QUANTA

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A publication for the faculty, staff, students, alumni, emeriti & friends of the Department of Physics at Virginia Tech

Message from the Chair:

I write this year's newsletter message knowing that it has been a different and challenging year for all who receive this. I'm sure you all have stories to share from this year like no other. I will share with you some of how we dealt with the COVID-19 pandemic in the Physics Department.

Like most universities, we made a rapid transition to online learning in mid-March after an extra week of spring break was added to prepare. I was proud of how our faculty, staff, and students handled the transition. The staff did a great job providing the technical equipment needed for online learning, including some custom-made webcam assemblies. Faculty, graduate teaching assistants, and students quickly became familiar with Zoom and some of its features like breakout rooms. Labs were a particular challenge. Our teaching lab staff and director did an enormous amount of work to prepare online videos of the experiments along with data files that the students could analyze with the software they normally use in lab. Making all that work smoothly for the ~ 2800 students we teach in introductory physics laboratories was no small feat! Research in experimental laboratories was mostly halted for a few months but was restarted under carefully controlled conditions in June. The majority of the occupants of Robeson have been working at home since March. Our normal department functions have continued in that mode – faculty and students consult with staff via Zoom and email, Ph.D. final oral exams are done virtually via Zoom, research group meetings happen via Zoom, recruiting events for new students are done via Zoom, etc. While we all look forward to returning to normal, most people have told me about learning new ways of doing things that they may continue even after we return to a more familiar situation.

Our research activities have continued strong. In this newsletter, you will find Virginia Tech News pieces highlighting some of the published research work of our faculty and students in the past year. Of note in this particular year are some new research activities that were added. The research group of Professor Uwe Täuber turned their computational modeling expertise to numerical simulations that model the COVID-19 pandemic when contact and mobility constraints are implemented. Professor Rana Ashkar's research group is collaborating with Oak Ridge National Laboratory to use neutron scattering techniques to investigate how cell membranes and the COVID-19 virus impact each other and what therapeutic candidates could make cell membranes more resistant to viral entry.

We recruited two new faculty members this year. Dr. Marie Boer joined us this fall, and Dr. Alexandru Petrescu will join us in Fall 2021. You can read more about them and postdoctoral research faculty that have joined us recently in this issue. Among students, we continue to have a thriving undergraduate and graduate student population. This year we had a total of 75 students receive the BS or BA degree, 7 received Masters, and 16 received Ph.D. degrees. You can read about our virtual graduation ceremony and honors for our students in this issue.

I hope you enjoy this newsletter. Feel free to drop me a line or even better, when we return to normal times, should you be in Blacksburg come and see me in Robeson Hall. It would be great to catch up and introduce you to new arrivals since you left.

Happy Holidays!

IN THIS ISSUE:

College of Science
Virginia Tech

Nahum Arav Part of Team to Discover Quasar Tsunamis Capable of Preventing Stars from Forming

Using the unique capabilities of NASA's Hubble Space Telescope, a team of astronomers led by Virginia Tech's Nahum Arav has discovered the most energetic outflows ever witnessed in the universe.

The outflows emanate from quasars and tear across interstellar space similar to tsunamis on Earth, wreaking havoc on the galaxies in which the quasars reside. Quasars are the brilliant, compact cores of distant galaxies that can shine 1,000 times brighter than their host galaxies of hundreds of millions of stars. Their central engines are supermassive black holes that are engorged with infalling dust, gas, and stars, said Arav, a professor in the Department of Physics, part of the Virginia Tech College of Science.

Quasars are created when a black hole devours matter, thus emitting intense radiation. Driven by the blistering radiation pressure from the black hole, concussive blasts push material away from the galaxy's center into outflows that accelerate to breathtaking velocities that are a few percent of the speed of light, Arav said.

"These outflows are crucial for the understanding of galaxies' formation," Arav said. "They are pushing hundreds of solar masses of material each year. The amount of mechanical energy that these outflows carry is up to several hundreds of times higher than the luminosity of the entire Milky Way galaxy."

The findings appear in the March issue of Astrophysical Journal Supplements. Arav's research team includes post-doctorate researcher Timothy Miller and doctoral student Xinfeng Xu, both from Virginia Tech, as well as Gerard Kriss and Rachel Plesha of the Space Telescope Science Institute in Baltimore, Maryland.

The quasar winds disseminate across the galaxy's disc, violently sweeping material that otherwise would have formed new stars. Radiation pushes the gas and dust for far greater distances than scientists previously thought, creating a galaxy-wide event, according to the study.

As this cosmic tsunami slams into interstellar material, its temperature spikes to billions of degrees, where material glows largely in X-rays, but also widely across the light spectrum. Anyone witnessing this event would see a fantastic show of fireworks. “You'll get lots of radiation first in X-rays and gamma rays, and afterwards it will percolate to visible and infrared light,” Arav said. “You'd get a huge light show, like Christmas trees all over the galaxy.”

Numerical simulation of galaxy evolution suggest that such outflows can explain some important cosmological puzzles, such as why astronomers observe so few large galaxies in the universe and why there is a relationship between the mass of the galaxy and the mass of its central black hole. This study show that such powerful quasar outflows should be prevalent in the early universe.

“Both theoreticians and observers have known for decades that there is some physical process that shuts off star formation in massive galaxies, but the nature of that process has been a mystery. Putting the observed outflows into our simulations solves these outstanding problems in galactic evolution,” said Jeremiah P. Ostriker, an eminent cosmologist at Columbia and Princeton universities. (Ostriker was not involved with this study.)

Aside from measuring the most energetic quasars ever observed, the team also discovered another outflow accelerating faster than any other. The outflow increased from nearly 43 million miles per hour to roughly 46 million miles per hour in a three-year period. The scientists believe its acceleration will continue to increase as time passes.

“There were so many discoveries in the data that I felt like a kid in a candy store,” Miller added.

Astronomers were able to clock the breakneck speed of gas being accelerated by the quasar wind by looking at spectral “fingerprints” of light from the glowing gas. The Hubble ultraviolet data shows that these absorption features were shifted in the spectrum because of the fast motion of the gas across space. This is due to the Doppler effect, where the motion of an object compresses or stretches wavelengths of light depending on whether it is approaching or receding from us. Only Hubble has the ultraviolet sensitivity to obtain the necessary observations leading to this discovery, according to NASA.

Nahum Arav

Written by Ann Jenkins and Ray Villard of the Space Telescope Science Institute, with additional reporting by Steven Mackay of the Virginia Tech College of Science. VT News March 19, 2020

Physics Professor Among Researchers Detailing How Antineutrio Detectors Could Aid Nuclear Nonproliferation

Patrick Huber, a professor in the Virginia Tech Department of Physics, has co-authored an article that describes the potential uses and limitations of antineutrino detectors for nuclear security applications related to reactor, spent fuel, and explosion monitoring.

The article appears in the latest issue of Reviews of Modern Physics. In the paper, the scientists review current and projected readiness of various antineutrino-based monitoring technologies. Huber's co-authors include Adam Bernstein and Nathaniel Bowden, physicists at Lawrence Livermore National Laboratory (LLNL), part of the University of California, Berkeley; as well as Bethany Goldblum, also from U.C. Berkeley; Igor Jovanovic, of the University of Michigan; and John Mattingly, of North Carolina State University.

In the paper, Huber and cohorts argue that a tiny particle could offer help for a big problem – the threat of nuclear proliferation. "For more than six decades, scientists have been developing instruments for fundamental physics that can detect antineutrinos, particles that have no electric charge, almost no mass and easily pass through matter," the team said. "Antineutrinos are emitted in vast quantities by nuclear reactors, and since the 1970s, scientists have considered turning antineutrino detection into a tool for nuclear security."

With advances by scientists at LLNL and other institutions, researchers are moving closer to deploying technology to remotely monitor these subatomic particles from nuclear power plants at long distances. Such a breakthrough would allow them to warn international authorities about the illicit production of plutonium, a key material for nuclear weapons. It also could help with verification of existing and planned treaties that seek to limit nuclear weapons materials production worldwide.

Antineutrinos, the antimatter counterpart to neutrinos, are produced in nuclear power plants when the fissile materials of uranium and plutonium break apart, creating fission products that emit antineutrinos in the process.

Patrick Huber

"At close range from a reactor, antineutrinos allow the measurement of plutonium content and the production rate," said Huber, director of the Center for Neutrino Physics at Virginia Tech and a member of the Virginia Tech College of Science faculty. "This capability would provide high-level assurances of treaty compliance while being less intrusive to the facility."

The study was initiated as part of an ongoing research effort led by LLNL and supported by the National Nuclear Security Administration's Office of Defense Nuclear Nonproliferation Research and Development. Huber and team contend that advances in applied antineutrino physics have the potential to strengthen the existing Treaty on the Nonproliferation of Nuclear Weapons, which provides a framework for facilitating the peaceful use of nuclear technology while reducing nuclear weapons proliferation risks through safeguards, monitoring, and verification.

In their paper, the researchers see potential for three applications of antineutrino technology — near-field nuclear reactor monitoring, far-field monitoring, and monitoring spent nuclear fuel. They conclude that antineutrino technology stationed within about 100 meters of a nuclear reactor could ensure that nations are not making and diverting weapons-usable material under the cover of civilian energy production. By measuring the quantity of antineutrinos produced during a set period, it is possible to approximately quantify the amount of plutonium or uranium in a reactor.

In the area of far-field monitoring, the researchers also said technology for detecting nuclear reactor activity at discovery or exclusion at ranges of 120 miles is possible. A third application for antineutrino technology to detect diversion of material could be to monitor the spent fuel that has been used to operate nuclear reactors. Several of the article's authors are involved in efforts to advance antineutrino detection technology.

Huber is part of a Virginia Tech research team participating in the Daya Bay experiment, which to date has provided the most precise measurement of antineutrino emission from reactors. Huber, working with Jonathan Link, Camillo Mariani, and Alireza Haghighat at Virginia Tech, also has developed and tested a highly efficient technology to detect reactor neutrinos without using flammable liquids.

The years-long project centers on a high-tech box full of luminescent plastic cubes stacked atop one another that can be placed just outside a nuclear reactor operated by a rogue nation. Dubbed CHANDLER, the box has shown success in detecting subatomic particles known as neutrinos produced by the reactor, which can be used to track the amount of plutonium produced in the reactor core. Tests were carried out by the CHANDLER team, led by Link, a professor in physics, at Dominion Power's North Anna Nuclear Generating Station near Mineral, Virginia.

Written by Stephen Wampler, public information officer for the Lawrence Livermore National Laboratory at University of California, Berkeley. Additional reporting by Steven Mackay of the Virginia Tech College of Science. VT News March 19, 2020

Ice, ice, Maybe: Neutrino Anomalies in Antarctica Explained by Physics' Ian Shoemaker

Ian Shoemaker

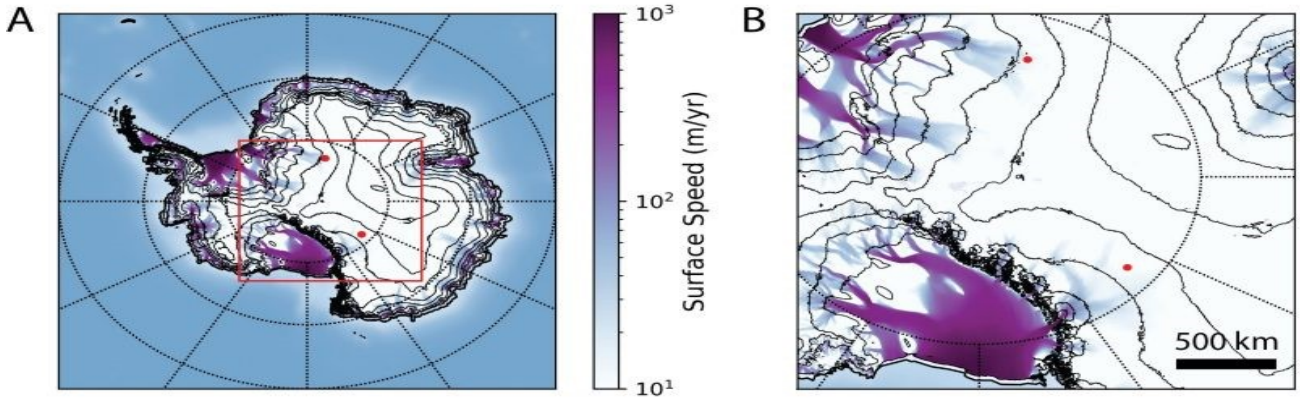
A new research paper co-authored by a Virginia Tech assistant professor of physics provides a new explanation for two recent strange events that occurred in Antarctica – high-energy neutrinos appearing to come up out of the Earth on their own accord and head skyward.

The anomalies occurred in 2016 and 2018 and were discovered by scientists searching for ultra-high-energy cosmic rays and neutrinos coming from space, all tracked by an array of radio antennas attached to a balloon floating roughly 23 miles above the South Pole. Neutrinos are exceedingly small particles, created in a number of ways, including exploding stars and gamma ray bursts. They are everywhere within the universe and are tiny enough to pass through just about any object, from people to lead to buildings and the Earth itself.

The events were discovered by scientists at the ANITA experiment — that's short for Antarctic Impulsive Transient Antenna, started in 2006 — in the South Pole. Twice, ANITA scientists discovered radio signals mimicking highly energetic neutrinos seemingly coming upward out of the ground on their own accord. Scientists remain perplexed by the activity, with some 40 papers so far giving wildly different answers — the pulses are neutrinos that passed unencumbered through the entire core of Earth and came out of the ground; the pulses are the long sought-after "fourth" neutrino known as the sterile neutrino; the mysterious "dark matter" of space is to blame; or this is an entirely unknown frontier of particle and/or astrophysics physics begging for a Nobel.

Ian Shoemaker, an assistant professor in the Department of Physics and the Center for Neutrino Physics, both part of the Virginia Tech College of Science, has a different, simpler explanation. In a recent paper published in the journal Annals of Glaciology, Shoemaker and several colleagues posit that the anomalies are not from neutrinos, but are merely unflipped reflections of the ultra-high-energy cosmic rays that arrive from space — miss the top layer ice — then enter the ground, striking deep, compacted snow known as firn.

"We think sub-surface firn is the culprit," said Shoemaker, adding that "firn is something between snow and glacial ice. It's compacted snow that's not quite dense enough to be ice. So, you can have density inversions, with ranges where you go from high density back to low density, and those crucial sorts of interfaces where this reflection can happen and could explain these events."



Shoemaker was joined on the paper by his former Ph.D. advisor, Alexander Kusenko of the University of California Los Angeles' Department of Physics and Astronomy; Andrew Romero-Wolf, a member of the ANITA team and a researcher at the California Institute of Technology's Jet Propulsion Laboratory; and four other researchers, including two glaciologists: Dustin Shroeder from Stanford University and Martin Siegert from Imperial College London.

Call it a case of Occam's razor (that's the centuries-old theory that the simplest solution in most likely the correct one, for those who skipped philosophy in college), but Shoemaker isn't railing ANITA. "Whatever ANITA has found, it is very interesting, but it may not be a Nobel prize-winning particle physics discovery." But he's not discounting that the so-called anomalies have no scientific merit. "ANITA still could have discovered something interesting about glaciology instead of particle physics, it could be ANITA discovered some unusual small glacial lakes."

Sub-glacial lakes were another consideration by Shoemaker and his team for the reflections. These lakes, deep underground, though, are too far spread apart according to current research, and hence are not the most likely explanation. But if there are far more lakes than previously known, this discovery would be a big win for scientists who study the landscape and interior of Antarctica. Shoemaker and his team suggest scientists purposefully blast radio signals into the areas where the anomalies occurred.

"I didn't know anything about them, but they really do exist," Shoemaker said of sub-glacier lakes in Antarctica. "There are lakes under the ice in Antarctica, and those would have the right reflective properties, but they're not widespread enough. Our idea is that part of the radio pulse from a cosmic ray can get deep into the ice before reflecting, so you can have the reflection without the phase flip. Without flipping the wave, in that case, it really looks like a neutrino."

Shoemaker added that, "When cosmic rays, or neutrinos, go through ice at very high energies, they scatter on materials inside the ice, on protons and electrons, and they can make a burst of radio, a big nice radio signal that scientists can see. The problem is that these signals have the radio pulse characteristic of a neutrino, but appear to be traversing vastly more than is possible given known physics. Ordinary neutrinos just don't so this. But cosmic rays at these energies are common occurrences and have been seen by many, many experiments."

Written by Steven Mackay

VT News June 9, 2020

Findings by Physicist Rana Ashkar Upend Understanding of Cholesterol's Effects on Cellular Membranes

Rana Ashkar

For more than a decade, scientists have accepted that cholesterol – a key component of cell membranes – did not uniformly affect membranes of different types. But a new study led by Assistant Professor Rana Ashkar of the Virginia Tech Department of Physics finds that cholesterol actually does adhere to biophysical principles.

The findings, published recently in the Proceedings of the National Academy of Sciences, have far-reaching implications in the general understanding of disease, the design of drug delivery methods, and many other biological applications that require specific assumptions about the role of cholesterol in cell membranes.

"Cholesterol is known to promote tighter molecular packing in cell membranes, but reports about how it stiffens membranes have been so conflicting," said Ashkar, who is a faculty member in the Virginia Tech College of Science. "In this work, we show that, at the nanoscale level, cholesterol indeed causes membrane stiffening, as predicted by physical laws. These findings affect our understanding of the biological function of cholesterol and its role in health and disease."

According to the study, cell membranes are thin layers of fatty molecules that define cell boundaries and regulate various biological functions, including how viruses spread and how cells divide. To enable such functions, membranes should be able to bend and permit shape changes. This bending propensity is determined by how packed the molecular building blocks are; tighter packing results in stiffer membranes that cannot bend so easily, Ashkar added.

Cholesterol's impact on cell membranes at the molecular level

Cholesterol is found in high quantities in bacon, egg, cheese, and many other comfort foods. While too much cholesterol can harm the body, regulated amounts of cholesterol in cell membranes are absolutely necessary for the normal function of cells. Anomalies in cholesterol amounts are often associated with various disease conditions.

Besides cholesterol, our cell membranes are primarily formed of lipids, which are small, fatty molecules that self-assemble into bilayer structures when present in water – and nearly 60 percent of the human body is made of water. Together, lipids and cholesterol form the barriers that define our cells and regulate the cellular exchange of nutrients.

At the molecular level, cholesterol possesses a slick and rigid structure. When it interacts with our cell membranes, it jams itself right in between lipids, which results in a more densely packed membrane. According to structure-property relations, this would naturally result in a stiffer membrane.

Yet, for the past 10 or so years, physicists and biologists have assumed that cholesterol had nearly no effect on the stiffness of membranes formed of cis-unsaturated lipids, a common type of lipid found in our cells, despite its well-documented effect on lipid packing.

“It defied our understanding of what cholesterol does to cell membranes,” Ashkar said. “It also contradicts standard structure-property relationships in self-assembled materials.”

These perceptions are important because in ideal circumstances, cell membranes should maintain a semi-rigid structure: rigid enough to keep its form, but flexible enough to allow for the dynamic movement of signaling proteins and functional domains. Misconceptions about how cholesterol stiffens cell membranes impact our understanding of membrane function.

The data initially made little sense, but as she probed deeper, Ashkar found a clear case of how soft materials can “apparently” exhibit different properties, depending on the parameters of the observation method. She found that over short length and time scales over which important signaling events occur — we’re talking nanometers and nanoseconds — the added cholesterol induces membrane stiffening that one would expect.

Proving her point

To contradict an established doctrine in science requires more than just one set of data points. “We found these results a while back, but they were met with skepticism because they’re so against the existing notions,” Ashkar said.

Ashkar’s first tests used neutron spin-echo spectroscopy, a unique probe that enables the study of materials on the nanoscale. These experiments were performed at the two major neutron scattering facilities in the United States, the NIST Center for Neutron Research and the Spallation Neutron Source at Oak Ridge National Laboratory.

Ashkar bolstered her evidence with computer modeling simulations, in collaboration with George Khelashvilli, an assistant professor at the Weill Cornell Medicine Department of Physiology & Biophysics, and further validated the experimental findings with recent nuclear magnetic resonance measurements, in collaboration with Michael Brown, a professor of chemistry and biochemistry at the University of Arizona. The data consistency in all three methods provided thorough evidence for Ashkar’s hypothesis and confirmed standard structure-property relations in lipid membranes.

“These results call for a reassessment of existing constructs of how cholesterol affects lipid membranes,” Ashkar said. “If we don’t have the right assumptions, we cannot make the right predictions, and we will not have the right design for the treatment of viruses, diseases, or other biological anomalies.”

Written by Andrew Tie

VT News September 4, 2020

Solutions to Big Problems: They're in the (Soft Matter) Solution

For most people, a coffee stain may go unnoticed, an everyday accident. In the world of physics, though, learning more about why that splotch of coffee dried a certain way could hold the answers to discoveries that improve everything from the paint on new cars to nano-scale drug delivery.

A coffee ring stain occurs because of different ways that liquid evaporates across the wet area. As liquid evaporates more quickly from the outer ring of the spill, liquid molecules from the interior of the spill rush toward the edge to replace what has evaporated, bringing the particles dissolved in the spill to the outer edge.

Drying a solution with solutes dispersed throughout it has become a typical way of creating either new or better materials, but physicists are convinced that there is much to be gained from better understanding how soft matter solutions dry, including solutions of colloidal particles, polymers, and their mixtures. Many such solutions, for example, ink and paint, can be found in your home. Even blood, a cup of hot chocolate, or a respiratory droplet containing virus particles can be regarded as a colloidal solution.

This spring, Shengfeng Cheng, an assistant professor in the Department of Physics, in the College of Science, was awarded a National Science Foundation CAREER Award for research in "Nonequilibrium Physics in Drying Soft Matter Solutions." A CAREER award is one of the NSF's most prestigious awards of early-career faculty who have potential to serve as academic role models in research and education and to lead advances in the mission of their organization. Cheng has been awarded $514,786 for 5 years in pursuit of better understanding of drying soft matter solutions.

Physicists such as Cheng aim to control the movement and distribution of substances dissolved into a solvent as a solution is dried.

"Understanding the drying behavior of solute-laden droplets may lead to new methods of fabricating particulate materials, such as a thin film coating a solid surface or drug-loaded particles with the desired distribution of materials," Cheng said.

If it all seems abstract, Cheng said, consider how an automobile factory paints a new car on the assembly line: Cathodic e-coating (a pre-primer), the primer, basecoat, clearcoat – and sealing, sanding, drying, and oven-baking it at least three times between stages. There are as many as 20 steps involved in getting a vibrant coat of paint on a new car.

Shengfeng Cheng

"The question is," he said, "can we mix things in a solvent in the first place and spray it onto a car, and then get stratified layers after one drying process? This is a more efficient way of coating a surface."

If drying conditions of soft matter solutions can be controlled, Cheng said, physicists hope to make material production and application as a "one-pot process: mixing stuff, put it in a solvent, dry it in a controlled way, and you have it."

With this CAREER award, Cheng said he wants to understand the key physics underlying the drying process of a solution of particles, polymers, or their mixtures. The most important component is that various gradients emerge during drying. That is, physical properties of the solution become nonuniform when it dries. For a coffee spill, it is the evaporation rate. But other properties, such as temperature and concentration, can also develop nonuniformity. Interestingly, various solutes present in a solution might respond to these gradients in different ways. By fine-tuning the drying conditions, Cheng hopes he may be able to control the gradients and therefore manipulate how the polymers and particles are spread throughout the final product, dry films.

"We perform all these experiments on a computer, which gives us full control and enables us to test a wide range of possible scenarios," Cheng said.

While making the process of painting new cars more efficient may be a nice-to-have achievement, other applications involving drying soft matter solutions could solve critical world issues.

These include other surfaces that would benefit from a multi-layer coating, in which one layer is mechanically strong and other is chemically useful, such as antibacterial coatings on medical devices and tools.

And solar energy efficiency could be greatly enhanced with better light-absorbing coatings on photovoltaics, Cheng said, the modules that convert light into electricity. A good understanding of drying, as mundane as it sounds, may help make better coatings.

The research may even become more relevant as the world is trying to cope with the coronavirus pandemic. Respiratory droplets are also a soft matter solution. A better understanding of how respiratory droplets dry would help inform policy makers about the best practices to mitigate the virus' spread.

"Of course, it is hard for me to claim that we will solve all these problems," Cheng said, "but I believe our work may shed light on better understanding of the drying behavior of solute-laden droplets and lead to new methods that can improve these issues."

Written by Lon Wagner

VT News September 9, 2020

Welcome Our New Faculty Members

Marie Boer joined us as an assistant professor in August 2020. She is an experimental nuclear physicist who is a member of our Center for Neutrino Physics. Before arriving at Virginia Tech, Marie was most recently a postdoctoral research associate at the University of New Hampshire. Her research is in the understanding of quark and gluon distributions and spin structure inside nucleons. Through an agreement with Jefferson Lab in Newport News, Virginia, Marie's position is a JLab Bridge appointment since the majority of her research effort will be using the CEBAF electron accelerator there. Marie earned a bachelor's degree from UPMC in Paris, France and a doctorate in nuclear physics from Paris-Sud University.

Alexandru Petrescu will be joining us as an assistant professor in August 2021. He is a theoretical condensed matter physicist who focuses on quantum information science. Before arriving at Virginia Tech, Alex has most recently been a postdoctoral fellow at Institut Quantique, Université de Sherbrooke in Canada. His research studies nonequilibrium open-system quantum many-body problems with applications for experimental systems such as superconducting circuits, ultracold atoms, trapped ions, or optomechanical systems. Alex earned a bachelor's degree in physics from Princeton University and a doctorate in physics from Yale University and Ecole Polytechnique in Paris, France.

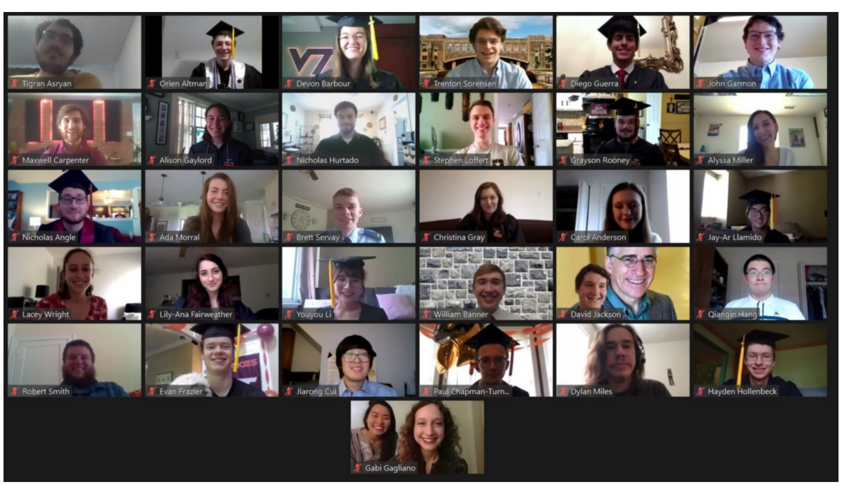
Applause, Applause!

- ◊ Graduate student **Rebekah Pestes** won the 2020 Gertrude Scharff-Goldhaber Prize. She was honored with an online award ceremony hosted through Brookhaven National Lab on July 9, 2020.
- ◊ Graduate student **George Barron** was a recipient of a Department of Energy Office of Science Graduate Student Research Award.
- ◊ The department's **Ladies of Robeson** group hosted a virtual viewing of the film "Picture a Scientist" and an interesting online discussion afterwards. They also developed posters highlighting the 100 year anniversary of the women's right to vote and remembering the legacy of Supreme Court Justice Ruth Bader Ginsburg.
- ◊ The department's **Society of Physics Students** held online coffee/donut sessions and other online events to keep our students engaged socially during Fall 2020.
- ◊ Congratulations to our Society of Physics Students chapter (advisor Alma Robinson and 2019-20 President Olti Myrtaj) for being named an Outstanding SPS Chapter for 2019 – 20.

Awards Day

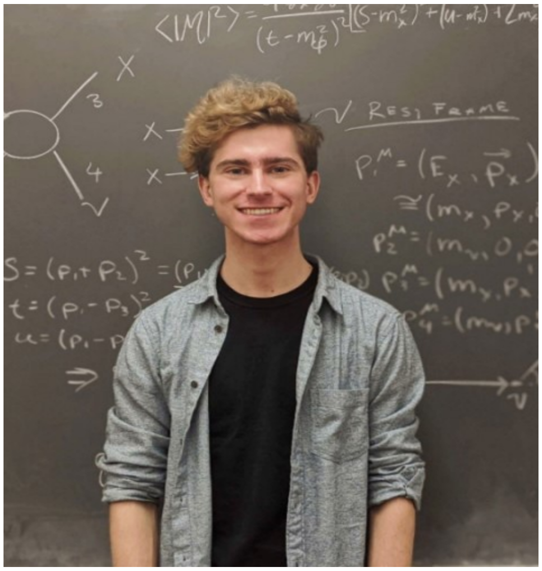
Due to the pandemic, we had to cancel our planned in-person Awards Day Ceremony in April 2020. We congratulate all the student award winners and thank all the generous donors that make this student support possible.

Physics Graduation, May 2020



This was a unique year for our annual spring graduation ceremony. We hosted a live-streamed event on May 16, 2020 that preserved many of the traditions of our usual ceremony. We thank all the students, department faculty and staff, and family and friends that joined in. A new feature this year was the opportunity for the graduating students to each say a few words of their own. The photo here shows a group shot of the BA and BS recipients during the event. A video of the event is available at: https://www.youtube.com/watch?v=ElvgYjR12V8&feature=youtu.be

College of Science Student Selected as Associate Editor for Prestigious Undergraduate Research Publication



Olti Myrtaj has big plans to expand accessibility for those interested in physics and mathematics research. This inaccessibility is a problem he intends to fix by facing it head on.

"I want to serve as a catalyst that encourages both scientists and nonscientists alike to realize the importance of research in physics and mathematics," said Myrtaj.

Olti Myrtaj has big plans to expand accessibility for those interested in physics and mathematics research. This inaccessibility is a problem he intends to fix by facing it head on.

"I want to serve as a catalyst that encourages both scientists and nonscientists alike to realize the importance of research in physics and mathematics," said Myrtaj.

Now a junior double majoring in physics and mathematics, both part of the Virginia Tech College of Science, Myrtaj says the decision to do undergraduate research was an easy one, in no small part because he enjoys asking questions and autonomously exploring problems. Key to his experience was his willingness to ask a lot of questions when faced with unfamiliar research topics, as well as taking the time to independently gather materials to address research questions.

"Undergraduate research gives me the opportunity to face complex situations with problems that do not have immediate answers. It has really broadened my understanding and capability to effectively research," said Myrtaj, who currently does particle physics research on dark matter, which is still not fully understood by scientists even after decades of research.

"This frontier research in particle physics is prohibitively technical and abstract to nonscientists, but that does not make it unimportant. Understanding nature at its most fundamental levels revolutionizes our view of the world and inspires people everywhere. On another note, worldwide particle physics projects have even shattered political barriers, making collaboration between scientists of different nations possible. Scientists' abilities to make their work accessible arouses the curiosity of generations, enhances scientific critical thinking skills of populations, and exemplifies consolidated global efforts to understand our unfamiliar world," he said.

For Myrtaj, communicating recent discoveries in physics to friends and professors is a lot of fun. Previously, he served as editor of the Virginia Tech Society of Physics Students' biweekly newsletter, The Naked Singularity. So when the chance came to be a part of a national group of undergraduates that have similar sentiments about the sciences, Myrtaj said he jumped at the opportunity.

This spring, Myrtaj was selected from a pool of competitive applicants to be an associate editor of the Journal of Undergraduate Research and Creative Activity (UReCA) for the National Collegiate Honors Council (NCHC) during the 2020-21 publication period. He was encouraged to pursue the position at the recommendation of Christina McIntyre, Virginia Tech's director of professional development, national scholarships, and international scholarships for the Honors College and recently elected vice president of the NCHC.

"UReCA is a high-quality peer-reviewed undergraduate research journal, so I am proud that Virginia Tech has representation on the editorial board. This is a unique opportunity for Olti – to serve in the spirit of Ut Prosim and to develop his reviewing and writing talents," said McIntyre.

While the appointment is a celebration of his outstanding research and incredible dedication to his academic studies, serving as assistant editor for an esteemed undergraduate research journal is at the same time another opportunity for him to prepare for his future career.

"My editorship with UReCA will prepare me for the endeavor of critically analyzing research articles, a skill that I will make use of when I pursue a Ph.D. in theoretical physics," he said.

Myrtaj encourages other students to pursue research based on their interests as a means to build upon their skill sets. "Tenacity, the ability to collaborate with others, and patience" are essential skills for anyone doing research in any field, according to him. In addition, he says undergraduate research experiences will benefit both the professional and personal lives of the students involved.

McIntyre shares his sentiments. "The training NCHC provides the UReCA editors and the collaborative nature of the team will build on his research experience to further develop Olti professionally. I would encourage other [Virginia Tech] students to be inspired by this and strive for these national level opportunities."

Written by Rachel Kinzer Corell and Abby Mercatoris-Morrison

VT News June 10, 2020

Welcome to our New Research Faculty!

Zahra Tabrizi– Zahra is from Iran and works on neutrino physics. She did her studies in Iran, received her PhD in particle physics from the institute for research in Fundamental sciences, and simultaneously spent 2.5 years at UNICAMP, Brazil as a visitor. She then did her first postdoc at the University of Sao Paulo, before deciding to move to the US for her second postdoc at Virginia Tech. It took over a year to receive the US visa, so she travelled around the world and visited world class universities and labs during this period, like CERN in Switzerland, Karlsruhe institute of Technology in Germany, the physics institute at Paris-sud university, to name a few. Her studies focused on the model building and phenomenology of neutrino physics, mainly on studying physics beyond the Standard Model using the neutrino experiments.

Vinh Xuan Ho- Vinh is an incoming post-doc from Vietnam. He was a Ph.D. student in the Physics Department, Virginia Tech and graduated in April 2020. His current research focuses on graphene-based photodetectors in the mid-infrared region.

Mukul Bhattacharya– Mukul is currently a Postdoctoral Research Associate working in the Center for Neutrino Physics at Virginia Tech. His research focuses on studying the origin and composition of cosmic ray nuclei. Prior to starting this position, he completed his PhD in Physics from the University of Texas at Austin in August 2020. He worked with Prof. Pawan Kumar on the underlying physics of astrophysical phenomena such as fast radio bursts, gamma-ray bursts and gravitational waves that arise from energetic compact objects. He received his Master of Arts degree in Physics from UT in May 2018. Before joining the UT Austin graduate program, he had obtained his Bachelor of Science degree in Physics from the Indian Institute of Science, Bangalore.

Chenxu Liu- Chenxu is a new Postdoc researcher in Prof. Sophia Economou and Edwin Barnes's group of Physics department, Virginia Tech. He received his Ph.D. degree from University of Pittsburgh advised by Prof. David Pekker and Prof. Gurudev Dutt. His research interests include a variety of interesting questions in quantum optics, circuit quantum electrodynamics, quantum computing and information processing using superconducting qubits, microwave photons, and other hybrid quantum computing platforms.

Wenya Shu- Wenya received his Ph.D. degree in Civil Engineering from Rice University (2020). He joined Prof. Nadir Kaplan's group as a postdoctoral fellow in September. His expertise covers applications of solid and computational mechanics in the modeling of complex material and structural systems. The primary focus of his current research is on bio-inspired and biological matters.

Francesco Capozzi- Francesco Capozzi has been a postdoc in astroparticle physics since 2016. Since his PhD at the University of Bari (South-East Italy) he has been fascinated by elementary particles called neutrinos. One of his main goals is studying how neutrinos transform into one another, a phenomenon called neutrino oscillations. This is a key ingredient to a correct interpretation of the neutrinos signals we receive from astrophysical sources, where they are usually copiously produced. He am also interested in exploring fundamental particle physics and Beyond the Standard Model physics both with and without the use of neutrinos. Apart from its mathematical point of view, he is deeply in love with Nature in a more practical way: he enjoys whatever adventurous outdoor activity you may think about, especially if it's on the mountains, such as rock climbing, skiing, hiking, trail running.

Bernadette Cogswell- Dr. Cogswell is a Research Scientist at Virginia Tech University's Center for Neutrino Physics. She earned her Ph.D. from Vanderbilt University studying the phenomenology of neutrino oscillations at particle accelerator experiments. She also held a Postdoctoral position at the Princeton Program on Science and Global Security where she studied the technical and policy potential for particle physics detectors to contribute to nuclear nonproliferation monitoring regimes. Her current work focuses on antineutrino detection and nuclear nonproliferation.

Woo-Ram Lee- Woo-Ram received his PhD from KAIST, South Korea, and recently joined Virginia Tech as a postdoctoral research associate. His research area is theoretical condensed matter physics, focusing on transport and optical properties of fermionic systems. At Virginia Tech, he is involved in an interesting project for building up measurement-based algorithms for quantum simulation of many-body fermionic systems.

In Short

- **Professor Michel Pleimling** was selected as a Europhysics Letters Distinguished Referee.

- **Emeritus Professor David Jenkins** was part of an article published in the journal *Nature* on work done as part of the CEBAF Large Acceptance Spectrometer detector at Jefferson Lab in Newport News, VA.

- **Professors Satoru Emori and Jean Heremans** and their research groups had a *Physical Review Letters* article chosen as an Editor's Suggestion, a distinction reserved for only one in six articles published in that journal.

- The College of Science Dean's Discovery Fund provides seed money to support innovative ideas and research. These faculty members from Physics received support from this fund this year:

  -**Professor Shengfeng Cheng** (with Prof. Greg Liu of Chemistry) "Next-generation porous carbon fibers by polymer synthesis and molecular simulations"

  -**Professors Satoru Emori and Tommy O'Donnell** "Superconducting Thin Films for Dark Matter and Neutrino Detection"

  -**Professors Djordje Minic and Tatsu Takeuchi** "Unraveling the Hidden Connec tion between Dark Matter and the Hubble Scale"

- The department successfully ran its second summer of the National Science Foundation supported Research Experience for Undergraduates (REU) program. This summer was in an online format due to the COVID-19 pandemic. Five students from across the United States did research with faculty in our Center for Neutrino Physics. The program was headed by **Professor Camillo Mariani** with administrative support from staff member **Betty Wilkins**.

- **Professors Shengfeng Cheng, Shunsaku Horiuchi, and Vinh Nguyen** were promoted by the Virginia Tech Board of Visitors to associate professor with tenure.

- **Professor Sophia Economou** was promoted by the Virginia Tech Board of Visitors to full professor.

- **Dr. Almas Khan** was promoted by the Virginia Tech Board of Visitors to Advanced Instructor.

In Short Continued

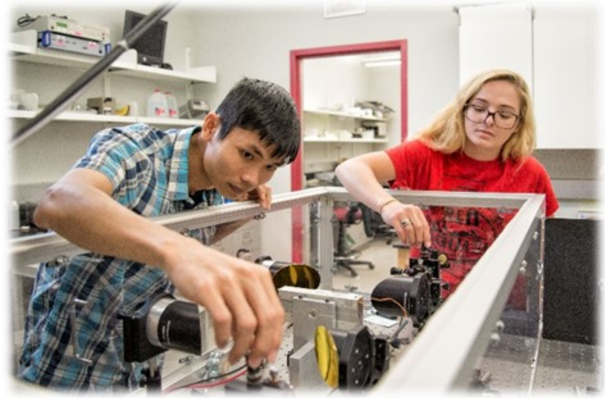
- **Professor Rana Ashkar** published a tutorial in the *Journal of Applied Physics* intended to introduce polymer researchers to neutron scattering spectroscopy.
- **Professor Sophia Economou** is part of the Brookhaven National Laboratory Co-Design Center for Quantum Advantage (C2QA), one of five Department of Energy National Quantum Information Science Centers announced in September 2020.
- **Professors Jean Heremans and Vicki Soghomonian** and their research groups had a *Physical Review Letters* article chosen as an Editor's Suggestion, a distinction reserved for only one in six articles published in that journal.
- The COVID-19 simulation work of **Professor Uwe Täuber** and his research group was featured in a segment that ran on National Public Radio.
- **Professor Rana Ashkar's** research group's work on cell membranes and COVID-19 was featured on the Oak Ridge National Laboratory website.
- **Professor Patrick Huber** had an article about "Neutrinos for Peace" appear in the *CERN Courier.*
- **Professor Bruce Vogelaar** and his research group were part of an article published in *Nature* on the observation of neutrinos produced in the CNO fusion cycle in the Sun using the Borexino detector.

In Memoriam

Dr. Testuro Mizutani passed away on September 28, 2020 in St. Malo, France, where he was enjoying his retirement. Tetsuro was a faculty member in our department from 1982 - 2010, when he was honored with emeritus status. More can be read about him at: https://vtnews.vt.edu/articles/2010/06/2010-511.html

Department of Physics Annual Fund

VIRGINIA TECH



Your Support helps Invent the Future

The Department of Physics continues to increase the quality and prominence of its research and educational programs. Our nationally and internationally recognized faculty, pursuing research in the areas of particle and nuclear physics, hard and soft condensed matter physics, biophysics and astrophysics while providing our students with a sound education that melds fundamental principles with current research, are helping Virginia Tech improve its standing as one of the top STEM schools in the country.

Your support is critical for our success. Contributions from our alumni, parents, and friends aid our deserving students, enhance our state-of-the-art facilities, and allow our students to explore a wide array of career opportunities. Gifts to the Annual Fund allow the departmental leadership to respond to opportunities immediately and to allocate resources where they can have the greatest impact.

Every gift counts – no matter the size. Our goal this year is to increase overall alumni participation. A gift to the Department of Physics is the clearest signal our alumni and friends can give to show their support of the great work of our faculty and increasing the quality of experience for our students. When all of us give, the collective contribution makes a significant difference.

When you receive your College of Science Annual Fund letter or phone call, please earmark your support for the Department of Physics Annual Fund (881383). Simply make a notation on the gift card or let the caller know that you want to direct your donation to Physics! To make an immediate contribution, you may visit the university's website at givingto.vt.edu or contact the Office of Gift Accounting at (800) 533-1144

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We thank you in advance for your support!

QUANTA 2020

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