Vandalizing the Universe

University of Idaho
Department of Physics

Home of Physics and Astronomy on the Idaho Palouse

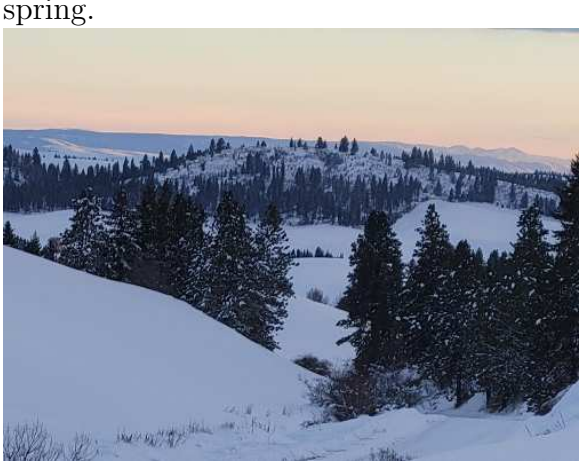
Newsletter Issue No. 3 MMXXII Editor: J.R. Hiller

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

Message from the Chair

It was the year of the moose! We had several warnings of campus incursions, one sighting in our parking lot, and three near the house. Almost got a photo, but the camera app misfired.

It was also a year with more snow. The image shows the middle of the landscape in the masthead (looking south from our front porch). A fluctuation back toward the way things used to be, continuing with a rainy spring.



This has not dampened the wild turkeys' spirits, though. We've had five or six males displaying at a time, with these three posing for the newsletter. The flock does make quite a mess. One learned to fly up to a bird feeder and kick it, dropping to the ground to join his friends in the bounty. They can't perch on the feeders but will try nearby branches as well as the mid-air kicking.

One of our own rabbits also posed. I call this guy El Toro, for his flared nostrils and no-fear approach. He does live behind a six-foot fence to guard against coyotes. One pup of our local pack was found sleeping under a bush beneath our home-office window and has returned a couple times as a teenager. The rest howl from a distance and our dog

howls back, sometimes even mimicking the coyote tonal patterns.

Along with all the wildlife activity, there was quite a bit of physics, as documented here. You can find the usual summaries of publications, presentations, and grant funding. We've also gained a new telescope and, as promised in the previous newsletter, a new faculty member doing computational astrophysics and part of the LIGO collaboration on gravitational waves. Articles about both follow below.

The pandemic has eased somewhat, with a return to fully in-person teaching and new activities for the physics club. The club president, Sam Callos, has provided a summary of things they've been doing, including some photos. The days of U Idaho Bound have also returned, with campus visits by admitted students and their parents. This gave Marty Ytreberg and me the opportunity to promote our revised Applied Physics BS, which now offers the option to pick electives from a science in addition to the original engineering list. (Marty subbed for me on the eve of Orthodox Easter.) We hope to begin an internship program, particularly with Idaho National Lab but other employers as well, where an Applied BS can be tuned to maximize student preparation for an internship and future related employment. We've also been in contact with North Idaho College, to work toward a 2+2 agreement that will facilitate transfers and act as a template for other community colleges; the adjustments in our course offerings, to accommodate four-year completions for transfers have already been made.

I hope that you have had a similarly safe and productive year and look forward to the next!

Best regards,

New Faculty Introduction: Zach Etienne

Greetings! It's an absolute pleasure to be welcomed among peers in the UI Physics department. John has graciously given me the opportunity to write a few paragraphs introducing myself and my current research. But it would be a disservice to the reputation of long winded professors everywhere if I didn't write at least seven!

As a child growing up in southern Indiana I loved math and science, and especially computers. I learned what a physicist was in high school, and more excitingly, I learned it was possible to earn a doctorate in the field. How cool is that?! So as an undergraduate at Indiana University, I chose to major in math and physics. It was a tough four years, but like many of my fellow physicists I cherished the intellectual challenge. By the end of it, I had earned B.S. degrees in physics

and math, with a minor in astronomy. I had also accepted a fellowship to attend the University of Illinois Physics PhD program.

My first year at Illinois, I joined Stuart Shapiro's research group in computational astrophysics and numerical relativity. As these fields lie at the confluence of astronomy, computer science, math, and physics, it was a perfect match for my interests. My PhD work centered on performing pioneering simulations of black holes, neutron stars, and white dwarfs, in which we solved Einstein's equations of general relativity (GR) coupled to the equations of GR magnetohydrodynamics.

Through my PhD, I spent significant time developing a computational framework that was among the state of the art in my field. To fully leverage the framework, I took the unusual step of staying in the same research group as a postdoc. This was a very productive time in my career. By the end of it, I had accepted a faculty offer in the math department at West Virginia U (WVU) and a JSI Prize Postdoctoral Fellow at NASA Goddard/U of Maryland. I deferred the faculty position to spend another year as postdoc. It was a year well spent; I developed connections with many research groups in my field–connections that remain strong to this day.

Meanwhile at home, my wife had recently given birth to our first son Maverick at the time. In spite of the strong headwinds, she earned her PhD from the venerable U of Illinois Ag Econ program and had received several faculty offers around the time I had received mine. To their credit, WVU was the only institution that solved our two-body problem. WVU also took a big risk in hiring me, as gravitational waves - one of the most important products from my simulations - hadn't even been discovered yet!

Our years as Assistant Professors at WVU were an absolute whirlwind. Gravitational waves from binary black holes and binary neutron stars were directly observed for the first time, which brought feelings of vindication for more than a decade of work in the field. My wife gave birth to our second son Malcolm, and managed to continue to publish papers at an ungodly rate while I managed to raise well over $1M in funding for my research group. A year after we earned tenure, she applied for an Endowed Chair position in Commodity Risk Management here at UI and was offered the position. By the good graces of this department and university, we managed to solve the two-body problem a second time. For this we will always be grateful, and our family is loving the wide open spaces of Idaho so far!

My research these days mostly focuses on constructing theoretical predictions of gravitational wave sources, like binary black holes and neutron stars. When it comes to the simplest system - binary black holes - the gravitational wave observations must be compared to millions of theoretically predicted waves to extract information about the black holes masses and spins. These predictions must be built upon simulations that fully solve the general relativistic field equations, but due to computational expense only a catalog of a few thousand have been constructed to date.

Sophisticated interpolation methods have been developed to bridge the gap from the thousands of waves in the catalog to the millions of predictions needed. This approach has been largely successful with the rather noisy gravitational wave observations to date, but such a small catalog will be insufficient for the more sensitive detectors of the future! To address this core need, I have been working over the past few years to take the unprecedented step of fitting binary black hole simulations on a consumer-grade desktop computer. With this capability, I'll be launching a volunteer computing/citizen science project called BlackHoles@Home. Progress is rapid these days, and to keep up with what's happening now... and what's on the horizon, visit https://blackholesathome.net

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New Telescope Acquired

by Jason Barnes

With financial support from the College of Science, the Department has obtained a new telescope with an aperture diameter of 0.5 meters, or 20 inches. We now have the second-largest telescope in the state of Idaho, behind the 24 at the College of Southern Idaho. (We cannot fit one any bigger in our dome, so there was a knee in the price curve there where anything bigger would have been many times the cost). Boise States telescope is a 16. The telescope at Jewett Observatory over at WSU is only a 14, so our telescope has twice the light-collecting area of theirs!

Graduate students Steven Kreyche and Will Miller, along with undergraduate Thomas Gibson and I, retrieved the 350-lb box from central receiving and unboxed the telescope up at the Observatory near the golf course on the west side of campus. We got it installed on the mount on February 14, and then we got some clear skies two nights later.

We astronomers call the event where a telescope looks at the sky for the first time"First Light." We do not have a real astronomical camera on it yet, but we were able to use the eyepiece to test the telescope. And it looks awesome! I took some really primitive photos through my phone of Tycho crater on the Moon and of the star forming region in the Orion Nebula.

Getting this thing up and running has been a goal of mine ever since Christine Berven showed me the Observatory when I visited campus on the interview shortlist back in March 2008. Sincere thank you to everyone for the help and financial support in getting us finally up and running.

SPS Activities

by Sam Callos, SPS President

This year saw a resurgence of activities for the University of Idahos Society of Physics Students (SPS) after COVID forced us all online. We were able to re-register SPS as an official club after 7 years!

In September of 2021, SPS traveled to the Fossil Bowl in Clarkia, ID. Fossils were discovered in the area in 1972 and are the result of a lake from about 15 million years ago. A lot of the fossils in the area are from vegetation that was around the area at the time.

In February of 2022, we went to the University of Idaho Library where we saw all the things being offered at The Mill. We learned how to make pins, stickers, and the 3D printer. We were able to use the 3D

printing services to print a spherical cow for Uidaho Bound!

In March, SPS hosted a table at Uidaho Bound where we met many future Vandals. SPS was also given a tour of Dr. Jason Barnes Tesla Model X. We saw how its autopilot worked as well as how it uses power over time - all displayed on the screen in the vehicle.

In April, we hosted Uidaho Bound again and hosted a talk from Dr. Christine Berven about her work on mesoscopic electron transport in 2D electron gas systems. We also visited the Geology Department to see the resident mammoth fossil, nicknamed Cola. Cola was found in Soda Springs, ID in the 1960s and went through several hands before ending up at the University of Idaho. Cola is believed to be a Jeffersonian Mammoth from approximately 11,700 years ago.

At the end of April, SPS was able to view the stars at the observatory on campus using the new 20 inch telescope recently installed. We were able to see many things, including the Beehive Cluster and the Great Globular Cluster in the constellation of Hercules!

The SPS table at UI Bound with Steve Kreyche, Sam Callos, Connor O'Neill, Nathan Rubio, and Kaylee Maret (photo by J. DeWitt)

UIdaho Bound Event

With the return of in-person events, as the pandemic fades (or lulls – we shall see), the University brought back the days of UIdaho Bound. The first for this year was on March 26. Our department was well rep-

resented, with a table for the department and, right next door, one for the SPS club, in a sea of other tables at the Kibbie Dome. Leah Bergman represented the faculty, Jessica DeWitt the staff, and the SPS club brought President Sam (Samantha) Callos and several members.

UI Bound reps: Leah Bergman, Sam Callos, and Nathan Rubio
(photo by J. DeWitt)

Faculty

Astrophysics 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
- Zachariah Etienne, Associate Professor, Ph.D. University of Illinois 2009
- 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

Ramachandran Kasu, Ph.D., Postdoctoral Fellow

Brian Petty, Scientific Instrument Maker

Leonardo Werneck, Ph.D., Postdoctoral Fellow

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!!

Awards in 2022

Dean's Award: Margot Dillon

Undergraduate research: Sam Callos

Deans Graduate Award: Jonathan Barnes

Best Physics TA: Dillon Morehouse

Outstanding Graduate entry, CoS Student Research Expo: Isiaka Lukman

UI Alumni Silver and Gold Award and Fellow of the Los Alamos National Laboratory: Blas Uberuaga (BA 1994)

DOE Early Career Award: Miles Beaux (PhD 2010)

Sam Callos with Department Chair John Hiller.

Dillon Morehouse with Professor Berven.

New Graduates

Margot Dillon (B.S. 2021)

Jonathan Flores (B.S. 2021)

Kari Greenback (B.S. 2022)

Andrew Harley (B.S. 2022)

Andrew Johnson (B.S. 2022)

Jett Kauffman (B.S. 2022)

Stephen Maria (B.S. 2022)

Cole Thompson (B.S. 2021)

Orion Wheeler (Applied B.S. 2022)

Daniel Coulter (M.S. 2022) Advisor: Jason Barnes

Joseph A'Hearn (Ph.D. 2022)
Thesis advisor: Matt Hedman
Thesis title: Gravitational Interactions and Resonances in Ring-Moon Systems

Jonathan Barnes (Ph.D. 2021)
Thesis advisor: Marty Ytreberg
Thesis title: Using modeling to understand structure-function relationships in proteins

Mohammad Khan (Ph.D. 2021)
Thesis advisor: You Qiang
Thesis title: Radiation Effects on Metal Fe and Core-Shell Ti-TiO_2 Nanoparticles by Molecular Dynamics Simulation

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Summer Graduate Research Projects 2021

Victor Afigbo (Hedman)
Calculating the amplitudes of density waves in Saturns rings

Elizabeth Atang (G. Barnes)
Variation in the depth of lunar regolith

Mohammad Khan (Qiang)
Defect distribution of Ti Nanoparticle for neutron radiation

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

Isiaka Lukman (Bergman)
Renewed Raman Selection Rule Calculations for Anisotropic β-Phase Ga_2O_3

Dillon Morehouse (Berven)
Measuring and modeling vertical and lateral superconductor-permanent magnet oscillations

Jinming Zhang (Qiang)
Deposition for ion radiation nano-detectors

Completed Thesis Projects

Joseph A'Hearn

PhD thesis: Gravitational Interactions and Resonances in Ring-Moon Systems

While resonances determine the large-scale dynamical structure of planetary systems, interactions among the small bodies in these resonances impact their orbital evolution. We use numerical simulations to study the orbital evolution of interacting small bodies orbiting within two different locations in Saturns rings, and of interacting equal-mass co-orbitals. Modeling the clumps in Saturns D68 ringlet as co-orbital point-masses reveals the fragility of low-mass co-orbital satellite systems. Simulations of multiple massive bodies in a common corotation resonance site, such as the ring arc of Saturns moon Aegaeon, reveal the importance of interaction timescales for multi-body orbital dynamics. We also investigate the planetary normal mode spectra of Uranus and Neptune to predict where in their rings we might expect to see resonant phenomena.

Jonathan Barnes

PhD thesis: Using modeling to understand structure-function relationships in proteins

Proteins are critical to the function of cells and to life. It is well established that changes to the DNA sequence (genotype) of a protein can have a significant impact on how they function or interact within the cell. Understanding the mapping between changes in a protein genotype and how those changes modify an organism phenotype is a largely unsolved problem in biology. Solving this problem will require integration of

experimental methods with computational and mathematical approaches. In this thesis, we utilize both computational and mathematical methodologies. We start by using statistical methods to investigate potential physical features that can explain epistasis in proteins. Here we find a number of intuitive features that play a role, but we can only explain 30% of the observed epistasis in both protein binding and folding. Next, we use molecular dynamics to inform statistical models and predict the spectral sensitivity of opsin proteins with high accuracy. Following that, we investigate a suite of fast methods for predicting protein-protein binding affinity, finding their performance to be largely context dependent. Lastly, we explore using two different molecular modeling techniques to calculate free energies and build a watch list of antibody escape mutations for the current COVID-19 pandemic.

Mohammad Khan

PhD thesis: Radiation Effects on Metal Fe and Core-Shell Ti-TiO_2 Nanoparticles by Molecular Dynamics Simulation

Nanoparticles, due to their small size and radiation absorption property, are widely used in nuclear nanotechnology as well as radiation environment. Radiation-induced defects could negatively affect mechanical properties, potentially leading to accidents. In this study, the molecular dynamics (MD) method, as a powerful atomic-level simulation tool, is applied to investigate and characterize formation and evolution of point defects in irradiated Fe nanoparticle (NP) and core-shell Ti-TiO_2 NP by using a recent updated many-body interatomic potential. MD especially helps us to gain access to length and time scales that are not accessible experimentally and to learn more about the multi-scale phenomena that occur during the irradiation of nanomaterials. This dissertation has focused on understanding the atomic-level mechanism of irradiation damages and defect formations in Fe nanoparticle (NP) and core-shell Ti-TiO_2 NP. To test the NPs compatibility for several neutron energy and temperature stability, a series of MD simulations have been done for Fe NP and core-shell Ti-TiO_2 NP. The results from the simulation provide the defect orientation on NP after irradiation and can be used to predict the experimental results.

Recent Publications (2021-22)

Student authors are underlined.

Astrophysics and Planetary Science
(the large number of LIGO publications are not included)

Steven M. Kreyche; Jason W. Barnes; Billy L. Quarles; Jack J. Lissauer; John E. Chambers, "Investigating Tidal Obliquity Variations with SMERCURY-T", The Planetary Science Journal, 2:5 #187, 2021 September 9.

Mitri, Giuseppe; Barnes, Jason; Coustenis, Athena; Flamini, Enrico; Hayes, Alexander; Lorenz, Ralph D.; Mastrogiuseppe, Marco; Orosei, Roberto; Postberg, Frank; Reh, Kim; Soderblom, Jason M.; Sotin, Christophe; Tobie, Gabriel; Tortora, Paolo; Buitton, Veronique; Wurz, Peter, "Exploration of Enceladus and Titan: Investigating Ocean Worlds' Evolution and Habitability in the Saturn System", Experimental Astronomy, 2021 July 22.

Jason W. Barnes; Elizabeth P. Turtle; Melissa G. Trainer; Ralph D. Lorenz; Shannon M. MacKenzie; William B. Brinckerhoff; Morgan L. Cable; Carolyn M. Ernst; Caroline Freissinet; Kevin P. Hand; Alexander G. Hayes; Sarah M. Hörst; Jeffrey R. Johnson; Erich Karkoschka; David J. Lawrence; Alice Le Gall; Juan M. Lora;

Christopher P. McKay; Richard Miller; Scott L. Murchie; Catherine D. Neish; Claire E. Newman; Jorge Nuñez; Mark P. Panning; Ann M. Parsons; Patrick N. Paplowski; Lynnae C. Quick; Jani Radebaugh; Scot C. R. Rafkin; Michael A. Ravine; Hiroaki Shiraishi; Jason M. Soderblom; Kristin Sotzen; Angela M. Stickle; Ellen R. Stofan; Cyril Szopa; Tetsuya Tokan; Colin Wilson; R. Aileen Yingst; Kris Zacny; Simon C. Stähler, "Science Goals and Objectives for the Dragonfly Titan Rotorcraft Relocatable Lander", The Planetary Science Journal, 2:4 #130, 2021 July 19.

MacKenzie, Shannon M.; Birch, Samuel P.D.; Hörst, Sarah; Sotin, Christophe; Barth, Erika; Lora, Juan; Trainer, Melissa G.; Corlies, Paul; Malaska, Michael J.; Sciamma-O'Brien, Ella; Thelen, Alexander E.; Turtle, Elizabeth; Radebaugh, Jani; Hanley, Jennifer; Solomonidou, Anezina; Newmann, Claire; Regoli, Leonardo; Rodriguez, Sebastien; Seignovert, Benoit; Hayes, Alex; Journaux, Baptiste; Steckloff, Jordan; Nna-Mvondo, Delphine; Cornet, Thomas; Palmer, Maureen; Lopes, Rosaly; Vinatier, Sandrine; Lorenz, Ralph; Nixon, Conor; Czaplinski, Ellen; Barnes, Jason W.; Sittler, Ed; Coates, Andrew, "Titan: Earth-like on the Outside, Ocean World on the Inside", The Planetary Science Journal, 2:112, 2021 June.

Dhingra, Rajani D.; Jennings, Donald E.; Barnes, Jason W.; Cottini, Valeria, "Lower Surface Temperature at Bright Ephermeral Feature Site on Titan's North Pole", Geophysical Research Letters, 48 (7) e2020GL091708, 2021 April 16.

Miller, William J.; Barnes, Jason W.; MacKenzie, Shannon M., "Solving the Alhazen-Ptolemy Problem: Determining Specular Points on Spherical Surfaces", The Planetary Science Journal, 2:63, 2021 March 29.

Myers, Samuel A.; Barnes, Jason W.; Ahlers, John P., "Constraints on Sub-Neptune Planet Candidate KOI-972.01 via Joint Asteroseismology / Gravity Darkening Analysis", The Planetary Science Journal, 2:35, 2021 February 24.

Ralph D. Lorenz; Shannon M. MacKenzie; Catherine D. Neish; Alice Le Gall; Elizabeth P. Turtle; Jason W. Barnes; Melissa G. Trainer; Alyssa Werynski; Joshua Hedgepeth; Erich Karkoschka, "Selection and Characteristics of the Dragonfly Landing Site near Selk Crater, Titan", The Planetary Science Journal, 2:24 (13pp), 2021 February.

L. R. Werneck, Z. B. Etienne, E. Abdalla, B. Cuadros-Melgar and C. E. Pellicer, "NRPyCritCol & SFcollapse1D: an open-source, user-friendly toolkit to study critical phenomena," Class. Quant. Grav. **38**, 245005 (2021).

A. Murguia-Berthier, S. C. Noble, L. F. Roberts, E. Ramirez-Ruiz, L. R. Werneck, M. Kolacki, Z. B. Etienne, M. Avara, M. Campanelli and R. Ciolfi, *et al.* "HARM3D+NUC: A New Method for Simulating the Post-merger Phase of Binary Neutron Star Mergers with GRMHD, Tabulated EOS, and Neutrino Leakage," Astrophys. J. **919**, 95 (2021).

S. Habib, A. Ramos-Buades, E. A. Huerta, S. Husa, R. Haas and Z. Etienne, "Initial Data and Eccentricity Reduction Toolkit for Binary Black Hole Numerical Relativity Waveforms," Class. Quant. Grav. **38**, 125007 (2021).

B. J. Kelly, Z. B. Etienne, J. Golomb, J. D. Schnittman, J. G. Baker, S. C. Noble and G. Ryan, "Electromagnetic Emission from a Binary Black Hole Merger Remnant in Plasma: Field Alignment and Plasma Temperature," Phys. Rev. D **103**, 063039 (2021).

C. W. Lewandowski, T. D. Knowles, Z. B. Etienne and B. D'Urso, "High sensitivity accelerometry with a feedback-cooled magnetically levitated microsphere," Phys. Rev. Applied **15**, 014050 (2021).

H. Sharma, M.M. Hedman, D.H. Wooden, A. Colaprete, A.M. Cook. 2021. Constraining Low- Altitude Lunar Dust using the LADEE-UVS Data. JGR-Planets 126:e2021JE006935

R.G. French, B. Bridges, M.M. Hedman, P.D. Nicholson, C. Mankovich, C.A. McGhee-French. 2021. Kronoseismology V: A panoply of waves in Saturns C ring driven by high-order planetary oscillations. Icarus 370:114660.

A.M. Rymer, K.D. Runyon, B. Clyde, J.I. Nuñez, R. Nikoukar, K.M. Soderlund, K. Sayanagi, M. Hofstdter, L.C. Quick, S.Alan Stern, T. Becker, M.M. Hedman, I. Cohen, F. Crary, J.J. Fortney, J. Vertesi, C. Hansen, I. de Pater, C. Paty, T. Spilker, T. Stallard, G.B. Hospodarsky, H. Todd Smith, H. Wakeford, S.E. Moran, A. Annex, P. Schenk, M. Ozimek, J. Arrieta, R.L. McNutt, Jr., A. Masters, A.A. Simon, S. Ensor, C.T. Apland, J. Bruzzi, D.A. Pathoff, C. Scott, C. Campo, C. Keupiarz, C.J. Cohrane, C. Gantz, D. Rodriguez, D. Gallagher, D. Hurley, D. Crowley, E. Abel, E. Provornikova, E.P. Turtle, G. Clark, J. Wilkes, J. Hunt, J.H. Roberts, J. Rehm, K. Murray, L. Wolfrath, L.N. Fletcher, L. Spilker, E.S. Martin, M. Parisi, M. Norkus, N. Izenberg, R. Stough, R.J. Vervack, Jr., K. Mandt, K.B. Stevenson, S. Kijewski, W. Cheng, J.D. Feldman, G. Allen, D. Prabhu, S. Dutta, C. Young, J. Williams. 2021. Neptune Odyssey: A Flagship Conceor for the Exploration of the Neptune-Trion System. PSJ 2:184.

M.M. Hedman, M. Young. 2021. Evidence that a Novel Type of Satellite Wake Might Exist in Saturns E Ring. PSJ 2:127.

M.M. Hedman, R.O. Chancia. 2021. Uranus Hidden Narrow Rings PSJ 2:107.

J.A. A'Hearn, M.M. Hedman, D.P.Hamilton. 2021. Modeling Saturns D68 Clumps as a Coorbital Satellite System. PSJ 2:74.

Biological Physics

L. Sheneman, G. Stephanopoulos, A. E. Vasdekis, "Deep Learning Classification of Lipid Droplets in Quantitative Phase Images," PLOS ONE 16, e0249196 (2021).

N. R. Subedi, S. Yaraghi, P. S. Jung, G. Kukal, A. G. McDonald, D. N. Christodoulides, A. E Vasdekis, "Airy Light-Sheet Raman Imaging," Optics Express **29**, 31941 (2021).

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Patel D, Haag SL, Patel JS, Ytreberg FM, Bernards MT, "Paired Simulations and Experimental Investigations into the Calcium-dependent Conformation of Albumin," J Chem Inf Model 62:1282 (2022).

Condensed Matter Physics

D. Thapa, J. Lapp, I. Lukman, and L. Bergman, "Ultra-wide bandgap β-Ga_2 O_3 films: Optical, phonon, and temperature response properties, AIP Advances **11**, 125022 (2021).

Hadronic Physics

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).

H. Alanazi and R. Machleidt, "The Relevance of Pion-Exchange Contributions Versus Contact Terms in the Chiral Effective Field Theory Description of Nucleon-Nucleon Scattering," Few Body Syst. **62**, 1 (2021).

Y. Nosyk, D. R. Entem and R. Machleidt, "Nucleon-nucleon potentials from Δ-full chiral effective-field-theory and implications," Phys. Rev. C **104**, 054001 (2021).

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F. Sammarruca and R. Millerson, "The Equation of State of Neutron-Rich Matter at Fourth Order of Chiral Effective Field Theory and the Radius of a Medium-Mass Neutron Star," Universe **8**, 133 (2022).

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F. Sammarruca and R. Millerson, "Analysis of the neutron matter equation of state and the symmetry energy up to fourth order of chiral effective field theory," Phys. Rev. C **104**, 034308 (2021).

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

S.S. Chabysheva and J.R. Hiller, "Nonperturbative light-front effective potential for static sources in quenched scalar Yukawa theory," Phys. Rev. D **105**, 056027 (2022).

Physics Education

C. Berven, *Physics Problem-Solving Techniques for Understanding & Success in First Year Mechanics*, Cognella Academic Publishing (2022).

Recent Presentations (2021-22)

(severely curtailed by the pandemic)

Astrophysics and Planetary Science

J. Barnes, "Dragonfly: NASA's Nuclear-Powered Titan Rotorcraft Lander", invited presentation at the Center for Advanced Energy Studies, University of Idaho Roundtable, Idaho Falls, Idaho (delivered virtually), 2021 April 19.

J. Barnes, "Dragonfly: NASA's Titan Rotorcraft Lander", invited colloquium for the Department of Physics at Idaho State University, Pocatello, Idaho (delivered virtually), 2021 August 30; invited colloquium for at the Department of Astronomy at Northern Arizona University, Flagstaff, Arizona (delivered virtually), 2021 November 15.

Z. Etienne, Advancing Multimessenger Astrophysics with Next-Generation Black Hole and Neutron Star Binary Merger Simulations, University of Idaho Physics Colloquium, August 2021.

H. Sharma, M.M. Hedman, S. Vahidinia. Variations in the Near-Infrared Spectra of Enceladus. 2021 meeting of the American Geophysical Union (virtual), meeting of the Division for Planetary Sciences (virtual), Lunar and Planetary Science Conference (virtual).

J.A. A'Hearn, M.M. Hedman, C. Mankovich, M. Marley. Ice Giant Ring Seismology. 2021 European meeting of the American Geophysical Union (virtual), meeting of the Division for Planetary Sciences (virtual), European Planetary Science Conference (virtual), meeting of the Division for Dynamical Astronomy (virtual).

M.M. Hedman. Resonant phenomena in the Saturn System. 2021 XX Brazilion Colloquium of Orbital Dynamics (invited, virtual).

M. Dillon, M.M. Hedman. Evidence of a highly inclined dusty ringlet in Saturns C ring. 2021 meeting of the Division for Planetary Sciences (virtual).

M.M. Hedman, M. El Moutamid, P. Nicholson, M. Tiscareno. Recording history in planetary rings with density waves. 2021 meeting of the Division for Dynamical Astronomy (virtual).

Biological Physics

A. Vasdekis, Cell Bio Conference ASCB/EMBO (2021).

F.M. Ytreberg, North Idaho College Undergraduate Student Seminar, Moscow, ID, June 2021

Condensed Matter Physics

I. Lukman, "Ultra -Wide Bandgap Semiconductor Gallium Oxide UI College of Science, Student Research Exposition, 2021.

I. Lukman, "Growth and Properties of Extreme-Wide Bandgap Gallium Oxide National Society of Black Engineers, 2021.

M.Z.H. Khan, Y. Qiang. "Radiation effect distribution observed on core-shell nanoparticles by molecular dynamics simulation," 16th Annual, UNIVERSITY OF IDAHO COLLEGE OF SCIENCE STUDENT RESEARCH EXPOSITION, October 2021.

M.Z.H. Khan, Y. Qiang. "The Radiation effect observation on core-shell Ti@TiO2 by molecular dynamics simulation," APS March Meeting 2021, virtual.

Y. Qiang, "Advanced Magnetic Separation Nanotechnology for Used Nuclear Fuel Recycling," Plenary Talk at Material Science Expo 2021, Dec. 2021.

Y. Qiang "Advanced Radiation Nanodetector for nuclear energy application," Keynote talk at V-Mat 2021, 3rd Edition of Materials Science and Nanoscience Webinar.

Y. Qiang, "Nanophysics and Nanomaterials for Space Science," NASA ISGC meeting, McCall ID, Aug. 2021.

Hadronic Physics

S. Chabysheva and J. Hiller, "Impacts of the quantum vacuum," UI Physics Department colloquium, 15 November 2021.

S. Chabysheva, "Rotational symmetry in a light-front effective potential," contributed virtual talk, Light-cone 2021: Physics of hadrons on the light front, South Korea, December 2021.

J. Hiller, "Simplicity and complexity in the light-front vacuum," invited virtual talk, APCTP Focus Program in Nuclear Physics 2021 Part II: Science Opportunities with EIC, South Korea, July 2021.

J. Hiller, "A nonperturbative perspective on the light-front vacuum," invited virtual talk, Light-cone 2021: Physics of hadrons on the light front, South Korea, December 2021.

R. Machleidt, "The Dream of the German Atomic Bomb," (virtual) Colloquium, Department of Physics and Astronomy, Washington State University, Pullman, WA, Sep. 2, 2021; Department of Physics, Idaho State University, Pocatello, ID, Feb. 14, 2022.

R. Machleidt, "Fake News at the *ab initio* Front," (virtual) Theory Seminar, Argonne National Laboratory, Argonne, IL, Feb. 21, 2022.

R. Machleidt, "From phenomenological to chiral interactions," (virtual) Talk at the Invited Session: 30 Years of Effective Field Theories in Few-Nucleon Physics—A Steven Weinberg Celebration, 2022 April Meeting of the APS, New York, NY, April 12, 2022.

R. Machleidt, "Diverse News from the *ab initio* Front," (virtual) Nuclear Theory Seminar, Facility for Rare Isotope Beams (FRIB), Michigan State University, East Lansing, MI, May 3, 2022.

Current External Funding

Astrophysics and Planetary Science

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).

PI: Jason W. Barnes (UIdaho), Co-I Shannon M. MacKenzie (JHU/APL), Co-I Michael J. Malaska (JPL/Caltech), Co-I Rajani D. Dhingra (JPL/Caltech), Exploring Titans "Wet Sidewalk Effect." NASA Cassini Data Analysis Program, 2022-2024, $589,380 ($377,771 to 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).

Z. Etienne, Boosting Algorithmic Efficiency: Numerical Relativity in Dynamical, Curvilinear Coordinates, NSF Gravitational Physics–Theory, 2021-2024, $174,803.

Z. Etienne, Collaborative Research: WoUMMA: Toward Binary Neutron Star Mergers on a Moving-mesh, NSF Windows on the Universe: The Era of Multi-Messenger Astrophysics, 2021-2024, $483,465 ($226,347 to Etienne).

Z. Etienne, COVID Augmentation on Advancing Computational Methods to Understand the Dynamics of Ejection, Accretion, Winds and Jets in Neutron Star Mergers award, NASA COVID, 2021-2022, $28,609.

Z. Etienne, Collaborative Research: Measuring G with a Magneto-Gravitational Trap, NSF Gravitational PhysicsExperiment, 2020-2023, $567,990 ($118,517 to Etienne).

Z. Etienne, Collaborative Research: Frameworks: The Einstein Toolkit ecosystem: Enabling fundamental research in the era of multi-messenger astrophysics, NSF OAC, 2020-2024, $2,300,415 ($335,902 to Etienne).

Z. Etienne, REU Site: Undergraduate Astrophysics Research in Appalachia at West Virginia University, NSF Special Programs in Astronomy, 2020-2022, $339,477.

Z. Etienne, Advancing Computational Methods to Understand the Dynamics of Ejection, Accretion, Winds and Jets in Neutron Star Mergers, NASA Theoretical and Computational Astrophysics Networks (TCAN), 2018-2022, $1,590,362 ($295,231 to Etienne).

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, 2018-2022, $330,244 ($208,915 to UIdaho).

D.P. Hamilton (PI University of Maryland), M.M. Hedman (Co-I, University of Idaho. NASA Cassini Data Analysis Program, 2018-2022, $439,191 ($27,989 to UIdaho).

M.M. Hedman (PI University of Idaho), M. Marley (Co-I U. Arizona), J. Fortney (Collaborator UCSC). Seismological Studies of the Ice Giants. NASA Cassini Data Analysis Program, 2021-2024, $242.783 ($178,271 to UIdaho).

M.M. Hedman (PI University of Idaho), R. French (Co-I SETI Institute), D.P. Hamilton (Co-I U. Maryland). The Recent History of Saturns Dusty Rings. NASA Cassini Data Analysis Program, 2021-2024, $543,223 ($275,386 to UIdaho).

M.M. Hedman (PI University of Idaho), R.G. French (Co-I Wellesley College), M. El Moutamid (Collaborator Cornell U), J. Fuller (Collaborator, Caltech), P.D. Nicholson (Collaborator Cornell U.) Using Saturns rings to probe oscillations and asymmetries in the planets interior. NASA Cassini Data Analysis Program, 2017-2022, $323,937 ($226,662 to UIdaho).

D. Blaney (PI JPL), K. Hibbitts (Deputy PI APL), C. Bruce (PM JPL), A. Santo (Deputy PM APL), R. Green (IS JPL), R. Clark (Co-I PSI), B. Dalton (Co-I JPL), A. Davies (Co-I JPL), M.M. Hedman (Co-I University of Idaho), Y. Langevin (Co-I University of Paris), J. Lunine (Co-I Cornell University), T. McCord (Co-I Bear Fight Institute), S. Murchie (Co-I APL), C. Paranicas (Co-I APL), F. Seeles (Co-I APL), J. Soderblum (Co-I MIT), Mapping Imaging Spectrometer for Europa (MISE), NASA Europa Instrument Investigation Program, Funding Dates and Budget TBD ($69,411 to UIdaho).

M.M. Hedman (PI University of Idaho), D. Wooden (Co-I NASA Ames), A. Colaprete (Co-I NASA Ames), A. Cook (Co-I NASA Ames) Looking at lunar dust with LADEE, NASA Lunar Data Analysis Program 2015- 2022, $225,650 ($212,594 to UIdaho).

M.M. Hedman (PI University of Idaho), R.G. French (Co-I Wellesley College), Uranian ring dynamics and constraints on Uranus internal structure from occultation data, NASA Solar System Workings Program, 2015-2022, $340,202, ($163,075 to UIdaho).

Biological Physics

A.E. Vasdekis, National Science Foundation, PI, 2041523, Collaborative Research: Multidimensional single-cell phenotyping for elucidating genome to phenome relationships, $362,000, 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, $1,500,000, 09/18 06/22.

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, $306,000 (awarded to Vasdekis), 09/18 08/22.

A.E. Vasdekis, Department of Energy, Genomic Sciences Program, PI, DE-SC0022282, Integrative Imaging of Plant Roots during Symbiosis with Mycorrhizal Fungi, $1,700,000, 09/21 08/24.

A.E. Vasdekis, Department of Energy, Genomic Sciences Program, co-PI (PI: G. Stephanopoulos), Improving Fermentation Robustness by Cellular Noise Engineering, $430,000 (awarded to Vasdekis), 09/21 08/24.

A.E. Vasdekis, Department of Energy, Genomic Sciences Program, co-PI (PI: C. J. Marx), Converting methoxy groups on lignin-derived aromatics from a toxic hurdle to a useful resource: a systems-driven approach, $150,000, 09/21 08/24.

Wichman HA (PI), Ytreberg FM (associate director) "Center for Modeling Complex Interactions," NIH COBRE, 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.

C. Berven, Co-PI (PI H. Hess), 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, 2020-2022, $40,000 ($20,000 to Berven).

Y. Qiang, Advanced Nanomaterials for Next Generation Neutron Radiation Detection Using Machine Learning Approach, NASA IGSC, 2020-2022, $58,600.

Hadronic Physics

F. Sammarruca and R. Machleidt, Nuclear Theory at the University of Idaho, DOE Office of Science, 2021-2023, $240,000.

Reader Response Form (2022)

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Thanks!! We'll enjoy hearing from you!