

The Dilated Times

The newsletter of the Drew University Society of Physics Students

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Editors: Arlene Ovalle and Brett Becker

Quinn Returns to Drew to Teach

Dr. Paul Quinn ('96) has again returned to Drew to teach, this time as a visiting professor. Dr. Quinn is filling in for Dr. McGee who is on sabbatical this year.

Dr. Quinn graduated with degrees in physics and math from Drew in 1996 and entered a Physics PhD program at Lehigh, near where his girlfriend and now wife Janet lived. Janet is a Drew theatre grad. Dr. Quinn had completed two internships at Lehigh while still at Drew as an undergrad which is how he first became acquainted with the faculty and program there.

At Lehigh Dr. Quinn studied under Dr. Hong focusing on the statistical mechanics of granular systems. He received his PhD in the spring of 2001, successfully defending his thesis on his granular systems research which was published in three journals, *Physica A*, *Physical Review E*, and *Physical Review Letters*. Dr. Quinn has also published one other paper.

Dr. Quinn taught at Lehigh and at Drew before and is possibly looking into becoming a professor full time, but also re-



Dr. Quinn!

mains open to working in industry. Dr. Quinn turned down several other offers of employment in order to come to Drew for this year. He is currently continuing his research at Lehigh to keep active in the field. He is also involved in a research project that is attempting to maximize the volume of microwave popcorn by lowering the air pressure in the cooking environment! (Ask him for the details).

Dr. Quinn is teaching the intro course and laboratory section this semester and is teaching intro and the intro lab as well as astronomy next semester. He is absolutely pleased with his experience thus far, and is very confident that his Drew education is a major reason both for his success in the field and for his strong desire to return and teach with those that taught him.

- Brett Becker, '03

Becker Spends Year Abroad

During the 2000-01 academic year I studied physics at Trinity College Dublin in Ireland. Long before my departure several differences between Drew and Trinity became quite apparent. All of my classes were the entire academic year in length, which is fairly typical of the European academic system. The physics department at Trinity, quite different than ours at Drew, had several hundred undergrad students. The faculty was quite international. I had professors from England, former Soviet Republics, Russia, Germany, the U.S., and of course Ireland.

Many more interesting differences came into play once I got to class in Ireland. What Dr. Supplee and I believed from the Trinity literature to be one class turned out to actually be 8 different classes taught by 8 different professors. Specialization within physics begins in the undergrad

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Drew Summer Research Opportunity

Dr. McGee is looking for several good physics and chemistry majors for paid 2002 summer research on lasers, electronics, computer programming, and materials science. Projects are designed to match students' classroom experience and interests. Part of this work is in collaboration with Lucent Technologies and opportunities exist for students to gain experience in industrial research. Salary is \$3500 for 8-10 weeks; on-campus housing provided by Drew. Application forms will be available early in the 2002 Spring Semester. Interested students are encouraged to contact Dr. McGee. He can be reached by phone at 908-582-5149 or via e-mail at dmcgee@drew.edu or mcgeedj@lucent.com.

Notes From the Outside

I graduated from Drew in 1997. I pursued a non-traditional path for a physics major and became an attorney. I've been practicing for a little over a year and am developing a specialty in patent litigation. I hope to pursue patent prosecution as well. Contrary to how it sounds, prosecution is the opposite of litigation, involving drafting patent applications and trying to persuade the U. S. Patent Office to grant a patent. Realization of this hope depends on passing the patent bar, a notoriously difficult test on the statutes, regulations, and administrative guidelines governing the patent office.

Unlike most of my fellow students in law school, who chose their college majors based on their ambition to become lawyers, I chose the law based on my major. I majored in physics because it's interesting, I figured if I didn't study it in college I never would, and because once I had started I was too stubborn to quit. However, I knew before I began my first class that I had neither the aptitude nor the desire to pursue post-graduate studies or a technical career. I'd like to say I gave my future a great deal of thought, but in truth I chose law because I thought I'd probably be good at it and nothing better came along. As it turned out, I couldn't have chosen a better major, either to impress the law school admissions committee or to prepare me for a legal career.

Contrary to the opinion of my law school-bound, political science-major acquaintances at Drew, physics is an excellent background for the study of

law. Although most lawyers with science degrees pursue patent law, an education in science is a valuable asset for a career in any legal field. Law and science are both (or at least should be!) rigorous analytical disciplines, founded on logical reasoning based on underlying certainties. Statutes and supreme court cases are the Newton's laws of the legal system. Physics is also great for building self-confidence. After four years of physics, law school held no terrors.

A science degree or extensive technical experience is a must for anyone who wants to pursue patent prosecution. Scientific training isn't always necessary to understand patentable inventions (you can patent a bookmark, just as an example), but it is necessary to persuade employers you can do the job and it's required to sit for the patent bar. I strongly recommend a science background for patent litigation as well. It helps in understanding unfamiliar technology, creates a comfort factor with technical jargon, and confers credibility in the eyes of clients, opposing counsel, and colleagues.

While I've extolled the usefulness of a physics major as a precursor to legal studies, I don't want to suggest that the practical benefits are the only or the best reason to study physics. Despite the many frustrations, I enjoyed studying physics. It's a fascinating subject and that's reason enough.

-Helen Geib, '97

Summer With the Governor's School

This summer I worked at the New Jersey Governor's School in the Sciences right here at Drew University. For those of you who are unfamiliar with it, the Governor's School offers 81 high school students from around the state of New Jersey the opportunity to come to Drew University for a month in the summer and take college level science courses. My job in the Governor's School

program was that of a counselor, teaching assistant, lab assistant, rule enforcer, and so on. I was charged not only with aiding students in their course work and assisting them with their lab and team projects, but also with providing for their safety and well-being. It was a lot of responsibility but it was also a highly enjoyable experience that I wouldn't give up for anything in the world. The students were eager to learn, the professors were

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The Math Connection

Each time I teach Physics/Math 125, Mathematical Physics, I find myself asking the question, “Why are the laws of nature mathematical?” I am by no means the only one who has been intrigued by the question. Galileo said, “Philosophy is written in that great book which ever lies before our eyes - I mean the universe - but we cannot understand it if we do not first learn the language and grasp the symbols in which it is written.” Nobel laureate Eugene Wigner wrote a famous paper entitled *The Unreasonable Effectiveness of Mathematics in the Natural Sciences*.¹

I always get a thrill out of writing down Maxwell’s brief, beautiful equations and realizing that they describe all of classical electricity and magnetism and optics. Equally exciting is using Hamilton’s principle to derive the Euler-Lagrange equations. Once you have them, all you need to do is pick a Lagrangian (admittedly, not always an easy task), substitute it in the equations, and grind out the solution.

Most commonly, the laws of physics are written in terms of differential equations; Maxwell’s equations and the Euler-Lagrange equations are examples. They are the dialect of the mathematical language that tells us how nature works. To be sure, we need to know more than just the equations and the algorithms required to solve them. We must also be able to specify the initial or boundary conditions, as well as the constants in the equations that are unaffected by the application of the algorithms. The initial conditions can be problematical: Einstein’s equations of general relativity describe how the universe changes with time, but we have no law that says what the initial state of the universe was like.

In a recent article in the American Journal of Physics, the authors ask, “How is it possible that mathematical manipulations produce numbers that agree with experiments up to eleven decimal places?”² (They were, I’m sure, referring to the value of the electron’s magnetic moment predicted by quantum electrodynamics.) Is it likely, they ask, that both mathematics and physics are invented?

Most physicists would reject the notion that physical reality is just a mental construct. Perhaps, then, mathematics and physics are both discovered. Greek mathematics and much that followed had its roots in the external world. The authors mentioned above claim that a pure mind in an empty space of zero dimension could never have developed Pythagoras’s theorem.

What if mathematics is largely invented whereas physics is always a matter of discovery? The great British mathematician G.H. Hardy loved to twit his physics colleagues by saying that mathematicians can dream up far more interesting and elegant worlds than the one that physicists are stuck with. A mathematical formulation is only required to be self-consistent; a physical model must, in addition, be verifiable by experiment or observation.

While there is no final answer to the debate about the relationship between mathematics and physics, I am impressed by the fact that it seems impossible to identify any piece of mathematics that has found no application in physics. And today string theorists are working hand in hand with pure mathematicians to develop entirely new mathematics that is evidently necessary for the pursuit of a “theory of everything.”

When you tell someone you are a physics major, how often do you hear, “Math was never my best subject; I concentrated in English”? Such a statement suggests an analogy: mathematics is to physics as language is to literature. For me, however, that mathematics is the natural language of physics continues to be deeply mysterious. Certainly the connection between the two disciplines is a subject that deserves further thought. Any ideas?

- Ashley Carter

¹ E. Wigner, Communications on Pure and Applied Mathematics 13,1 (1960).

² A.C. de la Torre and R. Zamorano, American Journal of Physics 69 (2), Feb. 2001.

Hall of Science Update

The Hall of Science is back in operation once again after a summer of intense activity to replace all of the front end air handling equipment for the building at a cost of nearly three million dollars. The penthouse on the roof and the basement were gutted and all new equipment installed, while academic programs including the Governor's School, and occupants of the building scattered throughout the campus. It was touch and go as to whether we would be ready to open on time this fall, but people moved back into their offices during the last week of August and classes began on schedule.

Actual heat for the building, however, arrived later and barely in time for the cool fall days. Since all the original ducts were kept in the building, additional fine tuning of air flow to the vents and hood systems continues into the semester. Should a new science addition grace the campus in the coming years, the new system is large enough to handle the additional area.

A partial facelift of the building also occurred this summer as the first and second floor corridors were given new brighter flooring with different color striping for each corridor (physics is now on

the blue corridor!). New cloth tack boards line the entire outer walls of the corridors with colors to match the striping on the floor. On schedule next are complete renovations of the two major lecture halls, S-4 and S-244. Planning is just about complete for them and work will begin on S-4 at the end of the fall semester, with work on S-244 scheduled for next summer. Classrooms are also on the list for future upgrades. No new word on the infamous addition or lab renovation!

- Bob Fenstermacher

Summer Research at Penn State

Over the past summer, I participated in a Research Experience for Undergraduates (REU) at Penn State to give myself a clearer understanding of what I should look for and expect in a graduate school. This turned out to be a very fruitful endeavor. I learned a lot about the types of science I could do in grad school and what life there might be like. I also shared the experience with a diverse group of interested physics students who helped give me a memorable and fun experience.

The first thing I noticed about Penn State was its isolation from the suburbs that I call home in New Jersey. An agricultural area,

there is nothing but hills and farms outside of State College. This is nice, but I think I have decided not to choose a grad school any more rural than Penn State. My second big observation was that a research advisor largely determines the length and quality of time that one spends in grad school. This is worth noting, considering that the time spent in physics grad schools can be over 5 years. And there is definitely an advantage in choosing a larger school with many faculty in my chosen area of concentration.

Much of my time in the lab was spent shadowing the grad students there and learning their research techniques. We were analyzing the properties of the superconductor Magnesium Diboride, which must be cooled in liquid helium to

below 39K. However, I soon discovered the importance of being patient after I rashly dipped the compound in the helium. It turns out that unless the temperature is lowered *slowly*, the crystalline compound fragments and the sample is ruined. Whoops!

The rest of my summer consisted of many social, fun activities, from biking in the country to long talks with my roommates about exciting topics like quantum gravity. Overall, it was the group of undergraduates with me in the program that really made it a good summer. I would recommend this REU to anyone interested in experiencing physics research or graduate school in physics.

-Justin Hotchkiss, '02

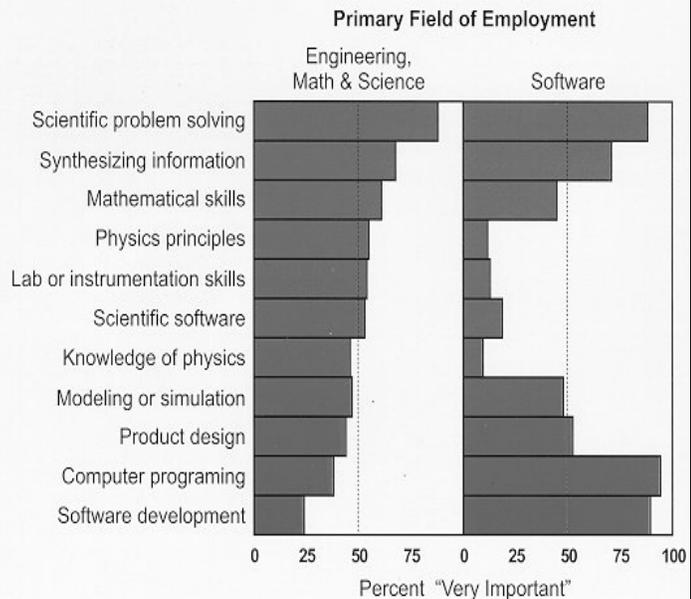
Career Corner

This issue's Career Corner focuses on the direction taken by physics bachelors. We know that many Drew physics majors follow additional graduate training in physics or related fields, but others have gone to law school (see this issue's *Notes From the Outside*), medical school, and for advanced education degrees. Still others wonder about job opportunities straight out of Drew. As we have often said, the physics major offers all of the traditional features of a strong liberal arts degree along with the problem solving and analytical skills of your physics training. Recent career information regarding physics bachelors has been garnered from surveys taken by the American Institute of Physics, and it is presented here in graphical form. Clearly sizable numbers of physics bachelors find work in the computer and engineering fields, many doing the work of engineers. This seems to reinforce recommendations to include a component of computer science into your studies at Drew. The data also seems to corroborate that physics majors will continue to require and find important those skills for problem solving and synthesizing information whether in software or more traditional science careers. More information can be found at www.aip.org/statistics.

- Bob Fenstermacher

What's Important?

Importance of knowledge and skills for physics bachelors, 5 - 7 years after degree



Percentage of physics bachelors who chose 4 or 5 on a 5-point scale where 5 = essential

Source: 1998-99 Bachelors Plus Five Study, preliminary results

What Do Physics Bachelors Do?

Type of Job	Percent
Software	28
Engineering	17
Science & Lab Technician	10
Management, Owner & Finance	19
Education	12
Active Military	5
Service and Other Non-Technical	9

Type of employment of physics bachelors 5 to 7 years after earning their degrees, 1999.

Source: 1998 Bachelors Plus Five Study

FIELD TRIP TO BELL LABS

On Friday October 5 Professor Pat Boeshaar invited interested students to attend a colloquium held at Lucent Technologies Bell Labs in Murray Hill. Speaker Geoffrey B. West, particle physicist and theorist of the Los Alamos National Laboratory and the Santa Fe Institute, intrigued an audience of Bell Labs scientists and our small group from Drew with his lecture: *The Universal Scale of Life: from Molecules and Cells to Whales and Ecosystems*. Geoffrey West has developed a theory to explain "quarter power" scaling laws in animals and plants. For example, it has been known since the 1930s that there is a relationship between the mass of a species and its rate of metabolism. The metabolic rate of a species is proportional to its mass raised to the power of three-quarters. This is just one of the many scaling relationships West mentioned in his lecture which involve a quarter or three-quarter power; these relationships hold true all the way from micro-organisms to blue whales.

Furthermore, West has found that this even applies to the mitochondria inside cells. Based on his research, West has come up with a mathematical

theory that explains these remarkable empirical findings. West is implementing his theory to try to find explanations for such things as aging and mortality. As West explained, the lifetime of a species increases as mass to the one quarter and heart rate decreases as mass to the one quarter. Therefore the total number of heart beats, he realized, is the same across all species (within a particular group of species, such as mammals). As West states, "The scaling laws for mortality fit in with the scaling laws for living. I realized that to come to grips with ageing and mortality you'd first better understand how living things are sustained."

Overall our group enjoyed the excursion to Bell Labs. We were presented with a different way in which a physicist is utilizing his background in physics to explore unexplained phenomena of a different field, in this case biology.

- Arlene Ovalle, '04

Quote obtained from *Yeah, but what about the crayfish?* By Edwin Cartlidge of Physics World

(Summer With the Governor's School, Continued from page 2)

enthusiastic in their presentation of the subject matter, and my fellow counselors were a wonderful group of people. It is a testament to how much I enjoyed my experience working in the Governor's School program that even though we were housed in Riker Hall I would leap on the opportunity to do the program again next summer.

- Peter Miraldo, '02



Peter (back row, 2nd from left) with his Governor's School students

*Check out the Physics Department
Web Page at*

<http://www.depts.drew.edu/phys/>

(Becker Spends Year Abroad, Continued from page 1)

years, but as an international student I had classes with the general physics, computational physics, and theoretical physics students. Quite interestingly, my lab classes were with the Theoretical students! Funding also isn't something to worry about at Trinity - my electronics professor had an annual budget of over 8 million dollars for his research in superconductivity.

The Irish physics students don't take any classes outside of physics and math, and were quite entertained by my stories of art, music, social science, and other classes that I have taken at Drew. Some were even amazed that I was also taking language classes at Trinity being completely unaware that a student at Trinity could study in two departments at the same time - they had simply never seen it before. My physics classes included optics, semiconductor electronic devices, thermodynamics, quantum mechanics, nuclear physics, mechanics, special relativity, and the relevant laboratory sections. I was also a member of a 4 student group that worked for 2 months on a special topic project that was at completion presented to the faculty and other students. My group studied quantum computing.

Homework in the form of workable problems was hard to come by, and reading was intense compared to our standards here. Many classes had several texts, compared to our customary one. Twice during the year each class had a tutorial session where problems were worked, but the normal class format was that of the strictest lecture setting.

Despite the large amount of students in the physics program, group meetings and events were frequent. Students in common years arranged their own group affairs as all of the students in a given year had the exact same schedule with the exact same students for each of their four years. Faculty interaction similar to our meetings and social events here was less frequent but did occur, and of course, if the meeting didn't start in a pub, it surely ended there!

Certainly the largest difference was the examina-

tion process. My entire physics grade was determined by one six hour exam in May. This exam determined my grade for all of the classes I attended except for lab which was marked separately. To give you a different perspective on the year end exam, I spent 256 hours in lecture, and my grade was determined by an 8 question, 6 hour exam! Not only did the questions on the exam expect a traditional answer, but a written explanation of the problem and its solution, most of which were 2-3 pages in length. In about half of the questions, the equations used had to be derived on the exam from scratch.

I had such a great time spending the year in Ireland that I find it very difficult to describe accurately. I made several friends in several countries including the U.S., many of whom I still have frequent contact with. It certainly was one of the best and most important decisions I have made in my life, and I strongly, strongly encourage anyone who has the interest in studying abroad to do so.

- Brett Becker, '03



Outside the Physics Laboratory at Trinity College Dublin.

UPCOMING SPS EVENTS

Friday, November 9

Science Day

The Physics department welcomes prospective physics students to a physics open house on the second floor of the Hall of Sciences

For more information, see <http://www.depts.drew.edu/claadmis/openhouses/science.html>

Tuesday, December 11

Holiday Taco Party
Dr. F's House
Time T.B.A.

Attention Alums!

To assist us with our continuing efforts to inform present and prospective students of the sweeping occupational range of Drew physics graduates, we are requesting that you send us a copy of your business card. Just write the year of your graduation on the back and mail it to Bob Fenstermacher here in the department. (You don't have to write anything - just do it!) We will then develop a display of cards for all to see in the hallway. By allowing current students to see what you are doing, you will be both promoting our cause and creating possibilities for informational contacts with these students. Our thanks in advance for your help.

Summer Internships

Information about physics internships for the summer of 2002 will appear on the hall bulletin board outside S-203. Most, but not all, are NSF internships at larger research institutions, and have application deadlines in January and February. Current sophomores and juniors are encouraged to talk with your advisor and investigate these possibilities. The work is 8-10 weeks long, pays approximately \$3000 or more and often includes room costs. This is your chance to explore the wider physics world of research and graduate schools.

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Address Correction Requested

Inside... Dr. Quinn returns, Physics major goes abroad, Summer research and experiences, Hall of Science update, and more!

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