Staff Notes

It’s hard to quantify the effect a machinist has on a physics department. A quality shop is considered essential to any research university; and whatever the tools, the shop is only as good as its machinist. Step in to any lab in the physics department at the University of Vermont, research or teaching, and you’ll find something that came through our machine shop. Possibly it’s only a repair, returning an otherwise broken tool to service. Likely it’s a modification, small or large improvements and adaptations to commercial equipment, tailored to better serve its mission here. But it’s not hard to find unique, fabricated completely in-house apparatuses; created here in the UVM physics department’s shop.

For the last eighteen years, that fabrication has been handled by Mike Hamblin. Mike is a long time veteran of UVM. Before joining the Physics Department as our resident machinist, he worked for twenty years in the Instrumentation and Model Facility across campus. He graduated from Cornell University with a B.S. in engineering, but quickly bonded with his new academic home. Mike’s commitment to UVM extends well beyond just being a quality machinist. He’s a dedicated supporter of Catamount Hockey, with a regular season pass. Mr. Hamblin can also be counted on to help keep the UVM campus beautiful, as he regularly picked up scrap metal as he walked across campus. In 2013, he was presented with a Dean’s Staff Award for Superior Performance; and in 2015 he headed off to well-deserved retirement.

Before leaving, Mike Hamblin helped select the new machinist that would take over the shop and continue on his work. Both Mike and the rest of the department are happy to welcome Douglas Gomez as our new staff machinist. Mr. Gomez is another veteran of UVM by way of IMF. He’s also an alumni of UVM, receiving B.S.’s in both Forestry and Mechanical Engineering. He’s settled in to our machine shop, and is already a valued member of our community. He has taught several graduate students how to use SolidWorks to draft parts for fabrication, and is handling requests from faculty and staff for research equipment, teaching lab apparatuses, and lecture demonstrations. Doug has also taken the lead on designing and laying out the new machine shop that will be built as part of the STEM project (see story on page 11).

Seeing Mike Hamblin in person around the department is, understandably, a rare occurrence these days. But if you know how to look, you can find him in the equipment and materials he shaped that will last for many years. Douglas Gomez is very ably taking up that proud legacy; and his influence can already be found outside the shop, in a further modified tool adapted to its changing mission, or in brand-new, just-built, one-of-a-kind equipment.

(Submitted by Dr. Luke Donforth. Photos courtesy of Prof. Furis.)

Faculty Notes

Dr. Matthew White is joining the faculty as Assistant Professor of Physics in Fall 2015. Dr. White, currently Assistant Professor at the Johannes Kepler University in Linz, Austria, received his Ph.D. in physics from the University of Colorado, Boulder in 2009. His research focuses on the physical processes occurring in organic solar cells and organic light-emitting diodes. He works in collaboration with researchers at the National Renewable Energy Lab (NREL) in Golden Colorado, and with Yamagata University (YU) Faculty of Engineering in Yonezawa, Japan.

Dr. Valeri Kotov was promoted to Associate Professor of Physics with tenure. A theoretical condensed matter physicist, Dr. Kotov has made pioneering contributions to our understanding of the electronic properties of graphene. His research is supported by the Department of Energy.
Awards and Honors

Senior physics major Kyle Robertson received the 2015 David W. Juenker Prize for outstanding scholarship in physics. The award was presented at the College of Arts and Sciences’ Honors ceremony held in Ira Allen Chapel on May 15, 2015.

Daniel Burrill, an M.S. candidate in Physics, was named Graduate Teaching Fellow of the Year in the Department of Physics. Dan received a certificate of achievement and a membership to the American Association of Physics Teachers at the physics department awards reception on April 30, 2015.
Undergraduate Honors Theses

Daniel G. Allman
Mode Entanglement in Lieb-Liniger Model
Adviser: Professor Del Maestro

Joshuah T. Heath
Pressure-Energy Relation in Canonical 2D Dipolar Bosons: A Path Integral Monte Carlo Study
Adviser: Professor Del Maestro

Kyle W. Robertson
Path Integral Monte Carlo Absorption Studies of Superfluid Helium-4 Mesoporous Silicates
Adviser: Professor Del Maestro

2015 Sigma Pi Sigma Inductees

Three undergraduates were inducted in the UVM chapter of Sigma Pi Sigma in April 2015: Renee C. Beneski, Casey L. Brinkman-Traverse and Derrick J. Butler. Founded in 1921, Sigma Pi Sigma is the national physics honor society. Sigma Pi Sigma honors outstanding scholarship and service in physics, encouraging and stimulating members in their scientific pursuits.

Nota Bene

We would enjoy hearing from all UVM physics alums and friends. Send your email to physics@uvm.edu.
Physics Department Receives Gift in Memory of Professor Robert Detenbeck

By Joshua Brown

When Robert W. Detenbeck, emeritus professor of physics, died last summer at age eighty, he was celebrated as an accomplished researcher and one of UVM’s most beloved teachers.

His widow, Jeanne Detenbeck G’77, has recently built on that legacy with a gift of $150,000 to establish a scholarship in his honor in the Department of Physics. The Dr. Robert W. Detenbeck Scholarship will be awarded to undergraduate or graduate students majoring in physics, with preference given to graduate students.

Originally, Mrs. Detenbeck had intended to fund the scholarship through her estate. But an unexpected and substantial jump in the value of the stock she had been holding for that purpose convinced her that it made sense to make the gift during her lifetime so she could see the impact of her philanthropy. “It’s something I never expected to be able to do and could never do again,” she says. “I hope I get a chance to meet the students who receive the scholarship.”

Professor Robert Detenbeck capped a twenty-eight-year career on the faculty at UVM as the winner of the Alumni Association’s George V. Kidder Outstanding Faculty Award in 1995, the year he retired. “Bob guided and mentored so many students,” recalls his wife of fifty-nine years. “That was what he really wanted to do most, to teach students and to advise them and such. After he died, I got cards and letters from former students and even faculty that he had helped along the way.”

“This generous gift comes at an opportune time,” says Dennis Clougherty, professor and chair of the UVM Physics Department. “We are in the process of launching a Ph.D. program in physics, and we are looking forward to growing this program in a newly constructed, state-of-the-art STEM complex in three years.”

Robert and Jeanne Detenbeck both received bachelor’s degrees from the University of Rochester—he in physics and she in chemistry. Robert earned his doctorate in physics at Princeton University in 1962. His research at UVM was primarily in optical physics.

Jeanne Detenbeck was something of a trailblazer for today’s growing numbers of nontraditional students, having earned her master’s degree at age forty-five. She began taking geology courses at UVM after a trip to Colorado and its mountainous beauty inspired her to learn more about the science that created it. “I began auditing courses, and it just evolved into a degree in geology,” she says.

As she thinks about the impact her giving will have over the years, she says, “This is a way to pay back the department for Bob’s time there. Having his name on the scholarship means something to them and to me.”
Student Research

The annual UVM Student Research Day held in April 2015 featured poster and oral presentations by students and faculty in physics and materials science.

- Yang Li, Real time monitor the growth process of TIPS-pentacene thin films
- Lane Manning, Exploration of Excitonic States in Mixed Organic Semiconductors
- Kyle Robertson, Path Integral Monte Carlo Absorption Studies of Superfluid Helium-4 in Mesoporous Silica
- Jeffrey Ulbrandt, Real-time synchrotron x-ray scattering study of nanocluster correlations and merging on surfaces

UVM undergrads attend Yale Physics Conference

*APS Conference for Undergraduate Women in Physics at Yale: January 16–18, 2015*

- Sanghita Sengupta, Diagrammatic Approach to Cold Atom-Surface Interactions
- Ben Himberg, GPGPU Quantum Monte Carlo
- Joshuah Heath, Pressure-Energy Relation in Canonical 2D Dipolar Bosons: A Path Integral Monte Carlo Study

UVM Physics undergrads Casey Brinkman-Traverse, Amanda Bertschinger and Renee Beneski with Yale Professor Sarah Demers.
2015 Graduates

*Bachelor of Science degree recipients*
Daniel Allman • Joshuah Heath
Kyle Robertson • Cole Van Seters

*Graduate degree recipients*
Daniel Burrill, M.S. Physics • Max Graves, M.S. Physics
Peter Harnish, M.S. Physics • Owen Myers, Ph.D. Materials Science

*Daniel Allman, Cole Van Seters, Joshuah Heath and Kyle Robertson (left to right) with Professor Clougherty at UVM Commencement 2015.*

**Congratulations Graduates!**
NanoDays 2015

The UVM chapters of the Society of Physics Students and Sigma Pi Sigma organized a series of events for NanoDays 2015, an annual national celebration of nanoscale science, technology and engineering that includes hands-on activities, demonstrations and lectures for the general public. The ECHO Science Center hosted the event. This is the ninth year of the UVM Physics-ECHO partnership.

Above: Physics staff member David Hammond (standing on left) prepares student volunteers from physics and materials science for the NanoDays event.

Left: SPS President-elect Renee Beneski leads a discussion of the structure of graphite at the ECHO Science Center. The UVM SPS chapter was named Distinguished Chapter in 2014 by the national organization.
Small Science at ECHO
By Luke Donforth

Visitors investigating how polarization is used in liquid crystal displays.

Resources and long-time ECHO collaborator) supplied samples of larval zebra mussels from Lake Champlain. Zebra mussels, an invasive species actively monitored in the lake, are more easily distinguished and detected earlier with the thoughtful application of polarized light.

Other applications of fundamental science principles ranged from the everyday (like sunglasses) through the artistic (creating murals and mica wall hangings) to engineering (stress analysis of materials). There is an online video tour of the activities here. The mini-grant brought together an interdisciplinary group of scientists and researchers from UVM to help tie together nanoscience, current research at UVM, and issues important to the local community. Both UVM and ECHO are grateful to the NISE Network for supporting their ongoing collaboration.

A version of this story originally appeared on the NISE Net Blog: www.nisenet.org/blog. For a video tour of the activities, check out http://bit.ly/1Pq9M6r; and for Professor Headrick’s talk, see http://bit.ly/1h0q7DC

The University of Vermont (UVM) Physics Department has been an active member of the Nanoscale Informal Science Education (NISE) Network since 2008. Although very much an institution of formal learning, UVM values and contributes to informal education in the surrounding community. UVM has a long partnership with the ECHO Lake Aquarium and Science Center, but the NISE Network has provided an excellent framework to strengthen and deepen the collaboration between the Physics department and ECHO.

UVM Physics and ECHO have worked together to put on six NanoDays events, science cafes, activities, and talks on nanoscience and other topics. The two institutions complement each other wonderfully, with the Physics department bringing graduate and undergraduate students, staff, and professors to facilitate NanoDays activities; and ECHO providing a comfortable forum for the public to interact with scientists, as well as training for those researchers on how to engage with the public. The public benefits from a deeper understanding of the science around them, and the scientists benefit from improved communication skills and a chance to share their joy about science.

The department chair, Dennis Clougherty, has been an enthusiastic driver and supporter of the collaboration, serving on advisory boards for ECHO; as well as allocating time from the department to support activities at ECHO. In the past, this allowed senior technician David Hammond to coordinate students from the department and extend the NanoDays activities beyond the kit. While we can all agree that the NanoDays kit is a fabulous resource for science museums; Professor Clougherty’s support and Mr. Hammond’s hard work allowed UVM to bring and facilitate not just the kit, but other activities that tied directly to issues of local interest or research done at UVM in the Physics department and Materials Science Program.

This past year, the UVM Physics Department and ECHO received a NISE Network mini-grant to develop an activity outside the purview of NanoDays. The ECHO Lake Aquarium and Science Center is charged with helping the public understand the Lake Champlain watershed, including facets of Education, Culture, History, and Opportunities for stewardship. The Physics Department wanted to strengthen that mission by highlighting how basic science is a useful tool for investigating, understanding, and caring for the world around us. Light, and specifically polarization, gave us a unifying theme to bring a number of activities and concepts to ECHO. Visible light, something most museum visitors have experience with, has wavelengths in the hundreds of nanometers. This provides a comfortable entry point to familiarize visitors with “nano”, and from there we can highlight how interacting with light at the length scale of its wavelength allows us to investigate both light and the world around us.

In addition to the bringing down a dozen graduate and undergraduate students to facilitate a day of bonus activities for the 400 museum visitors; Physics Professor Randall Headrick also came down to ECHO and gave two public lectures on light, its structure, and polarization. To reach more people, the talk was taped and made available online. Professor Headrick was able to discuss how the fundamental science principles the visitors were exploring were pertinent in his research on crystal structure, and also in their lives; such as what time the light reflecting off the lake will be mostly strongly polarized.

Polarization, the orientation of components of light, provides a tool with uses ranging from telling the time of day to monitoring invasive species in Lake Champlain. As an example of the latter, Professor J. Ellen Marsden (an ichthyologist with UVM’s Rubenstein School of Environment and Natural Resources and long-time ECHO collaborator) supplied samples of larval zebra mussels from Lake Champlain. Zebra mussels, an invasive species actively monitored in the lake, are more easily distinguished and detected earlier with the thoughtful application of polarized light.

Other applications of fundamental science principles ranged from the everyday (like sunglasses) through the artistic (creating murals and mica wall hangings) to engineering (stress analysis of materials). There is an online video tour of the activities here. The mini-grant brought together an interdisciplinary group of scientists and researchers from UVM to help tie together nanoscience, current research at UVM, and issues important to the local community. Both UVM and ECHO are grateful to the NISE Network for supporting their ongoing collaboration.

Generating a mechanical analogy of a polarized wave.

Two microscope views of the same sample from Lake Champlain without (left) and with (right) cross-polarized light filters. Zebra Mussel veligers stand out as the illuminated crosses in the right photo.

(Photo credit: David Hammond)
Due to the quantum nature of helium at very low temperature, each atom in this simulation is represented as a fluctuating cluster of tiny spheres separated by spring-like links. The computer code which produced the simulation was developed at the University of Vermont and can probe how atoms cooperate to form a superfluid at the nanoscale.

This computer simulation of a hole about ten atoms wide was created by University of Vermont physicist Adrian Del Maestro. Each colored ring represents one layer of helium atoms, with the outer atoms stuck to the wall of the hole. Only the inmost helium atoms, in blue, flow through this, the world's smallest pipe.

We all know intuitively that normal liquids flow more quickly as the channel containing them tightens. Think of a river flowing through narrow rapids. But what if a pipe were so amazingly tiny that only a few atoms of “superfluid” helium could squeeze through its opening at once? According to a longstanding quantum-mechanics model, this bizarre form of helium would behave differently from a normal liquid: far from speeding up, it would actually slow down.

For more than 70 years, scientists have been studying the flow of helium through ever-smaller pipes. But only recently has nanotechnology made it possible to reach the scale required to test the mathematical model — known as the Tomonaga-Luttinger theory (after the scientists who developed it) — in the real world.

Now, Adrian Del Maestro, a professor of physics at the University of Vermont, has collaborated with a team of researchers from McGill University and Leipzig University in Germany, to successfully create the smallest channel yet — less than 30 atoms wide.

In results published May 15 in the journal Science Advances, Del Maestro and the other researchers report that the flow of superfluid helium through this miniature faucet does, indeed, appear to slow down.

“Our results suggest that a quantum faucet does show a fundamentally different behavior,” says McGill physics professor Guillaume Gervais, who led the project. “We don’t have the smoking gun yet. But we think this a great step toward proving experimentally the Tomonaga-Luttinger theory in a real liquid.”

Where physics change

Insights from the research could someday contribute to novel technologies, such as nano-sensors with applications in GPS systems. But for now, Gervais says, the results are significant simply because “we’re pushing the limit of understanding things on the nanoscale. We’re approaching the grey zone where all physics changes.”

UVM’s Adrian Del Maestro used computer simulations — on parallel processors in the Vermont Advanced Computing Core located at the University of Vermont — to understand just how small the faucet has to be before this new physics emerges. “The ability to study a quantum liquid at such diminutive length scales in the laboratory is extremely exciting as it allows us to extend our fundamental understanding of how atoms cooperate to form the superfluid state of matter,” he says.

Continued on Page 10
Unlike ordinary liquids — water or maple syrup, for example — “a superfluid has no friction or no viscosity. It’s a perfect liquid,” Del Maestro says. As a result, it can flow through an extremely narrow channel; and once in motion, its cooperating atoms don’t need any pressure to keep going. Helium is the only element in nature known to become a superfluid; it does so when cooled to an extremely low temperature.

But slippery perfection has quantum limits, it seems. “The superfluid slowdown we observe signals that this cooperation is starting to break down as the width of the pipe narrows to the nanoscale,” Del Maestro said, and edges closer to the exotic one-dimensional limit envisioned in the Tomonaga-Luttinger theory.

“This ‘Luttinger liquid,’ as it’s sometimes called, is a very strange state of matter,” Del Maestro said. “Because it exists in strictly one dimension, it’s not really a liquid, it’s not really a superfluid, it’s not really a solid — it’s everything, all at once.” At least that’s one layman-friendly way to describe what the theory suggests. “We’ve thought for a long time: wouldn’t it be cool if we could figure out how to make one of these Luttinger liquids in the real world,” he said, “instead of just on our computers?”

With this new experiment, the team of scientists is getting close. But building what is probably the world’s smallest faucet has been no simple task. McGill’s Guillaume Gervais hatched the idea during a five-minute conversation over coffee with a world-leading theoretical physicist. That was eight years ago. But getting the nano-plumbing to work took “at least 100 trials — maybe 200,” says Gervais.

A beam of electrons as drill bit

Using a beam of electrons as a kind of drill bit, the team made holes as small as seven nanometers wide in a piece of silicon nitride, a tough material used in applications such as automotive diesel engines and high-performance ball bearings. By cooling the apparatus to very low temperatures, placing superfluid helium on one side of the pore and applying a vacuum to the other, the researchers were able to observe the flow of the superfluid through the channel. Varying the size of the channel, they found that the maximum speed of the flow slowed as the radius of the pore decreased.

An inadvertent breakthrough

For years, however, the researchers were frustrated by a technical glitch: the tiny pore in the silicon nitride material kept getting clogged by contaminants. Then one day, while Gervais was away at a conference abroad, a new student in his lab inadvertently deviated from the team’s operating procedure and left a valve open in the apparatus. “It turned out that this open valve kept the hole open,” Gervais says. “It was the key to getting the experiment to work. Scientific breakthroughs don’t always happen by design!”

And from this fortunate mistake, science now has an opening small enough that it begins to make visible a “new regime of matter,” Adrian Del Maestro says, “that’s never been explored before.”

Portions of this story were adapted from a release written by Chris Chipello.
UVM Breaks Ground for STEM Complex, Largest Capital Project in University History

By Jay Goyette

The University of Vermont officially broke ground May 15 on its $104 million STEM project, the largest capital project in UVM history.

Speakers at the event included Gov. Peter Shumlin, who has urged the university to produce more STEM graduates to meet the needs of Vermont’s high-tech sector, as well as Burlington Mayor Miro Weinberger, UVM Board of Trustees chair Deborah McAneny, President Tom Sullivan, doctoral student Lane Manning, and Richard Bundy, president and CEO of the University of Vermont Foundation.

Shumlin thanked UVM President Tom Sullivan for making the STEM project a strategic priority and stressed its importance to the state’s economic future. “I literally had an employer say to me recently, if you can find us the right STEM graduates, we are hiring right now in the state of Vermont – 90 people who we will pay starting at $90,000 a year plus benefits,” Shumlin said. “You know, when I was growing up in this state, there were not opportunities like that.”

Weinberger focused on the City of Burlington’s efforts to accelerate the city’s movement toward being a great tech city. “It is I think without doubt where the city’s economic future lies,” he said. “And when we look across the strategies that we might be able to accomplish to proactively move in that direction, I don’t think there is any greater, more significant step that can be taken than the one that UVM is announcing here today.”

Trustees chair Deborah McAneny said, “Simply put, this is the right facility at the right time and in the right place – for the university, for the state and for the nation.”

Sullivan called the occasion “a transformative day for the university, for Burlington, for the state of Vermont and well beyond our borders.” The STEM complex, he said, “signals Vermont’s arrival at the beginning of a new future, one where research, and teaching, and discovery, and creativity and innovation in the STEM disciplines will define the progress of qualitative knowledge for the 21st century.”

“I don’t know about the rest of you, but I am super geeked,” said Lane Manning, president of the Graduate Student Senate. Manning is set to receive a Ph.D. in materials science in a few months. “I’m excited. Let’s do it.”

The 266,000-square-foot STEM (science, technology, engineering and mathematics) complex will include two new buildings for classrooms, science labs and meeting space.

Of the $104 million total project cost, $26 million will come from non-debt sources, including private gifts. To date, $4.6 million has been raised in private gifts.

Architects for the project are Freeman French Freeman of Burlington, Vt., with Ellen Zweig of Cambridge, Mass.

The new laboratory and teaching spaces will allow UVM to continue to attract high-achieving students and faculty and to create new interdisciplinary STEM curricula that will engage and inspire the entire campus. With the White House calling for an additional one million STEM graduates over the next decade, UVM will increase the number of its STEM majors by 50 percent.

Aging facilities housing UVM programs in chemistry, physics, engineering, mathematics and statistics and computer science require upgrades to meet current needs. The university will construct a modern complex of laboratories, classrooms and meeting space to accommodate teaching and research and to create new opportunities for interdisciplinary collaboration.

The construction will be accomplished in three different phases over a four-year period. The first phase includes construction of the Discovery Building, a state-of-the-art teaching and research laboratory facility, while the second phase will construct the Innovation Building, which consists of classrooms and meeting space. Phase three will include renovations to Votey Hall, the existing engineering building.

Construction starts in summer 2015 and will be completed by May 2019, anchoring a larger redevelopment of the Central Campus. This includes renovation of the Billings Library, construction of a new $57 million residence hall and dining facility, demolition of “The Shoeboxes” residence halls, construction of a new inpatient facility for the UVM Medical Center and a $10 million renovation of Kalkin Hall.

In accordance with the University of Vermont’s “Environmental Design in New and Renovated Buildings” policy, the STEM Complex project is being designed, at minimum, to meet LEED Silver Level criteria.

Giving Opportunities

Your gift to the Department of Physics is invaluable and deeply appreciated. We offer naming opportunities for capital gifts in support of our departmental priorities, and we accept gifts in all amounts to any one of our departmental funds listed on the right. We also welcome deferred gifts and other gift-planning vehicles, which we understand can often make more substantial gifts possible. Contributions can be made online at https://alumni.uvm.edu/giving/

- Physics Fund
- Albert D. Crowell Research Fund
- Physics Colloquium Fund

For more information, please contact:

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