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Chad Hanna Contributes to Groundbreaking Discovery
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Dear Friends of the College,

Excitement was at an incredible high throughout the college and world in early February. One of our own physicists, Assistant Professor and Penn State alum Chad Hanna, was an integral part of the LIGO team that detected gravitational waves in September 2015. This astonishing discovery not only confirmed Albert Einstein’s theory of general relativity, dating to 1916, but also changed the way we will be able to study and understand the Universe. We have included a sizeable feature article on page 4 to help you learn about and understand the history, importance, detection, and future of gravitational-wave science.

On the academic side, our college, in partnership with the College of Information Sciences and Technology and the College of Engineering, developed a new intercollege undergraduate major in Data Sciences, which launches this summer. Undergraduate students will now have the opportunity to learn the technical fundamentals associated with data sciences and the skills needed to manage and analyze large-scale data. Learn more about the new major and how our researchers are tackling the influx of big data in science in the feature article on page 16.

The college is also working to expand its impact on society through the translation of intellectual property from the lab bench to industry, with the goal of becoming a leader in improving health, developing new materials, and addressing environmental issues. With the help of the Biotechnology Advisory Board, the college’s Office for Innovation (O4I) has been assisting inventors in capturing IP; providing resources; locating industry partners; and fostering startup companies. You can read more about their initiatives and success stories in the feature story on page 24.

In other exciting news, Penn State will begin its new fundraising campaign this summer, which will strengthen the University’s position as a leader in research, education, and global outreach. The eight themes currently under consideration for the campaign include: global engagement; cultural literacy; human health; sustainability and human security; access and affordability; digital innovation; discovery, excellence, and community; and Invent Penn State. While our college will support all of the University’s fundraising initiatives, we will be giving substantial attention to enhancing human health. You can learn about the campaign and our fundraising goals on page 32.

As you’ll see throughout this issue, members of our college community, including our faculty, students, and alumni, are making significant contributions to real-world projects and problems. Because of their collaborative spirit and desire to maximize their impact on the world, our college continues be a leader in both scientific research and academics. Thank you for your continued support and contributions to the successes of our initiatives.

Sincerely,
Gravitational waves are quite literally ripples in the fabric of our Universe. This new way of discovering how the Universe functions gives us the ability to begin to understand the Universe in a way that simply has been impossible before.”

—Chad Hanna
Rumors of the detection of gravitational waves had been circulating for months. Major news outlets were reporting that this significant news was in the making, and speculation among reputable scientists was making its rounds on Twitter and other social media outlets. Even *Nature*, one of the most highly respected scientific journals in the world, had published two articles in September 2015 and January 2016 that reported on the rumored gravitational waves. Excitement about this potential discovery was mounting, but the Laser Interferometer Gravitational-Wave Observatory (LIGO) was remaining mum.

Then, on February 8, LIGO, in conjunction with the National Science Foundation (NSF), announced that scientists would soon be providing an update on the search for gravitational waves. That press release led to a science media eruption—news outlets and social media users were certain they knew the outcome, and on February 11 at 10:30 a.m., the suspected, incredible news was confirmed to rejoicing scientists everywhere: gravitational waves had been detected and a new window into the Universe had been opened; the nearly imperceptible “chirp” of the gravitational wave was heard around the world. This detection of gravitational waves not only confirmed Albert Einstein’s theory of general relativity, dating to 1916, but also enabled scientists to witness the collision of two black holes.

This remarkable news was especially exciting to the Penn State community; one of Penn State’s own physicists, Assistant Professor Chad Hanna, played a leadership role in the analysis that led to this discovery.

“Gravitational waves are quite literally ripples in the fabric of our Universe,” said Hanna. “This new way of discovering how the Universe functions gives us the ability to begin to understand the Universe in a way that simply has been impossible before.”

Hanna started studying gravitational waves in the summer of 2003 as an undergraduate physics student at Penn State, joined the LIGO Scientific Collaboration in 2004, and returned to Penn State as a faculty member in 2014.

“After a decade of working with LIGO, always pressing onward to try and make a discovery possible, it’s almost impossible to believe it’s happened,” Hanna said. Hanna and some of his collaborators at LIGO and Penn State have spent the majority of their careers working to achieve this groundbreaking discovery.

Hanna leads a group of Penn State researchers conducting research on gravitational-wave science. Penn State’s Institute for Gravitation and the Cosmos, of which Hanna is a member, has had an important role in developing gravitational-wave science for two decades. Researchers in the institute have made influential contributions to all theoretical aspects of gravitational-wave
science, including mathematical and numerical general relativity, interface with astronomy and particle astrophysics, and data analysis. The institute, directed by Abhay Ashtekar, holder of the Eberly Chair in Physics, seeks a greater understanding of the physical universe by promoting interdisciplinary efforts to develop and study fundamental theories.

“The institute’s contributions to gravitational-wave science go well beyond those by researchers currently at Penn State. Our past members now lead important groups all over the world. For over two decades, we have also trained students and postdocs and several of them have chaired key search groups and played other leadership roles in LIGO and its European partner VIRGO,” said Ashtekar.

**Laying the Groundwork**

The LIGO Scientific Collaboration began in 1997 as a search by American scientists to detect gravitational waves. Today, more than 1,000 scientists worldwide collaborate on the project, including Hanna, who serves as a co-chair for LIGO’s Compact Binary Coalescence research group, which determined the astrophysics behind the event that was detected.
Although the LIGO collaboration has spent the last 19 years working diligently to detect gravitational waves, it wouldn’t have been possible without the work of Professor Joseph Weber, a physicist at the University of Maryland. Weber was the first to realize it may be possible to detect gravitational waves, and in the 1960s, he invented the first resonant-mass gravitational wave detector, known as a bar detector. For the bar experiment, Weber hung an enormous bar in an insulated vacuum chamber. He compared the vibrations in the bar with the vibrations in other bars located in facilities hundreds or thousands of miles away. If the separated bars vibrated in coincidence, one could claim this as evidence for the existence of gravitational waves. While bar detectors did not have the sensitivity required for measuring gravitational waves produced by realistic astrophysical sources, this effort laid the groundwork for future detectors. Weber’s work and profound influence gave scientists around the world the ability and inspiration to later develop the advanced laser interferometer gravitational wave detectors that were used for LIGO’s gravitational waves detection in September.

LIGO operates two gravitational-wave observatories: the LIGO Livingston Observatory in Livingston, Louisiana, and the LIGO Hanford Observatory on the Department of Energy’s Hanford site in Richland, Washington. The two observatories, which are 1,865 miles apart, are separated by this distance for a specific reason. Since the detectors are ultra-sensitive, they can detect the tiniest vibrations on Earth. If the instruments were in close proximity, there is a likelihood that they would detect the same vibrations at the same time, making it very difficult for scientists to distinguish between a vibration from an earthquake or from a gravitational wave.

Penn State physics alumna Amber Stuver began working on LIGO research as a graduate student at Penn State. Stuver currently works as a LIGO scientist at the LIGO Livingston observatory and a physics instructor at Louisiana State University.

“LIGO has been the entirety of my career since the summer before I started graduate school,” Stuver said. “I am fortunate to have been exposed to wonderful mentors at Penn State and supportive colleagues throughout my career.”

Her work began under Gabriela Gonzalez in June 1999, and continued with Sam Finn in 2001 after Gonzalez left Penn State. Each adviser taught her different skills that she could bring to the collaboration.

With Gonzalez, she said, “I was able to learn more about LIGO by working with her on the instrumentation needed for Advanced LIGO.” Her work with Finn took a different approach to the LIGO project: “With him, I learned how to analyze the large amounts of data that LIGO takes through statistical computer programming.”

When gravitational waves were detected at LIGO, Stuver also thought the reading was the result of a test. When LIGO announced that there had been no tests that day, Stuver’s gradual realization of the discovery began.

“That’s when I realized that this is not a drill. As the weeks went on and this detection candidate passed every test...
Having significant distance between the instruments lessens the chance that both facilities are detecting the same Earth sources at the same time. This distance allows scientists to compare data from both observatories and look for vibrations that occur at the same time, enabling them to dissect gravitational waves from Earth noise.

Each observatory is made up of two sections of four kilometers of evacuated pipe with lasers inside, meeting in an “L” shape. Inside this vacuum tunnel, a beam splitter divides a single entering laser beam into two beams, each traveling along one arm of the L. The beams reflect back and forth between mirrors that are suspended near each end station and near the vertex on either side of the beam splitter.

When a gravitational wave passes, the lengths of the paths that the divided laser beams take along each arm stretches the laser beam slightly, by only 1/10,000th of the diameter of a proton. This altered arm length causes each beam to travel a different distance, which indicates a gravitational wave.

Because LIGO detectors are in many respects the most sensitive instruments ever designed, in their initial proposal to NSF in the 1990s, the LIGO team had made a long-term plan in which the sensitivity was to be increased in steps. The penultimate detector was put to use in 2002 and searched for gravitational waves until 2010. As was anticipated in the NSF proposal, no gravitational waves were detected. However, the “null” result still led to some interesting bounds on astrophysical and cosmological processes. Over the next four years, LIGO scientists implemented the final improvements using sophisticated engineering and new, superior technology. A year later, Advanced LIGO was ready to detect—or
rather “hear”—because the signal is in the same frequency range as the sound waves that are audible to us—cosmic explosions from the far corners of the universe.

“Hearing” the Universe
On September 14, 2015, in the middle of the night, Hanna should have gotten the most important text message of his professional life. But it was so early in Advanced LIGO’s first observing run that he didn’t even have his text message alerts set up yet. In fact, many members of the scientific collaboration thought the gravitational wave detection, called GW150914, was merely a system test rather than a real-life event.

Shortly before 2:00 p.m. that day, right before a weekly institute seminar, Hanna was caught off-guard. He received word from LIGO that no tests had been performed on the system that day, meaning that gravitational waves had actually been detected.
Observatory,” said Cordova in her opening speech at the LIGO press conference.

The NSF in particular has believed in the potential of LIGO and has funded the project for decades. Many were skeptical when the NSF decided to spend $300 million to build the original LIGO observatories proposed in a scientific paper in 1972. It was a big risk for an agency that had only until then funded small-scale research projects.

“In 1992, when the National Science Board approved LIGO’s initial funding, it was the largest investment NSF had ever made,” said Cordova. “It was a big risk. But the National Science Foundation is the agency that takes these kinds of risks. NSF funds trailblazers.”

Cordova, with her background in physics, astronomy, and astrophysics, has been a staunch supporter of the project since she began as director of the NSF in 2014.

“LIGO is a groundbreaking discovery which demonstrates the vital importance of the mission of the NSF. Because of the NSF, we have opened a new observational window that will allow the world to see our universe in an entirely new way. It’s the start of a whole new way of looking at and learning about our cosmos,” she said.

Gonzalez came to the podium at the press conference to explain the science behind the discovery. She explained that the gravitational-wave signal was first detected at the LIGO Livingston facility, and the same reading detected at the LIGO Hanford facility a mere seven seconds later, even though the facilities are 1,865 miles apart.

The actual reading ended up being “a tiny fraction of a proton in diameter,” according to Gonzalez. “You can see that these signals have oscillations that grow in frequency and amplitude and then settle down, and that’s exactly the prediction that we know from solving Einstein’s equations on computers for the coalescence of black holes merging into a larger black hole and settling down.”

The LIGO team calculated a numerical relativity simulation for the event of two black holes merging, and the data lined up eerily with the gravitational wave detections at both LIGO facilities. The waveform gave the team much data and information about the event, including the distance away the black hole merger was.

“It was more than a billion light years away,” Gonzalez explained. “This merger happened 1.3 billion light years away when multicellular life here on Earth was just beginning to spread. The signal took a billion years to come to Earth and produce this tiny distortion in our detectors.”
Hanna and his Penn State LIGO group, including postdoctoral scholars Sydney Chamberlin and Duncan Meacher, and doctoral candidate Cody Messick, arrived at the seminar stunned. (Computational scientist Alex Pace would join the group a few months later and learn about the discovery on his first day of work.) Their years of work had finally come to fruition. As in any large scientific collaboration, LIGO has a protocol that requires a long series of internal tests and detailed data analysis before major results are announced to the outside world. Therefore, as overwhelming and exciting as it was, the event was not public knowledge, so Hanna and his team had to contain the momentous news.

“The rest of our colleagues in attendance were not part of LIGO, so we couldn’t say a word. Our silence stood for months to come,” Hanna said.

On February 11, 2016, after weeks of assessing the significance of GW150914 and collaborating on scientific publications about the detection, Hanna and his colleagues at LIGO and Penn State were finally allowed to let the world know what they had learned on September 14 of the previous year: gravitational waves do exist, and the goal the LIGO scientists had been working on since its inception had finally been achieved.

How did it feel to let the world in on the news that gravitational waves had been detected?

“Relief. Vindication. Anxiety about what to work on for the next ten years?” Hanna joked. “This has been a long road for me, but it doesn’t even compare to some of my colleagues who have been working in this field for decades. I like to think, though, that I felt at least a fraction of their joy when we finally made the discovery we have all worked so hard toward.”

Finding His Niche
Hanna began studying gravitational waves as a junior in college, conducting summer research on a scholarship at Penn State. Hanna worked with Ben Owen, currently a professor of physics at Texas Tech University and adjunct professor of physics at Penn State.

After graduating with his bachelor’s degree in physics from Penn State in 2004, Hanna began graduate study at Louisiana State University, but his Penn State and LIGO connections continued. Hanna’s graduate adviser was Gabriela Gonzales, former Penn State assistant professor of physics and current spokesperson for LIGO. Although he didn’t have a chance to work with Gonzalez before she left Penn State in 2001, her passion for her work, including LIGO, is what sold Hanna on attending Louisiana State University for his doctoral degree.

“When deciding on graduate school, I visited her group at LSU, and I confess, I didn’t think I would decide to go there before visiting. However, after meeting her I knew that she was someone with vision and passion and would not stop at anything to make sure her group would have the resources it needed to succeed. I did a full 180 and after a 26-hour visit to Baton Rouge and the LIGO Livingston Facility, I was hooked.”

When Hanna first started working with LIGO in graduate school, he was working on LIGO de-
powerful burst of light emitted from the neutron star. Now LIGO can detect this event also by the effect it has on space-time through gravitational waves and the presence of electromagnetic or high-energy particles near the event. In collisions between two black holes, there are no other signals. Therefore, gravitational waves provide the only means to learn about these spectacular events in which more energy is emitted during the last few seconds than are emitted by all stars in the Universe combined!

**Into the Future**

With this discovery, Hanna and his team at Penn State, as well as scientists around the world, are looking forward to understanding the Universe from a new perspective, where they can now listen to what they could not previously see. Having the ability to hear the Universe will allow scientists to observe the large portion of the Universe that is dark.

Hanna knows that where LIGO is right now with this research is only scratching the surface of the project’s potential. “I hope that ‘gravitational-wave observatory’ becomes as much of a household term as ‘telescope,’” he said. “The point is, over time, gravitational waves will be another way that we understand the Universe.”

Ashtekar agrees that this is only the beginning: “This first direct detection of gravitational waves is a breathtaking discovery that will stand out among the major achievements of 21st-century science because it opens the door to many discoveries that I believe will be made in the coming decade.”
The Institute for Gravitation and the Cosmos (IGC) is a multidisciplinary institute of Penn State researchers dedicated to the study of the most fundamental structure and constituents of the Universe. Thanks to the sustained support from the Eberly College of Science for over two decades, IGC researchers have been able to make seminal contributions at the forefront of fundamental science, including the physics, astrophysics, and mathematics of gravitational waves.

Gravitational waves are predicted by Einstein’s theory of general relativity. In this theory, the fabric of space-time is curved and gravitational waves are ripples in this fabric, produced by catastrophic events such as black hole collisions. Analysis of gravitational waves requires a mathematical framework that can capture the intricacies of general relativity, powerful computational tools that can handle some of the most complicated nonlinear differential equations, a solid understanding of astrophysical processes, and the ability to efficiently analyze some of the largest data sets encountered in fundamental science. Advances in all these areas were needed to arrive at the conclusion that the event seen by the LIGO collaboration on September 14, 2015 came from a collision of two black holes that occurred over a billion years ago!

Over the years, IGC researchers have made key contributions to all these different areas:

On the computational side, Dr. Bernd Bruegmann's group at IGC carried out the first numerical simulation of two black holes orbiting around each other.

On the analytic side, Dr. Jorge Pullin, together with a collaborator, developed a “close limit” approximation scheme that allows one to extract physics from the final stages of a black hole merger. It continues to serve as a powerful tool some fifteen years later.

While they were graduate students at IGC, Drs. Badri Krishnan and Miguel Campiglia provided the comprehensive analysis of the dynamics of the surface of a black hole, formed by either a gravitational collapse or a merger.

Another interesting discovery came from the fact that the LIGO detectors did not see any gravitational waves from 2002–2008 because they were then operating at a lower sensitivity. It concerns the crab pulsar, which was formed in a supernova explosion, recorded by Chinese astronomers in 1054. Through a careful analysis of the astrophysics involved, Dr. Ben Owen used
the absence of gravitational waves to show that there are no mountains higher than a centimeter on the crab pulsar!

Finally, as described in the accompanying article, Dr. Chad Hanna and his group played a key role in the identification of the source of the LIGO event of September 14.

In 2001, the National Science Foundation awarded Penn State a Physics Frontier Center with a mission to bring together scientists from different areas ranging from general relativity to astronomy and astrophysics to computer science, statistics, and data analysis. Under the leadership of Drs. Sam Finn and Pablo Laguna, the center organized a very large number of focus sessions, workshops, and outreach initiatives at Penn State. It is no exaggeration to say that the emergence of a cohesive field of gravitational-wave science in the United States owes much to these initiatives.

Hanna’s group has continued to play a leading role in the analysis of the rest of the data from the first scientific run of Advanced LIGO. The announcement of their findings is eagerly awaited. It is generally expected that, when the advanced detector reaches its design sensitivity, the LIGO collaboration will record dozens of events a year, thereby unveiling a new window on the Universe. This fall, Dr. B. Sathyaprakash, widely regarded as the foremost gravitational wave theorist in the United Kingdom, will join the physics and IGC faculty. In addition to significantly enhancing Penn State’s role in the anticipated discoveries by LIGO in coming years, his presence here will place us in a leadership position in the international collaboration for the next-generation gravitational-wave detectors, which are now being planned. Through its Swift mission center, Penn State is also actively involved in searches for electromagnetic follow-ups of sources of gravitational waves.

Finally, IGC has launched a new initiative called AMON, led by Drs. Douglas Cowen and Miguel Mostafá. The goal is to weave together a holistic picture of the cosmos by imaginatively combining the information brought to us by all the cosmic messengers from the high-energy universe—gravitational waves, gamma rays, neutrinos, and cosmic rays. Since IGC is currently the only institute with this capability, eleven leading astrophysical observatories from all over the world have signed letters of collaboration with AMON.

The future of gravitational wave research at IGC is very bright, indeed!
DATA DELUGE:
MAKING SENSE OF BIG DATA IN SCIENCE
EDUCATION AND RESEARCH

By Whittney Gould
BIG DATA is a ubiquitous term in today’s society. With modern technology seamlessly incorporated into so many aspects of human life, the possibilities for extracting information about our habits, our health, and the many other events of our daily life is huge.

But how can academia, research, and industry learn how to harness the power of the large sets of data we’re now able to collect?

Whether it’s helping to analyze large sets of data for research or educating the next generation of students, scientists in the Eberly College of Science are unlocking the potential of new opportunities in the era of big data.
New Data Sciences Major

Traditionally, many researchers analyzed small data sets using a single computer to help industry and academia make decisions. The questions researchers could address scientifically were constrained by limited streams of information, such as asking how many units were sold or during what time of year? Often, an analyst could tell something was happening, but could not address why something was happening, or predict how to make it happen again.

Recent advances in technology have led to much more voluminous and rapid data collection, whether part of carefully designed scientific experiments or unstructured data mined from social media. Thanks to concurrent improvements in computing power and algorithms, we’re able to use these large data sets in new ways.

For example, instead of just being able to calculate what is selling and when, we are now able to extract information about customers and identify correlations in customer choices to better meet the needs of each customer. This use of big data can be found pretty much anywhere on the Internet, like in the way that Amazon and Netflix recommend other products or movies that you might be interested in based on both information you provide and patterns in the behavior of other users.

This new influx of information and endless potential for analysis has opened the door to a whole new career field in data science.

A new intercollege undergraduate major at Penn State has been created to address the need for education in this area. The new Data Sciences major combines expertise from three colleges to address the many facets of the new field of data science that has quickly emerged over the last few years.

The new major that launches this summer is a partnership between the College of Information Sciences and Technology, the College of Engineering, and the Eberly College of Science. While partnering across colleges and units is common for graduate programs at the University, it’s much less common on the undergraduate side, particularly between three colleges as equal partners. But this new discipline truly requires substantial expertise and input from all three colleges, said David Hunter, head of the Department of Statistics at Penn State.

“There’s a huge need for people who can do this,” he said. “Everybody knows that there’s a deluge of data out there, but to make sense of it requires skills that don’t fit well into the University’s existing majors.”

Dean Douglas Cavener of the Eberly College of Science agrees with Hunter about the major’s importance. “Our world is overwhelmed with massive amounts of data that can potentially address global challenges,” he said. “To employ those data in solving problems and advancing society requires people with high-level skills in data analysis, and this is why our new major in Data Sciences is so important and timely.”

Students will learn the technical fundamentals associated with data sciences and the skills needed to manage and analyze large-scale data to address an expanding range of problems in industry, government, and academia. In addition to learning computer programming, data wrangling, statistical analysis techniques, and algorithms, students in the major will address ethics in the era of big data.

“Privacy is a major concern, and not just in cases where there is a federal law to back it up,” said Hunter. “At what point do people start to get concerned that you know too much about their online habits? We want our students to be aware of these issues if they are going to be the
experts in analyzing data.”

The program will hire a full-time faculty member in data ethics so that students will have a resource on campus to teach them about this important aspect of the job of a data scientist.

The need for increased computer science expertise is growing rapidly due to the massive size of today’s available data sets: “On the one hand, we’ve got a computer science program that trains students to do the coding side of dealing with data, which is substantial. Sometimes data sets are so large in their raw form that just dealing with files that size requires computer science expertise,” said Hunter.

Working with big data requires a different perspective than many statisticians are used to. “As statisticians we’re sort of coming at it from the other side. We have always talked about how to analyze data, but we have traditionally dealt with small data sets by today’s standards and we haven’t been preparing our students well enough to handle the computing side of things,” Hunter said.

The College of Information Sciences and Technology approached the other two colleges to propose a well-rounded approach to teaching data sciences for this interdisciplinary major.

Recognizing the importance of collaboration with other disciplines is a key aspect of the program. “This is a real strength of Penn State’s,” said Hunter. “We in Statistics have been involved in this conversation with IST and Computer Science from day one. In a lot of other places, the feeling is that one area owns data sciences, which hasn’t been the case here. This broader conversation makes our program well
positioned to tackle future challenges.”

The major will feature three options for students to choose from: Applied Data Sciences for those who want to focus on applications to science and industry, Computational Data Sciences for those who want to explore more of the computational challenges, and Statistical Modeling Data Sciences for those who are more interested in statistical modeling.

Where could students find jobs with a Data Sciences degree? “I don’t think I could tell you realistically where you couldn’t work as a data scientist,” said Hunter. “In most fields, there will be a need to analyze data.”

Other colleges at Penn State are also starting to recognize the importance of big data and incorporating it into their program curriculums, including the Department of Political Science’s Social Data Analytics major, the Smeal College of Business, and a certificate program at Penn State Great Valley in Data Analytics.

“It’s a huge movement, and the new major is just one outgrowth of it,” Hunter said.

**Early Adopters: Astronomy and Physics**

While the University is just now officially creating a full major in data sciences, some scientific fields have been training students in this type of research for years.

“In fields like astronomy and astrophysics, we have been training students to be data scientists since before that term had been invented,” said **Eric Ford**, professor of astronomy and astrophysics.

Astronomy and physics research has been garnering large data sets for years now, especially from large-scale projects like the Sloan Digital Sky Survey, which has had an enormous impact on the field, leading to more publications and citations than the Hubble Space Telescope. The Sloan Digital Sky Survey has ushered in a new wave of survey science, as astronomers learn to search through large databases to find patterns in the data, new classes of objects, and
rare objects that don’t fit in the existing categories. Penn State scientists have participated in the planning and execution of the Sloan Digital Sky Survey since 1994.

Today, Penn State is also a partner in the next generation of surveys, including the Hobby-Eberly Dark Energy Experiment and the Habitable Zone Planet Finder surveys to start in the coming year. Experience with these will prepare astronomers to make use of data from the Large Synoptic Survey Telescope, scheduled to start surveying the sky in 2023.

“Traditionally, astronomers spend lots of effort to develop instruments and collect data, yet often apply relatively simple statistical analyses or computational methods,” he explained. “As scientists collect scientific data more rapidly, it becomes essential that we be able to work with the resulting large and complex data sets.”

Ford uses his own research as an example. He focuses on interpreting observations of extrasolar planets to draw accurate inferences about the planets, the planetary systems they reside in, and the abundance of planets in our galaxy. He uses advanced statistical methods and dozens to thousands of computer cores to analyze observations from a variety of astronomical observatories, including ground-based telescopes like the Hobby-Eberly Telescope and space telescopes such as NASA’s Kepler mission. By applying science techniques, his group has advanced the state-of-the-art in searching for small planets and measuring their masses and densities to make inferences about their composition and formation.

“My research aims to enhance the science return of astronomical observatories and surveys by using the most powerful statistical and computational techniques available to analyze the data,” he said.

This translates to the education side of things, too. As astronomy students conduct their research, they have to learn many data science skills that are typically not in the core curriculum of any major. But students have been developing the data science skills necessary for astronomy and physics research since before the term “data science” was even coined.

“In the past, it could be a real challenge to explain to a company why a student trained in analyzing astronomical observations would be a great asset to their organization. As industry and government agencies have begun to embrace data-driven decision making, ‘data science’ became a compact way to describe the complex set of skills that our students develop and that employers are looking for,” said Ford.

Astronomy students feel the benefits of this training when it’s time to apply for a job. “We train students to develop a combination of statistics and computational tools that makes their domain expertise even more valuable,” Ford said.

The Galaxy Project
While data science has been part of astronomy and physics for a long time, biology has been much different.

“Data sciences have existed for a long time, but they didn’t extend to biology much,” said Anton Nekrutenko, professor of biochemistry and molecular biology.

Then, around 2005, it became possible to sequence DNA on a very large scale, which meant that biologists were suddenly faced with the types of large data sets that scientists in astronomy and physics were working with. Since these large data sets were a new challenge for biologists, no one really knew how to handle them.

“For the first time, biology became a data-driven science. The idea of Galaxy was to simplify large-data logistics for biologists through
the web,” Nekrutenko said. “You upload your data somewhere and you analyze it through a web interface.”

The project he refers to, The Galaxy Project, is data analysis software created by Nekrutenko and collaborator James Taylor of Johns Hopkins University. Nekrutenko is a biologist and Taylor a computer scientist by trade, so their skill sets combined brought a new perspective to the idea of data analysis in life sciences. Now this combination of life sciences knowledge and computational skills is referred to as bioinformatics, a field which both Nekrutenko and Taylor now work in.

Galaxy utilizes a cloud-computing approach to data analysis, so that software, data, and computer hardware infrastructure can be accessed from any location in the world rather than tied to any single physical location. This means that a project can easily allow for international collaborations.

Galaxy’s tagline, “Data intensive biology for everyone,” clearly states its mission. “The software is freely available to everyone, so they can take it and run their own Galaxies,” he said.

And by everyone, he means fields other than his own field of biology and bioinformatics. Galaxy may have started with a focus on biology and life sciences, but it now also serves fields like sociology, economics, astronomy, natural language processing, and climate research in addition to life sciences.

Whether Galaxy users install Galaxy locally or use the web-based software, Galaxy is open source, and will stay that way, according to Nekrutenko.

“There is no business model here. People should be able to analyze data using best practices, for free,” he said. “But our goal is not the freeness of the analysis, it’s that the analysis that you conduct today can be repeated in five years, so that when you publish your paper, the results are reproducible. One of the biggest challenges in biology is that the analyses in most of the papers you read cannot be reproduced. Data analysis should be reproducible.”

Galaxy records all analysis steps, settings, inputs, and outputs. Data can be organized visually in a variety of charts or graph forms. The information stays on the Galaxy server and the analysis can be run again if the scientist has a need for it. Galaxy tries to serve as many types of analyses as possible, and even offers an app store of sorts with Galaxy utilities and add-ons available called the Galaxy Tool Shed. Galaxy’s community of users creates many of these Galaxy utilities and add-ons.

It seems that scientists find the site useful, as currently Galaxy’s main server boasts 80,000 registered users worldwide and performs an average of 250,000 analyses per month. Galaxy has been directly cited in scientific papers more than 3,000 times since Galaxy Project staff began tracking the citations in 2011.

Galaxy has even spawned its own online and in-person user communities, with workshops and meetups taking place all over the world. The 2016 Galaxy Community Conference, an annual gathering of Galaxy enthusiasts orga-
nized by Galaxy Project staff, will take place later this month. 2016 marks the conference’s seventh year of bringing Galaxy staff and users together.

The Future of Data in Science

Regardless of their discipline, scientists in the Eberly College of Science agree that big data is here to stay. Learning to analyze the large amounts of data collected in a specific field is the future.

“It’s the new norm. If you want to publish the best papers, you have to take advantage of the available data, no matter what your field, whether you’re in biology or social sciences,” said Nekrutenko.

“Increasingly, we’re able to automate the data collection process, making it practical to collect much more data than before. If we want to realize the full potential of such large data sets, then we must develop statistical frameworks and computational methods that can work on ’big data,’” said Ford. “Data science is about how to draw appropriate conclusions from data, drawing upon a combination of domain expertise, mathematical modeling, and computational tools. What could be more important for science?”
Across the University, researchers are continually making discoveries and creating inventions that can have real-world impact and societal benefits. Although this intellectual property (IP) and innovation often can result in improving health, developing new materials, and addressing environmental issues, among other important matters, researchers are often unsure of how to actually transfer their technology from the lab bench to industry development and application. Luckily for researchers in the Eberly College of Science, the newly formed Office for Innovation (O4I) is assisting scientists in capitalizing on the many benefits of technology transfer, IP development, and commercialization.
**Encouraging Entrepreneurship**

The O4I had its genesis in 2012 with an initiative to improve IP awareness and the importance of protecting IP among faculty, postdoctoral scholars, and graduate students in the college. However, **Andrew Stephenson**, associate dean for research and innovation in the college, had a much broader vision for the office. Stephenson, who directs the O4I, envisioned the office serving as an innovation hub for researchers and industry; assisting inventors in capturing IP; providing resources to perform translational research in order to move new technologies toward usefulness; locating industry partners in order to make Eberly College of Science–developed technologies more attractive for licensing; and to foster startup companies based upon college technologies.

With support from Penn State President **Eric Barron**, the college is able to make Stephenson's vision a reality by assisting inventors using college and University-wide resources, including the new Invent Penn State initiative. According to Barron, “The aim of ‘Invent Penn State’ is to drive job creation, economic development and student career success by connecting researchers with the people who can help bring their discoveries to the marketplace. This will benefit the communities we serve and the innovators working among us. Penn State is developing a culture that encourages, nurtures, and rewards entrepreneurship.”

President Barron realized that in order to have a successful venture, inventors need more than just financial support; they also need legal advice, mentors, collaborators, and business training. Invent Penn State is an initiative that provides these types of resources for inventors and entrepreneurs through conferences and events, trainings, seminars, funding, fellowships, and facilities.

The O4I collaborates with the Invent Penn State initiative to assist researchers in getting their inventions from lab bench to industry and the public sector. The college recognized that to have this type of entrepreneurship and economic development from science, the O4I needed staff skilled in technology transfer with industry experience. The O4I added two full-time IP/tech transfer liaisons, **Melissa Long** and **Ashley Chan**; a graduate student intern, **Glenn Watson**; and a volunteer entrepreneur in residence, **Matt Rhodes**, who is also a Penn State alum and member of the Penn State Research Foundation. The team serves as consultants to inventors to help them understand and provide information and direction on IP, the tech transfer process, and working with industry. The group also interfaces with industry, helping to build relationships and market available technologies and inventions.

Stephenson, Long, and Chan work directly with inventors in the early stages of research, educating on the importance of protecting their work and helping them identify potential IP. Additionally, the team provides advice, identifies funding and University resources, and connects inventors to University contacts and industry collaborators to commercialize and license their inventions.

Entrepreneurship and startup businesses are sometimes a result of these inventions. Rather than selling IP to industry, some researchers choose to instead go into business themselves. Rhodes, the O4I entrepreneur in residence, is the key contact for those inventors considering a startup company. A successful entrepreneur in the semi-conductor industry himself, Rhodes is available to inventors for consultation to discuss the feasibility of a startup and advice on how to run a business.
Providing Industry Prospective

The O4I also collaborates with the college’s Biotechnology Advisory Board to help inventors by reviewing and evaluating IP and inventions, and providing industry advice on how to best get the inventions to market. The volunteer members of the board have been instrumental in creating an entrepreneurial environment for both researchers and students. The board, which developed out of the college’s master of biotechnology degree program, has several objectives, including: advancing new and novel biotechnologies; creating a culture of collaboration and partnership focused on advancing innovations to commercialization; becoming a recognized leader in integrating quality education with an entrepreneurial environment; and preparing and supporting faculty and students for successful development and commercialization of scientific innovations. The college’s Biotechnology Advisory Board is the first such volunteer board of its kind across the University. This group of alumni and friends of the college has University-wide regard; their activities are considered best practices and many other colleges are emulating the board and creating their own.

Stephenson believes this kind of board has been so valuable that he’s looking to find members in other disciplines to help further the college’s IP outside of biotechnology-related fields to start a Technology Advisory Board.

“We are really looking for alumni with experience in technology licensing and startups for disciplines outside of biotechnology, particularly in the areas of physical science, materials science, computational science, and analytics,” he said.

This new board will assist the O4I and Biotechnology Advisory Board with its technology transfer initiatives by providing high quality
feedback on technology inventions. Specifically, the board members will review technology and advise on de-risking and proof of concept strategies, advise Penn State inventors and research leaders, and advocate for emerging technologies in the college.

Bench to Big Picture
In addition to college resources and Invent Penn State, the University, through the Penn State Research Foundation (PSRF), collaborates with the college to support a Lab Bench to Commercialization Grant Program (LB2C) that provides funding for researchers in the college. This competitive grant program enables researchers to enhance the commercial potential of ongoing research and prepare them to translate their IP to the marketplace.

To apply for the grant program, applicants must demonstrate that the funding will significantly impact development activities for existing IP or research that may be commercialized. Research and inventions include tangible products, therapeutics, processes/methods, software, or improvement of a current market product. After being reviewed for scientific merit and commercialization potential, awardees are granted $75,000 to be used within one year. In addition to funding, researchers also have the added benefit of working with the PSRF Fund for Innovation Program, which assists grantees in critically evaluating their technology, finds market applications, and provides development and commercialization plan feedback. These services, along with the funding, provide inventors with the opportunity to take their inventions from the lab bench to the public sector where they can see real societal benefits.

“Historically we’ve not done well at generating IP despite the fact that we’re doing great science,” said Stephenson. “We’ve been great at impacting disciplines, just not society.”

However, the LB2C funding is helping to shift the college and its researchers into producing more IP and inventions. In the last two years, the college was able to award 8 of 26 applications. The first year resulted in one startup, Stephen Benkovic and his boron-based antifungals for agriculture and building materials, and several new or improved technologies involving the following faculty:
LB2C 2014/15 Awardees:

Gong Chen and Yanming Wang: Working to characterize a potential pharmaceutical therapeutic that suppresses tumor growth and reduces acute or chronic inflammation by reducing PAD4 enzyme activity to allow the body to naturally fight cancer cell growth and inflammatory diseases, such as Rheumatoid Arthritis and Lupus. Chen and Wang are working to build a startup company based on this technology and have an initial goal of entering clinical trials for the treatment of breast cancer.

Mauricio Terrones and Colleagues: Developing a thin graphene film that can be woven into fabrics or chemically altered to provide a wide range of properties. This graphene film could be used for a number of applications, including indicating structural damage in pipes or bridges, efficiently heating roadways and sidewalks for snow/ice removal, and ultra tough and insulating outerwear. Through his research centers, the Center for Atomically Thin Multifunctional Coatings (ATOMIC) and the Center for 2-Dimensional and Layered Materials (2DLM), Terrones is working with industry partners to develop the technology for specific market applications.

Scott Phillips and Colleagues: Developing an inexpensive, easy to use, and easy to read microfluidic diagnostic device composed of paper. These microfluidic devices can be altered to diagnose an incredible breadth of problems, from compounds like lead in water to the presence of pesticides on fruit. The diagnostics can also be tuned to give users either a quantitative (how much?) or qualitative (yes or no) result. Phillips is currently exploring possible product applications and is interested in building a startup company around this technology.
Greg Ferry, Thomas Wood, and Costas Maranas: Working to refine a biological process by which methane from orphan natural gas wells could be cleanly converted a number of products including a precursor to plastic or clean fuel. This technology is meant to increase gas well efficiency as well as convert harmful methane into commercially viable products. Woods recently received over $1M from a shale gas consortium to continue the scale up of the process to generate plastic precursors.

Frank Pugh: Optimizing his ChIP-exo technology, which characterizes epigenetic modifications on a genome-wide scale. Epigenetic modifications are the changes on DNA that help to regulate development, growth, and disease. Many cancers are caused by the change or mis-regulation of epigenetic marks in the genome.

Mauricio Terrones and Siyang Zheng: Developing a diagnostic device that uses a specially tuned carbon nanotube filter to capture and enrich viruses. Viral infections are often hard to diagnose because viruses are hard to culture and even harder to isolate. However, with this device, researchers and medical professionals could get definitive results from just a single swab or liquid sample. No culturing needed. Terrones and Zheng have created a startup company, called ViroLock Technologies, to continue development of the technology and work towards commercialization.

LB2C 2015/16 Awardees:

Sarah Assmann and Philip Bevilacqua: Developing a kit to determine the 3D structure of RNAs inside the cell. RNA structure has long been difficult to study due to inefficient and technically demanding methods. However, Assmann and Bevilacqua have created a kit that allows any researcher to study RNA structure. These methods are likely to be important for understanding cellular response to stress, such as chronic diseases, as well as compounds, such as pharmaceutical drugs. Assmann and Bevilaqua aim to license this technology to a company that produces research tools.
Corporate Collaboration

Connecting innovators with industry is beneficial to more than just the inventor and investor; the research brought to society has tangible effects on health, energy, food, security, and environmental issues. The relationships between the inventors, University, and industry also spur economic development in the Commonwealth and beyond.

The O4I team works with industry to help potential investors gain access to available technologies within the college. The office connects and markets to industry through several outlets, including having available technologies available on the O4I website, working with the University’s Office for Technology Management, and through the college’s Biotechnology Advisory Board. The O4I also collaborates with Penn State’s Office of Corporate and Foundation Relations, the Office for Industrial Partnerships, colleges and institutes on campus, and the Hershey Medical Center to develop University-wide partnership plans for industry.

The O4I contributes to this large group effort by identifying industry needs and fulfilling them. The O4I team works to develop a consortium of experts, consisting of Penn State researchers and company representatives in a particular subject area that work together to generate a resolution to a specific need. This type of collaboration often results in sponsored research and more IP being developed by college researchers. Additionally, the O4I team also assists those investigators who have already collaborated with a company and helps them to cultivate their relationships in industry.

Regardless of which step an investigator is on or a prospective industry partner may be at, the O4I is ready to assist both to achieve opportunities for meaningful collaboration. From capturing IP, to providing resources and establishing industrial relationships, the O4I is working towards achieving the translation of innovative research to the public, and in President Barron’s words, “turning great discoveries into a great economy, together.”

Inquiries?
Contact innovation@science.psu.edu
Advancing Penn State’s Strategic Goals

This summer, Penn State will embark on a new fundraising campaign that will strengthen the University’s position as a leader in research, education, and global outreach. Unlike previous campaigns, the fundraising effort will last a short five years, which will reflect the urgency of the challenges the campaign will address and will enable donors to witness their gifts at work almost immediately.

The eight themes currently under consideration for the campaign include: global engagement; cultural literacy; human health; sustainability and human security; access and affordability; digital innovation; discovery, excellence, and community; and Invent Penn State.

The themes are familiar—President Eric Barron has been discussing these matters since he became president in 2014. Efforts have been made to address the themes across the University during the last few years, and the president expects that the new campaign will greatly increase these endeavors. Each theme has the potential to make significant impacts locally, nationally, and globally, and Barron anticipates that donors will be excited about these big ideas because they are issues that are meaningful to them.

While the college will support all of the University’s fundraising initiatives in the new campaign, substantial attention will be given to enhancing human health. Penn State plans to harness the power of colleges and programs across the University to create an all-encompassing approach to individual and population health, and the Eberly College of Science will be a significant contributor.

Currently, more than 70 faculty members throughout the college have highly productive, ongoing research programs in some of the most competitive areas of biomedical and health science research, including but not limited to gene therapy, drug development, diagnostics, cancer biology, neurodegenerative diseases, molecular medicine, and medical genomics. Additionally, the college has assembled strong teams of investigators who conduct groundbreaking basic research in RNA biology, enzyme chemistry, epigenetics, and infectious disease, and who are at the forefront of the next wave of biomedical research.

Outside of the health theme, researchers in the college study ecological interactions among organisms, plant genetics, and species evolution. The college also is at the forefront of addressing both basic and applied questions regarding the production and use of renewable energy, energy storage, and the effects of energy extraction and...
consumption on the environment. In addition, faculty members study the origin and development of the Universe; materials, such as graphene and topological insulators; and sophisticated ways to analyze large datasets. Going forward, chemistry, physics, biology, statistics, and mathematics will be increasingly important in solving the most pressing problems of our time.

Students will also be fully involved in every aspect of these areas with our faculty, through both classroom and research opportunities. The college will provide students with the ability to help resolve these types of societal issues by training our students to problem solve and learn through hands-on experiences. These opportunities will enable students to transfer their coursework knowledge to real-world issues and make a significant impact on both their personal learning experience and the world around them.

For the college to remain a leader in scientific discoveries and innovations, our scientists need access to the newest sequencing, imaging, and other innovative technologies that drive these rapidly advancing fields. The college also must continue to make targeted hires to strengthen its expertise and leadership in these areas. To do all of this, the college has established fundraising goals to support students, faculty members, programs, and equipment purchases.

Although the number of themes and the focus of each will be further refined before the start of the campaign on July 1, the University hopes one thing will not change: Penn State’s students, faculty members, staff members, alumni, and friends will rally behind the campaign as a visible and impactful way of making a difference in Pennsylvania and beyond.

Tara Immel

USASEF 2016
Washington, D.C.

Penn State Science exhibited again at the USA Science and Engineering Festival, which took place on April 15–17, 2016 in Washington, D.C. The festival brings together aspiring and current scientists, engineers, and science enthusiasts from all over the country. More than 50,000 people attended to engage with some of the biggest names in STEM.
On Friday, January 15, members of the college community gathered to recognize individuals who have made a positive impact on the college’s climate and diversity in the past year. The College Climate and Diversity Awards, sponsored by the Eberly College of Science Climate and Diversity Committee, is an annual ceremony held by the college to celebrate achievements that improve the climate and diversity of the college.

This year, the Climate and Diversity Committee chose the following winners from thirteen nominations.

Stephen W. Schaeffer, professor of biology, was nominated by Charles Fisher, associate dean for graduate education, professor of biology, and Distinguished Senior Scholar of Biology.

According to Fisher, Schaeffer has worked diligently to increase the diversity in both the biology department, as well as in academia in general. He has advised or co-advised two of the three African American students that have received a Ph.D. from the biology program in the last ten years. In addition to his mentoring of students of color, Schaeffer works with all graduate students in the biology program interested in submitting a grant for the NSF Predoctoral Fellowship Program. Additionally, he serves on the NSF predoctoral panel each year, participates in the annual workshop for interested graduate students organized by The Graduate School, and also serves as one of the ombudspersons for the Department of Biology.

Schaeffer is an effective and dedicated mentor for underrepresented and minority students while also being a significant contributor to a positive climate for every graduate student in the department.
Physics and Astronomy for Women (PAW) was nominated by Rick Robinett, professor of physics. The PAW board members include Kelly Malone, Melissa Quinnan, Feifei Huang, Anne-Sylvie Deutsch, Victoria Lum-sargis, Susan Kempinger, and Amber McCreary.

PAW is a student club dedicated to advancing the status of women in physics and astronomy by providing a network of support and a forum to discuss issues facing women in these fields. Established in 2011, PAW has already had a great impact on the overall climate and diversity atmosphere of the Department of Physics, as well as making very specific contributions to both outreach and recruiting in the program, both at the Penn State level, but also with broader impacts stemming from their organization of regional conferences.

Starlette Sharp, director of the Penn State Millennium Scholars program, was nominated by Olivia Richards, Millennium Scholar and science student.

The Penn State Millennium Scholars program is designed for high-achieving science, technology, engineering, and math students who will become leaders in their chosen field and are committed to increasing the diversity of researchers and leaders in STEM fields.

After successfully completing three and a half years as the program director, Sharp now guides over 60 scholars. She works closely with the scholars to provide them with everything they will need to become successful in their chosen field.

According to Richards’ nomination, Sharp has a passion for helping underrepresented students in science and engineering succeed. Over the years, she has displayed such leadership in fostering a diverse and inclusive climate in the college community.
Faculty Spotlight

Stephen J. Benkovic, an Evan Pugh Professor of Chemistry and Holder of the Eberly Family Chair in Chemistry, has been elected as a Fellow of the National Academy of Inventors.

Rebekah Dawson, assistant professor of astronomy and astrophysics, focuses her research on understanding how planetary systems beyond our solar system originate. She is interested in identifying the key factors that contribute to planetary formation and evolution and that lead to the wide variety of planetary orbital and compositional properties observed in extrasolar planets. She combines simulations and theory with statistics and data analysis of observed planets to test theories of the origins of planetary systems. Dawson is developing a comprehensive blueprint to help understand newly discovered planets in the context of their system’s formation and evolution—important factors in whether the planets may harbor life. Prior to joining the faculty at Penn State, Dawson was a Miller Research Fellow at the Miller Institute for Basic Research in Science at the University of California, Berkeley from 2013 to 2015. She earned her doctoral degree in astronomy and astrophysics at Harvard University in 2013.

Faculty Awards and Honors

The prestigious Bruno Rossi Prize has been awarded this year to W. Niel Brandt, the Verne M. Willaman Professor of Astronomy and Astrophysics. The prize is the top award given each year by the High Energy Astrophysics Division of the American Astronomical Society.

To read more about faculty awards and honors, visit science.psu.edu/news-and-events.

New Faculty

Rebekah Dawson, assistant professor of astronomy and astrophysics, focuses her research on understanding how planetary systems beyond our solar system originate. She is interested in identifying the key factors that contribute to planetary formation and evolution and that lead to the wide variety of planetary orbital and compositional properties observed in extrasolar planets. She combines simulations and theory with statistics and data analysis of observed planets to test theories of the origins of planetary systems. Dawson is developing a comprehensive blueprint to help understand newly discovered planets in the context of their system’s formation and evolution—important factors in whether the planets may harbor life. Prior to joining the faculty at Penn State, Dawson was a Miller Research Fellow at the Miller Institute for Basic Research in Science at the University of California, Berkeley from 2013 to 2015. She earned her doctoral degree in astronomy and astrophysics at Harvard University in 2013.
Roberto Iglesias-Prieto, professor of biology, focuses his research on coral biology. He has made major contributions to our understanding of the photobiological processes involved in coral growth. Corals are an important component of the marine ecosystem and are comprised of both nonliving and living components. One of Iglesias-Prieto’s most recent contributions demonstrated an important function of the nonliving components of coral in capturing light that is used by the living components in photobiological processes, showing how global warming patterns are adversely affecting these communities. Before joining the faculty at Penn State, Iglesias-Prieto was professor in the Instituto de Ciencias del Mar y Limnología at the Universidad Nacional Autónoma de México from 1996 to 2016 and was head of the Reef Systems Academic Unit there from 2008 to 2014. He was senior scientist in the Department of Ecology at the Centro de Investigación Científica y Estudios Superiores de Ensenada in Mexico from 1994 to 1996 and a postdoctoral fellow at the University of California, Santa Barbara from 1993 to 1994. Iglesias-Prieto earned his doctoral degree in aquatic and population biology at the University of California, Santa Barbara in 1993.

Scott Phillips, an associate professor of chemistry and holder of the Lou Martarano Career Development Professorship, has been honored with the inaugural Stephen and Patricia Benkovic Early Career Professorship. Mikael Rechtsman, an assistant professor of physics, has been honored with an Alfred P. Sloan Research Fellowship in recognition of his research accomplishments. Raymond E. Schaak, DuPont Professor of Materials Chemistry at Penn State University, has been honored with the 2016 Inorganic Nanoscience Award from the American Chemical Society’s Division of Inorganic Chemistry.
Biology

Tracy Langkilde Selected to Lead the Biology Department

Tracy Langkilde, associate professor of biology, has been named the new head of the Department of Biology. Effective on February 1, Langkilde replaced Douglas Cavener, who had served as the biology head for fifteen years prior to being appointed dean of the Eberly College of Science in 2015. Langkilde said that her goals as department head focus particularly on offering outstanding educational opportunities; communicating research results to the public; and maintaining a pleasant, collaborative atmosphere. “I hope to further increase the visibility of our excellent research and teaching; enhance graduate and postdoctoral career development opportunities; transform undergraduate education using a bottom-up approach that leverages expertise within the department; and offer enhanced pedagogy training and mentoring opportunities, especially for new faculty members,” said Langkilde. “I also aim to enhance diversity by exploring new mechanisms to recruit diverse faculty members and students, make the workplace more family-friendly and maintain the wonderfully collegial atmosphere in the department by increasing opportunities for department members to get together.” As a researcher, Langkilde has focused on understanding how nature is organized and how species coexist. She is particularly interested in how species interactions shift over time in response to changes in the environment and corresponding selection pressures. Langkilde is the recipient of the 2011 George Mercer Award from the Ecological Society of America and the Edward D. Bellis Award in Ecology from Penn State for exceptional education and training of ecology graduate students. She is the author or co-author of 78 publications in peer-reviewed journals and has given numerous invited talks throughout the world. In addition, Langkilde is an associate editor of the journal Evolutionary Ecology, and she has served on multiple committees, councils, and teams. Langkilde has been a member of the Penn State faculty since 2007 and was promoted to associate professor in 2012. In 2014–15, she served as the Tombros Fellow for Undergraduate Research in the Eberly College of Science. Prior to joining Penn State, Langkilde was the Gaylord Donnelley Environmental Postdoctoral Fellow at Yale University. She earned a bachelor’s degree at James Cook University in 1999 and a Ph.D. degree at the University of Sydney in 2005.
Lauren Ulsh of Rochester, Minnesota, was honored as the student marshal for the Eberly College of Science during Penn State University’s fall commencement ceremonies on Saturday, December 19, 2015, on the University Park campus. Ulsh’s faculty escort for the commencement exercises was James A. Strauss, senior lecturer of biology at Penn State.

Ulsh graduated with a 4.0 grade point average and a bachelor of science degree in biology with a focus on neuroscience. She received The President’s Freshman Award in 2013, the President Sparks Award in 2014, and the Evan Pugh Scholar Award in 2015.

While at Penn State, Ulsh worked in the Addiction, Smoking, and Health Lab in the psychology department as a research assistant. Ulsh recruited, coordinated, and ran participants through a variety of studies to examine impulsiveness and self-control in the general population.

Ulsh also performed research at the Applied Neuroradiology Laboratory of David F. Kallmes in Rochester, Minnesota, during the summer of 2013. As a result of her work, she co-authored a paper, titled “Smoking is not associated with recurrence and retreatment of intracranial aneurysms after endovascular coiling,” which was published in the Journal of Neurosurgery in January 2015.

In addition to her academic achievements, Ulsh was active in organizations on campus and in the community. She was the 2015 Penn State Homecoming Donor Relations Director; a member of the Club Water Polo team; a THON committee member in 2014 and 2015; and a volunteer at the Mount Nittany Medical Center.

“I was extremely honored when I received word that I was selected as the Eberly College of Science Student Marshal. Not only was it heartening to know that my hard work did not go unnoticed, but I also am proud to represent the college that fueled my intellectual curiosity and love for learning,” Ulsh said. “I will never forget the support and opportunities that I received from friends, faculty, and staff at Penn State who helped me live in the present and prepare for the future.”

“After graduation, I plan to continually extend my own support to the undergraduate students of Penn State,” Ulsh said. She plans to attend medical school.

Ulsh is a graduate of Mayo High School in Rochester, Minnesota. She was accompanied at commencement by her parents Gregory and Kristen Ulsh, brothers Matt and Jeff Ulsh, sister-in-law Faith Ulsh, uncle Arn Caddick, and aunt Deb Caddick. —Joslyn Neiderer
Anna Wing and Joshua Bram, both of State College, Pennsylvania, were honored as student marshals during the Penn State Eberly College of Science spring commencement ceremonies on Saturday, May 7, 2016, on the University Park campus. Wing’s faculty escort was Joseph Reese, professor of biochemistry and molecular biology. Bram’s faculty escort was Stephen Schaeffer, professor of biology.

Student Spotlight
Spring 2016
Student Marshals

Anna Wing graduated with a 4.0 grade point average and a B.S. degree in biochemistry and molecular biology with a minor in English. In addition to her academic classes, she participated in research in the laboratory of Professor Reese, where she investigated transcription-regulation proteins under stressed conditions and the response of cells to DNA damage. She received a scholarship from the German Academic Exchange Service, which enabled her to perform research involving cells of the immune system in the laboratory of Kristina Schachtrup at the University of Freiburg in Germany during the summer of 2014. She also traveled to Tanzania to study ecology during the summer of 2013.

Penn State awards that Wing received include Eberly College of Science Braddock Scholarships from 2012 through 2016, Schreyer Honors Scholarships from 2012 through 2016, the President’s Freshman Award in 2013, the Women in Science and Engineering (WISER) Scholarship in 2013, the President Sparks Award in 2014, the Ronald Venezie Scholarship in Science for Honors Education in 2014, the Bayard D. Kunkle Scholarship in 2014, the Herko Family Scholarship in Biochemistry and Molecular Biology in 2015, and the Evan Pugh Scholar Award in 2015 and 2016.

Her service contributions to Penn State include her participation in the Penn State IFC/Panhellenic Dance Marathon (THON) throughout her college years. During the 2015–2016 academic year, she served as administrative chair for Springfield, a special-interest organization dedicated to supporting THON. She was a tutor for organic chemistry from 2014 through 2016, she was a volunteer at the Mt. Nittany Medical Center from 2013 through 2016, and she participated in the Penn State Presidential Leadership Academy from 2013 to 2016.

“I have gained such a strong family in my time at Penn State, from my work with professors in the classroom to the friends I have found in my clubs and extracurriculars,” Wing said. “My own personal network of Penn State connections now reaches across the country, and the alumni network reaches around the world.” After graduation, Wing will work in a cancer...
research lab at the University of Pennsylvania for one year, then she plans to attend medical school in the fall of 2017.

Wing is a graduate of the State College Area High School. She was joined at commencement by her parents Karen and Scott Wing.

Joshua Bram graduated with a 3.99 grade point average, a B.S. degree in biology with a focus on genetics and development, and a B.S. degree in immunology and infectious disease. In addition to his academic classes, he conducted research in the laboratory of Andrew Read, Evan Pugh Professor of Biology and Entomology and Eberly Professor of Biotechnology, where he studied the virulence of the malaria parasite and the evolution of drug resistance. He also served as a teaching assistant for a number of courses from 2013 through 2016.

The Penn State awards that Bram received for his scholarship and research include Eberly College of Science Braddock Scholarships from 2012 through 2016; the Schreyer Academic Excellence Scholarship from 2012 through 2016; the President’s Freshmen Award in 2013; Schreyer Ambassador Travel Grants in 2013, 2014, and 2015; Eberly College of Science Undergraduate Research Grants in 2013 and 2015; the Undergraduate Summer Discovery Grant in 2014; the Overall Life Science award in the Eberly College of Science Undergraduate Experiences Poster Session in 2014; the Bayard D. Kunkle Academic Achievement Scholarship in 2014; the Evan Pugh Junior Scholar Award in 2015; the Evan Pugh Senior Scholar Award in 2016; and the Eric A. Walker Award in 2016.

Bram also received an American Society of Microbiology Undergraduate Research Fellowship in the summer of 2015. He became a member of the Phi Beta Kappa Society in 2015, Phi Kappa Phi Society in 2014, and Gamma Sigma Delta Society in 2014.

His service contributions to Penn State include serving as the Science Lion Pride alumni relations director in the 2013–2014 academic year, helping to organize the Penn State IFC/ Panhellenic Dance Marathon (THON) during the 2014–2015 academic year, and serving as executive chair during the 2015–2016 academic year for Springfield, a special-interest organization dedicated to supporting THON. As part of the Penn State Humanitarian Engineering and Social Entrepreneurship Program, he traveled to Sierra Leone and Zambia in the summers of 2014 and 2015, respectively. He also traveled to Tanzania to study ecology during the summer of 2013. Bram was selected to be honored as a student representative on the Penn State Homecoming Court in the fall of 2015.

“As an alumnus, I will always be reminded of what I accomplished here, the opportunities provided to me as a student, and the great things that come out of Penn State every single day,” Bram said. “I know that I could not have attended a better school or gotten more out of my experience. The bright future ahead for our University will bring me back home to stand proud as a Penn State graduate for the rest of my life.”

After graduation, Bram plans to attend the Perelman School of Medicine at the University of Pennsylvania beginning later this year.

Bram is a graduate of the State College Area High School. He was joined at commencement by his father, Barry Bram; his mother, Ann Taylor; his stepparents, and family. —Joslyn Neiderer and Barbara Kennedy
This spring break, I traveled with Global Medical Brigades to Nicaragua as part of a medical/dental and public health brigade. In six days, we attended over 700 patients, built latrines, cement floors, and septic tanks for two families, as well as helped other brigade groups on a nearby water project.

Before this trip, I found myself trapped in a bubble of complacency and privilege. I studied in school for the sake of getting the grade, and lost sight of why I was here. I was absorbed in my own problems and stress, that I became oblivious to the real issues people face outside of my everyday life.

In that week, I felt like I made more of a real difference in the world than I have in my entire life. We directly interacted with and tended to patients, prepared medications, gave talks on disease prevention, and helped families with scarce resources have a clean place they can call home.

After seeing the impact that our simple services had on the community, I am emboldened to find my own way of further contributing to even more communities. As a science student, I strive to conduct research that will fundamentally improve these communities. For example, our doctors were hard pressed to diagnose everyone quickly; it would be very impactful if we could develop quick biomedical diagnostic tools for places like this.

This trip has reinvigorated my passion and appreciation for science and other cultures as well as made me place an increased value on global outreach, so much so that I am determined to volunteer at the Peace Corps before retirement.

—Emily Cribas is a junior studying biochemistry and molecular biology.
Popular “Study Smarter, Not Harder” Workshop Returns for Spring Semester

The popular “Study Smarter, Not Harder” workshops, organized by the Division of Undergraduate Studies (DUS) and the Eberly College of Science, expose students to strategies that can help them become more effective learners. Two workshops were offered during spring semester.

The workshops were taught by Jacqueline Bortiatynski, lecturer in chemistry, and Joshua Wede, lecturer in psychology, and were open to students in all majors at the University.

Attendees took away strategies to make their studying more efficient. In addition to learning the most effective, research-based study skills and strategies, students also learned what not to do when studying. During these workshops, Bortiatynski and Wede helped students analyze their existing study strategies and learn how to apply new techniques to their studying. The activities were hands-on, including short exercises that provided proof that the strategies work.

The students who participated in the workshops saw a difference in their performance.

“I feel the ‘Study Smarter, Not Harder’ workshop inspired me to take the time and effort to study with true focus and determination in order to prepare myself for exams and quizzes,” said Emily Strang, a first-year student in the Eberly College of Science.

The workshops are particularly helpful for first-year students making the transition from high school to college.

“It’s a great tool for anyone in college, especially first-semester freshmen,” said Adam Holz, a sophomore in DUS.

“In high school, I never studied, yet got good grades because things connected easily. When I started college, I quickly learned that studying was a necessity, but I did not know how to actually study,” said Brian Carvajal, a first-year student in the Eberly College of Science. “I thought that reading the textbook while taking a few notes was all that I really needed, but that never brought me the results I wanted. Attending the ‘Study Smarter, Not Harder’ lecture really taught me how to properly study, which was a huge help, especially for finals.” —Whitney Gould
Physics Major Sylvia Biscoveanu Awarded a Goldwater Scholarship

Eberly College of Science student Sylvia Biscoveanu is the recipient of a 2016–17 Goldwater Scholarship from the Barry Goldwater Scholarship and Excellence in Education Foundation. The scholarship is the premier award of its type in the fields of mathematics, science, and engineering. Biscoveanu, a junior from Yardley, Pennsylvania, is double majoring in Physics and Spanish and pursuing minors in Mathematics and Violin/Viola Performance. She is also a Schreyer Scholar.

“For me, winning the Goldwater is a validation of all the hard work I’ve put towards my research and classes. I am extremely honored and humbled to have been selected, and this reaffirms my decision to major in Physics,” said Biscoveanu. “I am encouraged that my work can make a difference in the scientific community in the future.”

Since her first year at Penn State, Biscoveanu has been conducting astrophysics research with Miguel Mostafá, associate professor of physics. She identifies the mass composition of cosmic rays—the most energetic particles in the Universe—using data from the Pierre Auger Observatory. Biscoveanu took her research experience abroad last fall when she worked with Dr. Fernando Arqueros, an Auger collaborator, and his group at the Universidad Complutense de Madrid.

Biscoveanu spent last summer participating in research with the Laser Interferometer Gravitational Wave Observatory (LIGO) Collaboration at Monash University in Melbourne, Australia through a research experience for undergraduates (REU). There, she worked with Dr. Eric Thrane on a project looking for magnetic noise interfering with the potential detection of a stochastic gravitational wave background. This summer, Biscoveanu will continue to work with LIGO through another REU at the California Institute of Technology.

“By her academic contributions and engagement in cutting-edge research, Sylvia has distinguished herself as a scholar of truly exceptional promise. We are absolutely delighted that she has been recognized with the prestigious Goldwater scholarship, and so proud to have her in our college community,” said Mary Beth Williams, senior associate dean and professor of chemistry in the Eberly College of Science.

In addition to the Goldwater Scholarship, Biscoveanu was recently awarded the Evan Pugh Scholar Award, an academic award given to those juniors and seniors who are in the upper 0.5 percent of their respective classes. Last year, she received a Goldwater honorable mention, and also received the award for the top undergraduate presentation at the Mid-Atlantic Section of the American Physical Society. In 2014, Biscoveanu was awarded the Women in Science and Engineering Research undergraduate fellowship from the NASA Pennsylvania Space Grant Consortium.

Aside from her research and academics, Biscoveanu is an accomplished musician, playing the violin and viola, and performing as the...
first violinist in a string quartet. Biscoveanu serves as the vice president of membership of the Penn State Music Service Club, whose goal is to spread the healing power of music throughout the State College community. She is also an active member of the Spanish Club.

After graduating in 2017, Biscoveanu plans to pursue her Ph.D. in Physics and conduct research in early universe cosmology while teaching at a university.

“Having worked with Ms. Biscoveanu for three years, I’ve been reminded of an earlier Penn State Physics major who was also a Schreyer Scholar, who participated in study abroad, was a virtuoso musician, did extensive research, won major Penn State and national awards and fellowships, and who is now a faculty member at an Ivy League university. I think that Sylvia is on a similar stellar trajectory and I’m sure she’ll continue to excel in her future career,” said Richard Robinett, professor of physics and associate head for undergraduate and graduate students in the Department of Physics.

The Goldwater Foundation is a federally endowed agency established in 1986. The Scholarship Program, honoring Sen. Barry Goldwater who served the United States for more than five decades as a soldier and statesman, was designed to foster and encourage outstanding undergraduate students to pursue careers in the fields of mathematics, the natural sciences, and engineering. Since the first scholarships were awarded in 1989, the foundation has bestowed $48 million in scholarship funds through more than 7,600 scholarships. —Tara Immel

THON Adventures

During THON 2016 weekend, Science LionPride (SLP) hosted a THON Adventures outreach event for THON children and their families where they conducted superhero-themed science experiments. SLP was joined by Mike Zeman, director of Science-U summer camps, and the Alliance of Heroic Hearts.
She recalls when she was younger, how she and her father enjoyed creating math problems to solve together. “We would be watching TV and a claim would be made. We’d then sit down and do some calculations,” she said. These calculations could involve anything from the number of seats in a movie theater to whether or not a company’s donation cost more than the marketing to promote it.

Life as a mathematics graduate student has her studying far more abstract concepts now. Her adviser, Jason Morton, asks his graduate students to choose four different research projects for their doctoral thesis. Jamshidi’s four projects include studying the connections between quantum mechanics and evolution, Gröbner bases, transference in cognitive autonomy, and nonclassical probability theory, a far cry from the simple calculations she used to do with her father.

“We want to take things to an abstract level, which sounds like a bad thing to most people,” Jamshidi said. “If you strip away as much of the shallow information as possible, you get to the deeper stuff, then you can connect seemingly unrelated topics.”

She used this approach to her first research project involving evolution and quantum mechanics. By comparing the relationships between quantum particles to the relationships between different species, Jamshidi was able to use mathematical techniques for evolution to describe some quantum-entangled states.

“These virtual particles tell us how the physical particles are related to each other, how they’re entangled,” she said. “They are just like extinct species, which tell us how the species we see today are related to each other.”

Her second research project, involving Gröbner bases, might be her favorite of the four. “There are a lot of open problems in math that boil down to calculating something called a Gröbner basis,” she said.

Gröbner bases contain the building blocks to describe all the information of a mathematical problem. The challenge with any Gröbner basis is that finding it requires a lot of computing power, which makes it difficult to study. Morton received a grant from Amazon to use a set of their high-capacity computer cores and server space, which will help Morton and Jamshidi...
take an old Gröbner basis algorithm and attempt to calculate it in a more modern way.

“We’re writing a Gröbner basis algorithm that is in parallel instead of in series; we’re breaking up the steps and doing them simultaneously instead of in order,” she said. “Modern computers are powerful in that they have multiple cores, so we want to use them all at once and split up the work.”

Another research project involves work for the defense industry. For this, she has served as an intern for the Air Force Research Laboratory at Wright-Patterson Air Force Base and now interns with the Cognitive Autonomy Group at the Penn State Applied Research Laboratory.

Jamshidi works on improving information fusion and learning algorithms, called neural networks. She has developed a system of rules that allow machines to make decisions more like humans do.

“The data we feed into a neural network act like past experiences—the algorithm maps out patterns based on how you’ve programmed it to learn from those experiences and, with those patterns, it tries to make decisions in new situations,” she said.

The existing algorithms only work well when the situation doesn’t change much. Jamshidi uses imaging as an example. Social media images don’t change in composition much—consisting mostly of smiling faces—so it’s easier for a learning algorithm to identify important shapes associated to faces. But for defense purposes, reconnaissance images might change in composition quite a bit: different objects in different landscapes and differing cultural norms could make it difficult for a machine to identify elements in an image.

“These algorithms don’t always pick up the right features. They can mistake a toilet paper roll for a cell phone,” Jamshidi explained, which is why it’s important to develop algorithms that do a better job finding the important features.

“I’m trying to create a mathematical model that mimics what humans seem to do,” she said.

Outside of her research, Jamshidi has received quite a few accolades. She won a Dean’s Climate and Diversity Award in 2013 for her work organizing a diversity workshop for graduate students in the Department of Mathematics, and a Harold F. Martin Graduate Assistant Outstanding Teaching Award from The Graduate School for her teaching excellence. She was a student representative on the Dean’s Selection Committee, founded the Mathematics Teaching Discussion Group in her department, and regularly contributes to the Graduate Student subcommittee of the college’s Climate and Diversity Committee.

When she’s done with her doctoral degree, Jamshidi would like to find a job as a math professor, where she can still teach and conduct research, and continue her work with the defense industry.

In her free time, she enjoys knitting, brewing her own European-style beers, and reading. And, of course, spreading her enthusiasm for math wherever she goes.

“I’m of the opinion that everyone would love math if they knew more about it!” she said.

—Whittney Gould

SCIENCE JOURNAL June 2016

47
Science outreach promotes understanding and awareness of current research by the public and has become essential for scientists and the broader research community. Government-funded grant programs require explicit plans to benefit the public via broader impacts, including outreach, and scientists are evaluated based on these impacts throughout their careers. While Penn State places a strong emphasis on promoting community engagement by researchers, new graduate students lack training in developing successful outreach programs.

To address this need, Biology graduate students Chris Thawley, Zach Fuller, and Allison Lewis approached the Department of Biology with the idea to create a course to give students the skills and experience to communicate science effectively and design meaningful outreach activities based around students’ own research interests.

With support from the biology department and the Eberly College of Science, BIOL 497F: Science Outreach and Communication launched in fall 2015 as a one-credit course with thirteen graduate and undergraduate students enrolled. This new course focused on giving students the skills and experience to communicate science effectively and design meaningful outreach activities based around students’ own research interests.

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Impact Beyond the Lab

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The first part of the class focused on building a solid foundation of teaching skills, including how to design effective outreach around key concepts and how to tailor activities to different ages and audiences. Using those skills, teams of students designed, planned, practiced, and re-
vised their own projects in preparation for two core outreach activities. The first was held at Exploration-U Community Science Night, hosted by Penn State’s Eberly College of Science Outreach Office at the Bellefonte Area High School.

The second project was independently organized by students and ranged from an interdisciplinary lecture on photography and ecology at a local high school to an engaging Q&A discussion about ant biology with elementary school students in Philadelphia.

Learning how to effectively communicate their research to the public excited the students in the course, who benefitted from both its content and format.

One entomology graduate student described this by noting, “in the beginning of this seminar I had a difficult time brainstorming ideas to develop an outreach activity that would directly relate to my research topic, chemical ecology. After designing and implementing two activities, I gained the confidence that I needed to discuss several different areas related to entomology in an effective way.”

The course also offered students the opportunity to recognize the impact that their scientific work has beyond the lab.

“Working with high school students was nothing like what I had expected, and ended up being one of the most formative events of my fall semester. It forced me to reflect on the broad importance of my work, and articulate that work in a way that is relatable and exciting to an audience that isn’t necessarily present out of pure interest.”—graduate student in biology

Thawley, Fuller, and Lewis are very grateful for the support they have received for the course. They plan to offer the course again in fall 2016 and hope to leave “Science Outreach and Communication” as a sustainable and permanent offering in the future.

Solutions to puzzles on page 48

Solution 1 Only 4, 5, and 6. The middle number must be larger than the three numbers in the top left corner and the three smaller than the bottom right. So the only possible entries are 4, 5, and 6.

<table>
<thead>
<tr>
<th>1</th>
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<tbody>
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<td>?</td>
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<tr>
<td>*</td>
<td>9</td>
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</tbody>
</table>

Here are two examples where 4 and 6 are in the center:

| 1 2 3  |
|---|---|---|
| 4 6 7 |
| 5 8 9 |

| 1 2 6  |
|---|---|---|
| 3 4 7 |
| 5 8 9 |

Solution 2 48 triangles total.
There are 25 small triangles, 13 equilateral triangles made of groups of four small triangles, 6 equilateral triangles made from 9 small triangles, 3 equilateral triangles made from 16 small triangles, and 1 triangle made of all 25 triangles.

Solution 3 No knight’s tour is possible. The movements of knights require that they alternate between black and white squares. By removing the corners, we have decreased the number of white squares to 9 while the black squares remain at 12. There is no way to alternate between black and white squares and reach all 12 without repeatedly visiting a white square.
Penn State alumnus and philanthropist Charles H. “Skip” Smith has committed $5 million to advance the research of Gong Chen, professor of biology and the Verne M. Willaman Chair in Life Sciences in the Eberly College of Science. Chen’s research holds promise for developing treatments for traumatic brain injuries, stroke, Alzheimer’s, and other neurodegenerative diseases.

“While the intricacies of Dr. Chen’s research are complex, all of us understand the debilitating effects of diseases like Alzheimer’s and Parkinson’s,” said Penn State President Eric Barron. “Skip Smith’s transformational gift will provide the much-needed resources and support to help move us closer toward an effective treatment. Skip has established an extraordinary legacy of giving to Penn State, and we are grateful that he has chosen to support research that is vital to families who are suffering from debilitating brain injuries and diseases.”

Chen and his team have developed a ground-breaking laboratory technique that promises to one day lead to clinical therapies for patients with damaged brain tissue. Smith’s gift will provide funding for the highly skilled staff, lab equipment and other materials necessary to move this research forward.

“Dr. Chen is pioneering some of the most exciting research in the field of brain repair research,” said Douglas Cavener, the Verne M. Willaman Dean of the Eberly College of Science. “Skip Smith’s extraordinary support will allow Dr. Chen and his team to accelerate the pace of discovery in this vitally important area.”

Chen’s laboratory recently used a cocktail of small molecules to transform human brain cells called astroglial cells into functioning neurons for the purpose of brain repair. Published online in the journal Cell Stem Cell on October 15, their findings provide preliminary indications that “chemical reprogramming” may one day lead to the development of drugs that could regenerate neurons and restore brain functions to patients.

The team is currently developing techniques for both gene therapy and drug therapy that can eventually move their lab research through all the stages of clinical trials in order to treat patients. They are now testing the use of their chemical reprogramming method on brain injuries such as stroke, spinal-cord injuries, and Alzheimer’s disease.

“I’m deeply grateful for Skip Smith’s generosity. Mr. Smith’s outstanding gift will allow my team and me to move our lab research to human clinical trials much faster, perhaps shortening the delivery of potential therapy to within ten years,” said Chen. “Skip’s generosity will surely encourage more students to join us—not only for great science, but also for deep humanity. I myself would like to follow Skip Smith’s model and return generosity back to society.”
Smith’s seven-figure support for Chen’s research is not his first transformational gift to the University. In 2010, his historic gift of $10 million launched construction of The Arboretum at Penn State, enabling the University’s decades-long vision for the project to come to fruition. The gift also named the H.O. Smith Botanic Gardens in honor of Smith’s late father, also a Penn State alumnus. Smith has since added to his support for the Arboretum, and now—with this new gift to support Chen’s work—his total lifetime giving to Penn State exceeds $18 million.

Smith’s gift to the Eberly College of Science will take his philanthropy in a new direction, as his first major gift to advance research at Penn State. “It is truly inspiring to know that Dr. Chen and his team may be only a decade away from a treatment for Alzheimer’s and related diseases,” said Smith. “If my support can help to bring this exciting prospect within closer reach, then it will have paid itself back tenfold.”

A resident of State College, Smith graduated from Penn State with a bachelor of science degree in electrical engineering in 1948. Along with his brothers and fellow Penn State graduates James B. Smith and Thomas L. Smith, Skip joined his father in the firm H.O. Smith and Sons, a real estate development and rental company established in 1951. In 1950 he also founded State College Television Co., now State College Audio-Visual Supply, owned by his son John.

Alumni and friends like Skip Smith are invaluable partners in fulfilling the University’s land-grant mission of education, research and service. Private gifts from alumni and friends enrich the experiences of students both in and out of the classroom; expand the research, and teaching capacity of faculty; enhance the University’s ability to recruit and retain top students and faculty; and help to ensure that students from every economic background have access to a Penn State education. The University’s colleges and campuses are now enlisting the support of alumni and friends to advance a range of unit-specific initiatives.—Dave Lieb

**Alumni Fellow**

Stephen Miller, Ph.D., ’69 B.S. Microbiology; ’73 M.S. Microbiology/Immunology; ’75 Ph.D. Microbiology/Immunology

Judy E. Gugenheim Research Professor of Microbiology Immunology at the Northwestern University Feinberg School of Medicine and director of the Northwestern University Interdepartmental Immunobiology Center

The Alumni Fellow Award is the most prestigious award given by the Penn State Alumni Association. Since 1973, the Alumni Fellow Award has been given to select alumni who, as leaders in their professional fields, are nominated by an academic college and accept an invitation from the President of the University to return to campus to share their expertise with students, faculty, and administrators.

*Congratulations to this remarkable alumnus and thank you for your outstanding work to advance the fields of science.*
Some people create bucket lists—series of activities they’d like to do or achieve in their lives, like visiting a new country, skydiving, or writing a book. But Tom Hellman ’70g Chemistry has a different sort of list, one that includes everything in his life for which he is grateful.

“When I made my gratitude list, I thought about all the institutions and people who had made a real difference in my life, both personally and professionally,” said Hellman, who retired in 2008 after 38 years as an executive in the industrial and manufacturing sectors. “Penn State came up high on the list and Gordon Hamilton was the person who made the difference.”

To honor Hamilton, professor emeritus of chemistry at Penn State, Hellman decided to set up the Dr. Gordon Hamilton Graduate Scholarship in Organic and Biological Chemistry with a gift of $50,000. The scholarship will provide recognition and assistance to graduate students in the Department of Chemistry who have demonstrated financial need.

“Gordon provided me with guidance and mentorship, but he also allowed me to be independent and chart my own course,” said Hellman. “I thought this scholarship would be consistent with his values as a teacher and scholar.”

Hamilton, who retired from Penn State in 1997 after 31 years, said he was surprised and honored to learn about the scholarship. “I probably had the distinction of being the only chemistry Ph.D. student who was also captain of the rugby team,” he said. “But I learned that when you get knocked down, you get back up again, and that was a valuable lesson.”

Hellman said he hopes through his scholarship to help students, in need of financial support as he once was, to realize their dreams. “A little scholarship like this,” he said, “may be the difference that allows an individual to prosper and accomplish their academic aspirations in an easier fashion.”
If you are inspired by Tom’s story and would like to contribute to the Dr. Gordon Hamilton Graduate Scholarship in Organic and Biological Chemistry, visit www.GiveTo.psu.edu/HamiltonGrad or

Make a check payable to Penn State Note in memo: Dr. Hamilton Graduate Scholarship Send to: Eberly College of Science 430 Thomas Building University Park, PA 16802

Gifts at any level will add to the impact of this scholarship.

Or, if another faculty member was instrumental in your life and you’d similarly like to honor them, scholarships like this can be established as outright gifts (generally $10,000 per year over a five-year pledge period) or as a deferred gift in your estate plan. For more information, please contact Joyce Matthews, senior director of development and alumni relations, at jvm2@psu.edu or 814-863-1247.

Science Mentoring Dinner 2016

One of the many ways that science alumni give back to the Eberly College of Science is by sharing their time with our students, to mentor them and provide educational and career guidance. Alumni receive great personal satisfaction from their mentor-protégé relationships, which often extend beyond graduation. As part of the formal mentoring program, the mentors and protégés gather for dinner and roundtable discussions, many meeting for the first time and connecting over mutual career interests and sharing best practices. Thank you to our mentors, who came from near and far, and to the students who enjoyed the evening.

We welcome new mentors into the program! Please email the assistant director of alumni relations at bhc10@psu.edu for more information.

Left to right, bottom to top:
Christa Hasenkopf, Sonja Cerra-Gilch, Fran Nelson, Darlene Dunay, Laurie Stanell, Jim Giranda
Greg Sam, Joe Flasher, Josh Yoder, Candace Good, Steve Beauparlant, Eric Freed, Janice Ward, Cathy Vrentas
Greg Radio, Julie Philippi, Rohit Moghe, Shawn Gallagher, Christina Winnicker, John Italia
Patrick Breslin, Jordan Irvin, Heather Erdman, Bill Flood, Nate Hafer (Not Pictured): Leslie Walsh
Welcome

REGENERON

The Corporate Associates Program is a newly launched program in the Eberly College of Science. It is designed to strengthen connections between companies and the college.

As the inaugural member, Regeneron is leading the way in supporting our vision of providing enhanced opportunities for our students. This early commitment reflects the innovative approach they use for developing new therapies that improve patient’s lives.

In the December issue, learn more about Regeneron and our Corporate Associates Program.

Free of charge
Gather your science friends and family, and join us for this informal event!

Tickets
Please contact 1-800-Nittany for ticket information. Our office will not have football tickets for sale in 2016.

For more information
Contact the Science Alumni Relations Office at 814-863-3705 or bhc10@psu.edu.

Each year more alumni attend the Penn State Science tailgate and reconnect to the Eberly College of Science. Come be a part of this growing science tradition.

Please Join Us for the 4th Annual All-Science Tailgate
September 17, 2016
Penn State Nittany Lions vs. Temple Owls
2 1/2 hours prior to kickoff time
Picnic Pavilion Inside Medlar Field at Lubrano Park
We’d like to hear your comments and feedback.
Go to science.psu.edu/sciencejournal and use our feedback form.

Want more Science Journal?
Check out science.psu.edu/sciencejournal.
And while you’re there, tell us what YOU think about the Science Journal!

Questions? Comments? Address Change?
Email sciencejournal@psu.edu or call 1-800-297-1429 (please leave a message with your name and updated address).

Share Your News!
Penn State Science will feature the accomplishments of our alumni on the science alumni website. Sharing your success stories is a great way to network with fellow alums and show how science grads have made an impact on the community and world! Share your career experiences since graduation and let us know how Penn State Science prepared you for your career pathway.

Share with us at
science.psu.edu/alumni/alumni-news
or by email
Barbie Collins, assistant director of alumni relations, at bhc10@psu.edu.
Upcoming Events

June 3–5
• Alumni Reunion Weekend

June 4
• Distinguished/Honorary Alumni Awards

July 14–17
• Arts Fest

September 17
• All Science Tailgate, Medlar Field

September 24
• Hobby-Eberly Telescope Rededication

October 6
• Science Benefactor’s Dinner

October 7
• Dean’s Advisory Board
• Homecoming Parade

October 27
• Alumni Fellow Inductions

October 28
• Alumni Board Society Meeting
• Celebrate Science! Dinner (Honoring Outstanding Science Alumni and Millennium Society Members)

For more information on any of the events listed above, visit science.psu.edu/alumni/events.