Michael Thoennessen Appointed New APS Editor in Chief

By David Voss

Nuclear physicist Michael Thoennessen has been selected to become APS Editor in Chief on September 1, 2017. Currently an Associate Director of the Facility for Rare Isotope Beams (FRIB) at Michigan State University (MSU) in Lansing, Michigan, and University Distinguished Professor of Physics at MSU, he was appointed following a vote of the APS Board of Directors on June 16.

“It is a great privilege and responsibility to serve as Editor in Chief of APS,” said Thoennessen. “I am excited about the opportunity to work with the outstanding editors and staff at Ridge to shape the future of the Physical Review journals.” Thoennessen will partner with APS Publisher Matthew Salter to take the journals through future challenges and opportunities.

Thoennessen received his Diploma from the University of Cologne in 1985 and obtained his Ph.D. in experimental nuclear physics from the State University of New York in Stony Brook in 1988. He joined the MSU physics faculty in 1990 and was named Associate Director of FRIB in 2015. FRIB is a $730 million user facility funded by the U.S. Department of Energy for nuclear science and is slated for completion in 2020. From 2004 to 2016, he was Supervisory Editor of the journal Nuclear Physics A.

“Michael Thoennessen has a broad knowledge of physics, extensive leadership experience, and the ability to work well with others. He is forward-thinking, especially regarding the future of our journals,” said Caltech professor of physics and 2011 APS President Barry Barish, who chaired the search committee. “We are very fortunate to have attracted him to become our next Editor in Chief.”

“I’m very pleased that Michael Thoennessen will become our next Editor in Chief and will be joining the APS Senior Management Team,” said APS CEO Kate Kirby. “His past leadership experience in publishing, his engagement with APS programs in education and diversity, and his service in many capacities, including as Chair of the APS Division of Nuclear Physics, provide him with valuable perspectives and a deep understanding of APS.”

Thoennessen will succeed Pierre Meystre as Editor in Chief. Meystre, named to the position in 2016, announced his resignation earlier this year in a message to APS staff, indicating that he felt miscast in the role. Meystre will continue as Editor in Chief until Thoennessen steps in.

“I am delighted that Michael Thoennessen will become our next Editor in Chief,” said Barry Barish, who chaired the search committee and will continue as Editor in Chief until September 1, 2017. “I am fortunate to have attracted him to become our next Editor in Chief.”

Research News: Editors’ Choice
A Monthly Recap of Papers Selected by the Physics Editors

Putting a Spin on Black Hole Mergers

As the number of black hole merger observations continues to rise, astrophysicists may soon be able to figure out where these merging black holes come from. To date, the Laser Interferometer Gravitational-Wave Observatory (LIGO) has detected three gravitational-wave signals—each bearing the mark of a violent collision of two black holes that eventually became one. The estimated mass in these gravitational pile-ups is relatively large, suggesting that the two initial black holes may themselves have been the product of earlier mergers between smaller black holes. If this so-called hierarchical formation is at work, then it could leave an imprint in the rotation rate, or spin, of the final black hole. Fortunately, spin is one of the quantities that can be inferred from LIGO data. Assuming hierarchical formation, the research team all calculated the expected distribution of spins and found it skewed towards black holes with high spins, as reported in Astrophysical Journal Letters (DOI: 10.3847/2041-8213/aa7045). They showed that LIGO would only need about ten merger observations to determine whether or not all black holes formed hierarchically.

Squeezing Out the Petawatts

Claiming the latest prize in the high-power laser sweepstakes, a research team has used an all-optical technique to compress and amplify optical pulses down to less than 20 femtoseconds in a petawatt-scale facility. In Optics Letters, Zeng et al. (DOI: 10.1364/OL.42.002014) report their use of chirped-pulse amplification (CPA) to reach a peak laser power of 4.9 petawatts. CPA involves imparting a frequency sweep to the pulse and removing different frequency components along paths of various lengths. At the output, the components pile up into a shorter pulse. CPA is a standard method for shortening laser pulse durations, but the research team was able to implement the method with an all-optical amplifier system. Conventional amplifiers that use doped glass or sapphire are limited to one or two petawatts, but the laser-pumped parametric amplifiers used here can go higher. Zeng et al. used lithium borate crystals to boost the pulse energy from hundreds of millijoules to over 168 joules. The authors believe that with larger crystals they can triple the petawatt power.

By Rachel Gaal

2017 APS Division of Atomic, Molecular, and Optical Physics Meeting — A typical phase diagram paints a picture of three states of matter: solid, liquid, and gas. But what about plasma? It’s the most abundant state of matter in the universe, but plasma can’t exist for long under normal terrestrial conditions.

Out in space, exotic plasmas can occur inside white dwarfs, large planets like Jupiter, and the Sun and other large stars. On Earth, researchers are studying fully ionized forms of plasma created under artificial conditions hovering just above absolute zero temperatures. By studying these in the lab, they hope to learn more about some astrophysical plasmas deep in space.

While the mechanism of its formation is known, the first such ultracold plasma was observed in the lab less than two decades ago, which might make this a budding field in physics. A number of recent results were presented at the 2017 DAMOP meeting in Sacramento, California.

Thomas Langin of Rice University was one speaker who has trekked down new paths in the field. As a graduate student, Langin worked with Thomas Killian of Rice University, a long-time researcher in ultracold plasma physics. Killian’s work over the years has spanned the first observations of plasma itself and of disorder-induced heating, all the way to present day with more detailed studies of plasma dynamics.

The experiment reported at DAMOP focused on the ion temperature evolution in strongly coupled plasmas, and what factors contribute to heating mechanisms during their lifespan. “I’m very excited to present my talk, which is no longer on the progress … but rather the actual laser cooling of an ultracold neutral plasma,” he announced during his lecture.

To create these ultracold neutral plasmas, a neutral, cold gas is photoionized to free the atomic electrons. Through a process known as disorder-induced heating, the newly created ions rapidly heat...

MATTER continued on page 5

Expanding the Fourth State of Matter

By Rachel Gaal

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MATTER continued on page 5
Spotlight on Development

Through Creative Philanthropy, the Braslau Family Honors Ones and Supports Students in Need

When David Braslau’s brother, Norman, died in 1996, David began thinking of how to honor him in a way that would make a real impact on people’s lives. “I wanted to found an APS prize or something for him,” he says. “He was a Ph.D. physicist with a long and impactful career at IBM, making some significant scientific contributions.” But, Braslau says, “I also felt that all the same people win the prizes, and that sort of annoys me, so I wanted to do something different, although at the time I didn’t pursue it.”

Then when his brother Bob, an aerospace engineer who worked on the Apollo program, passed away in 2014, David says the idea of a memorial for his brothers gained momentum. “I talked with Ted Hodapp [then director of education and diversity programs at APS] and Darlene Logan [then director of development] and I said I wanted to contribute something besides a ‘prize,’ he says. A travel grant program was an ideal solution.

The Braslau Family Travel Grant Endowment provides funding for low-income physics students to travel to APS meetings. During its first year of operation, grants have been awarded to six physics students, each receiving about $1100 for travel and lodging. These students, who would otherwise be unable to attend the conferences, were able to talk and meet other physicists.

Like his brothers, David followed his scientific and technical interests. He received his undergraduate degree in civil engineering from MIT and a Masters and Ph.D. in structural and engineering mechanics from UC Berkeley. Braslau wanted to try teaching, so he became a geophysics professor at the University of Minnesota but became more interested in the challenges of acoustics and aircraft noise. This led to his founding of David Braslau Associates, Inc., in 1971 to work on transportation and industrial noise, blast wave analysis, and acoustic control.

Braslau says that initiating the travel grant program is a way to remember his brothers but also to help disadvantaged students. “I recently got a nice letter thanking the Braslau family for travel support,” he says. “I’m not interested in just being a benefactor; I am interested in long-term results.”

If you too would like to make a difference in the lives of others, please contact APS Director of Development Irene Lukoff (lukoff@aps.org) to explore ways you can help.

This Month in Physics History

July 8, 1680: The First Experiments that Inspired the 18th century “Chladni figures”

Lionardo da Vinci noted the unusual patterns formed by particles in response to vibrations. So did other scientists who noticed that bits of bristle on the sounding board of an instrument would move in some areas but not in others. These so-called “Chladni figures” bear the name of the man who conducted the first in-depth investigations of the phenomenon: a German physicist and musician named Ernst Florens Friedrich Chladni.

Chladni was born in Wittenberg in 1756, the son of a long line of academics. His father was a law professor and dean of law at the University of Wittenberg. Both his mother and his sister died when he was still young, Chladni. He was mostly educated at home by his father, a strict disciplinarian. The boy was often confined to his room to study mathematics, and discouraged from fostering friendships, but he loved studying the stars and maps, yearned to travel, and largely began reading about science at age seven. As a teenager he was sent to boarding school near Leipzig, rooming with one of his teachers rather than with one of the other students. His father nixed his desire to study medicine and instead he earned a law degree instead.

Chladni went on to earn degrees in law and philosophy from the University of Leipzig, but his father died just as he completed his studies, leaving Chladni to provide for his family and his stepmother. But it also freed him to finally pursue his scientific interests. He eked out a narrow living giving lectures, initially on law, but eventually on geometry, geography, and the field to which he would go on to contribute so much as a researcher: acoustics.

Chladni first began conducting experiments in his flat, moving beyond the usual studies of vibrations in musical instruments to focus on transverse vibrations of rods—inspired by earlier work by Leonardo Euler and Daniel Bernoulli—before turning to vibrations of plates, then largely an unknown field. Chladni might not have known it at the time—there is no specific mention in his surviving writings—but certainly on July 8, 1680, Robert Hooke sprinkled sand over a solid metal plate, ran a violin bow along the edge to make the plate vibrate, and noted the usual patterns that formed as the sand grains rearranged themselves along the vibrational nodes.

Chladni would take that work to the next level with his systematic investigations of the vibration patterns of circular, square, and rectangular plates. By his own account, Chladni found inspiration in the work of Georg Christoph Lichtenberg, who scattered powders over the surface of electrically charged resin cakes to produce the patterns known today as Lichtenberg figures. Figuring he could do the same thing with sound, Chladni began scattering sand on his rods and plates. He had a musician’s ear and could discern slight changes in frequency, so he noticed that different frequencies produced different distinct patterns, and he recorded them assiduously.

Also, he developed a formula that predicted the sand patterns for vibrating circular plates. He published the results—including 11 plates and 16 figures—in his 1787 treatise Entdeckungen über die Theorie des Klanges. But his most seminal treatise was 1802’s Die Akustik, a systematic description of the vibrations of elastic bodies that earned him the moniker “father of acoustics.”

As for the underlying mechanism moving the particles, it appeared to be twofold. The sand particles were bouncing on the rapidly vibrating base, impinging on the surface at the crests and moving towards the nodes. But Chladni also noted that his bow, even finer particles as it moved across the plate, and these finer particles migrated toward the antinodes. This is due to a second transport mechanism, acoustic streaming, first observed by Michael Faraday back in 1831. It is the opposite of how airflow generates vibrations in a musical instrument; in this case, the vibrating plates produce a lateral fluid flow along its surface.

Because the vibrational patterns showed exactly where modes of vibrations fell in the back plates of musical instruments, the sand trick became a vital tool for violin makers and other instrument makers. It is still widely used today. Chladni himself invented two musical instruments: the eponymous, inspired by Benjamin Franklin’s glass harmonica, and the clavicylinder, an improvement of CHLADNI continued on page 3

Ernst Florens Friedrich Chladni

Sand placed on a vibrating plate exhibit distinct patterns called Chladni figures.

Ernst Florens Friedrich Chladni

Sand placed on a vibrating plate exhibit distinct patterns called Chladni figures.
A week after an APS member wrote to Senator Roy Blunt (R-MO) to support STEM education funding in President Trump’s fiscal year 2018 budget, Blunt responded in a letter to the newspaper. The comment that stood out in his response is more than what he would have hoped for.”

“They are making it impossible for us to have a home right now in the APS journals to publish their work.”

Visit the journal website at journals.aps.org/prmaterials

By Rachel Gaal

The first articles to appear in Physical Review Materials, the newest addition to the APS journal family, were published today, July 19, and judging from the response, the publication is off to a healthy start.

From the beginning, the journal has been envision as a broad-scope international journal for high-quality papers from physicists, materials scientists, chemists, engineers, and researchers in related disciplines.

“The first batch of papers is just great, and they cover all the bases for the journal,” said Chris Leighton, Editor. “In terms of subject matter, areas like energy storage and energy conversion, 2D materials, and nanomaterials are all hot areas.”

Leighton is Distinguished McKnight University Professor of Chemical Engineering and Materials Science and a graduate faculty member in Physics at the University of Minnesota. He obtained his Ph.D. degree in condensed matter physics at the University of Durham in the UK, and then completed his postdoctoral research at the University of California San Diego. His research deals with the electronic and magnetic properties of a wide range of novel materials, including complex oxides, oxide heterostructures, epitaxial alloys, organic conductors, and photovoltaics. He is a Fellow of the APS, and is Chair of the Topical Group on Magnetism and its Applications (GMAG).

“I am proud and excited to be the inaugural Lead Editor of PR Materials.” Leighton wrote in an editorial accompanying the first issue. “The APS and PR Materials staff have been hard at work for the last two months handling a volume of submissions that already indicates significant interest from the community. Managing Editor Athanasios Chantis, Editor Mu Wang, along with myself as Lead Editor, provide a mix of expert professional editors and research scientists active in the community, which we plan to maintain as the journal expands.” The journal is backed by an Editorial Board of 22 researchers from the U.S., Europe, Asia, and Australia, representing universities, national laboratories, user facilities, and research institutes.

“Definitely we have people who are already publishing in APS journals, but we also want to bring in people from outside the APS community,” Leighton emphasized. “It’s a very interdisciplinary field—people from physics, materials science, or even engineering or chemistry—and they don’t necessarily have a home right now in the APS journals to publish their work.”

Visit the journal website at journals.aps.org/prmaterials

By Matt Luchtel

Next to the wrenches and oil cans in almost any bike repair shop you’ll find well-worn copies of Lennard Zinn’s Zinn and the Art of Mountain Bike Maintenance, and its sibling Zinn and the Art of Road Bike Maintenance. The guides have taught countless aspiring mechanics nearly everything they could want to know about fixing bicycles.

Relaying on his background in physics and years as a bike-bUILDER, Zinn followed an unconventional career path, tying physics and bike mechanics together to bring cycling science to the general public.

“Bicycles are all just physics and math problems really,” Zinn said. Throughout his life, bicycles and physics have gone together.

“I grew up in Los Alamos, New Mexico—its a good place for bike riding,” Zinn said. Los Alamos is also a good place for physics. “My dad was a Ph.D. physicist at the Los Alamos National Laboratory,” Zinn said. “Everybody’s dad worked at this lab, it was a one-company town, and everybody’s dad was a physicist.”

Zinn started down that same path in the early 1960s and attended Colorado College for his bachelor’s degree. He majored in physics and capped it off with a project on the physics of bicycles. Inspired by an article in Scientific American, Zinn wrote early Fortran computer models to investigate why bikes stay upright.

However, he was not an indoor lab rat. Zinn competed as a cross-country skier before switching to cycling following a leg injury. he time he graduated, he was on the U.S. Olympic cycling team, competing in races all over the world. “In Los Alamos, it’s kind of accepted you get one year to play around after college, before you go to graduate school,” Zinn said.

But he never quite made it back to school. For a time he worked as a petroleum geophysicist but was soon laid off following a downturn in the oil market. Out of a job and living in Mountain View, California, Zinn found himself thumbing through the phonebook and spotted a name that he recognized: Tom Ritchey, one of the world’s master bike builders.

“It’s just like fate or something,” Zinn said. “I was like, ‘Whoa, I wonder if that’s the Tom Ritchey who makes those bikes.’ It was, and as fortune would have it, one of his employees had just quit that morning. Zinn convinced Ritchey to take on him and teach him the craft.

The late 1970s was an exciting time to be a part of the biking scene in Northern California. There, a tightknit community of bike enthusiasts had been prototyping the world’s first mountain bikes. It was an invention poised to revolutionize the cycling industry, and Tom Ritchey was right at the center of it. “This was all new territory—we were the first ones,” Zinn said.

Zinn shows off the details of a bikes he built in the 1980s.

By Mike Lucibella

Lennard Zinn’s Wild Ride

Hooke’s earlier musical cylinder, or “string phone.” And his research continues to inspire other scientists. Last year, a Physical Review Letters paper described how physicists at the University of Grenoble in France performed their own version of Chladni’s pioneering experiment. Rather than scattering sand on metal plates, they suspended polystyrene microbeads in water, injected the suspension into a circular opening at the base to create a drum that vibrated. Then they recorded the positions of the microbeads with a camera attached to a microscope. When the beads vibrated, the beads arranged themselves at the antinodes, forming patterns in a Liquid at Microscale. Chladni’s pioneering experiment has been envisioned as a broad-scope international journal for high-quality papers from physicists, materials scientists, chemists, engineers, and researchers in related disciplines.

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The ability to form such patterns in a microfluidic device opens the door to using sound waves to organize objects into specific patterns for various technological applications, such as grouping cells into colonies and then using changing frequencies to shift their size and distribution, thereby affecting their development.

Chladni died in April 1827 while on a lecture tour in Breslau, having never held a formal academic position. He never married, nor did he have children, and the site of his grave has been forgotten. But his patterns continue to inspire scientists and artists alike. While the great German author Johann Wolfgang von Goethe was mildly dismissive of Chladni when he first met him in Weimar in 1803, by the time of the latter’s death he had changed his tune. “Who will criticize our Chladni, the proud of the nation?” Goethe wrote. “The world owes him gratitude, since he made the transverse wave known.”

Further Reading:
To Disperse or Not To Disperse: Debating Negative Mass

By Rachel Gaal

Newton’s second law of motion tells us that objects will accelerate in the same direction as the applied force. But in a recent experiment, atoms in an atomic vapor accelerated in the opposite direction from the applied force. Correcting the motion of the vapor defied the laws of physics?

In Physical Review Letters, K. Sakuma et al. of Washington State University report their recent experimental work with a Bose-Einstein Condensate (BEC). They observed that this small, incredibly cold cloud of rubidium (Rb) atoms exhibited a “negative effective mass,” which differentiated it from the “positive effective mass” of classical measurements.

The phenomenon is subtle, and some news sources inaccurately described the paper as heralding the advent of a fluid with “negative mass.” Some headline writers, connecting the results with warp drives, antimatter particles, and the end of “physics as we know it,” had many physicists wagging their fingers.

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By Peter Engels and Michael Forbes, senior researchers on the experiment, told APS News. “This article stands mostly due to a confusion [with] mass … and the incorrect implication that our fluid could exist in empty space …”

But some media, including BBC, Live Science, and The Guardian, contacted Forbes and Engels about the results, and appropriately interpreted the physics. “A number of news outlets actually did their research.”

How to define mass, and the differentiation between “negative mass” and “negative effective mass,” was a topic that Engels and Forbes often had to clarify to reporters. Creating a fluid with “negative mass” is technically correct, they said, but only if “mass” is interpreted in a specific way.

“One main confusion of some of the media was interpreting the term ‘negative mass’ [as] negative gravitational mass, which indeed could have drastic consequences,” Engels and Forbes said. The correct concept is the “inertial mass,” they emphasized, which is what we think of in Newton’s second law: If you push an object, how does it accelerate? In fact, all inertial masses are “effective masses” by definition, since the term describes what someone actually observes.

In the experimental setup, Khamelchi et al. used a high-tech laser of the system, the expansion of the atomic cloud (middle) can be stopped in a region of “negative mass” (bottom).

By tuning the spin-orbit coupling in a Bose-Einstein condensate (top), the expansion of the atomic cloud (middle) can be stopped in a region of “negative mass” (bottom).

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up over nanoseconds, and the system quickly expands, giving the plasma a lifetime on the order of microseconds.

"The electrons expand and drag the ions with them, and over 20-30 microseconds, [the plasma] doubles and triples in size," Langin explained. "Even at these relatively high temperatures, you're still in this interesting regime, where the coulomb interactions [of the molecules] are so strong ... With this [experiment], we have a platform for studying systems similar to Jupiter's atmosphere, where dwarfs, and number of other systems in regime of strongly coupled plasmas."

Measuring the coulomb coupling parameter (the ratio of the potential energy between neighboring particles to their kinetic temperature) is a central focus of research in ultracold neutral plasmas. As the coulomb parameter increases above unity, the potential energy between ions starts to dominate thermal motion, and it becomes difficult to distinguish the small thermal motions of ions from the expanding plasma.

"In steady-state plasmas, the temperature is determined by the comparison of heating to cooling rate," Langin continued. "If you can change the cooling rate, you can make the plasma go to a lower temperature." This has been tried with single particles, but so far it's only been discussed theoretically for plasmas.

"We have the ability to cool along all three axes with crossed-polarized beams ... after 10 nanoseconds, we imaged the expanding cloud," he described. By using laser-induced fluorescence spectroscopy, they were able to see the temperature evolution of an ultracold neutral plasma.

Tate described. In this avalanche, the plasma quickly becomes fully ionized. "Our understanding right now is that the end of the avalanche process is what determines the subsequent electron temperature of the plasma, and the plasma will expand as if it had no [ionized] atoms at all.

Plasma temperature is only one of the basic characteristics needed to understand this state of matter, and new tools in atomic physics should expand the ability of researchers to test the parameters of plasma under more extreme conditions. Tinkering with the densities, cooling rates, and charges of this odd state of matter could expand the understanding of plasmas in the lab—and much of the universe around us.

"Once you have a critical density of ions so the electrons cannot escape, [the plasma] reaches what is called the 'avalanche regime'," Tate described. In this avalanche, the plasma quickly becomes fully ionized. "Our understanding right now is that the end of the avalanche process is what determines the subsequent electron temperature of the plasma, and the plasma will expand as if it had no [ionized] atoms at all."

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The peak power to 15 petawatts—a power level with which they could study exotic states of matter under extreme conditions.

**Peeking at Picosecondos**

What is the propulsion force of a single swimming bacteria? Unless you’ve got a probe with a resolution smaller than their movements, you’re at a loss for an answer. Thanks to delicate nanofibers and nanoparticles, however, researchers have now been able to develop a compact device that can measure forces with a sensitivity on the subpicowatt scale (less than 1 trillionth of a newton). In a paper from *Nature Photonics* (DOI: 10.1038/nphoton.2017.74), Huang et al. described their optic force transducer (NOFT), which is made from gold nanoparticles bonded to a compressible glycol film coated on a boron nitride sheet. Like a ball being pushed into a cushion, a stronger applied force pushes the nanoparticles to move closer toward the fibers. The thermal images confirmed the theory that hot spots are dry regions of the upper atmosphere, but Juno’s magnetometer debunked the predicted magnetic field of Jupiter—finding a value of nearly eight gauss, almost twice as strong as the upper atmosphere, but Juno’s magnetometer debunked the predicted magnetic field of Jupiter—finding a value of nearly eight gauss, almost twice as strong as expected. Particle instrumentation on board the spacecraft measured 11, 2017, will hover over Jupiter’s iconic giant red spot, where NASA scientists hope to peer below the swirling crimson cloud tops.

**Putting Weyl Materials to Use**

New work indicates that an unusual kind of semimetal discovered in 2015 could be used to build a range of electronic devices, from transistors to superlenses for electron microscopy. These solids host electronic excitations known as "Weyl" fermions that act like massless particles similar to photons. Researchers have speculated that these exotic materials could be used in nanoelectronics, spintronics, or quantum computing. Writing in *Physical Review B* (DOI: 10.1103/PhysRevB.95.214304), Hills et al. have presented a theoretical analysis of three possible applications of Weyl semimetals. The authors found that a structure made of multiple layers of Weyl semimetals should have a negative refractive index for electrons traveling through it. Such a structure would act as a lens that is able to focus a scanning tunneling microscope’s electron beam beyond the limits imposed by diffraction. They also suggest that Weyl semimetals could be used to build transistors potentially smaller and faster than conventional silicon transistors. Finally, their calculations reveal that an applied pressure could cause electrons in a Weyl semimetal to propagate similarly to light moving near a black hole. For more, see...

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basically [to] couple a quantum circuit to a mechanical oscillator,” Chu said.

“To generate more complex states, like Schrödinger cat states, you need a source of nonlinearity,” said Chu. “That’s where the qubit comes in … we have still been looking for a more robust, scalable, easily fabricated system that allows us to increase the complexity and performance of these kinds of devices.” The team’s approach is to use a small acoustic resonator coupled to the qubit.

"[The] mechanical resonator in our system is basically the sapphire substrate where we base our qubits,” said Chu as she showed a figure of their experimental setup. “When you think about the two polished faces of the sapphire wafer, it forms an enclosed cavity for bulk acoustic waves.” Chu admitted that her system was “embarrassingly simple,” and agreed that there is significant room for improvement, but the first steps to a quantum acoustic platform have opened doors that could lead to enhanced coherence and strong coupling interactions in the system. By re-imagining the limits of quantum physics, the results may help qubits become the basis for powerful computers.

**Senator continued from page 3**

year 2018 budget. In addition to the Forum on Education, the units include the Forum on Graduate Students, Division of Nuclear Physics, Topical Group on Hadronic Physics, and others. As a result of APS OPA’s concerted activities, more than 1200 APS members have contacted more than 335 members of Congress (including more than 100 in-person meetings) and urged them to reject proposed funding cuts to science. And those efforts have paid off:

Members of Congress rejected proposed science cuts in the fiscal year 2017 budget, and many have pledged to do the same in the fiscal year 2018 budget. To learn about key issues that APS OPA advocates for and to take action on them, visit the Advocacy Dashboard at www.aps.org/policy/issues/.

To stay informed on current science policy issues and ways to take action, sign up for APS OPA’s video newsletter, Signal Boost, at epurl.com/cz6nMx

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This relationship can be altered, using a second set of lasers and the spin-orbit-coupling technique to create an asymmetrical relationship. As a result of this alteration, there exists a small region of negative curvature in the velocity regime — in the experiments, this is equivalent to negative inertial mass occurring at certain values of the velocity. When the condensate nears and then enters this velocity regime while dispersing, the expansion first slows, and then reverses.

“A dramatic result from the spin-orbit-coupling lasers,” explained Forbes. “These allow us to shift the system, and shifting the dispersion relationships. Because of this shifted relationship, atoms moving at high velocities are much more strongly affected by the lasers, resulting in the velocity-dependent negative effective mass.”

Dr. Charles, a lead faculty member of the Dispersive Hydrodynamics Lab at the University of Colorado Boulder, has worked with Forbes and Engels in the field of dispersive hydrodynamics of BECs. “Dispersive hydrodynamics have developed significantly in the past year, but somewhat separately,” Hoofer told APS News. “[Engels] beautiful result brings the two together … demonstrating how dispersive concepts even and odd, which could impact the dispersive hydrodynamics during the course of dynamics.”

The fluid’s ripple, which might appear to defy physics, is just an innovative use of the dispersion relation in a BEC. But this peculiar relation has caught the eye of other atomic and molecular physicists. At the 48th APS Division of Atomic, Molecular, and Optical Physics (DAMOP) Meeting, an entire session was devoted to spin-orbit coupling in cold gases, where researchers are gathering to follow their ideas of next steps forward in the field.

“We’ve noticed that this has brought about a nice discussion within the community about the meaning of masses,” Engels said at the DAMOP meeting. “It’s nice that it gets people thinking about what is mass, why we call it effective, and if it make sense to call it negative.”

He mentioned a recent commentary article published in Physics Today on why physicists should take into account the idea of negative mass seriously. The author, Manu Paranjape of the University of Montreal, wrote that the debunking of negative gravitational mass dismissed the possibility of negative mass with any possibility, whether inertial or effective.

“The term is very specialized … even physicists who know the term and know what it is don’t realize the term for fundamental mass is [effective] mass,” added Forbes.

Looking forward, many physicists in the field are hoping use BECs to test the theory behind the Engels and Forbes experiment. The excitations in Degenrate Quantum Gases session at DAMOP featured talk of soliton trains, quantum turbulence and the dispersion of BEC’s in different types of traps. “We’ve done all of this analysis with Gross-Pitaevskii [simulations], but then there’s a quantum correction that comes in,” Forbes mentioned. “I want to start adding correction to the theory, and then we could have a more accurate picture.”

The two agreed that the negative mass results and discussion high-lighten an exciting fact about physics research. “It’s an interesting way of probing nonlinear dynamics,” Engels chuckled. “When things become nonlinear, they become a lot more interesting.”

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After a few years, Zinn started his own company in Boulder, Colorado in 1982. He looked for untapped niches in the market, and became best known for his custom bicycle frames for tall people. The size of his own bicycle was six-feet six-inches tall, used his background in physics to fix a problem that had been plaguing large bicycles for years. As a result of this, Zinn started designing for the front ends of big bikes developed a vio- lent wobble. “The shimmy would start under 25 miles per hour,” Zinn just build and build and build until you crashed or you figured some- thing else out to slow it down,” Zinn told Haywire.

He realized that big riders put the bike’s frame under a lot of stress, particularly at high speeds. The complex forces caused small vibrations to grow, eventually hit- ting a sort of resonance frequency (technically a “Hopf bifurcation”) that the bike’s frame under a lot of stress. “You crashed or you figured some- thing else out to slow it down,” Zinn said. “Well I think there’s very strong evidence to show you can.”

Zinn still rides every chance he gets when he’s not building a cus- tom bicycle or penning a new col-

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vination in its most humble form, as an exercise for young girls, also has the power to significantly improve the quality of life. It has value and its reach, recruiting and engaging more science champions in Congress and advancing sound science policy, it will need your support.

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I f we physicists are going to become a more inclusive community, we need to pay more attention to how we develop our leadership. As an example, after many years of slow improvement, the fraction of women undergradautes studying physics in the U.S. has recently declined (see figure). This may be only a blip, but there is every reason to be concerned that we have not made more progress over the last 50 years. If we are concerned, not just because it is hard to argue convincingly that our field offers equi-
table opportunities for all, but also because we badly need the skills that are currently being lost. Scott Page [1] has put forth a convincing case that a diverse skill set pro-
motes better problem solving. The essential assumption is that random skill sets do not
improve the likelihood of finding a solution. To open up a broader solution space you
need to increase the variety of tools available to
solve the problem.

Page takes this further, which helps in understanding what types of problems are most likely to benefit from a diverse group approach. He notes that problems that tend to be more “ladder-like” than others: Later con-
cepts build upon earlier ones, so there is a generally agreed-upon order in which to
learn tools. Physicists, for example, generally study Newton’s work before Einstein. This means if you take two physicists, the one with the less advanced education will typically add little value to the team, but the other one can add a great deal. And crowds do very
well at estimating because low and high guesses tend to aver-
age out. They also do well on complex problems where there is likely to be a range of possible solutions, each with advant-
ages and disadvantages. In these cases, where skills from several disciplines are needed, a diverse problem-solving group is more likely to generate a wider range of possible solutions and more likely to find a robust solution.

Perhaps this is why physics has been slower than some other
fields to become more diverse. We traditionally have dealt with problems where there is a high probability of there being one right answer and a well-defined way to approach finding that answer, and these problems are ones where individual experts outperform groups in finding solutions. But the problems we are working on are changing so quickly, and as these problems increasingly inter- and multi-disciplinary, we need to adapt.

Page discusses the importance of intellectual diversity. Keeping people with diverse backgrounds in physics does not automatically ensure that intellectual diversity increases; however, there is evidence from other fields that increasing the representation of women has a positive impact. Having women
in the pipeline or more institutional support for hire-
ing women [3]. LR leaders did not see a role for themselves
in changing the situation.

In contrast, HR leaders described themselves as “actively
involved” in hiring women and saw themselves as responsible for ensuring fair treatment of the women in their organization. For instance, one department head, probably aware of the studies showing that women faculty are often asked to serve on more committees than their male colleagues, actually took steps to quantify this. It would be interesting to look at the demographics of departments with LR and HR leaders and track how these demographics change with time. I expect that HR leaders are more likely to be found in units that are doing better than the average at recruiting and retaining women. While it would be nice to have that confirmed, I am confident enough of the results not to wait before arguing that we need
more HR leaders in physics.

Ann Nelson has made an excellent case [4] that we all need to take responsibility for making our field more inclu-
sive. We need to learn how to work in diverse groups and how to manage selection processes in our field in an unbiased
way. And as our field evolves, it is becoming increasingly
important that we have competent and informed leaders. As a graduate student, I was one of fewer than a hundred people
working on a hybrid bubble chamber experiment. Today, the
CMS collaboration at the Large Hadron Collider has about 3600 members. Not only are physics research groups
becoming larger, but also physicists are now members of multi-disciplinary efforts working to address complex
problems. Leading these teams is a demanding job.

For some time now, we have recognized the need to pro-
duce leaders who can function in the real world. They need to be able to help individuals
succeed in the current environment. This “fix the women”
approach to gender equity assumes that women lack the skills
needed to succeed and thus that providing the skills will solve the problem of female underrepresentation in the field and the responsibility for solving it to women.

This approach has had limited success, though a recent
study [3] indicates that some people in STEM leadership roles still believe that “women belong in the kitchen.” It is right to go on.

This study employed semi-structured interviews of 31 STEM
department chairs and deans at a large public university in
the U.S. We asked the deans to divide leaders into one of
two classes—as either Low Responsability (LR) or High Responsability (HR) leaders.

The fraction of undergraduate women studying physics has recently declined. Here, STEM fields include biological and biomedical sciences, computer and information sciences, engineering and engineering tech-
nologies, mathematics and statistics, and physical sciences and science technologies.

When LR leaders were asked to describe if change was
needed to address gender imbalance in their departments, they said things such as “Things are good enough,” or “[We are doing] better than others,” or “better than before,” or “simply not a problem” because 20% of our faculty are female, which is great,” or “More time will take care of the
issue,” etc. If these LR leaders admitted change was needed, then they saw the needed change as something outside of
their control; for example, there needed to be more women
students in the pipeline or more institutional support for hire-
ing women [3]. LR leaders did not see a role for themselves
in changing the situation.

In contrast, HR leaders described themselves as “actively
involved” in hiring women and saw themselves as responsible for ensuring fair treatment of the women in their organization. For instance, one department head, probably aware of the studies showing that women faculty are often asked to serve on more committees than their male colleagues, actually took steps to quantify this. It would be interesting to look at the demographics of departments with LR and HR leaders and track how these demographics change with time. I expect that HR leaders are more likely to be found in units that are doing better than the average at recruiting and retaining women.

The better-able people are to advocate for themselves and negotiate solutions that benefit everyone, the faster we will
advance on addressing work/life issues.

Diverse Leadership Matters

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physics. She is currently chairing the APS Committee on
Diversity of Women in Physics. Rankin is co-author of a textbook on vibrations and waves and of a recent review [4] on the need to increase the representation of women in science and engineering fields and ways to achieve that goal.

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