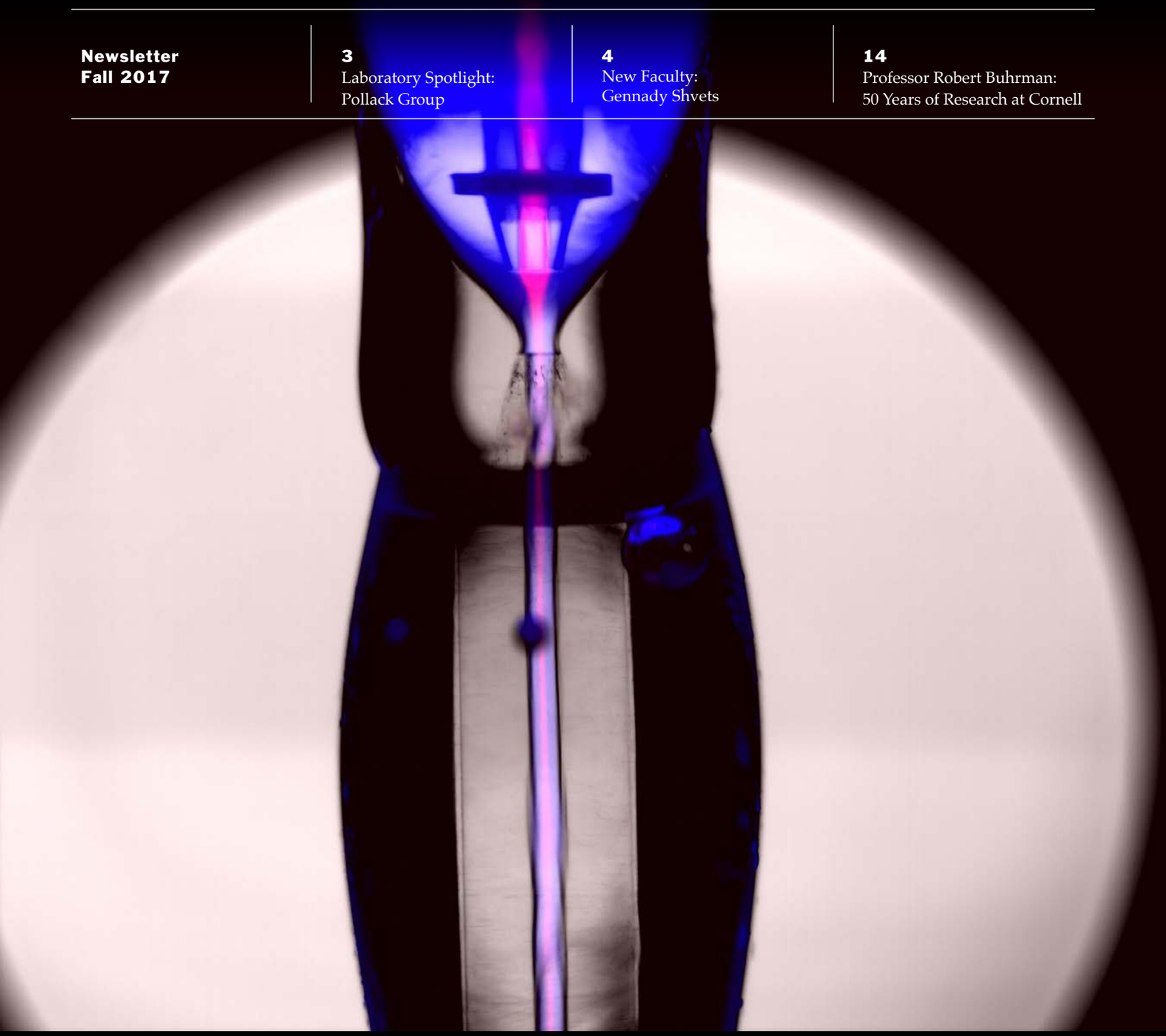
CornellEngineering
Applied and Engineering Physics

AEP

Newsletter
Fall 2017



DEAR FRIENDS OF AEP,

I'm delighted to send this annual newsletter to keep you up-to-date with events in AEP.

This issue highlights new faculty, visitors, research accomplishments and honors in our community. We hope you enjoy viewing photos of this years' joyful events in AEP, including our commencement ceremony, a recent celebration of the distinguished (and continuing) career of Professor Buhrman and, of course, our ever-popular reunion breakfast.

I've heard that many of you enjoy receiving news in this format, please continue to stay in touch!

With warm regards,
Lois Pollack
Professor and Director

Stay Connected

We want to hear from you! Write to us at aep_info@cornell.edu to share your stories, news, and events, or visit us online at aep.cornell.edu/aep/alumni to submit an alumni note.

Follow our social media pages to stay up-to-date with our latest news & events

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AEP's Alumni Newsletter
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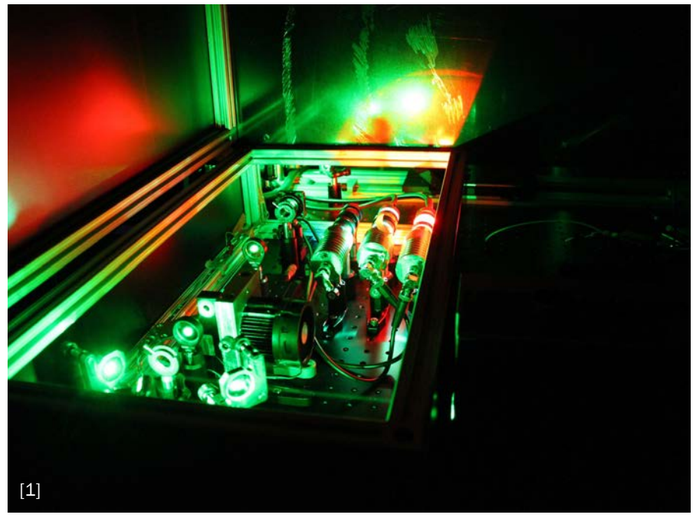
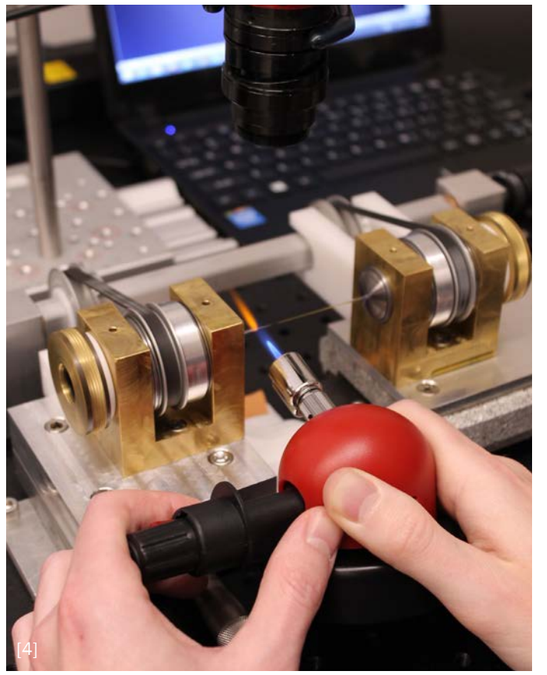


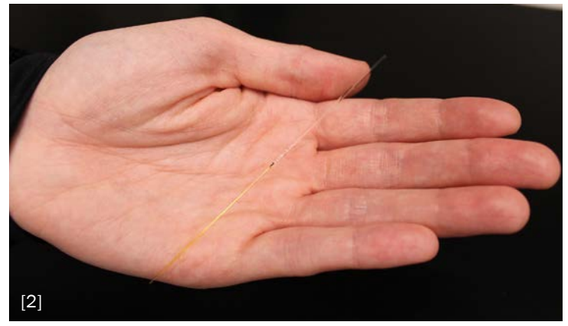
Top, Clockwise: [1] Back-end of custom fluorescence microscope for characterizing these devices. [2] Partially assembled mixer held by PhD Candidate Andrea Katz. [3] PhD candidates George Calvey and Andrea Katz test a new device in the fluorescence microscope. [4] A miniature glassblowing lathe, built in student shop, used in mixer fabrication.

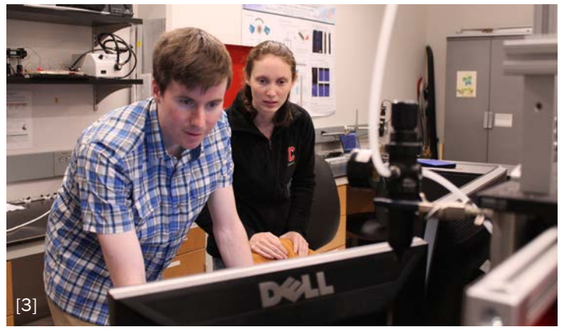
ABOUT THE COVER

LOIS POLLACK'S lab combines microfluidic mixers with new, powerful x-ray free electron lasers to capture atomically detailed snapshots of biomolecules as they function, on the millisecond to second timescale. This new technology provides a window into never-before-seen structural dynamics, revealing short-lived structures essential to function and aiding in future structure based drug design. Many drugs are small molecules that interfere with the action of disease-related proteins. Effective drug design can depend on knowledge of the shape or structure of these proteins. Drug molecules can bind to / interfere with proteins as they change shape to perform their functions.

The cover shows the region of a microfluidic mixer that combines a reacting chemical (blue) with biomolecule flow (red), milliseconds before the solution is ejected into the x-ray beam.





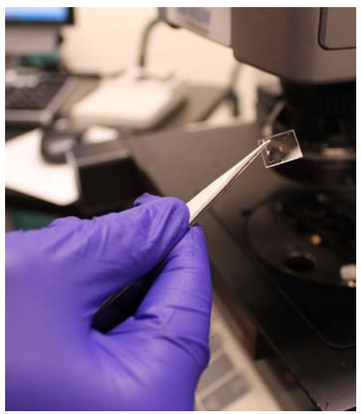


GENNADY SHVETS

By Chris Dawson

Gennady Shvets started his postsecondary education as an undergraduate student at the Moscow Institute of Physics and Technology, and then obtained his PhD in physics from the Massachusetts Institute of Technology. He was a postdoctoral fellow at Princeton University. During his doctoral and postdoctoral years, Shvets was firmly in the theoretical and computational camp.

"I was originally trained as a theorist," says Shvets today from his office in Cornell's Clark Hall, "but over time it became less and less practical to convince other researchers to test my ideas—I wanted to test them myself, so I became an experimentalist." After five years in the Plasma Physics Lab at Princeton, Shvets joined the faculty of the Illinois Institute of Technology, where he started his own research group. "And then, over time, the idea of impact became more important for me," says Shvets. "I wanted to build things. There is an incredible excitement within a group when experimentalists and theorists come together and try to either explain the collected experimental data, or to come up with new experiments based on theoretical insights." Shvets was later offered the opportunity to join the faculty in the Physics Department of the University of Texas at Austin to build an experimental group.



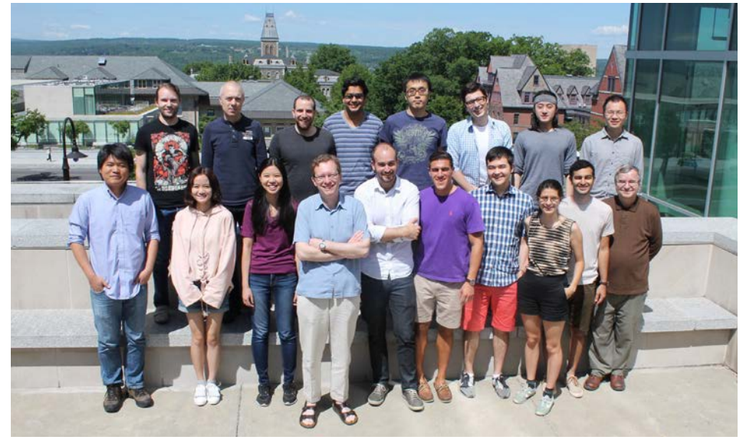
Above: Robert Delgado '18,, holds a slide with a metamaterial that has cat cells deposited on it. The lab is using an IR spectrometer to get the IR spectra of the cells. Non-invasive and non-destructive identification of different cell types allow for the early stage diagnosis and lead to more efficacious potential treatment of various human diseases, including cancer.
At top left: Gennady Shvets in the lab.

Eventually, his work became more applied in its nature, significantly broadening in scope to include nano-optics, artificial optical materials, and even biological sensing. He did not forget his accelerator roots. "As my interest in applications grew, I became even more interested in the idea of building a particle accelerator," says Shvets. "It would be much smaller than the one I was using at Fermi Lab and it would probably use lasers." Now, 20 years into his academic career, Shvets is at Cornell in the School of Applied and Engineering Physics. "At Austin, my interests broadened, my group grew. I found I had to become more agile mentally to switch from project to project. I started to see the connection between different areas of physics and engineering better, and it became clear to me that there are significant opportunities in developing novel optical devices for a wide range of applications, especially in energy, health, and defense areas."

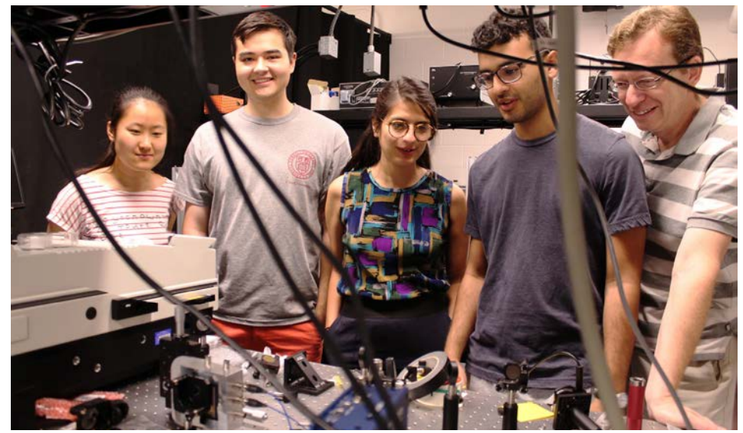
For Shvets, that big picture involved working more with optical and microwave metamaterials. "It is a good thing for a scientist to have exposure to new people and ideas," says Shvets. "Coming to Cornell has been good for me as a researcher. Moves like this can keep you from getting stale." One major factor in Shvets' decision to come to Cornell is the Cornell NanoScale Science and Technology Facility (CNF). The CNF has supported cutting-edge nanotechnology research for almost 40 years and continues to be one of the most highly-respected NSF-funded facilities in the nation.

"Here, I can make many nanostructured materials—CNF allows for rapid, consistent fabrication of new samples," says Shvets with a smile. "This has been a big boost to my work." The work Shvets is talking about shows just how broad his interests have become. The research interests listed on his faculty website include the fundamental science of metamaterials and plasmonics; active, nonlinear, and low-loss metamaterials and non-traditional optical devices based on them; biosensing and molecular fingerprinting of proteins and live cells using metamaterial arrays with applications to cellular phenotyping and early cancer detection; photonic topological insulators, graphene-based metamaterials, and electron beam-driven metamaterials; and advanced accelerator concepts and laser-plasma interactions, with specific emphasis on laser-plasma accelerators.

In other words, everything from fundamental theory to state-of-the-art applications. In this way, Shvets' work is the perfect exemplar of the department he has joined. A project Shvets is excited to recruit new graduate students for is the creation of a new kind of endoscope. "This project will place considerable emphasis on computational work," says Shvets. "Students will run things on supercomputers and learn skills that are in high demand." If successful, the endoscope will be able to detect differences between types of cells based on their optical response. "Some researchers believe a major difference between cancer cells and non-cancer cells is the chemical compositions of their membrane," says Shvets. "We want to attach the cells to metamaterial and then use infrared light to sense what sort of cells are there." This application is a long way from Shvets' beginning as a theoretician focused on plasma physics. Given his path from theory to experimentation to application, Shvets himself seems excited to see where his interests take him next. ■



Above: Members of the Shvets Group at Cornell stand in the plaza of the Physical Sciences Building. Below, left to right: Undergraduate students Yuchen Han '20, Robert Delgado '18, Davila Robledo '19, Bassel Saleh '19, and Professor Shvets in the lab in Clark Hall.



RUSSELL HEMLEY

By Emily Falco

Dr. Russell J. Hemley, one of the world's preeminent high-pressure scientists, joined the School of Applied and Engineering Physics this past spring as the Mary Upson Visiting Professor, engaging with students and faculty through research advising and collaboration. He also presented a seminar as a Henri Sack Lecturer, an endowed distinguished lectureship. Hemley is currently a Research Professor at The George Washington University in Washington, D.C. Hemley explores experimental and theoretical topics in physics and chemistry, earth and planetary science, and is interested in creating new materials that are potentially useful for technology. He studies a broad range of materials, ranging from simple ones like hydrogen and elemental solids, through complex, biological systems. He subjects these systems to extreme pressures and temperatures to discover new phenomena. Prior to his current position at The George Washington University, Hemley spent over thirty years at the Geophysical Laboratory and the Carnegie Institution of Washington, where he built a world class experimental high pressure group.

Hemley's connections to Cornell begin with Roald Hoffmann, Nobel Prize winner and Professor of Chemistry Emeritus. When Hemley was a graduate student at Harvard, Hoffmann gave a talk on carbon structures at high pressure, a research avenue Hemley had not previously considered investigating.

"At the time," he said, "I was struck by the interesting structures he was proposing in carbon."

Hemley was further inspired by Bill Bassett, Professor Emeritus in Earth and Atmospheric Sciences, a pioneer in the field of high-pressure research. Bassett gave a talk on the first applications of synchrotron radiation in high pressure geophysics, studying minerals at high pressure using CHESS in the early 1980s. This talk, combined with Hoffmann's research, catalyzed Hemley's passion for exploring high pressure science. He still maintains close relationships with the scientists that inspired his work.

While at Cornell, Hemley worked with Neil Ashcroft, Professor of Physics Emeritus. Both Ashcroft and Hoffmann are members of the Energy Frontier Research in Extreme Environments Center (EFree), a Washington D.C. center that Hemley directs. Because of the importance of synchrotron radiation to his research, Hemley has a long-standing relationship with CHESS, frequently collaborating with AEP Professor Joel Brock and others researchers at the facility. Recently, Hemley has been working with Sol Gruner, Professor of Physics, studying the effect of extreme environments on biological systems, such as components of microbes, proteins and membranes. This research can probe the limits of life as we know it, perhaps elucidating its origins.

In addition to serving as director of EFree, Hemley also directs the Capital/DOE Alliance Center (CDAC), a hub for high pressure science and technology research funded by the National Nuclear Security Administration. He also serves as Co-Executive Director for the Deep Carbon Observatory, a global research program working to transform our understanding of carbon in Earth, founded primarily by the Alfred P. Sloan Foundation.

Outside of his research, Hemley enjoys running, cross country skiing, and backpacking. He is an avid art enthusiast, and likes to travel. ■

[1] S. Wang, Y. Meng, N. Ando, M. Tate, S. Krasnicki, C. Yan, Q. Liang, J. Lai, H. Mao, S. M. Gruner, R. J. Hemley. "Single-crystal CVD diamonds as small-angle X-ray scattering windows for high-pressure research," J. Appl. Crystallogr., vol. 45, no. 3, pp. 453–457, Jun. 2012.

Above: Russell Hemley sits beside the high-pressure small angle x-ray scattering (hpSAXS) cell, in the physics lab of Professor Sol M. Gruner. The device is used at the Cornell High Energy Synchrotron Source (CHESS) to study effects of up to 4000 atmospheres of pressure on protein solutions. The cell contains 500 micron thick type IIa diamond windows, including one from Dr. Hemley's lab at Carnegie Institution of Washington, synthesized by microwave plasma-assisted chemical vapor deposition. The diamond windows are important for the hpSAXS cell because they are transparent to x-rays while still strong enough to not break under high pressure. [1]

MEGAN HOLTZ

Hometown: Lubbock, Texas
Program: PhD in Applied Physics
Research Lab: Muller Group

How did you become interested in engineering?
I liked physics – understanding the fundamentals behind how the universe works – and I also wanted to do something applicable that would make a difference in the world. I was concerned about global warming and so I became interested in renewable energy, which is in part an engineering problem. I liked the Energy Materials Center at Cornell and the collaborative environment that was happening across Cornell sciences and engineering. It was a great environment to work in with top-end facilities, so Cornell was my top pick.

Tell us about your current research project.
I worked on energy-related materials for a while: in particular, I wanted to watch what happened to fuel cell and battery materials as they operated on the nanoscale. We were able to put a tiny, Li-ion battery into a transmission electron microscope and watch the battery charge and discharge. We saw how the Li ions moved in and out of the battery electrode, and we also saw how the material cracked and degraded. We also saw fuel cell catalysts degrade on the nanoscale. Now, I've transitioned into working on functional oxides: this is a cool area where physics and materials science meet. I work as the TEM specialist on a team that developed an oxide where the magnetic moment in the material is coupled with the polarization, something that hadn't been done that well near room temperature in the past. My piece in the puzzle was finding how atoms were arranged in the sample, and measuring their picometer scale atomic displacements that gave the material its particular properties. If these types of materials can become implemented in computer memory, our hard drives may become more energy-efficient and stable.

KATHERINE SPOTH

Hometown: Buffalo, New York
Program: PhD in Applied Physics
Research Lab: Kourkoutis Group

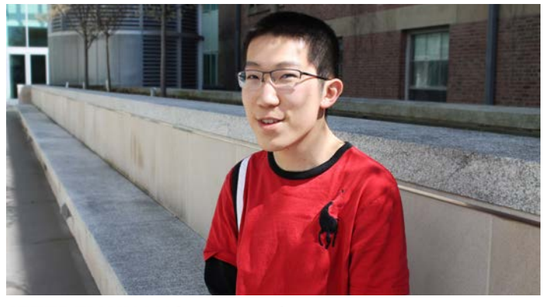
How did you become interested in engineering?
I took an engineering drawing class my freshman year of high school because my older brother recommended the course. I ended up loving the whole sequence of engineering classes! I decided to major in physics after taking AP Physics in my junior year, and completed my Bachelor Degree in Physics and Mathematics at the University at Buffalo in 2012.

I participated in the CHESS REU at Cornell during one summer of my undergrad - both my first experience with experimental research and my first visit to Cornell! I came to AEP for my PhD because I wanted to come back to Cornell after my REU experience, and the research in the department really appealed to me.

Tell us about your current research project.
I'm working on electron microscopy techniques to image biological specimens, especially whole cells, with nanometer resolution. A new pixelated direct electron detector for the electron microscope that was developed here at Cornell allows us to use scanning transmission electron microscopy to image delicate specimens, like cryogenically preserved cells. Unlike conventional STEM detectors, the new detector uses every electron that passes through the sample. This is important because the sample can only tolerate a small number of electrons before damaging.

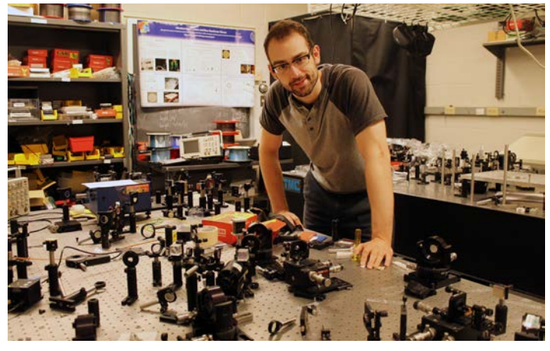
This technique will allow a wider variety of biological specimens to be imaged with high resolution in the TEM with no need for complicated sample thinning techniques.

NICHOLAS COTHARD received a NASA Space Technology Research Fellowship (NSTRF), a fully-funded graduate fellowship that supports his research for a year and is renewable for up to four years. Cothard's research involves making lens coatings for telescopes and other astronomical instruments to further development in detector read-out schemes—essentially, digital cameras for telescopes with greater resolution capabilities. Cothard's research is deeply integrated with a national telescope project in the Atacama Desert in Chile, called the Atacama Cosmology Telescope (ACT). He is a second-year PhD candidate in the Neimack Group.



JEFFREY HUANG received the annual College of Engineering Alumni Association (CEAA) Undergraduate Research Award for 2017. The award supports a student who has shown exceptional commitment and success in research in engineering in the continuation of their efforts for an entire year. Huang is an undergraduate student member of the Pollack Lab.

TIANYU WANG won the JenLab Young Investigator Award for Best Paper at SPIE Photonics West, the world's largest photonics technologies conference, held this past January in San Francisco, California. The award included a $2000 cash prize and an all-expense paid trip to Europe to present the work at a microscopy conference as an invited speaker. Wang is a PhD candidate in the Xu Group.



LOGAN WRIGHT has been awarded the 2017 D. J. Lovell Scholarship by SPIE, the international society for optics and photonics for his potential contributions to the field of optics, photonics or related field. Wright is a PhD candidate and member of the Wise Group, and is studying the propagation of intense pulses of light in multimode optical fibers, and ultrafast fiber laser sources. "I aspire to develop new optical tools for science. These devices will advance the flexibility and accessibility of optical workhorse instruments in, e.g. microscopy, but also provide fundamentally new ways of using light to understand complex systems across many disciplines," said Wright. The D. J. Lovell Scholarship is named for the radiometry and infrared optics consultant, author of Optical Anecdotes, and SPIE Fellow who died in 1984. The $11,000 scholarship is the society's most prestigious.

NEURONEX

The National Science Foundation (NSF) awarded Cornell University $9 million over five years to establish a neurotechnology hub, dedicated to developing new technologies for imaging the brain, then disseminating them to the wider neuroscience community. Psychiatric disorders including Alzheimer's Disease, Parkinson's Disease, autism, and schizophrenia, remain largely a mystery. NeuroNex fosters interdisciplinary research between the College of Engineering and the College of Arts and Sciences to combat brain diseases.

CHRIS XU (above photo, far left), Professor, is lead principal investigator (PI) for the hub. Co-PIs include (left to right) Joseph R. Fetcho, Neurobiology and Behavior; Nilay Yapici, Neurobiology and Behavior; Chris Schaffer, Meinig School of Biomedical Engineering; and Mert R. Sabuncu, Electrical and Computer Engineering / Meinig School of Biomedical Engineering.

Xu's expertise in optical imaging takes center stage as he and his collaborators develop new tools that will enable them to map the brains of many different animals. Says Xu, "We're pushing for imaging depth, speed, and volume. We want to image as much of the brain and the nervous system as we can in as short of a time as we can. That will enable us to attack neuroscience problems that are currently impossible."

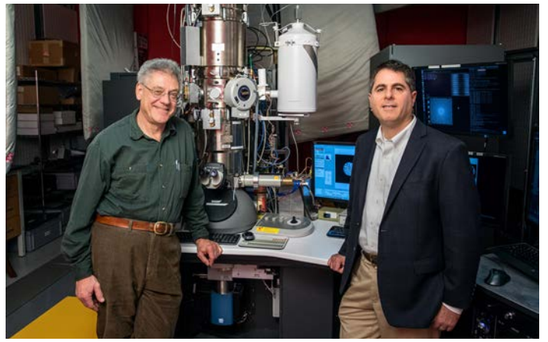
CRAIG FENNIE, Associate Professor, is part of a cross-campus collaboration that has been awarded $1 million from the W.M. Keck Foundation to transition its groundbreaking research from bold theory, based on extensive calculation, to creating a specific topological superconducting material that could pave the way to quantum computing. The team's project is titled "A Materials-by-Design Approach to an Odd-Parity Topological Superconductor."

LENA KOURKOUTIS, Assistant Professor, has been recognized with a National Science Foundation (NSF) Faculty Early Career Development Program awards, which supports junior faculty members' research projects and outreach efforts. Kourkoutis was awarded $550,000 over five years for a project aimed at understanding the processes at interfaces between liquids and solids that, for example, determine how batteries function and fail. The objective of this project is to develop and apply novel electron microscopy techniques that allow not only solid / solid, but also liquid / solid and soft / hard interfaces to be studied at the nanometer to atomic scale. This project will have an impact on science and technology by providing high-resolution characterization techniques of materials that are of interest for a wide range of technologies. The project will also provide stimulating and authentic experiences for freshmen, K-12 students and teachers with the goal of motivating a new generation of scientists. Microscopy will play a central role in these efforts, which include the development of a freshman laboratory module and a microscopy-based science kit for K-12 teachers nationwide.

GUILLAUME LAMBERT, Assistant Professor, was named recipient of an Alfred P. Sloan Foundation fellowship that supports early career faculty members' original research and broad-based education related to science, technology and economic performance. The Lambert Lab pursues interdisciplinary research at the intersection of physics and quantitative biology. Among Lambert's ongoing research projects is the study of the survival strategies used by bacteria in response to toxic environments.

MANFRED LINDAU, Professor Emeritus, was selected to receive the prestigious 2018 Sir Bernard Katz Award for Excellence in Research on Exocytosis and Endocytosis of the Biophysical Society Exocytosis and Endocytosis Subgroup.

The award was established in 2004 and has been awarded annually to outstanding scientists including 3 Nobel Laureates and numerous members of the National Academy of Sciences. Lindau will give a talk at the annual Exocytosis & Endocytosis Subgroup Symposium this February, when the award will also be presented. The conference will be held in San Francisco, California.



DAVID MULLER, (above, right), Professor, together with Sol Gruner Professor of Physics (at left), and members of their research groups, has developed a new device that makes the electron microscopes an even more powerful tool. Their electron microscope pixel array detector (EMPAD) yields not just an image, but a wealth of information about the electrons that create the image and, from that, more about the structure of the sample. Cornell's Center for Technology Licensing (CTL) has licensed the invention to FEI, a leading manufacturer of electron microscopes. FEI expects to complete the commercialization of the design and offer the detector for new and retrofitted electron microscopes this year.

ALUMNI CONNECTIONS

JOHN SILCOX, Professor Emeritus, was honored by alumnus Doug Merrill '89 Eng, MEN AEP '90, MBA JGSM '91 with the dedication of room 230 Rockefeller Hall. A few years ago, Merrill conceived the idea of making a donation to leave a lasting thank you to Silcox, and decided to name a classroom to acknowledge him. During his sophomore year at Cornell Merrill attended Silcox's class in Electromagnetism in this classroom. On April 24, Merrill returned to campus for a ceremony to express gratitude to his former professor. He spoke of the ways that Silcox helped to shape Merrill's undergraduate experience. A newly mounted plaque was unveiled to describe the room dedication.

DOUG MERRILL currently serves as the Director of Plant Operations for Dynapower Company, LLC, in South Burlington, Vermont. Prior to this role, he was the co-founder and CEE of Sunward Systems, LLC, a solar thermal design and integration form. He has taught manufacturing engineering and manufacturing management as an adjunct faculty member at the University of Vermont. Merrill's eldest son is in his first year at Cornell Engineering.

SPOTLIGHTS ON AEP ALUMNI

Our alumni lead extraordinary careers, and make incredible technological and research advancements. Highlighting your achievements is a priority for us, and we want to hear from you. We encourage you to share your story with us so that we may highlight it on our website. To do so, please submit an alumni note by visiting: **aep.cornell.edu/aep/alumni**. We look forward to hearing from you and sharing your stories!












AEP 2017 COMMENCEMENT

Applied and Engineering Physics students and faculty during the 2017 commencement celebration.

Photos by Gary Hodges, www.garyhodgesphoto.com









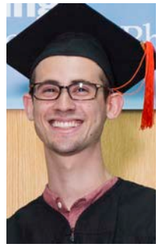
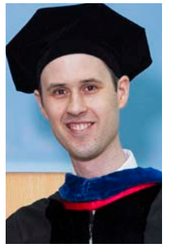


AEP COMMENCEMENT AWARDS

JUN WEI LAM

David Delano Clark Award for Best Master of Engineering Project

Henri S. Sack Award for Top Academic Performance by an MEng Graduate

JONATHAN C. KARSCH

Dorothy and Fred Chau Award for Excellence in Undergraduate Research in Engineering Physics

GREGORY FUCHS
Associate Professor, AEP

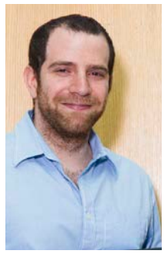
Dorothy and Fred Chau Project Supervision Awards

ALISON E. RUGAR

Paul Hartman Award for Excellence in Experimental Physics (Undergraduate)

SAIEN XIE

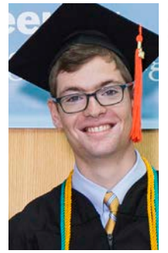
William Nichols Findley Award for Outstanding Graduate Research Paper




RAN A. GLADSTIEN GLADSTONE

BERIT H. GOODGE

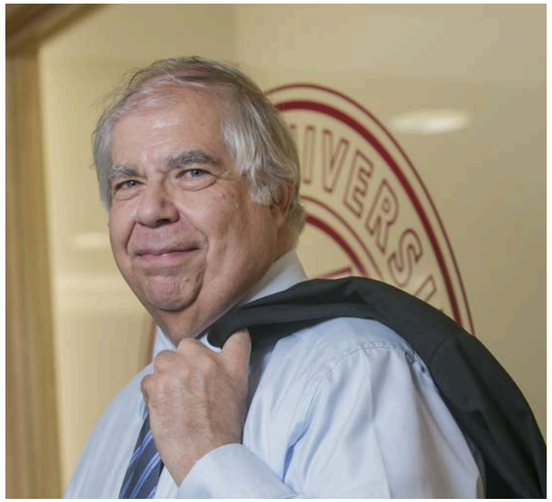
Trevor Cuykendall Awards for Most Oustanding Teaching Assistant



ZACHARY M. ZIEGLER

Trevor Cuykendall Award for Most Oustanding Academics

PROFESSOR ROBERT BUHRMAN: 50 YEARS OF RESEARCH AT CORNELL



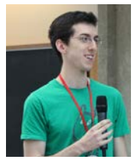
2017 marks the 50th year since BOB BUHRMAN arrived at Cornell as a graduate student. He was hired as a Cornell faculty member immediately upon his graduation, and has since served in many important roles — as a founder of the Cornell Nanofabrication Facility (CNF), Director of the School of Applied and Engineering Physics (AEP), founding Director of the NSF-funded Cornell Center for Nanoscale Systems, and as Senior Vice Provost for Research at Cornell. He has done all of this while maintaining an innovative research group with broad interests and impact. Last summer he has completed his term as Senior Vice Provost for Research and has returned to teaching and research at AEP.

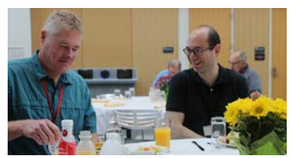
On Saturday, October 14, AEP celebrated Buhrman's 50 years of service with a symposium in his honor. Surrounded by former students, colleagues, and friends, Buhrman gave the keynote Henri Sack Memorial Lecture, titled, "An Expedition for Exploration and Discovery in Spintronics," highlighting the innovative research conducted in the Burhman Group from the last twenty years.

Other guest speakers included Elizabeth Carr MS '91, PhD '94, Ursula Gibson MS '78, PhD '82, Luqiao Liu MS '10, PhD '12, Monica Plisch MS '99, PhD '01, Vlad-Stefan Pribiag MS '06, PhD '10, Ilya Krivorotov (former post-doc), Anuj Bhagwati '91, MS '94, Robert A. Bartynski '80, Stephen Russek MS '86, PhD '90, Hans Hallen '84, MS '86, PhD '91, and Gösta Ehnholm (former post-doc). Please visit: www.buhrman50.aep.cornell.edu for more information.

Friends, colleagues, former students, and collaborators gathered for a symposium celebrating Bob Buhrman's 50 years at Cornell.

AEP ALUMNI

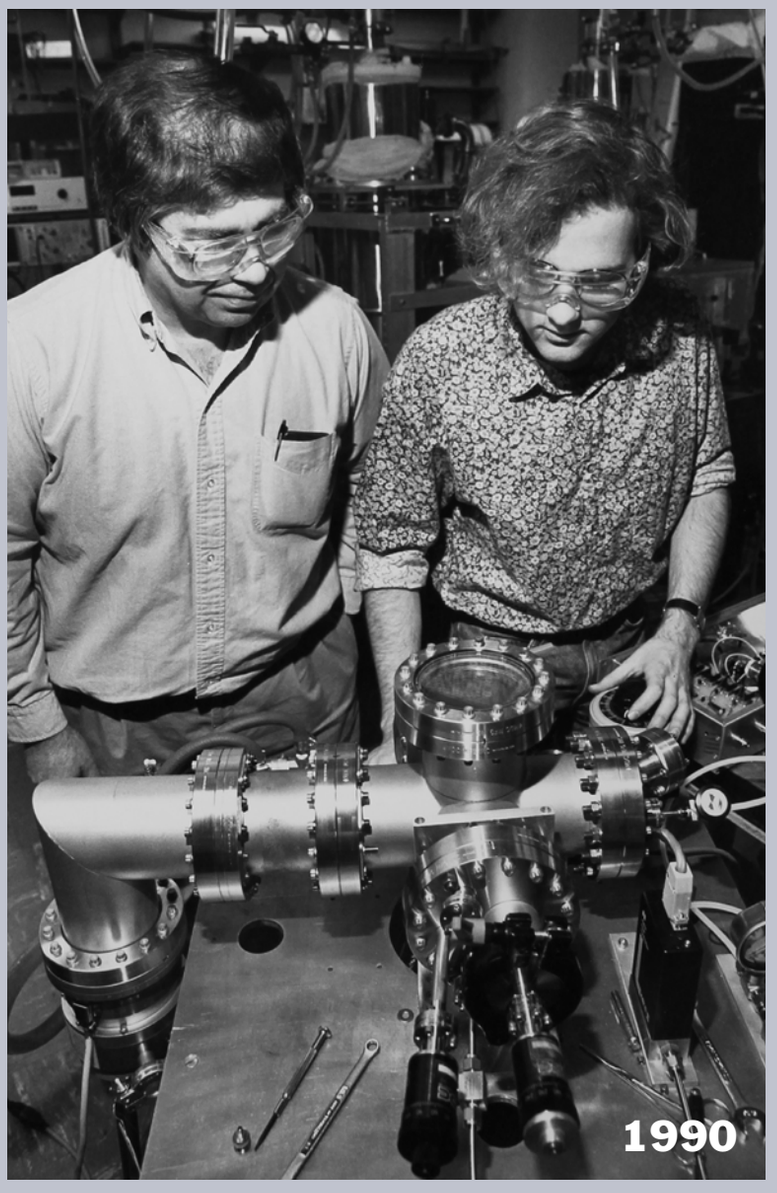




2017 REUNION BREAKFAST

Applied and Engineering Physics alumni and faculty gather for the 2017 Reunion Breakfast, held this past July in the Clark Atrium of the Physical Sciences Building.

Cornell University
School of Applied and Engineering Physics
271 Clark Hall / 142 Sci. Dr.
Ithaca, NY 14853-2501



BLAST FROM THE PAST

At left, Professor Robert Buhrman and former PhD student Brian Moeckly '94, observe a pulsed laser deposition system used to make high-temperature superconducting thin films. This photograph was taken in Al Sievers's lab before the Buhrman group purchased a laser.

Below, Buhrman and Moeckly reunited this October during the *Buhrman: 50 Years at Cornell* Symposium, a conference celebrating Buhrman's 50 years of research at Cornell. Read more about the symposium on page 14, and see all the photos by liking us on facebook at: www. facebook.com/CornellAEP.