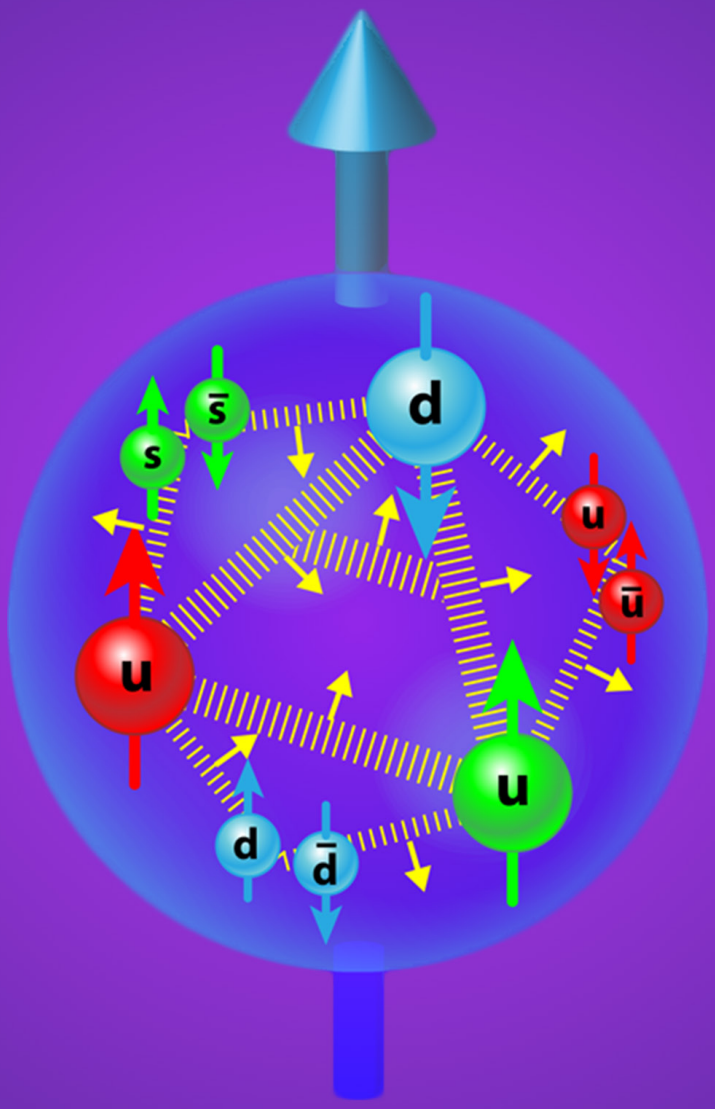
Physics & Astronomy

2017 DEPARTMENT NEWSLETTER



Lattice Quantum Chromodynamics calculations carried out by the research group of Profs. Keh-Fei Liu and Terry Draper and their students, post-docs, and collaborators have revealed the contributions of strange (s) and anti-strange ($\bar{s}$) quarks within the proton to its electric charge distribution and magnetization, and also the contributions of gluons, the force carriers of the strong interaction, to the proton's spin.

Image courtesy of American Physical Society/Alan Stonebraker. https://physics.aps.org/articles/v10/23

College of Arts and Sciences

Department of Physics and Astronomy

Physics & Astronomy

2017 DEPARTMENT NEWSLETTER

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Joseph Brill
Michael Cavagnero
Christopher Crawford
Sumit Das
Lance De Long
Terrence Draper
Anatoly Dymarsky
Michael Eides
Renee Fatemi
Gary Ferland
Susan Gardner
Tim Gorringe
Richard Hill
Ribhu Kaul
Wolfgang Korsch
Michael Kovash
Keh-Fei Liu
Nicholas Martin
Ganpathy Murthy
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Brad Plaster
Ambrose Seo
Alfred Shapere
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Lauren Falco
Sharmista Mukhoadhyay

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Moshe Elitzur
Bing An Li
Marcus McEllistrem
Jesse Weil

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pa.as.uky.edu

and keep in touch!

Please let us know if your address or contact information changes. Send a note via email, or call, the Physics & Astronomy Department Manager.

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Dear Friends of the Physics and Astronomy Department,

When I became Department Chair in July, my first task was to assemble an energetic team capable of building upon the many achievements of our outgoing Chair, Sumit Das. I'm pleased to announce that Brad Plaster has agreed to serve as the new Associate Chair, Chris Crawford will continue as Director of Graduate Studies, and Renée Fatemi will be our new Director of Undergraduate Studies. All three are relatively young faculty members who are full of energy and ideas.

Looking back on the last four years, I am pleased with our previous administration's accomplishments. To mention a just a few, we developed new "active-learning" versions of some of our introductory courses, we revamped our entire undergraduate lab curriculum, and we established a Physics and Astronomy Learning Center to support students in introductory courses. With the help of generous donations from alumni and friends, we continued to ramp up the quality and size of our graduate program by using "top-up" fellowships to bolster our recruitment efforts, we moved new graduate students into research sooner with summer research fellowships for first-year students, and we continued to increase our students' and the Department's international visibility by offering grants to fund graduate student travel to scientific conferences. We saw young faculty, like Doug Strachan and Ambrose Seo, win prestigious grants, and we hired two superb new faculty members, Anatoly Dymarsky and Richard Hill.

I am optimistic about what we will be able to accomplish in the next four years, including these priorities:

- Further strengthening our research programs, with an initial emphasis on astronomy and condensed matter physics.
- Redesigning our undergraduate curriculum, to better meet the diverse needs of our students and to prepare them to succeed in graduate school or real-world employment.
- Redoubling our efforts to recruit the best graduate students.
- Developing industrial partnerships, to create commercialization opportunities for faculty and job opportunities for our students.
- Cultivating a strong network of alumni and friends, establishing an Alumni Board, sponsoring reunions and other events. (Watch for announcements!)

This is just a partial list, and I welcome input from alumni and friends about these and other ideas. I hope you share my excitement about the next four years, and I look forward to working with you to advance our students', faculty members', and Department's stature and success.

With best wishes,

Alfred Shapere
Department Chair

GRADUATE PROGRAM

The Department congratulates its Ph.D. graduates during the 2016-2017 academic year. A listing of our Ph.D. graduates, together with their thesis title and their thesis advisor, is below:

1. Kevin Adkins, “Studying Transverse Momentum Dependent Distributions in Polarized Proton Collisions via Azimuthal Single Spin Asymmetries of Charged Pions in Jets”, Advisor: Renee Fatemi.
2. Mathias Boland, “Physical and Electronic Properties of Nanoscale 2D Materials”, Advisor: Doug Strachan.
3. Jonathan D’Emidio, “Quantum Criticality in SU(N) Spin Models”, Advisor: Ribhu Kaul.
4. Md Latiful Kabir, “A Measurement of the Parity Violating Asymmetry in the Neutron Capture of Helium-3 at SNS”, Advisor: Chris Crawford.
5. Kres Neely, “A First Experimental Limit on the Relative Rates of Muon Capture on Deuterium from the Quartet and Doublet Hyperfine Spin States of the md Atom”, Advisor: Tim Gorringe.
6. Nima Nouri, “Magnetic Field Non-Uniformity Challenges in Neutron Electric Dipole Moment Experiments”, Advisor: Brad Plaster.
7. Sabbir Sufian, “Strangeness Magnetic Moment of the Nucleon”, Advisor: Keh-Fei Liu.
8. Xinshuai Yan, “Neutron-Antineutron Transitions – Exploring B-L Violation with Quarks”, Advisor: Susan Gardner.
9. Yulong Yao, “Thermal Conductivities of Organic Semiconductors”, Advisor: Joseph Brill.

GRADUATE STUDENT PROFILES

Inaugural MacAdam Fellow:
Jonathan D’Emidio

Jon was selected as the department’s inaugural MacAdam Fellow for the 2016-2017 academic year. Jon came to UK in 2010 after receiving his B.S. in physics and a B.A. in French and Francophone Studies from Pennsylvania State University. Jon’s Ph.D. research, carried out with Prof. Ribhu Kaul, focused on the development of numerical and field theoretic studies of quantum many body systems and their applications to condensed matter physics. After defending his thesis in Spring 2017, Jon is now a post-doctoral researcher in the group of Frédéric Mila at l’École Polytechnique Fédérale de Lausanne, in Lausanne Switzerland. His new position will give him opportunities to broaden his interests and delve into the theory of quantum entanglement in many body physics.

Sabbir Sufian

Sabbir arrived at UK in 2010 after completing his undergraduate degree in physics with a minor in mathematics at the University of Dhaka, Bangladesh. Sabbir’s Ph.D. research, on first principles calculations of the structure of the nucleon using lattice Quantum Chromodynamics (featured on p. 5), was carried out with Prof. Keh-Fei Liu. Sabbir’s high-profile research resulted in seven different offers for post-doctoral researcher positions. After defending his thesis in Summer 2017, Sabbir is now a post-doctoral researcher at the Jefferson Laboratory in Newport News, VA, where he is pursuing lattice QCD calculations of parton distribution functions, and is also collaborating with experimental groups in combining lattice QCD calculations with experimental data.

QUARK AND GLUONS WITHIN THE PROTON

The notion of a quark was proposed by Murray Gell-Mann and George Zweig in 1964, and then discovered in experiments at the Stanford Linear Accelerator Center in 1968. Experiments conducted at numerous particle accelerator facilities over the following decades then revealed the existence of six so-called “flavors” of quarks, whimsically labeled “up”, “down”, “strange”, “charm”, “bottom”, and “top”. The top quark, the heaviest of the quarks with a mass more than 180 times that of the proton, was the final quark to be discovered in 1995 at the Fermi National Accelerator Facility located outside of Chicago, IL.

Quarks are all around us, as the protons and neutrons which comprise the nuclei of atoms are themselves composed of quarks, bound together by gluons, the force carrier of the strong interaction. Quarks carry fractional electric charge (either +2/3 times that of the magnitude of the electron’s charge e, or -1/3 times e) and are spin-1/2 particles; further, for each quark, there is an anti-quark, of opposite electric charge. In a simple picture, the proton is composed of three quarks – two up quarks, each with charge +(2/3)e, and one down quark, with charge –(1/3)e. However, at length scales smaller than the proton’s size, a much richer structure emerges, as quark-antiquark pairs of all six flavors, namely, up, down, strange, charm, bottom, and top, can, in principle, be present within the proton and are, in fact, continuously created and destroyed. For example, the cartoon image on the cover page illustrates the presence of the two up (u) and the single down (d) “valence quarks” within the proton, but also the presence of up-antiup (u-$\bar{u}$), down-antidown (d-$\bar{d}$), and strange-antistrange (s-$\bar{s}$) pairs.

This rich internal quark and gluon structure within the proton prompts numerous fundamental questions concerning the contributions of these quark-antiquark pairs within the proton to its macroscopic properties. For example, the proton is a spin 1/2 particle, but how the quarks’ intrinsic spins and their angular momentum resulting from their relativistic motion within the proton, and the gluons’ intrinsic spin and angular momentum, combine to yield the proton’s composite spin 1/2 is one such fundamental question. Another example concerns the contributions of these quark-antiquark pairs to the distribution of electric charge within the proton and their contribution to the proton’s magnetic moment.

To answer these questions, Prof. Keh-Fei Liu (pictured above, on the right) and Prof. Terry Draper (left) have been leading a research group here at the University of Kentucky, which for several decades now has focused on calculations within Quantum Chromodynamics (QCD), the fundamental theory of the strong interaction of quarks and gluons, aimed at resolving various fundamental questions, such as those just described. Their calculations are performed within the framework of Lattice QCD, in which simulations of quark-gluon dynamics within QCD are carried out on space-time lattices using supercomputing clusters.

In one recent breakthrough published in Physical Review Letters, Profs. Liu and Draper, together with UK physics graduate student Sabbir Sufian (profiled on p. 4), UK physics post-docs Jiang Lang and Yi-Bo Yang, and collaborator Andrei Alexandru (of George Washington University) have reported, for the first time, a precise calculation of the electric charge distribution and magnetization resulting from the strange quarks within the proton. Quite interestingly, they have shown that strange antiquarks are located slightly farther from the proton’s center than the strange quarks, and that the presence of these strange quarks increases the magnitude of the proton’s magnetic moment by about 0.8%. Impressively,

Continued from page 5

their result for the contribution of strange quarks to the magnetic moment is 10 times more precise than that determined by experiments. Their work has been covered widely in the press and, in a nod to its importance, was written up as a "News and Views" feature article in the journal Nature (http://www.nature.com/nature/journal/v544/n7651/full/nature21909.html).

In another breakthrough, also published in Physical Review Letters, Profs. Liu and Draper, together with Sufian, Yang, former UK physics post-doc Michael Glatzmaier, collaborator Alexandru (GWU), and collaborator Yong Zhao (University of Maryland), have reported a calculation of the contribution of the gluons' spin to the proton's spin. Their lattice QCD calculations, using numerous improved techniques, such as realistic quark masses, have shown that the contribution of the gluon spin is rather significant, in fact, up to 50% at resolution scales similar to those explored in experiments. Their work here has also attracted significant attention, including a "Viewpoint" article published on the American Physical Society's website (https://physics.aps.org/articles/v10/23).

UNDERGRADUATE GROWTH AND EXCELLENCE

After eight years of devoted service to our undergraduate program, Prof. Kwok-Wai Ng is stepping down as the department's Director of Undergraduate Studies (DUS) during the Fall 2017 semester. Following this transition period, Prof. Renee Fatemi will assume the DUS role. During Prof. Ng's tenure the number of undergraduate majors increased by 30%, culminating in a record graduating class of fifteen students in 2016. During the last decade the number of minors has also steadily climbed from a mere handful to nearly fifty students in the Spring of 2017. This increase may be due in part to the restructuring of the minor requirements to facilitate student's increasing desire to pursue interdisciplinary degrees.

The Physics and Astronomy Department continues to attract some of the strongest students in the College of Arts and Sciences, many of whom go on to garner international awards. In 2015 majors David Bowles (Class of 2017) and Jacob Hempel (Class of 2017) were the winners of the Mathematical Contest in Modeling, a contest where teams of undergraduates use mathematical modeling to present their solution to real world problems. This past year Ben Riley (Class of 2018) was one of 240 students nationwide selected to receive the Goldwater Scholarship, often considered the most prestigious undergraduate scholarship in the natural sciences, mathematics and engineering in the U.S..

Integrating undergraduate students into research projects is an ongoing mission of the department. Each semester ~10% of our majors are mentored by a faculty member on a unique research project, with many choosing to extend their research activities into summer months. Others use this experience to garner research positions at national and international laboratories. For example, both Ben Riley and Andrew Mullins (Class of 2018) were awarded summer research fellowships at the National Institute of Standards and Technology (NIST) in Maryland this summer. Grant Forbes (Class of 2018) also received funding to conduct research at the J-PARC proton accelerator facility in Japan this summer.

In addition to academics and research, our undergraduates are engaging in the nationwide conversation concerning the underrepresentation of minorities in the fields of physics and astronomy. Kate Collins (Class of 2018) was a founding member of the #IAmAWomanInSTEM project (http://www.uky.edu/iamawomaninstem/). This movement aims to support undergraduate women engaged in fields that rely primarily on the sciences, technologies and mathematics (STEM) fields. Undergraduate women are paired with female faculty/staff mentors, providing a support network that facilitates an increase in the graduation rates of women in STEM-related majors and minors at the post-secondary level.

UNDERGRADUATE GROWTH AND EXCELLENCE

IMPACT OF UNDERGRADUATE RESEARCH:

DEBORAH FERGUSON (CLASS OF 2016) AND PROF. SUSAN GARDNER REVEAL EVIDENCE OF IMPACTS THAT STRUCTURED THE MILKY WAY GALAXY

In just one example of the outstanding impact our undergraduate physics majors have had on our department's research mission, Deborah Ferguson, a Class of 2016 graduate and Singletary Scholar during her time at UK, was the lead author on a paper that was published in the Astrophysical Journal (ApJ). Ferguson conducted the research with Prof. Susan Gardner and Dr. Brian Yanny, a staff scientist and astrophysicist in the Fermilab Center for Particle Astrophysics. Their paper presented observational evidence of asymmetric ripples in the stellar disk of our galaxy, which had long been thought to be smooth. Using observations from the Sloan Digital Sky Survey (SDSS) telescope in New Mexico, Ferguson, Gardner and Yanny analyzed the spatial distribution of 3.6 million stars and found ripples that confirm previous work of the senior co-authors. These results can be interpreted as evidence of the Milky Way's ancient impacts, which could include an impact with the massive Sagittarius dwarf galaxy some 0.85 billion years ago. These impacts are thought to have been the "architects" of the Milky Way's central bar and spiral arms.

"Having access to millions of stars from the SDSS allowed us to study galactic structure in an entirely new way by breaking the sky up into smaller regions without loss of statistics," said Ferguson, who first reproduced the vertical asymmetry results Gardner and Yanny found in their earlier analysis. "It has been incredible watching this project evolve and the results emerge as we plotted the stellar densities and saw intriguing patterns across the footprint. As more studies are being done in this field, I am excited to see what we can learn about the structure of our galaxy and the forces that helped to shape it."

This ApJ paper evolved from Ferguon's senior thesis, which she completed as a component of the requirements for her honors degree from UK's Lewis Honors College. She has now completed her first year of graduate school at the Georgia Institute of Technology where she received a fellowship to pursue a doctorate in physics. "I am so fortunate to have had not only the opportunity to do undergraduate research, but to work on a project that ultimately led to being published," Ferguson said. "It is very motivating to have spent most of my undergraduate career working on a research project because it makes it clear how useful and important physics is."

The ApJ paper can be found at https://doi.org/10.3847/1538-4357/aa77fd.

OPENING OF THE PHYSICS AND ASTRONOMY LEARNING CENTER

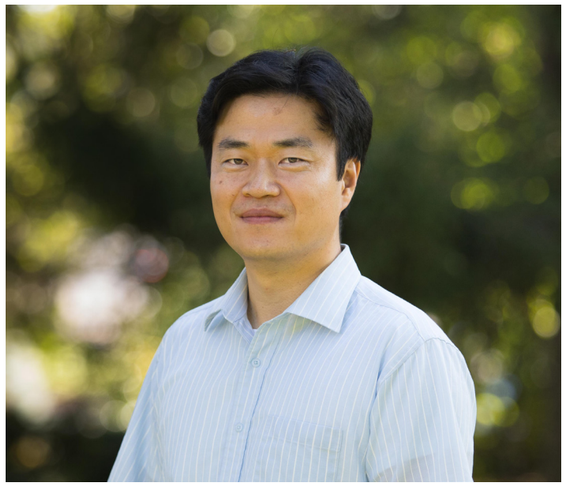
The department's new Physics and Astronomy Learning Center (PALC) was officially opened during the Fall 2016 semester. The PALC, located within close proximity to the lecture halls in the Chemistry-Physics Building, was designed to provide tutoring help for students enrolled in any of the department's physics and astronomy courses, and is especially targeted at those enrolled in our intensive 200-level introductory physics courses: PHY 211 and 213 (two-semester algebra/trigonometry-based sequence in mechanics and electromagnetism) and PHY 231 and 232 (two-semester calculus-based sequence in mechanics and electromagnetism). The facility is staffed by graduate student teaching assistants, under the leadership of our department's academic coordinators Dr. Maxwell Ankrah and Dr. Max Brown.

Upon entering the PALC, students swipe in with their student ID cards, thereby placing them in an electronic queue for one-on-one assistance with a TA. As quantified by the number of entry swipes, the PALC has been heavily utilized by students enrolled in these courses. During the 2016-2017 academic year, a total of 2,565 entries were recorded. Of these, 27% of the entries were for students enrolled in PHY 211, 26% for PHY 213, 20% for PHY 231, and 13% for PHY 232.

Views of the Physics and Astronomy Learning Center. LED screen on entry table includes a Student ID card reader for recording student visits.

CONDENSED MATTER FACULTY PROFILES: PROF. AMBROSE SEO AND PROF. DOUGLAS STRACHAN

Professors Ambrose Seo and Douglas Strachan were both recently promoted to the rank of Associate Professor of Physics with tenure. Both conduct research in experimental condensed matter physics and have been successful in receiving prestigious high-profile grants.



Prof. Ambrose Seo received the prestigious five-year National Science Foundation (NSF) Faculty Early Career Development (CAREER) award totaling $672,981. The CAREER award is given in support of junior faculty who exemplify the role of teacher-scholars through outstanding research, excellent education, and the integration of education and research within the context of the mission of the university. Funds from the award will allow Seo to investigate iridium oxides and unveil exotic collective phenomena, such as nontrivial topological states that are latent in bulk crystals, but emerge in dimensionally confined superlattices.

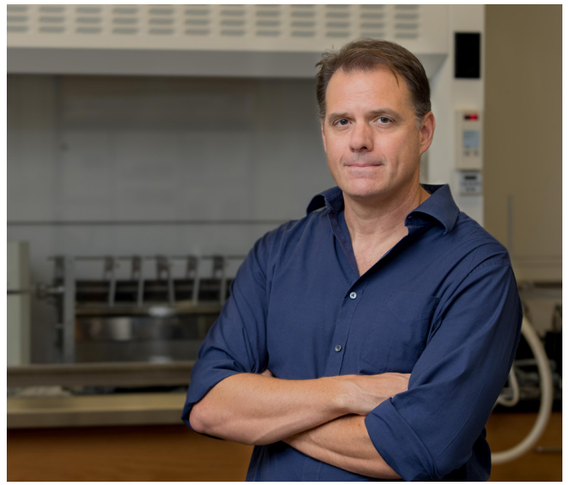
"My research is like building atomic-scale LEGO blocks to study their physical properties," Seo said. "These atomic LEGO blocks will be used in future electronic devices, which cannot be achieved by current semiconductor-based technology." The outcome of his project, "Two-Dimensional Superlattices of Epitaxial Pyrochlore Iridates," will fill existing gaps between physics theories and experiments, and lead scientists to an innovative, fundamental understanding of strongly correlated, spin-orbit coupled electrons in low-dimensional materials.

Another important component of the project is its impact on UK undergraduate and graduate students. "In the United States, we are in dire need of physicists with strong expertise in materials synthesis and characterization, for both academia and industry," Seo said. Participating graduate students will receive training in state-of-the-art materials synthesis and characterization, as well as opportunities to collaborate with scientists at national labs.

Seo's grant also contains an educational component, as part of which Seo is developing an applied materials physics course, available to both graduate and undergraduate students and aimed at integrating cutting-edge materials research topics with basic physics coursework. Focused on raising awareness of STEM careers in underrepresented areas, Seo is also developing an NSF Research Experiences for Undergraduates (REU) program for pre-service teachers.

Since he joined UK as an assistant professor of physics in 2010, Seo has been focusing on building a state-of-the-art laboratory for epitaxial materials syntheses and characterizations. Recently, he and his team have successfully carried out challenging research of various iridium oxide thin-films by using their unique techniques of multiple in-situ characterizations. He credits several pilot grants from the Kentucky Science and Engineering Foundation and the Kentucky NSF EPSCoR for allowing him to "tackle the more challenging, and very exciting, project of iridium oxide superlattices with this NSF CAREER grant."

Seo's long-term goal is to develop functionally integrated, rationally designed heterostructures using novel electronic materials such as complex oxides. "This NSF CAREER grant will allow us to run a highly competitive research program on new material systems, and to advance that long-term goal," he said.



Professor Douglas Strachan was the first faculty member hired in UK's new Center for Advanced Materials, and his Strachan Group now has two active grant awards, one from the National Science Foundation (NSF) and the other from the Department of Energy (DOE).

Strachan's DOE award is titled "Nanoscale Electrical Transfer and Coherent Transport Between Atomically-Thin Materials" and provides funds of $575,000 until August of 2019. The Strachan Group research funded under this award focuses on the experimental investigation of coherent electron transport across atomically-thin interfaces over extremely short length nanometer length scales.

Strachan's second award, from NSF, is titled "Interfacing Nanotubes and Graphene into Ordered Crystallographic Orientations Through Substrate-Induced Strain" and provides funds of $137,610 until June of 2018. The research funded under this award focuses on utilizing strain to probe and control the interactions and alignment of two of the most important nanomaterials, namely, carbon nanotubes and graphene.

Strachan explained, "Our research focuses on the experimental investigation of a variety of nanomaterials (such as nanoparticles, nanotubes, and 2-dimensional materials), their properties, formations, growths, and interactions, with the goal of elucidating the underlying physical behavior dictating these materials." The Strachan Group hopes to provide important physical insight that would be of broad use as future technologies are reduced to their smallest dimensions.

"Extremely small nanomater length-scale effects can dominate the behavior of nanomaterials, ranging from angstrom-level atomic-dimensions, which is the building-block scale of all materials, up to several 10s of nanometers, a size where quantum mechanical effects are still commonly prevalent," said Prof. Stachan. Materials in this size range are expected to form the foundation of a vast array of future technologies, from improved computers and electronics to novel sensors.

The Strachan Group takes a multidisciplinary approach to overcome the obstacles of nanoscale research, including ultra-high resolution scanning probe microscopies, mesoscopic transport measurements, catalysis and chemical syntheses, and nanoscale device fabrication techniques. "The interdisciplinary nature of our research makes a strong contribution to collaborative environment at UK while also providing excellent professional training for group members. The diversity of our research gives students the opportunity to learn a wide array of relevant techniques suitable for a multitude of careers in academia and industry," said Prof. Strachan.

Some of the ways in which Prof. Strachan is actively involved in the professional training of Physics students are: as faculty chair of the UK chapter of the Society of Physics Students (SPS), organizing the weekly Graduate Student Seminar Series, and supervising students at all levels, which have included several postdocs, 10 graduate students, 11 undergraduates, and 7 high school students from the local STEM magnet high school, Dunbar.

Strachan's teaching goals include transforming a graduate course on condensed matter physics into a new device physics course, as well as authoring an accompanying book. His research goals include high-resolution optical and electron microscopy investigations of the dynamics of various nanomaterial systems. "In this effort," he said, "we hope to utilize many of the interdisciplinary methods we are developing to branch into the field of biophysics by investigating the dynamics of nanomaterials relevant to biological systems."

ALUMNI SPOTLIGHT: GLENN GLASGOW

By Julie Wrinn

In his long career in medicine, Glenn Glasgow often received surprised looks when people heard what field his degree was in. "I would tell them, 'I have a Ph.D. in nuclear physics. It's not rocket science: it's harder.'"

He can say so in all humility, because this longtime Fellow in the American Association of Physicists in Medicine was unsuccessful in his first attempt at graduate study. Drawn to physics at an early age, Glasgow even stated "physicist" as his future occupation in his high school yearbook. But, "as a young man growing up in a very rural community," he said, "I had no real science mentors and very limited science guidance."

Glasgow well remembers his first semester at the University of Virginia graduate program, realizing that he was "if not two years, then fully one year behind students from the eastern schools who had a far better educational background than I did." He withdrew after one semester and returned to Western Kentucky University for a provisional teaching certificate. After completing all 32 hours in the spring and summer semesters, he learned about an opening for a high school physics teacher in Ohio.

It was the height of the cold war, and Piqua, Ohio, population 20,000, was unusual in that it had its own demonstration nuclear reactor. A requirement for the physics teacher at Piqua High School was to also serve as community radiation safety officer. To prepare for that, Glasgow needed a week-long course at the University of Kentucky in radiological defense monitoring.

"This was a time when there was quite a bit of concern about nuclear attack," Glasgow said. "The training involved using Geiger counters and other instrumentation to locate radioactive sources and to predict fall-out patterns if bombs were dropped on Chicago that would ultimately affect the Midwest." That week in Lexington in 1966 served as his introduction to radiology, atomic physics, and to UK.

Glasgow would teach high school for just one year, though he truly enjoyed it, but his interest in graduate work was stronger. He secured a position as a graduate assistant at UK to pursue doctoral work in nuclear structure and atomic physics and became aware of medical physics only upon looking for jobs. "I believe I got five offers, all from very excellent programs," he said. "And I thought, well this is such a strong response to my inquiries that I think I shall give this a try."

Glasgow ended up choosing a postdoctoral appointment in 1974 in radiation oncology with the Mallinckrodt Institute of Radiology at Washington University in St. Louis, one of the largest radiology departments in the country. Glasgow laments that it's now more difficult for students with degrees in the pure sciences to transition directly to medicine without a medical degree, compared to the wealth of such opportunities at that time, because he and his peers in medicine from pure science backgrounds were responsible for many innovations at the time. He said, "The cross-fertilization of ideas and talent from outside the field was a great driver in the development of medical physics in the seventies, eighties, and nineties."

Now in retirement, Glasgow makes it a priority to return to UK for regular visits and consistently supports the Marcus T. McEllistrem Summer Fellowship Fund, which provides summer research funding for outstanding graduate students in the Department of Physics and Astronomy. Prof. McEllistrem was Glasgow's thesis advisor, and Glasgow said, "He is an extraordinary individual in his own right, and I'm able to see him still once a year when I attend the Hall of Fame ceremony and the Dean's Advisory Council."

Glasgow has also taken up sailing on the Ohio River with the Louisville Sailing Club. When asked if his background in physics informs his sailing, Glasgow chuckles, "One would hope that a physicist with an understanding of force vectors and a lot of the physics of sailboats would be a good sailor. Unfortunately, that's not true. Sailing is more of an art than a science, and thus far I haven't been an outstanding sailor by any means. But I'm enjoying it very much."

Profs. McEllistrem and Glasgow (l. to r.) back on campus together, October 2016

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Support the Physics & Astronomy Development Fund

We study fundamental questions about nature. Undergraduate majors and graduate students take a complete array of courses with small class sizes that span modern topics in physics and astronomy, and they work closely with faculty researchers in studies of nuclear and particle physics, condensed matter and atomic physics, and astronomy and astrophysics.

Your gift to the Physics & Astronomy Development Fund will provide critical resources to respond to student needs, attract world-class faculty, and provide innovative opportunities to enable our students to compete in the global marketplace.

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We are grateful for your support!