PHYSICS @ UALBANY

UNIVERSITY AT ALBANY
State University of New York

Newsletter #3 - Fall 2019

Message from the Chair

I am very happy to introduce you to the University at Albany Physics Department. The Department is extremely active in research, undergraduate education, and graduate education. This document gives us the opportunity to present a selection of activities in which our students and faculty take part. In recent years, we have added seven new faculty to the department. These new faculty bring expertise in diverse areas of Physics, as well as innovative approaches to undergraduate education.

Training of students, both undergraduate and graduate, is a very important part of the Department's mission. We continue our annual PASCAL (Physics All Student Conference at ALbany) conference which provides opportunities for faculty to present an overview of their research group's focus, and students to present short talks and posters on their research projects.

We deeply appreciate friends and alumni who have supported the Department, and I look forward to the pleasant task of updating you as new activities and discoveries unfold.

http://www.albany.edu/physics/index.shtml
https://www.facebook.com/ualbanyphysics/

Physics @ UAlbany : About the Department

Undergraduate Studies:

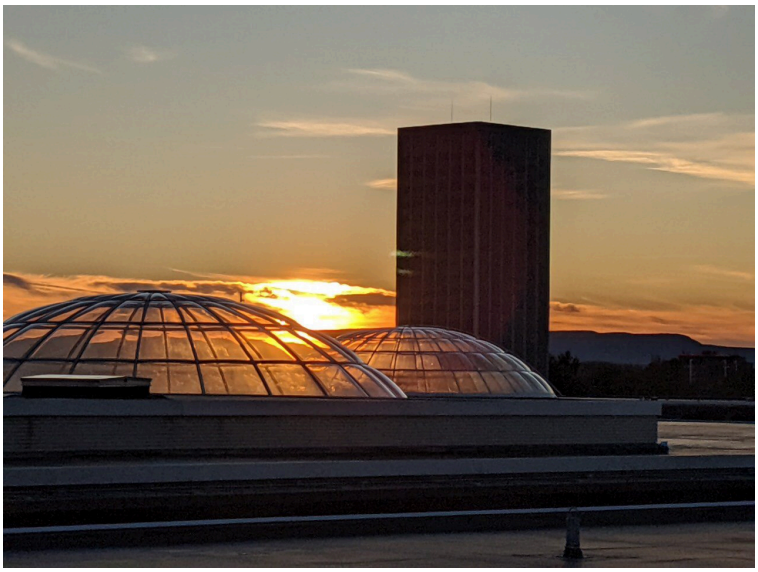
The UAlbany Physics Department gives high priority to undergraduate education. The objective of the department is to provide students a solid foundation in both classical and modern physics. Along with courses in classical mechanics, electromagnetic theory, atomic and nuclear physics, and thermal physics, students learn modern experimental techniques, principles of quantum mechanics, and applications. Elective courses in physics and in other sciences, independent study and research with faculty members in the active research fields of the department are encouraged. Our faculty is active in research, and a variety of research opportunities exist for motivated undergraduate students. In addition to the honors program, several of our talented and motivated undergraduates have been awarded summer research fellowships at NASA (National Aeronautics and Space Administration) and NIST (National Institute of Standards and Technology).

Careers

Graduates holding the bachelor's degree in physics find employment as laboratory or theoretical research assistants in physics or engineering, high-level medical technicians, science writers and editors, computer programmers, and secondary school teachers. A bachelor's degree in physics can be an ideal background for advanced study in other sciences, engineering, and the business and medical professions. A graduate degree in physics opens a broad spectrum of opportunities in pure and applied research in academia and industry.

Graduate Studies:

Graduate education in physics at UAlbany offers students a wide variety of research opportunities both in experimental and theoretical physics. As a part of their training, graduate students participate in research, take a wide variety of courses, and gain experience in teaching physics. All alumni of our graduate program have successful careers in academia or in industry. Prospective students are encouraged to visit the webpage describing the procedure for admission and to contact potential advisors.



Physics @ UAlbany : Introducing our Faculty

The physics department consists of 17 faculty members, 2 postdocs, 42 PhD students, 14 MSc students and 75 undergraduates. We graduate about 20 BS students per year (out of 2500 in the US) and 5 PhD students (out of about 1000 nationally). In the past 3 years, 100% of our doctoral students placed in research post doctoral positions or permanent industrial jobs before graduating.

Associate Professor **Keith Earle** is the current chair of the department. His research is primarily in electron paramagnetic resonance. When he's not too busy with administrative issues and research, he plays the bag pipes!

Assoc. Professor **Kevin Knuth** is the current associate chair of the department. His research is primarily on exoplanets and bayesian data analysis. He is also in charge of our observatory. On his free time he restores ancient Greek and Roman coins and is building his own R2D2 astromech droid!

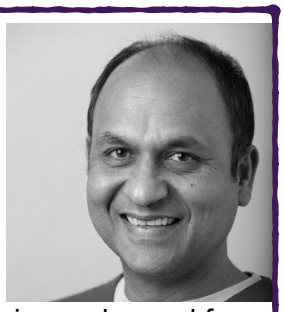
Professor **Ariel Caticha** is the former chair of the department. His research is primarily in information physics.

Assoc. Professor **Jesse Ernst**'s research is primarily in particle physics. He currently has one PhD student finishing on ATLAS, and one working on LUX. In his free time he plays drums in a blues band.

Asst. Professor **Herbert Fotso**'s research is in theoretical condensed matter.

Assoc. Professor **Philip Goyal**'s primary research area is information physics. He is particularly concerned with exploring how the concept of information can illuminate the foundations of quantum theory. In his spare time, he plays piano and enjoys pondering the physical basis of musical sound…

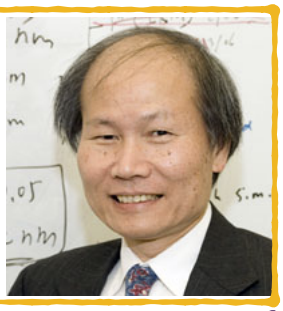
Assoc. Professor **Vivek Jain**'s research interest is in the field of experimental particle physics. He is currently on the ATLAS experiment at the Large Hadron Collider, where he is focussing on the properties of the Higgs boson. In his career, he has investigated the properties of all six quarks, and four of the six leptons!



Physics @ UAlbany : Introducing our Faculty (cont.)

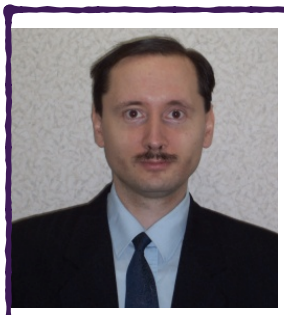
Asst. Professor **Alex Khmaladze**'s research is in biological imaging and spectroscopy.

Professor **T.S. Kuan**'s research is in solid-state physics and electron microscopy, currently focused on mechanical and transport properties of nm-thick films and superlattices. Besides physics, he enjoys playing the piano and reading.



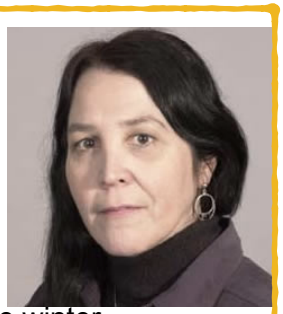
Professor **Bill Lanford** is in charge of the 4MV ion beam accelerator. He uses it to do research in solid-state physics.

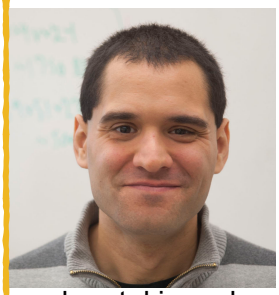
Asst. Professor **Cecilia Levy** is the newest faculty member of the department. Her research is primarily in experimental astro-particle physics in the quest for dark matter. On her free time she restores her 200 year old house, crochets and plays with her Newfoundland dogs.



Assoc. Professor **Oleg Lunin** is a string theorist working on studying duality between quantum gravity and strong interactions with a particular emphasis on applications to physics of black holes.

Professor **Carolyn MacDonald** is the director of the X-ray institute. Her research is in medical imaging. She is the author of a new textbook "An introduction to X-Ray Physics, Optics and Applications". She enjoys kayaking with her dogs in the summer and hibernating in the winter.





Assoc. Professor **Jonathan Petruccelli**'s research interests are computational imaging with both visible light and x-rays and efficient modeling of light propagation. He is an avid runner who can often be found on the 5K loop around campus when taking a break from research and teaching.

Asst. Professor **Daniel Robbins**' research focuses on theoretical particle physics, string theory, and supersymmetry. He is interested in exploring the space of consistent possible theories, and relationships between physics and geometry.

Visiting Asst. Professor **Anna Sharikova**'s research is in biological imaging and spectroscopy.

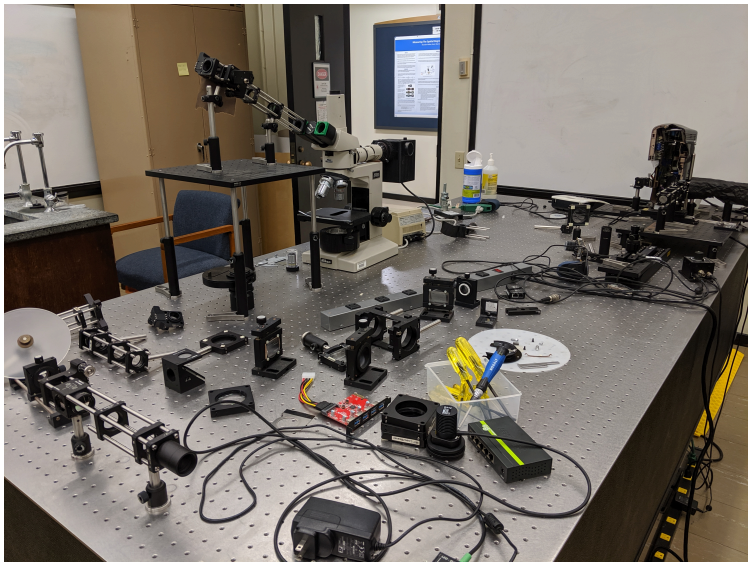
Asst. Professor **Matthew Szydagis**' research is in experimental astroparticle physics searching for dark matter with the LUX and LZ experiments. He is the faculty advisor to our local Society of Physics Students. He is a huge Star Trek fan.

Physics @ UAlbany : Faculty Promotion

Jon Petruccelli

Huge congratulations go to Prof. Petruccelli who was promoted from Assistant to Associate Professor.

The major focus of Prof. Petruccelli's work is the development of improved imaging techniques that image on phase rather than intensity. Phase measures the time delay of waves as they pass through matter so it can provide information on the thickness of an object. Prof. Petruccelli's work has applications in biological imaging of live cells which are nearly transparent and invisible in conventional images but can be clearly observed through phase. He is collaborating with Profs. Khmaladze (UAlbany Physics) and Mahajan (SUNY Buffalo) to use phase imaging to measure the impact of methamphetamines on brain cells. His work has also found application in the x-ray regime in the detection of breast cancer, for which phase imaging can significantly enhance image contrast compared with conventional mammography, leading to fewer false positives and missed cancers. In collaboration with Prof. MacDonald and the center for x-ray optics here at UAlbany, he is developing systems to improve mammography. Prof. Petruccelli's work also extends to modeling light propagation and his student Jeremy Wittkopp has recently had a paper accepted to JOSA A on improved computational methods to propagate polarized light.



Because his lab's work includes computational imaging, modeling, and experiment, Prof. Petruccelli's students have the opportunity to tackle projects in a variety of areas. His former Ph.D. student, Tonmoy Chakbraborty, wrote his dissertation on designing better microscope illumination for phase imaging. His current Ph.D. students, Jeremy Witkopp and Shane Carney are working on computational modeling of light propagation and computational algorithms for phase reconstruction, respectively. Prof. Petruccelli has also had 10 undergraduates engaged in research in his lab since he joined the physics department. An exciting new area of research opening up in his lab is the use of deep learning and GPU acceleration both for computational imaging and for faster light propagation algorithms.

Women in Physics: Eureka and SωPhy

The department is ever more engaged in making diversity in physics a priority! This summer, the department hosted young girls for a week as part of the **Girls Inc. Eureka!** program. Girls Inc. Eureka! is a free program that provides young girls with an introduction to STEM, personal development, sports, mentorship and career exploration. Girls commit to the program for five years. The department introduced the girls to refractor telescopes, nitrogen ice-cream, robotic arms, and, thanks to Prof. Earle, ChoreoPhysics, the interplay between modern dance and physics.

Meanwhile Prof. MacDonald and Levy decided to create the **Society of Women in Physics,** SωPhy (pronounced Sophie), at UAlbany. SωPhy's goal is to create a strong community for women in physics and STEM, guide young women through their undergraduate or graduate program, help them take the next step in their career, make new friends, and, of course, have fun! SωPhy members have already grown beyond physics, and many come from the other STEM disciplines. They are at all stages of their careers: budding scientists in high school, undergrads, grad students, postdocs and professors. SωPhy members are looking forward to being involved in the Girls Inc. Eureka! program next year!

SωPhy
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Observe the Moon Day

This year the UAlbany Department of Physics observed (pun intended!) the annual International Observe the Moon Night, as an event free and open to the public, on Saturday October 5th from 6:30-10pm, with observation led by Prof. Kevin Knuth through the University's 16-inch telescope on the roof of the Earth Science building. We also had Moon and star maps handed out to everyone, and constellation identification by laser pointer! Prof. Szydagis also entertained everyone waiting in line to enter the dome (yes, we had enough people for there to be long lines at times!) with his drone-flying antics. The purpose of the event was encouraging observation of and appreciation for the Earth's Moon, especially amongst those who have never seen it up close through a scope, but also raising awareness in general of the life-changing aspects of looking UP. The night was an enormous success with an estimated 60-70 attendees, and Saturn made a guest appearance by the Moon, which was in its first quarter, making for optimal viewing. The weather really cooperated with 0-10% max cloud cover from sunset until 10pm.

Prof. Knuth helps a guest with the telescope!

UPD had a lot of fun observing with everyone!

Physics @ UAlbany : Congratulations!

PhD. Defenses:

- ***Qinglin Li*** defended his PhD on “Microstate Geometries and Hidden Symmetries” in August 2019, and is now a postdoctoral researcher at Shenzhen University (China).
- ***Jia Tian*** defended his PhD on “Black Hole Microstates and Integrable Deformations in String Theory” in August 2018, and is now a postdoctoral researcher at Peking University (Beijing, China).
- ***Jenn Carter*** defended her Ph.D. on reflected light phase curves of close-in exoplanets in August 2018, and is now a Assistant Professor at Susquehanna University.

MSc.Defenses:

- ***Lianna D’Brant*** received her MSc. on “Imaging approaches to study neuron and astrocyte morphology” under Prof. Alexander Khmaladze and biology Prof. Annalisa Scimemi. She studied the cellular morphological changes of cultured C6 rat glial cells induced by methamphetamine using different imaging modalities. Lianna is currently working at the Neural Stem Cell Institute following her interest in neuroscience, screening intercellular antibodies for degenerative diseases associated with aging, such as Alzheimer's, Parkinson's and Huntington's Disease.

Welcome!

The department has also welcomed:

- 8 new MSc students: Desiree D’Moore, Alexander Fedok, Thomas Guile, Ben Lounsbery, Candace Mathews, Risinie Perera, Reci Rajkumar, and Du Zhaoyang

- 9 new PhD students: Wadiah Allahyani, Shahab Bahreini, Gregory Blockinger, Yucong Cai, Shane Carney, Rhucha Deshpande, Tyler Fish, Arthur Redgate, Arwa Bukhari , and Suman Gautam.

We wish them good luck in their graduate studies and hope they will be as successful as the rest of our students.

Emily Mangus - Class of 2017 - Optics Engineer at NASA

I think it was high school when I decided what I would be happy doing for the rest of my life. My 9th grade physics teacher taught the subject in such a way that I fell in love with it and I knew I wanted to continue learning it in college, and my dream was always NASA. Choosing a school was not hard, I lived 15 minutes from five or six of them and picked the cheapest one, as advised by my mother. I noticed SUNY Albany had a physics program, and they were a university so I knew I could do research, which I was very interested in. I attended SUNY Albany for my bachelor's degree in Physics and in my second year I asked one of my professors if I could work in his astro-particle physics lab, which was apparently unusual for an undergraduate student to do. He said yes, and I began working and receiving independent study credits for my time there.

While working in that lab for two years, I gained some of the best experience possible for both life and practicing science. My mentor was a woman who possessed a doctorate degree and was a strong force in an extremely male-dominated work environment. I learned lessons from her I will take with me to every job throughout my career. Fast forward to 2018, I did not want to go to graduate school because I did not know which path I wanted to take, so I graduated and started applying for jobs and willing to take anything I could get that even resembled something to do with science. I was nervous as I had been told not much could be done with just a bachelor's degree.

A few weeks before graduation, I applied for an internship at NASA I had heard about through my best friend's father. I was accepted and a week after graduation I moved to Greenbelt Maryland to do the internship at the NASA Goddard Space Flight Center. It was a consulting job where I and four other interns would interview what are called "Subject Matter Experts" (SMEs) and ask them questions about their job at Goddard.

Emily Mangus - Class of 2017 - Optics Engineer at NASA

We spoke to chief engineers, chief scientists, project managers, program managers, instrument specialists, and more all with the goal of getting a sense of what could be done better at this NASA center. was a huge feat as NASA Goddard has somewhere around 16,000 employees and is the home to the largest organization of scientists in the world. It was a huge feat as NASA Goddard has somewhere around 16,000 employees and is the home to the largest organization of scientists in the world. It was also not in my field at all, which was slightly discouraging, but I held a badge that granted me access into the largest organization of scientists in the world, and I wasn't going to leave.

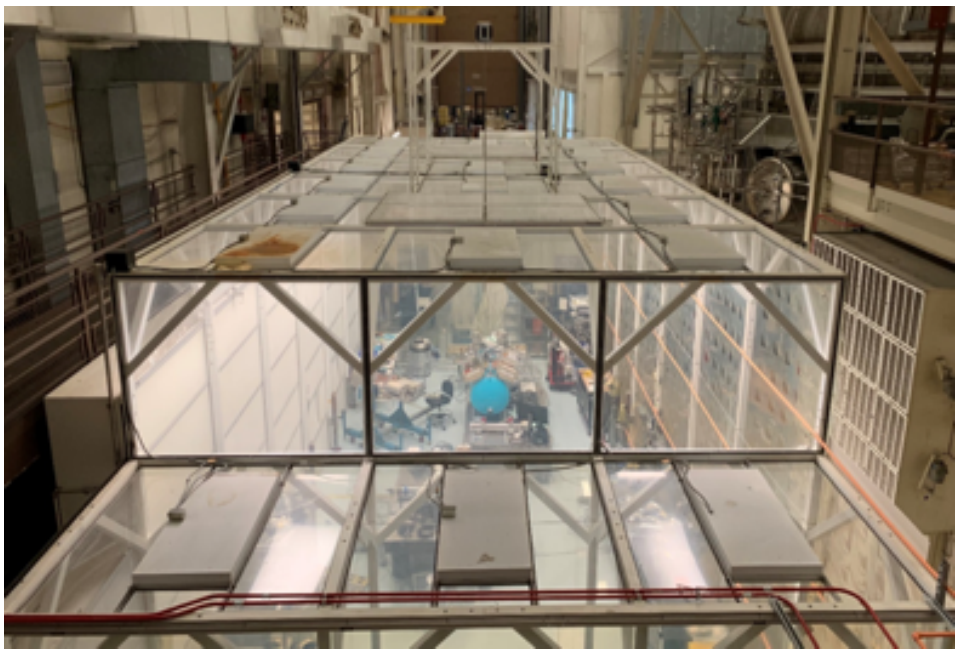
As the internship came to an end, I asked my advisors for an extension, which was granted, and by the time the extension ended I got myself a secretary job in the cybersecurity division of NASA Goddard. Again, not in my field. But during my down time in that job I emailed every chief scientist, engineer, project manager, and program manager I spoke to and asked to speak to them again. After about five meetings with different people asking how I could get myself a job in their branch, I finally got in a room with the head of the branch I currently work in, Environmental Test Engineering and Integration. He sent me to my current supervisor who handed me a printed out job requisition, interviewed me on the spot, and gave me the job a day later.

I now hold the title of "Optics Engineer" at the NASA Goddard Space Flight Center in the Environmental Test Engineering and Integration branch.

Emily Mangus - Class of 2017 - Optics Engineer at NASA

What this branch does is test instruments that will go in a spacecraft bus to see if they will survive the environment of a rocket launch, as well as the harsh environment of outer space. My piece in this huge puzzle that is a NASA mission is optical testing. Every single instrument has some type of optic on it, whether it is a mirror or a lens, and every mission uses these to manipulate light. My day-to-day job includes testing the integrity of these mirrors and lenses as well as their alignment to each other. Optical instruments used to test mirrors and lenses can also be used to characterize pretty much anything else, as long as it has a reference mirror or target mounted to it. A lot of my job has to do with creating coordinate systems that describe an instrument and where objects mounted on that instrument are located and how they are related to other items. Everything has to be in the perfect spot in order for the system as a whole to function properly. I use a software called Spatial Analyzer as well as CAD to map out and draw these systems.

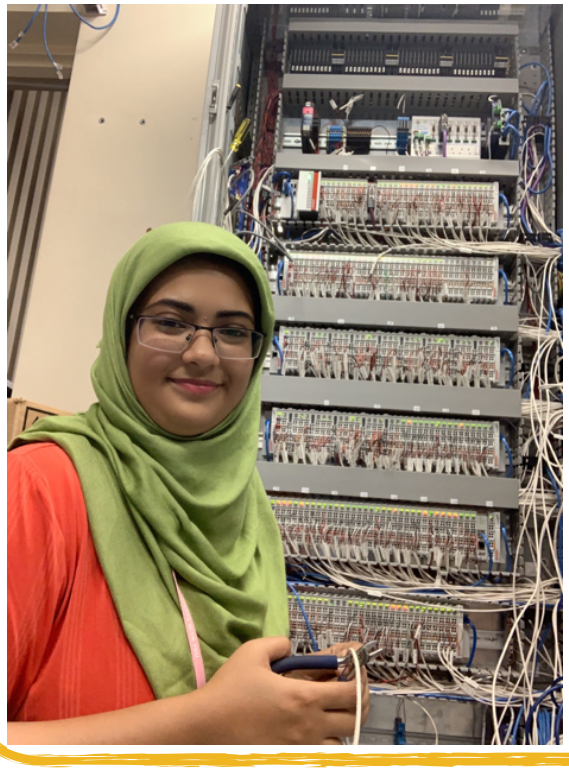
I am coming up on six months in this engineering position and I could not be happier with the job I am doing and the agency I am working for. In January of 2020, I will go back to school for my master's degree in applied physics at the Johns Hopkins Whiting School of Engineering. This will allow me to get to the next level in my current job and will open up more doors career-wise in the future. But, something I want to make extremely clear is that none of this was carefully planned. During the past year and a half, I had absolutely no idea what I was doing, I just now am beginning to have some sense of the direction I want to take. All I knew is that I loved practicing science and wanted to be in that career environment, and even though my first two jobs at NASA had nothing to do with science, I was not discouraged. There's no textbook answer to this no matter what anyone tells you, you take what is given to you and you make it work.



Graduate Students

Nishat Parveen (Prof. Levy's group):

I am a second-year graduate student working in Prof. Levy's Dark Matter research group. It has been a great opportunity for me to work on the world's most sensitive and the largest dark matter experiment - LZ (LUX-ZEPLIN) at UAlbany. I am working on different data analysis tasks and maintaining information repository. I am developing skills and preparing myself to work on the real data (expected next year). Besides playing with data, I have also worked in the laboratories. Last summer, I went to Lead, South Dakota as a shifter assisting in the construction of LZ detector which is currently being built at the Sanford Underground Research Facility (SURF). I also went to Stanford Linear Accelerator Center (SLAC), a national accelerator laboratory in California to help in the Krypton removal process to get pure Xenon which is an essential ingredient used in LZ experiment to detect dark matter.



The professors in our department are really supportive and helped me a lot to learn and develop research skills. I have gained a wealth of information from the weekly seminars and colloquium organized in our department and it also helped me to interact with the researchers from a diverse background in physics. It was a great experience to present at Physics All Student ConferenceAt Albany (PASCAL) 2019 and Astronomical Society of New York (ASNY) meeting held at UAlbany. I am also a member of UAlbany Toastmasters (now re-named as STEEL) and it has helped me to improve my public speaking skills. I am now anticipating for more opportunities at UAlbany!

Graduate Students

Weiyuan Sun (Prof. Petrucelli's group):

I am a fifth year Ph.D. student who is working with Prof. MacDonald and Prof. Petruccelli. During the past four years, I focused my academic interest on X-ray technology field related to X-ray phase imaging and the applications of capillary x-ray lenses. I have worked on a number of challenging and diverse projects.

One is about "Measurements and calculation of dose for focused beam orthovoltage therapy". In collaboration with the Department of Therapeutic Radiology, Yale University School of Medicine, we have worked to develop a more accurate method for radiation therapy. Polycapillary X-ray lenses can achieve pinpoint accuracy of dose delivery to small tumors near critical structures. Using tissue-equivalent material, I experimentally demonstrated for the first time that the dosage can be controlled quantitatively to give a medical usable value for cancer treatment. A paper summarizing the result was published in *Medical Physics.*

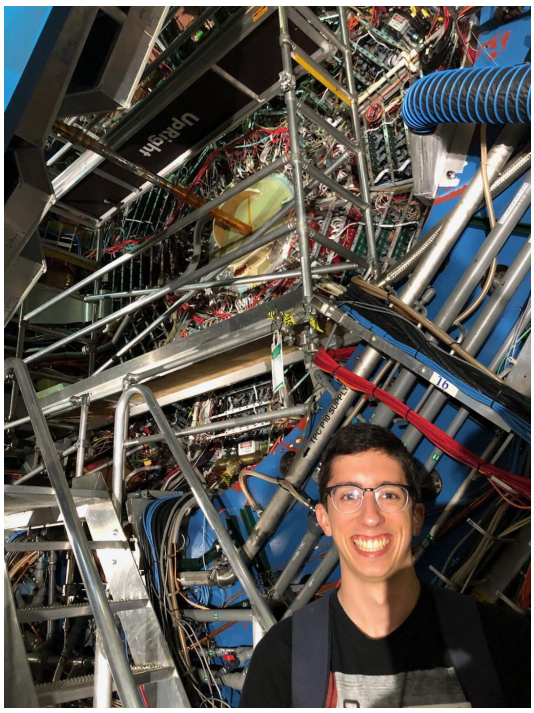
Another one is "X-ray phase imaging and phase retrieval". X-ray phase-contrast imaging has the potential to provide much higher contrast than conventional, intensity-based radiography, but requires beam coherence and computational processing. I have produced high quality images using two techniques, propagation-based and mesh-based imaging with the application of polycapillary X-ray lenses. Compared with attenuation-contrast imagine the result showed markedly clearer detail for the soft tissue, such as the mouse lung or sheep eyeball. Also, for the first time, quantitative phase retrieval was demonstrated for mesh-based imaging with an error in 5%. The work showed the potential for clinical applications by achieving the X-ray phase-contrast imaging with conventional X-ray sources, such as phase contrast Mammogram. Subsequent work is in process.

Beside of the concrete researches, I gained a lot more here, such as solid background in physics which I think will continue to feed me in my future research. High Standards in this department, not only show challenges but also provide chances for improvement. And I feel deeply grateful for all the help, support and inspiration from my professors and friends in the physics department.

Undergraduate Students

Bella Magliocca (senior - Prof. Szydagis's group):

Over the past year, I have been working in Professor Szydagis's lab conducting dark matter research. In particular, I have been working on the geyser bubble chamber which is essentially where I superheat water "sandwiched" in between oils in a container connected to a recondenser, after each detection of a dark matter like particle will explode up into the recondenser, and self reset after each explosion. My work over the summer consisted of trying to perfect my setup, ensure lab safety by creating a list of chemicals in our lab, and organizing the lab to create a safe and healthy lab environment for the entire group. So far this semester I have been working on the snowball chamber, which is the same concept but using supercooled water as the test subject. The research I have been conducting is very valuable and has educated me in many different ways than a regular physics education would be able to, from problem-solving to researching online different materials to create a better working setup.

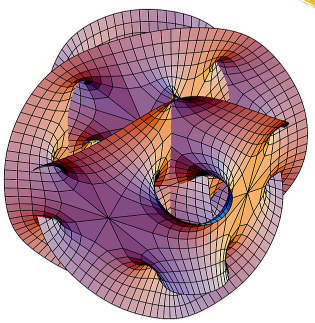


Juan Varela (senior - Prof. Levy's group):

Over my undergraduate career I have been fortunate enough to work in Professor Levy's dark matter research group, helping with the dealings of the LUX-ZEPLIN experiment. I was also able to participate in a REU program at Columbia University this past summer, working as part of their ATLAS group and learning more about the intricacies regarding particle physics data analysis. Giving me a glimpse of what it means to be a physicist aside from being in a classroom, I am very grateful for these research opportunities and will surely benefit me as I go on and apply to graduate school. Talking with the faculty at both schools, as well as other students with similar interests as myself, has helped me grow in the way I think and perceive about what it means to be a physicist. I cannot wait to see what is in store for me after I graduate, and what other exciting projects I can be part of.

Physics @ UAlbany : Research - Theory

String Theory



What is it for?

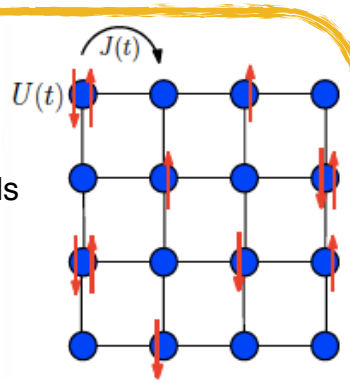
- Constructing a quantum theory of gravity and unifying the four fundamental forces.
- Analytical understanding of the strong interaction.
- Getting insights into strongly coupled systems, e.g. superconductors.

UAlbany string theory group consists of two faculty members, Prof. Lunin and Robbins, and three graduate students. The group pursues two main research directions:

- establishing connections between string theory, field theories, and geometry,
- using strings to understand black holes and strong interactions.

All four MSc and PhD alumni of the group have successful careers in scientific computing and software development, and former undergraduate students are enrolled in top graduate programs.

Condensed Matter Physics



Strongly Correlated Systems

- Encompasses some of the most technologically promising materials of our time: high temperature superconductors, heavy fermions, colossal magnetoresistive materials etc…
- Described by simple model Hamiltonians that are not amenable to solutions using standard approximations.

Because of the exponential growth of the problem with the system size, innovative methods and algorithms are essential if we are to go beyond our current understanding.. Prof. Fotso's research group develops algorithms and computer codes to study these systems in and out of equilibrium.

Quantum Information Processing and Quantum Optics

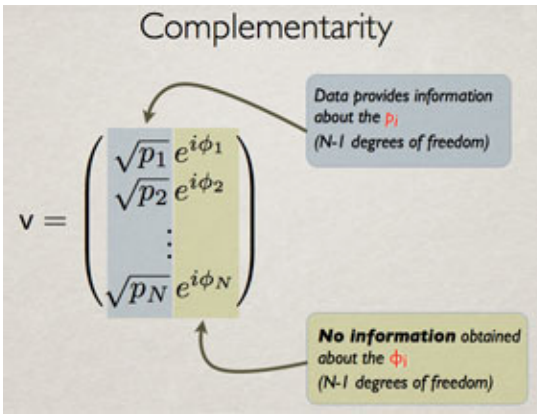
- Quantum computers, the computing paradigm of the future, will rely on controllable spin systems.
- Candidate systems that fulfill the required conditions are quantum emitters in the solid state which are susceptible to unwanted fluctuations in their environment.

Prof. Fotso's group studies the control of these systems and the conversion of stationary-to-flying qubits that is essential for quantum networks and quantum communication.

Physics @ UAlbany : Research - Theory (cont.)

Information Physics

Information Physics is focused on the role that information plays in our understanding of the physical world. Profs. Caticha, Goyal and Knuth explore the extent to which the laws of physics (quantum mechanics, space-time physics) might reflect the rules processing information—the broad goal is to explore the extent to which the laws of nature can be derived from informational principles.

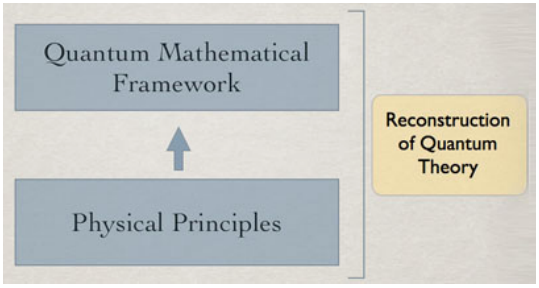


Foundations of Inference

Foundations of inference is concerned with the mathematical tools that formalize the process of making reasonable inferences from limited information. Previous work includes improved formal derivations of probability theory (Knuth; Caticha) and its relation to the principle of maximum entropy (Caticha); and application of maximum entropy to experimental data analysis (Earle). Current work includes the investigation of different ways of quantifying information in probabilistic experiments (Goyal).

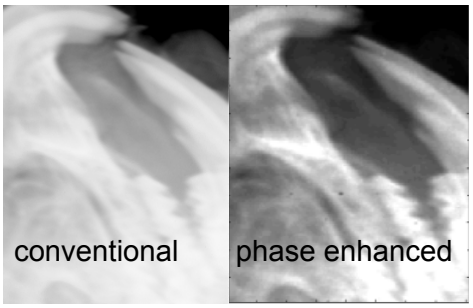
Foundations of Quantum Theory

Foundations of quantum theory aims to explore the counter-intuitive features of quantum theory (such as non-locality), and, more generally, to unravel its implications for our conception of physical reality.



A major part of our recent work is to derive the mathematics of quantum theory from a set of physical principles. Three distinct approaches, due respectively to Caticha; to Goyal; and to Goyal & Knuth, show how informational principles lead to quantum theory. These derivations draw upon our parallel work in the foundations of inference and information theory, and provide numerous important insights into the nature of the quantum. Other ongoing work includes investigation of identical quantum particles (Goyal), derivation of the Schroedinger equation (Caticha; Goyal), investigation of the Dirac equation (Goyal; Knuth), and identification of informationally-optimal quantum measurements (Goyal).
Currently, several doctoral students work on this topic (with Caticha and Goyal), with many previous students going on to positions in academia and industry.

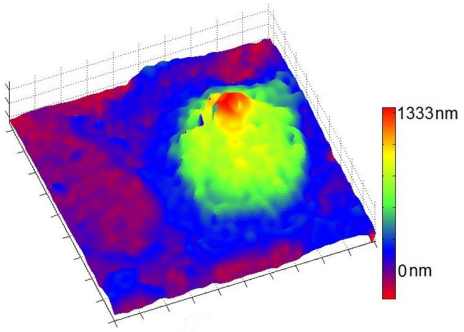
Optics



Experimental Optics and Computational Imaging

What is it?

- Applications-driven research focused on studying the properties of matter with light and x-rays.
- Includes the simulation and design of optical systems, data acquisition and data processing.
- Applications include biological imaging, medical imaging, chemistry and nondestructive inspection.



With four active members, Profs. MacDonald (x-ray optics), Petruccelli (computational imaging), Khmaladze and Sharikova (digital holography and Raman spectroscopy), specializing in different aspects of experimental optics, this is a very active field in the department. There are currently 6 graduate students and 6 undergraduates working Experimental Optics in the department. Current problems of interest include measuring cell volume to answer important biological questions, improving the diagnostic capability of mammography and the development of new imaging methodologies. Students graduating with experience in experimental or computational optics have gone on to successful careers in industry as well as academia.

Optical modeling and simulation

What is it?

- The development of various techniques to computationally model and simulate the behavior of light.

Professors MacDonald, Petruccelli and Fotso share an interest in optical modeling and simulation. Prof. MacDonald develops simulations of x-ray optics to aid in the design of x-ray systems, primarily for medical applications. Prof. Petruccelli is interested in tools to model the wave mechanics of light propagation more efficiently by taking advantage of the simplicity of ray tracing. Prof. Fotso is interested in the interaction of light and matter at the atomic level to study quantum information processing. There are currently 1 postdoc, 2 graduate students and 1 undergraduate student working in these areas. Students specializing in optical modeling and simulation have gone on to jobs in academia and industry.

Physics @ UAlbany : Research - Experiment (cont.)

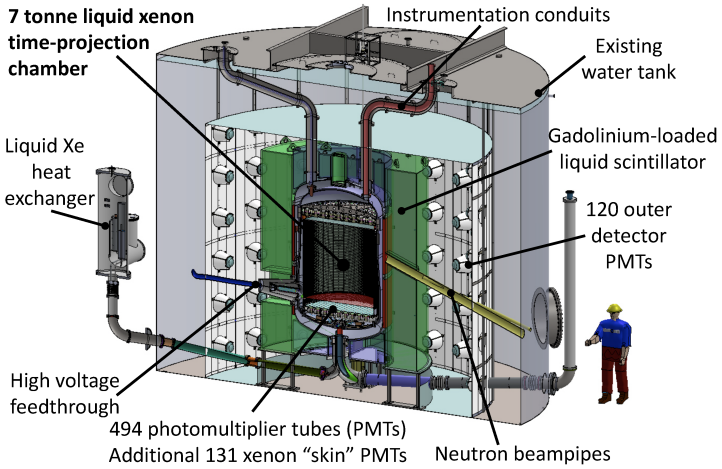
Particle Physics

Astroparticle physics

What is it?

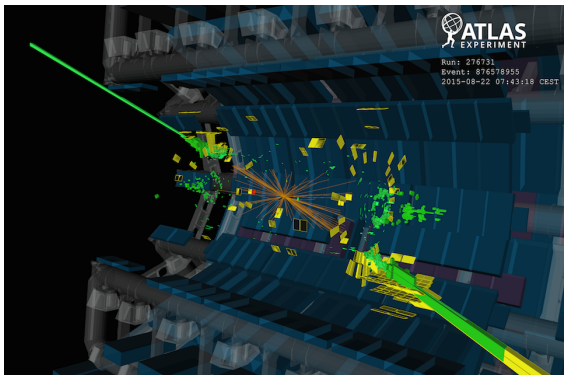
- Looks for new, undiscovered elementary particles of astronomical origin, such as dark matter.
- Mix between particle physics, astronomy, astrophysics, cosmology, solid-state physics, and detector physics.

The LZ Detector



The focus of Profs. Szydagis and Levy's research groups is the search for dark matter, which is thought to make up 25% of the universe. Their research consist of simulations and data analysis for the LUX and LZ experiments, and in-situ detector development for the next generation of dark matter detectors. This versatile research gives both undergraduate and graduate students all the tools necessary for a successful career in academia or in industry. The group currently consists of three PhD, 1 MSc, and 5 undergraduate students. Prof. Szydagis' two former postdocs have now moved on. One went to industry and works in Silicon Valley, while the other continued in academia and is now an assistant professor.

High Energy Physics

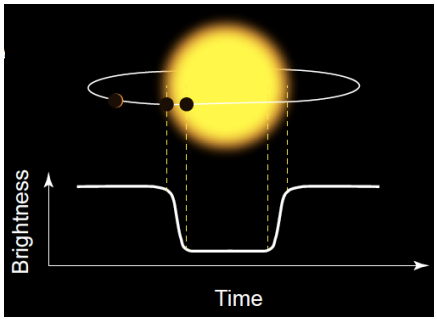


Prof. Jain is the department's tie to the Large Hadron Collider. He works on the ATLAS experiment which, alongside CMS, discovered the Higgs boson is 2012. His research group studies the coupling of the Higgs boson to third generation quarks (*b*, *t*) to understand whether the Higgs sector matches the predictions of the Standard Model, or whether it is part of a more complicated sector, as predicted by many proposed extensions to the SM. He also works on track and vertex reconstruction algorithms for the new inner tracker, which is being planned for the Phase-2 upgrade in 2024--2026. His graduate students have the opportunity to go to the LHC in Switzerland and give talks at international conferences.

Prof. Ernst links astroparticle and high energy physics by currently working with an ATLAS and a LUX PhD student to understand how the combination of information theory and machine learning can be used to improve measurement sensitivity on both ATLAS and LUX.

Physics @ UAlbany : Research - Experiment (cont.)

Exoplanets



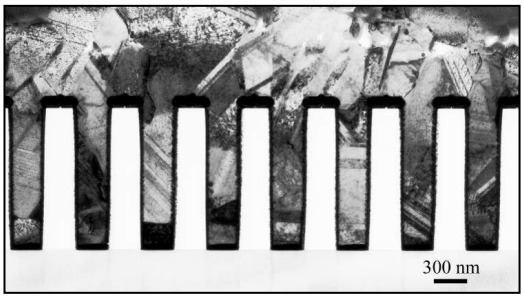
Prof. Knuth's research group is focused on carefully modeling photometric phenomena, such as reflected and refracted light, thermal emissions, and relativistic effects, such as Doppler beaming. Their models are carefully tested on real exoplanets using data from the Kepler Space Telescope. By employing Bayesian model testing they can select the most probable models based on the data, which leads to a better understanding of the physics of exoplanets.
The group consists of two graduate and one undergraduate students, and has graduated two PhD students and three MSc students.

Biophysics

Electron paramagnetic resonance is used to study the structure and dynamics of a wide range of materials and systems, for example, it is used to assess water penetration in cell membranes.

Prof. Earle's research group develops high field EPR instruments to study structure and dynamics. The sensitivity of high field EPR to small changes in local environment can be used to probe subtle changes in the electrochemical environment of a spin label. He also develops modern line shape analysis methods for further insights, making both theory and experiment important components of his work. His former students have all had success both in industry and academia.

Material Physics

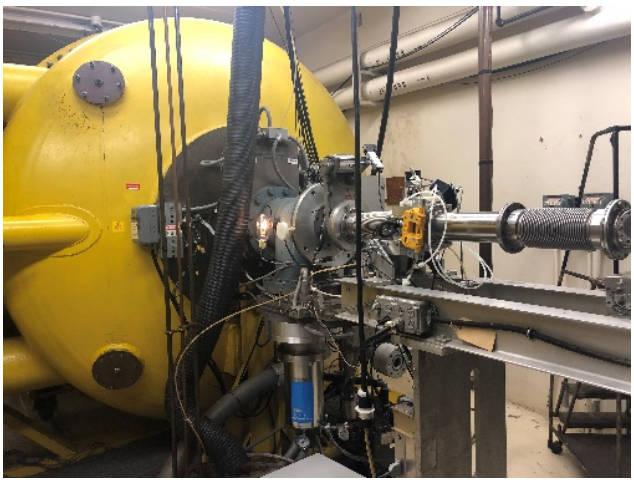


The major theme of Prof. Kuan's research program is to study the structure and behavior of solids with a few layers of atoms (thin films). His group is interested in the wetting, morphology, viscous flow, strain relaxation, carrier localization, and scattering at surface and interface of the layer. His former students have moved on to prestigious institutions like MIT and BNL, or are working for renowned companies like Intel.
Prof. Lanford's research harnesses the 4MV ion beam accelerator located on the Albany campus, which offers unique capabilities for material physics.

Physics @ UAlbany : Ion Beam Laboratory

The Ion Beam Laboratory (IBL) is home to an array of ion beam facilities, from the 4 MV Dynamitron Accelerator to the 400 kV Extrion ion implanter, along with a library of computer programs related to ion solid interactions.

The two major uses of ion beams are: (1) to analyze the composition of materials (Ion Beam Analysis, IBA), and (2) to modify a material by ion implanting atoms (Ion Beam Modification, IBM).



MeV IBA relies on the properties of the atomic nuclei of the bombarding beam and target atoms, and, hence, provides quantitative analyses without use of standard samples. This property holds for Rutherford Backscattering Spectrometry (RBS) which provides analysis for heavy elements in a lighter matrix and Nuclear Reaction Analysis (NRA) which provides analysis of light elements (including hydrogen). These techniques are now used in a wide variety of fields from microelectronics, to geology, to chemistry, to material science, to art history and archaeology.

IBM makes use of the simple fact that if you bombard a material with ions, those ions will lose energy and stop in the target, changing the composition of the target. A key point is that by implanting ions, one can make materials whose composition is far from that given by thermodynamic equilibrium. In addition you can use such ion implantation to introduce defects, to strain materials, to induce transport, and even to induce crystal fracture.

One of the unique features of the Dynamitron is that it was designed to produce large beam currents (up to 1 milliamp). Recently deuteron beams have been run to produce intense radiation (both neutron and gamma-ray) which provide some interesting opportunities for medical studies.

For more information go to https://www.albany.edu/ionbeamlab/.

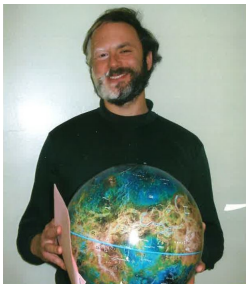
Physics @ UAlbany : Staff

Lecturers

Dr. Robert Schmitz

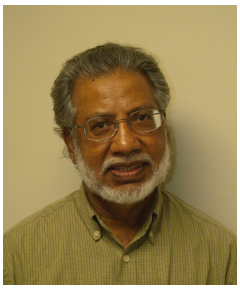
Physics instructor and undergraduate lab coordinator. He has an unusually large collection of video games!

Dr. Eric Woods



In Memoriam

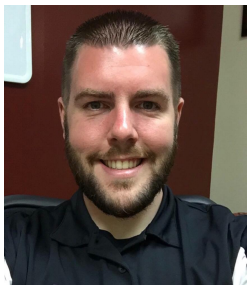
Dr. Shamshad Ahmad



A member of the department since 1979, it is with great sadness that we must say goodbye to Dr. Ahmad. He will be missed.

Administrative & Technical

David Liguori, Support Technician
David is involved with all things technical in the department including undergraduate and research lab equipment, computer software, computer hardware and a/v presentation systems. He enjoys working with students. In his own words: “jack of all trades, master of none”.



Ben Rekemeyer, Administrative Manager
I have been with the UAlbany since 2012 working as a Graduate Assistant, Resident Director, and Apartment Coordinator with Residential Life. I have a Bachelor’s Degree in Business Administration from SUNY Cobleskill and a Master’s Degree in Education Administration and Policy Studies from UAlbany. In an effort to broaden my skill set I made the switch from Student Affairs to the Physics Department in August of 2017. I’m a huge professional wrestling fan and have been to five Wrestlemanias, traveling all over the country to places such as Miami, New Orleans, NYC, Orlando, Philly, Dallas, and San Antonio to see live shows.

Paul Labate, Office Assistant
Paul is the go to person for students that have any questions relating to the department. Paul is very knowledgeable about the Physics curriculum and is always happy to guide students to exactly where they need to go. Every week he makes sure that everything is set up for our department’s guest speakers, helps faculty members adjust courses as needed, and helps students make sure they get into all of the right classes. If you’re ever walking through the Physics building and have some extra time on your hands make sure to stop in and say hi.

Physics @ UAlbany : Scholarships and Awards

The Physics Department would like to congratulate the following scholarship recipients:

- Undergraduate students **Andrew Knutson and Shamus Chowenhill**: for receiving The Anne Rebecca Oliver Memorial Scholarship.

The Physics Department would like to congratulate the following internal awards recipients:

- Graduate students **Nate Avish and Adam Preston** who received the C.L. Andrews Teaching Assistant of the Year award
- Graduate student **Eric Dohner** who received the Teaching Assistant Excellence in Service award
- Graduate student **Greg Rischbieter** who received the Comprehensive Exam Alam award
- Graduate students **Selman Ipek and Thomas Vandermeulen** who received the Akira Inomata Award for Excellence in Research
- Graduate student **Mohammed Abedi** who received the Student Adjunct of the Year award
- Undergraduate students **Emily Flanagan and Josh Martin** who received the Excellence in Undergraduate Research Award

And the winners of our annual undergraduate Joseph Henry competition:

- Overall winner: Simi Kaur
- 1-st place Senior: Andrew Knutson
- 1-st place Junior: Meng Zhang
- 1-st place Sophomore: Nathan Tinklepaugh

The Physics Department would like to congratulate **Prof. Jain** who was one of three distinguished nominees of the Torch Award, celebrating his involvement in undergraduate education and his “power of inspiration”.

Physics @ UAlbany : Donor Honor Roll

The Physics Department would like to thank the following for their generous contributions to the Department.

- *Mr. Christopher D. Hardt*
- *Mr. Andrew K. Kurau '12*
- *Mr. Ralph J. Rensing '81*
- *Franz Reidinger, Ph.D. ’70 and Mrs. Betsy E. Reidinger '70*
- *Earl H. Sexton, Ph.D. '75*
- *Ms. Wendy Swift*
- *Carlo Cafaro, Ph.D. '07*
- *Mr. George W. Murtha '16*
- *Mr. Joshua E. Meyer '12*
- *Roy S. Dunbar, Ph.D. '76*
- *Mr. Edwin Osterhout ’54 and Ms. Carol Osterhout '81*
- *Henry Makowitz, Ph.D. '73*
- *Terry Colquhoun*
- *Ms. Ilene Rubenstein*
- *Ayodele J. Coker, Ph.D. '74*
- *Ms. Wendy Swift*
- *Jeffrey T. Borenstein, Ph.D. '82*
- *Xin-Sheng Guo, Ph.D. ’88 and Ms. Ying Liu '90*