A Publication of the University of Vermont Department of Physics 2020

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MESSAGE FROM THE CHAIR RANDALL HEADRICK

June 2020

Greetings! We've been away for a while, as we've – literally – rebuilt the Physics Department from the ground up. Since we have some catching up to do, this newsletter combines newsworthy items from both 2019 and 2020 academic years, starting with the celebration of our 2019 graduates. 12 undergraduate physics majors received their degrees, which is one of our largest graduating classes ever. In addition, former graduate student Timothy Olszansky obtained his master's degree in Physics, while Sanghita Sengupta and Kim Hua were awarded PhDs in Materials Science.

Celebration of the 2020 graduating class was a more muted affair due to the COVID-19 pandemic, although an in-person ceremony is being planned for Fall 2020. The college awarded seven additional bachelor's degrees in physics including two students who defended honors theses (Aaditya Dimri and Jared Benson) and one Phi Beta Kappa inductee (Abby Postlewaite). Congratulations to all of our recent graduates! I wish you success in your future endeavors!

Active learning teaching of introductory physics (Fall 2019, above), example of a final project from *Extraterrestrial Life* (remote course, Spring 2020, right).

Some of the biggest milestones for the 2020 academic year were the move to the new office and teaching facilities in Innovation Hall, the first cohort of physics PhD students, major upgrades to departmental and university research facilities made possible by multiple external grants, the great resilience of physics department faculty and staff who responded to the COVID-19 outbreak by redesigning their courses on the fly for remote learning, and the successful implementation of research-based active learning teaching methods, both in the new PEARL classroom as well as remotely.

Research highlights abound. The department is enjoying a major upswing in funding, with nine new awards totaling over $2M credited directly to the physics department by UVM sponsored programs during 2019 and 2020 through March 31st. That total doesn't include several large institutional awards mentioned below that were led by physics faculty, or a new National Science Foundation CAREER award to Prof. Juan Vanegas for his work on characterizing the mechanical behavior and response to physical stimuli of cellular components at the nanometer scale through novel computational methods. The CAREER program is the NSF's most prestigious faculty early career program which typically provides generous research funding over five years. Vanegas joins only 12 other currently active CAREER awardees in the College of Arts and Sciences.

Additional research award topics include: (i) research on strongly interacting quantum liquids and gasses (Del Maestro), (ii) US-Japan collaboration on organic electronics (Furis), (iii) coherent x-ray scattering studies of thin film growth (Headrick), (iv) research on microcavities for organic light emitting diodes (White), (v) a project to form commercial partnerships around organic electronics and hybrid perovskite solar cells (Headrick). Two additional institutional research awards led by physics faculty members include an upgrade of the Vermont Advanced Computing Core (Del Maestro) and a NASA-funded Vermont Space Grant Consortium project to study interactions between two-dimensional materials and cold atoms in microgravity (Kotov). All of these project augment departmental strengths in condensed matter physics and in biological physics.

Personnel notes: Dr. Richards (Chad) Miller joined the Department as a Postdoctoral Associate in Fall 2019 to work on development of organic electronics and photovoltaic devices. In addition, Dr. Arjun Sharma will soon join the department as a postdoc to work on biophysical research. On behalf of the department, welcome to the new researchers! Two former postdocs, Dr. Hatem Barghathi and Dr. Rajitha Rajeshwar Tatikonda both recently moved on to new positions. Professor Adrian Del-Maestro plans to move to a new position at the University of Tennessee, Knoxville in Fall 2020. I'm proud to have had Professor Del Maestro as a colleague, and on behalf of the department I wish him great success in his new position. We've also had several faculty retirements. Prof. Joanna Rankin retired and was "promoted" to emeritus status after 39 years as a professor of physics. An event to celebrate her career was held in May 2019 (see the story below). Prof. Junru Wu recently retired in June 2020 after 32 years. Among his numerous professional and academic achievements, I want to highlight his service as Chair of the Department of Physics for a total of eleven years. A planned retirement event to celebrate his career has been postponed until an in-person meeting can be scheduled. Thank you to both Joanna and Junru -- you both served as excellent role models for your junior colleagues. I particularly appreciate your perseverance and good humor as we collectively coped with departmental growing pains and difficult challenges.

Many of the topics that I've touched on above are illustrated more fully in the sections below. Enjoy! My apologies if we've missed any important events. I would like to also specially acknowledge Beth Stinebring, who assembled and edited the content below. Beth herself also recently joined the department in April 2019. Welcome Beth, and great job!

Faculty Transitions

Prof. Joanna Rankin joined the Department of Physics faculty in 1980. Prof. Rankin dedicated 39 years of service and research to the students and faculty at UVM. Her retirement was celebrated with faculty, staff, students, and invited guests on May 10, 2019 at the Waterman Manor.

Prof. Rankin's Retirement Party

(Prof. Rankin’s Retirement Party-continued)

Senior Lecturer John Perry, Chair Randall Headrick

Long-time research collaborator and colleague Prof. Dan Stinebring of Oberlin College

Chair Randall Headrick addressing the party

(also in picture clockwise: Senior Lecturer John Perry, Prof. Joanna Rankin, Mary Fillmore, former student Isaac Backus, who traveled from the Univ. of Washington to attend the event., and Prof. Jie Yang)

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Musical Group “8 Cuerdas” Performing

Prof. Rankin’s Academic and Research Career at the University of Vermont

Early Days of Teaching at the University of Vermont

Joanna Rankin collaborating with Astronomers at the Pushchino Radio Astronomy Observatory circa 1990

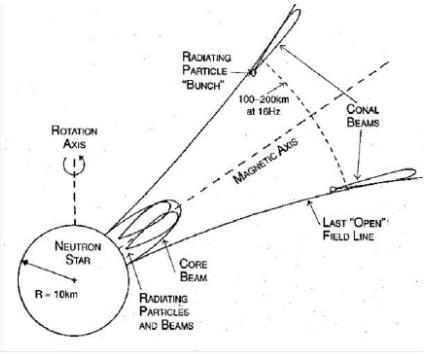
Joanna Rankin with Timothy Olszanski (MS student UVM ’19)

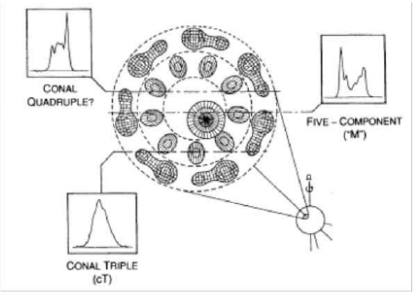
Joanna Rankin on research trip to Arecibo Observatory with students Mateus Teixeira, Isabel Kloumann, and Stephanie Young

Some of Professor Rankin's Research Included:

"Empirical Theory" Beaming Model

- Two concentric Conal Beams around a central Core beam—note this implies roughly symmetrical profile forms
- All three beams reflect the angular size of the polar flux tube at some height
- Polar-cap angular size scales as rotation-period $P^{-1/2}$—some 2.5° for a 1-sec pulsar
- thus the core and conal widths scale as $P^{-1/2}$ also
- Core may be emitted close to the surface
- Cones, outer and inner, are emitted at some 220 and 130 km
- A little spherical geometry allows us to match polarized profiles to the model
- Can then determine the basic geometry: magnetic latitude α and impact angle β





Rankin (1983, 1993)

25

Cones Comprised of Rotating Subbeam "Carousels"

Subpulse drifting, nulling and mode changing

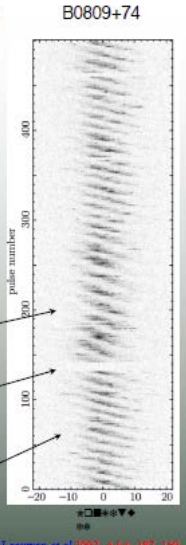
All three phenomena can be seen in this 500-pulse sequence.

These "Big Three" pulse-modulation effects are prototypical of CONAL emission and can be identified in the pulse sequences of many pulsars—but not usually so clearly!

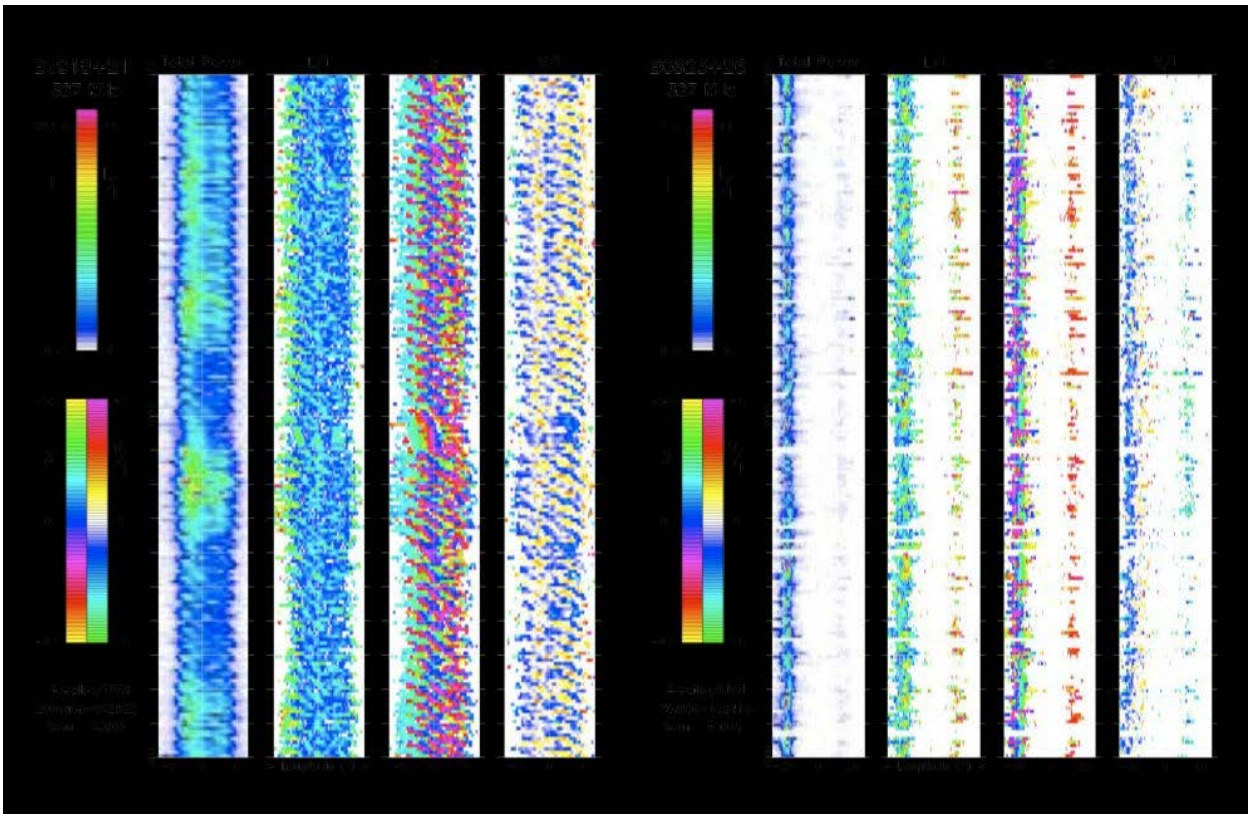
And, a restarted, slower drift "mode".

Then about ten "null" pulses

Note the usual 11-period (P_3) drift up to about pulse 130



van Leeuwen *et al* 2002, ASPC, 267, 159



Sequence of Individual Pulses_Cambridge Pulsar 1919_Arecibo Pulsar 0823_Observed and presented by Joanna Rankin

Joanna Rankin after earning her PhD at the University of Iowa and becoming an Assistant Professor of astronomy at Cornell University, joined the Physics Department at the University of Vermont in 1980 as an Associate Professor. She was promoted to Professor in 1988. She led and grew the astronomy program at UVM including founding the minor in astronomy and expanding the physics major with the addition of an astronomy track. She has inspired students to have an interest in observing the sky and provided many of them with life-changing research experiences at the Arecibo Observatory in Puerto Rico.

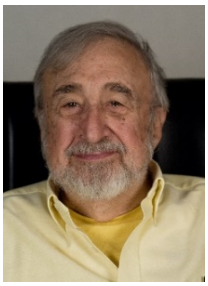
Joanna Rankin – 2008 Netherlands Low-Frequency Pulsar Meeting

Prof. Joanna Rankin has an international reputation in radio astronomy and the field of pulsar studies in particular. Joanna did early research work at Arecibo under the mentorship of Professor James Van Allen, and was there when pulsars were first discovered in 1967. Joanna has been a pioneer in realizing that pulsars simultaneously produce what are known as orthogonal modes of polarization. She has produced long, well-calibrated sequences of single pulses from some the brightest pulsars using the giant Arecibo telescope. Among her best known achievements in research is the cone/double cone model of pulsar emission which she developed herself and in part with renowned radio astronomer V. Radhakrishnan. In addition to her time spent in Arecibo, Puerto Rico Joanna has traveled and collaborated with scientists from three countries that have become important in her research: Russia, India, and the Netherlands. She has produced 123 refereed scientific publications to date. She has also founded the Arecibo Science Advocacy Partnership, a service organization dedicated to advancing the scientific excellence of Arecibo Observatory research. We are grateful for all of her contributions over her 39 years as a faculty member at UVM.

In Memoriam

Professor Robert Arns (Emeritus, former Dean of the College of Engineering and Mathematics, and former Senior Vice President for Academic Affairs) *

1933-2019



The UVM Department of Physics is sad to report that a beloved colleague and friend, Dr.Robert Arns, Emeritus Professor of Physics, passed away on April 6, 2019. Born in Buffalo, NY, Bob graduated from Canisius High School, graduated summa cum laude from Canisius College, and then earned his Ph.D. in nuclear and particle physics from the University of Michigan.

Dr. Arns taught at SUNY Buffalo and at the Ohio State University, and in 1977 moved to the University of Vermont as Senior Vice President for Academic Affairs (Provost) and Professor of Physics. Physics was a great love for Bob, and after eight years as Provost, he returned to teaching in the Physics Department. Except for three years as Dean of the College of Engineering and Mathematics, Bob remained in the Physics Department until he took early retirement in 1999. Bob was truly dedicated to the University of Vermont.

Bob was a dedicated student and curator of the history of science, both at UVM and beyond. He spearheaded efforts to preserve experimental equipment and scientific records, and to use the historical pieces in practical learning experiences for UVM students. Bob's legacy lives on, as hundreds of students and visitors each day pass by the physics museum pieces that are proudly displayed in the entrance to Discovery Hall, sparking scientific curiosity in generations to come.

He was a passionate artist, painting under the pseudonym of Mutin. His later works were based on the astrophysical images from NASA's Hubble Space Telescope. Many of his works were presented in two one-man shows and a joint show with his daughter Sue.

Arns published on a variety of subjects, including experimental nuclear physics, physics pedagogy, management, and the history of science. His work on the development of the transistor was recognized by the 1998 IEEE Life Members' Prize in Electrical History. His colleagues and friends will remember him fondly for his sharp wit and his many years of generous service to the physics department.

This memoriam was written by Prof. Dennis Clougherty and Prof. Matthew White and was presented by Matthew White at the 2019 Faculty Senate Meeting

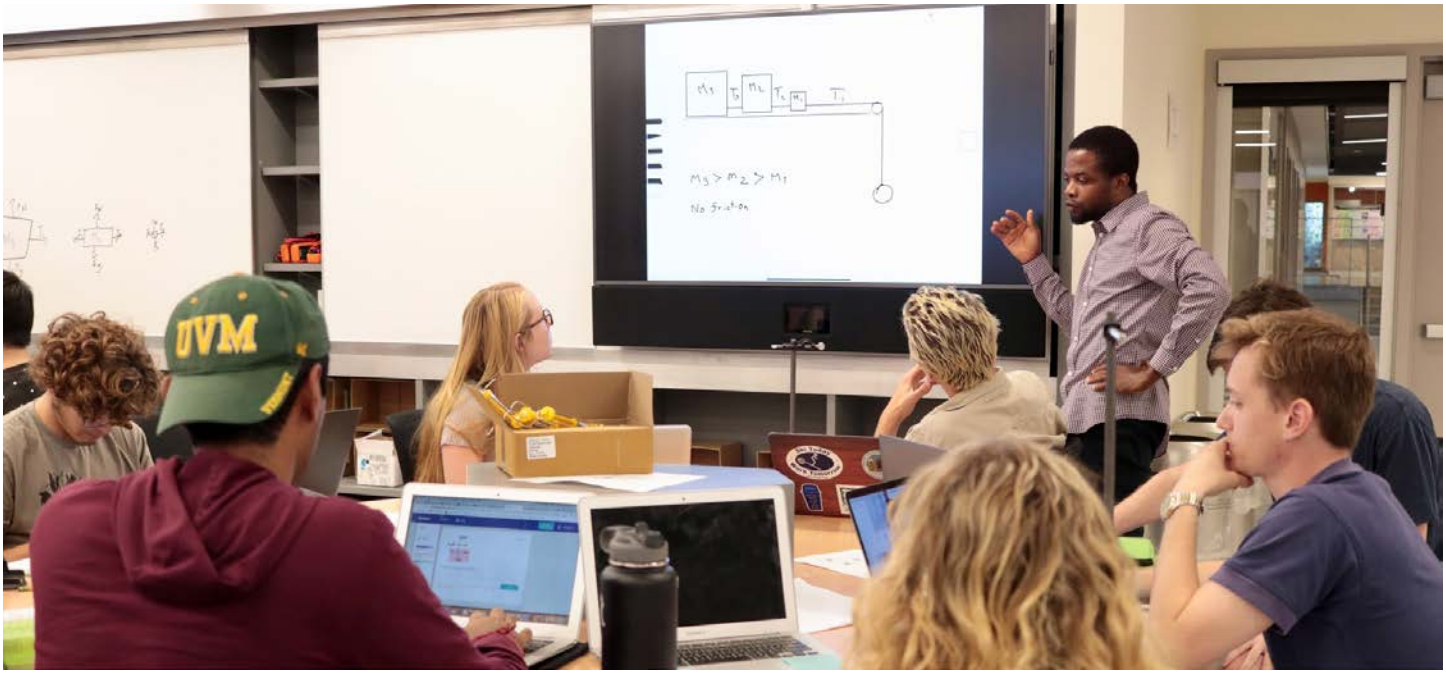
Robert Arns Photographs

Robert Arns at NES APS AAPT Conference

Robert Arns with Hope Green Arns at NES APS AAPT Conference

New Physics Education and Reasoning Laboratory

(2020 Graduate Teaching Assistant of the Year Saheed Ajibade pictured teaching)



The UVM Physics Department has been preparing for the opportunities of the new STEM complex for many years. In addtion to the excellent research infrastructure, a key driver of the complex was the chance to update classroom pedagody. We are now fully participating in what the Physics Education Research has demonstrated, over multiple decades, is a vastly superior method of instruction: active learning.

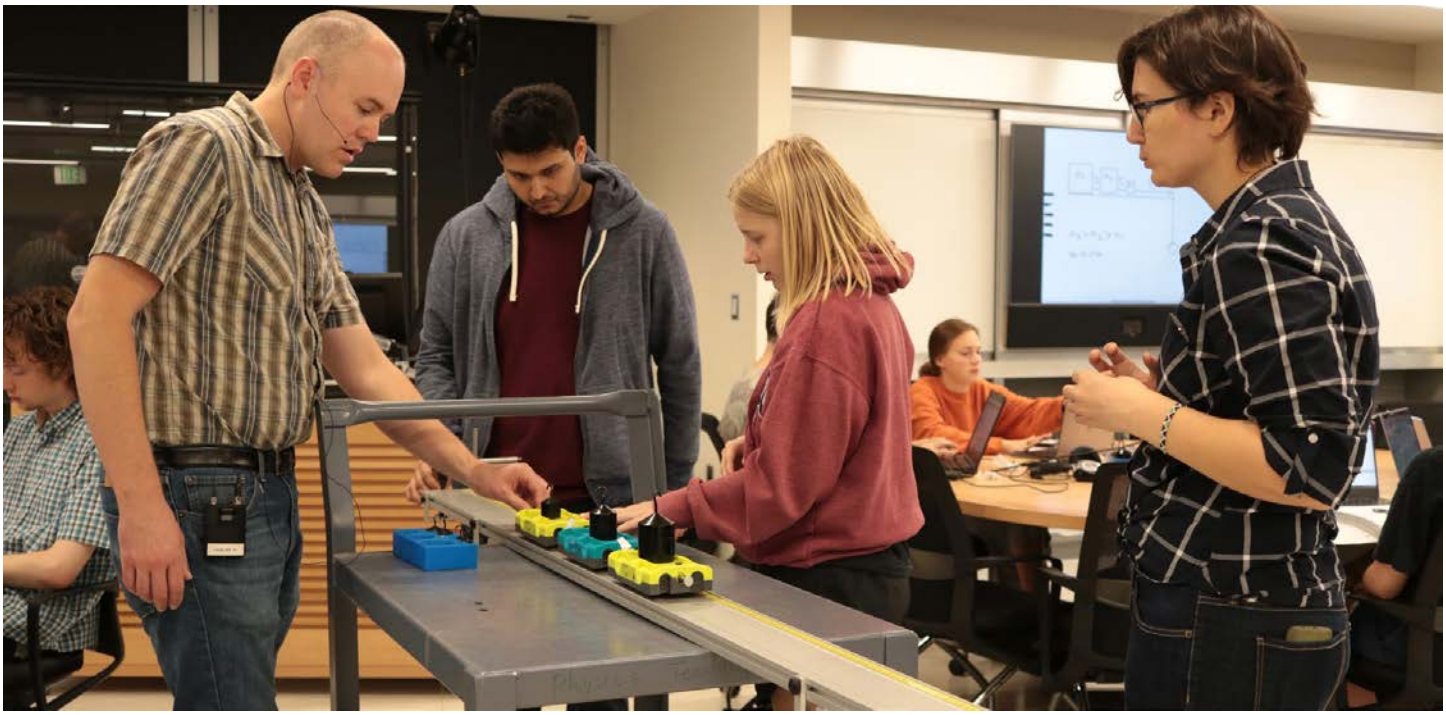
Inspired by programs at MIT and NCSU, and informed by experience at peer insitutions like Ithaca College, UVM Physics now offers all of its introductory courses in a model where the instructors work as guide to help students build their knowledge. Professors, lecturers, graduate students, and undergraduate learning assistants walk around the classroom; answering and asking questions of students to help them see connections and build deeper understanding.

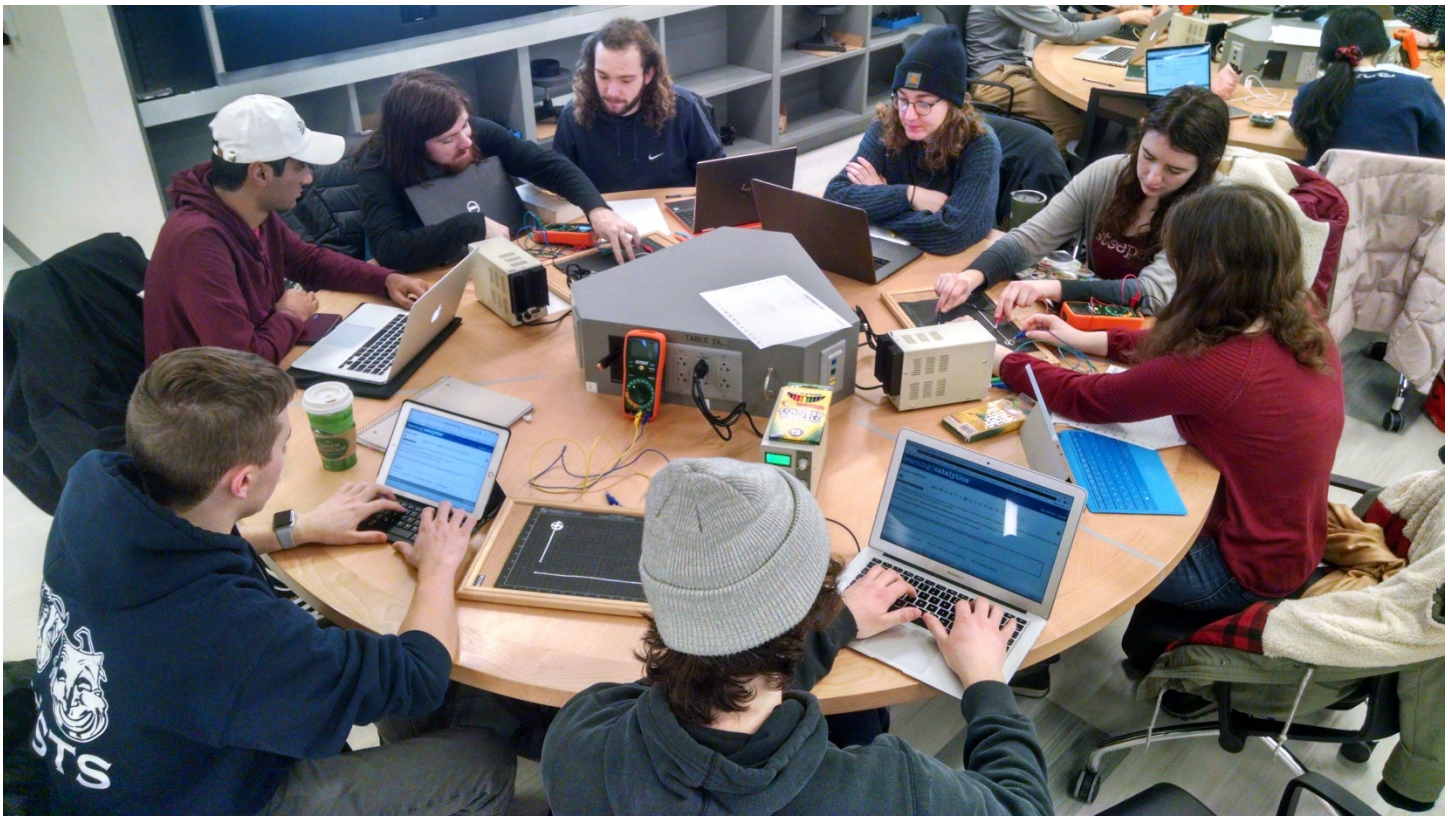
State of the art technology, like 4K screens that the students can present on, a LightBoard for problem solving while maintiaining a conversation with the students, and controllable cameras to provide up-close views of every demonstration bring the classroom into the 21st century. The cameras also allow recordings to be made available to students, for the benefit of students with or without accomodations. Finally, introductory physics would simply not be the same without toys. A brand new suite of equipment allows hands-on activities to happen at the moment that the professor thinks is most pertinent, instead of whenever in the week they have a lab session.

We’re less than a year in, and already demonstrating improved learning outcomes.

Physics Education and Reasoning Laboratory in Photographs

(Prof. Matthew White demonstrating/teaching)





2020 Physics Graduating Seniors and Award Winners

2020 Physics Award Winners

2020 Albert D. Crowell Award for Outstanding Experimental Research in Physics Winner:
Abigail Postlewaite

The Albert D. Crowell Award is given to a senior physics major demonstrating promise in experimental physics through a research or laboratory project.

2020 David W. Juenker Award for Outstanding Scholarship Winner:
Jared C. Benson

The David W. Juenker Prize is awarded annually to a senior physics major who performed outstanding service to the Department and their fellow majors as well as to those who have achieved an outstanding academic record.

2020 Graduate Teaching Assistant of the Year Winner:
Saheed Ajibade

2020 Undergraduate Teaching Assistant of the Year Winner:
Margaret Krause

2020 Maxwell Award

Every year, senior physics majors choose a faculty member that has had the most impact on their time here at UVM. The 2020 Maxwell Award was given to **Professor Valeri Kotov.** The coveted award is a chrome plated coffee urn that was found in the hallway of Cook building and has the names of all the award winners engraved on it.

2019-2020 PHI BETA KAPA INDUCTEES

Abigail Postlewaite

Adam Petrucci

2019-2020 PHYSICS GRADUATING SENIORS

Jared Benson	BS Physics
Paul Delucia	BS Physics
Aaditya Dimri	BS Physics
Eliot Heinrich	BS Physics
Griffin Marchand	BA Physics
Abigail Postlewaite	BS Physics
Joseph Turner	BS Physics

2019 Physics Awards and Honors

The 2019 Department of Physics Award Ceremony was held on May 3, 2019 in the John Dewey Lounge to present distinguished awards to students, staff, and faculty.

Emanuel Casiano-Diaz giving “Physics of Music” demonstration.

Luke Donforth and Emanuel Casiano-Diaz

Luke Donforth, who was given the Special Service to the Department Award at the Ceremony, setting up the “Physics of Music” Demonstration.

Albert D. Crowell Award

Albert D. Crowell was a professor and department chair in physics. In honor of Professor Crowell, the faculty of the Department of Physics give this award to a senior physics major for outstanding undergraduate experimental research in physics, as demonstrated through a research or laboratory project.

Prof. Madalina Furis presenting the Albert D. Crowell Award to Katrina Czar

David W. Juenker Physics Prize

David W. Juenker was a well-known and skillful experimental physicist and professor. In honor of Professor Juenker, the faculty of the Department of Physics give this award to a senior physics major for outstanding scholarship in physics.

Prof. Adrian Del-Maestro presenting the 2019 David W. Juenker Physics Prize to Jiangyong Yu

Detenbeck Summer Research Award

Prof. Adrian Del-Maestro presenting the Detenbeck Summer Research Award to Emanuel Casiano-Diaz

Sigma Pi Sigma Inductees:

Jared C. Benson
Katrina E. Czar
Adam N. Petrucci
Conner Winkeljohn

2019 Teaching Assistants of the Year

Prof. Jun-Ru Wu presenting the Graduate Teaching Assistant of the Year Award to Alina Karki

Senior Lecturer John Perry presenting the Undergraduate Teaching Assistant of the Year Award to Olivia Sergiovanni

2019 Maxwell Award

David Hammond presented Matthew White with the Maxwell Cup Award. Every year, senior physics majors choose a faculty member that has had the most impact on their time here at UVM. This coveted award is a chrome plated coffee urn that was found in the hallway of Cook building.

Department News

New 2019-2020 Grants

NASA - Novel Quantum Material

NSF- OAC

NSF- EAGER

NSF- IIP

NSF- CCF Cyber Team

NSF- CHE CAREER Grant

NSF- Oscillatory Diffusion

NSF- EMP

DOE

SONY

New 2018-2019 Grants

NSF- IRES US Japan Collaboration

NSF- MRI GPU

NASA-Critical Gas Surface Interaction

NSF- DMR Entanglement Entropy

NSF- DMR-Variable Pressure Scanning

DOE- Coherent X-Ray Studies

Prof. Juan Vanegas-2020 CAREER Grant Recipient

2020 has been an exciting year for the computational research group of Professor Vanegas. Two manuscripts so far have been published in the journals Biochemistry and Annual Reviews of Physical Chemistry from collaborations with groups at Sandia National Labs and the National Institutes of Health. An article lead by undergraduate alumni Conner Winkeljohn (B.S. in Physics ‘19) and graduate student Ben Himberg (Materials Science) is currently under review at the Journal of Chemical Physics B submitted for the virtual special issue “Computational and Experimental Advances in Biomembranes.” Materials Science graduate student Bharat Poudel and Professor Vanegas attended the Biophysical Society Annual meeting in San Diego, California in February, where they presented posters from their latest research.

Bharat Poudel, Rajitha Tatikonda, Juan Vanegas and Sergei Sukharev at the BPS Annual Meeting in 2019

Professor Vanegas recently received the prestigious CAREER award from the Chemical Theory, Models and Computational Methods program (Division of Chemistry) at the National Science Foundation. This award supports early-career faculty to stablish solid foundations for their research and educational activities. The $635K 5-year project will focus on characterizing the mechanical behavior and response to physical stimuli of cellular components at the nanometer scale through novel computational methods. Professor Vanegas develops state of the art computational tools to investigate two fundamental questions inthe area of nano-scale biomechanics: 1) what is the role of lipid chemical structure in the elastic properties of model biomembranes?, and 2) what are the activation mechanisms of mechanosensitive proteins (responsible for sensing external physical stimuli such as pressure)? Answering these questions is essential to understand numerous biological functions that strongly depend on mechanically-coupled processes including membrane fission and fusion, organelle and cellular shaping, cardiovascular control and development, osmotic regulation, and touch and pain sensing. The open-source computational tools and methods developed by Professor Vanegas’ group are enabling a broad range of studies on other areas of biophysics, materials science, and soft condensed matter.

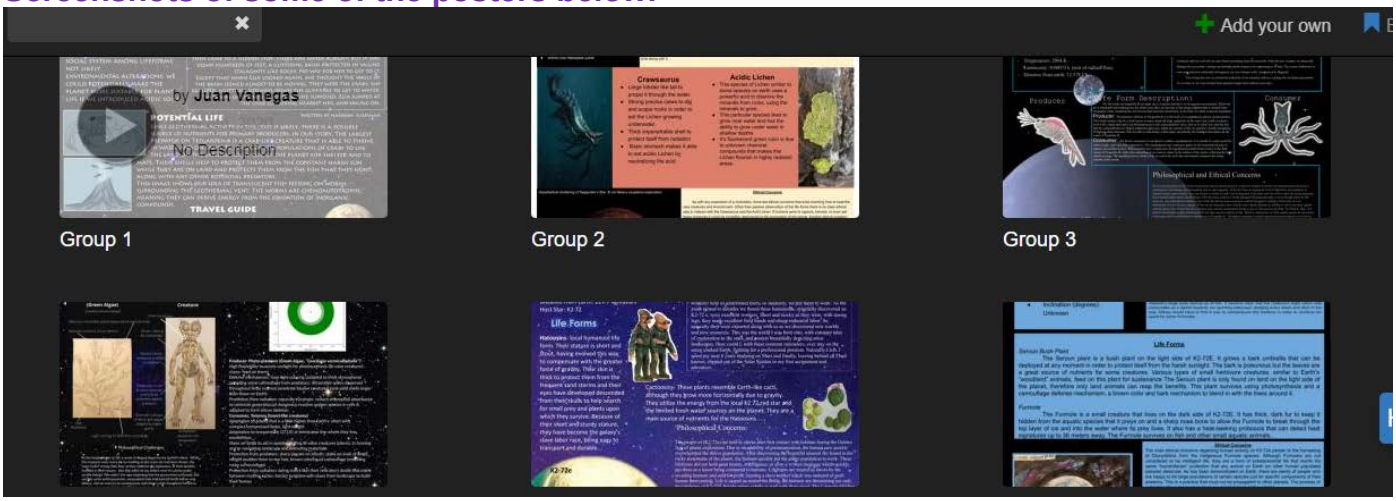
(Prof. Juan Vanegas-2020 CAREER Grant Recipient-continued)

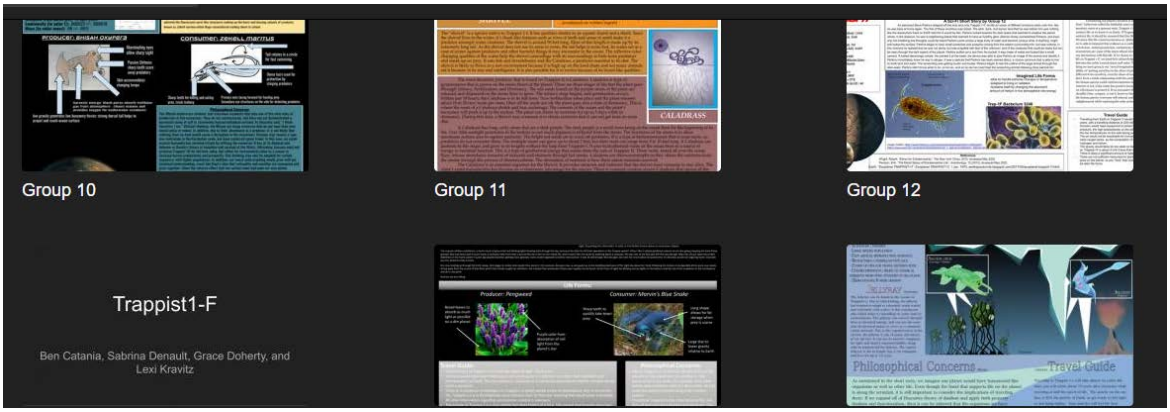
Side by side with research, Professor Vanegas has been busy this past academic year through various new educational projects. In Fall 2019, he taught PHYS011 – Elementary Physics for the first time in the new active learning studio/workshop environment. While this was a big challenge for everyone involved (both instructors and students), it resulted in significant improvements in learning outcomes for students. In Spring 2020, Professor Vanegas was one of the four co-instructors for a large (>240 students!) interdisciplinary course titled “AS096 - Extraterrestrial Life”. Together with Nico Perdrial from Geology, Sarah Alexander from English, and Michael Ashooh from Philosophy they developed a course that explores the possibility of life outside our planet through the lenses of science, fiction, and philosophy.

To read more about “AS096-Extraterrestrial Life” there is an article written in the UVM Cynic about the course https://vtcynic.com/features/english-geometry-philosophy-physics-and-aliens/

Students in “AS096-Extraterrestrial Life” working in groups had to come up with a short science fiction story and imagine the kind of life that could inhabit various real exoplanets that have been observed. There is a digital exhibit of the posters that students created for their final project. https://voicethread.com/myvoice/browse/threadbox/3063

Screenshots of some of the posters below:





2019 IRES UVM Summer Program at Yamagata University, Japan

A 10 week research and learning adventure at Yamagata University, Japan led by Prof. Madalina Furis

Prof. Madalina Furis

Hi there, fellow scientists! We are excited to host the first international Vermont-Japan research experience program for materials scientists funded by the National Science Foundation.

Focused on organic semiconductors and soft matter electronics, the program offers US students a chance to interact with world-renown scientists from Yamagata University, the birthplace of the white light organic LED.

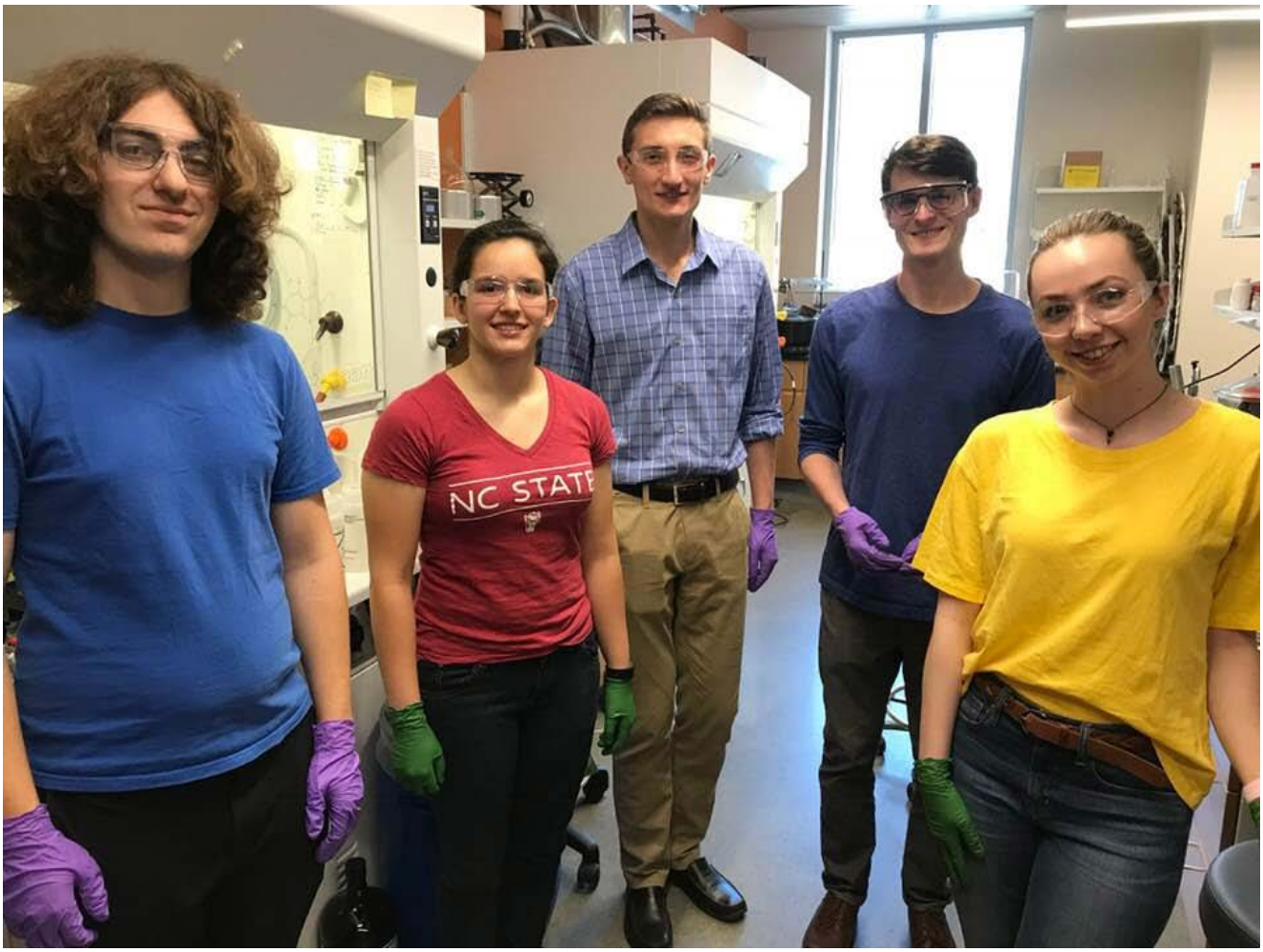
Located in Yonezawa, the birthplace of the famous rayon and the Teijin company (1905), Yamagata University carries on a glorious tradition of excellence in polymer science and engineering.

Follow our students as they navigate the cultural and professional experiences alongside their Japanese mentors and fellow students.

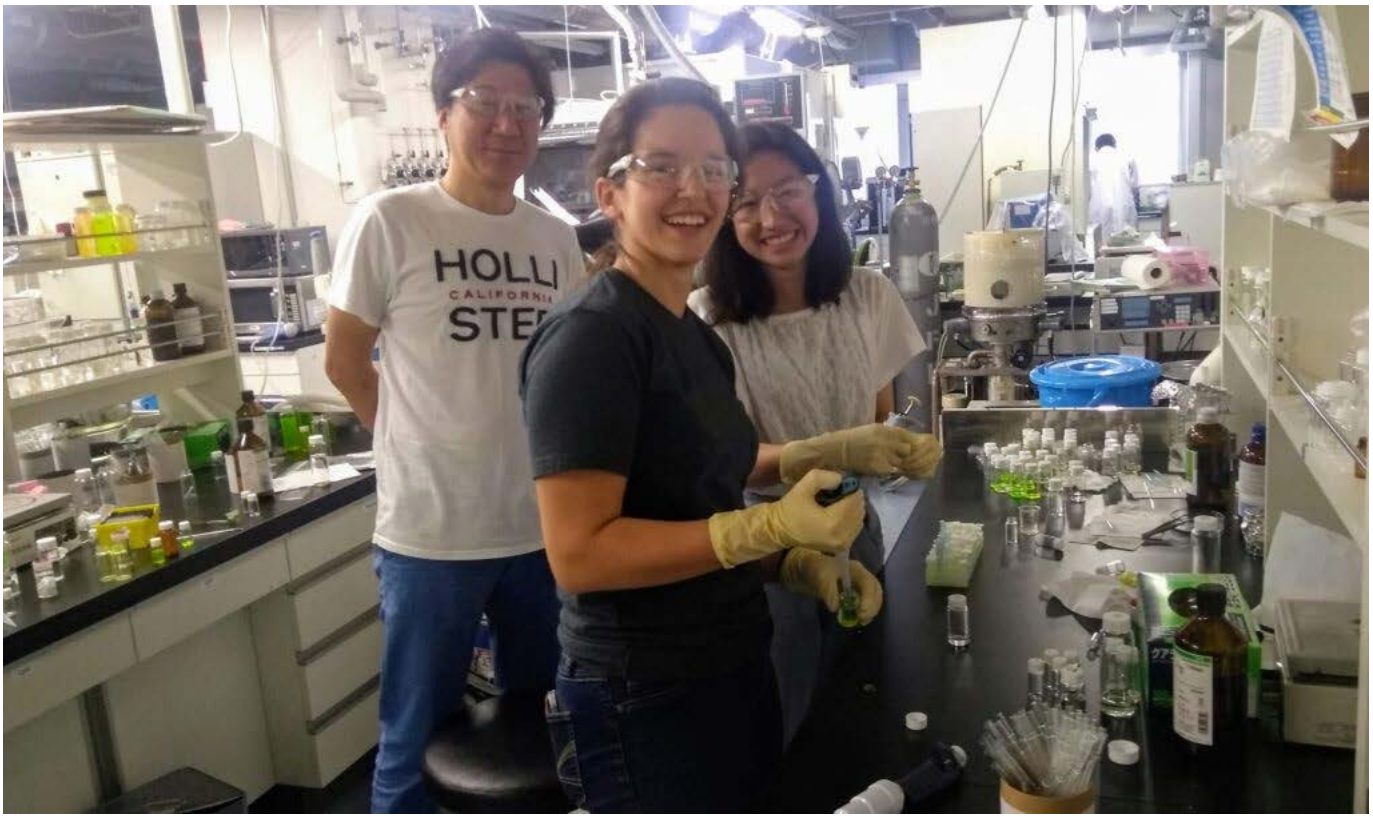
Read the blog at:

https://blog.uvm.edu/mfuris/

Our IRES team before departing from UVM. Left to right: Christopher Popham (Princeton), Daniela Fontecha (NC State), Grayson Glosser(UVM), Adam Dyer (Grad-UVM), Georgia Babb (UVM)



Georgia Babb IRES UVM Participant



Learning synthesis of perovskite nanoparticles in the Masahara Lab

View of Mt. Zao Volcano near Yamagata University

Hiking the Goshikinuma (Five Colored) Lakes. Left to right: Yuki Tsuda, Tsukasa Yoshida-sensei, Kyle Ikeda -sensei, Chris Popham Georgia Babb, Grayson Glosser, Daniela Fontecha and Adam Dyer.

UVM Completes Warp-Speed Upgrade of Its Supercomputer
“Deep Green” Cluster unveiled at July 31, 2019 Ceremony*

Using a $1 million grant from the National Science Foundation, the university added a cluster of 80 high performance graphics processing units, or GPUs, containing 460,000 processing cores to the VACC, housed in UVM's primary datacenter in South Burlington, over the winter and spring.

The new computing cluster, dubbed DeepGreen, is now operational. It can achieve a speed of over 1 petaflop, or one thousand million million computations per second, the equivalent of 20,000 laptop computers working in tandem.

“This is a massive upgrade,” said Richard Galbraith, UVM’s vice president for research, “and a necessary one. In this age of big data, having a facility like this is absolutely essential for our faculty to stay at the cutting edge of their disciplines.”

The upgrade positions the university well, said Adrian Del Maestro, Professor of Physics, Director of the VACC and principal investigator on the NSF grant.

“It one of the fastest supercomputers in New England,” he said, “and one of the 100 fastest academic supercomputers in the country."

According to Del Maestro, the increase in processing speed, combined with hyper-fast network connections within the cluster, will enable faculty to take on new types of research projects they did not have the computational power to explore in the past.

He cited three examples.

“Josh Bongard in Computer Science will use DeepGreen to analyze a gigantic crowd-sourced data set to produce safer human-robot interactions,” he said. “Hugh Garavan in Psychiatry will use the new machine learning cores on the cluster to determine the impact of substance use on developing adolescents using brain imaging. And Yolanda Chen in Plant and Soil Science can massively speed up the genome re-sequencing of the Colorado Potato Beetle to better combat emerging threats to our food supply in a changing climate.”

The upgraded VACC will also be a great asset in undergraduate education, said Safwan Wshah, an assistant professor in UVM’s Computer Science department who teaches machine learning and deep learning to about 80 students per year.

“Deep Green will enable them to take on more and bigger projects and put them at a distinct advantage as they enter a job market that is tightly focused.

First reported from “UVM Today” at https://www.uvm.edu/uvmnews

The Society of Physics Students (SPS)

The Society of Physics Students (SPS) is a student-run organization for all those who love physics - physics majors and otherwise. We meet on a biweekly basis to talk about physics news, research, and relate classroom topics to the larger world. We are deeply committed to the idea that physics is not just frustratingly hard math and confusing theses, but fundamentally cool. In this vein, this past year, we have held club movie nights, watching favorites such as Home Alone and then calculating the amount of force one would be hit with from a swinging paint can. We also believe physics is for all people. Each year, we have a diversity training for our members and try to understand how physics as a discipline interacts with different identities.

The University of Vermont

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