



DEPARTMENT OF

FALL 2021

Chemistry

MSU

College of **Natural Science** | Newsletter for Alumni and Friends

Molecules light the way to a new energy future

As policymakers turn toward science to address climate change, MSU physical-inorganic chemist Jim McCusker and his team are looking for inspiration from molecules to develop the next generation of solar energy technology. Their DOE-supported research was recently featured in the journal Nature.

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From the Department Chair...

I'm thrilled to connect with you as a new member of the Michigan State chemistry community, and I am delighted to join MSU as Barnett Rosenberg Professor and chairperson in the Department of Chemistry as of June 1, 2021. Previously, I was chemistry chair at Georgetown University, and am excited to bring my program in synthetic inorganic chemistry for catalysis and biology to MSU. As I've rapidly learned, there are so many wonderful things that our members are doing. It is exhilarating to be a Spartan chemist!

Our faculty members are recognized leaders at MSU as well as in state, national and international scientific communities. Kennie Merz is our most recent University Distinguished Professor, joining chemistry colleagues Marcos Dantus, Katharine Hunt, Paul Mantica, David Morrissey, Piotr Piecuch and recently retired John Frost with this prestigious title. Also of note, MSU John A. Hannah Distinguished Professor Angela Wilson became the 2021 American Chemical Society (ACS) president-elect and will assume the role of ACS president in 2022.

MSU chemistry faculty are incredibly dedicated to their students. The pandemic forced us to re-envision ways that we teach, mentor and engage our students. In 2020-2021, we made significant efforts to offer key laboratory courses in person and realized that our offices became much larger for office hours through Zoom! We are excited to offer our general chemistry and organic lab courses this fall in the new \$110 million STEM Teaching and Learning Facility on campus with the help of two new chemistry academic specialists—Brittany Busby and Veronica Zhang.



Tim Warren, Chair
Department of Chemistry
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"We are at the beginning of a large-scale investment in the future of the MSU chemistry enterprise."

Our students are stars. MSU's Chemistry Club competed in the Battle of the Chemistry Clubs competition in February 2020; their extensive chemistry knowledge and unrivaled teamwork earned them first place. And through the ACS-supported MSU organization, Women in Chemistry, our graduate students have started a peer mentoring program as new students begin their Ph.D. studies.

We are at the beginning of a large-scale investment in the future of the MSU chemistry enterprise, with the hire of 10 faculty members over the next several years. In addition to me, already on board are MSU Foundation Professor Thomas O'Halloran from Northwestern University, a world-renowned expert in bioinorganic chemistry; and Seokhyoung Kim, assistant professor, who has launched his program in the synthesis of nanomaterials for energy conversion. We will run three searches this year in the areas of organic chemistry, analytical chemistry and NMR applications.

We are incredibly grateful to outgoing chemistry chair Robert Maleczka, Jr., who led the department since 2010. We also appreciate continual support and contributions by our alumni and donors that serve as an important foundation for the growth of the department.

We continue to seek new ways to connect our alumni with current students to offer a two-way exchange and additional insight and opportunities to our students in the changing world they will help shape. Guided by faculty and supported by staff, it is through the efforts and accomplishments of our students that MSU chemistry will continue to make its mark.

Strong as one, we are extraordinary together. Go Green, Go MSU chemistry! 🍀



Theodore L. Brown, Ph.D., chemistry, '56, Founding Director Emeritus of the Arnold and Mabel Beckman Institute for Advanced Science and Technology at the University of Illinois, Urbana-Champaign, received the 2019 Annual Award of the University of Illinois Alumni Association for Distinguished Service.

Beth (Dugger) Kannel, chemistry, '72, has published an historical novel, *This Ardent Flame* (Five Star Cengage, June 2021).

Richard Yost, Ph.D., chemistry, '79, university professor and head of analytical chemistry at the University of Florida, was recently recognized with the MSACL Award for Distinguished Contribution to Clinical Mass Spectrometry, the Florida Academy of Sciences Medal, and the Pittsburgh Analytical Chemistry Award.

Robert Thompson, Ph.D., analytical chemistry, '82, received the 2021 Ohio PKAL STEM Educator of the Year Award for innovative teaching over his 37-year career at Oberlin College.

Robert L. Bencher, chemistry, '83, joins Q2 Solutions via divestment of Rules-Based Medicine from Myriad Genetics.

Joe Hupp, Ph.D., chemistry, '84, is the Morrison Professor of Chemistry at Northwestern University and was elected to the American Academy of Arts and Sciences.

John McPherson, chemistry, '96, completed his 17th year as a high school guidance counselor at Standish-Sterling Central High School.

Geoff Koboldt, chemistry, '97, earned the Phoenix 500 Award for being top faculty at the University of Phoenix, where he teaches MBA and undergraduate students business and strategy.

Mark Sislo, chemistry, '99; M.S., chemistry, '01, worked in the automotive industry as head of sales and marketing prior to opening his own wealth management and tax strategy practice.

Jonathan T. Lyon, chemistry '02, started a new tenure track position as assistant professor of chemistry at Murray State University in Kentucky in August 2020.

Yana Cen, Ph.D., chemistry, '06, assistant professor in the Department of Medicinal Chemistry at Virginia Commonwealth University, has been awarded a five-year NSF CAREER Award.

Rahman Shah Zaib Saleem, Ph.D., chemistry, '11, joined Lahore University of Management Sciences (LUMS) as a tenure track assistant professor and was recently promoted to associate professor.

Jamie Kubiak, chemistry, '14, is starting a new job teaching chemistry at The Bronx High School of Science this fall.

Cody Pinger, Ph.D., chemistry, '18, recently accepted a job with the NOAA (National Oceanic and Atmospheric Administration) Alaska Fisheries Science Center as a research chemist in Juneau, Alaska.

Alumni Awards



Njomen

Evert Njomen, Ph.D. 2019, was named a 2021 Hanna Gray Fellow by The Howard Hughes Medical Institute. Njomen currently works at Scripps Research Institute using small molecule compounds to identify proteins that could be used to develop treatments against a wide range of bacteria and viruses.



Terrell

Lamont Terrell, Ph.D. 2001, was named 2021 chair-elect of the Division of Organic Chemistry by the American Chemical Society and will serve as chair in 2022. Terrell is a drug discovery chemist at GlaxoSmithKline (GSK) and heads GSK's U.S. R&D early talent programs and university diversity recruitment initiative.

Alumni News



Lukulay



Morey



Turro

Patrick Lukulay, Ph.D. 1995, founder and president of Technology Solutions for Global Health, received MSU's 2021 NatSci Outstanding Alumni Award. In 2007, Lukulay joined—and later became VP of—United States Pharmacopeia, directing programs with USAID, WHO and the Gates Foundation to promote drug quality in developing countries.

Shannon Morey, B.S. 2010, who has taught physics, chemistry and robotics in the most vulnerable communities in Massachusetts, received MSU's 2021 NatSci Recent Alumni Award. She has innovated modeling and project-based learning curricula, initiated AP physics and chemistry courses and served as the director of education for Science from Scientists.

Claudia Turro, B.S., 1987, Ph.D., 1992, Ohio State University Dow Professor, chair of the Department of Chemistry and Biochemistry and director of the Center for Chemical and Biophysical Dynamics, received MSU's 2020 NatSci Outstanding Alumni Award. Her groundbreaking advances in inorganic chemistry, photochemistry and ultrafast spectroscopy have led to discoveries affecting medicinal chemistry and solar energy.



Boettger

Dorothy "Dort" Boettger, stock handler, died June 17, 2021, at the age of 92. Boettger joined the staff in 1966 and retired in 1991. Her position required physical strength and stamina in an era when many questioned if a woman could carry out the range of work involved, so Boettger secured her role in the department by proving she could bench press more than her own weight.



Haas

Ronald Haas, scientific instrument facilitator/supervisor, died April 21, 2021, at 80 years old. Haas brought his talents to MSU in 1969 after retirement from the U.S. Navy. A lifelong inventor and an engineer in the department's electronics shop, Haas aided research and teaching missions through the design and maintenance of analytical instrumentation for the cyclotron and various units across campus.



Horne

Fred Horne, chemistry professor, served on MSU's faculty for 22 years. He died April 21, 2021, at the age of 87. Horne left MSU in 1986 to become the second longest-serving dean of the College of Science at Oregon State University. A world-renowned expert in non-equilibrium thermodynamics, Horne embraced and advanced diversity, equity and inclusion and championed excellence in research and teaching.



Kirkpatrick

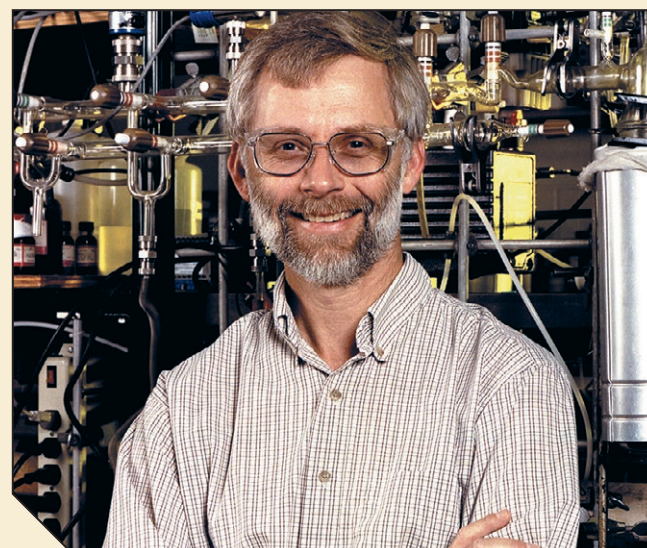
R. James Kirkpatrick, MSU Foundation Professor of chemistry and geological sciences, and former College of Natural Science Dean from 2007-2017, died on Jan. 7, 2020. He was 73 years old. Kirkpatrick was an internationally recognized expert in the structure, dynamics and energetics of materials of importance in geochemistry and materials applications.



Ward

Donald L. Ward, Academic Specialist Emeritus, died August 1, 2020. He was 76 years old. During his 29 years at MSU, Ward operated the small molecule single crystal X-ray structure determination laboratory and supported the chemical visualization facility. He served as the custodian of all radioisotope sources, managed the cobalt-60 irradiator facility and was assistant to the department safety officer.

Inaugural Greg L. Baker Memorial Lectureship



Greg Baker

On March 18, 2021, Karen Wooley, W. T. Doherty-Welch Chair in Chemistry and University Distinguished Professor at Texas A&M University, delivered MSU's inaugural Greg L. Baker Memorial Lectureship. Wooley's presentation, via Zoom, was attended by current students and faculty from MSU, as well as numerous alumni, past colleagues and friends of Baker.

Established in 2013, the lectureship is supported by a \$60,000 endowment created in honor of Baker, professor of chemistry at MSU from 1992 until his untimely death in 2012 at the age of 58. Alumni, colleagues and friends came forward to donate funds to form the endowment that honors Baker by providing for at least one lecture annually from one or more prominent scientists in the field of chemistry or chemically related science.

Baker received his Ph.D. in 1980 from Colorado State University and became director of organic materials research at Bell Communications Research in 1987. He joined the MSU faculty to fill one of three positions created to foster interdisciplinary research in polymer science. Baker established a successful research program that explored the development of environmentally degradable polymers, polymer-based systems for targeted drug delivery and composite polymer electrolyte membranes for battery and fuel cell applications. Just as important, Baker was a thoughtful scholar and colleague, a patient teacher, a skilled collaborator and a caring friend. 🍷



Kim

Seokhyoung Kim, assistant professor, joined the department on January 1, 2021. Kim's research group investigates the synthesis of semiconductor nanowires through vapor-liquid-solid growth and the novel properties of nanowire superlattices using numerical modeling and precision spectroscopy. Most previously, Kim was a postdoctoral fellow at Northwestern University. He received his Ph.D. from the University of North Carolina in 2019.



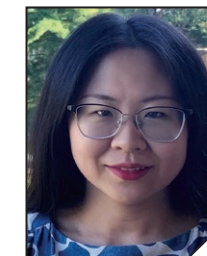
O'Halloran

Thomas O'Halloran, MSU Foundation Professor, joined MSU on January 1, 2021. Previously, he was the Morrison Professor at Northwestern University. O'Halloran will launch and direct MSU's new Elemental Health Institute, merging scientific expertise from across MSU to develop the emerging and dynamic field of metallomics and to understand how the chemistry of essential and toxic elements impacts human, animal, plant and microbial health.



Warren

Timothy Warren joined the faculty on June 1, 2021, as MSU Barnett Rosenberg Professor of Chemistry and department chair. Most recently, Warren served as the Richard D. Vorisek Professor and chairperson in the Department of Chemistry at Georgetown University in Washington, D.C. At MSU, Warren's research group continues to pioneer environmentally friendly methods for organic synthesis, investigate the interconversion of nitrogen and ammonia as carbon-free fuels and decode how biology uses nitric oxide as a messenger molecule.



Zhang



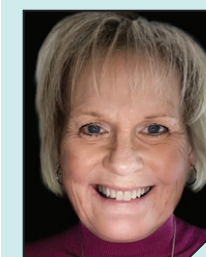
Busby

Veronica Mengqi Zhang and Brittany Busby, academic specialists, both joined the department in July 2021. Zhang and Busby will serve as laboratory coordinators and instructors, Zhang for the organic laboratory and Busby for the general chemistry sequence. They will be involved in curriculum development and training graduate student teaching assistants, with an emphasis on appreciating diversity and creating a welcoming and inclusive environment for learning. Before joining MSU, Zhang received her Ph.D. in chemistry from the University of Georgia; Busby completed a postdoctoral fellowship in chemistry education at Auburn University.



Karsten

Dianne Karsten, scientific stock handler, retired September 22, 2020, after more than 30 years of service in the department. An advocate for student safety, Karsten worked hand in hand with the general, organic and analytical teaching laboratory coordinators and teaching assistants to prepare the teaching labs for instruction each day. Her leadership and excellent service were recognized with the Naomi and Donald Hack Distinguished Staff Award in Chemistry in 2010.



McGaw

Elizabeth McGaw, research administrator, retired April 28, 2021, after 26 years of service. McGaw handled post-award research grant administration and supervised the department's business suite staff, which includes the graduate program, human resources and procurement. She began her career at MSU in 1994 as a business administrator and became a research administrator in 2015.



Morrissey

David J. Morrissey, University Distinguished Professor Emeritus, retired August 31, 2021. Since 2015, Morrissey was the associate director for operations at MSU's NSCL and was the associate director for nuclear science from 1995-1999 and 2009-2012. Morrissey and his students researched the production and physical separation of the most exotic, short-lived nuclei, some of which had never been observed before. He is a fellow of the American Physical Society.



Wulff

Bill Wulff, Professor Emeritus, retired May 15, 2020. Wulff's research concentrated on the area of organic synthesis and catalysis with the aim of pursuing novel approaches to design and development in synthetic organic chemistry. Wulff was awarded the College of Natural Science Distinguished Faculty Award in 2013.

Molecules light the way to a new energy future

As policymakers turn toward science to address climate change, one Michigan State University scientist is looking for inspiration from molecules to develop the next generation of solar energy technology.

MSU chemist James McCusker believes the future of solar energy lies in abundant, scalable materials designed to mimic and improve upon the energy conversion systems found in nature. McCusker and his team have leveraged a novel process that allows molecules to tell scientists how they should be modified to better absorb and convert absorbed light into useable energy. The method uses a molecular property known as quantum coherence, in which different aspects of a molecule are synchronous. Scientists believe that quantum coherence may play a role in natural photosynthesis.

Sunlight, although abundant, is a low-density energy source: this makes light capture a material-intensive problem (to quote McCusker, “There are a lot of leaves for a reason.”) However, some of the most effective approaches in use

“The research demonstrates that we can [apply] this coherence phenomenon to . . . a wide range of energy conversion applications.”

APPLICATIONS

today for solar energy conversion are based on some of the rarest elements on Earth (e.g., ruthenium, iridium, and platinum). Future solar technologies must be able to scale up with more efficient and cheaper methods of energy conversion.

One possible solution is to find more commonly available materials that can achieve the same result.

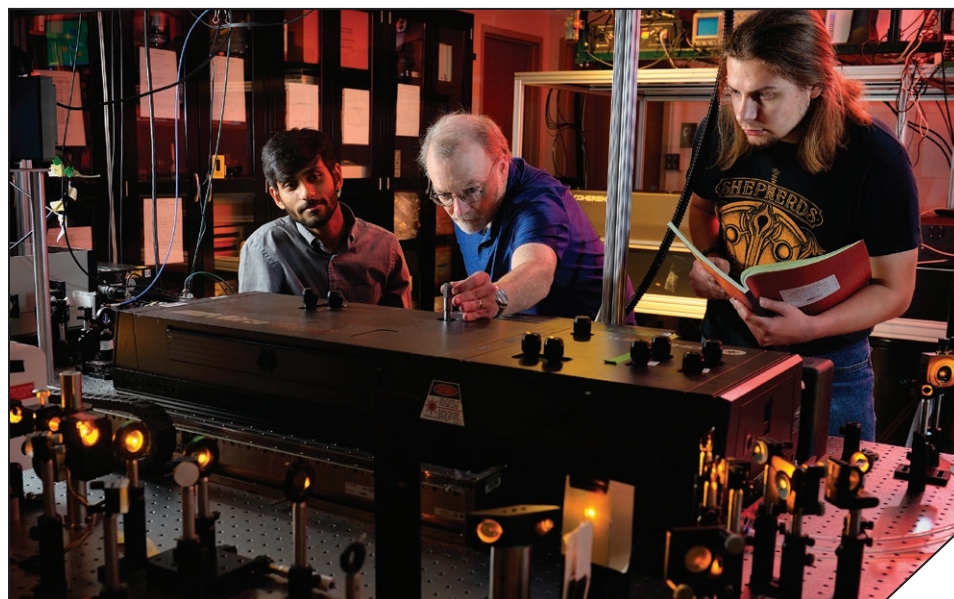
“The problem with switching from rare elements to something Earth-abundant, such as iron—where the scalability problem disappears—is that the processes that allow you to convert the absorbed sunlight into chemical energy are fundamentally different in these more widely available materials,” McCusker said. “The excited state produced by absorbing light energy in an iron-based compound, for example, decays too quickly to enable its use in a similar manner.”

Enter quantum coherence. By hitting a molecule with a burst of light lasting less than one-tenth of one trillionth of a second, McCusker and his students could observe the interconnection between the molecule’s excited state and its structure, allowing them to visualize how the atoms of the molecule were moving during the conversion of solar to chemical energy.

“Once we had a picture of how this process occurred, we were able to use that information to synthetically modify the molecule to slow the rate of the desired process down,” McCusker explained. “The research demonstrates that we can use this coherence phenomenon to teach us about what we might need to incorporate into the molecular structure of a chromophore that uses more earth-abundant materials. This will enable us to use the energy stored in the molecule upon absorption of light for a wide range of energy conversion applications.”

McCusker hopes that this breakthrough will speed up development of new technologies, eliminating a lot of the trial and error that goes into scientific endeavors by identifying right out of the gate what kind of system needs to be designed.

“We’re not there yet,” he said, “but the idea behind this research is to use quantum coherence to tap into information that the molecule already possesses and then use that information to change the rules of the game in our favor.”



Jim McCusker and graduate students Atanu Ghosh and Hayden Beissel confer on aligning the output of the ultrafast laser system in preparation for an experiment.

MSU nurtures sweet career

Next time you’re in a restaurant and you tear open one of those little packets of sweetener, or you consume a diet soft drink that contains that sweetener, you may want to give a nod to MSU alum John Witt (B.S., chemistry, ’57). He spent 15 years of his career leading a division of the pharmaceutical corporation that discovered and developed it.

After earning his bachelor’s degree from MSU and his Ph.D. in organic chemistry from the University of Illinois, Witt took a position with G.D. Searle, a mid-size pharmaceutical company located in the Chicago suburbs, doing process technology and improvement of manufacturing operations. He would later complete an MBA degree from the University of Chicago. “I realized this would be helpful as I moved into management positions,” he said.

Through the years, Witt moved into the new drug development area of the company as supervisor, director and then senior director.

Then in 1965, a chemist at Searle accidentally discovered the sweetener—which became known as NutraSweet.

“It was an exciting new product, a new area for us,” Witt said.

Searle partnered with a Japanese company known for its expertise in food ingredients and amino acid peptide chemistry to begin a new division—NutraSweet—and sent Witt, along with his family, to Tokyo to develop the technology and help launch the product. “It was a really interesting part of our lives,” he said. “I learned a lot professionally.”



Margaret and John Witt

Returning to the United States, Witt was part of a small group of individuals who were responsible for developing the product and the business. He retired as vice president of research and development for NutraSweet to found his own company—Witt Science Consulting—advising small pharmaceutical and venture capital firms in the development of new drugs. “I was able to get back to my drug-development roots,” he said.

Witt credits MSU with providing the education, training and nurturing that led him to do “reasonably well” in his career. He said MSU’s communication skills, humanities and social science requirements for undergrads helped make him a well-rounded individual.

“MSU broadened my vision beyond chemistry,” said Witt, whose focus was organic chemistry. “It expanded my horizons.”

The Witts recently established a planned gift to create the John Witt, Jr. and Margaret R. Witt Chemistry Endowment at MSU.

“One of the reasons I went to MSU was because I received a tuition scholarship that was renewed every year,” he added. “Now, giving back to education with our time, energy and finances is very important to us,” he said.

Over the years, Witt served for multiple terms as a member, and then as president of the Glenview, Illinois, Board of Education. In addition, he and his wife together have provided support for a number of educational activities and civic organizations throughout their lives.

Now retired, they are able to relax and enjoy life—living about half the year on the shores of Lake Michigan in Frankfort, Mich., and the other half in Glenview, Illinois, near their children and grandchildren who live in the Chicago area. Now that’s pretty sweet!

SUPPORT

“ . . . giving back to education with our time, energy and finances is very important to us.”

Melanie Cooper and James K. McCusker received Royal Society of Chemistry awards: Cooper, the 2020 Education Award for designing, implementing and evaluating outstanding evidence-based curricula; McCusker, the 2020 Chemical Dynamics Award for the combined application of synthesis and ultrafast spectroscopy to advance our understanding of the photophysical properties of transition metal complexes.

Xuefei Huang received a 2020 MSU William J. Beal Outstanding Faculty Award. Huang's lab investigates carbohydrate-based, next-generation vaccines focused on cancer and infectious disease indications.

Kenneth M. Merz was named a 2021 University Distinguished Professor. Merz's research considers computational science and biology toward developing materials for energy storage and drug discovery.

David J. Morrissey was named a lifetime Outstanding American Physical Society Referee for demonstrating exceptional work in assessing manuscripts published in Physical Review journals.

Piotr Piecuch was named an MSU Foundation Professor for contributions to coupled-cluster theory applied to many-electron systems and atomic nuclei, research on intermolecular forces and applications

of computational approaches to chemistry problems.

Angela Wilson was elected American Chemical Society (ACS) National Councilor (2020-2022) to serve as a voice on the council on behalf of physical chemists. Wilson was also named president-elect of ACS and will serve a three-year term (2021-2023) in the presidential succession (see story below).

Chemistry received several 2020 NatSci Awards. Thomas Hamann, Outstanding Faculty; Lynmarie Posey, Undergraduate Teaching; Dan Holmes, Distinguished Academic Staff; Elizabeth McGaw, Support Staff; Katharine Hunt, Norman L. and Olga K. Fritz Excellence in Teaching.

Angela Wilson elected president of American Chemical Society

Angela Wilson, John A. Hannah Distinguished Professor of chemistry at MSU, was elected 2021 president-elect by the American Chemical Society (ACS). Wilson will serve as president of the society in 2022 and immediate past president in 2023.

During her three-year presidential succession, Wilson will continue to serve on the ACS board of directors, which makes decisions on budgets, staffing and compensation, and the overall direction of the society.

Founded in 1876, the ACS is the world's largest scientific society with more than 155,000 members and a more than \$500 million budget.

"As president-elect, I have visited Capitol Hill virtually to advocate for support of scientific research and workforce development,"



Angela Wilson

said Wilson, who has been active in the ACS for 31 years. "I have also represented ACS at meetings in countries including India, Hungary and Canada,

and throughout the United States on topics ranging from diversity, equity, inclusion and respect to plastics to the future workforce."

As president, Wilson said she will aim to encourage people to enter science and engineering fields, promote entrepreneurship, improve science communication with the public and galvanize academic and industrial partnerships. She will also advocate for greater outreach and inclusion.

"The ACS president serves as the voice for the entire society in interactions with media and policymakers, as well as representing the society worldwide on topics from science to policy," Wilson said. "I am very honored to have this opportunity with ACS, a critical authority for science and the chemical enterprise." 🌱

Several chemistry students received 2021 awards from the American Chemical Society (ACS). Shannon Cartwright and Jessica Kline each received a 2021 Outstanding Student Awards. Cartwright received hers from the ACS's Analytical Chemistry Division, while Kline received hers from ACS's Physical Chemistry Division. Sidney Lipkovsky and Savannah Finley each received an Undergraduate Award in Organic Chemistry from the ACS Organic Chemistry Division. Natasha Perry was chosen by ACS's Organic Chemistry Division to receive its Undergraduate Award for Outstanding Achievement in Organic Chemistry.

Angel Edwards received a Dr. Martin Luther King Jr. Scholarship for academic achievements; campus and community work to promote inclusion, equity and justice; and a commitment to make this integral to her life's work. Edwards aspires to become a clinical pharmaceutical researcher focusing on the cardiovascular needs of minority patients.

Graciellou Klinger received the Great Lakes Bioenergy Research Center's (GLBRC) 2020 Jennifer L. Reed Bioenergy Science Award for her notable contributions to GLBRC's research portfolio. Specifically, Klinger developed an organic catalytic reaction to cleave key ether linkages in lignin and has filed a patent on the method.

Keenan Noyes received MSU's 2020 Undergraduate Research Supervisor Mentor of the Year Award, which honors research supervisors who mentor and have strong relationships with undergraduate student researchers and are role models in their field.

Morteza Sarparast received a one-year, competitive 2022 Pearl J. Aldrich Award for his proposal, "Recusing Effects of the Soluble Epoxide Hydrolase Inhibitor AUDA on Neurodegeneration Induced by A β and/or Tau in *Caenorhabditis elegans*," from the Pearl J. Aldrich Endowment in Gerontology. The endowment was established at MSU to support graduate students and faculty members who are committed to, or strongly considering, a career in a discipline that relates to aging.

A quantum leap for molecular simulations

Developing improved materials for things such as energy storage and drug discovery is of interest to researchers and society alike. Quantum mechanics (QM), a theory that describes the physical properties of nature on the atomic and subatomic scale, is the basis for molecular and materials scientists who develop these useful, futuristic products.

The challenge is that the QM calculations needed to describe the many properties of molecules and the materials they make up require a lot of computer power.

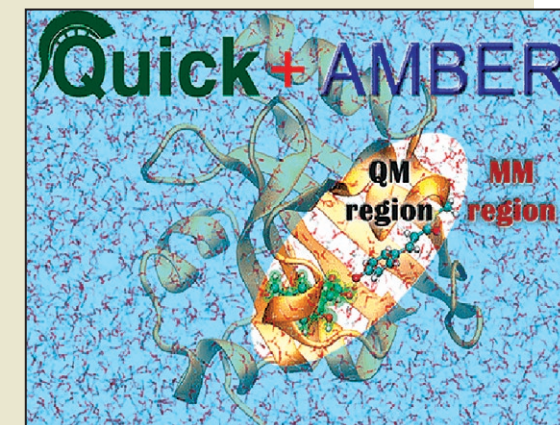
To address this issue, a small team of postdoctoral scholars led by Kenneth Merz, the Joseph Zichis Chair in Chemistry, developed innovative software that coordinates computations across multiple, powerful graphics processing units, or GPUs.

The open-source software, called QUICK, provides code for efficient QM calculations and mixed quantum/classical (QM/MM) simulations that enable researchers to address computationally intractable problems in a range of research areas such as computational materials design, catalyst design and drug design. The features implemented in QUICK usually require costly license fees, but researchers all over the world will have access to it free-of-charge.

"Our code can be used in a high-throughput fashion to generate data for Artificial Intelligence-based molecular design approaches, such as developing improved materials and drugs," said Merz, whose group worked with researchers from the University of California, San Diego, to jointly design the research, develop algorithms and engineer the software.

"This is like coordinating a fleet of trucks to deliver time-sensitive goods quickly from one place to another," added Madushanka Manathunga, an MSU postdoctoral scholar who was part of the team.

Traditionally, QM/MM codes are run using CPU-based approaches. GPUs give a significant boost in performance, allowing for longer simulations using more sophisticated quantum chemical methods. 🌱



This illustration represents the novel integration of the QUICK program as the engine to perform electronic structure calculations in QM/MM simulations with the AMBER software package for molecular dynamics.

QuSTEAM: Accelerating society's quantum leap



Beginning this October, Michigan State University chemists **Angela Wilson** and **Melanie Cooper** will combine forces on a \$700,000 grant to advance NSF's Convergence Accelerator Project.

The Convergence Accelerator supports use-inspired, team-based, multidisciplinary efforts that address challenges of national importance and will produce deliverables of value to society in the near future.

Cooper, a chemistry education expert who is internationally renowned for her three-dimensional learning model 3DL; and Wilson, a pioneer in the development of quantum mechanical methods for thermochemical and spectroscopic predictions, computational

chemistry expert, and director of MSU's Center for Quantum Computing, Science and Engineering, or MSU-Q, will join forces with four leading universities in the Midwest. The goal is to develop an undergraduate curriculum that combines Quantum Information Science, Technology, Engineering, Arts and Mathematics (QuSTEAM) to build a quantum smart workforce through a national model for innovative undergraduate curriculum in the emerging field of quantum technologies.

Reaping FRIB's isotopes to sow new science

Greg Severin is lead investigator on a four-year, \$13 million grant from the U.S. Department of Energy's Office of Science (DOE-SC) to expand FRIB's isotope harvesting capabilities of unused isotopes for a variety of research fields.

While FRIB's primary function is to create rare isotopes to address basic science questions in nuclear physics, only a selection of rare isotopes created in each FRIB experiment supports this goal, creating a bounty of additional rare isotopes that can be extracted and used in other applications.



When harvested, these additional rare isotopes become available for such scientific applications as medicine, biochemistry, materials science, horticulture and astrophysics. Over the next four years, the DOE-SC is supporting MSU scientists to improve and expand FRIB's isotope harvesting capabilities to broaden FRIB's scientific impact.

Planning and preparation are already underway for the new lab, scheduled to be completed by fiscal year 2024.

A biological fireworks show, 300 million years in the making

Five years ago, researchers at Northwestern University made international headlines when they discovered that human eggs, when fertilized by sperm, release billions of zinc ions, dubbed "zinc sparks."

Now, a new study conducted by MSU, Northwestern and the U.S. Department of Energy's Argonne National Laboratory reveals that these same sparks fly when frog eggs are fertilized. This means that the early chemistry of conception has evolutionary roots going back at least 300 million years, to the last common ancestor between frogs and people.

And the research has implications beyond this shared biology and deep-rooted history. It could also help shape future findings about how metals impact the earliest moments in human development.

"One of our long-term goals is to understand how zinc chemistry is used by cells to control life and death decisions, and hopefully to apply this understanding to address problems related to dietary zinc deficiency as well as human fertility," said Thomas

O'Halloran, MSU Foundation Professor who joined the faculty in January and was part of the original zinc spark discovery.

The team also discovered that fertilized eggs of African clawed frogs, or *Xenopus laevis*, eject another metal, manganese, in addition to zinc. It appears these ejected manganese ions collide with sperm surrounding the fertilized egg and prevent them from entering.

To make these discoveries, the team needed access to some of the most powerful microscopes in the world, as well as expertise that spanned chemistry, biology and X-ray physics. Using both X-ray and electron microscopy, the researchers determined the identity, concentrations and intracellular distributions of metals, found in small pockets around the outer layer of the eggs, both before and after fertilization.

With the discovery of manganese sparks in African clawed frogs, the team is excited to explore whether the element is released by human eggs when fertilized, and O'Halloran is poised to make those efforts successful as he launches and directs MSU's new

Elemental Health Institute (EHI). The EHI will develop ultrasensitive methods to understand how the chemistry of essential and toxic elements impacts human, animal, plant and microbial health.

"The emerging and dynamic field of metallomics is poised to make major contributions to fundamental research across many areas of biology such as embryonic development, evolution, plant physiology, neurobiology, host-pathogen interactions and environmental toxicities," O'Halloran said. "The goal is to build a national consortium for elemental health research by making MSU a locus for technology development and partnerships."

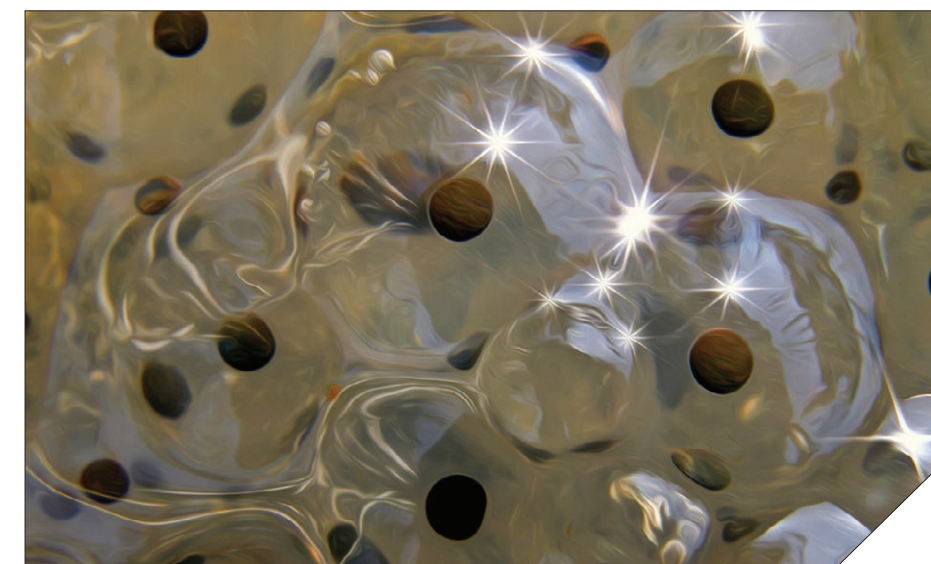
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A close-up of frog eggs reflecting light.

Teaching chemistry in the time of COVID

by Amy Pollock and Chrysoula Vasileiou

The 2020-2021 academic year will be remembered as one of the most challenging times of our lives, both personally and professionally.

At the department level, everyone involved in our teaching mission—professors, instructors, teaching assistants, advisors and support staff—had little to no time to adjust to the new COVID-dictated rules, which involved either moving classes online or significantly modifying in-person operations. Pressure was also felt by chemistry employees dealing with large service courses, especially academic specialists (teaching and advising) and support staff (course coordinators, lab prep and stockroom staff).

Most of our large gateway courses (both labs and lectures) that serve thousands of students every year, needed to adjust to an online format while still meeting most of the course learning objectives—not an easy task.

For lecture classes, many different online formats were employed (synchronous/asynchronous, electronic homework, group work), and significant effort was put into making courses both approachable and fair for everyone.

For online labs, videos were created in advance to showcase the most common experimental techniques. Students also met live online to discuss their plans and experiments with their groups and the instructors.

Most of our higher-level chemistry major's labs still operated in-person, following the appropriate social distancing/masking rules, while also maintaining an online component for students who either could not, or chose not to, attend in person.

Although the online version of the chemistry classes was sufficient and exposed us to new teaching techniques and approaches, we are all looking forward to working with students in person in the upcoming semesters.

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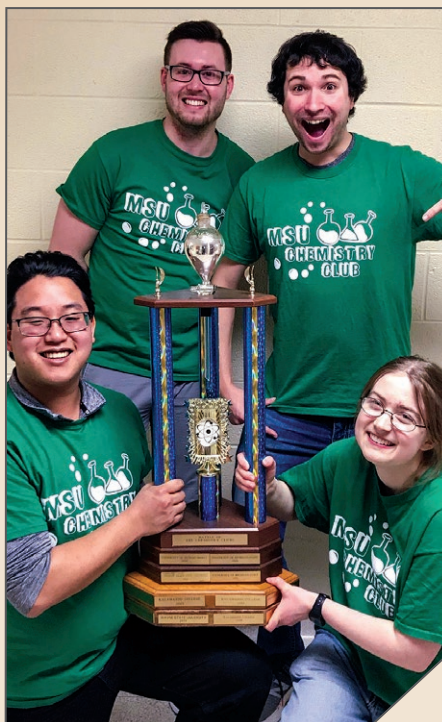
MSU Chemistry Club wins Battle of the Chemistry Clubs competition

MSU's Chemistry Club took first place in the 13th annual Battle of the Chemistry Clubs (BCC) competition held February 1, 2020.

The MSU Younger Chemists' Committee (a chapter of the American Chemical Society) sponsors the annual BCC competition, which attracts chemistry clubs throughout Michigan. Held on MSU's campus, this year's competition included ten colleges and universities in teams of at least four students each.

"On behalf of the department, I congratulate our chemistry club champions," said former chemistry chair Robert Maleczka. "This group of chemistry majors has shown a great esprit de corps and are terrific examples of students getting the most out of their MSU experience. A shout-out to the club's advisor, Sheba Onchiri, is also most certainly in order!"

"I consider such competitions as one of the best ways to demonstrate



Chemistry Club members (l to r): Michael Schwanitz, Joseph Hendrian, Austin King (president) and Natasha Perry (vice president) brought home first place in the 2020 Battle of the Chemistry Clubs for MSU.

students' talents," Onchiri added.

The BCC events cover a full day. Morning events include chemistry Jenga, a safety rules obstacle course, identifying elemental trivia in haiku poems and tests on the International Union of Pure and Applied Chemistry knowledge. MSU dominated in all these categories and held first place after the morning's events.

MSU's club continued to hold its lead throughout the afternoon in the titration race and in timed events that tested students' knowledge of density laws and regions of the visible light spectrum. The competition closed with Jeopardy-style trivia questions before a Final Jeopardy round clinched the win for MSU.

MSU's Chemistry Club fosters and promotes passion for chemistry among students from a variety of backgrounds and majors who share a common desire to expand their knowledge of the world. The club focuses on exploring chemistry topics rarely addressed in standard colloquia—and having fun. 🍷



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