CornellEngineering
Applied and Engineering Physics

AEP

Newsletter
December 2015

LOIS POLLACK

Dear Friends of AEP,

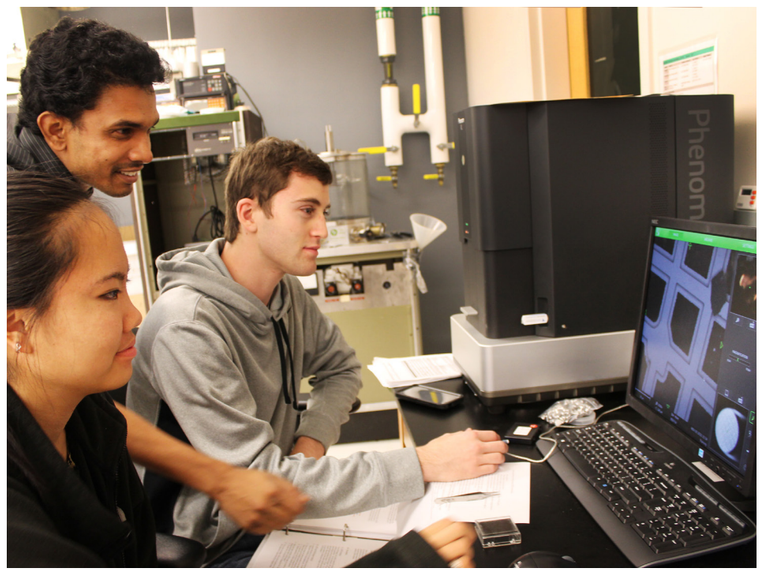
I'm delighted to introduce the latest edition of the AEP newsletter. I hope you enjoy our new format. We want to keep you engaged with AEP, by sharing stories about students, alums and faculty. In this issue, we spotlight some of the best and brightest among us: our three assistant professors.

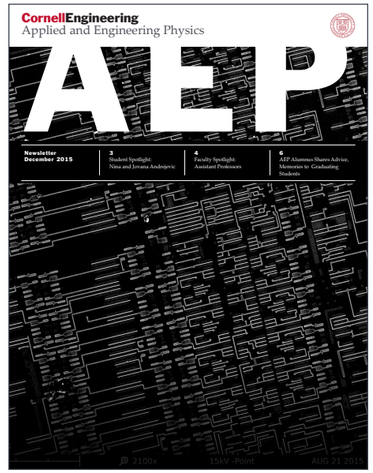
I've interacted with hundreds of students in my 15+ years on the faculty. It is always wonderful to hear from you, whether you are happily engaged in your career, making a move, or trying to recruit outstanding AEP grads!

Drop me a line at
aep_director@cornell.edu,
share an update on
www.aep.cornell.edu/aep/alumni/
or come visit during the annual alumni breakfast!

All the best,

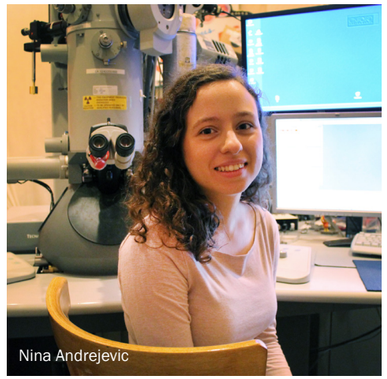
Lois Pollack
Professor and Director





ABOUT THE COVER

We purchased a scanning electron microscope for the Nanoscience and Nanotechnology lab, through the generosity of Mr. Lee Berlin, '58. The photo at left shows graduate student Reet Chaudhuri (center) teaching freshmen Joy Li and Ryan Butler to operate this instrument. With an electron microscope it is possible to observe objects that are too small to be seen with optical microscopes. The cover of this newsletter shows a picture of microelectronic test structures, one of the first images recorded with this new instrument.


Nina Andrejevic

INVESTIGATING THE NANOSCALE AND BELOW

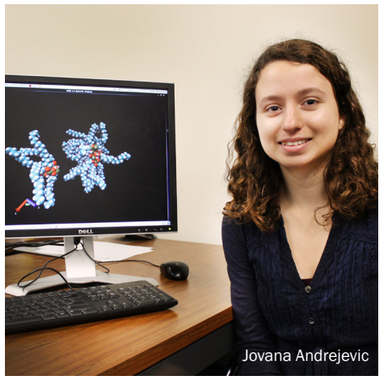
Born in Leskovac, Serbia, Nina and Jovana Andrejevic moved to a suburb of Chicago when they were seven. They spent the remainder of their childhood there. Daughters of architects, the twin sisters came of age having strong creative design influences as well as an enthusiasm for math and science. Their interest in scientific and technological perspectives developed further in their high school physics class, where their teacher used inventive ideas to solve challenging and objective problems.

In 2012, both enrolled in Cornell's College of Engineering. Initially they had limited knowledge about specific research topics, but they registered for *Introduction to Nanoscience and Nanotechnology* taught by Assistant Professor Lena Kourkoutis. This class provided their first insights into the world of the nanoscale. After examining laminar fluid flow, growing carbon nanotubes, and studying the luminous properties of quantum dots, Nina and Jovana were captivated with nanotechnology. Both also affiliated with AEP.

Nina went on to join Professor David Muller's research group. She is part of a team that places physics in an important, global context using electron microscopy to examine renewable energy materials. Alongside her graduate student mentors, she applies Transmission Electron Microscopy (TEM) and electron tomography to analyze carbon-supported platinum nanoparticles that serve as catalysts in fuel cells, a sustainable alternative to traditional energy conversion devices. Studying the platinum loading and distribution of the catalysts, the team hopes to help companies optimize the use of these expensive catalysts to make fuel cell technology more affordable and accessible.

Jovana joined Professor Paulette Clancy's computational research group, where she has incorporated interdisciplinary concepts into her research. She unites principles of chemistry, physics and computational science to study how quantum dots nucleate, grow, and interact. Like her sister, Jovana hopes to contribute to the development of renewable energy sources, particularly through the study of structures that are promising solar cell materials. Quantum dots are remarkably versatile in their potential applications, and she aims to understand their molecular level behaviors in order to implement them on a larger scale.

At Cornell, Nina and Jovana have had the opportunity to work as teaching assistants in physics. "An extremely rewarding experience," they both agree. The sisters not only hope to continue their research in graduate school, they have the long-term goal of becoming professors.


Jovana Andrejevic

When they're not in the lab, their favorite place at Cornell is in their residence hall JAM, a music-themed program house. They both play flute and piano. Since their freshman year they found a fantastic creative outlet from their studies playing music with fellow students, composing songs, and attending performances in the hall. As a take-away from Cornell, Nina and Jovana value the lasting bonds between AEP students, and the sense of strong support and encouragement from their colleagues. ■

Photo, Left: Nina Andrejevic with the FEI F20 TEM STEM (Transmission Electron Microscope and Scanning TEM), part of the Cornell Center for Materials Research in Duffield Hall. Right: Jovana Andrejevic with a sample of her research showing a simulation of interacting lead sulfide (PbS) quantum dots.

LENA KOURKOUTIS

The daughter of a physicist, Lena Kourkoutis grew up without the barriers most people have towards concepts in physics. She often accompanied her father to the university where he worked, gaining first-hand experience in a lab from a very young age. Curiosity is one of her innate characteristics. She was always encouraged to ask questions and this natural tendency drives her research to this day.

Kourkoutis' interests cover many different areas, but at their center is the desire to discover how materials, devices, and nature function. By exploring small scales and subcellular structure, she draws connections between various atomic arrangements and the functions of materials they create.

Her passion for curiosity and discovery is further embodied in the courses she teaches at AEP. *Intro to Nanoscience and Nanotechnology* is a hands-on class designed to familiarize freshmen with a nano-lab environment, using the process of lithography and state-of-the-art equipment to create computer chips used in devices such as smartphones. Additionally, she teaches a graduate course on nanocharacterization, which presents an overview of techniques that enable materials' studies at the nanometer scale and below. The course encourages students to discover and use Cornell's facilities to gain technical knowledge. Kourkoutis sees AEP's equipment as a paramount component of the school; it provides the means to bring research to a higher level. "We just got a new, first-of-its-kind electron microscope funded through the National Science Foundation, that will become available to all users on campus and beyond," says Kourkoutis. "It will allow researchers to image structures in materials, devices, and cells that have previously been hidden. People in AEP will push these techniques to the next level and thereby discover new science."

Kourkoutis joined the AEP faculty as both Assistant Professor and the Rebecca Q. and James C. Morgan Sesquicentennial Faculty Fellow in 2013. She was particularly drawn to teaching and researching at Cornell because of its interdisciplinary nature, which allows students to have a broad experience. Furthermore, she finds AEP researchers at the center of so many collaborations, because they are developing techniques that are both at the forefront of their field, and also relevant to many areas of science and technology. ■

GREG FUCHS

After teaching high school chemistry and physics for several years, Greg Fuchs was drawn to research in the field of applied physics. He enrolled as a graduate student at Cornell, receiving his Ph.D. in Applied Physics in 2007. Today he is both Assistant Professor and Director of Graduate Studies at AEP, immersed in pioneering new applied physics research and in guiding future scientists and engineers to do likewise.

Broadly speaking, Fuchs' research centers on spintronics and spin dynamics. He understands and uses electron spins in a practical way. The goal of his research is to develop new technology for storing and processing information efficiently. Fuchs appreciates the visionary nature of engineering physics, in that researchers use physics to solve problems and create new capabilities.

When asked to explain applied and engineering physics, he quotes astronaut Neil Armstrong: "Science is about what is, engineering is about what can be." Fuchs concludes by noting, "In AEP, we get to do both."

Fuchs teaches a sophomore class titled *Interfacing the Digital Domain with an Analog World*, in which he trains students to control measurement instrumentation using computers. The course provides undergraduates with an idea of what research is like, forcing them to learn problem solving and to wean off step-by-step instructions. In addition, Fuchs teaches a graduate class called *Micro/Nano-Fabrication and Processing*, which introduces the physics behind nanofabrication. The course is quite interdisciplinary; students from many fields of engineering enroll because it teaches the fundamentals of nanofabrication and the principals used in Cornell's world class nanofacility, CNF.

"Applied and Engineering Physics occupies a unique space in that we have a broad range of research—research that links to something valuable," says Fuchs. "The students here are superb—very interested, very motivated, with tons of great ideas." ■

JEFF MOSES

Jeff Moses is the latest addition to the Applied and Engineering Physics faculty he joined the School in 2014. As an undergraduate student at Yale University he made the transition from chemistry to physics, and later came to Cornell where he obtained a Ph.D. in 2007.

Most recently, Moses co-taught the undergraduate course *Interfacing the Digital Domain with an Analog World* alongside Assistant Professor Greg Fuchs. He admires the classroom focus on problems of practical importance at AEP, and enjoys the hands-on learning experience he presents to students through this laboratory-based class.

Inspired by the research and photographs of MIT Professor Doc Edgerton, Moses obtains stop-action images of electrons and coupled particles at the femtosecond. Using laser pulses to detect extremely brief events, his lab is both developing the laser technology and formulating experiments that use them. Ultimately he seeks common threads in cases where these ultra-rapid events contribute to function, such as the chemical changes that occur in the retina as the human eye responds to light.

A recent parent, Moses values the strong supportive community of Cornell, which enabled him to take some teaching relief after his daughter was born. He admires the solid community of AEP faculty. "Sometimes people see a small department as a weakness but I see it as a strength," he says. "There is a confident sense of ownership, responsibility and engagement in the faculty, in making the department what we want it to be. It has a strong sense of identity."

He is also excited about the interdisciplinary nature of his research, finding that it's a strength of the university to steer away from a straightforward, traditional approach, bringing together people from many areas of research. ■

SAVE THE DATE!

Saturday, June 11

We had a wonderful turnout this past summer; hope to see you this upcoming year!

JAMES DORRIS ('01) SHARES ADVICE, MEMORIES WITH STUDENTS


Left to Right: Thomas Gautier, Josh Geigel, James Dorris, John Newman, Mallika Bariya, Liele Getachew Degefu.

In September, Dr. James Dorris, Director of Electromagnetic Systems at Hyperloop Technologies, contacted his former advisor, Professor Joel Brock, asking to connect with AEP seniors. The growing company is seeking smart and passionate junior-level engineers who are well-rounded in various technical disciplines and well-versed in hard work. As a result, Dorris and colleague Josh Geigel, VP of Design Analysis at Hyperloop, visited Cornell for an informal dinner and discussion with AEP students. We followed up with Dorris to inquire about ways in which his time in AEP influenced his professional life.

What was your research focus as an AEP student, and how has it evolved since then?

As an undergrad, I was very interested in all things 'space.' I was a bit antisocial at Cornell and focusing on non-terrestrial research topics seemed fitting. I did a few summer research stints in astronomy (e.g., MIT Haystack Observatory, Cornell/NAIC Arecibo Observatory) and I very much wanted to be a scientist for NASA or, better yet, an astronaut. I chose to do a Ph.D. program at MIT for the sole purpose of establishing a collaboration with a research project at Johnson Space Center called VASIMR—a high power plasma rocket—and since I had done well in Electrity & Magnetics and Statical Mechanics, I thought that maybe plasma physics would suit me. Despite the kindness and support from my adviser at MIT, I was unable to establish the collaboration and instead ended up in San Diego doing my research at the DIII-D National Fusion Facility. My interests were evolving quite a bit during this time—I think September 11th helped generate my political awakening—I was beginning to focus much more on global politics and the slew of issues we face as a nation as well as a planet.

How has what you learned at Cornell influenced your current research?

I received a solid foundation in physics at AEP that served me well in graduate school and in subsequent pursuits. Beyond the coursework, it was the problem solving and coping skills—learning how to be stressed and tested on very hard problems—that helped me to develop confidence in my ability to contribute to all sorts of technical topics. That confidence was pretty low while actually at Cornell, but it's amazing what a few years and a change of scenery can do.

What's the most notable technological advancement you've been a part of?

The most notable project I've been involved with is by far the work I'm doing today at Hyperloop Technologies. I get to design and test multi-megawatt linear motors that travel faster than any other linear motor in the world (4x faster than the EMALs launch motors). I get to contribute to the entire propulsion system and help build out the team of engineers that will deliver our product to market. We're just getting started and the stress is high, but it's the best kind of stress an engineer could ask for.

What's the greatest piece of advice you can offer graduating students and young alum in the industry?

I'm hesitant to give advice but if I were able to do it over again, I'd want to tell my 21-year-old self: Only do a Ph.D. program if you identify a research project that you're super passionate about. Don't be afraid to go into industry and then go back to do a Ph.D. (many of my friends went this route with great success). Find projects to get involved with before you graduate that have you build something. It could be a web app, a control system, a piece of hardware, or a complex piece of simulation. It's tough to market yourself based only on classes you've taken. Be able to articulate what it is you're passionate about; not what classes you do well in but where and how you want to have an impact in the world. Said another way, what do you find the most frustrating? That might be somewhere you want to make an impact. Don't be overly concerned about people saying 'no' to you—whether for the job you want, a project on which you want mentoring, an investor for your startup, or even asking someone for a date—'no' seldom matters as much as we think it does. There are always similar (or better) jobs, new projects to join or perhaps develop yourself, and more potential investors or potential dates than you could possibly meet in a lifetime.

What's your most memorable moment in AEP?

I recall receiving a 29% on my first Quantum Mechanics exam in AEP. That was pretty memorable in a super embarrassing sort of way. Other than that, I remember mountain biking at Shindagin State Forest. It helped me relieve stress and develop a friendship with two other AEP students that I still keep in touch with today. Thanks, AEP! ■

STAY CONNECTED

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Congratulations, 2015 Graduates!

2015 GRADUATION AWARDS

Xincheng Lei
David Delano Clark Award for Best Master of Engineering Project

Logan G. Wright
William Nichols Finley Award for Outstanding Graduate Research Paper

Humna A. Awan
Paul Hartman Award for Excellence in Experimental Physics (Undergraduate)

Aaron Wan-Hin Hui
Dorothy and Fred Chau Award for Excellence in Undergraduate Research in Engineering Physics
Faculty Advisor: **Jeevak Parpia**

Hanzhang Pei
Henri S. Sack Award for Top Academic Performance by an M.Eng. Graduate

Kyle J. Dorsey
Trevor Cuykendall Award for Most Oustanding Teaching Assistant

Eric E. Grohn
Jack Mingde Jiang
Trevor Cuykendall Award for Most Oustanding Academics (Senior)

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