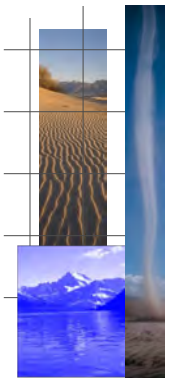

Schrödinger's Tiger

The Clemson University Physics and Astronomy Newsletter

Fall 2021 Volume 16, Issue 2

Gamma Rays Could Advance Understanding of UFOs' Role in the Evolution of Galaxies

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Using data gathered by the Large Area Telescope onboard NASA's Fermi Gamma-ray Space Telescope and a stacking technique combining signals too weak to be observed on their own, researchers detected gamma rays from UFOs in several nearby galaxies for the first time, providing a basis for scientists to understand what happened in our own Milky Way galaxy.

UFOs are ultra-fast outflows — powerful winds launched from very near supermassive black holes that scientists believe play an important role in regulating the growth of the black hole itself and its host galaxy.

Clemson University astrophysicists Chris Karwin (left) and Marco Ajello

Clemson University scientists' collaborative research is published in *The Astrophysical Journal*. Partners include the College of Charleston, the University of Chicago, and a host of other researchers who are part of the Fermi-LAT Collaboration, which includes hundreds of scientists from twelve countries. "Gamma Rays from Fast Black-Hole Winds" outlines the detection of gamma-ray emissions from UFOs launched by supermassive black holes.

Did You Know?

Black holes can launch extremely powerful winds, so they're not eating everything. They are like powerful vacuum cleaners that eject some of the dirt that gets near it, instead of sucking in everything. These ejections, which are tsunami-like winds, are made of highly ionized gas. When they interact with the interstellar medium, they create powerful shock waves. **Marco Ajello, an associate professor in Clemson College of Science's Department of Physics and Astronomy, who is co-leading the study**.

"Although these winds are challenging to detect, it is thought that they play a significant role in how a massive black hole and the host galaxy itself grow," said **Chris Karwin**, a postdoctoral fellow in the College of Science's Department of Physics and Astronomy and leader of the study. "Our gamma-ray observations show how supermassive black holes can transfer a large amount of energy to their host galaxy. These UFOs create shock waves, which act like pistons and actually accelerate charged particles, known as cosmic rays, to near the speed of light."

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A Message from the Chair

As many of you can imagine, it has been a very challenging semester for the Physics and Astronomy family. In addition to the pandemic, we lost a valued and beloved colleague, **Jian He**, unexpectedly. His legacy will continue in his students, his friends, and in his colleagues. Our faculty did an amazing job of taking care of his classes and his graduate students during this difficult transition. To honor his memory we have established the *Dr. Jian He Memorial Endowment in Physics & Astronomy.* This endowment will provide support for undergraduate students engaged in research in our department and carry forth his legacy. We also lost another dear colleague – Emeritus Professor **Tom Collins**, who taught in the Department for thirty-eight years!

In the midst of the challenges we faced this semester, we continue to thrive. Many of our alumni returned (in person and virtually) to tell our students about their career paths. This information helps us refine what we do and to better prepare our students to live productive lives. If you haven't already, please feel free to reach out and let us know what you are doing. We want to continue to bring alumni back to Clemson to help us show our students all the options they have before them.

We couldn't do this without your support. The gifts you have generously provided enable us to support our students and faculty, as we pursue our mission of research integrated with education. As we prepare to ring in a new year, I hope you will consider giving to advance our mission.

Go Tigers!

Dr. Sean Brittain
Chair, Department of Physics and Astronomy

Creating a Legacy — Giving to Clemson Physics & Astronomy

You can create a lasting legacy through your donation to the Clemson University Physics and Astronomy Department Foundation. Endowments to Clemson assure the best faculty, the brightest students and the most creative research projects. A substantial endowment can transform a good university into a great one. As a non-profit organization, the Foundation is exempt from federal income tax under Section 501 (c)(3) of the IRS Code, as amended.

The Foundation has been classified by the IRS as a public charity operated for the benefit of a state university as defined in the Internal Revenue Code of 1986 Section 170(b)(1)(A)(iv). Contributions to the University through the Foundation by individuals, corporations, organizations and other foundations qualify as tax deductions. There are several ways to donate. You may send a check to the Clemson University Foundation, P.O. Box 1889, Clemson, SC 29633.

Checks should be made payable to the Clemson University Foundation with Physics and Astronomy specified on the memo line. Alternately, you may visit the Clemson website: **https://cualumni.clemson.edu/give/physics-astronomy** and make a secure electronic donation. Thank you, as always, for your continued support of the department.

You may contact the Annual Giving Office at (864) 656-5896, should you have any questions regarding your donations. If you have other questions, you may contact the department directly at (864) 656-3416.

Every galaxy has a supermassive black hole at its center. Some are dormant. Others, called active galactic nuclei, are active, meaning that they draw in and "eat" the surrounding matter through a process called accretion.

While traveling through the galaxies, the winds gradually disable star formation. "The effect on the galaxy is dramatic," said **Marco Ajello**, an associate professor in Clemson College of Science's Department of Physics and Astronomy who is co-leading the study.

"The black hole at the center of the galaxy, and the galaxy itself, have a mechanism to grow together in mass — and this is the mechanism."

Because the gamma rays detected are produced by cosmic rays accelerated at the shock front, Karwin said it attests to the onset of the wind-host interaction and that the UFOs can energize charged particles up to the transition region between galactic and extragalactic cosmic rays.

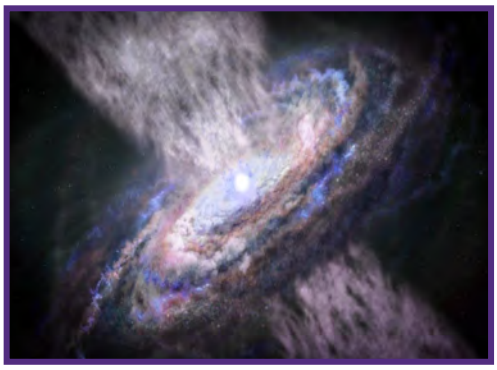


Illustration of supermassive black holes at the centers of galaxies. They can launch ultra-fast outflows (UFOs) that sweep through the galaxy like a powerful tsunami, removing shocking the gas, accelerating particles and shutting off star formation. Credit: Marco Ajello

The findings of the study could help scientists understand what happened in our own Milky Way galaxy. Sagittarius A* is the supermassive black hole at the center of the Milky Way with about 4 million times the sun's mass. Extending above and below the Milky Way's disc are Fermi bubbles, enormous round structures of hot gas emanating from the galactic center.

They are called Fermi bubbles because the Fermi Gamma-Ray Space Telescope, the source of the data used by Ajello and Karwin in the current study, discovered them in 2010.

Ajello said future work includes studying galaxies that have had active UFO winds for tens of millions of years that have already traveled to the outskirts of the galaxy.

This research was supported by the National Science Foundation and NASA through grants AST-1715256 and 80NSSC18K1718.

The College of Science pursues excellence in scientific discovery, learning and engagement that is both locally relevant and globally impactful. The life, physical and mathematical sciences converge to tackle some of tomorrow's scientific challenges, and our faculty are preparing the next generation of leading scientists.

The College offers high-impact transformational experiences such as research, internships and study abroad to help prepare our graduates for top industries, graduate programs and health professions.

Clemson College of Science, November 10, 2021

Strong Presence of the Biophysical Group at the Annual Meeting of the American Chemical Society

Presenting at international meetings is a crucial component of the success of every researcher. This gives the researcher the opportunity to make others aware about his or her discoveries and developments, and, at the same time, provides the unique chance to receive feedback. Typically, one wants to present at a meeting before the investigation is complete, to see if the academic community has addressed pertinent questions, or might suggest additional work to be done. Frequently a single question from someone during or after the talk opens the door for fruitful analysis and greatly improves the quality of the research. Keeping this in mind, the postdoctoral researchers and graduate and undergraduate students in the Clemson Biophysical Group focus on international meetings to disseminate their work.

The Spring 2021 ACS Annual Meeting. From the top right corner, clockwise: Dr. Shailesh Panday, Mihiri Hewa, Jacob Jeffrey, Mahesh Koirala, Dr. Angela Wu, and Dr. Gen Li.

One such international meeting, that attracts tens of thousand participants, is the Annual Meeting of the American Chemical Society. In 2021, this was a virtual meeting assigned to San Diego. While the Group was unable to experience the wonderful weather in San Diego, or to spend time at San Diego's popular restaurants, the meeting was, nonetheless, enjoyable. The Computational Biophysics and Bioinformatics Lab presented five talks and a poster.

Dr. Shailesh Panday delivered an invited talk on his development of a Gaussian-based method for the quick estimation of entropy change of protein-protein binding. In his talk Dr. Panday highlighted the importance of binding entropy in the computational prediction of protein-protein binding processes. In addition to traditional enthalpy via end-state free energy methods (like molecular mechanics and the Poisson Boltzmann Surface Area), he applied a newly proposed Gaussian-based method for the estimation of entropy of binding over a large dataset and subsets of specific protein classes. His results show that including entropy improves the accuracy of affinity prediction — appreciably i.e. the Pearson Correlation Coefficient from 0.3 to 0.33 (full dataset) and 0.56 to 0.74 for a class of interferon proteins.

Mihiri Hewa reported on a new method for predicting non-specifically surface bound ions. The importance of such a development stems from the fact that non-specifically bound ions are difficult to detect experimentally because of their low residential time, while being very important for the functionality of corresponding proteins. This new development enables the evaluation of binding free energy in a more comprehensive and physically sound manner compared to the previous algorithm-based method. This results in better predictions as benchmarked against experimental data.

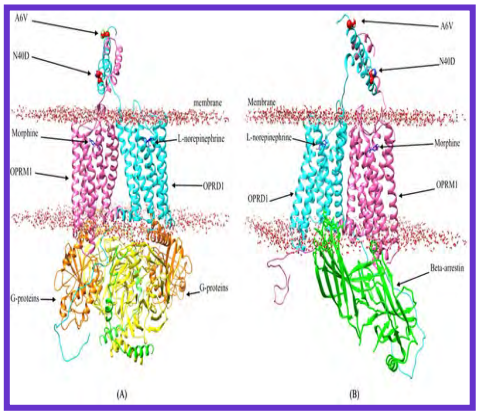
Jacob Jeffrey gave a talk on the contribution of various proteins in maintaining the hydrogen concentration in melanosomes. Melanosomes are large organelles and they are responsible for skin

Continued on next page

pigmentation and DNA variants in the corresponding proteins are associated with various diseases, including skin cancer. His talk focused on a collaborative study with Cornel University **(Dr. Jonathan Zippin)** and the NIH **(Dr. Stacie Loftus)** that addresses the hydrogen concentration maintenance by so called positive and negative regulator proteins. His work demonstrates that these positive and negative regulators compete with one another, resulting in optimum hydrogen concentration. Furthermore, mutations associated with skin cancer are shown to affect optimal hydrogen concentration.

Mahesh Koirala presented an invited talk on creatine pathways across a creatine transporter protein. The creatine transporter protein (CRT) is a transmembrane protein encoded by an X-linked gene, SLC6A8, that helps transport creatine from the outside of skeletal and cardiac cells to inside the cells. Creatine is essential for the temporal and spatial maintenance of the energy supply to skeletal and cardiac muscle. Creatine deficiency is found to be associated with creatine transporter deficiency (CTD), characterized by clinical features like mental retardation, hypotonia, seizures, behavioral problem, speech delay, etc. This accounts for 1-2 % of all unexplained X-linked intellectual disabilities. Understanding the molecular mechanism of the effects of missense mutations on CRT function, stability and interactions suggests a strategy for the design of therapeutic agents.

Dr. Gen Li presented a talk on developing methods and a stand-alone code to predict the change of thermodynamical properties (folding and binding free energies) of macromolecules and their assemblages caused by mutations. Such a development is inspired by the observation that diseases are frequently caused by mutations that affect these properties. Thus, to classify variants seen in human populations one wants to discriminate between pathogenic and benign mutations. This allows the early detection of mutations linked with an elevated risk of developing disease and will provide guidance in developing a treatment protocol.



Molecular signaling pathways: (A). G-protein signaling pathway. (B). β-arresting signaling pathway.

Dr. Angela Wu presented a poster "Opioid Addiction and Opioid Receptors Dimerization: Plausible Linkage of Mu Opioid Receptor Missense Mutations and Elevated Opioid Addiction Risk." Opioid addiction is a complex phenomenon that has genetic and social components. Because of such complexity, it is difficult to interpret the impact of genetic mutations on the outcome of opioid addiction. The Mu opioid receptor (OPRM1) and the Delta opioid receptor (OPRD1) are proteins associated with opioid addiction. Two such genetic mutations, A6V and N40D (found in the OPRM1 protein) have been found to be associated with substance dependence. Currently the work is published, and it is outcome of the collaboration with **Dr. William Hand** (PRISMA Health).

The participation in the ACS annual meeting allowed the Department's computational biophysics and bioinformatics researchers to be better presenters and to be provided with invaluable feedback. The meeting also inspired new research and motivated the Biophysical Group to pursue new lines of inquiry.

Submitted by Dr. Emil Alexov

Biophysics Research Experience for Undergraduates

This summer, the Department of Physics and Astronomy hosted a diverse pool of students from across the United States for an in-person summer Research Experience for Undergraduates (REU) program entitled "Nature's Machinery through the Prism of Physics, Biology, Chemistry, and Engineering." The REU program, funded by the National Science Foundation, ran from May 24 to July 30. Each of the sixteen students worked on collaborative and interdisciplinary projects with mentors from multiple disciplines in the College of Science and the College of Engineering and Applied Science.

Students who participated in the Biophysics REU Program, acquired hands-on research experience this past summer.

The COVID-19 pandemic imposed many particular challenges, including changes in policies regarding testing, face-coverings, social distancing, causing one student to participate remotely in all the activities.

The ten-week program started with an intensive "Biophysics Bootcamp," where students learned the basics skills required for working in the field of biophysics. The bootcamp was led by **Drs. Josh Alper** and **Hugo Sanabria** and consisted of a series of lectures provided by experts, as well as computational and experimental laboratory exercises with the support of an amazing group of physics graduate students.

The 2021 Biophysics Research Experience for Undergraduates combined important research experience with fun activities.

After the bootcamp, students went off to work with their primary and secondary mentors on their assigned projects. The partnering between labs led to an enhanced peer support system for the students and increased interactions with faculty members from different disciplines.

The faculty mentors also provided professional development and research tools: workshops, Journal Clubs, field trips to local biophysics-related companies, and ample opportunities to present progress on their research to the entire cohort. Finally, students presented their progress at the Summer Undergraduate Research Symposium at Clemson.

The summer wasn't all work – students participated in various fun and bonding activities, including a campus scavenger hunt, whitewater rafting, hiking Table Rock Mountain, trips to Atlanta and Greenville, and various banquets. Students who attended Clemson's Biophysics REU had a great time and left feeling satisfied with a great impression of Clemson University, biophysics research, and the Department of Physics and Astronomy. In addition, most of the participants declared they had increased their likelihood of attending graduate school.

We look forward to seeing their professional development and hosting another Biophysics REU next year!

Physics and Astronomy Loses Two Beloved Faculty Members

Dr. Jian He, 52, husband of **Ping Du**, passed away Thursday, October 14, 2021. He was born April 25, 1969 in Beijing, son of **Youfeng He** (father) and **Yonglian Liu** (mother-deceased).

Jian received his B.S. in physics from Jilin University in China and his Ph.D. in physics from the University of Tennessee in Knoxville, under the mentorship of **Drs. David G. Mandrus** and **Ward Plummer**. He joined Clemson University in 2004 as a postdoctoral researcher with **Dr. Terry M. Tritt**. He was hired as a faculty member in 2008 as an assistant professor and was recently promoted to the rank of full professor in May of 2021.

His research interests spanned several sub-areas of condensed matter physics and materials science: single crystal growth of transition metal oxides and intermetallics, novel materials' synthesis techniques, electrical, thermal, magnetic characterization, and thermoelectric materials research. He authored or co-authored over 257 peer reviewed publications, with 27 in 2020-21 alone. He mentored numerous graduate and undergraduate students who were able to be exposed to both his passion and his deep understanding of physics. He was a thesis advisor to five Ph.D. students. Jian had many friends and colleagues who will mourn is passing. He had two passions in his life: one was physics, and the other was soccer. He loved to play and to watch soccer and spent many weekends on the soccer field with friends and his soccer family. His passion for undergraduate research will be remembered by a fund established in his name to support undergraduate research in the department of Physics and Astronomy at Clemson University. *The Jian He Memorial Holding Account* has been established. Gifts can sent to the Clemson University Foundation, P.O. Box 1889, Clemson SC 29633-1889 or call 864-656-5896. Online gifts can be made via this link: https://iamatiger.clemson.edu/giving/giving-to-clemson?id=67ac04b5-9133-4ddf-b9e2-9e746ffa0610. These funds will be used to support the research of our undergraduate students.

Thomas Frank Collins, 87, of Central, husband to **Gary Matthews Collins**, passed away on November 14, 2021. Born in Macon, Georgia, he was the son of the late **James** and **Arline Chambliss Collins**.

Tom graduated with his bachelor's degree from Mercer University and master's degree from Clemson University. He was a professor of physics and astronomy for thirty-eight years at Clemson University and was named a Professor Emeritus. Along with other professors, they started Electrical Associates of Clemson. Tom was a member of Pendleton United Methodist Church.

He is survived by his wife of fifty-nine years, **Gary Matthews Collins**; daughters, **Kathy Collins Snider (Todd)** of Houston, Texas; **Christie Collins Schnagel (Todd)** of Gallatin, Tennessee; **Laura Rachael Collins** of Murfreesboro, Tennessee; and, granddaughters, **Rachael Welch-Snider (Kristen)** and **Bryn Snider**, both of Houston, Texas. He was predeceased by his parents and brothers, **James Collins, Jr.**, and **Russell Collins**. Memorial contributions can be made to the Parkinson's Foundation, 200 SE 1st Street, Suite 800, Miami, Florida 33131.

ATLIS Motor Vehicles and Clemson Partner to Advance Development of Electric Vehicle Batteries

Dr. Aparao Rao heads up the collaboration with ATLIS Motors to develop electric-vehicle batteries.

ATLIS Motor Vehicles, Inc. and Clemson University have partnered to advance development of electric-vehicle batteries that charge faster, last longer and can be scaled to fit a variety of vehicle classes.

ATLIS, a startup company based in Arizona, is developing battery cells and packs to power the Atlis XP Platform and XT Truck.

The associated battery research is being jointly executed at the Clemson Nanomaterials Institute (CNI). To further advance the technology, ATLIS and Clemson executed a three-year master research agreement led by CNI founder and director **Apparao Rao**, an expert in nanomaterials, the R. A. Bowen Professor of Physics, and a fellow of four prestigious societies – the American Physical Society, the American Association for Advancement of Science, the National Academy of Inventors and the Materials Research Society. Rao's research is focused on understanding and exploiting the properties of nanomaterials for energy harvesting and energy storage.

At CNI, Professor Rao along with his research associates and students will assist ATLIS with further development of their battery technology. Unlike existing cell designs, the ATLIS battery will utilize custom coatings to strike a balance between energy and power. These coatings, coupled with a special mechanical construction, will lead to optimized energy capacity and reduced charging time.

"I was presented the opportunity to partner with ATLIS through one of my former students who is now an engineer at ATLIS," said Rao. "Through this collaborative effort, I have not only been able to utilize my proficiency in nanomaterials to assist in further developing this superior cell technology, but I have also had the opportunity to provide an atmosphere where my students and postdoctoral researchers can experience firsthand the steps taken by industry to develop a product and bring it to market. This partnership highlights that CNI is a hub where academia-industrial partnerships are fostered by bringing faculty researchers together with industry partners to create new technologies."

ATLIS is developing an all-electric XT truck with the goal of outperforming gasoline and diesel-powered pickup trucks with a 500-mile range battery that recharges in less than 15 minutes. The ATLIS battery-cell technology features a minimum number of components, thus reducing assembly cost and complexity, while providing an ultra-fast charging structure. ATLIS aims to utilize formulations developed by the joint research team, through this partnership, to improve the overall function and structure of the battery with the intent to adapt the findings for use in future vehicle offerings.

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The CNI is located at the Clemson University Advanced Materials Research Laboratory in Anderson County. The Institute specializes in studying the fundamental properties and applications of a broad range of nanomaterials and is developing cutting-edge multidisciplinary research that can widen the frontiers of nanoscience and significantly impact industrial technologies. Established in 2013, CNI contains approximately 5,000 square-feet of research space and houses a variety of synthesis and characterization equipment. Currently, CNI has seven active agreements with industrial partners, and nearly ten faculty members and twenty–five students and postdocs use the facility for various collaborative projects.

"CNI is an excellent example of capabilities that exist in Clemson's research enterprise that can be leveraged by industrial partners to create collaborations that have an eye toward creating new technologies," said **Chase Kasper**, Director of Business Development at the Clemson University Research Foundation (CURF), which provides technology transfer and industry engagement support for Clemson's research enterprise. "The partnership between ATLIS and CNI is another example of how CURF is actively engaged in creating linkages and formalizing relationships with industry partners. We are very excited to see how the CNI and ATLIS will work together to advance and shape the future of the electric truck."

College of Science, February 23, 2021

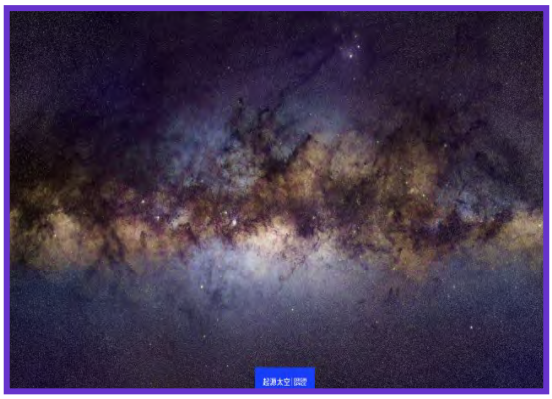
Clemson Grad Seeks to Mine Asteroids in New Business Venture

Tianhong Yu, who graduated from Clemson with his Ph.D. in physics has cofounded an exciting new company, along with colleague **Zhuxiao Wang**.

Origin Space Ltd. is a space resource exploration company, focusing on asteroid mining, which is the first such company in China. It aims to use outer space resources for deep space exploration. Yu is in charge of building the asteroid database and studying space-blockchain applications. The current database includes over 500,000 asteroids, including over 10,000 near Earth asteroids.

"Yang Wang No. 1" is a space telescope that works in dual bands of ultraviolet and visible light. The reason why the dual-band operation of ultraviolet and visible light is utilized is because current Chinese astronomical satellites don't use this technique.

To date, most of Chinese astronomical space telescopes have focused on high-energy bands, such as the "Wukong" dark matter particle detection satellite, the "Wise Eye" X-ray telescope, and the "Lobster Eye X-ray" telescope.



The Milky Way, taken by "Yang Wang No. 1" Credit: Origin Space

Yu looks forward to launching a small Optical/NUV telescope to do a survey of the full sky early next year. The goal is to eventually use the information collected to do asteroid mining.

To learn more about this ongoing astronomical research, please visit Origin Space Ltd.'s website at: https://origin.space/#/home

Search Is on for Endowed Chair in Medical Biophysics

The Department of Physics and Astronomy, in collaboration with the Department of Bioengineering and Prisma Health, invites applications to become the founding holder of the Dr. Waenard L. Miller, Jr. '69 and Sheila M. Miller Endowed Chair in Medical Biophysics, a tenured faculty position at the full professor level.

The inaugural holder of the **Dr. Waenard L. Miller, Jr.** '69 and **Sheila M. Miller** Endowed Chair in Medical Biophysics, will support Clemson University's effort to attain international prominence in medical biophysics by joining an interdisciplinary team with excellence in molecular and cellular biophysics, radiation medical physics, biomedical devices, nanomedicine, and bioinformatics.

The Dr. Waenard L. Miller, Jr. '69 and Sheila M. Miller Endowed Chair in Medical Biophysics will also have the opportunity to enhance collaboration across existing centers of excellence within the University (SC TRIMH, EPIC, the CUBEInc, SCBioCRAFT, the Clemson University School of Health Research, and the Clemson University Center for Human Genetics) and establish active collaborations with physician-scientists and clinical partners at Prisma Health.

The successful applicant will build a vibrant and diverse group of undergraduate, graduate, and postdoctoral researchers at Clemson University committed to bridging basic and clinical research. Clemson University is eager to complement existing strengths in the structure/function/dynamics relationship of biological macromolecules; single molecule to cellular biophysics; enabling technologies for diagnostic, therapeutic, and biomedical devices and instruments; and, developing clinically relevant therapeutic strategies (particularly nanomedicine, radiation therapy and targeted drug selection and design).

Scholars in all fields of medical biophysics will be given consideration. The successful applicant will have an internationally recognized research program in medical biophysics with a well-established track record of external funding, scholarly achievement, student mentorship, productive collaborations with clinicians, and commitment to inclusive excellence. Applicants should submit a letter of application, curriculum vitae, a statement of research interests, and a statement of teaching and mentorship philosophy (including how you envision your role in broadening participation in STEM) to Interolfio (http://apply.interfolio.com/97767). A list of professionals that can be contacted will be requested from finalists for the position. A review of applications will begin on January 3, 2022 and will continue until the position is filled.

As one of the top public land grant research universities in the nation, Clemson University attracts and powerfully unites students and faculty whose greatest desire is to make a difference in the lives of others. Having both the top Carnegie designation (Research Very High) and ranked among the best national public universities by *U.S. News & World Report*, Clemson excels in teaching, research, and service and harnesses the power of convergence as we tackle some of tomorrow's grand challenges and prepare the next generation of thought leaders. Our colleges and the Research Office are committed to supporting interdisciplinary research teams so that the scholarship of our researchers is bounded only by their curiosity. Please contact MBPSearch@clemson.edu with questions.

Clemson Researchers Decode Thermal Conductivity with Light

Graduate research assistant **Prakash Parajuli**; research assistant professor **Sriparna Bhattacharya**; and Clemson Nanomaterials Institute (CNI) Founding Director **Apparao Rao** (all members of CNI in the College of Science's Department of Physics and Astronomy) worked with an international team of scientists to examine a highly efficient thermoelectric material in a new way - by using light. Their research has been published in the journal *Advanced Science* and is titled "High zT and its Origin in Sb-doped GeTe Single Crystals."

While others have reported GeTe-based materials with high zT, these were polycrystalline materials. Polycrystals have boundaries among the many small crystals of which they are formed. While such boundaries favorably impede heat transfer, they mask the origin of fundamental processes that lead to high zT.

This low thermal conductivity came as a surprise, since the material's simple crystalline structure should allow for heat to flow easily throughout the crystal. Doping GeTe with the right amount of antimony can maximize electron flow and minimize heat flow. This study found that the presence of 8 antimony atoms for every 100 GeTe gives rise to a new set of phonons, which effectively reduce heat flow that was confirmed both experimentally and theoretically. The team, along with collaborators who grew the crystals, performed electronic and thermal transport measurements in addition to density functional theory calculations to find this mechanism in two ways: first, through modeling, using the thermal conductivity data; second, through Raman spectroscopy, which probes the phonons within a material.

Rao said that the collaborators' wide range of expertise was key to their success. The group included **Fengjiao Liu**, a former Ph.D. student at CNI; **Rahul Rao**, Research Physical Scientist at the Air Force Research Laboratory, Wright-Patterson Air Force Base; and, **Oliver Rancu**, a high school student at the South Carolina Governor's School for Science and Mathematics who worked with the team through Clemson's SPRI (Summer Program for Research Interns) program. Because of the pandemic, the team worked with Rancu via Zoom, guiding him with some of Parajuli's calculations using an alternate Matlab code.

"I am so very grateful for the opportunity to work with the CNI team members this summer," said Rancu, who hails from Anderson, South Carolina. "I have learned so many things about both physics and the research experience in general. It truly was priceless, and this research publication is just another addition to an already fantastic experience."

"I was very impressed by Oliver," Parajuli added. "He caught on quickly with the necessary framework for the theory."

College of Science, February 23, 2021

The Clemson University Physics and Astronomy Newsletter

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Department News

The Department welcomes Kim Webb in her new role as department Administrative Assistant.

Patrick Johnson, a native of the Caribbean island of Nevis, graduated from the Department with a B.S. in physics in 2012 and returned in 2018 to pursue a Ph.D., which he completed in August of this past year. Patrick has now joined our department as a Research Associate, working as both the EBIT operator and as general research support for our experimental groups.

Dr. Emil Alexov has been awarded the Dr. Wallace R. Roy Professorship. This professorship recognizes a high degree of collaboration with Prisma Health, success in health research funding and scholarship, evidence of leadership for multidisciplinary health research teams, and mentoring of graduate students.

Dr. Mounib El-Eid, adjunct professor in the department, is visiting Clemson this spring, after retiring from the American University of Beirut. He hopes to spend an extended period of time at Clemson every year, to collaborate with colleagues on astrophysical research.

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