professors were not telling me to leave. When I returned after a year of reflection, I decided that two things would change: (1) I was going to enter the lives of people around me, on and off campus; and (2) when I left the final time, it would be either because I graduated or because my professors had thrown me out, but I was not going to *take myself out*.

Garrison Keillor closes the short daily radio program of poetry readings, "The Writer's Almanac,"[12] by saying, "Be well, do good work, and keep in touch." Those are three important ingredients for wholeness of life. Practice maintenance. Be competent. Nurture relationships. To experience our place in the world with equanimity, the inner life and the outer life must be of a piece. The poet Rainer Maria Rilke eloquently expressed this yearning for wholeness:[13]

Ah, not to be cut off,
Not through the slightest partition
shut out from the law of the stars.
The inner—what is it? if not the
intensified sky,
Hurled through with birds
and deep with the winds of homecoming.

//

About the Author

Dwight E. ("Ed") Neuenschwander was born in New Mexico, grew up in Kansas and Colorado, and graduated from the University of Southern Colorado in Pueblo in 1976 with a degree in physics and math. He did some graduate work at Kansas State University in Manhattan and eventually finished a PhD in physics at Arizona State University (ASU) in Tempe in 1983. Dwight taught at ASU and Northern Michigan University in Marquette, and has been a professor of physics at Southern Nazarene University (near Oklahoma City) for 25 years.

A former director of SPS and Sigma Pi Sigma (1995-97), he edited SPS publications for 15 years and continues writing the "Elegant Connections in Physics" column for *The SPS Observer* and *Radiations*, the official publication of Sigma Pi Sigma. He has served on the SPS Council since 1991, coached the US Physics Team that competes in the International Physics Olympiad, and authored books for undergraduate physicists, including titles on Noether's theorem (2011, Johns Hopkins Univ. Press) and tensor calculus (in press).

Dwight enjoys mountain and desert solitude and starry nights; motorcycle trips and old cars; the Beatles' *Abbey Road* and Samuel Barber's *Adagio for Strings*; books, art museums, and trying to operate a tenor sax. He and his wife Rhonda have two sons and three wonderful grandchildren. He is pictured at left during a workshop at the 2012 Quadrennial Physics Congress of Sigma Pi Sigma (PhysCon), held in Orlando, FL. Photo by Ken Cole.

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[2] Robert Frost, "The Death of the Hired Man," *Complete Poems of Robert Frost*, Henry Hold & Co., New York, NY (1949); reprinted in *Adventures in American Literature*, John Gehlmann and Mary Rives Bowman, eds. Harcourt, Brace, & Co., New York, NY (1958), pp. 263-267.

[3] Charles Dickens, *A Christmas Carol* (first published 1843), published in 1957 (by Nelson Doubleday (1957, Garden City, NY) as the first of three Dickens Christmas stories, under the title *Christmas Stories*, illustrated by Walter Seaton.
[This excellent volume was part of an extensive book club set called "Junior Deluxe Editions." One of the best things my parents did for me at that age was to sign me up in that book club. Titles by Dickens, Robert Louis Stevenson, Mark Twain, Howard Pyle, and many others came each month and it helped make a reader out of me.]

[4] Of course, some students have the opposite problem; they never get around to getting the problems started, or they do them carelessly. I am not talking about those students here.

[5] Ref. 1, "Some Facts About Student Depression and Suicide."

[6] Henry David Thoreau, *Walden* (first published 1854), Houghton Mifflin Co., Boston, MA (1960), Sherman Paul, ed.

[7] In a radio interview, photographer David Plowden describes how, when he decided to become a photographer, he told himself, "Plowden, don't be a hack. Do it right." David Plowden interview titled "Disappearing America," from "The Story," North Carolina Public Radio, broadcast on National Public Radio, Dec. 7, 2007.

[8] Freeman Dyson, *Disturbing the Universe* (Harper & Row, New York, 1979), writes, "We do not all have the talent or the ambition to become prima donnas. The essential factor which keeps the scientific enterprise healthy is a shared respect for quality. Everybody can take pride in the quality of his own work, and we expect rough treatment from our colleagues whenever we produce something shoddy. The knowledge that quality counts makes even routine tasks rewarding." See also Robert Pirsig, *Zen and the Art of Motorcycle Maintenance* (Morrow, New York, 1974, 1999), wherein Quality is a proper noun.

[9] John Stachel, Ed., *Einstein's Miraculous Year: Five Papers that Changed the Face of Physics* (Princeton University Press, Princeton, NJ, 1998).

[10] Walter Isaacson, *Einstein: His Life and Universe* (Simon & Schuster, New York, 2007), pp. 79–84.

[11] Samuel Crothers, "Every Man's Natural Desire to Be Somebody Else," reprinted in *Exploring Life Through Literature* (Scott Foresman and Co., Chicago, IL, 1964), pp. 413–420.

[12] "Writer's Almanac" is broadcast weekdays on NPR stations; http://minnesota.publicradio.org/radio/programs/writers_almanac/.

[13] *Ahead of All Parting: The Selected Poetry and Prose of Rainer Maria Rilke*, translated and edited by Stephen Mitchell (Modern Library, New York, 1995), p. 191.

Taking Good Care of Yourself

WHAT TO DO IF YOU ARE FEELING DOWN AND OUT (OR SOMEONE YOU KNOW IS)

by Jim Bauer,
Personal Counselor at the College for Creative Studies in Detroit, MI

Some well-intentioned family member or friend may have told you that college would be "fun" or "easy" because you're so "smart" and "bright." Now that you're actually in college, you may be feeling the opposite—more alone, vulnerable, anxious, and, maybe, not as smart as you once thought you were.

This is normal. The experience of higher education is intended to be challenging. Many students want to make as great an impact as Galileo did, but the pressure to build upon 2,000-plus years of theoretical physics can be overwhelming. It's no surprise that we become frustrated about our abilities. We live in a drive-through-window culture. We expect more, and we expect it faster. The pressures we face (social, academic, financial, etc.) can be hard to bear at times.

Know that you're not alone. Difficult feelings are part of adjusting to a new environment, dealing with academic expectations, and meeting new people. Chances are that the feelings will disappear like light in a black hole. If they don't, here are some things to consider as you explore how to feel better:

- Are you eating a balanced diet with plenty of vegetables, fruits, and water?
- Are you consuming too much caffeine? Two hundred milligrams per day (just over two cups of coffee) is considered a safe dose, but I suggest using caffeine sparingly.
- Are you on any new medications?
- When was your last blood test? Have your thyroid and vitamin levels tested. Deficiencies in these areas can cause feelings of depression.

If you're in relatively good health and maintaining a balanced lifestyle, but you're still feeling lousy, you may have something else going on. It may be a good idea to connect with your school counselor, a support group, your family doctor, or a local mental health therapist if you are:

- Feeling depressed
- Overly anxious
- Overly sensitive
- Losing interest in things you used to enjoy
- Experiencing changes in your sleep
- Having difficulty concentrating
- Noticing a drop in self-esteem
- Struggling with changes in physical energy
- Worrying excessively
- Having difficulty controlling your thoughts and actions
- Feeling increased anger or irritability
- Having thoughts of suicide

If any of this sounds familiar, it may be a good idea to contact someone who can help. If you're feeling depressed and having thoughts of suicide, please contact someone as soon as possible There is hope, and you can feel better (see resources below).

If you're a friend, professor, family member, or anyone else concerned about someone showing some of these signs, please say something to that person. Gently provide your observations, express your concern, and ask if he or she is okay or needs some help. Say, for example, "Hi John. I've noticed that you have not been engaging in the classroom discussions like you used too. You seem to be more tired than usual. I'm not sure what's going on for you, but I'm concerned, and I wanted to check in with you. Are you doing okay? Is there anything going on in your life that you'd like to talk about or need some help with?" //

RESOURCES

SUICIDE PREVENTION

The American Foundation for Suicide Prevention (AFSP) has a 24-hour hotline you can call (1-800-273-8255) and resources online at www.afsp.org.

MENTAL HEALTH RESOURCES

ULifeline is an online mental health resource designed especially for college students. It contains information about a variety of mental health topics, mental health self-assessments, strategies to help yourself or a friend who may be experiencing a mental health concern, and a searchable listing of campus resources for assistance. ULifeline can be found at www.ulifeline.org.

Considering Counseling?

Some things to expect

by M. Dolores Cimini
Licensed Psychologist, Director of the Middle Earth Peer Assistance Program at the University at Albany, State University of New York

Deciding to seek counseling can be a difficult step, but it can also be the first step in making a change.

Counseling involves attending regularly scheduled sessions with a professional, talking about what is bothering you as openly and honestly as you can, and sometimes completing tasks or "homework" assignments. Moving forward through counseling often means recognizing that you may need to change the way you think, feel, or behave. Usually, you must try out new ways of doing things. Also, in the course of counseling, you may come to realize that things you once thought of in only a positive or negative way can be viewed a bit differently. The challenge of pushing your limits may cause some frustration, but with commitment and practice, you will find that you can feel better, stretch your limits, and find new and exciting aspects of yourself. //

When physics and life get hard, what gets you through?

Knowing that I've made it further than anyone in my family because of their sacrifices and that they support me. I can't let them or myself down.

When physics and life get hard, what gets you through?

Mountain Dew and the solution manual. Chocolate! Dr. Pepper! Coffee!

When physics and life get hard, what gets you through?

God for life, for physics. Keep faith with physics.

SUPPORT GROUPS
Many colleges and universities have student groups that provide support for their peers. Shown here are members of the University at Albany's Middle Earth Peer Assistance Program who staff a hotline for students. Photo courtesy of Dolores Cimini.

Finding [or Building] a Community

TIPS FOR IMPROVING THE CULTURE OF YOUR PHYSICS DEPARTMENT

by Kendra Redmond
Society of Physics Students Programs Manager

Sometimes physics students feel isolated. Sometimes physics students *are* isolated. Whether due to department size, department culture, personal reasons, or other factors, the absence of camaraderie and support within any major can lead to students losing motivation, dropping out, and being at increased risk for depression and anxiety.

If your physics department culture is less than awesome . . .

FIND COMMUNITY ELSEWHERE

If you are having trouble finding students with whom to study and commiserate or faculty who can provide advice and encouragement in your department, seek support elsewhere! Going at physics and life alone makes both much more challenging.

Your physics department may be small, but the physics community is BIG—there is a whole world of physicists out there! Be active regionally, nationally, or globally by participating in summer internships and research experiences (great ways to bond with fellow physics students and expand your personal and professional networks). Attend SPS zone meetings and physics meetings hosted by other professional societies. Get online and visit places like the SPS Facebook group and the Sigma Pi Sigma LinkedIn group, where you can interact with other physics enthusiasts. Run for the SPS National Council. Contact SPS chapters at a nearby college and join in on their events.

Mentors can be an important source of support and networking. If you would like to get to know a certain faculty member in your department or another, take a chance and set up a meeting. Ask people who inspire you to tell you their stories—this could open the door to an ongoing mentoring relationship. Many schools, professional societies, and organizations have mentoring programs that pair students with professionals working in their desired field.

Also, recognize that you can and should be engaged in communities outside of physics. Often you will find like-minded thinkers in other departments. Joining a bowling league, church choir, or campus group can provide a much-needed break from the stresses of physics. Quality time with friends and family can help to place physics homework and exams in perspective and refresh the spirit. You might also consider volunteering for a community service program in your area.

If you feel too overwhelmed, burned out, or otherwise not up to the task of seeking out community, you might benefit from talking to a professional counselor or mentor. Although it may not be talked about very much, lots of us in the physics community have benefited from talking with trained professionals whose job it is to help people regain perspective and make life manageable—and even fun—again. See Dolores Cimini's article on page 19 for more on what to expect from a counseling session.

Know that you are never out of options. Schools, majors, and research advisors can be changed, classes can be dropped, and career goals can be reassessed. Studying physics, or any other discipline, should not be done at the expense of your health and well-being.

TAKE STEPS TO BUILD COMMUNITY IN YOUR DEPARTMENT

Often a strong department community starts with a small group of students (sometimes n = 1) who cause change. If your department does not have a student lounge or similar place where students collaborate on projects, study for exams, and hang out, establishing one is a great place to start. This effort may be as simple as announcing that anyone who wants to work on homework of any kind is welcome to do so in room x from 7 to 10 pm each night. You might also invite like-minded students or faculty members out for lunch and honest discussion about how to improve the culture of the department.

For other community-building ideas, check out the Back to School feature in the Summer 2013 issue of *The SPS Observer*, www.spsobserver.org/2013/summer.html. //

On the flip side, a cohesive, supportive department that fosters community can have exactly the opposite effect—it can draw in new majors, as well as people who will never consider a degree in physics but enjoy being a part of the group. A community of support can encourage struggling students and offer strength and rejuvenation when students experience "burnout."

The culture of your physics department is important.

When physics and life get hard, what gets you through?

Music. Mozart, Beethoven, and Pachelbel.

If your physics department culture is awesome . . .

CONSIDER WHO IS BEING LEFT OUT

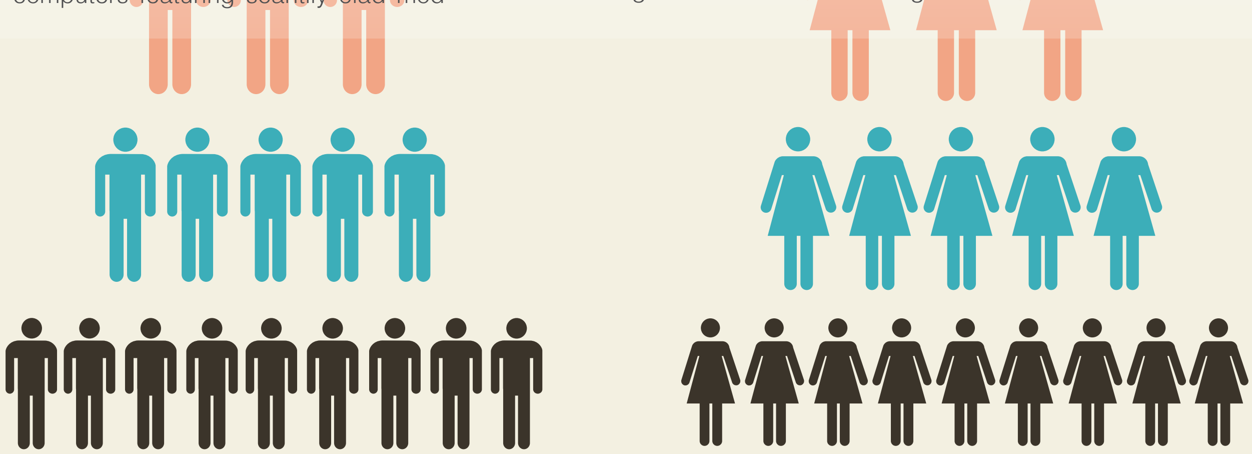
If your physics department is vibrant, supportive, and a great place to be a student, be thankful! Then take a few minutes to consider whether everyone is experiencing that same feeling of belonging. Are first-year students welcomed into the department? Are international students, minority students, and women feeling included? Is there anyone on the outskirts of the department that might benefit from a personal invitation to your next event or study session? Are there graduate students, postdocs, or faculty members who might like to be more engaged?

If there are people on the outside, consider how to make your group more inviting. Maybe you need to replace screen savers on the physics lounge computers featuring scantily clad models with something else. (Trust me, if you have screen savers like this you NEED to replace them, even if they make people laugh.) Maybe you need to cosponsor an event with a minority group on campus, host a lunch for first-year students, or invite a new faculty member to give a talk at an SPS meeting. Maybe you need to order a veggie lover's pizza and one fewer meat lover's pizzas. The point is, do it!

HELP SUSTAIN THE CULTURE

Just because your department has a great culture right now doesn't mean that it always will. An inclusive, supportive culture is the result of hard work, whether visible or not, and if new leaders don't emerge it will fade away. So pay attention to who is being left out and do something about it. Take on leadership roles, official or unofficial, and encourage the students coming after you to continue your positive traditions.

Departments are unique places in that their constituents change over almost completely every four years. The students who lead the SPS meetings and do the research in your department today will not even be memories for the students who are there five years from now. That is why it is so important to welcome incoming students and help them become enthusiastic, contributing members of your department that can carry on the legacy of inclusivity. Consider this important role as a mentor for younger students in the department to be one of your top priorities. One of the most important ways of sustaining a positive environment is to pass on traditions and customs to incoming students. //



Normal is a Dryer Setting Awkward is for Life

by Kaelyn Badura, Class of 2016, Florida State University in Tallahassee

IN THE SPRING OF 2013, KAELYN OVERCAME HER DISCOMFORT WITH PUBLIC SPEAKING AND GAVE A TALK AT TEDXFSU. PORTIONS OF THE TALK ARE EXCERPTED HERE.

I can kind of be awkward sometimes. To be even more honest than that, it's more often than not. I'm never in my comfort zone. I don't even think I have a comfort zone. I would like to share with you what makes me uncomfortable and, well, that's a lot of things . . . from spiders to public speaking to high heels.

Did you know that when you search the word "awkward" on the Internet, there over 100 million results on Bing alone, and that there are over a 8.5 million books written about it? For something that has a negative stigma, it's pretty popular.

But do we really understand what it means to be awkward? One thing I've learned as a physics major is sometimes the best way to answer a question is with another question. So in what department or what college on the university campus would you expect to find the most amount of socially awkward students or even faculty?

I guess I have no shame. I actually went to the class of 2016 page and posted this and got some pretty interesting responses. 5.36 percent of people assume that it might be in arts, human sciences, media, communications, or even music. 94.64 percent thought it might be science or engineering or math. So this kind of got me thinking. If people who are in some fields are expected to be awkward and that's where the prevalence is expected to be, how do they identify themselves?

My physics teacher was kind enough to allow me to just give this actual survey [about whether being awkward is good or bad]. And it is amazing to me that the people who don't identify as awkward are almost twice as likely to think that being awkward is bad.

Twenty percent of the students surveyed in the STEM fields thought that being awkward has some benefits. 79.9 thought that it was inherently detrimental and hindered your personal growth. 50.2 percent of that group identifies as awkward themselves. That's a pretty negative connotation from something a lot of people are experiencing.

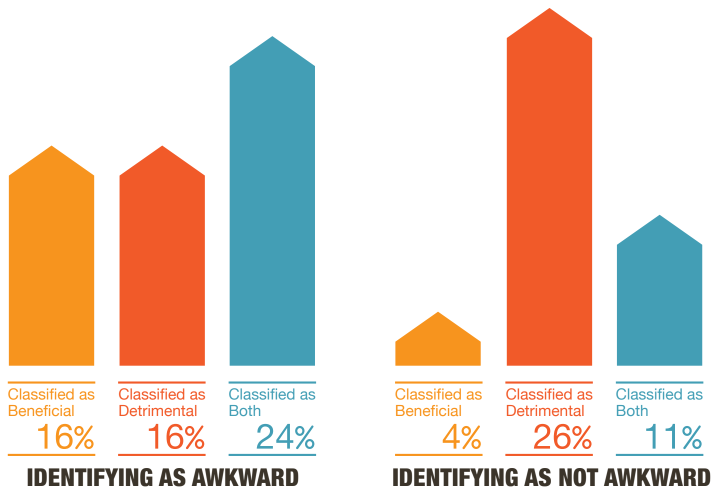
But what if I told you that being awkward was what you made it? What if I told you that being awkward was all about your attitude? But what if I told you that being awkward could be the key to success?

I had this moment of realization one day driving home back to central Florida from

Another Awkward Survey

KAELYN'S SURVEY OF STEM STUDENTS

What intrigued Kaelyn was the number of self-reported awkward people who thought that being awkward was detrimental (red) as opposed to beneficial (orange). Many people in each group thought that being awkward could be either detrimental or beneficial (blue).



Being awkward

COULD BE THE KEY TO SUCCESS

Tallahassee. Just zoning out while driving, like I'm sure many others do. And I happened to glance over and the girl in the car next to me was going the exact same speed, and we made eye contact. I'm used to feeling uncomfortable in situations like this. But I stood my ground because I wanted to see what she did. It took all of ten seconds for her to speed up and we did not meet again.

But then I realized being awkward isn't just a social convention. It's part of the human condition, and rather than it being a lack of ability to respond to people, it's a hyperawareness. I mean, I think it's pretty hard to respond to people or to actually be coherent sometimes when I'm wondering, "What are they thinking? Am I talking too much? Am I talking too slow? Did I wear the right thing today?"

If you're put into a situation where you experience discomfort, your body also responds. Your sympathetic nervous system effectively prepares you to cope with sudden stress. Your adrenal glands release adrenaline and other hormones that increase breathing, heart rate, and blood pressure, which would explain blushing, shaking, difficulty speaking, the lack of coherence.

But did you know that the same hormones allow your senses to be sharper, allow for better memory, and allow for better tolerance for pain? These same stressful situations are the ones that provide the perfect stimulus. Viktor Frankl once said, "In between the stimulus and a response there's a space. In that space lies the power to choose our response and in our power lies our growth and our freedom." The secret's in the spaces. PhD Elisha Goldstein poses the question, "What if awareness of that space, in that moment, could change the rest of your life?"

Although being awkward and having awkward situations does cause stress, it's important to remember that there's such a thing as eustress, a good type of stress, and that it's a healthy and important part of life. It also releases norepinephrine, one of the principle excitatory neurotransmitters, increases your good mood, and makes situations that would be otherwise challenging seem like a better opportunity for you to grow.

Refining this awareness, or in this case, hyperawareness of spaces allows you to be more flexible in your decision making, to develop methods that allow you to calm yourself back down when you're put into a situation that would normally cause you to freeze up. And when you lose your coherence, it makes it possible to come back from it. It promotes greater focus, empathy, compassion (both toward yourself and others), and a better understanding of your values, your aspirations, and your personal skills.

It's all about attitude. You have to be willing to embrace these uncomfortable situations and these awkward moments. Because what does this lead to? Increased self-awareness, introspection, increased hormones that make you happy, better focus, memory, and resilience, and stimulation of brain growth.

What do all these things equal long term, when you're willing to put yourself out there and to grow? You're more likely to pursue higher education. If you get your college degree, you're a lot more likely to make an even greater professional salary. And these skills you develop while you're combating the discomfort and while you're releasing these hormones make for longer-lasting happiness.

So I would like to leave you with this: normal is a dryer setting, but awkward is for life. //

When physics and life get hard, what gets you through?

Remembering that without the challenge I get lazy and wouldn't be inclined to learn as much as I'd like to.

STUDENT RESPONSES: BENEFICIAL

"Personally, I feel as if awkward situations can be beneficial to one's personal growth."

"More beneficial than not. It can open up more friendships and other connections."

STUDENT RESPONSES: DETRIMENTAL

"Awkward = detrimental."

"Detrimental. I can't make many friends or deal with situations that are embarrassing."

"...it just means you're different."

STUDENT RESPONSES: BOTH

"I think it's situation dependent whether it's helpful or harmful. For example, it could be harmful if being awkward causes you to freeze up [in an interview], but the interviewer could like that so it's positive."

WATCH THE TALK

To see Kaelyn's full talk, visit http://tedxtalks.ted.com/video/Normal-is-a-Dryer-Setting-Awkwa.

The Struggles of Paul Ehrenfest

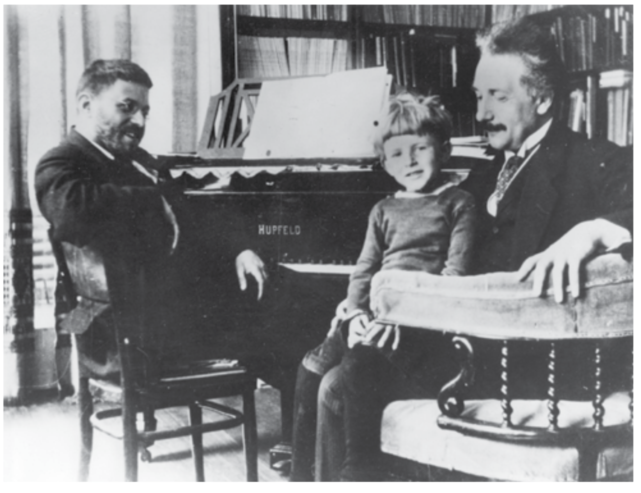
by Dwight E. Neuenschwander
Professor of Physics at Southern Nazarene University in Bethany, OK

During the founding years of quantum mechanics, the Niels Bohr Institute in Copenhagen, Denmark, hosted an annual spring meeting where the hottest topics in physics were discussed. It became traditional to close the meeting with a skit that parodied the state of physics at the time. The 1932 conference coincided with the tenth anniversary of the institute's founding and needed to end on a special note.

A few years earlier, Wolfgang Pauli had suggested the existence of a particle carrying zero mass and zero electric charge that could explain the missing energy and momentum in beta decay, a type of radioactive decay of the nucleus. He called this hypothetical particle the "neutron." When in 1932 James Chadwick discovered the massive neutral particle we now call the neutron, Enrico Fermi suggested that the name of Pauli's particle be changed to *neutrino*, the "little neutral one."

At the Bohr Institute's 1932 meeting, Pauli's neutrino was still a speculative teaser, with many doubters. This offered the perfect theme for the 1932 closing skit, modeled on Goethe's *Faust*, in which Faust, who has attempted to master all knowledge and remains frustrated, makes a pact with the devil (Mephistopheles), who will do Faust's bidding in this life. With Mephistopheles' help, Faust seduces the beautiful Gretchen, but their relationship leads to tragedy. Of the brilliant Copenhagen parody, which portrayed Pauli and Paul Ehrenfest, George Gamow wrote, "The theme of this dramatic masterpiece has Pauli (Mephistopheles) trying to sell to the unbelieving Ehrenfest (*Faust*) the idea of a weightless neutrino (Gretchen)."[1]

Ehrenfest (1880–1933) was born in Austria and earned his PhD under Ludwig Boltzmann. During his career Ehrenfest made fundamental contributions to statistical mechanics and quantum theory, and was held in the highest esteem by his students and colleagues. In September 1912, on the recommendation of Arnold Sommerfeld, he was offered the prestigious chair at the University of Leiden in the Netherlands, held by the departing H.A. Lorentz.



PAUL EHRENFEST (left), Ehrenfest's son, Paul, Jr., and Albert Einstein. Ehrenfest and Einstein were close friends, the latter staying in the Ehrenfest home whenever he visited Leiden, Netherlands. Image credit: Museum Boerhaave, Leiden, courtesy of the Emilio Segrè Visual Archives.

Paul Ehrenfest always insisted on honesty in thought and action. In the preface to Ehrenfest's collected papers, H.B.G. Casimir wrote that Ehrenfest's lectures were brilliant in an unconventional way:[2]

> *He emphasized salient points rather than continuity of argumentation; the essential formulae appeared on the blackboard almost as aesthetical entities and not only as links in a chain of deductions. . . . One had very little inclination to go to sleep during Ehrenfest's lectures, but if one ever showed any tendency in that direction one was immediately and ruthlessly called to order.*

In his 1934 memorial essay for Ehrenfest, Albert Einstein recalled when they first met 22 years earlier: "We also discussed the theory of relativity, to which he responded with a certain skepticism but with the critical judgment peculiar to him. Within a few hours we were true friends—as though our dreams and aspirations were meant for each other. We remained joined in close friendship until he departed this life."[13] Whenever Einstein visited Leiden, he stayed in the Ehrenfest home.

The authors of the *Faust* parody no doubt chose Ehrenfest as Faust because of his inherent skepticism, his brilliance, his mastery of a comprehensive range of subjects, and his sterling standards of truth. Casimir recalled that "To Ehrenfest . . . discussions and arguments were an essential part of his scientific activity and the best way to clarify an obscure point."[2] Ehrenfest's skepticism of *Gretchen* was genuine.

But whether or not it was consciously recognized by the *Faust* parody playwrights, Ehrenfest's personality also fit the gloominess of the original Faust. In the 1932 skit, the opening scene begins with Faust (Ehrenfest) brooding with dissatisfaction over the vast knowledge he has mastered:

I have–alas–learned Valence Chemistry,
Theory of Groups, and the Electric Field,
And Transformation Theory as revealed
by Sophus Lie in eighteen-ninety-three.
Yet here I stand, for all my lore,
No wiser than I was before.

From the factual notes about his career mentioned above, we might assume that life for Ehrenfest was always a forward-looking adventure. Far from it. From a young age he was a melancholy figure who struggled with chronic depression. Paul was the youngest of five brothers and suffered from poor health as a child. He was often the target of anti-Semitism. His mother died when he was 10. He loathed school, and his academic performance suffered. His school experiences were sufficiently negative that, years later, he insisted that his own children be educated at home.[4]

His biographer, Martin Klein, wrote, "He was often miserable, deeply depressed, and at odds with himself and the world." When Paul was 16 his father died. Older brother Arthur convinced Paul to remain in school, and his outlook seemed to improve. Klein continues, "Paul was apparently able to work himself out of depression, which had sometimes been deep enough to make him contemplate suicide. His intellectual interests grew stronger, perhaps as a form of self-protection."[4]

In 1899 Paul enrolled in the Technische Hochschule in Vienna and attended lectures by Boltzmann on the new subject of statistical mechanics. It was under Boltzmann's influence that Paul's loathing of school was replaced by a passion for physics and mathematics. European students in those days typically migrated from one university to another to study under a variety of mentors. Starting in 1901, Ehrenfest took courses at the University of Göttingen under David Hilbert, Walther Nernst, Felix Klein, Johannes Stark, and Karl Schwarzschild. At Göttingen he met a young Russian mathematics student, Tatyana Alexeyevna Afanasyeva. At that time women were not allowed to attend meetings of the mathematics club, a rule that Ehrenfest successfully challenged after "quite a battle."[4] (His tenacity would resurface after Hitler came to power, when he found jobs for German Jews fleeing the Nazis.[5]) He returned to Vienna in 1904 and completed his doctorate that June under Boltzmann's direction, writing a dissertation on the motion of rigid bodies in fluids. His advisors respected this work, but, as was the pattern throughout his life, Ehrenfest felt it to be inadequate. He did not publish his dissertation. However, Tatyana soon joined him and they were married in Vienna that December.[4]

After finishing his PhD, Dr. Ehrenfest had difficulty securing a permanent position. Despite repeated residences in Vienna, Göttingen, and St. Petersburg, his letters of application to numerous institutions in Europe and North America proved fruitless. He published several important papers between 1904 and 1912, but his situation did not stabilize until he was offered the Leiden position in 1912. Even then, Ehrenfest continued suffering from unrealistic self-doubt.

EHRENFEST AND STATISTICAL MECHANICS

Boltzmann, Ehrenfest's mentor, was a principal founder of statistical mechanics. The Boltzmann transport equation, an inhomogenous equation of continuity, describes the evolution of the velocity distribution function for particles of an ideal gas;[7] its equilibrium solution is the Boltzmann factor, $P_n \sim \exp(-E_n/kT)$, which gives the probability for a particle to be in state n at energy E_n in an environment at absolute temperature T. The factor k converting temperature to energy is today called "Boltzmann's constant." Boltzmann thereby founded an approach to equilibrium and out-of-equilibrium thermodynamics, based on the assumption that a macroscopic system can be partitioned into a set of independent microscopic subsystems, i.e., atoms. The keystone concept in Boltzmann's approach was his celebrated "H theorem." The quantity H was Boltzmann's name for the average value of the logarithm of P_n, and the H theorem demonstrates that H in an isolated system never increases.[8] This allows the definition of entropy, which never decreases in an isolated system, to be proportional to $-H$, leading to the microscopic interpretation of entropy as a measure of disorder.

Boltzmann and Ehrenfest were kindred spirits not only in their love of statistical mechanics, but also in their melancholy dispositions. In 1906 the physical reality of atoms was still controversial. Jacob Bronowski wrote,[9]

Had anti-atomic doctrines then really won the day, our advance would certainly have been set back by decades, and perhaps a hundred years. . . . Did Boltzmann just argue? No. He lived and died that passion. In 1906, at the age of sixty-two, feeling isolated and defeated, at the very moment when atomic doctrine was going to win, he thought all was lost, and committed suicide.

Ehrenfest wrote an obituary for his mentor and friend. Boltzmann had promised the editors of *Enzyklopädie der Mathematischen Wissenschaften* an article on statistical mechanics, and the editors asked Ehrenfest to write it in Boltzmann's place. He and his wife and colleague Tatyana worked together on this project,[10] which took longer than expected but was expanded into the classic book, *The Conceptual Foundations of the Statistical Approach in Mechanics.*[11] In it they made some clarifying distinctions in Boltzmann's assumptions and simplified his proof of the H theorem.

EHRENFEST AND QUANTUM MECHANICS

Thus, one of Paul Ehrenfest's major contributions to physics was laying a groundwork in statistical mechanics that facilitated the statistical interpretation of the quantum mechanics soon to come. Important among these was his recognition of the importance of the "action" J, the closed-path line integral of momentum times displacement:

$$J \equiv \oint p \cdot dr. \quad (1)$$

The action plays an important role in the classical dynamics of periodic systems. In classical mechanics, J was shown to be an "adiabatic invariant." Adiabatic invariance occurs when a system exhibits a conservation law that would not otherwise occur, when changes are made very slowly so that there is little variation in system parameters during one cycle. For instance, if a simple pendulum's length changes, neither its period T nor its energy E remain constant. But if the change is made sufficiently slowly, then the time-average of ET is conserved.[12]

In the early days of confronting quantized oscillators, quantized radiation, and quantized atoms, with their finite energy gaps between energy levels, it was thought the system should not make transitions between states *too* easily. Ehrenfest realized that adiabatic invariants, notably J, could be the path to a quantum theory. David Bohm noted, "In fact, Ehrenfest originally argued from the adiabatic invariance of J that this was the only classical quantity that could sensibly be quantized."[13] This inspired the algorithm of setting $J = nh$ for periodic systems, the Bohr-Sommerfeld-Wilson quantization rules, with n an integer and h the quantum. Bohr's 1913 model of the hydrogen atom offers a famous example.[14] More generally, the energy of a periodic system becomes quantized through J because $p = \pm\sqrt{[2m(E—U(x))]}$. Thus came about the precursor of quantum mechanics, what we now call "old quantum theory," based on adiabatic invariance as recognized by Ehrenfest. Old quantum theory held the field for about 10 years, between the Bohr atom and the advent of quantum mechanics in terms of de Broglie wave functions and the Schrödinger equation that took over in the mid-1920s.

One of the beauties of science is that its revolutions do not result in the leaders of the old order being hanged and their books being burned. Revolutions in physics seldom discard preceding theories. Rather, the old ideas typically become special cases of the new. Indeed, as a new theory gets constructed, this "correspondence principle" offers guidance.

Let us explore one elegant display of the correspondence principle that occurs with "Ehrenfest's theorem." (See your favorite quantum mechanics textbook for reference.) The theorem shows that, in general, quantum mechanics contains Newtonian mechanics as a special case. Newton's second law says that for a net force derivable from a potential energy function $U(x)$ (here considering one-dimensional motion), a particle's momentum changes with time according to

$$-\frac{dU}{dx} = \frac{dp}{dt}\,. \quad (2)$$

Newtonian mechanics assumes the existence of a precise particle trajectory for which the instantaneous location *and* momentum can be simultaneously known, in principle, to an infinite number of decimal places. But quantum mechanics changes that picture.

For a particle moving along the x axis, quantum mechanics calculations are done in terms of a complex number $\Psi(x,t)$, called a "wave function." Its square, $\Psi^*\Psi$ (* denotes complex conjugate), is a probability distribution. The probability $P(a,b)$ of locating the particle in the interval $[a,b]$ along the x axis is

$$P(a,b) = \int_a^b \Psi^* \Psi \, dx \quad (3)$$

where $P(-\infty,+\infty) = 1$ because the particle has to be *somewhere* so long as it exists. The ensemble average value of an observable Q (represented in the formalism as an operator) follows from the rules of statistics with a continuous probability density,

$$\langle Q \rangle = \int_{-\infty}^{+\infty} \Psi^* Q \Psi \, dx. \quad (4)$$

These maneuvers describe what can be done with Ψ when we know it. The way to find Ψ, given the particle's mass m and the potential energy function whereby it interacts with the rest of the world, is to solve the Schrödinger equation,

$$\frac{-\hbar^2}{2m}\frac{\partial^2 \Psi}{\partial x^2} + U(x)\Psi = \frac{-\hbar}{i}\frac{\partial \Psi}{\partial t} \quad (5)$$

or, for brevity,

$$H\Psi = \frac{-\hbar}{i}\frac{\partial \Psi}{\partial t} \quad (6)$$

where $H = p^2/2m + U$ (the "Hamiltonian"), with

$$p\Psi = \frac{\hbar}{i}\frac{\partial \Psi}{\partial x}\,. \quad (7)$$

This statement about momentum being a derivative is equivalent to the de Broglie postulate that, corresponding to a free particle of momentum p, there exists a harmonic wave of wavenumber k, $\Psi \sim \cos(kx) \sim e^{ikx} = e^{ipx/\hbar}$. Consideration of the quantity $p\Psi \sim pe^{ipx/\hbar}$ leads to Eq. (7). But a harmonic wave extends to infinity and therefore gives a uniform probability distribution constant across all space. That does not make sense for describing a realistic particle, which can be at least approximately localized.

Borrowing a page from wave physics, quantum mechanics builds wave pulses by adding many harmonics to form a superposition of waves. Where the wave pulse is sharply peaked, the probability density for locating the particle there is large and the rest of the pulse damps out as one approaches infinity, as $P(-\infty,+\infty) = 1$ requires. The price paid for this formulation is that as a superposition of harmonics, there is no unique wavenumber for a wave pulse; therefore the approximately localized particle cannot have a unique momentum.

However, when the width of the wave pulse becomes very small, then the particle begins to approach the classical ideal of localization. Since probability implies an ensemble of measurements on identically prepared systems, the ensemble average of

dp/dt should equal the ensemble average of the Newtonian force. Ehrenfest showed this to be so by proving that

$$\langle \frac{-\partial U}{\partial x} \rangle = \langle \frac{dp}{dt} \rangle. \tag{8}$$

Yesterday's great discovery is today's homework exercise, and so it is with Ehrenfest's theorem. We do not *really know* Ehrenfest's theorem until we make it our own by proving it for ourselves. An efficient way to do that makes use of the following result for the ensemble average of the time rate of change of any quantity Q:

$$\langle \frac{dQ}{dt} \rangle = \langle \frac{\partial Q}{\partial t} \rangle + \frac{i}{\hbar} \langle (H, Q) \rangle \tag{9}$$

where $(H,Q) \equiv HQ - QH$, the "commutator" of H and Q. Before proving Ehrenfest's theorem, we must prove this identity; then Ehrenfest's theorem follows at once. To proceed, differentiate Eq. (4) with respect to time, which yields

$$\frac{d\langle Q \rangle}{dt} = \int_{-\infty}^{+\infty} \left\{ \frac{\partial \Psi^*}{\partial t} Q + \Psi^* \frac{\partial Q}{\partial t} \Psi + \Psi^* Q \frac{\partial \Psi}{\partial t} \right\} dx. \tag{10}$$

Use Eq. (7) to replace $\partial\Psi/\partial t$ with $-iH/\hbar$ (and likewise for its complex conjugate, noting that $H^* = H$ if $U^* = U$, which is necessary for $P(-\infty,+\infty) = 1$ to hold for all time), and obtain Eq. (9).

Ehrenfest's theorem follows by setting $Q = p$. Since momentum is proportional to the gradient, it is not explicitly a time-dependent operator; hence $\partial p/\partial t = 0$. Since p commutes with itself, $(H,p) = (U,p)$ so that

$$(Up - pU)\Psi = \frac{\hbar}{i} \left[U \frac{\partial \Psi}{\partial x} - \frac{\partial}{\partial x}(U\Psi) \right] - \frac{\hbar}{i} \frac{\partial U}{\partial x} \tag{11}$$

and Ehrenfest's theorem follows at once.

Ehrenfest's theorem is fundamental because it shows that quantum mechanics and Newtonian physics are consistent in the sense that the latter is contained within the more comprehensive former. Even though exact Newtonian trajectories do not exist in quantum mechanics (and only approximately so in the real world), the Newtonian paradigm still exists within quantum theory as an ensemble average.

PAUL EHRENFEST'S END

Our mention of Ehrenfest's contributions to physics must be limited to samples here. Our purpose was not to recite them all, but to show that Paul Ehrenfest earned the respect of other physicists professionally, in addition to having their respect as a human being and friend. An obituary for him published in the October 27, 1933, issue of *Science* lamented,[15]

> *The sudden news of the death of Professor Paul Ehrenfest, of the University of Leiden, has given his many friends all over the world a great shock of intense sorrow. It is difficult, with the pain lying as a stone on our hearts, to try to enumerate the special virtues of his lovable character and his great mind. Perhaps they were his honesty and his strong and humble desire to help where he could. Everybody could count on his help, and it was especially so for his students, not restricted to physics alone . . .*

How tragic, then, that in Ehrenfest's own mind, no matter what he accomplished, he always felt himself and his work to be of little worth, even though his colleagues held him in the highest esteem. His despondency became a downward spiral. To complicate his state of mind further, he and his wife Tatyana suffered a fateful partial estrangement,[16] and he had enormous trouble accepting the fact that one of his beloved children, his son Wassik, had Down syndrome and required lifelong clinical attention.

In May 1931 Ehrenfest told Bohr in a letter, "I have completely lost contact with theoretical physics. I cannot read anything anymore and feel myself incompetent to have even the most modest grasp about what makes sense in the flood of articles and books. Perhaps I cannot at all be helped anymore."[4]

In August of that same year he wrote a farewell letter to some of his former students:

> *. . . I have you much more to thank than you realize. Your affection, your consistent wish to give me confidence in myself made it possible until just recently for me to maintain my enthusiasm. Forgive me that it is now over.*

His last letter to some close friends, including Bohr and Einstein, evidently never sent, also carries the sad farewell message of one who has given up all hope:[4]

> *In recent years it has become ever more difficult for me to follow the developments in physics with understanding. After trying, ever more enervated and torn, I have finally given up in desperation. This made me completely weary of life . . .*

On September 25, 1933, Paul Ehrenfest saw no future for himself or his son Wassik. In the waiting room of a clinic where Wassik was being treated, Paul shot Wassik. Then he turned the gun on himself.

The following year Albert Einstein published a memoriam to his friend. He sadly wrote,[17]

> *He was not merely the best teacher in our profession whom I have ever known; he was also passionately preoccupied with the development and destiny of men, especially his students. . . . His students and colleagues in Leiden loved and esteemed him. They knew his utter devotion, his nature so wholly attuned to service and help. Should he not have been a happy man?*
>
> *In truth he felt unhappier than anyone else who was close to me. The reason was that he did not feel equal to the lofty task that confronted him. Of what use*

was it that everyone held him in esteem? His sense of inadequacy, objectively unjustified, plagued him incessantly, often robbing him of the peace of mind necessary for tranquil research. . . .

We whose lives have been enriched by the power and integrity of his spirit, the kindness and warmth of his rich mind, and not least his irrepressible humor and trenchant wit—we know how much his departure has impoverished us. He will live on in his students and in all whose aspirations were guided by his personality.

WHAT PAUL EHRENFEST CAN TEACH US BESIDES PHYSICS

Because he was a great teacher, I trust that Paul Ehrenfest would not mind us trying to extract insights from his story. Along with the statistical mechanics and quantum theory that we learn from him, he has even more important lessons to teach us about *life*. In a previous set of articles on depression and suicide among students,[18] we learned that students whose depression places them at risk for suicide often exhibit a pattern of behaviors. Paul Ehrenfest exhibited these behaviors. To him, ending it all made perfect *logical* sense because he saw no other way out. He was chronically melancholic, he had suffered loss at a young age, he talked about suicide before doing it. Above all, he was consistently harder on himself than was anyone else, underrating what he *did* have to offer, and exaggerating his own inadequacies. *If the little voice telling us we don't measure up is coming from inside our own heads, and not from our respected mentors who know us well, then that voice is a liar*. The tragedy for Paul and Wassik Ehrenfest, and their family and friends, is that Paul listened to that lying voice.

The study of physics is challenging, demanding, and frustrating at times. Sometimes we feel like quitting. Paul Ehrenfest's pain was very real, and that must be respected. He needed help and compassion, not judgment. I don't know how much help was available to Ehrenfest, or whether he availed himself of whatever help was available. But I do know that sources of help, with grace and understanding, *are* accessible today.

Two months ago I served as the faculty representative on the Student Development Committee of my university's board of trustees. This committee's responsibilities include the on-campus clinic and counseling center. The members learned that, last year, over five thousand appointments were made with the counseling center at a school of about 2,000 students (the center also serves the local community). Most of the appointments were about mental health issues. This generated focused discussion in the committee meeting. It was impressively clear that everyone took seriously their role in providing resources and an environment where struggling students could be met at the points of their needs. Each struggle is personal, but resources and caring people are willing and available. [For more on this, please see the story by Jim Bauer on page 18.]

The 2004 articles[18] cited studies showing that chronically depressed students typically imagine they are facing their difficulties alone. *You are not alone*. As a faculty member, I implore you: When you are stuck, when you see no way ahead, come talk to me. And I will seek you out if I detect something is going wrong. Together, we will work something out. Doing physics is not the most important task of the physics community. *Our most important task is to be a community*. [For thoughts about finding and building a community, see the story by Kendra Redmond on page 20.]

DOING PHYSICS IS NOT THE MOST IMPORTANT TASK OF THE PHYSICS COMMUNITY.

Our most important task is to be a community.

In most of my dealings with distressed students—and this was certainly true in my own experience as a distressed student—one's identity and self-worth as a person can too easily be equated to how one is doing in this major or in that course. In his farewell letter Ehrenfest said it had become "*ever more difficult for me to follow the developments in physics with understanding. . . . I have finally given up in desperation. This made me completely weary of life . . .*" Ehrenfest's personal struggles show that he was wrestling with more issues than dissatisfaction with his understanding of physics. But physics was an important part of who he was, and it's an important part of your life and mine, too.

In the 1971 movie *Le Mans*, Steve McQueen's character, Michael Delaney, when asked what's so important about racing as to risk one's life for it, replied that, to a race car driver, "Everything else is just waiting." Nobody consciously decides that his or her worth *as a person* depends on winning Le Mans or getting an A in quantum mechanics. We get drawn into performance-as-intrinsic-worth traps incrementally and unconsciously. Yes, we physics students, like race car drivers, should do everything we can to achieve excellence. We should take the *work* seriously, but we should not take *ourselves* seriously. My small grandchildren do not care what my grades were or how many papers I have published. But they do care—and they can tell—whether or not I am genuine. My worth as a *person* has nothing to do with physics. And as much as I love it, physics is only a small part of a very large world of experiences to appreciate.

Ehrenfest and Bohr met in 1918, in Leiden. M.J. Klein recalls how they "had much to talk about together—from the current problems of quantum theory to the Icelandic sagas . . . Their exchanges ranged over heaven and earth as Ehrenfest showed his new friend the treasures of the Dutch museums and the brilliant colors of the bulb fields."[4] Sometimes the museums and Icelandic sagas and the fields of flowers are more important than quantum theory.

As we pursue the elegant connections in physics, let us never let a stack of physics papers disconnect us from the great range of experiences that life has to offer:

Parchment—is that the sacred fount
From which you drink to still your thirst forever?
If your refreshment does not mount
From your own soul, you gain it never.
—Faust [19]

//

ACKNOWLEDGMENTS

I wish to thank Kendra Redmond and Daniel Golombek for making some insightful suggestions in the preparation of this article.

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I have, alas, studied philosophy,
Jurisprudence and medicine, too,
And, worst of all, theology
With keen endeavor, through and through—
And here I am for all my lore,
The wretched fool I was before . . .

Walter Kaufmann, tr., *Goethe's Faust* (Doubleday, Garden City, NY, 1963), p. 93.

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15. G.E. Uhlenbeck, S. Goudsmit, and G.H. Dieke, "Paul Ehrenfest," obituary in *Science* **78**(2026), Oct. 27, 1933, pp. 377–378; or http://www.jstor.org/stable/1660647?seq=1.

17. *Ibid*., pp. 236–239.

18. "Sometimes I Feel Like Quitting," "Some Facts About Student Depression and Suicide," and "The Longer View," *SPS Observer* (Fall 2004), pp. 1–7.

19. Goethe's *Faust* (Kaufmann translation), Ref. 1, p. 107.

I Never Asked for This!

ADVENTURES AT THE 166TH ACOUSTICAL SOCIETY OF AMERICA (ASA) MEETING, DECEMBER 2–6, IN SAN FRANCISCO, CA

by Morgan Smathers
Class of 2014 at Rhodes College in Memphis, TN

While waiting for a specimen to be scanned this summer, I took a short break and noticed an e-mail inviting me to an Acoustical Society of America meeting scheduled to take place in five months. As a rising senior, I had attended numerous undergraduate conferences—from small SPS zone meetings to the giant PhysCon 2012—but I had never been to a major scientific conference.

I approached my advisor, Brent Hoffmeister, with a proposal to present my research at the meeting. After three years of working I certainly had plenty of data. So I submitted an abstract just days before I left for summer adventures and began working on a poster I intended to finish upon my return. Another student, Catherine Miller, also submitted a poster abstract. All that was left was to wait . . .

Nearly two months later, Catt and I received a surprise; instead of presenting in the undergraduate poster session, we would each be giving 15-minute oral presentations during the general biomedical acoustics session. Upon receiving this news, there may have been several slight moments of panic on our parts.

After three months of practice and preparation, we flew across the country to sunny California. We had no idea what to expect, but we dove right in.

Unlike the tightly prescribed undergraduate conferences I had attended, in which there were at most two parallel sessions, the ASA meeting consisted of seemingly countless simultaneous talks about sound that filled half the conference rooms in the Union Square Hilton. We attended a crowded talk on marine biologists trying to piggyback off technology to map whale migration, and later we found our way to a surprising number of talks about bubbles. One professor described his attempt to co-teach a course about designing instruments with a music teacher and an art teacher. His conclusion, "It was a wonderful and fascinating experience, one we will probably never do again." As the days continued, each of us developed our own taste in talks. I was fascinated by defense applications, such as using acoustics to locate low aerial objects. Catt enjoyed presentations on acoustical architecture.

On Tuesday evening we rehearsed our talks one last time, still nervous about the presentations we could hardly believe we were giving. Catt went first, describing our efforts to use ultrasonic imaging to measure bone density. I followed with a more quantitative comparison of our technique to multiple microtomography scans. The professors and grad students in attendance had half a dozen questions for each of us. I've since been told that was a hefty number of questions, but a good sign. Then the moderator quipped that the next presenter was a no-show, and I could answer questions for 15 more minutes. I blanched, but steeled myself to dissect the merits of various ultrasonic gates or transducer frequencies. Thankfully, a break was declared, and several questioners approached us with friendly explanations, suggestions, and simple congratulations.

Presenting to top professionals in our field was an opportunity we would not trade. We made friends with physicists from France, Germany, and Ireland, and, at an evening student mixer, met students from around the world. Even though I may not return to physics research after graduating this May, the meeting was well worth the trip. Being pushed out of my comfort zone ended up being one of the best experiences of the entire conference. //

Being pushed out of my comfort zone

ENDED UP BEING ONE OF THE BEST EXPERIENCES OF THE ENTIRE CONFERENCE

THE AUTHOR poses for a photo at the 166th ASA Meeting. Photo courtesy of Morgan Smathers.

NEXT UP

The acoustics community will come together again to discuss topics ranging from musical instruments to aircraft noise at the 167th ASA Meeting, May 5–9, 2014, in Providence, Rhode Island. For more information, see http://acousticalsociety.org/meetings/providence.

TUNE IN

Check out "lay language" papers describing some of the talks given at the last ASA meeting. Visit www.acoustics.org/press/166th/lay_lang.html.

DPF: From α_s to Z[1]

ATTENDING THE 2013 MEETING OF THE AMERICAN PHYSICAL SOCIETY (APS) DIVISION OF PARTICLES AND FIELDS (DPF), AUGUST 13–17 IN SANTA CRUZ, CA

by Elwin Martin
Class of 2014 at the Georgia Institute of Technology in Atlanta

I attended the American Physical Society (APS) Division of Particles and Fields (DPF) meeting primarily to present results from my work on flavor-changing neutral currents, but while I was there I also learned much about the state of high-energy physics (HEP) in general. Plenary talks gave overviews of results across the HEP community factions known as "frontiers," relatively recent divisions created by the Department of Energy (DOE) that are intended to better organize the distribution of research funds. Unfortunately, this DOE scheme seems to have imposed artificial barriers between HEP physicists, creating competition where it perhaps should not be. The usefulness of frontiers as a concept was thus often discussed during the meeting.

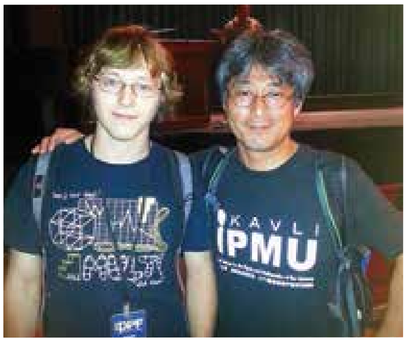
The goal of DPF this year was to nail down the community's priorities; it focused on Snowmass, a meeting that took place the previous week that laid the groundwork for the goals the community hopes to meet over the next 10 years. The title of my favorite plenary talk, given by Michael Peskin from Stanford, asked an important question: "What have we learned at the Energy Frontier?" The takeaway message was that there are many ideas for the next machine to be built—too many, in fact. Today's funding climate will allow for investment in only a handful of the high-energy particle accelerators and other ideas proposed at Snowmass. Peskin outlined three main facets of the energy frontier future: searches for heavy particles (which may or may not be plausible with presently attainable energies), precision Higgs boson studies that may lead to new physics, and searches for new physics connected to W, Z, and top physics.

THE GOAL OF DPF THIS YEAR WAS TO NAIL DOWN
the community's priorities

The meeting also had an important social component. It was clear that most attendees and presenters knew one another but were willing to welcome new people to the top quark research community. Unlike many other meetings, all meals were provided. During one lunch, Sarah Demers from Yale gave a great overview of gender bias in physics and science as a whole, keeping the discussion comfortable and light.

There was also a "Young Physicists Forum," "young" meaning somewhere between undergraduate and early postdoc. The panelists came prepared to discuss how young academics can be successful, but the discussion turned surprisingly pessimistic at times. A recurring theme among the questions was the timing for one's exit from academia. Questions like "How many postdoctoral positions should I take before I know I should quit?" gave me the impression that young physicists are far from naive; we border on cynical. The chatter wasn't all gloomy, though. Important questions about how to distinguish oneself in a large collaboration and opportunities available in national laboratories were addressed. The panel advised us to become the collaboration expert in whatever we do best. I think this advice is salient even in small organizations, and striving for mastery of a relevant and useful skill in one's research group is a goal I will keep in mind.

Overall, the most important thing I learned from this meeting was that the high-energy community is a wonderful one, despite the inherent competition. I look forward to returning to DPF in 2015 as a graduate student. //



THE AUTHOR (left) poses for a photograph with DPF guest speaker Hitoshi Murayama of the University of California, Berkeley. Photo courtesy of Elwin Martin.

NEXT UP

Many researchers who presented at DPF will also attend the much larger 2014 APS April Meeting, April 5–8, in Savannah, GA. See: www.aps.org/meetings/meeting.cfm?name=APR14.

MORE INFORMATION

Read the DPF newsletter, check out a report about DOE priorities, and learn about the future of neutrino physics at the DPF website: www.aps.org/units/dpf/.meeting.cfm?name=APR14.

the SPS Observer
American Institute of Physics College Park
One Physics Ellipse
College Park, MD 20740

Connect with Your Zone!

SPS zone (regional) meetings are THE place to meet fellow physics students in your area, share your research, and experience great physics talks and tours. Make plans now to attend a zone meeting near you!

To learn more or find out if additional meetings have been added, visit **www.spsnational.org/governance/zones**.

Spring 2014 SPS Zone Meetings

ZONE 1: April 11–12 at the University of Massachusetts, Amherst

ZONE 2: April 5 at the University of Rochester in New York

ZONE 3: April 25-26 at Seton Hall University in New Jersey

ZONE 4: March 7-9 at the University of Maryland – College Park

ZONE 6: March 14–16 at the University of Puerto Rico at Mayagüez

ZONE 7: February 21-22 at the University of Michigan – Ann Arbor

ZONE 8: April 11-13 at the University of Tennessee-Knoxville

ZONE 10: February 21-22 at Rhodes College in Memphis, Tennessee

ZONE 11: April 4-5 at the University of Northern Iowa, Cedar Falls

ZONE 13: March 20–22 at Abilene Christian University in Texas

ZONE 14: March 1–3 at the Colorado School of Mines

ZONE 15: April 11–12 at the Utah State University, Logan

ZONE 18: March 20–21, at California State University, Long Beach

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