NSF announces $25 million institute in Chicago for quantum biology research

UChicago, Chicago State, UIC, Harvard to investigate quantum imaging, create quantum workforce
A s part of a nationwide initiative to boost re- search in quantum science, the National Sci- ence Foundation will establish a $25 million institute in Chicago to investigate quantum sensing for biology and train the quantum workforce. Headquartered at the University of Chicago and in partnership with Chicago State University, the University of Illinois at Chicago and Harvard University, the insti- tute will be funded for five years.

The goals of the Quantum Leap Challenge Institute for Quantum Sensing for Biophysics and Bioengineering (QuBBE) are twofold: to develop the quantum workforce through STEM education and outreach. The institute joins a growing hub of quantum research and industry in the Chicago area, including two U.S. Department of Energy quantum centers led by UChicago-affiliated Argonne National Laboratory and Fermilab, UChicago’s Pritzker School of Molecular Engineering, the Chicago-Quantum Exchange, quan- tum startup accelerator Duality, and multiple tech incubators and startup companies.

Using sensitivity for sensing Quantum technology research seeks to exploit the behaviors of par- ticles at the subatomic level, which are subject to different rules than what we see around us. Such particles can exist in two different places simultaneously, tunnel through walls or change states when measured. Quantum systems are extremely sensitive and react to the tiniest changes in their environment—a quality which has intrigued scientists who hope to harness this property for sensing. This sensitivity is why quantum computers are so difficult to make, but could also be an asset: “We seek to turn that challenge on its head, and use the extreme sensi- tivity for sensing,” Engel said.

“For example, when an immune cell comes in contact with a pathogen, we know that single molecule-level interactions influence how the cell deforms and adheres and kills whatever its target is; but it’s not well-understood, because sensing and measuring what those single molecules are doing in real time, in such a small space, is so hard,” said Allison Squires, Neubauer Family Assistant Professor of Molecular Engineering at UChicago and a member of the new insti- tute. “If we can put a quantum sensor right there to directly read out what’s happening, that would be a game-changer.”

There are two scientific challenges the institute is designed to address. The first is to make these systems sensitive enough to pick up the changes scientists want to measure, and to ignore everything else. Because when it comes to biology, the noisiest environments are the most scientifically interesting. “You’d love to be able to peer inside a cell and watch the machinery at work,” Engel said, “but it’s one of the noisiest, most complex environments out there.”

The second challenge is to make sure scientists are measuring what they intend to measure, since the scales are so small. Thus the institute’s goal is to develop ways to integrate quantum sensing along with more traditional imaging, so that scientists can first understand where the probe is in the cell and then get readings from the quantum sensors. This research will require intense collaboration across disci- plines, including scientists and engineers from UChicago’s Depart- ments of Chemistry and Physics, the Pritzker School of Molecular Engineering, and the Biological Sciences Division, as well as scien- tists at Chicago State, UIC and Harvard. UChicago’s affiliations with nearby Argonne and Fermilab offer access to expertise and unique resources, such as supercomputers and synchrotrons.

Quantum collaborations The collaboration is also intended to boost the involvement of Chi- cago students in quantum research ranging from K-12 to Ph.D.s, particularly those in underserved communities. Planned activities at Chicago State University include the cre- ation of a certificate program in quantum science and the continued development of curriculum that will train students in skills needed for the quantum workforce. CSU faculty and students will also perform outreach with Chicago Public Schools. This grant will offer funding support for students at UChicago, Chicago State and UIC. Faculty from all institutions also will collaborate on scientific explo- ration, bringing together ideas and resources.

The field of quantum technology is at a crossroads, and this is a unique opportunity for our students to be in on the ground floor of a new and growing industry,” said Valerie Goss, associate professor of chemistry, in the department of chemistry, physics and engineering studies at Chicago State University. “This collaboration will open doors for both students and faculty across disciplines to build net- works, develop fundamental research, and share resources and oppor- tunities between our universities.”

A centerpiece of the program is pairing students with both aca- demic and industry partners—an approach designed to prepare stu- dents for success in the workforce and also to speed the process from scientific discovery to implementation.

“For me the most exciting thing is the questions this technology can answer that we haven’t thought of yet,” said Peter Maurer, as- sistant professor of molecular engineering at UChicago and another member of the new institute. “We know of amazing potential ap- plications, but I think probably the biggest ones are still to be discov- ered and that’s what excites me most: actually finding those applica- tions and realizing them.”

In the Sept. 2 statement, NSF also announced funding for the NSF Quantum Leap Challenge Institute for Robust Quantum Simu- lation, led by the University of Maryland in College Park to develop quantum systems as well as the methods and tools for large-scale quantum simulations that will allow for quantum computation. “Our Quantum Leap Challenge Institutes program is develop- ing the foundation of quantum information sciences, as well as de- veloping the future students, faculty, startups, and industry partners who are engaged in it,” said Sean L. Jones, NSF assistant director of mathematical and physical sciences. “These two new institutes are tapping into challenging fields that have the potential to develop the next generation of tools that will establish the United States at the forefront of quantum innovation.”

NSF announces $25 million institute in Chicago for quantum biology research By Louise Lerner
Three UChicago faculty are now at the helm of top ACS Journals as editors-in-chief. Along with Stuart Rowan as editor-in-chief for ACS Macro Letters, two other faculty members were appointed in 2021 as editors-in-chief for ACS Publications including Chuan He for ACS Chemical Biology and Laura Gagliardi for the Journal of Chemical Theory and Computation.

ACS Chemical Biology, established in 2006, provides an international forum for the rapid communication of research that broadly embraces the interface between chemistry and biology. “Since its inception, ACS Chemical Biology has established itself as the main platform for chemical biologists to communicate their research and share scientific discoveries,” says Prof. He. “I envision the journal expanding its scope to encompass emerging research areas which are likely to blossom in the coming decade.” He also looks forward to building relationships with young chemical biologists through new initiatives and believes that the journal can play an active role in encouraging all chemical biologists to explore new areas of research.

The Journal of Chemical Theory and Computation, established in 2005, publishes papers reporting new theories, methodology, and/or important applications in quantum electronic structure, molecular dynamics, and statistical mechanics. Gagliardi served as Associate Editor of JCTC from 2016 to 2020 and published in the journal more than 35 times. “It is a great honor to have two of my wonderful colleagues be chosen as the next Editor-in-Chief of these two great ACS journals,” said Rowan. “I am very excited to have two of my wonderful colleagues be chosen as the next Editor-in-Chief of these two great ACS journals.”

Women in Chemistry: A student-led effort to create community among women and other gender minorities

Women in Chemistry (WiC) is a long-standing student-led group that helps foster relationships between women and other gender minorities in the University of Chicago’s Department of Chemistry for mutual encouragement, and to promote women in science by creating a supportive environment through engaging speakers and monthly social events. “WiC is a student-led and focused organization, so we invite speakers based on the interests of the members,” says Olivia Laxton, a Chemistry Graduate student. “They can include exploring nontraditional career paths or traditional academic and industry chemists. Another outlet for connection is having separate ‘coffee chats’ with a female or gender minority researcher hosted as part of a Department lecture series.

To develop community across the Department, WiC runs a mentoring program where members are matched up with incoming first-year students based on their research interests. “The mentorship is a very fun program,” says Maia Czaikowski, a Chemistry Graduate student. “It allows incoming students to connect with others outside of their lab group.”

WiC also plays an integral role in recruiting prospective students. There is a long-standing tradition of WiC hosting a brunch for prospective female and underrepresented students to connect to current students. “The WiC brunch is an important event at the end of recruitment because it gives prospective students the chance to ask questions and share thoughts that they wouldn’t normally ask in mixed settings,” says Czaikowski. “When I was invited to other schools as a prospective student, there were no gender-specific events, but I think it makes a difference.”

“There’s strong participation in recruitment by WiC members,” says Subhashree Pani, a Chemistry Graduate Student. “In science, you get used to being the only woman in a male-dominated field but when you’re surrounded by all women Chemists, for a moment you don’t feel like a minority.”
Infrared imaging can enhance our senses by “seeing” through heavy weather, opaque plastic containers, and old paintings, and by identifying chemicals by their signature. But infrared detectors are expensive and complicated to manufacture, and the process often produces low yields. New startup QDIR, based on technology developed in the lab of University of Chicago professor and Chicago Quantum Exchange member Philippe Guyot-Sionnest, is working to commercialize a new, low-cost way to create these detectors: with quantum dots.

QDIR’s approach is getting attention. The company is an active member of the fourth cohort of Argonne National Laboratory’s Chain Reaction Innovations (CRI) program, which embeds entrepreneurs at the lab in two-year stints to develop revolutionary technologies, and was awarded a National Science Foundation Phase I SBIR grant to support commercialization of its core technology. “Over the past year, we’ve gotten an increasing amount of interest from companies in the industry,” said Guyot-Sionnest, who is a professor of chemistry at UChicago. “Infrared detectors are so expensive, but now we have developed something in the lab that could be useful, and it will be great to see where this goes.”

The company’s technology is based on colloidal quantum dots: tiny semiconductor nanocrystals that range from 1 to 20 nanometers in dimension and suspended in a liquid. These quantum dots are made from silicon that is chemically “silicized” to make silicon wafer-like materials, and a host of other materials that absorb infrared light. The company’s breakthrough lies in the manufacturing process.

While infrared detectors are often made from bulk crystals, QDIR’s detectors are made from solutions, which can be painted directly onto silicon integrated circuits—a cheaper and less complicated way to ultimately develop detectors. And while the bulk crystals create low yields, QDIR’s process has the potential to have very high throughput of product. It simplifies the manufacturing process, reduces cost, and creates higher yield.

Ackerman says they hope to validate the imaging capabilities of the technology with both short-wave infrared (good for revealing chemical features of a substance) and mid-wave infrared (good for thermal imaging of objects). They hope to achieve a higher sensitivity than current detectors, or the same sensitivity at higher operating temperatures. Many current systems require that the detector be cooled cryogenically. Short wave infrared light can be used to see through silicon wafers, inspect fruits, sort materials based on their specific absorption. Image courtesy Dr. Xian Tang.

Potential target markets for this technology are product engineers and equipment manufacturers that are developing machine vision, non-invasive quality testing systems, surveillance methods, and even autonomous transportation vehicles.

As part of the Argonne CRI program, Ackerman will use office and lab space at Argonne to work throughout the next year on validating the technology with potential customers and scaling production. The program also provides business mentorship to participants, and Ackerman hopes to continue to develop the business side of the company by seeking out customers and strategic relationships.

“At the end of CRI we hope QDIR can stand up on its own,” Ackerman said. “We could ultimately provide a better, inexpensive alternative to existing technology.”

Startup QDIR uses quantum dots for infrared detectors

By Emily Ayashford

THE DEPARTMENT OF CHEMISTRY

has started a campaign to fully endow two graduate student fellowships to honor the legacies of Professors Jack Halpern and Stephen Berry. Both were exceptional scientists and leaders in their fields, and both were longstanding members of our department. The fellowships were initiated by their families, and our goal is to raise funds so that each can fully support a graduate student.

Double your Donation in 2022: We are delighted to inform you that your charitable donation will be matched dollar-for-dollar (up to $25K per donor). Click the link below to contribute, and be sure to indicate the fellowship that you wish to support.

DONATE

More Information

The Department of Chemistry has a long history of excellence in research, education, and service. Our faculty are leaders in their fields, and our students are well-prepared for success in any career. We invite you to learn more about our department and the opportunities available to you.

Chemistry Events

The Department of Chemistry hosts a variety of events throughout the year, including lectures, seminars, and symposia. Our events are open to the public, and we encourage you to attend.

Connect with Us

Find us on Facebook, LinkedIn, Twitter, and Instagram at @UCHCChemistry.

Notable Awards

Paul Alivisatos accepts Priestley Medal

Paul Alivisatos, Chuan He, Weimin Lin, & Jongsong Park recognized as Highly Cited Researchers by Clarivate

John Anderson promoted to Associate Professor & Bozhi Tian promoted to Professor

Laura Gagliardi wins Royal Society of Chemistry Prize

Dr. Wuttig was born in Washington, D.C., and spent time in Germany, Japan, and the U.S. during her early years. She received her A.B. in Chemistry from Princeton University. There, she was introduced to scientific research in the laboratories of Prof. Hans Yang, Robert Carra, and Andrew Bocarsly, where she developed a great interest in the chemistry underlying electricity-driven processes. She received her Ph.D. from the Massachusetts Institute of Technology, where she investigated electrocatalytic CO2 reduction with Prof. Yogesh Sherendranath as an NSF Graduate Research Fellow. She then joined Prof. F. Dean Toste’s research group as an NIH Postdoctoral Fellow at U.C. Berkeley. There, she worked on understanding molecular electrocatalytic manifolds for selective radical processes.

Prof. Anna Wuttig Joins Department of Chemistry

Professor Anna Wuttig is joining the Department of Chemistry as a Neubauer Family Assistant Professor. The mission of the Wuttig group is to integrate renewable energy input into the synthesis of products across the chemical value chain by advancing the science underlying chemical reactivity at electrified interfaces.

Dr. Wuttig was born in Washington, D.C., and spent time in Germany, Japan, and the U.S. during her early years. She received her A.B. in Chemistry from Princeton University. There, she was introduced to scientific research in the laboratories of Prof. Hans Yang, Robert Carra, and Andrew Bocarsly, where she developed a great interest in the chemistry underlying electricity-driven processes. She received her Ph.D. from the Massachusetts Institute of Technology, where she investigated electrocatalytic CO2 reduction with Prof. Yogesh Sherendranath as an NSF Graduate Research Fellow. She then joined Prof. F. Dean Toste’s research group as an NIH Postdoctoral Fellow at U.C. Berkeley. There, she worked on understanding molecular electrocatalytic manifolds for selective radical processes.

PhDs

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Winter Quarter 2022

Sarah Brown (Silberman)
Xiaying Feng (Lin)
Jonathan Keim (Snyder)
Allison McMillan (Silberman)
Peter Qi (Snyder)
Brooke Schuster (Tuttle-Modelling)

Winter Quarter 2022

Meng Yi (Snyder)
Sarah Zinn (Ingold)

MS in Chemistry

Anna Wuttig Autumn Quarter 2021

Ignacio Xiongton Che Duran
Chuhui Fu
Indrani Ghosh
Yu Ling Goh
Black Ryan Hance
Sohe Kim
Zaiping Lin
Colin Francis Lynch
Tyrus Joseph Plaisant
Arturo Soza-De La Vega
Anna Olivia Schouten
Qing Shen
Xingyu Shen
Riley Simont
Deborah Mary Thomas
Cole Joseph Wagner

HAO NING

Winter Quarter 2022

Huaoyang You
Winter Quarter 2022

Caitlin Cyrialla Bellora
Mengui Cao
Miao Chen
Sijia Chen
Alex Edward Cralish
Maai Czakowski
Julia Lucette Driscoll
Jingtung Geng
Spencer Cheng Guo
Menghui He
Shou-Ting Hsieh
Ethan Hyland
Olivia Laxton
Sean Lee
Seung Yoon Lee
Beiyi Li
Jinquan Liu
Jianning Mao
Lauren Elizabeth Munsamara
Daniel Pyle

Notable Awards

Paul Alivisatos accepts Priestley Medal
Paul Alivisatos, Chuan He, Weimin Lin, & Jongsong Park recognized as Highly Cited Researchers by Clarivate
John Anderson promoted to Associate Professor & Bozhi Tian promoted to Professor
Laura Gagliardi wins Royal Society of Chemistry Prize
Dr. Wuttig elected to Academia Nazionale dei Lincei
Kat Yee C. Lee honored with Chung-Ling Tien Leadership in Education Award
Sarah King awarded Air Force Office of Scientific Research Award
Mark Levin awarded Sloan Fellowship
Benoit Roux receives Packard Fellowship in Science and Engineering
Benoit Roux elected fellow in the Royal Society of Canada (RSC)
Noberett E. Scherer nominated the 2022 C.E.K. Mees Medal Recipient by The Optical Society of America, now named Optica
Andrei Tokmakoff elected to National Academy of Sciences
Dear friends,

With a long, cold winter behind us, spring is bursting forth all over our beautiful campus. And with the promise of the new season comes renewed energy, fresh ideas, and sustained growth within the Department of Chemistry. I’d like to begin with some good news from the 2022 U.S. News ranking of chemistry programs: this year, UChicago has leapfrogged from 14 to 7 nationwide, and we aim to rise further. With relatively low COVID levels on our campus, the majority of our research activities and teaching have resumed in person. While not all difficulties are behind us, I’m looking forward to busy hallways, bustling laboratories, and more in-person with students, staff, and esteemed colleagues.

Our faculty is growing with recently appointed faculty, and we look forward to sharing their research and other contributions in upcoming issues of The Chemists Club. In this issue, you can learn more about Anna Wuttig, who joined us in 2021 as a Neubauer Family Assistant Professor. Anna completed her postdoc at UC Berkeley after earning her Ph.D. at MIT. Anna works to integrate renewable energy input into the synthesis of products across the chemical value chain by advancing the science underlying chemical reactivity at electrified interfaces. We are also delighted to welcome Jack W. Szostak to our faculty starting in September after many years at Harvard University. His biochemical inquiries into the origins of life will continue in our Department, where the construction of his new research space is underway.

Our faculty continues to take the lead in cross-campus research initiatives. Greg Engel will head a new National Science Foundation institute called the Quantum Leap Challenge Institute for Quantum Sensing for Biophysics and Bioengineering (QuBBE), which aims to discover new applications for quantum technology in biology and to develop the quantum workforce through STEM education and outreach.

Three UChicago faculty are now at the helm of top ACS Journals as editors-in-chief. Along with Stuart Rowan as editor-in-chief for ACS Macro Letters, two other faculty members were appointed in 2021 as editors-in-chief for ACS Publications: Chuan He for ACS Chemical Biology and Laura Gagliardi for the Journal of Chemical Theory and Computation.

To honor the legacies of Professor Steven Berry and Professor Jack Halpern, we have established graduate student fellowships in their names and are raising funds to fully endow them. We invite you to support the memory of these exceptional scientists by making a contribution to the fellowship funds. Our goal is to raise sufficient funds in time to award the first of these fellowships next year, so we will match your donations $ for $ (up to $25K per donor).

We are planning to host an event around UChicago Alumni Weekend (May 19–22) to reconnect our chemistry community. We hope you will be able to join us.

Viresh Rawal
Professor and Chair