

Quantum Leap 2023

The Melton Memorial Observatory

By: Martin Bowers

Now in its 95th year of operation, the Melton Memorial Observatory serves both as an astronomy laboratory for the University of South Carolina and as a science ambassador to the general public. Dedicated in 1928 in memoriam of Dr. William Davis Melton, former president of the University, the observatory continues fulfilling its mission to teach the science of Astronomy.

Although most weeknights are reserved for laboratory use, the observatory is open every clear Monday evening for public viewing. We also host special viewing events and provide daytime tours for numerous organizations throughout the year. One popular annual event is a night of stargazing for Family Weekend. In the 2023 version of this event, a great many special guests of all ages were treated to views of Lunar craters and the rings of Saturn.

As shown in Figure 1, the observatory's main instrument is a 16" Cassegrain telescope driven by a truly massive mount. Although currently driven by modern electronics, the mount itself dates back to 1928, and its continual operation testifies to the design and craftsmanship of its builders. With the assistance of student volunteers, public viewing nights also use rooftop-mounted portable telescopes to provide simultaneous viewing of multiple objects.

Sometimes during a public viewing session, we will set up one telescope with a camera. This enables us to view dim objects on a computer screen not easily seen through an eyepiece in our light-polluted metropolitan environment as well



Figure 1: Melton 16" Cassegrain Telescope

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as demonstrate the process of astro-imaging. A few examples are seen in figures 2 and 3.

The Lunar image in Figure 2 was made from a video sequence captured live during a public viewing session in April of this year. Using freeware software, the sharpest frames were selected, aligned, and sharpened to produce a dramatic view of the Moon's surface.

Figure 3 shows Messier 13, the great globular cluster in Hercules. This image was made in June of this year using similar stacking techniques but with a different sort of camera. In this case, a DSLR (Digital Single Lens Reflex) camera was used to continuously capture 10" exposures. Our guests viewed the individual frames live on a laptop screen during a regular Monday night viewing session, and the processed result was then posted on the Melton Facebook page.

The observatory is open most clear Monday evenings throughout the year. All you need to do for an out-of-this-world experience is stop by and climb the spiral staircase into the dome.

Come check us out!



Figure 2: Lunar Surface



Figure 3: M13, the Great Globular Cluster in Hercules

MESSAGE FROM THE CHAIR



exciting first year for me. There have been many new developments in the Department last year.

First, we are proud to welcome two new staff members to the Department! Our new Business

Welcome to another year of *Quantum Leap!* This is my second newsletter as the Chair of the Department of Physics and Astronomy here at the University of South Carolina. It's been an

Manager, Mr. Doug Brooks, and our new Student Services Coordinator, Ms. Nancy Kesar, are here to help us advance our mission of excellence in research and education.

Second, several members of the Department have been recognized by the University and national organizations. At the University, Prof. Varsha Kulkarni received the 2023 USC Educational Foundation Research Award for Science, Mathematics, and Engineering. Prof. Frank Avignone was awarded the 2023 USC College of Arts and Sciences Distinguished Faculty Award, and Prof. Ralf Gothe was selected for the 2023 Breakthrough Leadership in Research Award. Ms. Beth Powell was awarded the 2023 Staff Senate Outstanding Staff Award (2nd place). At the national level, Prof. Timir Datta was named a 2022 Fellow of the American Association for Advancement of Science.

Last year, our Department hosted an international collaboration meeting of CUORE collaboration. The week of intense discussions of neutrino physics culminated in “Hidden Neutrinos: a symposium in honor of the 90th birthday of Prof. Frank Avignone.” Many distinguished physicists from all over the world attended the meeting to talk about Prof. Avignone’s many contributions to the field of particle astrophysics.

The Department will also host the XV International Conference on Beauty, Charm, and Hyperons in Hadronic Interactions (BEACH 2024) on 3-7 June 2024. This conference will take place in the Historic District of beautiful Charleston, SC. Such meetings boost the reputation of our Department and the University of South Carolina as the international research powerhouse.

There were promotions and retirements in our Department. We are happy to announce that Prof. Matthias Schindler has been promoted to Full Professor. Prof. Alice Churukian has been named an Undergraduate Program Director. We look forward to their continuing service to the department and the University.

At the same time, two of our faculty members decided to retire last year. After many years of

service, Prof. Fred Myhrer and Prof. Jeff Wilson announced their retirement. We wish them all the best and hope they will still visit the Department often.

A significant development occurred last year: the Department agreed on a long-term strategic plan, which will chart our way forward in the next five years. I want to thank the Strategic Planning Committee, headed by Prof. Mas Crawford, for this achievement! The Department is poised to grow in size and its research, educational, and outreach activities. We already started the implementation of our Strategic Plan: this year, we are searching for three new faculty in observational astronomy, experimental nuclear physics, and experimental condensed matter physics. We hope those initiatives will help us better serve the people of the great state of South Carolina!

We would love to hear from you, whether far away or nearby. If you are in the vicinity, please stop by!



Alexey A. Petrov

UPDATES FROM THE DIRECTORS

News from the Director of Graduate Studies

By Matthias Schindler

When we think of breakthrough discoveries, we often think of the “big names” – the people who end up going to Stockholm to collect their Nobel Prizes. However research in physics and astronomy is most often a collaborative effort, and success is not possible without the contributions of many researchers – among them graduate students. They are often the unsung heroes of large-scale research endeavors: working on crucial details, spending countless hours testing and calibrating detectors, and taking long shifts running an experiment. The same is true for our graduate students. They form the backbone of the many exciting research projects that are

being pursued in our department, and without our graduate students, these projects would not be feasible.

New students

Ten new graduate students joined the department in the past year: Mohammadali Khosravi, Deepak Sharma, and Ahmad Sherzad joined us in Spring 2023, and Nathan Astin, Andrew Boldy, Tara Hassanzadeh, Siavash Karbasizadeh, Kasra Kiaee, Thomas Lee, and Sudheer Muhammad started their graduate student journey at USC in Fall 2023. We are excited to welcome them as new members of the department.

New graduates

Congratulations to all new graduates! Douglas Adams, Vincent Dowling, Abdul (Rahman) Mohtasebzadeh, Kenneth Stephenson, Kevin Wilson, and Chatura Kuruppu obtained their Ph.D.'s, while Franklin Adams, Anne Flannery, and Nishadi Silva completed their M.S. degrees. We wish them all the best for their next steps and are looking forward to hearing about their future successes.



New Graduate students in the Fall 2023 cohort From left to right: (Tara Hassanzadeh, Cheongheon Lee, Kasra Kiaee, Andrew Boldy, Nathaniel Astin, Sudheer Muhammad, Siavash Karbasizadeh)

Awards

Congratulations to the recipients of the Department of Physics and Astronomy Graduate Student Awards: Arjun Karki was the recipient of the Graduate Research Award, Jean-Joseph Benoit received the Graduate Teaching Award, and David Edwins and Edoardo Vergallo Gazzina received the Graduate Service Award. In addition, new graduate student Kasra Kiaee was accepted for the highly competitive CAS Graduate Assistantship Enhancement Program.



Winners of our departmental Graduate Student Awards (April 2023). From left to right: Arjun Karki (Research), David Edwins (Service), Edoardo Vergallo Gazzina (Service), Jean-Joseph Benoit (Teaching), Dr. Matthias Schindler (Director of Graduate Studies)

News from the Director of Undergraduate Studies

By Alice Churukian

Over the past several years, we have been working to improve our undergraduate program and this year is no different. We continue to work on adding a major in Astrophysics and are looking to expand in other areas as well. Areas under consideration include Biomedical Physics, computational physics, and Quantitative Finance. Progress on the transformation of our Introductory Physics courses to the Lecture/Studio format continues. During the summer of 2022, we did modest renovations to a classroom and offered the calculus-based mechanics course, Physics 211, in the new format. Evaluation is still underway, but initial

findings are favorable. Using an internationally approved concept survey we can compare our students' gains in conceptual understanding of forces not only to our own students before the conversion but also to students around the globe. Before the conversion, our students' learning gains were in the middle to lower end of the range that is considered normal for students in "traditional" introductory physics course. Post conversion, our students' conceptual gains – both semesters - moved solidly into the range of what is considered normal for students enrolled in "active engagement" courses such as ours. Student reactions have been mixed on

surveys and informal discussions. Some love the collaboration and hands-on learning while others dislike having to talk with their peers and learn the concepts “on their own.” This fall, we implemented the second-semester course in the

calculus-based sequence. Unable to renovate the laboratory rooms over the summer, the studio sessions are meeting in one of the lab rooms with some modifications to accommodate group work.

Plans for renovating the lab rooms next summer are underway. Once we have the new studio rooms, we will begin converting the algebra-based into physics courses to the Lecture/Studio format while also changing the content to be engaging to students of the life sciences.

Two undergraduate physics students received major awards during last spring’s University Awards Ceremony: Grayson Fletcher received the Nina and Frank Avignone Fellowship for achievement in physics and Alexander Nelli received the Lovelace Family Endowed Scholarship, which rotates between physics and mathematics.

Congratulations and best wishes to our 2022-2023 Graduates:

Fall 22

- Brennan Ortiz

Spring 23

- Nathaniel Astin
- Andrew Boldy
- Dilip Demsar
- Caleb Fairchild
- Grayson Fletcher
- Tyler Kagen
- Alexander Nelli
- Daria Vecherskaia



Grayson Fletcher (Class of 2023) received the Nina and Frank Avignone Fellowship Award. Dr. Alice Churukian (Director of Undergraduate Studies) presented this award at the special Awards Day celebration on April 20, 2023.

RESEARCH GROUPS

SmartState Center for Experimental Nanoscale Physics

By Rongying Jin

Center faculty, post-doctoral fellows, graduate-, undergraduate- and high-school students strive for excellence in research. During July 2022 and June 2023, we published 21 journal articles. Prof. Pershin has also co-authored a book, **Memristors, and Memelements: Mathematics, Physics and Fiction**, published by Springer (see the cover page on the next page). This book, written by two pioneers in the field, offers a straightforward and succinct explanation of memristors and other memory elements. It emphasizes the contrast between their mathematical definition and their physical reality. As a result, the reader will be able to differentiate between what is experimentally achievable and various fictitious claims that are present in scientific literature.

As the authors stressed, the book should be easily accessible not only to graduate students and researchers in Physics and Engineering, but also to undergraduate students interested in this topic.

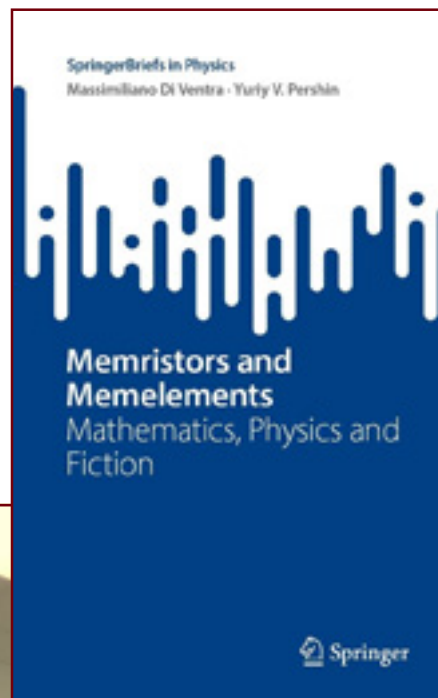
To promote research excellence, the Center facilitates various forms of discussion, including

- weekly Journal Club talk (scheduled by Dr. Bryan Chavez) or invited Condensed Matter Physics Seminar (scheduled by Prof. Rongying Jin)
- monthly center faculty meeting (every second Friday afternoon)
- daily coffee break gathering.

The synergistic activities described above between researchers illustrate the ability and motivation to work together effectively for successful project delivery. In addition, the partnership/collaboration with industry is instrumental to the project's mission. The center researchers visited and toured ThorLabs

Spectral Works in Columbia to explore opportunities for both scientific innovation and workforce development (see photo on the left).

We will routinely update news via the center website: https://sc.edu/study/colleges_schools/artsandsciences/physics_and_astronomy/research/cenphys/index.php.



USC condensed matter physicists (6 faculty members, 2 postdoctoral fellows, and 8 graduate students) visited (on March 29, 2023) ThorLabs Spectral Works at Columbia led by Mr. Jason Williamson.

Experimental Nuclear Physics Group

By Ralf Gothe, Yordanka Ilieva, and Steffen Strauch

The study of the atomic nucleus and its constituents at the quark level is at the core of our research. We are leading experiments at one of the flagship facilities for nuclear physics research in the U.S., the Thomas Jefferson National Accelerator Facility (JLab), and at the Paul Scherrer Institute (PSI) in Switzerland. We have also been responsible for the construction of critical equipment for major nuclear physics experiments at JLab and PSI. Our studies on Quantum ChromoDynamics (QCD) and nuclei are recognized as U.S. nuclear science frontiers, and our research helps to address basic questions such as: what is the origin of confinement and most of the visible mass in the universe, what is the nature of neutron stars, and what are the properties of dense nuclear matter? Answering these and related questions is a complex task requiring dedicated experimental observations

and careful testing of theoretical predictions against measured observations.

Currently, our group is comprised of faculty members Ralf Gothe, Yordanka Ilieva, and Steffen Strauch, postdoctoral fellow Matthew Nicol, postgraduate Anne Flannery, and graduate students Chris McLaughlin, Krishna Neupane, Alexis Osmond, and Nishadi Silva (see Figure 1).

We are excited to be able to share with you new and important results from our experiments at JLab. We extracted and published information on the first radial excitation of the Delta resonance that, before, had only been theoretically predicted. With our data, we could confirm the prediction, which underlines how the experimental and theoretical understanding of the strong interaction becomes more refined year after year, which we documented in a review article this spring. Chris

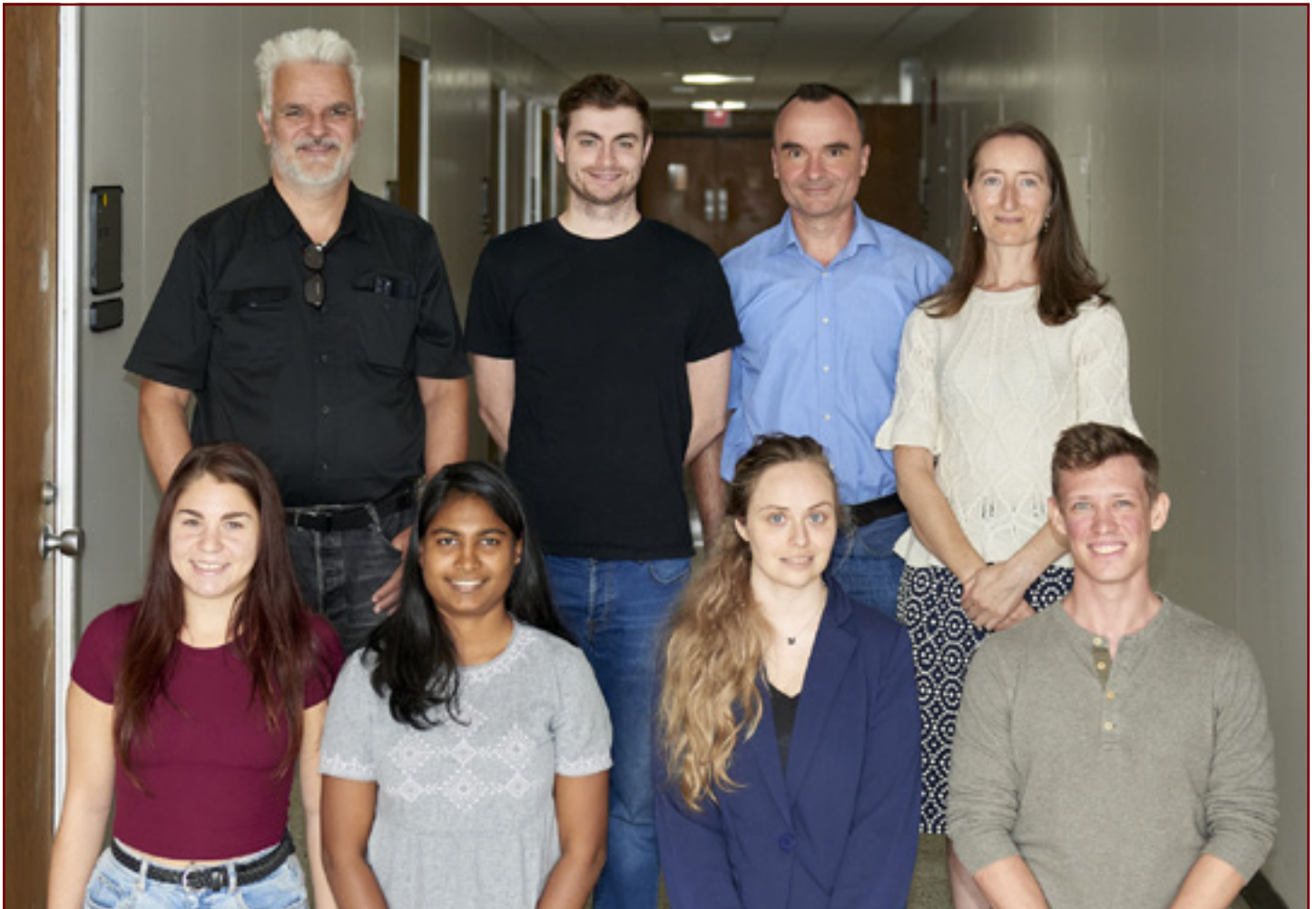


Figure 1: Front row from left to right: Alexis Osmond, Nishadi Silva, Anne Flannery, and Christopher McLaughlin. Back row from left to right: Ralf Gothe, Matthew Nicol, Steffen Strauch, and Yordanka Ilieva. Krishna Neupane could not join us when the photograph was taken.

McLauchlin further refines the analysis of this data to include the determination of the beam-spin-asymmetry cross sections and works to reduce the statistical uncertainty further by analyzing the data of another major experimental measurement campaign. In a more recent experiment, an even higher-energy electron beam smashed into a proton target, which caused a spray of nuclear reactions that were then measured by the new CEBAF Large Acceptance Spectrometer (CLAS12). We will use these novel data to search for new excited states of the nucleon and to probe deeper into the origin of the visible mass in our universe. Krishna Neupane has already extracted the first normalized yields for one of the more complicated multi-particle final states to achieve these goals. He and Alexis Osmond, who joined us this summer, have simulated and explored how an energy and luminosity upgrade could be a unique opportunity for an extension of our program. Their results provided key information that we incorporated into the “Strong Interaction Physics at the Luminosity Frontier with 22 GeV Electrons at Jefferson Lab” whitepaper.

We continued the data analysis of our low-energy deuteron experiment from JLab, where a beam of

the same target cell. The CLAS detector measured the recoil deuteron and the charged products, a proton, and a pion, of the decay of the scattered Λ . In the past year, our efforts were focused on the determination of the number of the Λ beam particles. Nishadi Silva extracted the yield of inclusive Λ photoproduction and successfully defended her master's thesis on this topic. In the summer, undergraduate Dayton Proffit began a new analysis where the deuteron nucleus breaks up when hit by a Λ particle. In this case, two protons, a pion, and a neutron are detected by the CLAS. Dayton's work on a small data sample showed that an improved momentum determination of the neutron is needed. Both studies provide input for the estimate of the probability of Λ -deuteron scattering, which will shed light on the elusive hyperon-nucleon three-body force that could be key to resolving the hyperon puzzle in neutron stars. Our research on this topic was presented at the HADRON23 international conference in Italy and our latest results will be presented at the meeting of The Southeastern Section of the American Physical Society.

In the past year, we continued our work on detector projects supporting a future U.S. Electron Ion

Collider (EIC). Our collaborative proposal to develop a muon detection system based on the one constructed for Belle-II was funded. In the summer, undergraduate Preston White implemented a simplified layered detector design in an existing simulation framework. The design is a sandwich of thin scintillation layers and steel plates and allows for a proof-of-principle of muon identification. Preston will be presenting his research at the Division of Nuclear Physics Fall Meeting this year. The funding also allowed us to purchase several scintillator bars of different lengths, whose timing and position resolution we will be measuring on a test bench. A

continuation proposal for next year is awaiting a decision. Our goal is to construct the muon detector in our detector lab on campus that was developed for the FTOF and MUSE scintillators.

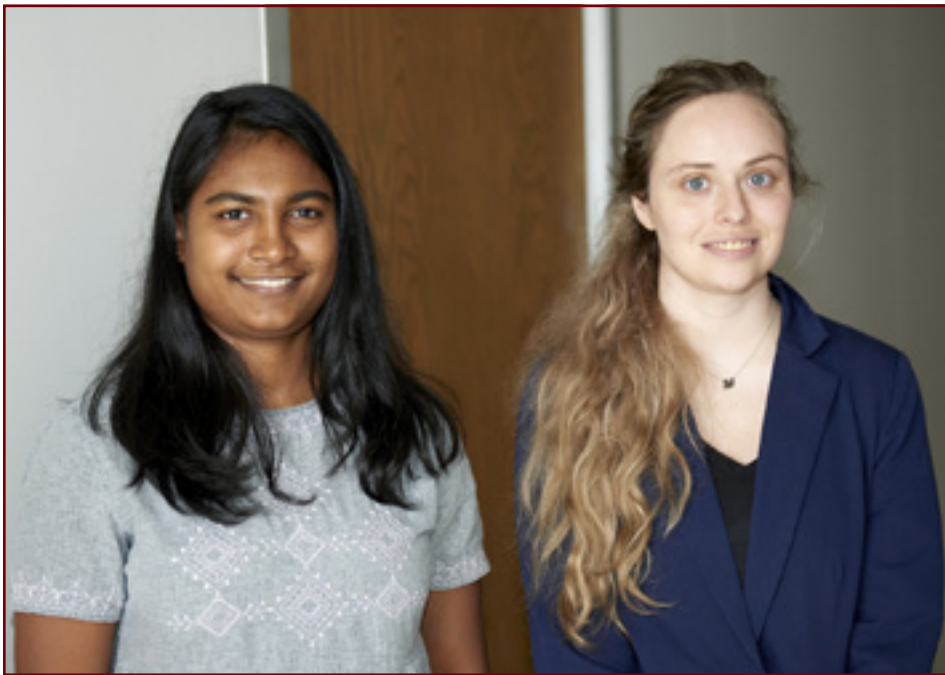


Figure 2: Nishadi Silva (left) and Anne Flannery (right) earned their M.Sc. degree this summer. Congratulations!

shortly lived Λ particles is produced in a first step when the primary real photon beam interacts with a deuteron nucleus. In a second step, the Λ beam scatters elastically off another deuteron in

With the start of production data taking this past summer, our Muon Scattering Experiment (MUSE) at PSI has begun measuring cross sections of electrons and muons that scatter elastically off a proton target. The data will allow us to directly compare μp and $e p$ interactions, extract the proton charge radius, and study two-photon exchange effects. Anne successfully completed her M.S. project with her work on gamma calibrations of MUSE scintillation detectors. She graduated in the summer. The scattered-particle scintillators are part of the triggering system, and precise energy calibration of these detectors is critical for understanding the detection threshold of electrons and muons. Knowledge of that threshold is a key input to radiative corrections that need to be applied when interpreting our measured cross-sections. The project got much-

needed reinforcement with Dr. Matthew Nicol who joined from York University as our group's new postdoctoral fellow. Matt took part in the MUSE workfest for a productive week at Stony Brook University. He and other developers made substantial progress towards the data analysis software for MUSE. One of Matt's main goals is the inclusion of relevant physics processes in an event generator for the MUSE Monte Carlo simulation, and to tackle the problem of rare event simulations. Matt, Anne, and other members of the group have worked on detector maintenance and calibration. In 2023, we have supported the first part of the MUSE beam time with 65 experiment shifts, more shifts are coming up in December. S. Strauch followed E. Downie (GWU) as elected spokesperson for MUSE in April 2023.

Theoretical Nuclear and Particle Physics

By Brett D. Altschul, Vladimir Gudkov, Pawel Mazur, Alexander Monin, Alexey Petrov, Matthias Schindler

The theory group, consisting of faculty members Brett Altschul, Vladimir Gudkov, Pawel Mazur, Alexander Monin, Alexey Petrov, and Matthias Schindler, as well as graduate students and post-doctoral associates, is active in many different areas of medium- and high-energy nuclear and particle physics research.

Brett Altschul is currently working with several graduate students on different projects. Harry Oslislo, who is finishing a Ph.D. in the department after retiring from a career with the pharmaceutical company Merck & Co., has been working with Dr. Altschul on understanding the transition period at the end of inflation in the early universe. Inflation is a paradigm in cosmological models in which the universe underwent a brief but explosive period of exponential expansion in the earliest moments after the Big Bang. The smoothing effect of the rapid expansion would explain why the universe as we see it today is almost perfectly flat, with an extremely homogenous distribution of matter and energy. Mr. Oslislo's dissertation research has looked at the consequences of having a gradual end to the inflationary epoch, rather than the rather abrupt transition that is usually assumed.

Another student working with Dr. Altschul, Sapan Karki, is also finishing his dissertation, having worked and published on a number of topics

related to fundamental symmetries, including the possibilities of CPT violation and breaking of relativistic Lorentz boost symmetry. As part of this work, Mr. Karki has effectively led the way for an international group of collaborators performing calculations of quantum corrections in the kinds of theories that are capable of describing these exotic forms of symmetry breaking. Most recently, he has turned to studying quantum corrections in theories featuring both fermions and bosons, coupled through solitary wave configurations, and his work with Dr. Altschul has shown that the most natural descriptions of some tunneling processes in such systems may involve the interchange of novel pairs—each pair consisting of just half a fermion bound to half an antifermion!

Vladimir Gudkov continues to be involved in a variety of projects to study fundamental symmetries in particle physics and nuclear systems. His theoretical work supports several experimental programs in the U.S. and Japan, related to the activity of the international NOPTREX collaboration for a search for time-reversal invariance violation in neutron scattering at the Japan Proton Accelerator Research Complex (J-PARC) facility in Japan.

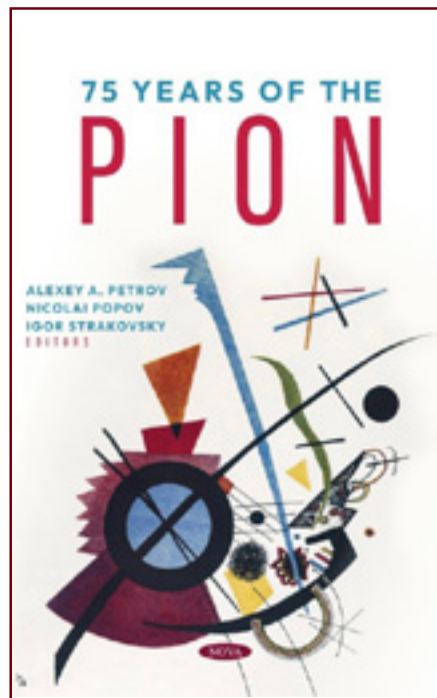
Dr. Monin is working on new developments in the theory of nonperturbative systems. In the world of physics, we are always trying to uncover the

secrets of the universe, and frequently we need to venture beyond our usual methods to find the answers. In quantum field theory, we often use a method called perturbation theory, expanding observables in power series in a small coupling constant like the electron charge. However, there are times when this method falls short—particularly when dealing with exceptionally strong forces like in quantum chromodynamics (QCD), which describes the interactions that hold nucleons together, or when there are lots of particles involved. Figuring out new ways to understand these tricky situations is a big challenge in physics today. Upcoming experiments will explore energies where traditional methods are inadequate, emphasizing the need for new approaches. Currently, Dr. Monin is working on better ways to tackle these tough situations. He and his collaborators have made good progress in simple cases, leading to demonstrations of intriguing differences in how forces behave in different theories. Additionally, they have been investigating energy and charge fluxes in specific field theories. Remarkably, these theories can be explained using an effective field theory technique. This helps our understanding of energy and charge dynamics in these theories, even when the forces are strong, and Dr. Monin plans to apply the method to more general cases that are less reliant on certain special conditions.

In 1973 H. Fritsch, M. Gell-Mann, and H. Leutwyler proposed quantum chromodynamics as the theory of the strong interactions. Matthias Schindler, together with his colleague S. Scherer contributed an article to a commemorative volume, *50 Years of Quantum Chromodynamics*, to be published in the *European Physical Journal* this year. This volume is a comprehensive review of the developments and successes in QCD, both theoretically and experimentally, over the last five decades. Together with his collaborators R. Springer and Thomas Richardson (formerly a graduate student in our department and now a postdoctoral researcher in Mainz, Germany), Dr. Schindler also published an invited review article on the implications of the large- N_c approach on

the nucleon-nucleon interactions, a topic that they have been pursuing for the last few years.

Searches for heavy new particles predicted by theories that would supersede the Standard Model of particle physics do not necessarily require huge particle accelerators. Studies of minute quantum effects, called indirect searches for New Physics, allow for observing new ultra-heavy particles at low-energy accelerators and in tabletop experiments. Alexey Petrov and his research group, which includes postdoctoral fellow Girish Kumar and a graduate student Sudheer Muhammad, continue their work to evaluate the effects of strong interactions that limit our ability to interpret the outcomes of such experiments and propose new observables in lepton-flavor-violating transitions with muons and tau-leptons. Dr. Petrov's research also addresses theoretical analyses of baryon-number-violating transitions in heavy and light quark systems at colliders and in muon conversion experiments. He has recently published a new book, *75 Years of the Pion*.



Dr. Petrov has been helping to evaluate and direct experimental research at many high-energy physics labs around the world. He continues his service as a member of the Belle Program

Advisory Committee (BPAC), KEK Lab (Japan), providing recommendations on scientific, technical, and planning issues related to Japan's High Energy Accelerator Research Organization (KEK) B-factory project, mainly focusing on the progress of the Belle II experiment. This year, he's been invited to become a member of the International Advisory Committee for the newest accelerator lab, the Super Tau-Charm Factory (STCF), currently under construction in Hefei (China).

EVENTS, EDUCATION AND OUTREACH



Figure 1: Our volunteers for this year! Unfortunately, not everyone was pictured.

Midway Physics Day

By Yanwen Wu

This year marks the 29th Midway Physics Day (MPD) at the SC State Fair. A lot of things are the same. Around 25 faculty and student mentors performed demos for nearly 2000 high school students and teachers from all over South Carolina, continuing to deliver the message that physics is exciting and fun. Thorlabs was able to join us again this year. They had an exciting demonstration. At the same time, we are also ushering in some big changes. We had a few new demonstrations and new schools come to the event this year! Professor Jeff Wilson retired this year. He has been the cornerstone of MPD for so long, that it is strange to not see his face peering through the polarizer sheets at the demonstrations for the first time. Sam



Figure 2: Volodymyr Shablenko demonstrating liquid nitrogen to the students.

Beal, our Student Coordinator, who has been a constant in the department and a big contributor to the success of MPD, is now reprising his role at the School of Journalism. Both will be missed dearly, and it is not just because they have left some big shoes to fill. Fortunately, we do have people stepping up to meet this challenge. We would like to introduce everyone to the “new Sam”, Nancy Kesar (our new Student Coordinator), and the “new Jeff”, Yanwen Wu (Associate Professor). They have done an outstanding job in continuing the legacy of MPD this year. Their efforts and hard work paid off as we checked off another successful year at the SC State Fair. Until next time, “meet us at the rocket”.



Figure 3: Natile Turman doing live demonstrations.

News From Milind Kunchur

Professor Milind Kunchur had a productive sabbatical in 2023, forging collaborations with people in many different fields. This culminated in the completion of a comprehensive 24-page long review paper “The Human Auditory System and Audio”, published on July 28th, which has corrected decades-old misconceptions and brought a new level of understanding to multiple overlapping disciplines (Acoustics, Audio Engineering, Biomedical Engineering, Communication Sciences, Music, Neuroscience, Otolaryngology, Physics, and Physiology). One striking result of this work is that the number of informational variations resolved by the ear’s output has seventeen more zeros than the number of stars in the universe!

During 2023, Kunchur was an invited speaker at three international conferences and gave seven colloquia. His various 2023 talks were given in the following departments/organizations: Physics, Audio Engineering, Applied Physics, Biology, Neuroscience, Public Health, and Music. The Audio Engineering Society (AES) invited him to conduct a workshop “Toward an objective understanding of high-end audio” (the first of its kind) at their Convention in Helsinki, Finland in May 2023. This

workshop was like a Woodstock event for high-end audio. The panel members had many AES officers including the 2022-2023 AES president (Prof. Joshua Reiss from Queen Mary University of London).

On the teaching front, during his sabbatical, Prof. Kunchur had the opportunity to talk to students and teachers in other parts of the world, in addition to having close contact with physics teachers (ranging from high school to university level) in the Carolinas and Georgia through his life membership and service in the SACS-AAPT.



Audio Engineering Society (AES) workshop “Toward an objective understanding of high-end audio”, co-organized by Professor Kunchur, at the AES Convention in Helsinki, Finland in May 2023.

He is currently serving as the 2023-2024 SACS-AAPT president and will be organizing and hosting the Spring 2024 conference. Kunchur received a CTE (USC's Center for Teaching Excellence) Letter of Commendation in Spring 2023, marking his 7th teaching honor and the

highest overall teaching recognition at USC. He has been working on converting his teaching experience into transferable and actionable advice and gave a workshop at CTE on August 30, 2023. This workshop had high attendance and received glowing reviews from the attendees.

STUDENT AND ALUMNI SPOTLIGHTS

Sigma Pi Sigma

By Adam Fisher

Early in 2023, I was very excited to hear from Dr. Yanwen Wu about the Sigma Pi Sigma ($\Sigma\Pi\Sigma$) chapter being re-started at the Univ. of South Carolina's Physics and Astronomy Department. It is a wonderful organization for keeping alumnus, like me, engaged with their local, regional, and national scientific communities. This is particularly true for those of us working in an industry that may be less in tune with current scientific achievements, as time passes. Beyond my excitement about the return of the

chapter, to be allowed to be the first inductee was a significant and meaningful honor. As an alumnus of the department, I am continually amazed at the opportunities (graduate school, career, awards, and beyond) that come with that distinction. As a member of the $\Sigma\Pi\Sigma$, I have already begun to leverage the tools and communities granted to recipients.

The induction process was a positive experience, with an opportunity to reconnect with past professors and colleagues, as well as meet the many new faces that now call USC home. This was a great opportunity to catch up on the current state of the department, as well as look for new ways to engage with the university and, more specifically, the Physics and Astronomy department. I am very much looking forward to the next induction ceremony and the chance to connect with the future generation of scientific leaders. The Physics and Astronomy student body is fortunate to have such a committed faculty, like Dr. Wu. The alumnus, local community, academic community, Sigma Pi Sigma Chapter, and I are grateful for all the things the department does for academia and for encouraging the next generation of leaders to approach problems with a scientific mind and curiosity.

The USC chapter of $\Sigma\Pi\Sigma$ will start hosting annual induction ceremonies for our undergraduate students. We are excited to acknowledge the service and scholarship that our students perform both inside and outside of the classroom.



The S.M.A.R.T Program

By Caleb Duff

The study of physics lends itself well to academic settings. Access to other brilliant researchers and advanced equipment leads to ample opportunities to explore new ideas. With all these advantages, it can be easy to feel that a physicist can only work in academia. While the benefits are many, there are also a multitude of opportunities outside of academia for physicists to research and contribute their knowledge to society.

I have had the privilege these last few years while working on my Ph.D. to be a S.M.A.R.T. scholar. The S.M.A.R.T. program is an outreach program by the U.S. Department of Defense (DoD) to help recruit STEM students for the next generation of DoD researchers. The program emphasizes giving students both academic and practical experience to help them excel in their chosen field of research.

To join the program, students apply by describing their research goals, professional aspirations, and desired fields of work. The S.M.A.R.T. program then sends these applications out to DoD research facilities across the country. Project leaders then assess the applications and interview applicants to find out if their program is a good match for them. They will then be

given annual research projects to work on each summer at the facility and become a full-time employee upon graduation.

Once students have participated in the program, many opportunities lie before them. Some students will stay in leadership positions to help direct future research, while others become independent contractors. Advisement positions are also open for those students to help military leaders and politicians with scientific matters.

I deeply appreciate my time participating in the S.M.A.R.T. program. I have had the opportunity to work with fantastic mentors and future coworkers on research close to my heart. The opportunity to always be given new problems to solve and tackle them with skills I've been honing all these years is deeply satisfying.

The skills gained in your studies do not only have a home in academia. Many opportunities exist in a variety of places. The combination of mathematics, problem-solving, lab skills, and general ability to learn challenging things can get you far in many places. Always feel free to explore more than you thought could be done before!

The Dual Nature Of A Graduate

By Edoardo Vergallo Gazzina

I am currently a third year PhD student at USC, and I am passionate about physics and mathematics. In the past semesters, I have almost always been a Teaching Assistant for the Astronomy course, thus I familiarized with the material, as well as the students' expectations and experiences. As a graduate student, your goal should always be to push yourself, to be better, to thrive, and also to enrich your community. For these reasons, when Dr. Petrov offered me the opportunity to be the Instructor of records for Astronomy 101, the "yes" came strong and natural. However, before accepting the position, I made sure I was qualified enough to start this journey, because, regardless of my physics knowledge, I knew that I had to interact with young students, most of which are not science majors, and most of which

are freshmen; your first experience with science and College should be challenging, but exciting at the same time; you should feel the need to know more, and to improve your skills so that you can reach that goal.

This is the first (and one of the most important) aspects of this dual nature that I am loving: the possibility of guiding and helping newly students through a path that I took too, and to try my best to make sure they can walk that path with (at least) the same passion I had. Needless to say, most of them are scared of science, and mathematics in particular. Being a student, sometimes I find myself struggling with problems too, and I have a deep desire to let them see the beauty of this field, and to get comfortable with formulas and

numbers, so that eventually they can start seeing them as the powerful tools they are, and not just as a tedious routine of rules, that fell from the sky and somehow work.

A funny aspect is that my schedule is also planned so that I have a class to attend right before the class I teach, so that during the same morning I take off my student clothes, and wear the instructor ones. This is the second aspect I love: being able to live on both sides of the desk in such a short period of time.

It is truly a mind-opening experience, and the ability to understand what each part involved in a lecture needs and feels, is really invaluable. This “transforming” aspect makes me empathize more with the students, because I know how stressful the night before an exam can be, or how something can go wrong and a deadline is missed. At the same time, it makes me strive to be a good student, one that submits assignments in time, is responsive in class and gives feedback, one that listens.



There is no shame in admitting that we are human beings, and learning is an ongoing process: no one is all knowledgeable at birth, and a good mind never takes a day off from learning. I have a long way to go still, as an instructor, as well as a scientist, but this experience is teaching me a very good lesson on how to be better in both.

NEWS

Lunch With The Chair

Dr. Petrov hosts a weekly lunch with faculty where they can enjoy a meal and talk Physics.

Five O'clock Tea

Every Wednesday our faculty have teatime where they come together and build community.

Snowmass Process

Alexey Petrov led the activities of the Frontier for Rare Processes and Precision Measurements of the Snowmass process that concluded in 2023. The Snowmass process establish a vision for the US Particle Physics for the next 10 years.

Awards

Timir Datta

2022 Fellow of the American Association for Advancement of Science.

Beth Powell

2nd place 2023 Staff Senate Outstanding Staff Award.

Frank Avignone

2023 USC College of Arts and Sciences Distinguished Faculty Award.

Varsha Kulkarni

2023 USC Educational Foundation Research Award for Science, Mathematics, and Engineering

Ralf Gothe

2023 Breakthrough Leadership in Research Award.

Jake Martin

Best Student Paper Award titled “Measurement of Magnetic Particle Concentrations in Wildfire Ash via Compact NMR” at the 2022 IEEE Sensors conference



UNIVERSITY OF
South Carolina

Department of Physics and Astronomy

712 Main Street, PSC #404
Columbia, SC 29208

Telephone: 803-777-8105

Fax: 803-777-3065

Email: nkesar@mailbox.sc.edu

www.physics.sc.edu

Department Chair

Alexey Petrov

Director of Graduate Studies

Matthias Schindler

Director of Undergraduate Studies

Alice Churukian

Editors

Nancy Kesar, Sasha Monin

Layout and Design

David Bishop