As undergraduates it is hard to know exactly what career paths we might wish to pursue. While tying one’s passion to a potential career path may seem easy, external pressures from parents and other influences may deter us from becoming our authentic selves. Additionally, it is sometimes hard to see past current college struggles and how they are molding us into the professionals we will become.

With the help of Sam Zorn (’15), the Drew Society of Physics Students hosted an event that allowed our fellow undergraduate students to hear about some recent physics alum’s unique paths to success. The Drew University SPS thought it would be interesting to know what difficulties our majors faced along the way, whether they always saw themselves where they are now, what detours they faced, and what kept them motivated. They had been in our position and therefore could be a great resource for us.

At the event, we were joined by ten alums; six in person and four via video conferencing. Current science majors interested in pursuing careers in science, engineering, medicine, data science, or continuing on to higher levels of education had the chance to hear from a diverse panel.
Famous Physicist: Feynman at 100

By Matt Gronert ‘21

Richard Feynman was born in Far Rockaway, New York in 1918 to a family that encouraged both him and his sister (who would also go on to become a physicist) to explore. As a child he fixed radios, did science experiments in his garage, and questioned everything. It could be said that not much changed in his progression to adulthood. He went to MIT and then Princeton to pursue his love of physics. During World War II, Feynman worked on the Manhattan Project in the theoretical division. While he was working on creating the Atomic Bomb, his young wife and high school sweetheart Arline died of tuberculosis (Feynman’s autobiographical book, What Do You Care What Other People Think?, details their relationship.). After the war he began teaching, first at Cornell, then at Caltech where he would spend the remainder of his career. His main contributions to science are in Quantum Electrodynamics. His Feynman Diagrams are pictures that describe mathematical formulas that would be too abstract to understand intuitively. This work earned him the Nobel Prize in 1965. At the end of his career he served on the Presidential Commission for the Challenger Space Shuttle tragedy. There he famously showed that O-rings lose their shape retention properties in the cold, the property which caused the disaster to occur.

Feynman was the author of several popular books as well as a set of introductory physics textbooks which were transcribed from his famous series of lectures at Caltech. This past May would have been Richard Feynman’s 100th birthday. He wore many hats in his life including Nobel Prize winner, educator, science communicator, safe-cracker, bomb builder, artist, bongo-ist, unstoppable prankster, womanizer, and provocateur. Perhaps more succinctly, he was relentlessly curious about the world. Examined with a modern lens, many might rightfully cringe at some of his behavior with the opposite sex; but barring these deficits, he was and is an example on how to live an authentic life, without pretension, and with great enthusiasm for the most important questions: Why and How?

Professor Quotations

Professor Larson on a smear of chalk representing the Thompson Nucleus: “That’s some positive goo.”

Professor Larson in relation to Quantization of Light: “You only get one Tide pod.”

Professor Larson on Special Relativity: “We’re on a train called Earth.”

Professor Surace on Life: “Never apologize. It’s a sign of weakness.”

Professor Supplee in Phys 150: “Give me thirty seconds to go grab a toy. Time me.” *Sprints out of the room*
We presented the participants with the following list of pre-compiled questions:

- How hard/easy was it to get into grad school?
- How much stuff from our degrees do you actually use?
- What experiences in college contributed to your decision of graduate studies or employment?
- How do you know what you want to do?
- What is Graduate School culture like?
- What information do you wish you had as an early undergraduate?
- How hard is it to go into the engineering workforce with a B.A. in physics?
- What difficulties did you face on the way to where you are now?
- Did you always see yourself where you are now? Any detours? What kept you motivated?
- As an alum of Drew, what advice can you offer current students?

The panel answered these questions honestly and gave us insight into our futures. A key takeaway was the importance of internships in finding what interests us as well as what doesn’t. They gave us a strong sense of what it’s like to work in industry versus immediately pursuing higher education. We were reminded of the plethora of opportunities at our disposal, and encouraged to use the resources we have.

Sophomore Katelynn Fleming shared her favorite part of the event, “In an impromptu evaluation of Drew’s Physics Program after the main discussion, the former majors shared their thoughts on the curriculum and things they wished they had done. Some of their suggestions included: take linear algebra, read more scientific papers, make connections with professors and peers, present at conferences, learn to work well in teams, and do more projects without instructions. They felt these things either did or would have helped them moving into the grad school and professional world. It was great to hear that overall they felt they were well prepared by Drew to go into the next phases of their physics lives.”

Alum Sam Zorn did a lot of the organizing and recruiting for the event. We asked for his reflection on the process, and he responded as follows:

It was a pleasure having the opportunity to come back to Drew and be a part of the career panel. This all started with the idea of getting alum of the physics department more involved with SPS and being there for current students who wanted to discuss life after college. I remember being a senior at the university and not having a clear picture of what I wanted to do after graduation. This is the scenario in particular that I would like to help out with the current physic students. Having a network of alums who are at different stages of their careers and/or education can be a powerful resource for students and we are all willing to speak with you. Although only 10 of us could attend the career panel, there are many more who would like to get involved. In fact, when working with the alumni house, we discussed that there is a network of several hundred physics alums and I will be reaching out to as many as I can to see if they would like to reconnect.

If you have any questions regarding research opportunities, jobs, internships, grad school, or any general question, please do not hesitate to reach out to me at SamuelEZorn@gmail.com and I can try to refer you to an alum that is well suited to answer your questions.

Thanks to all our alums, professors, staff, and students who helped to make this event a success!
The science Nobel Laureates for this year have been announced. Among them are the oldest laureate ever and two of the forty-eight women (as opposed to over eight hundred men) ever chosen for this prestigious award. The Nobel Prize was established in the will of Alfred Nobel, the Swedish chemist and inventor of dynamite. Nobel requested that his fortune be put into a fund to be awarded to the people who, “during the preceding year, have conferred the greatest benefit to humankind.” The prize was split into five areas: physics, chemistry, physiology or medicine, literature, and international peace. Since then, a prize has been added for the economic sciences. Each prize consists of a certain amount of money, so a prize can be awarded in parts, at most to three people. The prizes are often awarded years after a breakthrough occurred because its scientific validity and implications take time to become clear.

The Royal Swedish Academy of Science, which awards the physics and chemistry prizes, announced that the physics prize would be split between Arthur Ashkin, of New Jersey, Gérard Mourou, of France and Donna Strickland, of Canada for breakthroughs in laser physics. A short description of their work, according to the Nobel Prize webpage, follows.

Arthur Ashkin earned his prize for his work at Bell Laboratories “for the optical tweezers and their application to biological systems.” Much like a tiny version of the tractor beam of science fiction, Arthur’s optical tweezers catch a particle up to the size of a bacteria in a focused beam of laser light. The sphere is centered and moved using radiation pressure within the power gradient of the beam. The particle or bacteria can be moved or held still by the tweezers, making it easier to study or transport. Originally, Arthur worked with virus capsids, but after leaving the experiment in the lab overnight, he observed that bacteria had grown on the sample and were also trapped by the beam. This technology has numerous medical and technological implications that are becoming apparent.

Gérard Mourou and Donna Strickland were awarded a quarter each of the prize for their work together to form a “method of generating high-intensity, ultra-short optical pulses.” To understand their method, known as chirped pulse amplification (CPA), consider light as having a length and a height, or a wavelength and amplitude respectively. Amplifying light means increasing the height of the light wave, which makes it a higher energy wave. This process will make it brighter.
There are limits to how much a wave can be amplified at a given wavelength. However, their strategy amplifies a laser beam past the limit by stretching its wavelength first, then amplifying it, then shrinking its wavelength again. The wavelength goes back to its former size, but the beam maintains the heightened amplitude. This strategy has allowed for the fastest cameras in the world, which are able to distinguish micro-events over a millionth of a billionth of a second. Before this very fast camera, those events seemed instantaneous, but now we can watch them unfold.

These breakthroughs, which the Royal Swedish Academy of Sciences summed up as “groundbreaking inventions in the field of laser physics,” have brought some technologies of science fiction to life and laid the foundation for revolutionary technologies to come.

**PhysCon 2019 Content Announced**

By Shanjida Khan ’20

PhysCon 2019 is quickly approaching, and Drew physics students are getting excited. Also known as The Quadrennial Physics Congress, Phys Con is a three-day conference sponsored by the national Society of Physics Students (SPS) and hosted by the Physics Honors Society, Sigma Pi Sigma. Every three years PhysCon brings together thousands of undergraduate physics and astronomy students, alumni and faculty. In 2016 Drew alumni Jenny Soter, Natalya Shcherban and Rachel Newburg attended PhysCon in San Francisco, California. The theme was “Unifying Fields: Science Driving Innovation.”

Jenny Soter reflected on her attendance:

I had a great experience attending PhysCon 2016 as an undergrad at Drew. Now as a PhD student looking back, I really appreciate what a special opportunity I had thanks to Drew SPS. I can say from speaking with other physics and engineering graduate students at
Dartmouth that not many undergraduates have that opportunity or prioritize attending large-scale conferences, but, it can really set your resume apart in internship/job applications during grad school admissions.

My current advisor at Dartmouth even took ten minutes during my interview to mention how impressed he was with my level of experience presenting at conferences and how he wishes more undergrads would get involved since it’s such an important part of grad school and scientific research in general. I also had mentors from Los Alamos National Laboratory tell me the importance of making sure your research culminates in something tangible like a conference presentation to show the quality of your work. So, I definitely believe having the opportunity to attend PhysCon to present my research while I was at Drew set into motion numerous other amazing opportunities for myself, and I highly encourage other undergrads to seek out conferences.

The next PhysCon will be held from November 14-16, 2019 in the Rhode Island Convention Center in Providence, Rhode Island. With “Making Waves and Breaking Boundaries” as the new theme, PhysCon 2019 will enable physics enthusiasts to build a learning community, attend tours, poster sessions, and workshops, and participate in various events and activities.

According to the list that was posted on the national SPS website (www.spsnational.org), the event will host five plenary speakers. Dame Susan Jocelyn Bell Burnell, an astrophysicist who was recently awarded the Special Breakthrough Prize in Fundamental Physics for her discovery of radio pulsars, gave a talk in PhysCon 2016. Dr. Bell Burnell will be speaking again next year. The second plenary speaker, Sandeep Giri, is an industrial physicist who currently manages in advanced technology manufacturing engineering at Google. The third speaker, Dr. John C. Mather, is a Senior Astrophysicist in the Observational Cosmology Laboratory at NASA’s Goddard Space Flight Center and the Senior Project Scientist for the James Webb Space Telescope. The fourth speaker will be Dr. Jami Valentine Miller, the first African-American woman to earn a Ph.D. in Physics from Johns Hopkins University. Lastly, Dr. Ellen William, a Distinguished University Professor at the University of Maryland, whose research interests are surface chemistry and nanotechnology, will be present as well.

The 2019 Physics Congress will also feature a new event called Breaking Boundaries. In this engaging program, SPS chapters from across the country will be able to inspire one another and improve themselves by collaborating and showcasing their events, accomplishments, and unique cultures. This will also be a great way to promote SPS chapters. Breaking Boundaries will also host career and graduate school fairs and have fun opportunities such as t-shirt exchange and design contests, and more!

Overall, the 2019 Physics Congress will be a wonderful participation opportunity for Drew physics students. Interest in attending is high among physics majors, and travel cost fundraising events are being planned. More information to follow...

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**Famous Physicist Quotations**

“I was born not knowing and have had only a little time to change that here and there.”

~Richard Feynman

“I do not feel obliged to believe that that same God who has endowed us with senses, reason, and intellect has intended us to forgo their use.”

~Galileo Galilei
Career Corner: A Physics PhD for You?

By Bob Fenstermacher ’63

This issue focuses on some of the career statistics related to having a PhD in physics, courtesy of the AIP Statistics Research Group. The decision to pursue a PhD in physics or a related field should be one that is carefully considered from many perspectives, from your passion to devote another 5-7 years in classes and research, to your love of topic, just to name a few. A previous issue of Career Corner looked into the graduate school decision in detail (Fall Issue 2011).

It’s also helpful to look at the career factors following the earning of a PhD. Where are PhD’s in physics actually finding jobs? What kind of salaries might be expected? And are there regrets about that degree? The American Institute of Physics (AIP) regularly collects data on these topics. For more information on careers overall, check out, https://www.aip.org/statistics/employment.

So where do PhD’s in physics find careers? Many years ago it was accepted that you might continue your graduate school research direction in a paid job: at a research University, a government laboratory, or a private sector research lab. While a few continue that practice today, such positions have diminished considerably. A PhD is considered evidence of the ability to pursue independent research, as well as having attained significantly higher knowledge in the field of physics, mathematics, and computer science. It shows a persistence in achieving project success. All of these qualities are transferable to different career options shown in Figure 1.

One can immediately see that pure physics is now a clear minority choice for physics PhD recipients. Almost 25% gravitate toward the computer world, and 1 in 5 are doing engineering work. 1 in 10 are in the business world, and many theoretical physicists have found lucrative careers in the financial world. So the PhD in physics is still a “ticket” to a rewarding and exciting career, but not necessarily one following the narrow path of your graduate school research.

A rough idea of salaries to be expected is shown in Figure 2. While not broken down into all the employment field subgroups, it clearly shows the large disparity between staying in the university and post-doctoral worlds and joining the higher salary...Continued on Page 9
Shanu: This past summer, I worked mostly alongside Matt to improve the extended part of the confocal microscope setup that previous students had been working on. We spent the first half of DSSI building an ideal setup that would measure the scattering coefficient of tissue phantoms. Although I did not manage to get the microscope to take experimental measurements, I learned a lot from Dr. Larson and my peers about optics, problem-solving skills, and teamwork. I look forward to using what I have learned in my future physics classes at Drew, and eventually in graduate school, where I plan to study Biomedical Engineering.

Matt: Shanu and I designed an experimental setup to measure the optical properties of our tissue phantoms, specifically those with scattering coefficients closer to actual human skin. It was exciting to figure out a method that both accommodated the limits of our sensitive equipment, and allowed us to check the accuracy of our theoretical model. Dr. Larson offered her expert guidance throughout and I am very grateful for having had the opportunity to work in her lab. Although our main focus was on physics, I mostly learned how to solve problems effectively- especially when no one around knows the answer! It was such great fun to be able to do something I enjoy all day- and in such good company.
Private sector market including the business, engineering, and computer worlds. These are starting salaries only, and don’t necessarily reflect mid-career situations. There will likely be a significant difference between 4-year colleges and research universities at mid-career.

Finally we might take a look at “buyer’s remorse” with respect to attaining a PhD in physics. Is everyone happy with their decision? The perfect pathway when graduating from Drew may not be followed for many reasons. Some Drew physics graduates left graduate school and pursued careers in the other areas mentioned. Figure 3 shows attitudes of those completing a PhD. US citizens seem more satisfied with their school choice, although a full 15% would either not choose physics again or not choose the degree itself. So it’s important to carefully consider whether this path is for you. Take advantage of all the opportunities available when making this decision. Pursue independent research. Talk with faculty and others who have gone down this path. Think about your passion for the intense physics experience to come in the next few years of your life. Enjoy the journey.

Rutendo: My lab partner Perry and I were tasked with getting the imaging camera up and running. The result of this would have allowed us to image specimens being observed. Although we were not able to get the camera to take images, I gained a better appreciation for electronics in general. Putting my theoretical knowledge of coding to use proved to be challenging. Overall however, this lab confirmed my love for physics, and the fact that I want to be a mechanical engineer.

Perry: This past summer, I had the opportunity to work with Dr. Bjorg Larson on the application of confocal microscopy for skin cancer detection. I worked on Python image recognition and MatLab data acquisition algorithms. Over the course of 8 weeks I acquired that crucial quality all researchers must have: persistence. I became flexible and adaptive in my problem-solving approaches. Failure became a marker of progress, and success a license to take new risks and not an end in itself. I admire Dr. Larson’s appreciation of leading a lab fueled with diverse perspectives. I believe this was the reason she welcomed me, a biology major with little experience in physics and an interest in biomedical engineering, with open arms. I look forward to working in Larson’s lab this spring and summer as we continue to develop imaging techniques that may one day positively impact people’s lives.

Katelynn: Working in Dr. Larson’s lab over the summer was my first experience with hands-on research, and it was excellent. I walked into the process knowing only the very basics of optics, but Professor Larson was always empowering. She addressed every roadblock as an opportunity for teaching and learning. We used a substance called a tissue phantom as a test subject for the microscope. I ended up using modeling software to create and 3D print a mold to make the tissue phantom, and trying to prevent bubbles from being formed in the sample. I also delved into some coding centered around getting the microscope to work and streamlining a theoretical simulation. The best part of the summer though was the environment: learning together, collaborating, and gelling as a team. And if there were some paper airplane contests, 70’s music, and laser piano theorizations along the way, they certainly only enriched the experience.

From all of us, a big thank you to Dr. Larson for a fantastic experience!
We Need Your Business Card!

We’re very proud of our alums and want to share your paths with current students. Let us know what you are up to and where you are working. Send us your business card for our display. Please send your card or cards to:

Dr. Minjoon Kouh  
Department of Physics  
Drew University  
36 Madison Avenue  
Madison, NJ 07940.

Remember:  
The observatory is open to the public on clear Friday nights!

Physics Humor  
Shared by Luis Muncharaz Duran ’20

Isaac Newton: *slaps roof of car*  
Car: *slaps Isaac Newton*

Visit the physics department website and see past issues of the Dilated Times at:  
www.drew.edu/physics-department/

Inside...  
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Contributors...  
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