PHYSICS & ASTRONOMY at UGA

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MESSAGE FROM THE HEAD...

Welcome to Volume 3 of the Newsletter for the UGA Department of Physics and Astronomy. I am happy to report that the department has been very active over the past six months, in spite of the pandemic. You will find in these pages a range of interesting stories and exciting activities. One issue of note, not discussed here, is that UGA plans to return to a "normal" instructional format by Fall 2021, with most of our community returning to on-site operations after July 1. The precautions and policies put in place by the UGA administration and implemented in our building proved to be successful for us in the end. Not a single one of our faculty or staff were diagnosed with COVID-19. Nevertheless, I am sure that we have all missed our daily routines on campus and look forward to seeing our students, colleagues, and co-workers in person.

In the current issue, you will find highlights of UGA's first venture into space, happenings in our research labs, and news from our community members. Let me draw your attention to the local, national, and international awards received by our outstanding students and faculty. In particular, Terry (Yoong) Phang was one of only two UGA students named as a 2021 Barry Goldwater Scholarship recipient. In total this year, only 410 students received this award across the country, while only 63 UGA students since 1995 have been so honored. Terry is only the second student in the history of our department to be named a Goldwater Scholar. We are immensely proud of Terry, a junior Physics and Mathematics double major, and look forward to more exciting accomplishments from him in the future.

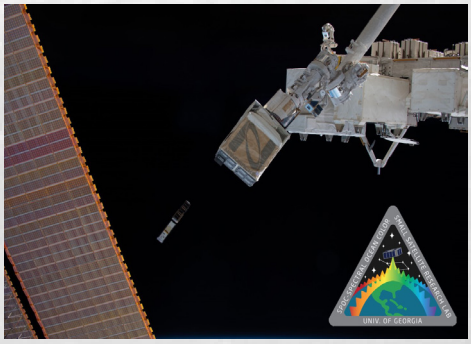
Stay tuned for more news from us as we welcome this fall a new incoming class of Astrophysics and Physics majors and graduate students. Also, alumni, don't forget to update us on your status and activities.

Take care and stay safe,
Phillip ♦

The Northup Grumman Antares Rocket lifting the Cygnus capsule, containing UGA's SPOC (Spectral Ocean Color) Mission to the International Space Station, 9:16pm on October 2, 2020. Credit: NASA Wallops/Patrick Black

UGA's FIRST SATELLITE LAUNCHED!

On October 2nd, 2020 UGA's first satellite was launched into space aboard a Northup Grumman Antares Rocket. The Special Ocean Color Imager (SPOC) was built by the UGA Small Satellite Research Laboratory as part of NASA's Undergraduate Student Instrument Program (USIP). The mission and launch were made possible by an interdisciplinary group of students and faculty from around campus. The lab is hosted in the basement of the Physics Building where the team is getting ready to deliver their second mission, MOCI, by the end of 2021. ♦



UGA's SPOC (Spectral Ocean Color) Mission being released into space by the NanoRacks deployer on the ISS, 4:05am on November 5, 2020. Credit: NASA/Astronaut Kate Rubins

Andrea Hill Wins Women in Physics Essay Competition

The First Annual Women in Physics Essay Competition came about in celebration of Women's History Month. Graduate student Sydney Whilden pitched the idea to the Committee for Equity, Diversity and Inclusion because, she says, "I figured it would inspire people to research women's contributions to physics on their own, plus I love writing and reading other people's writing."

This year's winner is Senior Andrea Hill. Andrea is interested in particle physics, and she's headed to College Park in the fall to begin graduate school at the University of Maryland. Congratulations to Andrea! ♦

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TEACHING PHYSICS DURING COVID-19

Last spring, graduate students worked together to find solutions to teaching physics labs while also keeping students safe from contracting or spreading COVID-19. This interview with Mona Asadinamin, graduate student, and Lauren Sgro, graduate student and head teaching assistant, describes their experiences adapting to the challenging circumstances.

1. When did you realize that you were going to have to change the way you taught to adjust to teaching during the pandemic?

Mona: It was during the spring break last year that I realized the situation will get much worse if students are going to come back to campus. At that point, the only way to slow down the spread was to minimize the interaction between people. For the hands-on labs, like physics labs, the balance between safety and students' learning was a real challenge.

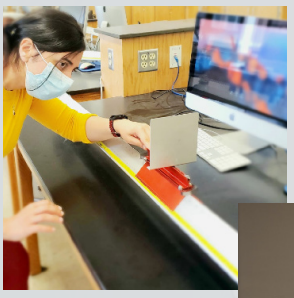
Lauren: After everything first officially shut down. I recall the university closed for a week or so, and on that second week I met with the faculty, Tom Barnello and Ryan McArdle to talk about the clear fact that we weren't coming back to in person classes. Until that point, everything was sort of up in the air and didn't feel real.

2. How did the graduate student teaching assistants/ lab coordinator make decisions about the format of labs?

Mona: The decision was made through several meetings with our departments' authorities and teaching assistants. We reached an agreement to film the labs, provide students with the data set and prepare data analysis instructions in a PowerPoint format. Teaching assistants were responsible to hold online office hours and grade the reports based on the pre-designed rubrics on eLC.

Lauren: Well, it was obvious right away that we were going to have to make some lab videos of us doing the experiments. That was pretty much decided in that initial meeting that I just mentioned. So, we sent out an email asking any graduate TAs that wanted to help with the videos to come meet in the lab rooms. Then, we all brainstormed on the best way to present the

information conveyed in the videos and settled on making PowerPoint presentations to walk the students through the lab. Unfortunately, the lab rooms do not have Zoom monitors, so we decided that doing a synchronous class with all that equipment was not going to work. Some TAs helped with the videos and some students helped with the presentations, and some did both. Then, we went back and forth through some editing to make a final product. At that time, we were just worrying about the labs left in the semester, thank goodness. When we realized that the summer semester was going to be virtual as well, I picked Mona to help me finish creating the online versions for the rest of the labs! I certainly could not have handled that all by myself, so I was really grateful to have her help.



3. Do you have any examples of an obstacle you expected, and then maybe another that you didn't expect? Did you come up with any solutions that you're particularly proud of?

Mona: The main obstacle was to make sure students will get the most out of the online labs. On the one hand we did not want to burden students and add to their anxiety of online classes, whereas on the other hand, we wanted to make sure they will have a reasonable level of understanding about the concepts. Another obstacle was to give students a feel for the lab procedures. We came up with the idea of adding the closest available lab simulations to let students explore the experiment by themselves.

I feel proud to contribute to students' learning in such a difficult situation. I am very proud of all the students and teaching assistants, especially those who helped with the filming and preparing instruction presentations for the labs: Jayne Dailey, Nima Karimitari, Abed Mohamadzade, Lauren Sgro, Learnmore Shenje, Matthew Wilson and specially Ryan Thomas McArdle who has been always helpful during the challenging time.

Lauren: There were tons of obstacles I certainly could not have foreseen! There we so many different ideas on how the labs should run under Covid. Choosing the options that worked best and were safest for the TAs and students was really difficult, while trying to honor everyone's opinion and input. After several semesters, there are still edits to the lab presentations that have to be made, based on student feedback and questions. When you are teaching in person, it is so easy to figure out what to stress to your students because you are there doing the experiment with them in real time and answering their questions as they come up. When teaching asynchronously, it was important to anticipate students' questions ahead of time and include the relevant information in the presentation to limit confusion; it turns out that students are much less likely to ask for help in a virtual setting.

I was really proud of these presentations. They are so thorough and I think could be used as student aides for a long time to come! I'm also really happy with our use of online simulations to help provide the students with an interactive experience. Quite often we were able to use simulations that reflected the in-person experiment and drove home the main points of the lab.

4. Are there any strategies that you learned during this time that you'll carry over into semesters that are conducted primarily in-person?

Mona: It was a great experience to learn how to teach those that are sitting at home and don't have the opportunity to work with the lab setup and learn through experimenting. The instructions had to be straightforward, so a lot of revisions were necessary to reduce the level of confusion. I look at the online lab designs as practice to improve my teaching skills. It taught me that teaching and learning will go on, even in a severe situation like a pandemic.

Lauren: Something I have found is that students really benefit from having the lecture material in multiple formats. I have really noticed this when extrapolating our physics lab adaptions to the astronomy labs. For astronomy lab, I used to just talk and write on the board. Then the students would complete a worksheet or use the telescopes, and that is it. But now, I am talking to some people in person, some on Zoom recording my Zoom lecture and sometimes making supplementary materials to clarify concepts for the virtual students. Then, all the students have access to review the lecture and the lecture notes/materials, and they seem to really benefit from this. ♦

AWARDS

Professor Weliweriya Recognized for Superior Teaching

Please join us in congratulating Professor Weliweriya for his recent recognition as Franklin College of Arts and Sciences Outstanding Teacher. The award is given in honor of a professor's exemplary commitment to student learning and success.

Of his work, Professor Weliweriya says, "We all need things that make us excited to be alive, making us glad to wake up in the morning and push our limits during the daytime. Looking at groups of students who make arguments over problem-solving approaches, fist bumps, or loud shouts as they come across an 'Aha Moment!' and comments like 'This guy made me reclaim my love for physics after the horrors of high school' takes my job satisfaction to another level."

Professor Weliweriya has an impressive body of pedagogical research, the most recent of which is "Student Feedback on Transition to Online Instructions During the COVID-19 Pandemic." In this study, Professor Weliweriya, Dr. Tara Cotten (Lecturer in our Department), and their research students collected data about student responses to virtual learning. In another recent study, Professor Weliweriya and others studied the processes students use to problem-solve when interpreting classroom materials such as sketches, diagrams, pictures, graphs, tables, and mathematical equations. That study can be found here.

This year, Professor Weliweriya received an EETI Augmented, Remote, and Virtual Experimentation Grant from the Engineering Education Transformations Institute (EETI) in UGA's College of Engineering. The study's title is "Exploring XR Technologies to Augment and Transform Textbook Problems and Enable Remote, Collaborative Problem Solving in Engineering Course." This work is done in collaboration with professors in the School of Electrical and Computer Engineering and the College of Engineering.

When he talks about his goals, in his teaching and in his research, Professor Weliweriya says, "I want every student who took my class to finish the semester with the idea, 'Physics is more fun than I anticipated, and the world is full of unknowns to be solved, just like any other physics problem.'" ♦

American Association of Physics Teachers selects Student-Professor Collaboration for its Best Pedagogical Presentation Award

The North Carolina Section of the American Association of Physics Teachers (AAPT) has selected the work of Professor Nandana Weliweriya and undergraduate researcher Richa Bhome for their Best Pedagogical Presentation award.

As one of the active researchers in UGA's physics education research group, Professor Weliweriya mentors undergraduate researchers. Six of his mentees have presented at UGA's Center for Undergraduate Research Opportunities (CURO) Symposium.

"My goal," Weliweriya says, "is to have these undergraduate researchers present at a national conference by the end of this summer."

Richa Bhome first presented her research "Use of Lottery Tickets (IF-AT scratch-off cards) to Solve Problems in Introductory-Level Physics Courses," as a poster at UGA's 2020 Center for Undergraduate Research Opportunities Symposium. The abstract and the poster are available here.

The main ideas behind using the IF-AT cards are to improve physics instruction by using fun activities (lottery cards) to solve physics problems, promote group work, and boost students' conceptual thinking.

In November of 2020, Professor Weliweriya presented the poster at the Fall 2020 NCS-AAPT/ SACS-AAPT virtual meeting.

This award recognizes Weliweriya's commitment to education and research, and it supports further research and the presentation of similar research at a national meeting. This award is a step toward the

goal of having an undergraduate researcher present a paper at a national conference.

About his plans for the future, Weliweriya says, “I am hopeful that we will get back to traditional teaching methods in the fall or spring that may help us collect data and submit an AAPT or Physics Education Research Conference article on this project for the following summer."

In the meantime, Professor Weliweriya is involved in introducing his innovative pedagogy to encourage undergraduate research at other UGA institutions. The Center for Teaching and Learning has selected him as a participant in the Active Learning Summer Institute’s project to redesign Student-Centered Active Learning Environment for Undergraduate Programs courses. ♦

The Royal Astronomical Society Award Winners Announced

Congratulations to Professor Hall! The Royal Astronomical Society has named her winner of the 2021 Winton Award in Astronomy.

The Royal Astronomical Society (RAS), founded in 1820, encourages and promotes the study of astronomy, solar-system science, geophysics and closely related branches of science. The Winton prizes are for research by a Post-Doctoral Fellow whose career has shown the most promising development.

Hall completed her undergraduate degree at the University of Sheffield in 2013 and earned her doctorate at the University of Edinburgh in 2017. She became one of two women in the inaugural class of Winton Exoplanet Fellows, a program that recognizes accomplished scientists in the early stage of their career and provides them with the opportunity to conduct independent research that could establish them as future leaders in their field. She relocated to the USA in 2020 to accept a position at UGA (see Fall 2020 Newsletter).

"We are extremely excited to learn that Dr. Hall has received the Winton Award from the UK's Royal Astronomical Society," said Phillip Stancil, professor and head of the Department of Physics and Astronomy. "The award recognizes Dr. Hall's ground-breaking computational studies of the evolution of planetary systems, performed while she was a postdoctoral associate at the University of Leicester. After just three short months at UGA, Dr. Hall is already building an outstanding research group, which will elevate UGA's reputation in computational astrophysics, leading to improved understanding of how planets form."

“Receiving this award is a huge honour,” Dr. Hall said, “and I am absolutely delighted. This award is a fantastic start to my career at the University of Georgia, and I am looking forward to many years of success here.”

In their announcement, the RAS wrote, “By connecting the theory of protoplanetary discs to observations, Dr. Hall is building a distinctive research program at the forefront of the quest to understand how planets form.” ♦

Advanced Surface Engineering Division 2021 Grad Student Award

In November 2020, the American Vacuum Society (AVS) Advanced Surface Engineering Division (ASED) Awards Committee selected Hoang Luong as one of three finalists for the 2021 ICMCTF Graduate Student Awards. This spring, Luong learned that he had won the Silver Prize.

The ASED of the AVS provides a continuing forum for fostering the understanding of advanced surface engineering technologies. ASED brings together scientists and technologists from academia and industry, thereby merging research with application and promoting coating integration in materials design and engineering.

The ASED awards committee oversees the annual International Conference on Metallurgical Coatings and Thin Films (ICMCTF) graduate student awards. ASED seeks to recognize students of exceptional ability who show promise for significant future

achievement in ASED-related fields.

As a finalist for the Graduate Student Award, Luong attended the 2021 ICMCTF Conference via Zoom this April. All three finalists spoke at the conference, during which the winners of the Gold, Silver, and Bronze Awards were determined.

Luong's talk, "The Magneto-Plasmonic Properties of Ag-Co Composite Nanostructures," investigates magneto-plasmonic properties of well-identified plasmonic nano-lattices (such as nanohole arrays and nano-triangle arrays), based on Ag-Co composite materials.

"I am deeply honored to receive the Silver prize in the 2021 ICMCTF Graduate Student Awards," Luong says. "Our work has been recognized by the Awards Committee, which makes me very happy!" ♦

LAB UPDATES

Prof. Abate's Research Group Develops New Nanoimaging Technique to Help Understand the Unique Properties of 2D Materials at the Nanoscale

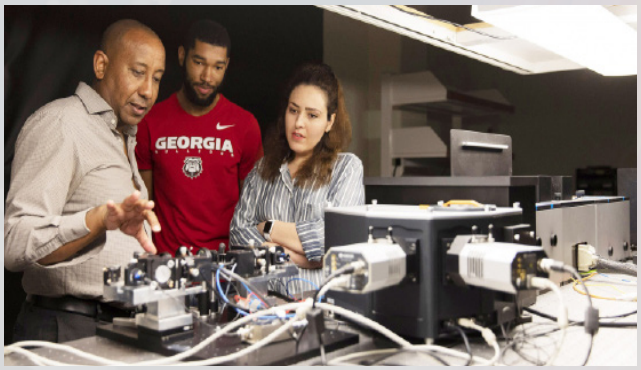
The process moves researchers a step closer to using the new materials in applications

Written by Alan Flurry, and originally published Feb. 5, 2021 in UGA Today. Within 24 hours, it was reposted on 9 popular science news sites.

When we think about the links to the future – the global transition to solar and wind energy, tactile virtual reality or synthetic neurons – there's no shortage of big ideas. It's the materials to execute the big ideas – the ability to manufacture the lithium-ion batteries, opto-electronics and hydrogen fuel cells – that stand between concept and reality.

Enter two-dimensional materials, the latest step in innovation. Consisting of a single layer of atoms, phosphorene exhibits new properties with far-reaching potential. With a capability to be combined like Lego blocks, these materials offer connections to future products, including new means to convey both power and people, with more-efficient energy transmission, and solar- and wind-powered vehicles on roads and in skies.

A study led by Prof. Abate's Research Group announces the successful use of a new nanoimaging technique that will allow researchers to test and identify these materials in a comprehensive way at the nanoscale for the first time. Now, there's a way to experiment with new materials for our big ideas at a really, really small scale.



"Fundamental science – small-scale electrical conductivity, light emission, structural changes – happen at the nanoscale," said Yohannes Abate, Susan Dasher and Charles Dasher MD Professor of Physics in the Franklin College of Arts and Sciences and lead author on the new paper. "This new tool allows us to visualize all of this combined at unprecedented specificity and resolution."

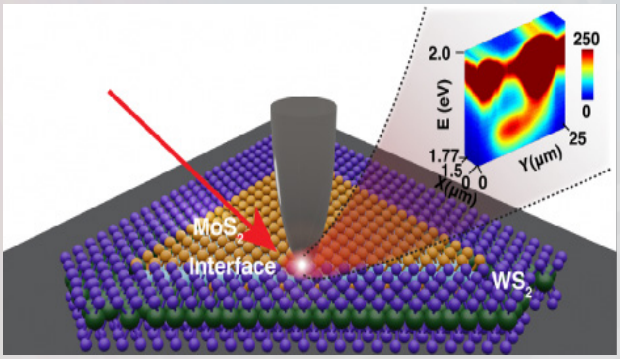
"Since we cannot see atoms with traditional methods, we needed to invent new tools to visualize them," he said. The hyperspectral imaging technique allows scientists to inspect electrical properties, optical properties, and mechanical properties at the fundamental length scale simultaneously.

The hyperspectral imaging research is supported by grants from the United States Air Force and the National Science Foundation. The researchers created a one-atom thick sheet of two kinds of semiconductors stitched together, similar to assembling an atomic Lego set, with properties not found in traditional thick materials. With single-atom-thick crystals, each atom is literally exposed on the surface, combining atomic properties that result in new properties.

"At the heart of materials science is the need to

understand fundamental properties of new materials, otherwise it is impossible to take advantage of their unique properties," Abate said. "This technique puts us one step closer to being able to use these materials for a number of potential applications."

Those include various forms of electronics or light-emitting systems applications. How to verify the effect of very small changes in atomic composition, conductivity and light response of single-atom-thick materials simultaneously has been the challenge until now, Abate said.



Nobel Prize-winning physicist Richard Feynman, who envisioned nanotechnology as early as the 1960s, predicted that as scientists would be able to choose and replace certain kinds of atoms, they would be able to fabricate practically any imaginable material.

"More than half a century later, we're not there yet, but where we are, we can visualize them, and at that scale there are new issues that can arise and we have to understand those properties as a part of understanding the large scale material properties, before we can use them," Abate said.

The paper, "Photodegradation Protection in 2D In-Plane Heterostructures Revealed by Hyperspectral Nanoimaging: The Role of Nanointerface 2D Alloys" is published in the journal *ACS Nano*.

Abstract:
Single-layer heterostructures exhibit striking quasiparticle properties and many-body interaction effects that hold promise for a range of applications. However, their properties can be altered by intrinsic and extrinsic defects, thus diminishing their applicability. Therefore, it is of paramount importance to identify defects and understand 2D materials' degradation over time using advanced multimodal imaging techniques. Here we implemented a liquid-phase precursor approach to synthesize 2D in-plane MoS_2–WS_2 heterostructures exhibiting nanoscale alloyed interfaces and map exotic interface effects during photodegradation using a combination of hyperspectral tip-enhanced photoluminescence and Raman and near-field nanoscopy. Surprisingly, 2D alloyed regions exhibit thermal and photodegradation stability providing protection against oxidation. Coupled with surface and interface strain, 2D alloy regions create stable localized potential wells that concentrate excitonic species via a charge carrier funneling effect. These results demonstrate that 2D alloys can withstand extreme degradation effects over time and could enable stable 2D device engineering.

Authors:
Alireza Fali, Tianyi Zhang, Jason Patrick Terry, Ethan Kahn, Kazunori Fujisawa, Bernd Kabius, Sandhaya Koirala, Yassamin Ghafouri, Da Zhou, Wenshen Song, Li Yang, Mauricio Terrones, and Yohannes Abate ♦

Researchers Develop New One-Step Process for Creating Self-Assembled Metamaterials

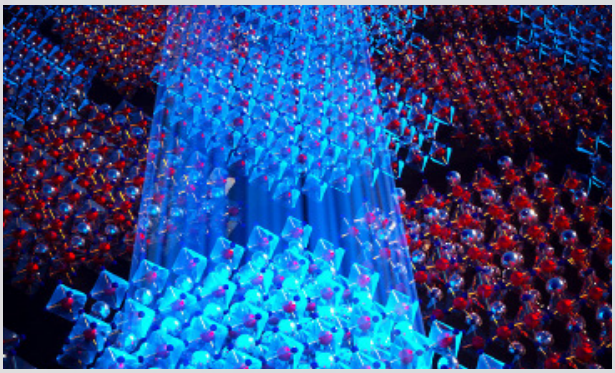
UGA Professor Yohannes Abate and graduate student Alireza Fali along with researchers at University of Minnesota Twin Cities and City University of New York have discovered a groundbreaking one-step process for creating materials with unique properties, called metamaterials. Their results show the realistic possibility of designing similar self-assembled structures with the potential of creating "built-to-order" nanostructures for wide application in electronics and optical devices.

The research was published and featured on the cover of *Nano Letters*, a peer-reviewed scientific journal published by the American Chemical Society.

In general, metamaterials are materials made in the lab to provide specific physical, chemical, electrical, and optical properties otherwise impossible to find in naturally occurring materials. These materials can have unique properties which make them ideal for a variety of applications from optical filters and medical devices to aircraft soundproofing and infrastructure monitoring. Usually these nano-scale materials are

painstakingly produced in a specialized clean room environment over days and weeks in a multi-step fabrication process.

In this new research, a University of Minnesota team was studying a thin-film material called strontium stannate or $SrSnO_3$. During their research, they noticed the surprising formation of checkerboard patterns at the nano scale similar to the metamaterial structures fabricated in the costly, multistep process.



While studying a thin-film material called strontium stannate ($SrSnO_3$), University of Minnesota researchers noticed the surprising formation of checkerboard patterns at the nano scale similar to structures fabricated in costly, multistep processes. Their results show the realistic possibility of designing similar self-assembled structures with wide applications in materials for electronics and optical devices. Credit: Jalan Group, University of Minnesota

"At first we thought this must be a mistake, but soon realized that the periodic pattern is a mixture of two phases of the same material with different crystal structures" said Bharat Jalan, the senior author of the study and an expert in material synthesis who is the Shell Chair in the University of Minnesota's Department of Chemical Engineering and Materials Science. "After consulting with colleagues at the University of Minnesota, University of Georgia, and City University of New York, we realized that we may have discovered something quite special that can potentially have some unique applications."

The material had spontaneously organized into an ordered structure as it changed from one phase to another. During what is called a "first-order structural phase transition" process, the material moved into a mixed-phase in which some parts of the system completed the transition and others did not.

"These nanoscale periodic patterns are the direct consequence of the first-order structural phase transition in this material," said University of Minnesota aerospace engineering and mechanics Professor Richard James, a co-author of the study and a Distinguished McKnight University Professor. "For the first time, our work enables a host of possibilities for utilizing reversible structural phase transformations with nanoelectronic and photonic systems."

In fact, the team demonstrated a process for the first-ever, self-assembled, tunable nanostructure to create metamaterials in just one step. The researchers were able to tune the ability to store electrical charge property within a single film using temperature and laser wavelength. They effectively created a variable photonic crystal material with 99 percent efficiency.

Using high-resolution electron microscopes, the researchers confirmed the unique structure of the material.

"We observed that the boundaries between these crystallographic phases were sharply defined at the atomic scale, which is remarkable for a self-assembled process," said Professor Andre Mkhoyan, a co-author of the study, an expert in advanced electron microscopy, and the Ray D. and Mary T. Johnson/Mayon Plastics Chair in the Department of Chemical Engineering and Materials Science at the University of Minnesota.

The researchers are now looking to future applications for their discovery in optical and electronic devices.

"When we started this research, we never thought about these applications. We were driven by the fundamental study of the physics of the material," Jalan said. "Now, all of a sudden, we seem to have opened up a completely new area of research, which is driven by the possibility of many new and exciting applications."

In addition to Jalan, the team included University of Minnesota researchers Abhinav Prakash, Ashley Bucsek, Tianqi Wang, Tristan K. Truttmann, Hwanhui Yun, K. Andre Mkhoyan, and Richard James; University of Georgia researchers Alireza Fali and Yohannes Abate; City University of New York researchers Michele Cotrufo and Andrea Alù; and Argonne National Laboratory researchers Jong-Woo Kim and Philip J. Ryan.

The research was primarily funded by the National Science Foundation (NSF), and the Air Force Office of Scientific Research (AFOSR) with additional support from the University of Minnesota Institute on the Environment, Norwegian Centennial

Chair Program, and two Vannevar Bush Faculty Fellowships. Work at the University of Minnesota involving thin film characterization was supported by the U.S. Department of Energy. Parts of the research were carried out at the Minnesota Nano Center and Characterization Facility at the University of Minnesota, funded in part by the National Science Foundation. Additional work was completed at the Advanced Photon Source, an Office of Science User Facility operated for the U.S. Department of Energy Office of Science by Argonne National Laboratory.

To read the full research paper entitled "Self-Assembled Periodic Nanostructures Using Martensitic Phase Transformations" visit the ACS Publications website. Originally posted on University of Minnesota College of Science and Engineering News. ♦

DR. WHITNEY INGRAM VISITS

On February 11, Franklin Student Ambassadors hosted a special event featuring alumna Dr. Whitney Ingram.

Dr. Ingram graduated from the University of Georgia with her BS in Physics in 2011 and PhD in Physics in 2016. She holds the honorable distinction of being the first African American woman to graduate from UGA with a PhD in Physics. Her research focus and dissertation were on the fabrication and application of plasmonic nanomaterials using nanosphere lithography.

Dr. Ingram authored and co-authored over 15 publications under the training of her mentor Dr. Yiping Zhao. In 2015, she was selected as one of 65 students from the United States to attend the Nobel Laureate Conference in Lindau, Germany.

Currently, Dr. Ingram is a senior R&D engineer at Sandia National Laboratories (SNL), which is a government research facility that specializes in advanced defense and intelligence technology, in addition to keeping the US nuclear stockpile safe and secure. In addition to her dedication to work, Ingram has remained dedicated to encouraging STEM education for the next generation. ♦

ALUMNI HIGHLIGHTS

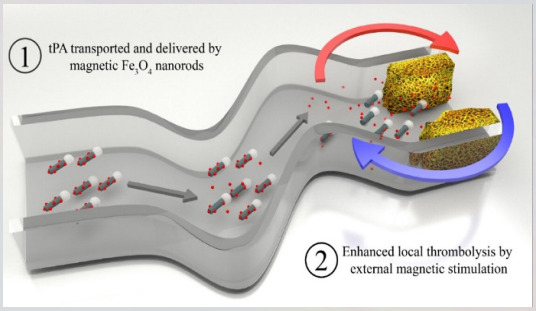
Jessica Doppler is a graduate student at UC Riverside working with Professor Laura Sales to study galaxy formation using cosmological simulations. One of the outreach projects she is involved in was recently featured in the *Wall Street Journal*. Her first lead author publication on globular clusters as tracers of dark matter was accepted to the *Monthly Notices of Royal Astronomical Society* in December 2020, and this January she gave a press conference on her work on globular clusters and the dark matter content of seemingly dark-matter-free dwarf galaxies at the 237th American Astronomical Society meeting. In 2017, she graduated from UGA, where she worked with Professor Loris Magnani on the relationship between gas and dust at high galactic latitudes.

Benjamin Liewehr is a PhD student at the strong-field nanophysics group at the University of Rostock. He was recently awarded a third funding period through the state fellowship program, starting in April this year. In this research project, Liewehr uses finite-difference time-domain simulations to investigate the nonlinear optical response of laser induced attosecond nanoplasma formation. In 2016 Liewehr graduated from UGA with a master's and received the Anderson-Pioletti Award from the Department of Physics & Astronomy.

Matthew Williams is currently a lecturer at Murray State University and will transition to a tenure-track assistant professorship in the fall. Williams graduated from UGA in 2015. ♦

FACULTY UPDATES

Congratulations to Dr. Yiping Zhao



for his recognition as **Fellow of the International Association of Advanced Materials (FIAAM).** Fellow of IAAM is a prestigious honor that the IAAM confers upon researchers and scientists to appreciate their hard work and efforts for the advanced materials community.

The International Association of Advanced Materials, IAAM, was founded as a non-profit organization on 20 January 2010, with the aim for promotion of advanced materials to global excellence. The organization works to create a highly interactive international network of researchers, students, and professionals from academia and industry working in the interdisciplinary fields of advanced materials science, engineering, and technology.

By honoring the researchers and scientific elites with this coveted title, IAAM recognizes their hard work and also hopes to motivate young and upcoming researchers to take research up as a long-term career.

In this role, Dr. Zhao delivered the 2020 IAAM Fellow Lecture in the Advanced Materials Lecture Series 2020. The talk, Functional Magnetic Nanomotors to Improve Ischemic Stroke Treatment, described the limitations of the current treatment, systemic thrombolysis with intravenous tissue plasminogen activator (tPA), for patients who have had an acute ischemic stroke, and explained how Dr. Zhao's work with rotary magnetic iron oxide (Fe_3O_4)-nanorods addresses these limitations.

Dr. Zhao discussed the synthesis, functionalization of the magnetic nanorods, the physical and chemical mechanism of the improved thrombolysis, and the results from both the in vitro and animal tests, as well as future challenges.

About the Fellowship, Dr. Zhao says, "I am very happy that my work has been recognized by IAAM."

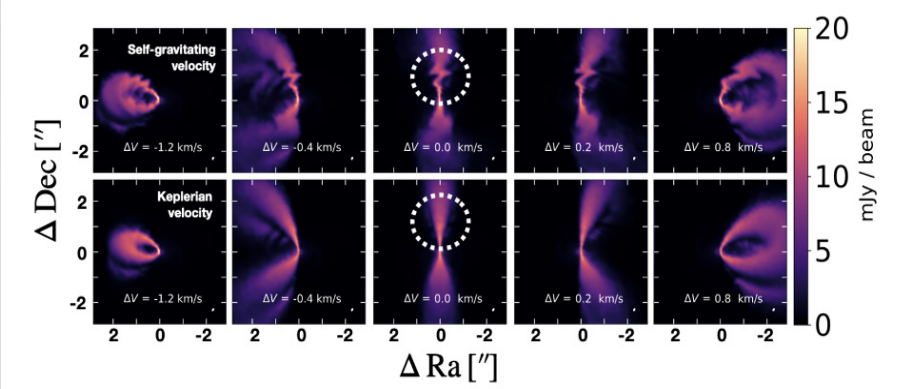
Loris Magnani determined, with graduate student Emmanuel Donate, that a substantial portion of the so called "dark molecular gas" in the interstellar medium was actually detectable in the CO(1-0) transition at 115 GHz. This established that at least a third of this gas was actually spectroscopically detectable and thus could be studied kinematically.

Nandana Weliweriaya received a EETI Augmented, Remote, and Virtual Experimentation Grant from Engineering Education Transformations Institute (EETI) from UGA's College of Engineering. He also received the NCS-AAPT Award for the best pedagogical presentation from the North Carolina Section of the American Association of Physics Teachers (NCS-AAPT). He was selected as a participant in the Active Learning Summer Institute (ALSI) 2021, conducted by UGA's Center for Teaching and Learning, to redesign SCALE-UP courses.

Tho Nguyen and his research group discovered the strong Rashba-type spin orbit coupling in 2D organic-inorganic hybrid perovskites. You can read more details about their work in Nature. The same research group discovered an artificial hyperfine interaction using superparamagnetic nanoparticles. The full paper is here. This research group also discovered optical hydrogen sensors with sub-second response and ppm detection limit. To read more about this work, see the full pdf.

Craig Wiegert was chosen by the Center for Teaching and Learning as a member of the 2020 Senior Teaching Fellows.

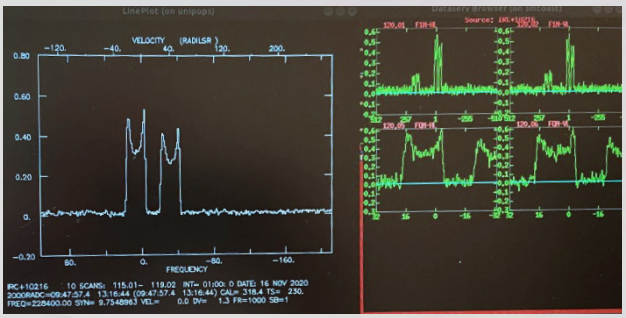
Cass Hall discovered the existence of the gravitational instability wiggle ("GI-Wiggle") - a distinctive zigzag kinematical feature that is present in self-gravitating discs (see image below). She has received the Royal Astronomical Society Winton Award for the postdoctoral fellow whose career has shown the most promising development in the UK.



Synthetic ALMA channel maps - "images" of the emission at a particular velocity - for the CO J=3-2 line from Hall's simulated discs. The lower panels show the results for a disc without self-gravity, which shows the "butterfly" pattern resulting from Keplerian rotation. The upper panels show the corresponding channel maps for a gravitationally unstable disc: the spiral density waves manifest as very clear "GI-wiggles" in the channel maps. If detected in real discs, these wiggles would represent unambiguous evidence for gravitational instability.

Phillip Stancil, a computational physicist, received 200 hours of observing time on the Submillimeter Telescope (SMT) at the Arizona Radio Observatory in November and December 2020 and in March and April 2021. While the SMT is located on Mt. Graham near Tucson, AZ, he had to observe remotely due to the pandemic. Luckily, he had Dr. Magnani to train him on how to be an observer! The project, which also included Dr. Lucy Ziurys (U. Arizona) and Dr. Ziwei Zhang (former UGA graduate student, now at RIKEN, Tokyo), involved studying molecular rotational emission lines in carbon- and oxygen-rich stellar outflows.

Submillimeter Telescope (SMT) at the Arizona Radio Observatory



Screen Monitoring Observations at the SMT

As chair of the Laboratory Astrophysics Division (LAD) of the American Astronomical Society (AAS), Dr. Stancil also co-organized LAD invited talk sessions for the virtual Winter 2021 and Summer 2021 AAS conferences. ♦

STUDENT UPDATES

UNDERGRADUATES

Terry Phang Named Goldwater Scholar

Yoong "Terry" Phang, from Cumming, is a third-year majoring in physics and mathematics with a focus on condensed matter physics. (Photo by Stephanie Schupska)

Physics undergraduate Terry Phang is among 410 undergraduates across the nation to be recognized as a Barry Goldwater Scholar in 2021, earning the highest undergraduate award of its type for the fields of the natural sciences, mathematics and engineering. Phang is one of two UGA students to be recognized for this honor.

Phang, from Cumming, is a third-year student majoring in physics and mathematics with a focus on condensed matter physics. Claire Bunn, a third year UGA student majoring in genetics and minoring in statistics, also received the award.

Since 1995, 63 UGA students have received the Goldwater Scholarship, which recognizes exceptional sophomores and juniors across the United States. "The University of Georgia is proud of Claire and Terry for this impressive achievement," said President Jere W. Morehead.

This year, recipients were selected from a field of more than 5,000 college sophomores and juniors who were nominated by 438 academic institutions nationwide. Each awardee will receive up to $7,500 toward the cost of tuition, fees, books and room and board. Of this year's Goldwater Scholars, 51 are mathematics and computer science majors, 291 are majoring in the natural sciences and 68 are majoring in engineering.

Having lived and attended school in both the United States, a developed country, and Malaysia, a developing country, Phang recalls the stark differences in the technology and other resources available for STEM education in each school system. As a student in the U.S., he read studies describing the detrimental effect of insufficient resources on student interest in STEM fields within developing countries.

"At UGA, I am striving to increase student retention in STEM fields through my teaching, mentoring and volunteering roles, while creating a culturally inclusive learning environment," he said. "I hope that my work as a Malaysian American scientist will inspire people of many backgrounds to pursue an education and career in STEM."

Phang's long-term goals are to pursue a PhD in physics and conduct research at a national laboratory, focusing on magnetism in quantum materials. As a physicist, he plans to work at the intersection of theory and experiment to investigate the fundamental properties of these materials and further the quest to realize their vast potential for applications in energy-related technology and information science.

Currently, Phang is researching the properties of magnetic nanomaterials and working on smartphone physics for mobile learning with Yiping Zhao, Distinguished Research Professor of Physics. Prior to this, he conducted research with Tho Nguyen, associate professor of physics, using spectroscopy to study the magneto-optical effects of organic semiconductors. He also has held a research internship with research scientist Benjamin Lawrie at Oak Ridge National Laboratory in which he used computational methods for data analysis of quantum materials. He was recently invited to conduct research this summer at the University of California, Berkeley with Stephen Leone, professor of chemistry and physics.

Phang's UGA involvement includes service as president of the Society of Physics Students, Honors Program teaching assistant, Rankin M. Smith Student Athlete Academic Center tutor, Chinese Culture and Language Association public relations officer, UGA MATHCOUNTS Outreach and IMPACT Service Trips volunteer, and member of the Department of Physics and Astronomy's Diversity, Equity and Inclusion Committee. He has received a CURO Summer Fellowship, UGA Physics and Astronomy Undergraduate Research Scholarship, and UGA Experiential Learning Scholarship and is a member of Phi Kappa Phi.

The scholarship honoring Sen. Barry Goldwater was created to encourage outstanding students to pursue careers in the fields of mathematics, natural sciences and engineering. Since its first award in 1989, the Barry Goldwater Scholarship and Excellence in Education Foundation has bestowed 9,457 scholarships. Terry is only the second student from the department to receive this award. ♦

Richa Mandar Bhome presented in the CURO Symposium: Richa Mandar Bhome; Nandana Weliweriya, "Use of Lottery Tickets (IF-AT scratch-off cards) to Solve Problems in Introductory-Level Physics Courses."

Jessica Cmiel and **Heather Hewitt** received the department's Astrophysics Award as seniors. Having graduated this May, Jessica will begin her PhD at Harvard University this fall studying Environmental Science and Engineering with research in atmospheric evolution of terrestrial planets and exoplanets, while Heather starts her Astrophysics PhD program this fall at Arizona State University researching astronomy education.

Elijah Courtney received the department's Charles H. Wheatley Award as a senior. Elijah graduated summa cum this spring after concluding his research with Dr. Stancil on the formation and abundance of helium hydride in the early universe, and he will begin a Physics PhD this fall at Stanford University in an experimental research group.

Douglas Kellar and **Andrew Tran** received the department's Undergraduate Grant for Research in Physics or Astronomy. Douglas graduates in May 2022 with a BS in physics and chemistry. His research uses lasers and imaging techniques to study how charge moves around small molecules in response to light. Taking images of this process helps determine the bond energies of these complexes. After UGA he plans on going to medical school to become a surgeon.

Laney Norton received the Linville L. Hendren Memorial Scholarship.

John Thomas and **Katie Tran** received a Spring 2021 CURO Research Assistantship, The Center for Undergraduate Research Opportunities (CURO), The University of Georgia. John is a senior.

Sophia Villamor received the department's Ted L. Simons Award. ♦

Undergraduate Department Awards Recipients (Left to Right): Elijah Courtney, Jessica Cmiel, Heather Hewitt, Douglas Kellar, Andrew Tran, and Laney Norton

GRADUATES

Alireza Fali received the department's Sean M. Kirkpatrick Award for Outstanding Achievement in Graduate Research.

Hoang Luong received a Graduate Education Advancement Board Graduate Fellowship from UGA's graduate school.

Abed Mohamadzade received an Outstanding Teaching Assistant award from the Office of Instruction and the Center for Teaching and Learning. He also received a 2021 Summer Research Grant from UGA's Graduate School. The goal of his summer research project is to design and construct a solution and a gas-phase UV-VIS spectrometer. Gas-phase absorption spectra are highly desirable both for experimental reasons and in comparison to/benchmarking of ab initio calculations and dynamics simulations.

Lauren Sgro received the department's Bill Cummings award, which recognizes the graduate student who best exemplifies excellence as a student and as a teacher of undergraduates.

Lenny Shenje Lenny's work with Dr. Ullrich's research group was published in the JPCC and the JCP. The JPCC paper highlighted the group's Femtosecond Transient Absorption study (TAS) of the carrier dynamics in copper oxide thin films. The JCP paper was a multiwavelength TAS study of the ultrafast cyclopropenone photodissociation mechanisms in collaboration with Dr. Popik's group in the Chemsitry Department. Lenny also received a Graduate Education Advancement Board Graduate Fellowship from UGA's graduate school. You can read more about the award here.

Eric Suter received an Outstanding Teaching Assistant award from the Office of Instruction and the Center for Teaching and Learning.

Jason Terry received the department's Anderson-Pioletti Award. This award recognizes a first or second year graduate student showing exceptional promise.

Jason Gilchrist and **Matthew Wilson** received the department's Robert Woods Teaching Award. ♦

Graduate Department Awards Recipients (Left to Right): Jason Terry, Alireza Fali, Lauren Sgro, Jason Gilchrist, and Matthew Wilson

EQUITY, DIVERSITY, AND INCLUSION INITIATIVE

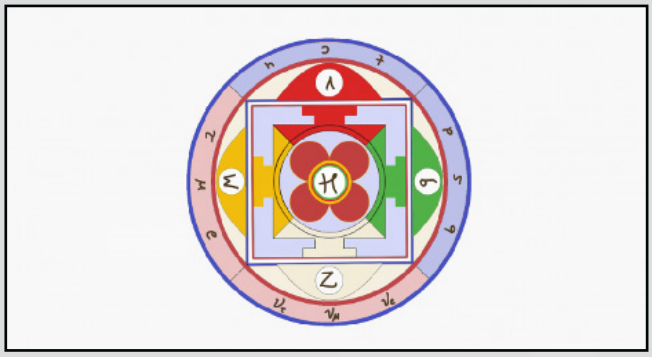
My name is Terry Phang, and I am a 3rd year undergraduate writing on behalf of the Department of Physics and Astronomy's Equity, Diversity, and Inclusion (EDI) committee. Having had the opportunity to work on some exciting research projects under the guidance of faculty and graduate students in the last few years, I recognize the importance and value of participating in research as an undergraduate. However, it is not always easy for students, especially underclassmen, to either find the initiative to start doing research in physics early on or figure out where to start, in part because of the breadth and depth of topics to choose from in the fields of physics and astronomy, the hesitancy to commit to a long-term project during their undergraduate years, anxiety about having taken the appropriate level of coursework to start on a research project, and any combination of these reasons, among other reasons. These effects can also be amplified amongst underprivileged groups, who may not have the means to pursue a full research project given other pressing priorities like holding down a job.

To the extent that we can play a role in mitigating this effect and make physics research more accessible among the undergraduate student body at UGA and at external institutions, I seek to launch a **Directed Reading Program** *within our department, modeled after a popular program of the same name in mathematics departments across the nation. The purpose of such a program is to pair undergraduate students with a graduate student mentor to read literature on a mutually interesting topic and meet once a week for several weeks to discuss the topic. Depending on the popularity of this program, it might also be beneficial to introduce the opportunity for participating undergraduates to present a summary of what they have read at the end of the semester at a Society of Physics Students (SPS) meeting. This relaxed, discussion-driven environment would (a) allow students seeking research opportunities to explore different topics in a low-commitment manner, (b) provide background on a topic prior to fully committing to a given research project, (c) teach the skills necessary to read scientific literature and/or perform a literature search and communicate their findings, and (d) allow non-majors who still have a general interest in physics to learn more about a topic of their choice. Graduate students can also benefit from providing mentorship to the undergraduate student, as it will encourage reading driven by their enthusiasm for the topic and help them connect to the campus community in a new way. Ideally, we would love to see this program extend beyond UGA, especially to external minority-serving institutions and perhaps even local high schools.*

Any interested undergraduates, graduate students, or other interested parties can contact me at ysp79161@uga.edu, or reach out to any of the other EDI committee members: Cassandra Hall (Cassandra.Hall@uga.edu), Sampath Gamage (Sampath.Gamage@uga.edu), Brittany Johnson (bjohnso@uga.edu), and Sydney Whilden (sydney.whilden25@uga.edu). ♦

STANDARD MODEL MANDALA

Bijay Duwal



Paubha is the traditional art form of Nepal which is believed to have developed from ancient paintings dating back to the lifetime of Buddha. Among its many formats, the mandala representation is one of the most popular. In this scheme, the mandala, a geometric figure, takes a central position, and is surrounded by different deities. A mandala (literally 'circle' in Sanskrit) represents the universe based on Hindu and Buddhist cosmologies. According to these cosmologies, the universe exists with its central axis at a mountain called Mount Meru. This axis is surrounded by four continents at four cardinal points and further by circular mountain ranges and seas. All of these elements of the universe are represented by different geometric shapes and are embellished by different colors, thus forming a cosmic diagram – a mandala.

Particle physics is a branch of modern physics that studies the fundamental particles of nature and their interactions. The theory that describes these elementary particles and three of the four fundamental forces of nature: the electromagnetic force, the weak force, and the strong force (the other is the gravitational force), is known as the Standard Model. According to this theory, the universe is pervaded by a field called the Higgs field. All elementary particles interact with this field, acquiring their mass. The particle that mediates this interaction is called the Higgs boson (H). Among elementary particles, there is a group of particles called force-carrier particles. The fundamental forces between other elementary particles arise due to the exchange of these force-carrier particles: the electromagnetic force from the photon (γ), the weak force from the W boson (W) and Z boson (Z), and the strong force from the gluon (g). Also, there is another group of elementary particles called matter particles. This group of particles can further be classified into two subgroups: quarks and leptons. There are six types of quarks: up (u) and down (d) of 1st generation, charm (c) and strange (s) of 2nd generation, and top (t) and bottom (b) of 3rd generation. Similarly, there are six types of leptons: the electron (e) and electron-neutrino (ν_e) of 1st generation, muon (μ) and muon-neutrino (ν_μ) of 2nd generation, and tau (τ) and tau-neutrino (ν_τ) of 3rd generation. All of these particles, along with the respective anti-particles, make the universe tick.

I grew up watching Paubha paintings in Kathmandu Valley, and I was always fascinated by the depiction of mandalas in those paintings. My very first serious encounter with the Standard Model was when I took an introductory course on Particle Physics offered by our department in the fall of 2020. I was equally fascinated by this wonderful theory of elementary particles, and I started to see the connection of this theory with the mandala depiction. The Standard Model Mandala is an attempt of amalgamation: between art and science, between East and West, and between ancient and modern. Actually, this is an attempt against these partitions. Humans share common sentiment of appreciating nature irrespective of their identity, place, and age. The fact that art inspired by ancient mystics can illustrate the science developed by modern physicists exemplifies this universality. ♦

STAFF HIGHLIGHT

Mike Caplinger,
Systems Administration Specialist

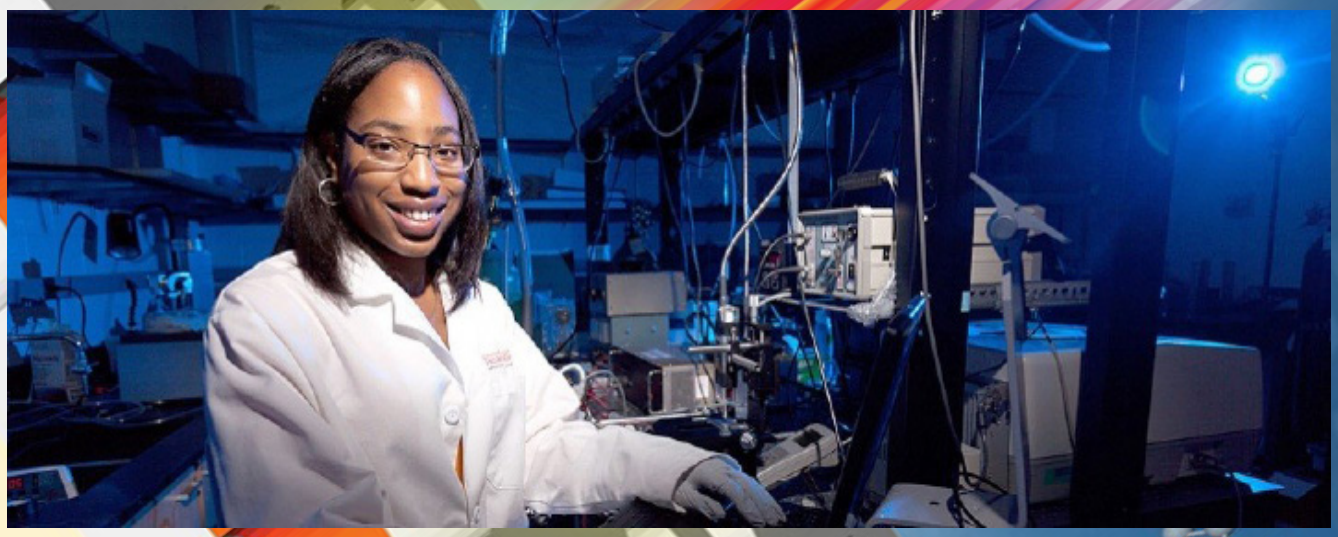
Q: What do you do in the department?
A: IT consulting and support

Q: Is there one task that you look forward to doing most?
A: Buying new stuff!

Q: When did you start? How did you hear about the job?
A: I started in March 1997, after hearing about the job opening from Dr. Shaw's son David, who has been a friend of mine for a long time.

Q: Do you have a favorite memory of a student? Of a faculty member?
A: On my very first day of work I met Dr. Baker, who was department head at the time, and he was wearing shorts and a tee-shirt. I knew then this was the job for me!!

Q: Are there any exciting developments you're looking forward to?
A: I hope to keep helping out the faculty and getting to play with new hardware for at least another decade. ♦



Send us your updates on new jobs, awards, marriages, children, retirements or special trips to Jessica Hudgins at **jh72780@uga.edu,** or call **706-542-2485**. We are especially interested in receiving your email addresses, so that we can send out reminders about upcoming events.

Help Us Grow...

Visit gail.uga.edu/physics to support the UGA Physics and Astronomy department.

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