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UNIVERSITY OF KENTUCKY · COLLEGE OF ARTS & SCIENCES

Department of Physics & Astronomy



Greetings from the Department

August 2021

Dear Alumni and Friends of Physics and Astronomy,

I would like to begin this letter by thanking Prof. Alfred Shapere, who stepped down as department chair on June 30, for his four years of outstanding service to the department. For me, it was an honor to have worked closely with Al as the associate chair. From this vantage point, I directly witnessed his dedication and commitment to the department as he led us through the many challenges of the past four years. These included the ongoing renovation of the Chemistry-Physics Building and the relocation of half of the department from our building to Blazer Dining Hall, and then, of course, the pandemic and the near instantaneous pivot of teaching from in-person to online and the many other challenges associated with the pandemic.

Al's thoughtful leadership carried the department through all of these disruptions. In addition, he led the department to many accomplishments and successes. A partial list of these includes the hiring of Assistant Professors Bill Gannon, Ryan MacLellan and Yuanyuan Su; growth to our graduate program and the stipends paid to our graduate students; and expanded access to research opportunities for our undergraduate students. Of special note, our department has been busy this summer with our first National Science Foundation-funded Research Experience for Undergraduates (REU) program (Prof. Christopher Crawford, principal investigator), whose goal is to provide research opportunities to underrepresented

students, including first-generation college students, from Kentucky and the broader Appalachian region.

My goals and priorities for the next four years include continued growth to our numbers and diversity of our undergraduate physics majors program, continued efforts to recruit strong and diverse incoming graduate student classes, rejuvenation of our astronomy and condensed matter research groups, investments in new emerging research directions, such as quantum materials, quantum information and big data; and continued efforts to engage in interactions with alumni and friends of the department.

I will be joined on this journey over the next four years by Prof. Ganpathy Murthy, a theoretical condensed matter physicist, who will be the new associate chair; Prof. Christopher Crawford, an experimental nuclear physicist, who will continue in his role as the director of Graduate Studies; and Prof. Ron Wilhelm, an observational astronomer, who will be the new director of Undergraduate Studies. I also would like to take this opportunity to thank Prof. Renee Fatemi, who decided to step down from her role as director of Undergraduate Studies, following four years of outstanding service in which she made important strides in improving the numbers, climate, and diversity of our undergraduate program.

I look forward to opportunities to interact with many of you in the years ahead, and I am always open to input and comments. Please don't hesitate to reach out to me via email or telephone.

With best wishes,

Brad Plaster
Department Chair
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177F Chemistry-Physics Building



By Jenny Wells-Hosley

A team of faculty and students from the University of Kentucky Department of Physics and Astronomy in the College of Arts and Sciences, supported by the National Science Foundation (NSF), has contributed to a major experiment at the U.S. Department of Energy's Fermi National Accelerator Laboratory (Fermilab). The landmark results, announced today, are changing how physicists understand the subatomic world.

Fermilab's three-year Muon g-2 experiment revealed that fundamental particles, called muons, behave in a way not predicted by the Standard Model of particle

physics. The researchers think this behavior could be caused by the existence of undiscovered particles or forces.

“This new landmark result from the Fermilab Muon g-2 experiment verified a previous tantalizing hint from an experiment at Brookhaven National Laboratory for the need to consider new particles and forces in nature,” said Renee Fatemi, UK professor of physics and co-principal investigator. [Read more.](#)

To learn more about the Muon g-2 experiment, visit <https://journals.aps.org/prl/abstract/10.1103/PhysRevLett.126.141801>.



By Jenny Wells-Hosley

An international team of researchers have discovered a galaxy cluster acting like a passenger on what astronomers are calling an "intergalactic highway." The cluster is known as the "Northern Clump" and is located about 690 million light years from Earth. Previously, scientists discovered an enormous filament, a thin strip of very hot gas, that stretched for at least 50 million light years. This new study found evidence that the Northern Clump is traveling along this filament, similar to how a car moves along the interstate.

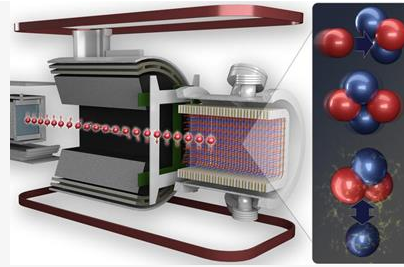
A variety of telescopic images allowed the researchers to observe the galaxy cluster and its movement. Yuanyuan Su, an assistant professor in the University of Kentucky Department of Physics and Astronomy, is one of the lead researchers on the project and led the analysis of the X-ray observation taken by the Chandra X-ray Observatory.

The Chandra telescope has an unprecedented spatial resolution among X-ray telescopes, which reveals a sharp contact edge towards south as the cluster travels through the cosmic filaments.

"In theory and simulations, massive objects in the universe are predicted to grow through the accretion of substructures along the filament of dark matter. It is exciting that such an event is caught in action thanks to the joint observations of X-ray, optical and radio telescopes," Su said. "More discoveries like this are expected over the next few years, particularly with eROSITA, a newly launched survey observatory aiming to provide the deepest view of the X-ray sky." [Read more.](#)

Professor Chris Crawford and Oak Ridge Team
Measure Weak Force

Chris Crawford, a professor in the University of Kentucky College of Arts and Sciences' Department of Physics and Astronomy, is the co-leader of a team that just precisely measured the weak interaction between protons and neutrons, also known as the weak force — one of four fundamental forces in nature.



The one-of-a-kind experiment was executed at the U.S. Department of Energy's Oak Ridge National Laboratory and is the culmination of a decade of research, preparation and analysis. The result quantifies the weak force theory as predicted by the Standard Model of Particle Physics. [Read more.](#)

The experiment measured the weak force between protons and neutrons by detecting the tiny electrical signal produced when a neutron and a helium-3 nucleus combine and then decay as they move through the helium gas target cell.

Professor William J. Gannon Explores Low-Dimensional Spin Chains and Spin Liquids in Metals

The department has welcomed Bill Gannon as assistant professor of Physics and Astronomy in the fall of 2019 after postdoctoral fellowships at Stony Brook University and Brookhaven National Laboratory, Texas A&M University and the University of British Columbia.



Assistant Professor Bill Gannon

Gannon received his B.S. degree in physics from the University of Michigan and his Ph.D. from Northwestern University. He is originally from Alexandria, Virginia, just across the Potomac River from Washington, D.C.

Gannon's primary research interests are in the synthesis of materials with interesting quantum magnetic properties, which he studies using neutron scattering. You can read more about his research [here](#).

How 4 Different Physics Labs at UK Persevered During Covid-19

By Julie Wrinn

Experimental scientists at UK faced unique setbacks during the pandemic, and none more so than experimental physics, where the loss of hands-on time in laboratories is especially difficult to overcome. To protect the health and safety of students, faculty, and staff involved in experimental research, the university established a four-phase plan for resumption of research, from the most restrictive (phase 1, March-June 2020) to the least restrictive (phase 4, begun in April 2021), when 70-100% of normal activities resumed. We visited the labs of Professors Bill Gannon, Nicholas Martin, Brad Plaster, and Ambrose Seo to learn how they pressed forward

to recreate the lab experience for their students while adhering to health and safety protocols. You can read their accounts [here](#).

Nisheeta Desai (Ph.D. 2020) Sheds Light on Mysterious World of Theoretical Physics

By Jenny Wells-Hosley

In theoretical physics, a significant outstanding challenge is the mathematical description of the collective motion of electrons in synthetic materials. Despite nearly a century of research, the subtle laws of quantum mechanics in this regime remain poorly understood. But a University of Kentucky alumna is leading the field in the right direction.

Nisheeta Desai, a 2020 UK graduate and now postdoctoral fellow at the Tata Institute of Fundamental Research, in collaboration with her mentor, Ribhu Kaul, in the UK Department of Physics and Astronomy, has developed a theory that sheds new light on these mysteries. Their work, which recently published in *Nature Physics*, shows how the quantum motion of a synthetic material can be controlled by external magnetic fields. Such magnets may be key to realizing new quantum technologies.

“In our work, we study interactions between a large number of particles and their effect on properties of the material,” Desai said. [Read more.](#)



Originally from Mumbai, India, Desai joined the graduate program at UK in 2014. During that time, she was awarded the Keith B. MacAdam Graduate Excellence Fellowship.

Congratulations to Our Students Who Earned Ph.D.s in the 2020–21 Academic Year

Ashkan Abtahi: “A Theoretical and Experimental Study of Charge Transport in Organic Thermoelectric Materials and Charge Transfer States in Organic Photovoltaics” (Graham (Chemistry) and Brill) – now a postdoc at Purdue University.

Fatih Balli: “Optical Metasurfaces” (Hastings (Electrical Engineering) and DeLong) – now an Optical Design Engineer at ASELAN (Turkey).

Maryam Dehghanian: “A Multi-Wavelength Study of the Disk Winds and their Role in the AGN Studies” (Ferland) – now a postdoc at Space Telescope Science Institute (housed at UK).

Ali Frotanpour: “Magnetization Dynamics in Kagome Artificial Spin Ice Considering the Effect of Vertex and Geometrical Lattice Distortion” (DeLong) – now a plasma engineer at Lam Research (Oregon).

Lakshya Malhotra: “Analyzing the effect of ‘second-class currents’ on Neutron Beta decay observables and Effect of Thomas Rotation on the relativistic transformations

of Electromagnetic Fields” (Plaster) –now a postdoc at U. Wisconsin.

Tom Pace: “Predicting Material Properties: Applications of Multi-Scale Multiphysics Numerical Modeling to Transport Problems in Biochemical Systems and Chemical Process Engineering” (Kekenes-Huskey (Chemistry) and Kaul) – now a postdoc at Loyola University Chicago.

Justin Woods: “ Electric and Magnetic transport properties of Periodic and Aperiodic Artificial Spin Ice” (DeLong) – now a postdoc at Argonne National Lab.

2020–21 Scholarships and Fellowships

We are saddened to share news of the recent passing of Barbara DeMarcus Mostert, who established a scholarship in honor of her late husband, Wendell C. DeMarcus, a longtime distinguished faculty member in our department. Many thanks to her and other alumni and friends for their generous support of the following students:

- **Wendell C. DeMarcus Scholarship:** Nathan Duncan, Richard Lai, Tabitha Charter, Michael Navis, Jacob Styer, Faith Makumbi, and Alexandra Mucci
- **Keith B. MacAdam Graduate Excellence Fellowship in Physics & Astronomy:** Sinong Liu
- **Physics and Astronomy Alumni Scholarship:** Gabija Ziemyte

Private support makes an enormous difference for our students. Thank you!

THE PHYSICS & ASTRONOMY DEVELOPMENT FUND

Your gift to the Physics and 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. We explore 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.

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For questions please contact Debra Gold (debra.gold@uky.edu) or 859-257-8124.



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