Vandalizing the Universe

University of Idaho
Department of Physics

Home of Physics and Astronomy on the Idaho Palouse

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URL: https://www.uidaho.edu/sci/physics/news/physics-newsletter

Message from the Chair

Despite the interference of the pandemic, we have carried on with our teaching and research. With safety protocols in place, classes and labs did function, through the efforts of the faculty and teaching assistants. Much of the teaching was done by Zoom, though some classes and the instructional labs met in person in a hybrid format that mixed remote and in-person participation. This pushed continued expansion of video technology use. We do expect to be back fully in-person for the fall semester, with the now-familiar video technologies playing a supporting role that will broaden the student experience.

Meanwhile, winters seem to have gotten milder. I've heard stories of deep snows in the hills where we live, east of Moscow. Instead we have turkeys cavorting in light snow, in flocks up to 60 individuals. In the photo, two have jumped/flown onto the main gate of our rabbit compound (slash dog run; the rabbits are in separate pens) and a nearby tree, roosting as if they were tiny birds. Ben Franklin thought very highly of turkeys;[1] he would have loved Idaho.

This fall, in addition to the return to the classroom, we expect the arrival of a new faculty member, Professor Zach Etienne, who specializes in computational astrophysics, particularly black-hole and neutron-star collisions. This work requires general relativity and relativistic hydrodynamics as well as nuclear equations of state for neutron stars. He is one of the maintainers of the software package for computational GR, known as the Einstein Toolkit, and is currently building resources for an "@home" project that will let personal computers help analyze black-hole collisions.

[1] The claim that he proposed the turkey as the national bird is, however, a myth.

Prof. Etienne will join us from West Virginia University while his wife assumes the endowed chair of risk management in the Department of Agricultural Economics & Rural Sociology.

I hope you enjoy reading this latest newsletter. There is an article about the 100th anniversary of the Physics Shop, founded by Leonard Halland; a contribution from an emeritus faculty member about nuclear physicist C.S. Wu commemorated with a new stamp; an update from an alum; an anecdote about chiral perturbation theory; a brief description of a recent breakthrough in cell imaging; summaries of graduate and undergraduate research projects; and updates on publications, presentations, and funding.

Best wishes for a safe year,

John

Blas Uberuaga (B.A. 1994) Named APS Fellow

Just this past summer, Dr. Blas Uberuaga, a scientist at Los Alamos National Laboratory and a U Idaho graduate, was selected as a Fellow of the American Physical Society. He has published nearly 250 papers that have been cited over 20,000 times for an h-index of 51 (according to Google Scholar).

Dr. Uberuaga graduated from U Idaho in 1994 and went on to a Ph.D. in physics at the University of Washington, where his thesis, advised by Hannes Jonsson, focused on the determination of the properties of defects in silicon and germanium via computational means. Upon graduation in 2000, he joined Los Alamos National Laboratory (LANL) as a postdoc with Arthur Voter in the Theoretical Division. The postdoctoral work focused on the development and application of so-called accelerated molecular dynamics, methods to accelerate the dynamical simulation of atomistic models.

In 2004, Dr. Uberuaga became staff in the Materials Science and Technology Division, where he has been ever since. His work there has focused on radiation effects in materials related to nuclear energy, with an emphasis on damage in both nanocrystalline materials and ionic oxides. He currently leads three projects: an Energy Frontier Research Center funded by DOE's Office of Basic Energy Sciences (BES) that is examining the coupling of irradiation and corrosion in materials; another BES project on the role of cation disorder on atomic transport in complex oxides; and an internal LANL project dedicated to the discovery and optimization of scintillator materials.

100$^{\text{th}}$ Anniversary for Physics Shop

(a brief history by Charles Cornwall, Chemical Engineering shop manager)

I was a work study Student for Earl Brooks in the Physics Shop from Spring of 1990 until his retirement in 1991. Most of what I know about the history of the shop he told me. I also worked with John Failla in the Physics shop after that, and he also told me things he learned from the faculty of the time. Some of them had worked here with Leonard Halland.

My understanding was that Leonard Halland founded the Physics Shop in 1921 and purchased the first equipment at that time. The first machine was a modified line drive milling machine made by Browne and Sharpe. That machine was sent to Surplus sometime before the Physics Shop and the Chemical Engineering Shop combined into a shared space in room 222 of Buchanan Engineering Laboratory (BEL).

After the shops moved into the shared space, they were able to pool resources between the Halland Physics Shop Endowment and the Chemical Engineering Development Fund to purchase modern Computer Numerical Control machine tools and upgraded manual machine tools. The Halland endowment continues to support shop activities to this day.

Physics Machine Shop Personnel:

Leonard Halland	1921- 1960
Andy Vant (??)	1960 to 1969
Earl Brooks	1969-1991
John Failla	1991-2017
Brian Petty	2017-Present

Leonard Halland's obituary can be found at https://lmtribune.com/obituaries/leonard-halland-104-ui-professor-emeritus/article_71fd750a-1e5b-5d06-a82b-9918a8a9ce31.html

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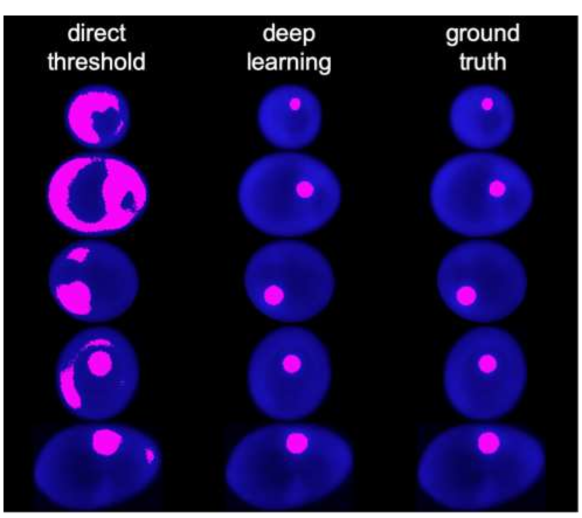
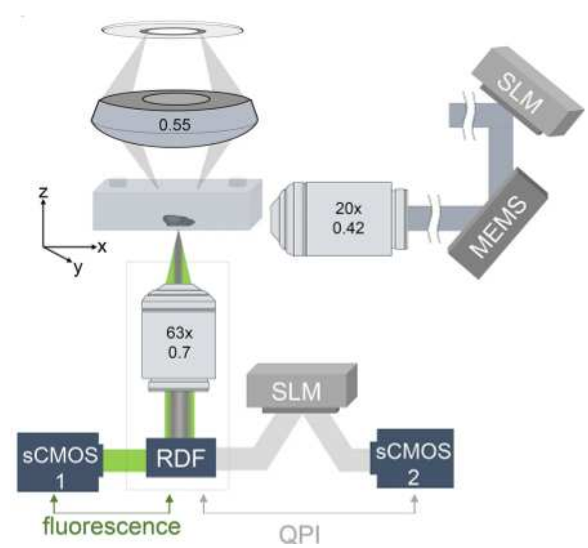
AI at UI: Neural Network Classification of Cell Structure

A recent publication by Vasdekis *et al.*, "Deep learning classification of lipid droplets in quantitative phase images," describes the combination of machine learning with the emerging quantitative phase imaging (QPI) method to image the oleaginous Yarrowia lipolytica. This yeast exhibits high lipid content with notable applications in biofuels production. QPI relies on optical interferometry and is not unlike the method used by LIGO to detect gravitational waves, though on a much smaller scale. Further, QPI does not require staining and exhibits low photo-toxicity; however, QPI also lacks specificity in visualizing key cellular targets. The UI team addressed this shortcoming by adopting neural networks to classify such cellular structures, with a focus on lipid droplets. The figure shows a comparison between conventional methods (direct threshold) with convolutional neural networks (CNNs); CNNs agree with the ground truth with > 95% precision.



In parallel, the team combined QPI with light-sheet fluorescence microscopy to perform related experiments. Specifically, the setup (see figure below) uses a (quasi-) lattice-light-sheet illumination scheme, similar to the one invented by E. Betzig (a physicist at UC Berkeley). This enables ultra-low illumination densities during fluorescent imaging, which improves the longevity of light-exposed living cells. Further, rather than illuminating the entire cell, lattice light-sheet microscopy uses thin sheets of laser light to illuminate one slice at a time. This provides 3D information, as well as reduces the total laser exposure. The implementation by Vasdekis, published in *Scientific Reports*, is patented, the first constructed in Idaho, and the first to have integrated QPI.



Weinberg's proposal of chiral perturbation theory

by Ruprecht Machleidt

The Nobel Laureate, Steven Weinberg, has made many contributions to theoretical physics, notably the development of the electroweak theory for which he was awarded the Nobel Prize in 1979 together with Salam and Glashow. But Weinberg has also made a remarkable contribution to nuclear physics. In the year 1990, he proposed to use what has become known as "chiral perturbation theory" to solve the nuclear force problem in the light of quantum chromodynamics (QCD). Since I have worked all my life on the theory of nuclear forces, I picked this idea up (in 2001) and have described my adventure with Weinbergs idea in a letter entitled "Weinberg's proposal of 1990: A very personal view" recently published in the international physics journal *Few-Body Systems*.

From the abstract: "My personal encounter with Weinberg's proposal of 1990 was a really entertaining one: My collaborator David Entem and I had embarked to show that Weinberg's idea, though smart and beautiful, was essentially useless in practice (like so many of those genius ideas of the 1980s where people claimed to have "derived the nuclear force from QCD"). However, in trying to do so, we showed the opposite; namely, we showed that Weinberg's idea worked better than allowed by any reasonable means."

No kidding: when this happens, research is fun. Ever since, chiral perturbation theory has become the modern theory of nuclear forces.

Nuclear Physicist C-S Wu Remembered with New Stamp

by Philip A. Deutchman, Emeritus Professor of Physics

The U.S. Postal service issued a new, forever stamp that is a portrait of the nuclear physicist, Chien-Shiung Wu. She is not known to the general public, but is famous to physics students because of her groundbreaking experiment on the beta decay of radioactive nuclei. When I was a grad student, we referred to her respectfully as "Madame Wu," with perhaps a tinge of mystery and intrigue involved.

In a village near Shanghai, a girl named Chien-Shiung Wu was born. In school, she was a very bright student. At seventeen, she entered the National Central University in Nanjing. She studied mathematics, but later switched to physics. After graduation, she did research at the Chinese Institute of Physics of the Academia Sinica. Her supervisor, who obtained a Ph.D. from the University of Michigan, encouraged Miss Wu to get her Ph.D from the same university. So, Miss Wu applied and was accepted. She and a girlfriend then sailed to San Francisco. When they arrived, they visited the University of California at Berkeley. Wu also visited the famous Lawrence Radiation Laboratory, named after Ernest Lawrence who invented the first cyclotron. The physicist, Luke Yuan, who escorted her would become her future husband. But, while in California, she heard that the University of Michigan did not allow women to use their front entrance. She immediately changed her plans and enrolled at U.C. Berkeley.

At the lab, Wu studied beta decay and became an authority on the subject. After completing her Ph.D. in 1940, she stayed on to do post-doctoral research. In 1942, she and Mr. Yuan got married and they moved to the East Coast to accept jobs. Wu taught at Smith College, but then accepted a research position at Princeton. In 1944, Wu joined the top-secret Manhattan Project which was assigned to build the atomic bomb. Shhh! Don't tell anyone. It was actually a nuclear bomb. It is believed that she was the only Asian person on this project.

After WWII, she became a research professor at Columbia, where she remained until retirement. Her parents remained in China and wrote her not to return home. So in 1954, she became a U.S. citizen. In 1956, Wu carried out the famous "Wu Experiment" that would make a valuable contribution to nuclear and particle physics. Her experiment examined beta decay, where a radioactive nucleus decays into a new nucleus, plus an electron (the beta ray) and a neutrino. For our purpose, we only need to focus on the electron.

As nuclear and particle physics evolved, numerous conservation laws were discovered. These laws are considered to be "sacred cows," and if an experiment ever showed that one of these laws crashed and burned when hitting the ground of reality, it would ruin your day.

One of these laws was known as Conservation of Parity. Parity, from Latin (paritas), translates to "equal status." For simplicity, imagine a single nucleus as a microscopic, spinning ball. By turning on a magnetic field, the nucleus will align its North Pole-South Pole axis along the field line. Parity says that there is an equal chance that an electron may be emitted from the North or South Pole of the nucleus.

However, in Wu's experiment, the sample contains a large number of identical, radioactive nuclei. Very low temperatures are required to prevent nuclei from thermally knocking each other about, and ruining their spin alignments. For a large number of nuclei, parity predicts there should be equal numbers of electrons collectively emitted from their North and South Poles. "Madame Wu" would test this claim experimentally.

In the 1950s, there were two, young and bright Chinese-American theoretical physicists, named T.D. Lee and C.N. Yang, who were making names for themselves. They were interested in the theory of Parity Conservation, which physicists thought should always be conserved. In 1956, after much theoretical work, Lee and Yang predicted that parity might not be conserved. Then they searched all the experimental data involving the newly discovered weak force, where beta decay was but one example. However, they could not find any evidence for or against parity conservation. Knowing that C.S. Wu was a beta-decay expert, they contacted her and began working on ideas to do an experiment. Realizing that she could be involved with a breakthrough experiment, she immediately started work in May of 1956.

Her experiment was designed to measure electrons emitted from the beta decay of radioactive Cobalt-60. It needed a strong, magnetic field to line up all the nuclei spinning in the same way. This is like having a large group of ice-skaters individually spinning in the same way, but each holding to their own spot on the ice. And, she needed low temperatures. Wu contacted physicist Ernest Ambler of the National Bureau of Standards in Washington, D.C, where they had a low-temperature lab. In their experimental arrangement, they had only one electron counter situated above the sample. To measure electrons coming from the nuclear North Poles, the magnetic field was pointed upwards. This aligned their North Poles to face the detector. Then, to measure electrons coming from their South Poles, the magnetic field was reversed, which turned the nuclei upside down. Now the South Poles faced the detector. By December of 1956, Wu and Ambler experimentally and shockingly discovered that electrons were overwhelmingly coming from the South Poles. This asymmetry was the first evidence that the law of parity was violated! Although upsetting the physics community, other experimentalists soon confirmed Wu's results.

In 1957, the Nobel Prize was awarded to Lee and Yang for their theoretical work. C.S. Wu was mentioned in their acceptance speech. She was not included in the Prize.

However, throughout her career, "Madame Wu" was honored for her achievements. She was elected a member to prestigious science organizations. She received numerous awards, prizes and medals. She was the first woman to be President of the American Physical Society; first woman to receive the Comstock Prize from the National Academy of Sciences; and, the first woman to receive a Research Corporation Award. She was awarded honorary degrees from many universities, including Harvard, Yale and Princeton. And in 1978, she was the first person to be awarded the new Wolf Prize, at its first offering. This prize considers candidates who are of Nobel caliber. But still, why not the Nobel? Some of the most eminent physicists of the day did champion Wu's case. Starting in 1958, she was nominated at least seven times, until her death in 1997.[2] A year later, she was posthumously inducted into the National Womens Hall of Fame.

Finally, I thank the U.S. Postal Service for honoring this unique scientist by issuing her "forever" stamp in 2021. Now, the public can see her portrait with the caption, "Chien-Shiung Wu, Nuclear Physicist," and wonder: Who is she? And, even be curious enough to find out.

Faculty

Astronomy and Planetary Science

- Gwen Barnes, Research Assistant Professor, Ph.D. University of Arizona 2007
- Jason Barnes, Professor and Dyess Faculty Fellow, Ph.D. University of Arizona 2004
- Matthew Hedman, Associate Professor and Director of Graduate Studies, Ph.D. Princeton University 2002

Biological Physics

- Andreas Vasdekis, Associate Professor, Ph.D. University of St. Andrews 2008
- F. Marty Ytreberg, Professor and Associate Director of the Institute for Modeling Collaboration and Innovation, Ph.D. University of Maine 2000

Condensed Matter Physics

- Leah Bergman, Professor, Ph.D. North Carolina State University 1995
- Christine Berven, Associate Professor, Ph.D. University of Oregon 1995
- You Qiang, Professor, Ph.D. University of Freiburg 1997

Hadronic Physics

- Sophia Chabysheva, Clinical Assistant Professor, Ph.D. Southern Methodist University 2009
- John Hiller, Professor and Chair, Ph.D. University of Maryland 1980
- Ruprecht Machleidt, University Distinguished Professor, Ph.D. University of Bonn 1973
- Francesca Sammarruca, Professor and Secretary of the University Faculty, Ph.D. Virginia Polytechnic Institute 1988

Staff

Jessica DeWitt, Administrative Assistant

Eric Foard, Ph.D., Director of Physics Laboratory Education

Shahla Nemati, Ph.D., Postdoctoral Fellow

Brian Petty, Scientific Instrument Maker

Nava Subedi, Ph.D., Postdoctoral Fellow

Peter Wojcik, Ph.D., Lecturer

[2] Editor's note: A Nobel is awarded only to someone living.

Awards in 2021

Dean's Award: Carlos Muñoz

Deans Graduate Award: Randy Millerson

Undergraduate research award: Tristin Sanchez

Best Physics TA: Ross Miller

College of Science Staff Outstanding Service Award: Jessica DeWitt (awarded jointly to all College financial staff for their efforts during the pandemic)

Carlos Muñoz with Dean Ginger Carney.

Tristin Sanchez with Professor Sammarruca.

Donations

If you would like to donate to the Physics Department, please contact Eric Bennett, the Director of Development for the College of Science at ebennett@uidaho.edu, 208-885-9106, or University of Idaho College of Science, 875 Perimeter Drive, MS 3025, Moscow, ID 83844-3025. Online donations can be made at https://www.uidaho.edu/giving/way-to-give. Entering 'Physics' in the designation field will present you with a list of funds associated with the Department. Thank you!!

Ross Miller with Professor Sammarruca.

Jessica DeWitt with Dean Carney.

These photos were taken by Terry Evans, of the College of Science Dean's Office, during a modest award ceremony in EP 122, with the unmistakable pandemic-induced masks and social distancing.

Transitions

Dinesh Thapa moved on to a postdoctoral position elsewhere.

Shahla Nemati continued after her PhD as a postdoc in biophysics.

New Graduates

First, an update: Sam Myers, who graduated last year with a B.S., was awarded the 2020 Carson Fellowship (https://www.lpl.arizona.edu/invest/carson-fellowship/2020) at the Lunar and Planetary Laboratory of the University of Arizona, where he is pursuing a Ph.D. in Planetary Science.

Daniel Daily (B.S. 2020)

Karen Martinez (B.S. 2020)

Erin Henkhaus (B.S. 2021)

Carlos Muñoz (B.S. 2021)

Tristin Sanchez (Applied B.S. 2021)

Jonathan Barnes (M.S. 2020)
Advisor: Marty Ytreberg

Ross Miller (M.S. 2020)
Advisor: Ruprecht Machleidt

Elizabeth Atang (M.S. 2021)
Advisors: Francesca Sammarruca, Gwen Barnes

Randy Millerson (Ph.D. 2020)
Thesis advisor: Francesca Sammarruca
Thesis title: In-Medium Nucleonic Interactions and Chiral Effective Field Theory: Insight into the Nuclear and Neutron Matter Equation of State from Neutron Skins to Neutron Stars

Peter Wojcik (Ph.D. 2020)
Thesis advisors: David McIlroy, Christine Berven
Thesis title: The Utilization of One-Dimensional Silica Nanosprings as an Insulating Support to Characterize the Morphology, Electrical Transport, and Optoelectronic Properties of Two-Dimensional Nano-Coatings

Hamdah Alanazi (Ph.D. 2021) who will return to her home country, Saudi Arabia, and assume a professorship in physics at the Shaqra University in Shaqra, which is located 190 km north-west from the capital, Riad.
Thesis advisor: Ruprecht Machleidt
Thesis title: The relevance of pion-exchange contributions versus contact terms in the chiral effective field theory description of nucleon-nucleon scattering

Summer Graduate Research Projects 2020

Elizabeth Atang (Sammarruca)
Reconciling the saturation properties of the nuclear matter equation of state

Alexander Bray (Bergman)
β-Gallium Oxide Thin Films for Gas Sensor Applications

Mohammed Khan (Qiang)
The Radiation effect observation on core-shell Ti-TiO2 by molecular dynamics simulations

Rabindra Khanal (Qiang)
Study of Iron-Based Soft Magnetic Nanocomposite Films

Isiaka Lukman (Bergman)
Raman Selection Rule Calculation for Semiconductor Phases

Ross Miller (Machleidt)
Effective field theory for Strong nuclear forces

Dillon Morehouse (Berven)
Ab-initio physics model for superconductor-permanent magnet levitation bearings

Sanjoy Saha (Machleidt)
Local Nucleon-nucleon potentials up to fourth order of chiral effective field theory

Completed Thesis Projects

Randy Millerson

The thesis addresses theories of nuclear matter. The latter is found in atomic nuclei and, in much denser form, in the interior of astrophysical systems known as neutron stars. (This matter is so dense that a sugar-cube-sized amount of it weighs approximately as much as Mount Everest.) Remarkably, the same physical mechanism which determines the formation of the so-called “neutron skin” (a neutron-dominated layer of the atomic nucleus) is also responsible for the pressure that supports neutron stars against gravitational collapse. In this project, state-of-the-art nuclear forces were applied to many-body systems ranging from nuclei to compact stars. We set theoretical constraints on physical quantities which are expected to be measured in the near future with unprecedented accuracy.

Hamdah Alanazi

The fundamental theory of the strong interactions, quantum chromodynamics, is (nearly) symmetric with respect to the chirality (roughly speaking, the projection of spin on the momentum) of its quarks and gluons. The standard way to demonstrate the relevance of chiral symmetry for the nucleon-nucleon (NN) interaction is to consider higher partial waves of NN scattering which are controlled entirely by the long-range chiral pion-exchanges. Short-range forces, such as contact interactions, do not contribute beyond the lowest partial waves. However, in applications of NN potentials to nuclear structure and reactions, the lower partial waves are the important ones, making the largest contributions. Lower partial waves are sensitive to the short-range potential, and so, when the short-range interactions dominate over the chiral pion contributions in lower partial waves, then the predictions from “chiral potentials” would have little to do with chiral symmetry. To address this issue, we investigated systematically the role of the (chiral) one- and two-pion exchanges, on the one hand, and the effect of the contact interactions, on the other hand, in the lower partial waves of NN scattering. We were able to clearly identify the signature of chiral symmetry in lower partial waves. Our study has also a pedagogical spin-off as it demonstrates in detail how the reproduction of the lower partial-wave phase shifts comes about from the various ingredients of the theory.

Peter Wojcik

The project explored the nucleation, evolution, and growth dynamics of silica nanosprings and the utilization of silica nanosprings as an insulating support to characterize the morphology, electrical transport, and optoelectronic properties of two-dimensional nanocoatings. The primary results of this research were threefold. First, we identified the mechanisms of initial formation and growth dynamics of silica nanosprings. Second, we coated the surface of silica nanosprings with a novel conductive carbon to create a coreshell structure and definitively identified that the conductive carbon is a nanocrystalline graphitic layer consisting of an agglomeration of carbon nanospheres formed by the accretion of graphitic flakes. Third, we observed the photoconductive behavior of a single ZnO-coated silica nanospring, presented models to explain the photoconduction and recombination mechanisms responsible for the observed sub-bandgap photocurrent rise and decay behavior, and presented a phenomenological model to describe the characteristics of the saturation photocurrent dependence on excitation intensity.

A single silica nanospring is composed of multiple individual amorphous silica nanowires bound together via a common catalyst to form a larger, well-defined helical structure with a wire diameter of ~70-500 nm, an outer diameter of ~200-1000 nm, and lengths on the order of hundreds of microns. Until now, the initial phases of formation and growth dynamics of this type of silica nanospring had not been explored. We found that low-temperature growth conditions facilitate the formation of an asymmetrically-shaped gold catalyst. A row of silica nanowires is formed in an energetically favorable process beneath the gold catalyst. The varying growth rates of the individual nanowires produce an asymmetry in the interfacial surface tension and a corresponding variable work of adhesion along the outer boundary of the catalystnanowires interface. The variable work of adhesion provides the asymmetry necessary for the catalysts helical precession, which subsequently produces the silica nanosprings helical morphology.

The surface of silica nanosprings can be coated with an assortment of conducting and semiconducting materials to create a multifunctional nanomaterial that can be utilized in a wide variety of applications. One of these conducting materials, referred to as graphite from the University of Idaho thermolyzed asphalt reaction (GUITAR), has been coated onto silica nanosprings, and its structural and electrical properties have been investigated. Using a silica nanospring as a platform for GUITAR has allowed, for the first time, transmission electron microscopy images of a GUITAR coating that fully reveal its morphology. Images of a GUITAR coating obtained from scanning electron microscopy, transmission electron microscopy, and atomic force microscopy, together indicate that a GUITAR coating on a silica nanospring is a ~100 nm thick layer composed of an agglomeration of carbon hemispheres ~50-100 nm in diameter formed by the accretion of graphitic flakes ~1-5 nm in diameter. A Raman spectroscopic analysis of GUITAR and the measurements of the electrical resistivity and temperature coefficient of resistivity of 11 single GUITAR-coated silica nanospring electrical devices indicate that GUITAR is a form of nanocrystalline graphite.

Polycrystalline ZnO was coated onto silica nanosprings using atomic layer deposition, and an electrical device consisting of a single ZnO-coated silica nanospring was fabricated and used to investigate the optoelectronic properties of the ZnO layer using near-ultraviolet (405 nm) and sub-bandgap (532 and 633 nm) excitation. The photocurrent responses of all three excitation sources display a typical two-step fast and slow rise and decay response. Physical models were presented, and we proposed that the photocurrent rise and decay characteristics depend on the excitation energy and the trapping of electrons and holes in intermediate defect levels within the bandgap. A phenomenological model was presented to explain the breaks in the slopes of the saturation photocurrent versus excitation intensity profile for each excitation source. We found that these slopes are a function of the transition probabilities of defect states, the number of carriers available to populate the conduction (valence) band, and the rate at which electrons and holes recombine.

Undergraduate Research Projects

Samantha Callos (Hedman)
: Collecting and processing a large set of Cassini images of Saturns main rings as part of a project to characterize the dusty spokes seen over Saturns B ring, whose origin is still highly uncertain.

Nathaniel Davis (Bergman)
: Diamond technology.

Margot Dillon (Hedman)
: Analyzing Cassini Images of one of Saturns dusty rings in order to measure its inclination (tilt), which appears to be unusually high and so might imply that it is being perturbed by some non-gravitational force.

Ben Evanson (Berven)
: Micro-scale coronal discharge physics.

Jonathan Flores (Chabysheva)
: Modeling cross sections for deuteron disintegration into its constituent proton and neutron.

Erin Henkhaus and Jeremiah Chapleski (Berven) Investigations of superconductor/permanent magnet levitation.

Jett Kauffman (J Barnes)
: Using specular glints off of Titan lakes to investigate atmospheric haze structure and time-variability.

Peik Lund (Ytreberg)
: Predicting species that might be susceptible to coronavirus infection.

Kaylee Maret (Sammarruca)
Computational aspects of nuclear astrophysics.

Carlos Muñoz (Qiang)
Using the 3D software SOLIDWORK for the mechanical design of an experimental setup for radiation detector measurements.

Tristin Sanchez (Bergman)
Ultra-wide-gap semiconductors.
and (Vasdekis)
Developing light-sheet microscopy that operates with sparse photons.

Dustin Taylor (Hiller)
Numerical solution of the Klein-Gordon equation in curved spacetimes with spherical symmetry.

Cole Thompson (Vasdekis)
Developing light-sheet microscopy and machine-learning.

Orion Wheeler (J Barnes)
Generating Titan maps from Cassini Visual and Infrared Mapping Spectrometer data

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Recent Publications (2020-21)

Student authors are underlined.

Astronomy and Planetary Science

Heslar, Michaell; Barnes, Jason W.; Soderblom, Jason M.; Dhingra, Rajani; Seignovert, Benot; Sotin, Christophe, "Sun Glitter on Titans Kraken Mare: Evidence for Tidal Currents and Wind Waves, The Planetary Science Journal Volume 1 #2, 35 2020 September.

Dhingra, Rajani; Barnes, Jason W.; Heslar, Michael; Brown, Robert H.; Buratti, Bonnie J.; Sotin, Chirstophe; Nicholson, Philip D.; Baines, Kevin H.; Clark, Roger N.; Soderblom, Jason M.; Jaumann, Ralf; Rodriguez, Sebastien; Le Mouelic, Stphane, "Spatio-Temporal Variation of Bright Ephemeral Features on Titans North Pole, The Planetary Science Journal, Vol. 1 #2 Article 31, 2020 September.

Barnes, Jason W.;MacKenzie, Shannon M.; Young, Eliot F.; Soderblom, Jason M.; Hayes, Alexan- der G.; Sotin, Christophe; Brown, Robert H.; Soderblom, Laurence A., "Diffraction-Limited Titan Surface Imaging from Orbit Using Near-Infrared Atmospheric Windows, The Planetary Science Journal, Vol. 1 #1 Article 24, 2020 June.

Ahlers, John P.; Johnson, Marshall; Stausun, Keivan; Coln, Knicole; Barnes, Jason W.; Stevens, Daniel; Beatty, Thomas; Gaudi, B. Scott; Collins, Karen; Rodriguez, Joseph; Ricker, George; Vander- spek, Roland; Latham, David; Seager, Sara; Winn, Joshua; Jenkins, Jon M.; Caldwell, Douglas A.; Goeke, Bob; Hounsell, Rebekah; Levine, Al; Osborn, Hugh; Paegert, Martin; Rowden, Pam; Tenen- baum, Peter; Ting, Eric B., "KELT-9bs Asymmetric TESS Light Curve Caused by rapid Stellar Rotation and Spin-Orbit Misalignment, The Astronomical Journal, Volume 160, Issue 1, 2020 June 5.

Kreyche, Steven M.; Barnes, Jason W.; Quarles, Billy L.; Lissauer, Jack J.; Chambers, John E.; Hedman, Matthew M., "Orbital Eccentricity Influence the Obliquity Stability of Retrograde-Rotating Planets, The Planetary Science Journal, Volume 1, Issue 1, 2020 April 14.

Jackson, Brian; Lorenz, Ralph; Barnes, Jason W.; Szurgot, Michelle, "Dust Devils on Titan, Journal of Geophysical Research Planets, Volume 125, Issue 3, 2020 March.

Quarles, Billy; Barnes, Jason W.; Lissauer, Jack J.; Chambers, John, "Obliquity Evolution of the Potentially Habitable Exoplanet Kepler-62f, Astrobiology, Volume 20, Number 2, 2020 February.

M.M. Hedman, B. Bridges. 2020. Changes in a dusty ringlet in the Cassini Division after 2010. PSJ 1:43.

L.C. Quick, A. Roberge, A. Barr-Milnar, M.M. Hedman. 2020. Forecasting rates of volcanic activity on terrestrial exoplanets and implications for cryovolcanic activity on extrasolar ocean worlds. PASP 132:1014.

R.G. Jerousek, J.E. Colwell, M.M. Hedman, R.G. French, E.A. Marouf, L.W. Esposito, P.D. Nicholson. 2020. Saturns C ring and Cassini Division: Particle sizes from Cassini UVIS, VIMS and RSS occultations. Icarus 344:113365.

P.D. Nicholson, T. Ansty, M.M. Hedman, D. Creel, J. Ahlers, R.A. Harbison, R.H. Brown, R.N. Clark, K.H. Baines, B.J. Buratti, C. Sotin, S. V. Badman. 2020. Occultation observations of Saturns rings with Cassini VIMS Icarus 344:113356.

M.M. Hedman, P. Helfenstein, R.O. Chancia, P. Thomas, E. Roussos, C. Paranicas, A.J. Verbiscer. 2020. Photometric analyses of Saturns small moons: Aegaeon, Methone and Pallene are dark; Helene and Calypso are bright. AJ 159:129.

L.C. Quick, M.M. Hedman. 2020. Characterizing deposits emplaced by cryovolcanic plumes on Europa. Icarus 343:113667

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K.E. Miller, J.H. Waite, Jr., R.S. Perryman, M.E. Perry, A. Bouquet, B.A. Magee, B. Solton, T. Brockwell, M.M. Hedman, C.R. Glein. 2020. Cassini INMS constraints on the composition and latitudinal fractionation of Saturn ring rain material. Icarus 339:113595.

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Biological Physics

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Condensed Matter Physics

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Hadronic Physics

F. Sammarruca, R. Machleidt, and R. Millerson, “Temperature effects on the neutron matter equation of state obtained from chiral effective field theory,” Mod. Phys. Lett. A **35**, 2050156 (2020)

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R. Machleidt and F. Sammarruca, “Can chiral EFT give us satisfaction?,” Eur. Phys. J. A **56**, 95 (2020)

R. Machleidt, “Weinberg’s proposal of 1990: A very personal view,” Few Body Syst. **62**, 21 (2021).

M. Vorabbi, M. Gennari, P. Finelli, C. Giusti, P. Navrátil and R. Machleidt, “Impact of Three-Body Forces on Elastic Nucleon-Nucleus Scattering Observables,” Phys. Rev. C **103**, 024604 (2021).

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S.S. Chabysheva and J.R. Hiller, “Casimir force on a light front,” Prog. Part. Nucl. Phys. **117**, 103836 (2021).

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Recent Presentations (2020-21)

(severely curtailed by the pandemic)

Astronomy and Planetary Science

G.D. Barnes, The Moons Craters: What do they tell us?, Idaho State University, Department of Physics, colloquium via Zoom. October 12, 2020; and Palouse Astronomical Society via Zoom. October 26, 2020.

J. Barnes, Dragonfly: NASAs Rotorcraft Lander for Saturns Moon Titan, American Astronomical Society (AAS) summer meeting, virtual, 2020 June; York University (Canada) Technologies for Exo-Planetary Science, Toronto, Canada (delivered virtually), 2020 November 11; University of California Santa Cruz, (delivered remotely), 2020 May 1; astrobiology colloquium at the University of Washington, Seattle, Washington (delivered remotely), 2020 April 14; Mexican Astrobiology Society roundtable keynote address, Puebla, Mexico (delivered virtually), 2020 December 11.

J. Barnes, Titan: A Hazy Waterworld that we can Visit, Exoplanets in our Backyard, Houston, Texas, Poster, 2020 February 6.

M.M. Hedman, M. El Moutamid, P.D. Nicholson. Reading Saturns recent history in its Rings. 2020 meeting of the Division for Planetary Science (virtual)

M.M. Hedman, B. Bridges. Sudden changes in the structure and orbit of one of Saturns dusty rings. 2020 meeting of the Division for Dynamical Astronomy (virtual)

M. Young, M.M. Hedman. Evidence for a new type of moonlet wake near Enceladus. 2020 meeting of the Division for Dynamical Astronomy (virtual)

J.A. AHearn, M.M. Hedman, D.P. Hamilton. Periodic orbits for small N co-orbital satellite systems. 2020 meeting of Division for Dynamical Astronomy (virtual)

Biological Physics

A. E. Vasdekis, Probing Stochastic Chemical Dynamics in Single Living Cells, as a Matter of Fat, University of Washington (Seattle, USA, 10/2020).

Condensed Matter Physics

Dillon Morehouse, Daniel Daily, Erin Henkhaus, Alison LaDuke, Grant Thurman, Herbert Hess, and Christine Berven, “Anharmonicity of Type-II Superconductor Permanent Magnet Levitation Oscillations, Applied Superconductivity Conference 2020 (Oct. 24 Nov. 7, 2020)

You Qiang, “Advanced Magnetic Separation Nanotechnology for Spent Nuclear Fuel Recycling, invited talk at international conference of Advanced Energy Materials, May 8 to 11, 2020 in Athens, Greece.

You Qiang, “Advanced radiation detector for nuclear energy application, Plenary Speaker, International Conference and Exhibition on Quantum Mechanics and Nuclear Engineering, May 21-22, 2020 in Athens, Greece.

You Qiang, “Advanced Magnetic Separation Nanotechnology for Nuclear Waste Recycle, Keynote Speaker, Webinar on Nanotechnology, Oct. 21-22, 2020.

You Qiang, “Nuclear Waste Treatment: Advanced Magnetic Separation Nanotechnology, Keynote Speaker, International Webinar on Nanomaterials, October 31, 2020.

You Qiang, “Recent Development of Nanomaterials and Nanotechnology in Nuclear Energy, Plenary Talk, Webinar of Materials meeting 2021.

Hadronic Physics

F. Sammarruca, Exploring the relationship between nuclear matter saturation and finite nuclei with chiral two- and three-nucleon forces, Fall Meeting of the Division of Nuclear Physics of the American Physical Society, October 29 November 1, 2020.

F. Sammarruca, Nuclear forces in the medium: Insight from the equation of state, Nuclear Theory Seminar at NSCL/FRIB, April 20, 2021.

F. Sammarruca, Women and Physics in the Third Millennium, Physics Department Colloquium in celebration of Womens History Month, Kennesaw State University, Marietta Campus, April 23, 2021.

R. Machleidt, The Never-Ending Dream of Mankind: The Theory of Everything, University of Idaho Physics Colloquium, January 2020.

R. Machleidt, Nuclear Forces, a series of six invited lectures delivered virtually, Department of Physics, Tohoku University, Sendai, Japan, April-June 2020.

Current External Funding

Astronomy and Planetary Science

G.D. Barnes, I.J. Daubar (co-I), S. Quintana (co-I), Mars Data Analysis Program (MDAP), NASA Blasting Mars: Surface Halos Produced by Current Impact Cratering, 20182021, $284,998.

G.D. Barnes, NASA Mars Data Analysis, Blasting Mars: What Factors Enable Detection of New Impact Sites?, 2021-2023, $466,258.

C. J. Cline, G.D. Barnes (Co-I), J. Anderson, M. Cintala, O. Barnouin, R. Daly, Solar System Workings, NASA, The role of small-scale target heterogeneities in the formation and morphology of small craters. 2020-2023, $1,071,913 ($132,086 for UIdaho)

Elizabeth Turtle (JHU/APL), Deputy PI Jason W. Barnes (UIdaho). Dragonfly. NASA New Frontiers, 2018-2038, $849,000,000 ($4,000,000 for UIdaho)

Shannon MacKenzie (JHU/APL), Co-I: Jason W. Barnes (UIdaho). Exploring Titans “Wet Sidewalk Effect.” NASA Cassini Data Analysis Program, 2019-2021, $337,619

M.M. Hedman (PI University of Idaho), S. Vahidinia (Co-I NASA Ames), D. Dhingra (Collaborator). Investigating the Enceladus plume with Cassini-VIMS remote-sensing data. Characterizing Dusty Spokes in Saturns main rings. NASA Cassini Data Analysis Program, 2018-2021, $330,244.

D.P. Hamilton (PI University of Maryland), M.M. Hedman (Co-I, University of Idaho. NASA Cassini Data Analysis Program, 2018-2021, $439,191.

Biological Physics

A.E. Vasdekis, National Science Foundation, PI, 2041523, Collaborative Research: Multidimensional single-cell phenotyping for elucidating genome to phenome relationships, $336,514, 03/21 03/24.

A.E. Vasdekis, National Science Foundation, senior personnel, (PI: T. Xing), CBET-2019231, MRI: Acquisition of a 3D Printer for Studying Biofluids and Biomechanics, $252,542 (total award), 09/20 08/23.

A.E. Vasdekis, Department of Energy, Genomic Sciences Program, PI, DE-SC0019249, Imaging metabolome and enzyme dynamics for co-optimizing yields and titers in biofuel producing microorganisms, 2018-2021, $1,500,000

A.E. Vasdekis, Department of Energy, Genomic Sciences Program, co-PI: C. Marx, Using gene editing and an accumulated bioproduct as a reported for genotypic and phenotypic heterogeneity in growth-vs-production for M. extorquens conversion of aromatics to butanol, 2018-2021, $300,000

Ytreberg FM (PI), Ogbunugafor CB (Co-PI), Miller CR (Co-PI), Weinreich DM (Co-PI) RII Track-2 FEC: Using Biophysical Protein Models to Map Genetic Variation to Phenotypes, NSF EPSCoR, 2017 - 2021, $6,000,000, with $181,000 awarded to A.E. Vasdekis as senior personnel

Wichman HA (PI), Ytreberg FM (associate director) Center for Modeling Complex Interactions, NIH COBRE, 2015 - 2020, $10,572,579; 2020-2025, $10,999,565

Condensed Matter Physics

Matt McCluskey WSU PI and Leah Bergman Co-PI. Defects in Gallium Oxide. Department of Energy. DOE Office of Science Program Office, Division of Materials Science and Engineering, 2019-2022, $450,279 with $187,291 for Bergman.

H. Hess, C. Berven (Co-I), Advanced Energy Storage System for Electric Vehicle Charging Stations for Rural Communities in the Pacific Northwest. Pacific Northwest Transportation Consortium (PacTrans), USDOT University Transportation Center for Federal Region 10. 2019-2022, $40,000.

Samrat Choudhury PI and You Qiang Co-PI, Advanced Nanomaterials for Next Generation Neutron Radiation Detection Using Machine Learning Approach, NASA EPSCoR, 2020-2021, $41,991.

Hadronic Physics

F. Sammarruca and R. Machleidt. Nuclear Theory at the University of Idaho, DOE Office of Science, 2018-2021, $339,000

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Thanks!! We'll enjoy hearing from you!