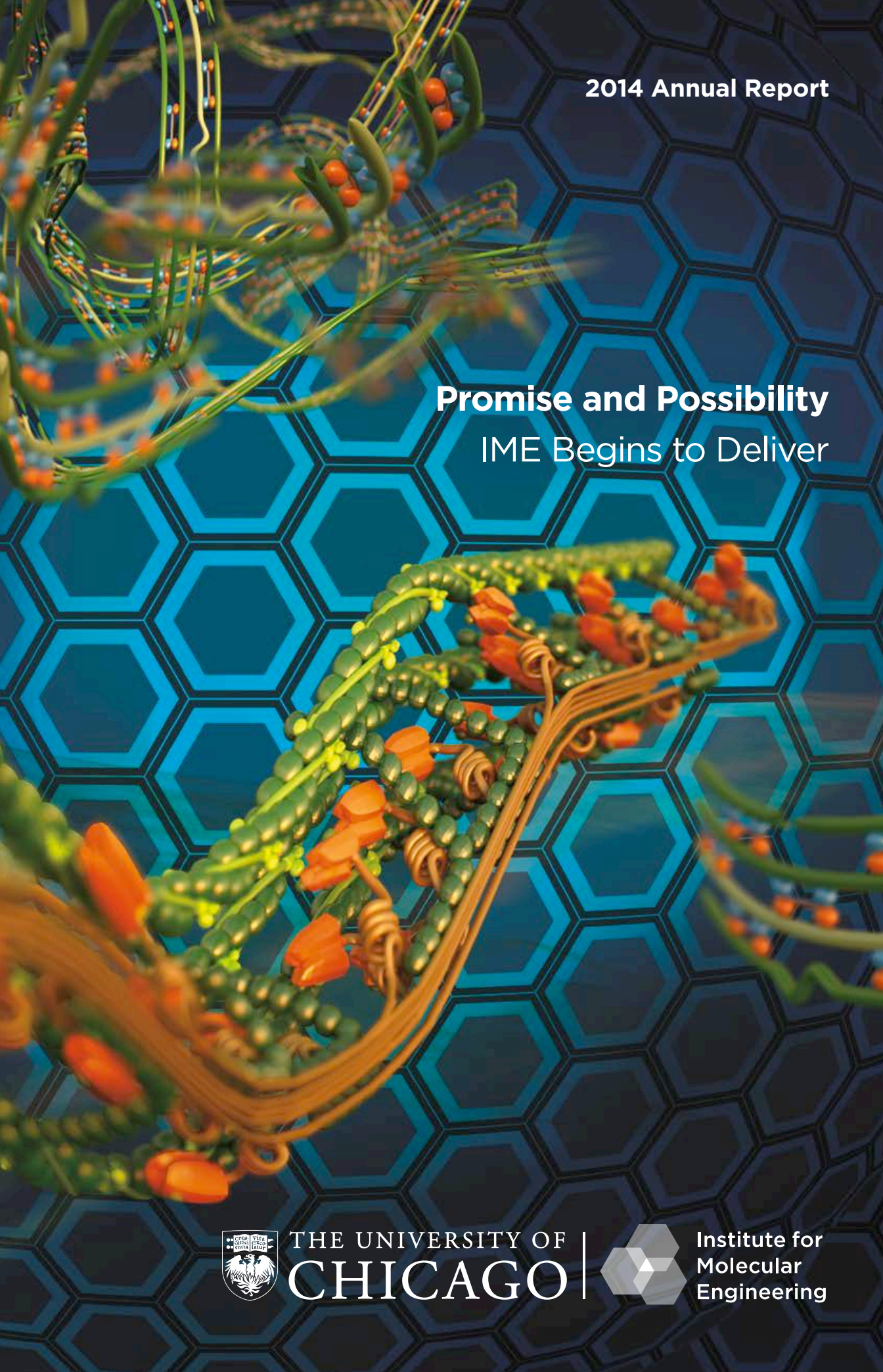

2014 Annual Report

Promise and Possibility

IME Begins to Deliver

THE UNIVERSITY OF CHICAGO

Institute for Molecular Engineering

"IME is committed to the discovery, dissemination, and application of new knowledge—transformational research that leads to solutions for society and industry."

—Matthew Tirrell, Pritzker Director and Dean, Institute for Molecular Engineering

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THE UNIVERSITY OF CHICAGO

Matthew Tirrell
Pritzker Director and Dean
Institute for Molecular Engineering

Transformational Progress
IME advancing excellence

The calendar year 2014 brought two principal changes in the evolution of the Institute for Molecular Engineering:
1) We launched educational programs at the graduate and undergraduate levels, and
2) Increased our faculty with the hiring of our first assistant professor.

During this year, we also grew our research volume from about $4 million in 2013 to $10 million annually in 2014, developed and began to implement a plan to equip and staff the Pritzker Nanofabrication Facility, and attracted two new endowed professorships to IME.

In September, our first twenty PhD students in Molecular Engineering arrived at the University of Chicago from institutions as near and far as the University of Illinois at Urbana-Champaign, Caltech, Georgia Tech, and Zhejiang University in China. IME offered in the fall a set of four new courses to these graduate students, but also encouraged them to sample broadly from the sciences and other offerings of the University of Chicago. At the same time, I had the exciting responsibility of delivering the first undergraduate course in Molecular Engineering. The course, Introduction to Emerging Technologies, attracted seventy undergraduate students in their second, third, and fourth years. We covered four areas of emerging technology: tissue engineering, nanolithography, quantum information, and energy storage. The students' evaluations have been very positive; suffice it to say, both the students and the instructor learned a lot. Three new undergraduate engineering courses are on tap for Winter Quarter 2015. An exciting event of 2014 was the granting of the first PhD degree in Molecular Engineering to Paulina Rincon-Delgadillo, mentored by Professor Paul Nealey.

The calendar year 2014 brought new faculty hiring and new faculty members taking up residence in IME. The new hire is our first assistant professor, Dr. Jun Huang, who did his PhD in bioengineering at Georgia Tech and is currently a postdoctoral research associate in the Mark Davis Lab at Stanford, one of the

foremost experimental immunology groups in the world. Jun is the recipient of a National Institutes of Health Pathway to Independence Award, which is designed to facilitate a timely transition from a mentored postdoctoral research position to a stable independent research position. The award carries $250,000 per year of research support for his first three years with us, with his initial appointment beginning July 1, 2015. He will strengthen the immuno-engineering theme led by Melody Swartz and Jeff Hubbell. On July 1, 2014, Melody and Jeff, as well as Andrew Cleland, officially became part of the IME faculty. Melody Swartz holds the William B. Ogden Professorship, Jeff Hubbell the Barry L. MacLean Professorship for Molecular Engineering Innovation and Enterprise, and Andrew Cleland the John A. MacLean Sr. Professorship for Molecular Engineering Innovation and Enterprise. The tenured and tenure-track IME faculty now stands at nine members, seven of whom have a 25 percent appointment at Argonne National Laboratory.

Andrew Cleland has also been named Director of the Pritzker Nanofabrication Facility in the William Eckhardt Research Center. The gift from the Pritzker Foundation has enabled us to acquire new tools for the facility before the Eckhardt Center opens. We aim to have the facility up and running soon after the opening of the Eckhardt Center, now planned for late August 2015.

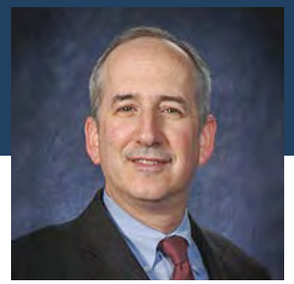
We are very appreciative of new support that has come to the Institute for Molecular Engineering. In 2014, we added two new endowed professorships. One is from Jim and Paula Crown for the Crown Family Professor and Director of the Water Research Initiative. The other is from the Millicent and Eugene Bell Foundation for the Eugene Bell Professorship in Tissue Engineering to promote innovative, collaborative work in tissue engineering in the IME, jointly with the Marine Biological Laboratory. Searches to fill these professorships are underway.

As always, we strive to optimize the special opportunity that comes with doing something for the first time. That is the unique promise and possibility of IME, embodied in our vision and mission:

VISION The Institute for Molecular Engineering is transforming research and education to become a world leader in solving major technological problems of global significance, and continually inspiring creative applications of molecular-level science.

MISSION Our mission is to translate discoveries in physics, chemistry, biology, and medicine into solutions to important societal problems, and to create a research and teaching environment to enhance and transmit these capabilities to future generations.

Matthew Tirrell
Pritzker Director and Dean
Institute for Molecular Engineering



Eric D. Isaacs
Provost
The University of Chicago

Letter from Provost Eric D. Isaacs

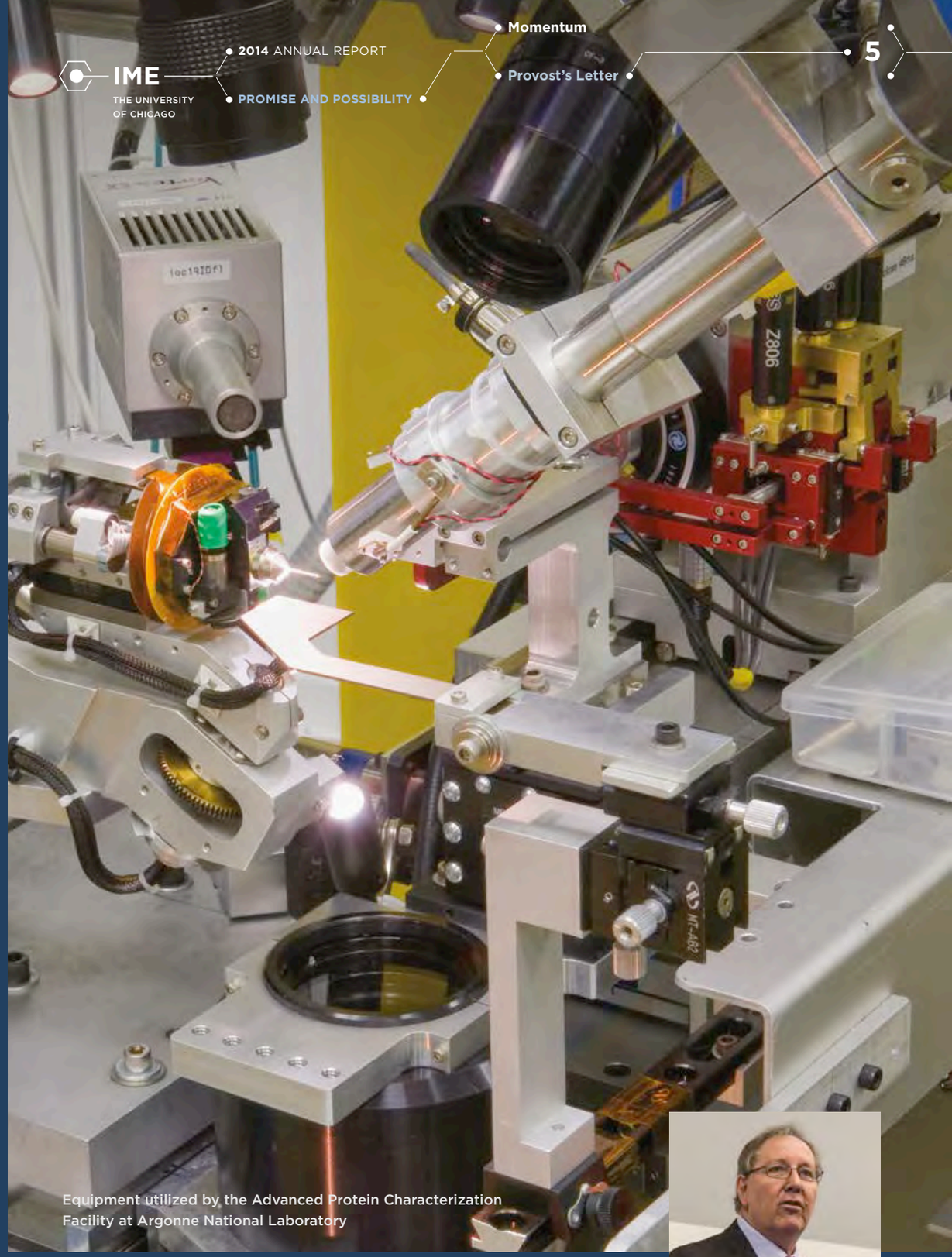
One of the key paradigmatic shifts of the 21st century is the blurring of boundaries between basic and applied science in almost every discipline. Nowhere is this more evident than in areas of research at the molecular level. Health, energy, water, and computation are but a few of the areas where we cannot make progress in basic science without having significant strengths in engineering. When the University of Chicago decided to move forward with molecular engineering three years ago, we did so with an eye to the science of the future and structured the Institute for Molecular Engineering in a way that would allow us to attract world-class scientists and engineers.

Since its founding, we have hired 10 faculty members into IME, and have recruited the first class of twenty molecular engineering PhD students. The IME has become a critical partner with Argonne National Laboratory, Marine Biological Laboratory, and Ben-Gurion University of the Negev, showing its potential not only to attract the best to the University of Chicago, but also to serve as a collaborative partner with scientists and engineers around the world. With the graduation of its first PhD student last May and the addition of an undergraduate major ready to launch, the IME has become fully integrated into the life of the University and has already begun to realize its potential.

This coming August, the IME will move into the William Eckhardt Research Center, which will also serve as the new home for the Department of Astronomy and Astrophysics, and the Kavli Institute for Cosmological Physics. The new research facilities housed in the Center will include the Pritzker Nanofabrication Facility that will enable new opportunities for our faculty and students in their work on quantum engineering and nanoscale manipulation and molecular design.

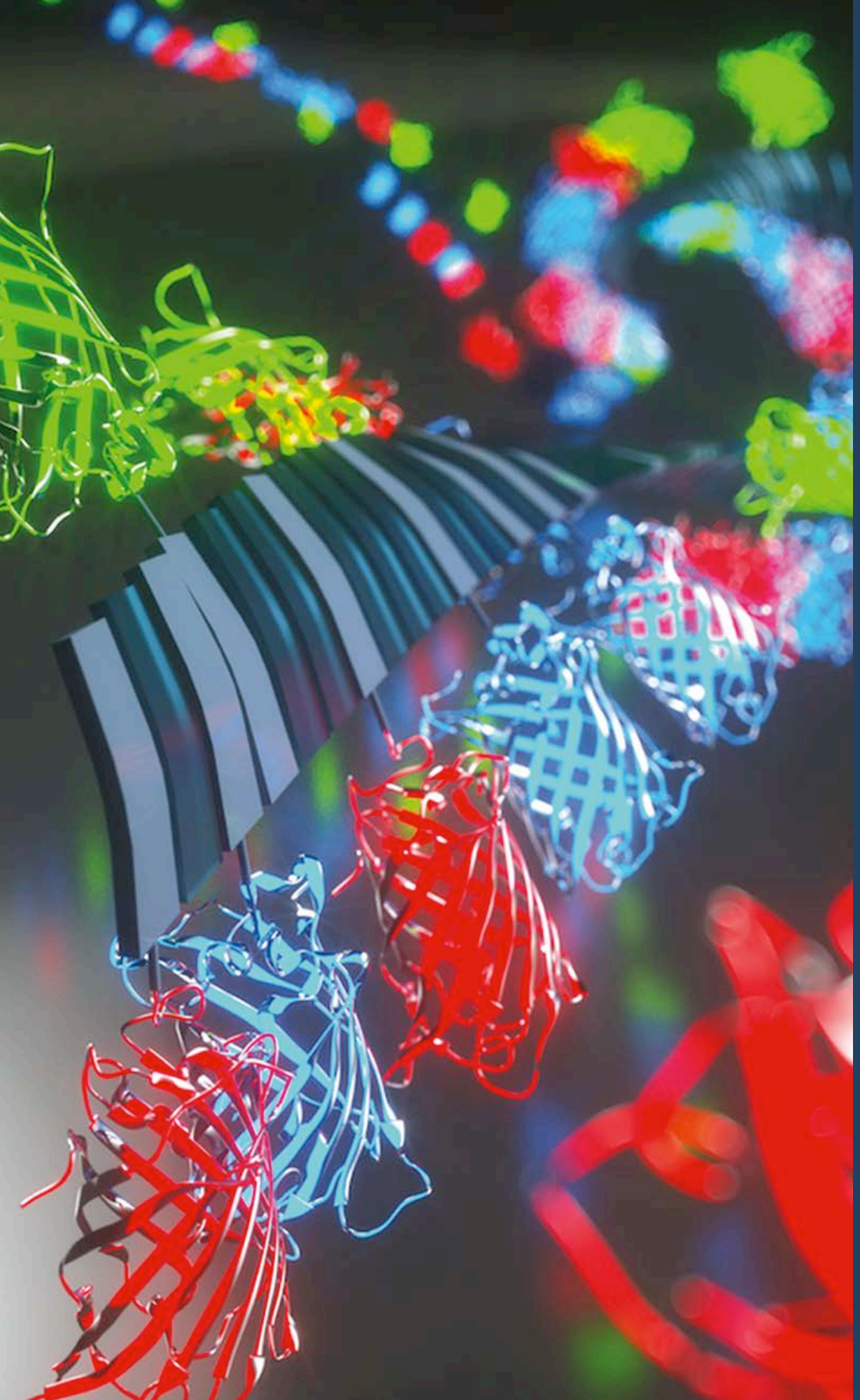
I view the evolution of IME as transformational, not only for our campus, but for the broader future of engineering research and education. We will guide the development of IME in such a way that it not only influences the world of engineering, but also provides the maximum benefit for our students. As we always have at the University of Chicago, we are breaking new ground.

Eric D. Isaacs
Provost
The University of Chicago



Equipment utilized by the Advanced Protein Characterization Facility at Argonne National Laboratory

"Argonne's partnership with UChicago through the Institute for Molecular Engineering brings an in-depth and long-term focus on solutions to global issues in energy and the environment, whether it be energy efficient computing from quantum systems, or new technologies for water. IME brings creative science to big problems." —Peter Littlewood, Director, Argonne National Laboratory



Institute for Molecular Engineering

By the Numbers

New stats for 2014 show growth at the Institute for Molecular Engineering. Our faculty continued to expand, we appointed 12 new fellows, matriculated the new class of PhD students, and began teaching the first set of courses. We were a destination for faculty and visitors from around the world and continued to realize publications and grants. We have exceptional talent and great momentum—we are poised to deliver results.

46 PhD students

46 Postdoctoral researchers

27 Undergraduate researchers

3 New professors

12 New IME fellows

4 Sabbatical professors

6 Ongoing faculty searches

8 New staff members

3 New international collaborations

8 Speakers in new First Thursday Distinguished Colloquium Series

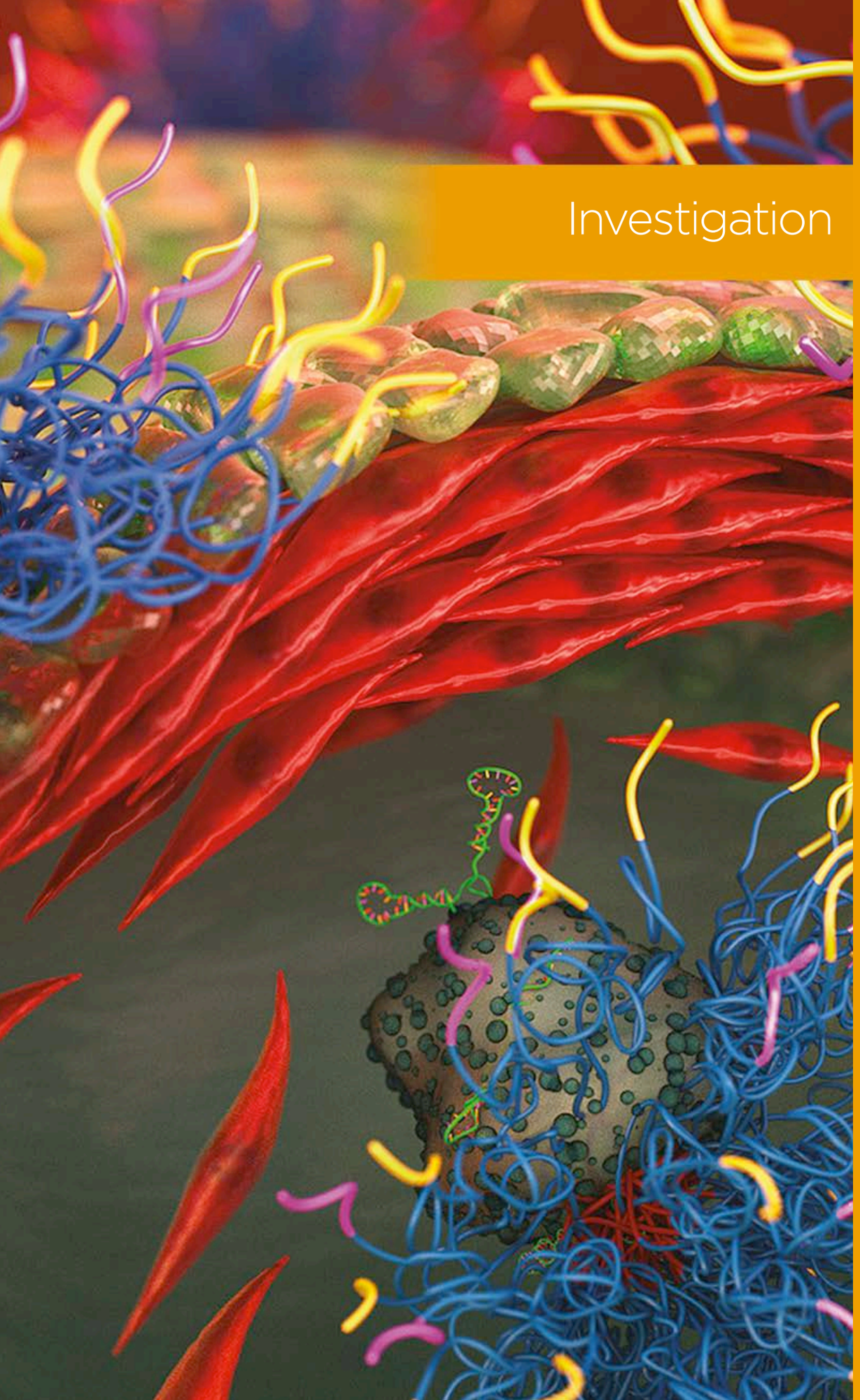
4 New courses

120 Countries represented among visitors to the IME website

64 New publications

10^7 Dollars of grants

Paulina Rincon-Delgadillo, PhD'14, first graduate of IME (story p. 34)



Investigation

Improving Efficacy

Immune function research may lead to better treatments for diseases

Newly appointed Assistant Professor in Molecular Engineering Jun Huang's research focuses on the immune function of cells that work together to maintain a healthy immune system and fight against infections. By studying these immune cells on the molecular level, Huang's research could lead to improved vaccine efficacy and novel immunotherapy for cancer treatment.

Huang and his group of researchers are working to identify influenza proteins that could be used to develop future flu vaccines. Current flu vaccines are not effective enough, and the virus mutates constantly, so there is no universal influenza vaccine for different strains. Huang's research efforts could guide novel vaccine design and better protect us from the flu.

"A long-standing barrier that has prevented us from thoroughly understanding the fundamental mechanism of immune regulation is our inability to precisely identify important molecules and quantitatively measure their interactions," Huang said. State-of-the-art technology will allow Huang to cross this technical barrier. Single-molecule and single-cell imaging techniques can quantitatively measure important molecular interactions with resolutions on the nanometer and millisecond scale.

"When you work with a group of excellent people, we all excel."
—Jun Huang

Huang's group also plans to collaborate with several UChicago faculty members at IME and UChicago Medicine to study the role of regulatory T cells, which suppress excessive immune responses. This immunosuppressive function of regulatory T cells can be used to treat cancers, autoimmune diseases, and organ transplantation rejection. But exactly how regulatory T cells intervene their suppressive function remains unclear.

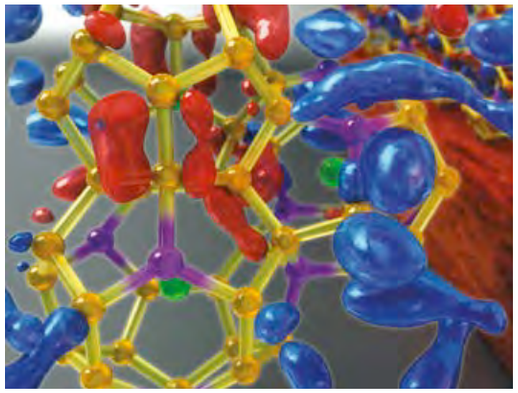
Huang's team will harness the power of single-cell profiling, imaging, and sequencing techniques to investigate the mechanism of suppression and develop novel immuno-therapy for cancer treatment.

Targeting Solutions

Molecular simulation leads to discovery of new materials for solar energy harvesting

Giulia Galli, Liew Family Professor in Molecular Engineering, and her team used a combination of sophisticated molecular simulations based on first principles to predict novel materials for solar energy conversion: a new class of silicon-based clathrates. Made from inexpensive, naturally abundant, and non-toxic elements, this type of clathrates has been investigated for thermoelectric applications (conversion of temperature gradients into electricity) instead of photovoltaic applications. Galli's team, through *ab initio* calculations, predicted that these materials could be an excellent low-cost alternative to crystalline silicon for solar energy conversion.

The study of the new clathrate, $K_8Al_8Si_{38}$, featured on the cover of the August 2014 issue of *Energy & Environmental Science*, reported that it absorbs light in the visible range, has a band



Visualization of structure of clathrate $K_8Al_8Si_{38}$

gap similar to that of crystalline silicon, and is remarkably stable in air up to 996°C. The team performed detailed first-principles modeling of charge carrier mobility, which influences the overall photovoltaic efficiency. Their results showed that the mobility properties of $K_8Al_8Si_{38}$ compare well to those of crystalline silicon without requiring an additional purification step as in the case of silicon. Among available alternatives to crystalline silicon, the new material performs much better than amorphous silicon and organic photovoltaics in terms of charge carrier mobilities.

Giulia Galli

Ab initio simulations were also used by Galli's team to predict charge extraction channels in nanocomposites for solar energy conversion. The research on solar nanocomposites appeared on the cover of *Physical Review Letters* in winter 2014. As in the case of clathrates, the first-principles simulations were conducted using optimized codes and Argonne National Laboratory's high-performance computers.

"After our simulations were completed, we went to an experimental group and convinced them to measure the properties that we had predicted—indicating that these materials would be good for solar energy harvesting—and our predictions were correct!" Galli said. "Having a close connection to experimentalists leads to more impactful work and opens doors to new applications. That's why I am so excited to have joined IME, where computational scientists and experimentalists work side-by-side daily to address outstanding problems in science and engineering," she added.

Energy conversion efficiency is one of the several global challenges that IME researchers are addressing with a variety of techniques.

> "Having a close connection to experimentalists leads to more impactful work and opens doors to new applications. That's why I am so excited to have joined IME."
> —Giulia Galli

The Measure of Progress

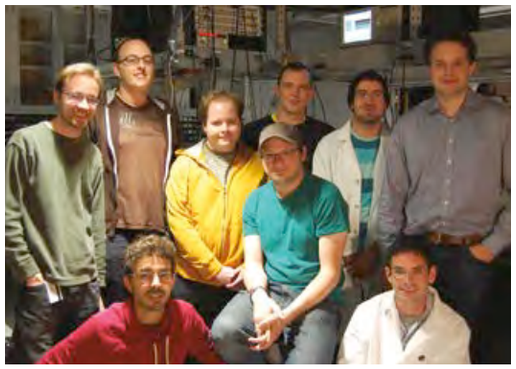
Controlling quantum states to dramatically shift technology capabilities

Researchers in IME Professor David Awschalom's group are working to harness quantum phenomena for use in cutting-edge applications ranging from highly sensitive nanoscale probes for biological applications to ultra-secure quantum communication networks.

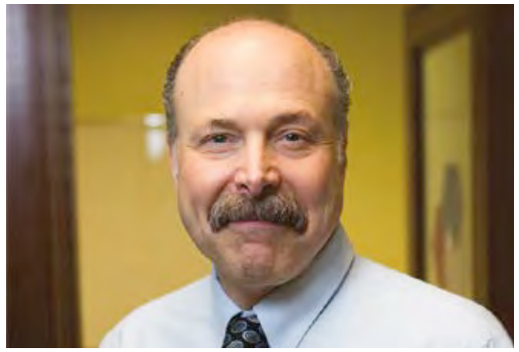
The group is focused on developing photonic and electronic quantum control techniques for future quantum machines by using a different approach than seen in today's technologies—exploiting atomic-scale crystal defects in semiconductors. In particular, defects in diamond and silicon carbide behave like an isolated molecule trapped within the solid state and can display impressive quantum properties, such as the remarkably long time a quantum state remains coherent, even at room temperature.

"Surprisingly, crystalline defects in diamond-like materials offer a unique opportunity to explore quantum phenomena in the solid state," said Awschalom, Liew Family Professor in Spintronics and Quantum Information.

With individual defects found in laboratory-grown diamond, Awschalom's team developed a technique that uses ultrafast pulses of laser light to create a sequence of quantum-state snapshots—a movie of how a defect's quantum state changes in time—over timescales from femtoseconds (a billionth of a millionth of a second) to nanoseconds



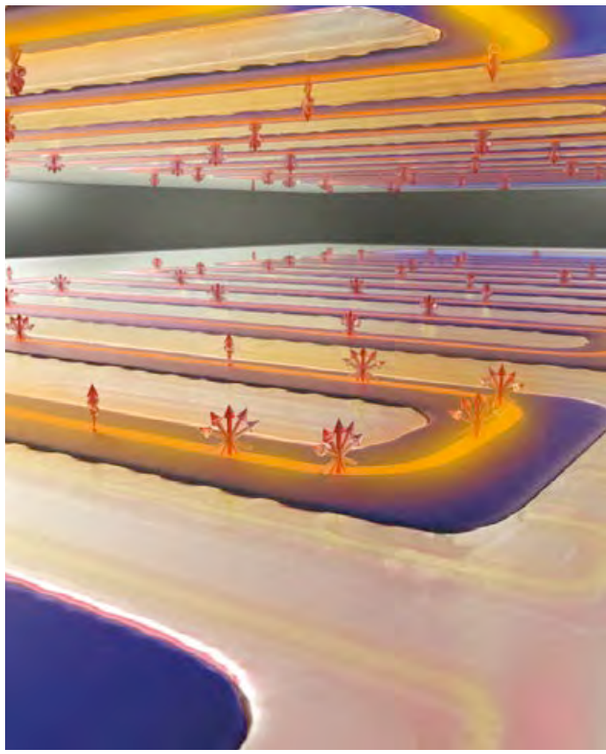
Awschalom Group researchers



David Awschalom

(a thousandth of a millionth of a second). The difference in timescales is like the difference between an hour and a century. This technique is powerful enough to completely control the quantum state using only light—no wires—on some of the fastest timescales measured in these systems to date.

"IME innovates by combining science, materials, and technology with relevant theory," Awschalom said. "Here, we're working to solve problems in an interdisciplinary manner across a broad range of issues."



Twelve Fellows Join IME

Pritzker Director and Dean of the Institute for Molecular Engineering Matthew Tirrell announced the appointment of 12 new fellows to IME in the winter of 2014. Each fellow is an acclaimed research pioneer across the disciplines of physics, chemistry, biological sciences, and medicine. Fellows participate in IME's strategic planning and initiatives and will serve for a term of three years, renewable by mutual agreement.

Ian Foster
Arthur Holly Compton Distinguished Service Professor, Department of Computer Science, Director, Computation Institute, Distinguished Fellow, Mathematics and Computer Science Division, Argonne National Laboratory

Distributed, parallel, and data-intensive computing technologies and their applications to scientific problems in such domains as climate change and biomedicine

Daniel López
Group Leader, Nanofabrication and Devices Group, Center for Nanoscale Materials, Argonne National Laboratory

Long-range interactions in nanoscale systems; nano and micro electromechanical systems; non-linear dynamics in nanoscale devices and synchronization

John F. Mitchell
Senior Scientist and Associate Director, Materials Science Division, Argonne National Laboratory

Strategic synthesis, crystal growth, and structural studies of correlated electron transition metal oxides and chalcogenides using neutron and X-ray scattering

Cristina Negri
Principal Agronomist and Environmental Engineer, Argonne National Laboratory; Senior Fellow, Energy Policy Institute at Chicago

Systems approaches where industrial ecology concepts are applied to water and land management, both in agricultural and urban contexts

Michael R. Norman
Director, Materials Science Division; Principal Investigator, Center for Emergent Superconductivity; Argonne Distinguished Fellow, Argonne National Laboratory

Many body theory on heavy fermion and high temperature cuprate superconductors; spin liquids; quantum criticality; and the interpretation of spectroscopic data

Marsha Rosner
Charles B. Huggins Professor, Ben May Department for Cancer Research; Senior Fellow, Institute for Genomics and Systems Biology

Growth factor or oncogenic stimulation regulated cell growth and differentiation mechanisms and their implications in therapeutic intervention

David Schuster
Assistant Professor, Department of Physics and James Franck Institute

Experimental aspects of quantum information and quantum control; hybrid quantum systems using superconducting circuits to interface with other quantum degrees of freedom

Jonathan Simon
Neubauer Family Assistant Professor, Department of Physics and James Franck Institute

Hybrid quantum systems using superconducting circuits to interface with other quantum degrees of freedom, such as solid-state electron spins, electrons trapped on the surface of liquid helium, and nano mechanical resonators

Seth W. Snyder
Leader, Water-Energy Nexus Initiative, Argonne National Laboratory; Senior Fellow, Energy Policy Institute at Chicago

Technology and engineering in renewable energy, water and energy efficiency

Anne Sperling
Associate Professor, Department of Medicine; Faculty Director, University of Chicago Medicine Comprehensive Cancer Center Flow Cytometry and Antibody Technology (CAT) Facility

Roles of the immune system in both mouse model lung diseases and translational research with immune cells from patients with asthma, idiopathic pulmonary fibrosis, and sarcoidosis

Dmitri Talapin
Professor, Department of Chemistry and James Franck Institute

Inorganic nanomaterials; self-organization phenomena; solution-processed electronic materials

Patrick Wilson
Associate Professor, Department of Medicine, Gwen Knapp Center for Lupus and Immunology Research

B cell immunity and autoimmunity: B cells in health and disease

Integrative Innovation

Forging Ahead

During 2014, multidisciplinary teams of researchers from around the world advanced solutions to ensure access and preservation of clean, fresh drinking water.

Millions of people throughout the world lack safe water, a problem that researchers from the University of Chicago, Israel's Ben-Gurion University of the Negev, and Argonne National Laboratory have been working to address.

Researchers in multi-institutional collaborative teams worked on new materials, processes, and filtration technologies that will help to solve these challenges. Specifically, scientists at IME worked to develop antifouling materials and technologies for water purification, and to create methods for tracing groundwater flow and determining how long the water has been underground.

One team developed new nanoscience-based catalysts for decontaminating water. Another group prepared membranes with controllable nanopores, which could overcome the limitations of current filtration systems. Researchers also worked to develop a tool to diagnose, predict, and give guidance for prevention and control of membrane biofouling. Another team's efforts designed and created a new copolymer that could be applied to water purification and desalination systems.

Finally, a team worked to develop and apply a method of extracting krypton 81 gas from groundwater in Israel, which they tested using a new method to determine how long the groundwater was underground, which allowed them to map the water's flow trajectory.

These research areas address critical issues concerning water sources and use multidisciplinary efforts and teams of researchers to find solutions. Research, testing, and development of these technologies, materials, and processes will continue in 2015.

Typical of conditions in many locations throughout the world, water is rationed and distributed by truck for residents in a village in India.

Powerful Partnership
IME, Argonne collaborate on water initiative

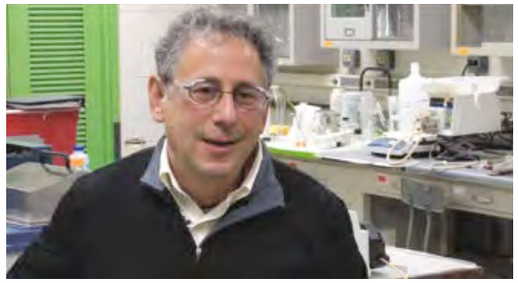
A collaboration between IME and Argonne National Laboratory aims to ensure that future generations have access to clean, safe, fresh water. The water-based partnership will include five projects in its first year, specifically focused on further fundamental understanding of molecular level behavior of water, novel water treatment technology, and new ways to trace the flow of water in the environment.

"We wanted to start a regional water center that focuses on transformational change instead of incremental change. We're interested in creating solutions that transform the way water works at a generational level," said Seth Snyder, Water-Energy Nexus Initiative leader and IME Fellow.

One of their first projects will involve developing technologies for using water more effectively in industry and agriculture. Water is necessary for running power plants and growing crops, but reliable power grids and growing agriculture sectors require a sustainable water supply. IME researchers will work to design better materials and technologies. Argonne researchers will use data, modeling, and analysis from water allocation, treatment, and reuse to better understand the balance between water supply, demand, and quality.

IME will also take the lead on creating novel materials and evaluating their performance. For example, IME and Argonne plan to implement better materials into membranes that are used for water filtration. The state-of-the-art membranes often get clogged due to biofouling. With an innovative functional membrane, not only can the fouling problem be reduced, but particulates gathered from filtration can also be used to collect nutrients for producing energy and fertilizer.

"As IME gains a better understanding of how materials work, they can build better equipment for water conservation," Snyder said. "IME will be a leader in new materials for membranes, sensors, detectors, and catalysis."



> "IME will be a leader in new materials for membranes, sensors, detectors, and catalysis."
> — Seth Snyder

Since reclaiming water represents a core opportunity for water management, Snyder also wants the initiative to focus on using current resources instead of looking for new sources of water.

"We want to make it economically advantageous to treat waste water, which would ultimately improve the environment," Snyder said.

Advancing Understanding
Summer research in Israel helps to further fundamental understanding, technologies

For 10 days in 114-degree weather in the middle of the desert in the Northern Jordan River Valley, a group of students and researchers from the University of Chicago, Argonne National Laboratory (ANL), and Ben-Gurion University of the Negev (BGU) in Israel used a device in the back of a van to extract gas from groundwater samples.

Using a new radioactive dating technique, the team precisely dated the groundwater and mapped its trajectory, information that helps them to better understand its behavior. It will also help them to determine how much water can be extracted from those areas without reaching deeper into layers that have more salinity, which is harmful to agriculture and industry.

Spearheaded by IME, these efforts were part of an expanded cooperation for water initiatives between UChicago, ANL, and BGU.

"The funding from this collaboration allowed us to conduct testing with real samples while we were developing methods," said Reika Yokochi, a researcher at the University of Chicago's Department of the Geophysical Sciences. "It not only allowed us to obtain valuable data about water resources in this area, but also enabled us to test new sensing technologies and methods."

The multidisciplinary group heading the research collaboration includes Yokochi, Zheng-Tian Lu, a senior physicist at ANL, and Professor Eilon Adar, hydrologist and the director of BGU's Zuckerberg Institute for Water Research. Students Ryan Bernier, a UChicago Metcalf Fellow, and Jacob Zappala at ANL took part in the on-site research.

The group used a new portable gas extraction device to obtain gas from groundwater and then shipped cylinders of the gas to Yokochi's laboratory at the University. Yokochi processed the gases and extracted krypton, which is introduced into the water when it is mixed with air on the surface. The krypton was then transferred to Lu's laboratory at ANL, where he used a new method, called radio krypton dating, to calculate the age of the water.

> "This is a gift in research. Normally it takes years to achieve such results, especially when the collaboration is in such great disciplines."
> —Professor Eilon Adar, hydrologist and director of BGU's Zuckerberg Institute for Water Research

Radio krypton dating involves counting the amount of a rare isotope, krypton 81, in the gas extracted from the water to determine how long the water has been underground. Analyzing gases from several locations allows the team to map the flow of water underground.

Members of a research group from Ben-Gurion University of the Negev, the University of Chicago, and Argonne National Laboratory access a high pressurized artesian well to obtain a gas sample.

The fieldwork and the results wouldn't have been possible without the funding from the collaborative effort, which grants money to early stage research.

"This is a gift in research," explained Adar. "Normally it takes years to achieve such results, especially when the collaboration is in such great disciplines."

Novel Design

UChicago co-leads new center of excellence for advanced materials research

Research is currently underway at the Center for Hierarchical Materials Design (CHiMaD), a new effort co-directed by the University of Chicago's Juan de Pablo, Liew Family Professor in Molecular Engineering. The center is dedicated to developing the next generation of computational tools, databases, and experimental techniques to enable design of novel materials, one of the primary goals of the Obama administration's Materials Genome Initiative (MGI).

CHiMaD was developed by a consortium that will receive $25 million over five years from the National Institute of Standards and Technology (NIST). Northwestern University leads the consortium, which includes UChicago, the Northwestern-Argonne Institute of Science and Engineering (a partnership between Northwestern and the Department of Energy's Argonne National Laboratory), and the Computation Institute (a partnership between UChicago and Argonne).

"The consortium serves to emphasize the growing preeminence of the city of Chicago as an epicenter for world-class advanced materials research," de Pablo said. "The concentration of talent and experimental resources provided by Northwestern, the University of Chicago, and Argonne, as well as other premier universities in the city, are, increasingly, a magnet for advanced research initiatives such as the NIST Center of Excellence."

Although the center officially started in January 2014, the President of NIST, University Provost Eric D. Isaacs, and the three center co-directors held a kickoff meeting in May 2014. Activities are well underway and several research groups, including IME faculty at the University of Chicago and 10 University graduate and postdoctoral students, are "already making great discoveries in evolutionary design and the synthesis of novel photovoltaic materials," de Pablo said.

"The center is also starting to generate a lot of interest from industry," de Pablo said. "We have a number of companies approaching us to interact with the center, or with IME through the center."

De Pablo co-directs the center with Gregory Olson, the Walter P. Murphy Professor of Materials Science and Engineering at Northwestern, and Peter W. Voorhees, the Frank C. Engelhart Professor of Materials Science and Engineering in the McCormick School of Engineering and Applied Science.

Co-director and University of Chicago professor Juan de Pablo presents at the inaugural Center for Hierarchical Materials Design (CHiMaD) gathering of scientists at Northwestern University.

"We want to show that in principle this is possible and to build functional devices in just a few years—it's very ambitious."
—David Awschalom

Revolutionizing Communication

IME leading quantum engineering research team

IME will lead a team of researchers from five universities in a five-year, $6.75 million project to create a new class of quantum devices that allow communication among quantum computers.

Quantum-based technologies exploit the physical rules that govern very small particles—such as atoms and electrons—rather than the classical physics evident in everyday life. Compared to binary computing, the use of quantum states of matter to communicate and store information could radically increase computing memory and speed and completely change how society thinks about information. Recent dramatic advances in this field have prompted researchers to begin considering quantum computing as a realistic possibility.

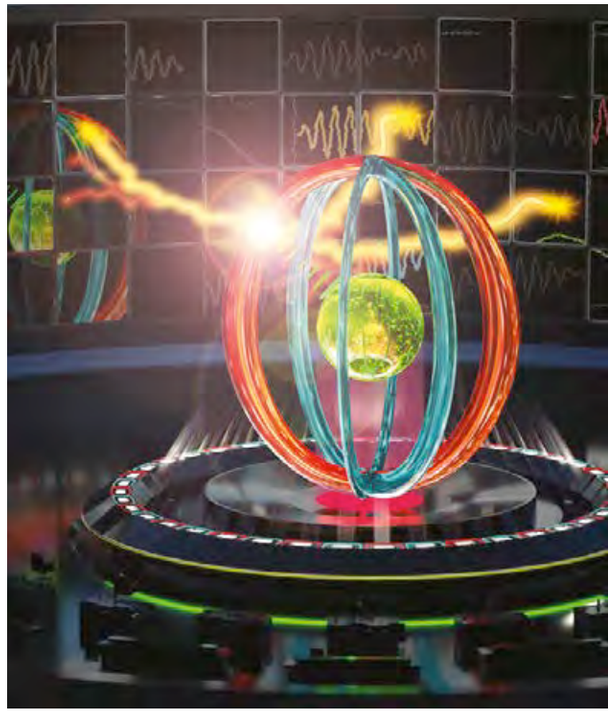
The team of researchers will also synthesize new materials, manipulate quantum states with photonics and electronics, fabricate robust devices at the nanometer scale, and develop communication links between these devices.

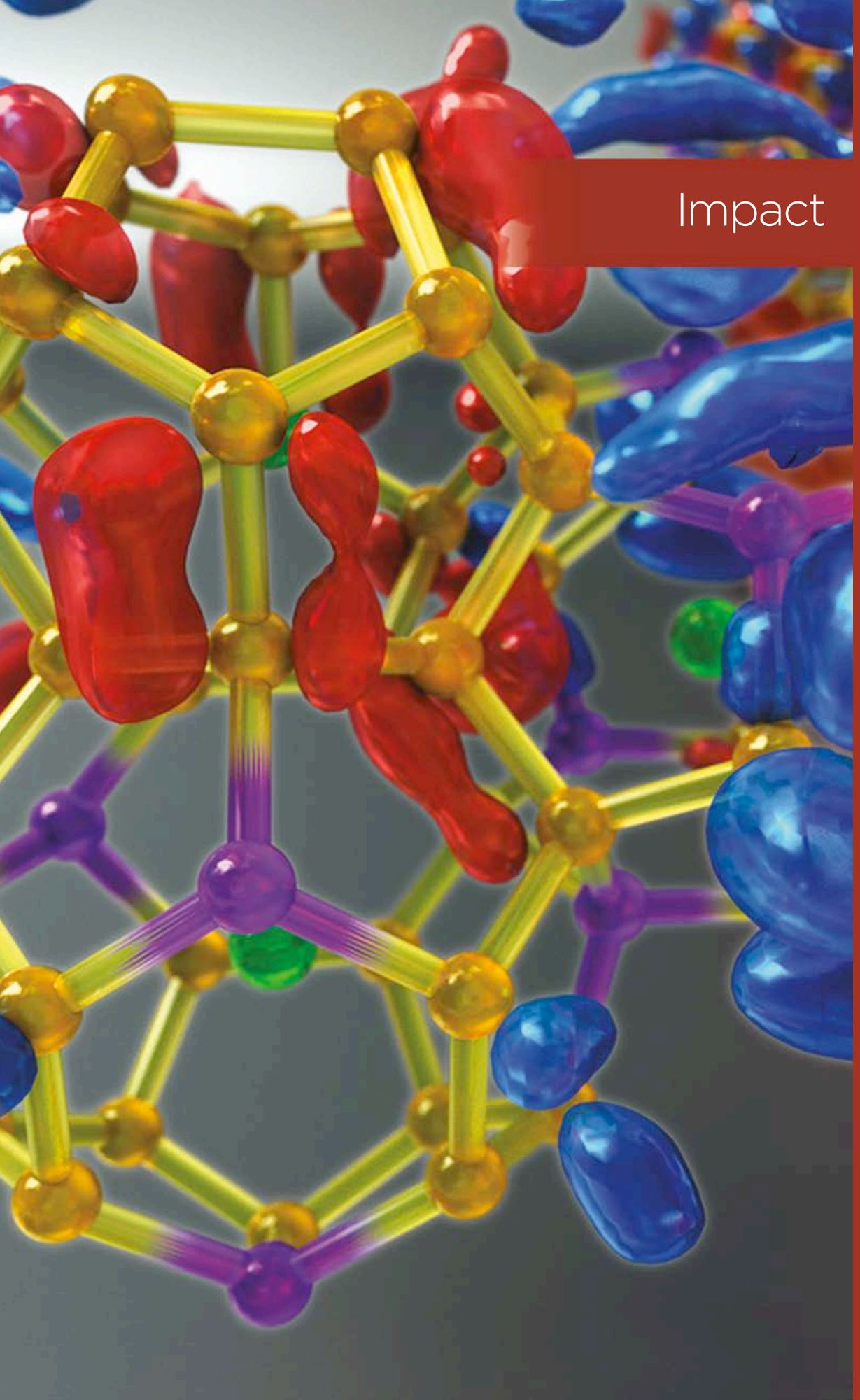
One key technology in development is structures that can transform quantum information from microwave to optical frequencies, thus allowing the near-lossless transmission of information through an optical fiber.

The team of researchers has an ambitious plan to design and fabricate new submicron devices that could form the basis for a quantum network. This involves developing methods to link quantum bits to one another using microwaves, mechanical vibrations, and light.

"We want to show that in principle this is possible and to build functional devices in just a few years—it's very ambitious," said the project's lead scientist David Awschalom, an IME physicist and Liew Family Professor in Spintronics and Quantum Information. "Surprisingly, it's turning out to be less complicated to manipulate quantum states in semiconductors and superconductors than expected."

Working closely with co-leader Andrew Cleland, John A. MacLean Sr. Professor for Molecular Engineering Innovation and Enterprise, the team includes faculty at Cornell, Yale, Caltech, and McGill.





Impact

Innovative Growth

IME searching for researchers to fill record six new faculty positions

Six positions are open at IME for researchers and innovators who bring a unique skill set and expertise to solving problems such as energy storage, energy conservation, and clean water. "It's very rare for an institute of this magnitude to have six open faculty positions at the same time, but IME carefully selects candidates that fit into our rigorous, interdisciplinary program," said IME Executive Director Sharon Feng. "We want to bring in researchers who will make a big impact."

The six positions are the latest in the continued growth of the faculty and staff. IME boasts a core faculty of 10 and continues to expand rapidly, with the goal of having 25 full-time faculty within the next five to eight years. Once filled, the six faculty positions will help IME continue its groundbreaking research through collaboration across an interdisciplinary environment. The positions vary in focus, with each of them supporting a key research area for the institute.

New Faculty Position Highlights

Eugene Bell Professor in Tissue Engineering The professorship will foster scholarship on tissue engineering at the Marine Biological Laboratory (MBL) and IME, where scientists are focused on exploring innovative technology at the molecular scale, with the potential for societal impact in areas including health care, computing, energy, and the environment.

The newly appointed faculty member will work closely with MBL researchers to study regeneration in model organisms such as amphibians with the hopes of ultimately being able to mimic those capabilities in mammals and, eventually, produce breakthroughs in healing damaged human tissues and organs. The position is funded by a $3.5 million donation from the Millicent and Eugene Bell Foundation.

Crown Family Professor of Molecular Engineering and Director of the Water Initiative The professorship in molecular engineering will be dedicated to the development of technological solutions to the world's water crisis. This scholar will lead IME's water utilization investigations, which include purification via membranes, biotechnology and catalysis, and efficient use of water in agriculture.

The position is funded by a $3.5 million donation from Chicago philanthropists James and Paula Crown.

IME also has open positions for professorships in Synthesis of Soft Materials, Quantum Information Engineering, Immuno-engineering, and Genomics and Systems Biology.

"IME has an exciting growth trajectory as a world leader in innovative solutions to some of society's biggest problems. We are excited about the talent that these searches will bring to IME at the University."
—Jeffrey Hubbell, Barry L. MacLean Professor for Molecular Engineering Innovation and Enterprise and head of three faculty search committees

Increasing Capacity
Pritzker Nanofabrication Facility to support IME projects

A new, 10,000-square-foot nanofabrication facility within the William Eckhardt Research Center on the University of Chicago campus will support work on new applications in computing, health care, communications, smart materials, and more. In recognition of the $15 million gift from the Pritzker Foundation, the facility, along with its additional support space, has been named the Pritzker Nanofabrication Facility.

Photo of the William Eckhardt Research Center progressing toward completion

The William Eckhardt Research Center, a major new home for the physical sciences and molecular engineering located on Ellis Avenue, is scheduled to open in late August 2015. The Pritzker Nanofabrication Facility will house a suite of tools that can fabricate complex, integrated electronic, mechanical, and fluidic structures. This facility is expected to bridge the gap between academia and industry, leading to the creation of new nanotechnology applications. The scale of these applications can be as small as a few atoms. One example of such an application might be a tiny, ultra-low-power device that combines computation, communication, and storage capabilities.

Andrew Cleland

The Institute for Molecular Engineering will manage the facility, which will be available to researchers across the University and to external users, including other institutions and industry. The building is specially engineered to accommodate the particular needs of this large facility. The creation of the Pritzker Nanofabrication Facility will fulfill the vision for a multidisciplinary, state-of-the-art facility that will provide distinct advantages. Andrew Cleland, John A. MacLean Sr. Professor for Molecular Engineering Innovation and Enterprise, was named the facility's first director.

"The generous gifts from the Pritzker Foundation will make this facility one of the go-to locations for nano and microscale research and development in the US—it will provide fantastic opportunities for students, researchers, and industry," Cleland said.

> "The generous gifts from the Pritzker Foundation will make this facility one of the go-to locations for nano and microscale research and development in the US—it will provide fantastic opportunities for students, researchers, and industry."
> —Andrew Cleland

The Chicago Innovation Exchange opened at the University of Chicago in October 2014.

Enabling Opportunity
IME is part of new 'Innovation Campus'

Matt Tirrell, Pritzker Director and Dean of IME, joined University of Chicago President Robert J. Zimmer, Illinois Governor Pat Quinn, Illinois Senator Mark Kirk, Chicago Mayor Rahm Emanuel, and University administrators for a ribbon-cutting ceremony on October 16 to celebrate the opening of the Chicago Innovation Exchange (CIE) on 53rd Street and Harper Avenue.

CIE is dedicated to nurturing new businesses and product development, such as those coming out of the UChicago-managed national laboratories, Argonne and Fermilab, and the IME.

The CIE is slated to open an additional 7,000-square-foot space in 2015, which will house dedicated office space for IME, as well as a "fab lab" (fabrication laboratory), with 3-D printers, mills, and other equipment. This new fab lab will be shared by researchers modeling new inventions both within IME and beyond.

"The IME office at the CIE will give faculty and staff connections to collaborators, mentors, and the broader innovation and entrepreneurial ecosystem here in Chicago," said John Flavin, Executive Director of the Chicago Innovation Exchange. "The CIE will serve as a gateway and support a fully integrated collaborative innovation and entrepreneurship initiative."

CIE's diverse partners, which also include the Computation Institute, Chicago Booth, the Institute of Politics, the Marine Biological Laboratory, the Michael P. Polsky Center for Entrepreneurship and Innovation, UChicagoTech, the University's Center for Technology Development and Ventures, and the Urban Education Institute, come together to develop solutions to a variety of societal challenges, including improvements in the generation and storage of energy, conservation and treatment of water, computation and analysis of data, provision of health care, education, and growth of the economy.

> "The IME office at the CIE will give faculty and staff connections to collaborators, mentors, and the broader innovation and entrepreneurial ecosystem here in Chicago."
> —John Flavin

Postdoctoral researcher Eunji Chung and alumna Sarah Perry work in the Tirrell Lab.

Fellowship for Women

Rosenbaum-Faber gift supports women in STEM fields through the Institute for Molecular Engineering

In 2011, STEM (science, technology, engineering, and mathematics) workers accounted for 7.2 million jobs, according to the U.S. Census Bureau. Women held 26 percent of those jobs, even though they composed nearly half the workforce.

Former Provost Thomas F. Rosenbaum and Katherine T. Faber have established a $100,000 graduate research fellowship at the University of Chicago's Institute for Molecular Engineering to advance the interests and representation of women in STEM fields.

"Kathy and I hope that this fellowship will help make the IME and the University of Chicago the destination for the most talented and diverse young scientists and engineers," Rosenbaum said.

Rosenbaum, previously the John T. Wilson Distinguished Service Professor in Physics at the University of Chicago, served as the University's Provost in a seven-year term that ended in 2014. He became President of the California Institute of Technology in July 2014.

Faber, previously the Walter P. Murphy Professor of Materials Science and Engineering at Northwestern University and co-founder and co-director of the Northwestern University/Art Institute of Chicago Center for Scientific Studies in the Arts, is now the Simon Ramo Professor of Materials Science in Caltech's engineering and applied sciences division.

Rosenbaum and Faber have both worked actively to support women in STEM careers, playing critical roles in organizing the Chicago Collaboration for Women in STEM, a collaboration between UChicago and Northwestern to enhance the recruitment and advancement of women faculty members in those fields.

Shaping the Future

Popoff brings University experience, perspective to IME initiatives

When asked to help shape the future of the Institute for Molecular Engineering, Rovana Popoff, the newly appointed Associate Executive Director, readily agreed. She was excited about the opportunity to work with a growing organization that brings together people across disciplines.

"I've been at the University for 20 years. I've been here as a student, a lecturer, and a staff member working in administration, and I am bringing all of that perspective to IME, an organization now building partnerships within the University and setting new standards," Popoff said.

Popoff began her career in higher education management as an academic advisor in the College at the University of Chicago in 2004. She then served as both the Director of the Chicago Academic Achievement Program and the Director of Scholarship Advising before she was recruited to Dartmouth College, where she served as the Associate Dean of the College. In 2009, Popoff returned to the University of Chicago and worked as the Deputy Dean of Students in the Office of the Dean of Students in the College.

Since she began her new role at IME in October 2014, Popoff has been working with IME's senior leadership team to create and implement strategic initiatives, including establishing a governance structure for the organization and developing partnerships to create various academic programs, particularly for undergraduates.

"We are focusing on student affairs," Popoff said. "As the organization grows, we need systems and structures in place. We have more undergraduates interested than anyone anticipated, and we are expanding the graduate program."

> "We are focusing on student affairs. As the organization grows, we need systems and structures in place."
> —Rovana Popoff

Rovana Popoff

Popoff has been working with professors Paul Nealey, Melody Swartz, and David Awschalom in developing IME's curriculum and creating an undergraduate major, which they hope to have in place in 2015.

"The faculty teach the students how to take the knowledge that they're gaining in science and make it relevant in the real world," she said.

By the end of spring 2016, Popoff expects that IME will have at least 120 students working toward a minor and about 60 students working toward the major.

Inspiring Scientific Interest

The *STAGE* Lab is a place for *S*cientists, *T*echnologists and *A*rtists *G*enerating *E*xploration

The challenge to turn a more than 100-year-old theatre into a contemporary, multifunctional performance space was met upon the completion of the *STAGE* Lab in October 2014. The newly renovated theatre space is a laboratory for creating and developing multimedia theatre pieces inspired by science and technology.

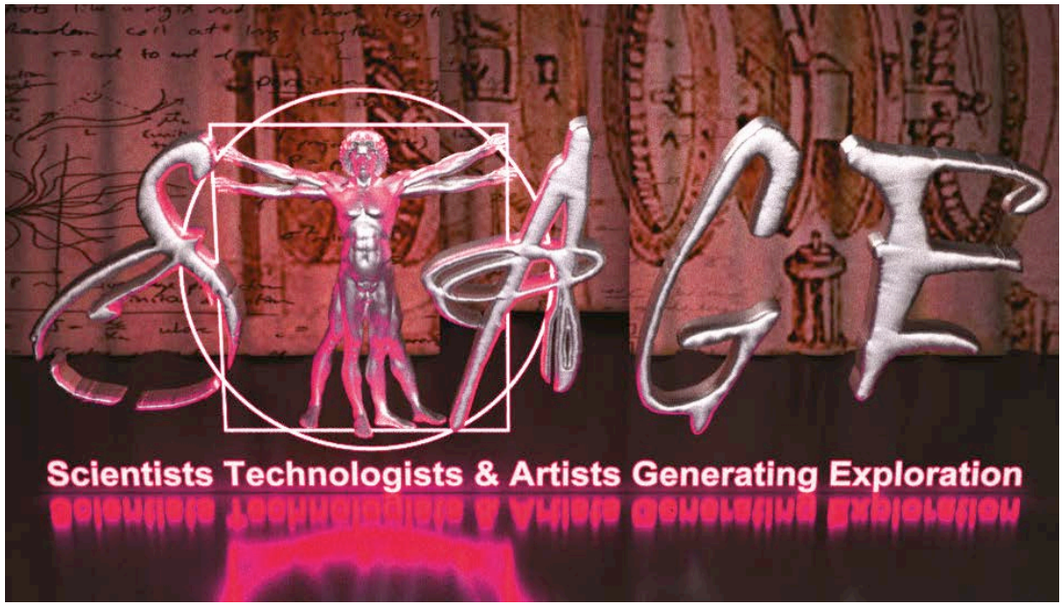
"In the *STAGE* Lab, we create emotionally engaging stories that have a great deal to do with science and technology. We believe that's the most powerful way to arouse curiosity and excitement about science in the public arena," says Nancy Kawalek, IME Professor and Distinguished Fellow in the Arts, Science, and Technology, and the founder and director of *STAGE*.

In the first half of 2015, Kawalek will direct one such story, a workshop production of *The Art of Questionable Provenance*, which marks the official opening of the new *STAGE* Lab space. Kawalek collaborated on this new theatre piece with physicist Geoffrey Grinstein of the IBM Thomas J. Watson Research Center in New York, along with a group of neuroscientists and professional actors.

Melina Blees recently joined the *STAGE* Lab after receiving her PhD in physics from Cornell. Her graduate work focused on applying techniques from the paper arts to nanoscience. Blees, who is a practicing artist as well as a scientist, is collaborating on *The Art of Questionable Provenance* and the next *STAGE* theatre piece, *Symmetry*.

In 2014, Kawalek was appointed a member of the Museum of Science and Industry's Exhibits Advisory Committee. She and UChicago professors Robert Chaskin, Terry Nichols Clark, and Senior Lecturer Betty Farrell received a grant from the University's Center in Paris to hold a workshop there in May 2015 on "Arts & Culture in Urban Communities."

Nancy Kawalek



Charting New Courses

Molecular engineering faculty teach first University of Chicago courses

A group of IME faculty members is working to provide students with the knowledge and tools they need to develop solutions to society's most technical challenges.

> "You can see already that students are happy to be here. They have formed a vibrant and cohesive group."
> —Juan de Pablo

Matt Tirrell, IME Pritzker Director and Dean, Juan de Pablo, Liew Family Professor in Molecular Engineering, and Paul Nealey, Brady W. Dougan Professor in Molecular Engineering, began teaching students in autum quarter 2014, the official start of both the molecular engineering PhD program and the undergraduate minor. More than 90 graduate and undergraduate students enrolled in available courses.

"We are preparing UChicago students for careers they may not have otherwise considered," Tirrell said.

Emre Sevgen, a first-year graduate student in molecular engineering, took de Pablo's statistical mechanics course to learn a new way of thinking and enhance his problem solving skills. "I'm a problem solving person, and I want to be solving interesting problems for the rest of my life," Sevgen said. "This class provided me many tools to do that."

The molecular engineering curriculum is designed to help students change their perspectives, explained Tirrell. Instead of teaching students a traditional tool set, which is what happens at most engineering schools, the curriculum teaches students to solve problems and combine skill sets across disciplines.

"The point in creating the curriculum is not to add more science, but to add something in addition to science," Tirrell said. "This is part of a direction led by President Zimmer during the last few years to connect the campus to the world around us."

That is an opportunity that both undergraduate students in the College and graduate students find valuable and one of the qualities that is attracting PhD students from around the world to the IME. "Many students we were competing to recruit chose the IME over other top-ranked schools," de Pablo said. "There is a sense of excitement and opportunity here: We are offering something new and they're interested in getting in at the bottom."

"We were all drawn here for different reasons," Sevgen said. "When we have a problem outside of our area of expertise, we have a classmate who has those skills and that experience."

Many of the undergraduate students taking the courses plan to continue with the curriculum and obtain the minor. Others are taking select courses to obtain what they feel is valuable experience.

Matt Tirrell lectures during an IME course.

2014 Highlights

Expert Exposure

World-renowned scientists lecture at new monthly series

Since its October 2014 inaugural colloquium by Nobel Laureate David Wineland, prominent thought leaders have engaged the IME and campus community in stimulating discussions through the First Thursday Distinguished Colloquium Series. This new speaker series fosters interdisciplinary scientific collaborations across campus and beyond.

First Thursday Distinguished Colloquium Series speaker Ashutosh Chilkoti, a professor with Duke University's Department of Biomedical Engineering

Scientific Socializing

Students, faculty, and staff gathered for the first IME Molecular Mixer in November 2014. The "Science in the Spotlight" themed social event included red carpet photos, wine, food, and music. Attendees were encouraged to wear their lab coats or formal attire.

Other social events throughout the year also promote camaraderie among students, faculty, and staff.

Building Pipelines for Diverse Talent

In 2014, IME broadened its efforts to ensure a continuing flow of diverse candidates for its graduate program.

As a part of the Leadership Alliance, a national consortium of research and teaching colleges, universities, and private industry, IME committed to hosting up to three undergraduate summer interns per year. IME hosted its first Leadership Alliance summer intern from the University of Puerto Rico.

Through an effort sparked by the formation of IME, the University of Chicago also became an institution member of the National GEM Consortium, an organization dedicated to helping underrepresented minority students succeed in graduate education in applied science and engineering. The consortium offers tools that help expose excellent students to university programs and aid in recruitment of diverse students.

As a member of the GEM Consortium, IME and other science-based divisions and organizations at the University have the opportunity to host GEM Fellows, graduate students at the institution supported by funds from the consortium for up to five years.

"With IME in its infancy, it was a great time to establish these relationships and begin to make connections," said Chinonye Nnakwe, Director of Graduate Diversity Initiatives at the University and the UChicago representative for the GEM Consortium.

Chinonye Nnakwe

Nnakwe applied to the GEM Consortium on behalf of the IME and several other science-based divisions at the University, including the Biological Sciences and Physical Sciences Divisions, and the College. The application was approved unanimously by the GEM board of directors at its 2014 annual meeting.

2013–14 Noteworthy Events IME PARTICIPATION

NOVEMBER 4, 2013
Lecture *Keynote lecture in Chemical Engineering Fundamentals–Area 1*, American Institute of Chemical Engineers Annual Meeting, San Francisco, Juan de Pablo

DECEMBER 4
Lecture *Britton Chance Distinguished Lecture*, University of Pennsylvania, Melody Swartz

MARCH 4, 2014
Chicago Dialogue—Precursor to World Urban Forum 7
The Informed City: Sustainable Water in the 21st Century City, University of Chicago, Sharon Feng

MARCH 7
Object-based, art-science workshop *Classical, Modern, and Postmodern across the Disciplines*, Smart Museum of Art, University of Chicago, Nancy Kawalek

MARCH 13
Lecture *Eastman Lecture in Polymer Science and Engineering*, University of Akron, Matt Tirrell

MARCH 26
Lectures *Russell Marker Lectures*, Cornell University, David Awschalom

APRIL 7
Lecture *Hans Bethe Lecture*, Cornell University, David Awschalom

MAY 26
Lecture *Nanoparticles that Target Diseases Without Symptoms: A Tool for P4 Medicine*, University of Chicago Center in Beijing, Matt Tirrell

MAY 29–30
Workshop *IME–Argonne–National University of Taiwan Workshop on Molecular Imaging*, Taiwan, IME faculty and fellows

JUNE 5
Lecture *Uncommon Core Lecture: Water, Water, Everywhere, nor Any Drop to Drink*, University of Chicago, Steve Sibener

JULY 7
Lecture *Plenary Lecture, World Congress of Biomechanics*, Boston, Melody Swartz

SEPTEMBER 18–19
Workshop *AIMR First Joint Research Center Workshop*, Tohoku University Advanced Institute for Materials Research (AIMR), Sendai, Japan, IME faculty and fellows

SEPTEMBER 22–23
Student presentations event *NMS Patterning Review*, University of Chicago, Juan de Pablo and Paul Nealey

OCTOBER 27–28
Workshop *IME–Argonne–MBL–National University of Taiwan Workshop on Molecular Imaging*, Argonne National Laboratory, IME faculty and fellows

David Awschalom to receive 2015 Lilienfeld Prize

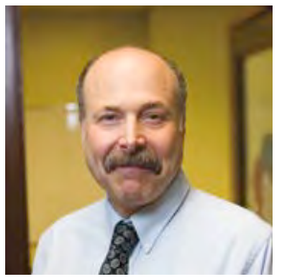
The American Physical Society has announced that it will present its 2015 Julius Edgar Lilienfeld Prize to David Awschalom. The award goes to a single individual for outstanding contributions to physics who also has exceptional skills in lecturing to diverse audiences.

"I'm taken by surprise and deeply honored to receive this award from the scientific community," said Awschalom, Liew Family Professor in Molecular Engineering. "This recognition is a reflection of my remarkable students and collaborators, whose excellence and dedication drive our laboratory research."

The Lilienfeld Prize consists of $10,000, a certificate citing the researcher's contributions, and expenses for three lectures given at an APS meeting, research university, and predominantly undergraduate institution.

Awschalom became a founding member of IME last year. He is a pioneer in semiconductor spintronics and quantum information engineering, performing experiments that explore photonics, electronics, and semiconductor-based quantum information processing at the nanometer scale.

The APS cited Awschalom "for sustained contributions to the physics of spin-coherent materials and systems, including the optical discovery of the spin Hall effect and spin control in quantum nanostructures and non-magnetic semiconductors, as well as his superb lecturing on these topics to diverse audiences."



David Awschalom

Additional Recognition

Juan de Pablo
- 2013 Staudinger-Durrer Medal, ETH, Switzerland
- 2013 Elected Foreign Fellow, Mexican Academy of Sciences

Sharon Feng
- March 2014 Scientist of the Month, Association for Women in Science, Chicago

Giulia Galli
- Senior Fellow of the Computation Institute, University of Chicago

Undergraduates at IME

Cosmic Testing
Polymer from IME sent to International Space Station

In January 2015, the Dragon Capsule on the SpaceX Falcon 9 rocket carried a polymer synthesized in IME's Tirrell Lab to the International Space Station (ISS). The polymer, a large molecule composed of small, repeating units joined together, can suppress bacterial virulence—or the effort by bacteria to infect a host. It is part of the Pathogen HOst ENteric Interactions eXperiment (Phoenix) and was developed in collaboration with a group at the Arizona State University Biodesign Institute.

Working together, researchers in IME's Tirrell Lab and the lab of John Alverdy, MD, in the Department of Surgery, designed the polymer, which suppresses virulence without killing the "good" bacteria. In preliminary trials, 80 percent of mice with an antibiotic resistant infection but no treatment died within three days, while every mouse treated with the polymer survived the infection.

Once the Dragon Capsule arrived on the ISS, Italian astronaut Samantha Christoforetti carefully added

On January 10, a SpaceX Dragon Lab capsule carried IME's polymer on a resupply mission to the International Space Station.

infectious bacteria and the polymer to worm cultures. Video monitoring recorded the lifespan of the worms for 14 days, and the capsule returned to earth for extensive analysis of gene expression. David Goldfeld, an undergraduate research assistant who worked on this polymeric material in the Tirrell Lab, and social media outreach coordinator for IME, live-tweeted about the experiment.

"If we can understand how the polymer behaves in microgravity in space, we can get a view of how virulence works in bacteria and responds to gene changes," Goldfeld said. "Then we can better understand how to control virulence to prevent and fight infection both on earth and in space."

Innovating Education
IME establishes minor

More than 70 students took the first undergraduate courses offered this year as part of the Institute for Molecular Engineering's new undergraduate minor program. The institute offered seven courses to undergraduates and is working to develop more for the upcoming academic year. These courses will serve both the minor and the major program that will be announced in the fall of 2015.

The Institute for Molecular Engineering brings together students from different backgrounds and interests to develop a foundational understanding of disciplinary integration and scientific problem solving. Each course focuses on the approaches that molecular engineers use to develop advanced

Paul Nealey

technologies for solving society's most challenging problems in areas such as cancer bioengineering, water resources, quantum materials, and regenerative medicine.

"We are teaching students to assess problems from multiple perspectives, to be able to define and articulate the nature of a problem, and finally to work toward a solution," explained Paul Nealey, IME Director of Undergraduate Studies.

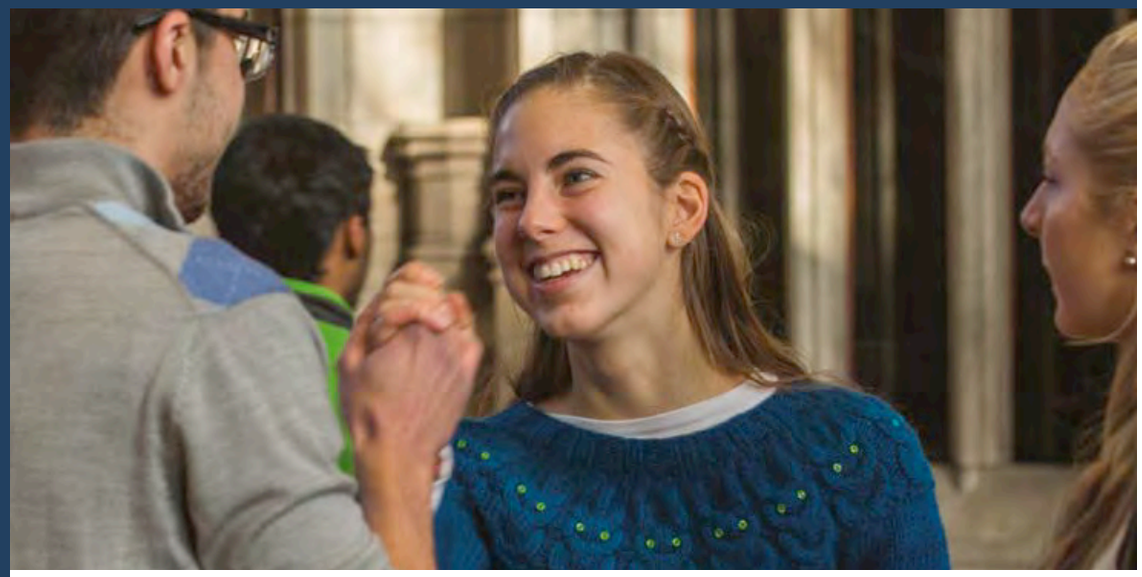
"The new undergraduate course offerings in molecular engineering mark a pivotal moment in the University's undergraduate curriculum," said John W. Boyer, Dean of the College.

Prestigious Honor
IME student from the Awschalom Group receives Marshall Scholarship

Hope Bretscher, a fourth-year physics major at UChicago, was recently awarded a Marshall Scholarship, a prestigious award that will finance her graduate studies in science and human rights in the United Kingdom next year.

Bretscher is interested in ways to produce sustainable and renewable energy in the developing world. "I think access to a basic minimum of energy can be viewed as a human right," she said. "Energy is necessary for people to obtain other human rights, like health care and education."

"Hope is an extraordinary student who is deeply curious about a broad range of physics."
—David Awschalom



Next year, Bretscher will head to Scotland to pursue a master's degree in science and technology in society at the University of Edinburgh. The program will help her investigate the connection between science and human rights, with an emphasis on cultural contexts.

The following year, Bretscher will move to England to earn a second master's degree at the University of Cambridge. While there, she will work in an optics lab with a professor whose research includes enhancing the power of solar cells. Bretscher said solar cell technology interests her because it generates electricity from sunlight—reducing dependence on power grids and pollution.

David Awschalom, Liew Family Professor in Molecular Engineering, has mentored Bretscher in his research group since her junior year. "She is a dedicated and thoughtful researcher with high standards, whose scientific and personal qualities make her truly deserving of this honor," said Awschalom.

Positioning Students for Success

First PhD in Molecular Engineering Awarded to Paulina Rincon-Delgadillo

Paulina Rincon-Delgadillo graduated June 14 with the first doctoral degree in molecular engineering from the University of Chicago. A dual-degree student, Rincon-Delgadillo is receiving a second doctorate, in electrical engineering, from Belgium's Catholic University of Leuven.

Rincon-Delgadillo received her bachelor's degree in chemical engineering from the Western Institute of Technology and Higher Education in Guadalajara, Mexico. She worked in the private sector for five years before moving to the United States for graduate study. Rincon-Delgadillo joined the group of Paul Nealey, Brady W. Dougan Professor in Molecular Engineering, who was at the University of Wisconsin–Madison, in 2009. She moved with Nealey, her advisor, to UChicago after he became a founding member of the Institute for Molecular Engineering in 2012.

"One of the most amazing things about Paulina is her adventurous spirit," said Nealey. "It's entirely appropriate that she's the first graduate of the Institute for Molecular Engineering. That's totally in line with the way that her PhD has progressed in general."

Rincon-Delgadillo is returning to Belgium, where she has been hired as a researcher at imec, a global consortium of semiconductor companies.

Paulina Rincon-Delgadillo

IME's inaugural class of PhD students

First PhD Class

On Monday, September 29, 2014, a select group of 20 women and men made history: They represented the inaugural class of PhD students entering the Institute for Molecular Engineering, the first engineering program ever established at the University of Chicago.

The students, who come from a broad range of academic backgrounds, share a desire to define new territory, both as students in a revolutionary program and as scientists in a new age of engineering.

Juan de Pablo, Liew Family Professor in Molecular Engineering and Director of Graduate Studies, said the goal of the degree's designers was to develop a flexible program while providing pedagogical structure.

Juan de Pablo

"Our students have such diverse backgrounds," de Pablo said. "We have to establish a core knowledge and courses that provide unifying principles, such as statistical mechanics, materials science. When these students finish, they will be well equipped with not only scientific knowledge but also leadership skills."

UChicago was an easy option for Elyse Watkins, a 22-year-old 2014 graduate of Georgia Tech and an NSF Graduate Fellow. She is one of the few biomedical engineers in the PhD class. "IME is unique. It feels like a start-up," she said.

> "The boundaries aren't set. We'll mold the program into what it's going to be in 20 years."
> —Elyse Watkins, IME PhD student

A PhD program has been integral to the structure of IME since it was founded in 2011, and some graduate students accompanied the Institute's founding faculty. But it took time to develop a program that reflects the current landscape of technology innovation, incorporates broad-based collaboration across disciplines, integrates opportunities in industries, and unifies a diverse, independent population. The Council of the University Senate approved a proposal for a PhD degree to be granted by the Institute for Molecular Engineering in May 2013; the first students were admitted last winter.

Yu Kambe, 24, has a BS in materials science and engineering from Cornell University and worked at C3 Nano Inc., a start-up developing the next generation of touch screen materials. "I love that IME is cultivating a collaborative environment—that's pretty unprecedented," Kambe said. "We're here to prove a discipline. I'm getting the same shivers of excitement from this that I got from my job at a start-up. We're going to see where this discipline will take us."

IME Alumni Profiles

Sarah Perry

PhD from University of Illinois at Urbana-Champaign, 2010

Postdoctoral appointment at IME ended in 2014

Current position: Assistant Professor in Chemical Engineering, University of Massachusetts Amherst

Sarah Perry was part of the initial core group that moved with IME Pritzker Director and Dean Matt Tirrell to the University of Chicago, helped to establish IME's safety program as the first chair of the IME safety committee, and participated in the growth and development of IME.

In the Tirrell Lab, Perry's fundamental research in biomimetic materials and polymer self-assembly could ultimately lead to the formulation of vaccines that can withstand high temperatures. This advancement would dramatically decrease the cost of vaccines by eliminating the need for refrigeration, improve the accessibility of vaccines in developing countries, both in terms of lower costs and in terms of transportability, and thus directly improve human health on a potentially global scale.

"Collaborations with other research groups really helped to strengthen my scientific understanding of a particular topic, but also to broaden my perspective. Combined, the different viewpoints really help to inform the science and identify important questions to pursue," Perry said.

Matt Kade

PhD from University of California, Santa Barbara, 2010

Postdoctoral appointment at IME ended in 2014

Current position: Polymer chemist, Tricida, a biotechnology start-up

Matt Kade was part of the first small group of postdoctoral researchers that came with Pritzker Director and Dean Matt Tirrell to IME. During his time at IME, Kade helped with laboratory planning at UChicago and Argonne, collaborated with researchers and UChicago Medicine, and worked with undergraduate students on research projects.

"I learned how to communicate my research and tailor my presentations to scientists from a variety of fields," Kade said. "I also had the opportunity to mentor younger scientists, which was mutually beneficial."

While at IME, Kade worked on alternatives for antibiotics with John Alverdy, MD, head of minimally invasive surgery at UChicago Medicine.

"By working at IME, we had collaborators at UChicago Medicine, which helped take our research a step further," Kade said. "We were able to conduct tests on pathogen strands from across the street."

Now, Kade works at Tricida, a biotechnology start-up company in San Francisco, where he and a team of chemists developed a non-absorbed polymer drug for patients with chronic kidney disease.

Abram Falk

PhD from Harvard, 2010

Postdoctoral appointment at IME ended in 2014

Current position: Research staff member, IBM Research, nanodevices group

One of Abram Falk's most exciting research results at IME showed that scientists could manipulate quantum states in silicon carbide, one of the main materials driving modern power electronics and LEDs.

"A main focus of ours has been to use materials that are compatible with industrial processes," Falk said. "Hopefully our results will be driving industry."

While at IME, Falk also collaborated with researchers to explore physical concepts like quantum entanglement at room temperature, something that normally requires extreme conditions. This research lays a foundation for applications like unhackable data transmission and magnetic resonance imaging of individual molecules.

"My new job will require a background in not only physics, which my PhD is in, but also chemistry and materials science," Falk said.

At IBM, Falk will conduct research on carbon electronics.

> "IME is set up to be inherently interdisciplinary, and I think that experience really paid off for me."
> —Abram Falk

Bret Ulery

PhD from Iowa State, 2010

Postdoctoral appointment at IME ended in 2014

Current position: Assistant Professor, University of Missouri

After two years researching bone tissue engineering, Bret Ulery was looking for an opportunity to get back into materials immunology. After talking to IME Pritzker Director Matt Tirrell at the annual American Institute of Chemical Engineers meeting, Ulery was sure that IME was the best place for him.

"Matt's research and mentorship combined with the opportunity to join the new and exciting venture at IME made the choice easy for me," Ulery said.

Having completed a postdoctoral appointment, Ulery came to IME with a true sense of what he wanted to accomplish. At IME, he focused on using biomolecular materials to induce desirable immune responses, specifically designing nanoparticles capable of functioning as vaccine delivery systems or cancer therapies.

"Matt Tirrell and IME gave me the freedom to gain new research and laboratory management skills while simultaneously allowing me to explore independent ideas," Ulery said. "I have the potential to be so much more successful in my career due to the time I spent at IME."

Global Network

Pushing the Frontiers
Expanded collaboration tackles imaging on the molecular level

A new collaborative effort between researchers at IME, affiliated laboratories, and National Taiwan University could yield advances that may revolutionize medicine.

An expansion of the partnership that already existed between the Molecular Imaging Center at National Taiwan University and Argonne National Laboratory allowed for the inclusion of IME and the Marine Biological Laboratory (MBL).

"While the University of Chicago is renowned for strong medical imaging skills," said IME Executive Director Sharon Feng, "studying interactions on a cellular and molecular level is different."

"The smaller things are in size, the harder they are to characterize and work on," Feng said. "This collaborative effort will allow researchers to push the frontiers of understanding to a molecular level."

Professor Isaac Tseng (left), Director, Molecular Imaging Center, National Taiwan University, and Matt Tirrell, Pritzker Director and Dean, IME, sign the agreement documents.

A group of scientists, including six from National Taiwan University, four National Taiwan University postdocs who are working at Chicago-area institutions (the University of Illinois at Chicago, the Illinois Institute of Technology, Northwestern University, and Argonne National Laboratory), six researchers from Argonne, and one researcher from MBL came to Chicago in October to work on ideas for collaboration. During the course of the two-day workshop, the researchers identified nine projects that they plan to work on together.

The collaboration will also help researchers to share the cost for high-resolution imaging equipment, which increases in cost inversely to the size of items studied.

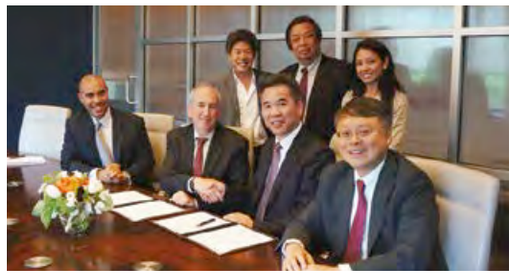
Students from China's Shanghai Tech to Study at IME

A partnership between IME and Shanghai Tech, a new interdisciplinary university in China, will enable several of that university's undergraduate students to spend their senior year at IME.

"Shanghai Tech has a very similar concept to IME: They are cross disciplinary and aspire to solve the world's big problems," said Sharon Feng, Executive Director of IME. "They feel inspired by us and contacted us to see if we can work together."

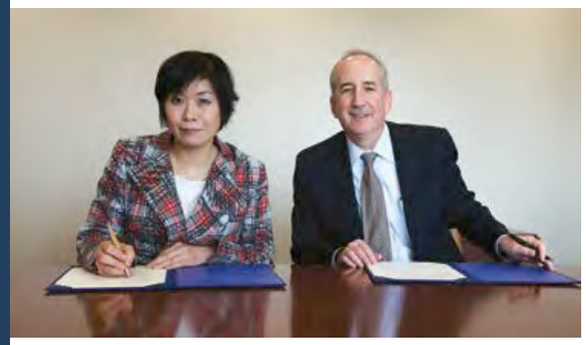
IME Pritzker Director and Dean Matt Tirrell and Feng traveled to Shanghai in May to tour the campus and discuss the program. Representatives from IME and Shanghai Tech signed a memorandum of understanding during the visit. Subsequent discussions and the visit of President Mianhen Jiang of Shanghai Tech to UChicago resulted in the establishment of a new program between the two universities. Nicknamed 3+1+N, this program will allow several selected undergraduates to spend three years studying at Shanghai Tech before studying with IME at UChicago, and if they do well, students could attend graduate school at UChicago.

University of Chicago Provost Eric D. Isaacs and Shanghai Tech officials sign the partnership agreement.



IME, Japan's Advanced Institute for Materials Research Establish Joint Research Center

Japan's Advanced Institute for Materials Research (AIMR) and IME established a joint research center to collaborate on projects that could lead to a new generation of information processing technologies; inexpensive and efficient solar cells; low-power electronics that reduce the impact on the environment; and stronger, lighter alloys for the transportation industry.



Motoko Kotani, AIMR Director, and Eric D. Isaacs, University of Chicago Provost, sign an agreement.

"AIMR is one of the leading materials research institutes in the world, and their research efforts overlap with ours, from energy to computing to mathematics," said David Awschalom, Liew Family Professor in Molecular Engineering and head of the UChicago-AIMR Joint Research Center. "The joint institute will also give students the opportunity to have a cultural experience and work with researchers outside of their countries."

Through collaborative projects, scientific workshops, and student and faculty exchanges, the joint center will catalyze new research efforts between the two institutes. Specific research projects led by pairs of faculty from both institutions are under development, and IME graduate students and postdoctoral scholars will have an opportunity to perform research at AIMR in Japan. IME faculty will also engage in yearly scientific workshops in alternating locations.

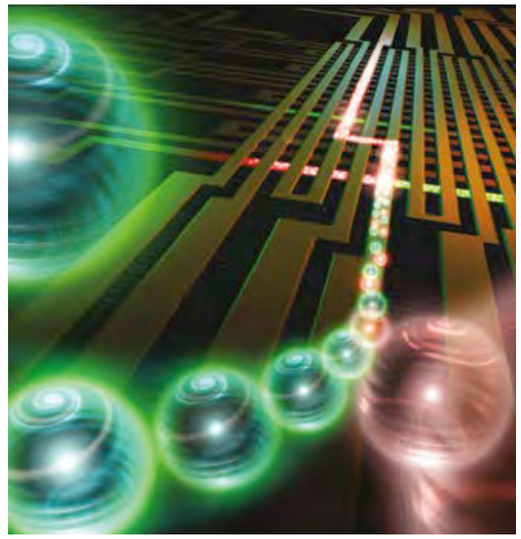
The Inaugural IME-AIMR Joint Research Center workshop took place in September at Tohoku University in Japan.

"The AIMR is thrilled to enter into its first international partnership with the University of Chicago and to strengthen its relationships through the workshop," said Motoko Kotani, AIMR Director.

Throughout the two-day event, chemists, physicists, mathematicians, and materials scientists met to present cutting-edge research and explore themes for collaboration, such as the quantum manipulation of matter and energy harvesting and storage.

"The visit highlighted a variety of emerging research opportunities where we hope to develop productive collaborations with our colleagues in Sendai, driven by young researchers from both institutes," Awschalom said.

A search is currently underway for postdoctoral researchers to help launch collaborations in Japan and at IME. AIMR has generously agreed to fund the first postdoctoral scientists and engineers who will perform their research at IME and spend a few weeks each year with colleagues in Tohoku. The next technical workshop for faculty and students will take place this fall on the University of Chicago campus at the new William Eckhardt Research Center.



Support the Institute for Molecular Engineering

Acknowledgements

We are very grateful to our donors, whose generosity supports and expands the vision of the Institute for Molecular Engineering. With your help, in the past four years the IME has grown to a faculty comprised of 10 research and scientific thought leaders from across disciplines and around the world. We have formed partnerships with Ben-Gurion University of the Negev and with numerous corporate entities. In fall 2015, our students, laboratories, and faculty will have a new home in the new William Eckhardt Research Center, a truly collaborative space for scientific inquiry at all levels.

In 2014, IME hit several critical milestones. We graduated our first doctoral student and welcomed the first undergraduate students in the IME minor program—while continuing to produce cutting-edge research with applications that redefine how to resolve pressing world problems.

IME tackles big issues, such as the availability of clean water, efficient energy storage, and improved cancer and medical treatment, through the development of new technologies, including quantum solutions for data storage and security, the development of antifouling membranes, and nanofabrication of block copolymers that self-assemble to create new materials.

IME researchers take time in March 2014 to conduct a workshop for 35 Chicago-area middle school girls as part of the Expanding Your Horizons outreach program, hosted at the University of Chicago.

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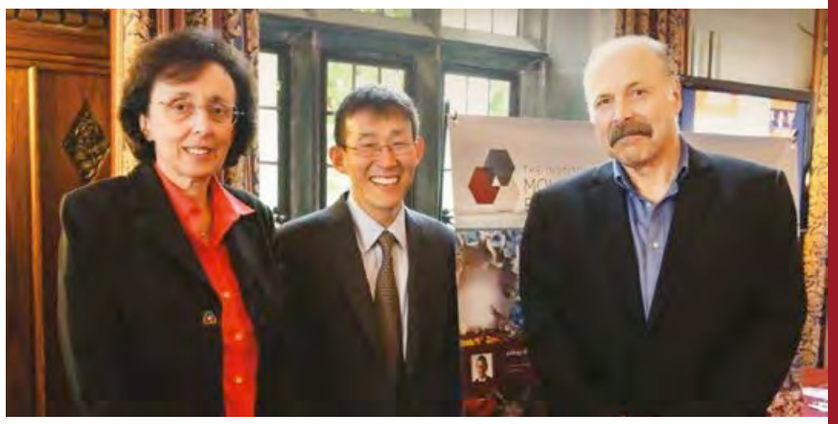

Two of the IME Liew Family Professors—Giulia Galli and David Awschalom—meet with Trustee John M. Liew on June 5 at the UChicago Knowledge Fair, a Celebration of Leaders in Philanthropy.

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The first engineering program offered in the history of the University connects molecular-level science in chemistry, physics, and biology to determine what the disciplines can do together—and create a "path from science to society… and to put what happens in the labs here into practice in the world," as Pritzker Director and Dean Matthew Tirrell explained.

A gift to the IME supports the inquiries of one of the most innovative scientific collaborations in the world, housed at the University of Chicago.

Your gift impacts a continually evolving set of solutions to problems that touch people's lives on a daily basis: water, health, energy, environment, and information.

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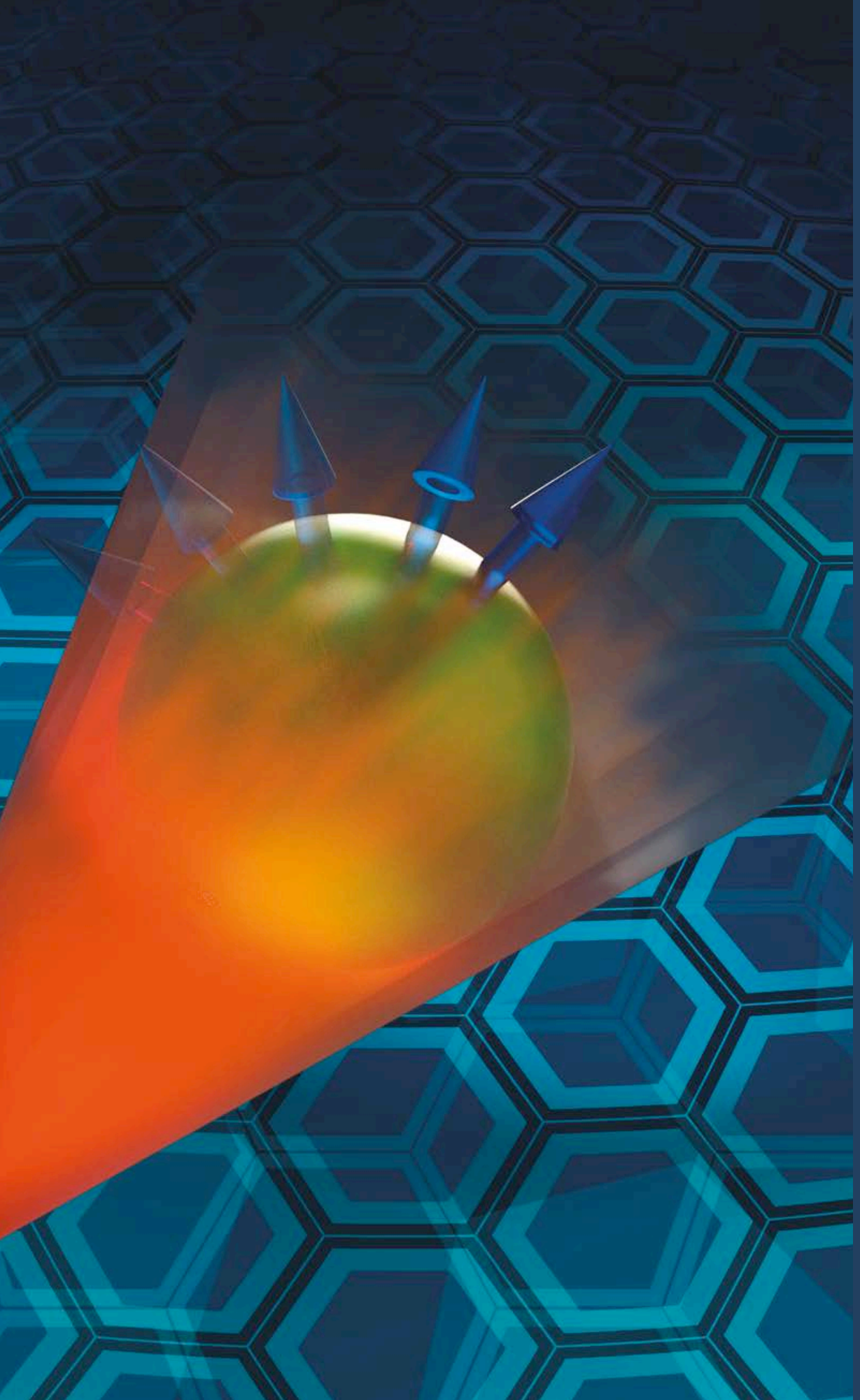

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by Peter Allen, IME Artist-in-Residence.

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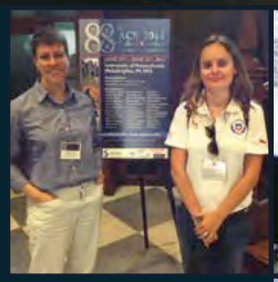
Snapshots from 2014

Above: UChicago faculty, students, and researchers at the First Thursday Distinguished Colloquium Series. Martin Zanni from the University of Wisconsin–Madison presented his work on 2D White-Light Spectroscopy.



Above: IME researchers Sarah Perry and Lorraine Leon attended the American Chemical Society 2014 Colloid and Surface Science Symposium at the University of Pennsylvania in June 2014.

Below: Two photos of guests enjoying the first Open House for the newly renovated *STAGE* Lab.

Above: All eyes were on the SpaceX resupply mission to the International Space Station in January 2015 as a polymer synthesized in IME's Tirrell Lab was delivered for use in an experiment related to suppressing bacterial infection. (story p. 32)

Above: Two photos from the annual IME summer picnic

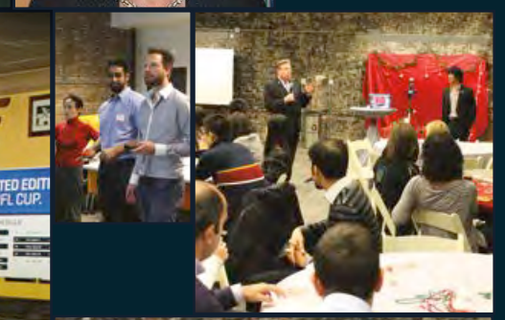
Below: In February 2014, IME welcomed the first group of admitted PhD students to campus during the IME Admitted Students Visiting Weekend. The PhD students toured facilities at UChicago and Argonne National Laboratory, in addition to seeing a bit of the City of Chicago.

Above: Newly admitted IME graduate students relax at the Seven Ten Lane bowling lounge during the IME Admitted Students Visiting Weekend.

Left: In November 2014, IME's Molecular Mixer featured food, drinks, music, and red carpet photos using lab coats and fashion accessories.

Left: The new William Eckhardt Research Center building had the last of its exterior windows put in place in May 2014.

Left: The American Association for Cancer Research featured IME Professor Melody Swartz in its series of articles: *Researchers Behind the Journals.*



Above: Three photos from the annual IME holiday party held at the Chicago Innovation Exchange

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