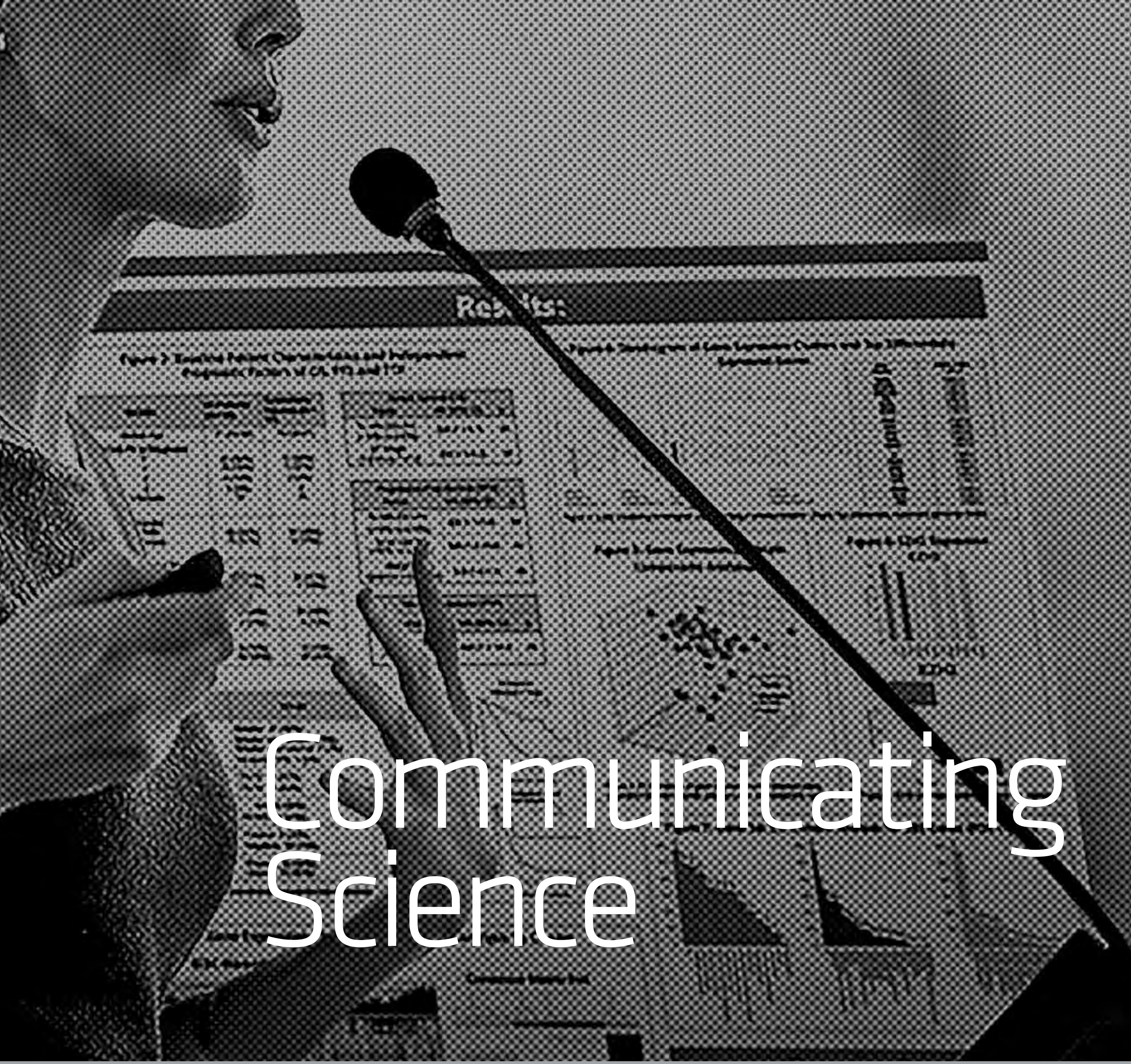


Communicating Science

The 25th Annual Cottrell Scholar Conference
July 10-12, 2019 at Westin La Paloma

COTTRELL SCHOLAR CONFERENCE

RESEARCH CORPORATION *for* SCIENCE ADVANCEMENT

2019 Conference Planning Committee

Mario Affatigato, Chair
Department of Physics
Coe College

Julio de Paula
Department of Chemistry
Lewis & Clark College

Jordan Gerton
Department of Physics
University of Utah

Gina MacDonald
Department of Chemistry and Biochemistry
James Madison University

Nicola Pohl
Department of Chemistry
Indiana University Bloomington

Jennifer Prescher
Department of Chemistry
University of California, Irvine

Scott Shaw
Department of Chemistry
University of Iowa

Silvia Ronco, Chair
Senior Program Director
Research Corporation for Science Advancement

From the President

Welcome to the conference!

This is the 25th year of the Cottrell Scholar program, bringing the total number of Scholars to 444. In addition, we are pleased to welcome two new Scholars from Germany again this year through our partnership with the German Fulbright Commission.

Cottrell Scholars are triple threat—you excel in research; you care deeply about effective innovation to improve learning and success in what are often seen by students as the most difficult courses on campus; and you recognize and embrace your responsibilities as members, and soon leaders, of academic communities at department, institution, and national levels. Sharing your values about what it means to be a teacher-scholar makes the Cottrell Scholar community a powerhouse of science advancement, and during the next few days you will find like-minded colleagues here with whom you can collaborate, often with Research Corporation support.

As a Cottrell Scholar you are part of a movement that lasts well beyond your initial three-year award cycle. You are always welcome at our conferences, and more than that you are encouraged to be actively involved in this growing community. In addition to the conference and the Cottrell Collaborative initiatives that result, RCSA offers a variety of opportunities for Scholars after their first three years. We provide competitive funding for new research directions (SEED grants) and for a major project (the FRED Award) through Cottrell Plus, and as part of Cottrell Plus we recognize the accomplishments of our Scholars with the Science Teaching and Research (STAR) and IMPACT awards. We also offer support for Scholar-organized events, including regional Cottrell Scholar meetings.

For this conference, we are excited to explore how we can more effectively inform and enlighten non-expert audiences. Basic science is not well understood by the public, yet we look to the public for the bulk of research funding and for approval of rational, evidence-based policies for the social good. So, in addition to the three areas of excellence you all share in research, teaching, and academic citizenship, we challenge you to excel in making science accessible beyond academia.

We share our planet with over 7.5 billion people, and only a relatively small number are research scientists. Thus we need all of our voices to speak clearly of the truth and wonder of science if we are to fuel the imagination and enthusiasm of our fellow citizens and address today's most pressing challenges.

Enjoy the conference!

Daniel Linzer
President and Chief Executive Officer
Research Corporation for Science Advancement

From the Program Directors

Welcome to the 2019 Cottrell Scholar Conference!

Sharpening your science communication skills, and helping your students to do the same, is vital to promoting STEM education and building a better world. Therefore, communicating science is highly appropriate as the main focus of our 25th-annual conference.

But getting the message across can be difficult. The vast majority of people are not trained as scientists, and many are intimidated by scientific terms and concepts. To be truly "heard," you must adjust your vocabulary and delivery style to the audience you are trying to inform. Reaching the general public, advising your congressman, or instructing a class of fifth graders require different words and approaches. Two conference workshops, delivered by Katie Orenstein (OpEd Project) and Brandon Echter (Science Friday), will provide important tips and communication tools to help you adapt your message to various audiences.

Continuing our long-standing tradition, the CS Conference is a celebration of the new class of Cottrell Scholars and the new ideas that emerge from formal and casual conversations. If you are a new Scholar, please know that you were selected not only for your impressive research and educational programs, but also for your strong potential for being an active member of the Cottrell Scholar family. And if you are a returning Scholar, take some time to introduce yourself to new Scholars and welcome them to this worthwhile community. Effective communication begins with you. We encourage you to listen, speak up, and, above all, network with conference participants!

A great way to pursue new educational ideas with potential national impact is to participate in a project with the Cottrell Scholars Collaborative (CSC). A cross-disciplinary network begun in 2011, CSC's overarching goal is to improve undergraduate and graduate science education at colleges and universities across the country. CSC participation is also an excellent way to develop your academic leadership skills. If you have questions about getting involved in CSC activities, please approach us or other members of the CS community.

We hope you find this event informative and stimulating. We're always looking for advice on how to make both the CS program and the conference even better—so communicate!

Mario Affatigato
Professor of Physics
Coe College

Silvia Ronco
Senior Program Director
Research Corporation for Science Advancement

Conference Objectives and Survey

To empower scholars to enhance their science communication skills and practices, participants will:

- → Discuss successful activities and approaches for communicating with diverse audiences
- → Learn how to tweak their message to specific audiences and platforms
- → Learn how to write Op-Ed columns effectively
- → Become familiar with tactics for effective use of social media
- → Discuss science communication in the context of STEM education
- → Identify topics that may lead to successful Cottrell Scholar Collaborative projects
- → Have the opportunity to form teams and become involved in science communication projects of national impact.

Statement on Promoting Diversity and Inclusion, and Avoiding Harassment

Research Corporation for Science Advancement fosters an environment for listening and considering new ideas from a diverse group, with respect for all participants without regard to gender, race, ethnicity, sexual orientation, age or any other aspect of how we identify ourselves other than as fellow scientists.

RCSA does not tolerate any form of harassment, which could include verbal or physical conduct that has the purpose or effect of substantially interfering with anyone else's participation or performance at this conference, or of creating an intimidating, hostile, or offensive environment; any such harassment may result in dismissal from the conference.

2019 Cottrell Scholar Conference Agenda

Communicating Science
Westin La Paloma

Wednesday, July 10, 2019

2:00 - 6:00 pm	**Registration**	Retail Foyer
3:00 - 4:00 pm	**Opening Reception** Drinks and Light Hors d'Oeuvres	Murphey Patio
4:00 - 4:45 pm	**Welcome and Introductions** Dan Linzer, RCSA President **Conference Overview and Goals** Silvia Ronco, Mario Affatigato **Introduction of Scholars**	Murphey
4:45 - 6:00 pm	**2019 Cottrell Scholar Presentations**	Murphey
6:15 - 8:30 pm	**Dinner**	Sonoran I
7:15 - 8:15 pm	**2018 FRED Award Presentation** Will Dichtel **Cottrell Scholar Trophy Ceremony**	Sonoran I

2019 Cottrell Scholar Conference Agenda Continued

Communicating Science
Westin La Paloma

Thursday, July 11, 2019

7:00 am	**Registration**	Finger Rock Foyer
7:00 - 8:00 am	**Breakfast**	Murphey Patio
8:00 - 9:30 am	**2019 Cottrell Scholar Presentations**	Murphey
9:30 - 9:45 am	**Morning Break**	Finger Rock Foyer
9:45 - 10:30 am	**STAR Presentations** Sarah Keller and Steve Bradforth	Murphey
10:30 am - 12:00 pm	**Breakout Session I** *Science Communication: Knowing Your Audience*	Finger Rock I, II, III & Primrose
	Regroup to discuss	Murphey
12:00 - 1:00 pm	**Lunch**	Sonoran
1:00 - 2:30 pm	**Keynote Presentation** *Owning Expertise: A Live Experiment in How Credibility Works and How Ideas Rise* Katie Orenstein, The OpEd Project	Murphey
	Discussion / Q&A	
2:30 - 3:00 pm	**Afternoon Break**	Finger Rock Foyer
3:00 - 4:30 pm	**Breakout Session II** *Communication Platforms*	Finger Rock I, II, III & Primrose
	Regroup to discuss	Murphey
4:30 - 6:00 pm	**Pool Time** Swimming & Informal Discussions	
6:00 - 7:00 pm	**Reception Honoring New Cottrell Scholars** Poster Session with Drinks & Light Hors d'Oeuvres	Sonoran
7:00 - 8:00 pm	**Buffet Dinner**	Sonoran
8:00 - 10:00 pm	**Trilateral Science Slam—Russia, Germany, USA** Sponsored by the German Fulbright Commission	Grand Ballroom

2019 Cottrell Scholar Conference Agenda Continued

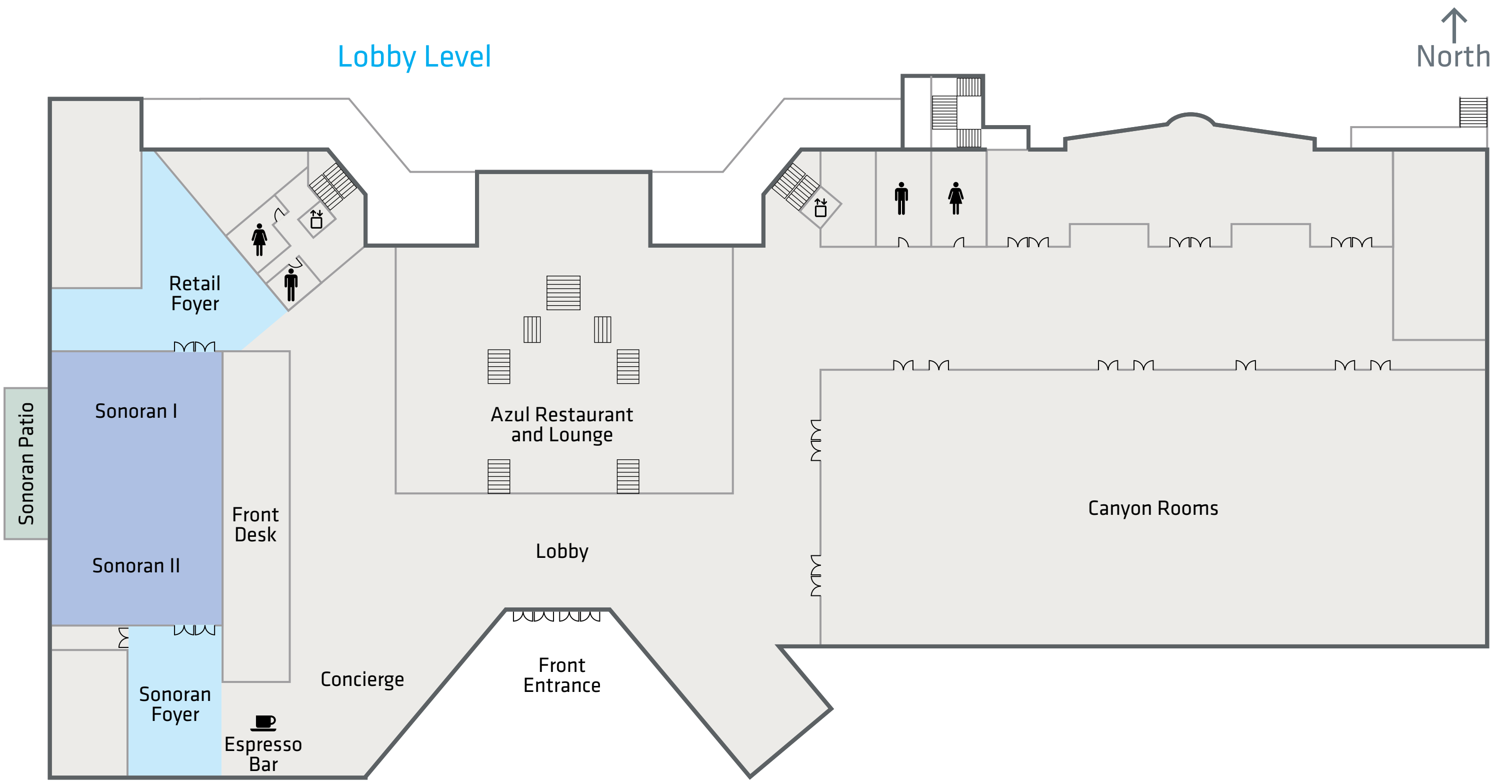
Communicating Science
Westin La Paloma

Friday, July 12, 2019

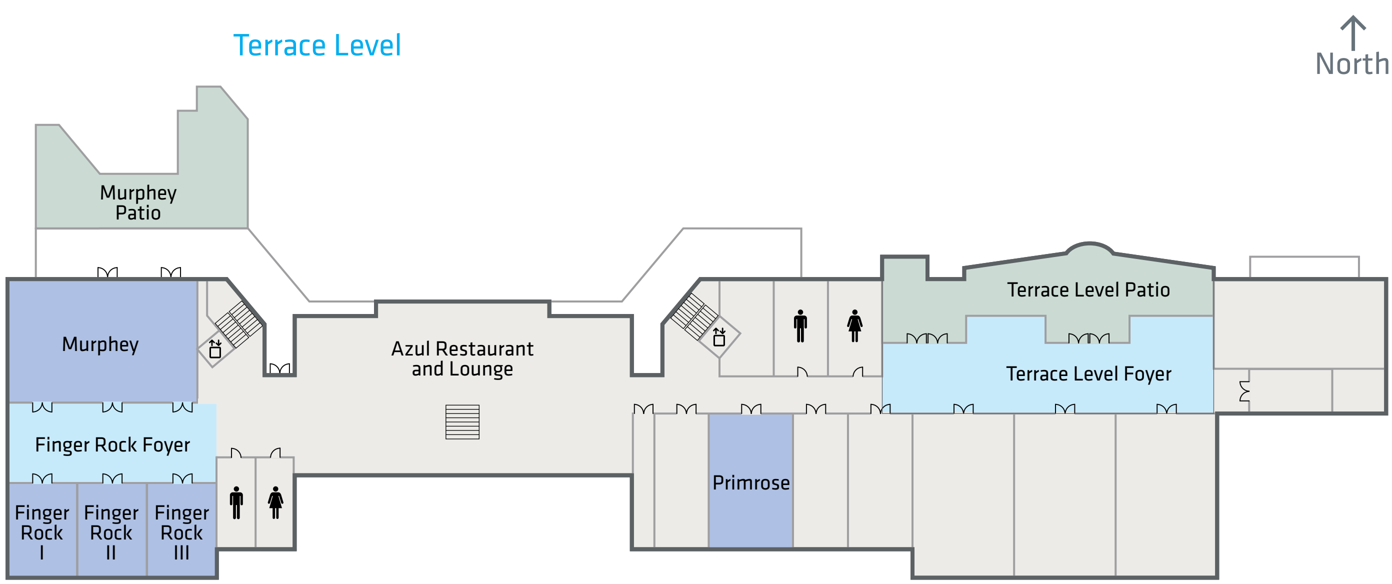
7:00 - 8:00 am	**Breakfast**	Murphey Patio
8:00 - 9:00 am	**Cottrell Scholar Collaborative Presentations**	Murphey
9:00 - 9:30 am	**Morning Break**	
9:30 - 11:00 am	**Keynote Presentation** *Be Human: A Guide to Effective Science Communication Online and On-Air* Brandon Echter, Science Friday	
11:00 am - 12:30 pm	**Breakout Session III** *Barriers to Engagement*	Finger Rock I, II, III & Primrose, Murphey
12:30 - 1:30 pm	**Lunch with Poster Session**	Sonoran I
1:30 - 2:15 pm	**IMPACT Presentation** Keivan Stassun **STAR Presentation** Andy Ellington	Murphey
2:15 - 4:30 pm	**Breakout Session IV** Unstructured Time to Work on Educational Collaborations; Networking	Finger Rock I, II, III & Primrose, Murphey
4:45 - 5:00 pm	**Conference Survey**	Murphey
5:00 - 6:00 pm	**Pool Time** Swimming & Informal Discussions	
6:00 - 7:00 pm	**Reception** Drinks & Light Hors d'Oeuvres	Terrace Level Foyer
7:00 - 9:30 pm	**Family Dinner** All Guests are Invited to Join	Terrace Level Patio

Westin La Paloma Resort and Spa

Lobby Level



Terrace Level



Keynote Speaker

Owning Expertise: A Live Experiment in How Credibility Works and How Ideas Rise

Katie Orenstein
Founder and CEO,
The OpEd Project

Abstract: This interactive session presents current data on the demographics of public discourse, and addresses core questions of thought leadership: what do we know, why does it matter, and how can we maximize our impact? We will also do a large-group experiment in credibility. Participants will walk away with bold ideas, a deeper sense of what they, as well as their colleagues, know and stand for, and actionable steps. Keynotes are paired with 10 or more spots in our day-long programs around the nation, in order to maximize concrete results.

Bio: Katie Orenstein, Founder and CEO of The OpEd Project, writes and speaks frequently about the intersection of media and mythology—that is, what we think is fact or fiction and how that shapes our ideas about politics, culture and history. She has contributed to the op-ed pages of the *New York Times*, *Washington Post* and *Miami Herald*. She has lectured at Stanford and appeared on ABC TV World News, Good Morning America, MSNBC, CNN and NPR. A graduate of Harvard (BA) and Columbia (MA) universities, she is the author of *Little Red Riding Hood Uncloaked: Sex, Morality and the Evolution of a Fairy Tale*. Orenstein has worked around the world and particularly in Haiti, where she reported, consulted with the United Nations, and worked with a team of human rights lawyers to assist victims of military and paramilitary violence in seeking justice. She is a recipient of The Diana P. Scott Integrity in Action Award, and a fellowship from Echoing Green, which selected The OpEd Project as one of the most innovative social enterprises worldwide, out of 1,500 applicants.

Keynote Speaker

Be Human: a Guide to Effective Science Communication Online and On-Air

Brandon Echter
Digital Department,
Science Friday

Abstract: In an era when research is routinely misunderstood, misrepresented, or misinterpreted, it's more important than ever for all scientists to advocate for their research themselves. Since 1991, the Science Friday Initiative has been connecting researchers to the public—through a weekly public radio show, articles, social media, videos, classroom activities, live events, and more—and have become experts in communicating science in the way the public understands. In this session, Brandon Echter, digital managing editor, will explain what the science communication professionals are looking for when finding sources, some of the common pitfalls scientists fall into when communicating their research to the world, and ways researchers can become advocates using their own voice and personality. We'll look at case studies of particularly effective communicators today like squid biologist Sarah McAnulty, venom researcher Dr. Mandë Holford, and more. This session will also include a hands-on workshop so researchers will be able to identify their strengths as a communicator, develop their voice for online communication, and inspire a plan for how they can advocate for their research going forward.

Bio: Brandon Echter is Science Friday's digital managing editor. He oversees their digital and social presence, from articles and visuals on the website to Twitter activities to SciFri's annual Cephalopod Week. Projects he has worked on and overseen have been honored by the Online Journalism Awards, Shorty Awards, and Webby Awards for their innovative storytelling. Brandon has also presented on digital strategy and engagement at the Online News Association Conference, the Science Writers Conference, the Communications Network, NPR's Digital Day, and others—as well as private consultations with public media and nonprofit organizations. Previously, he was Science Friday's engagement manager.

He's an avid Twitter user, cephalopod fanboy, lover of memes, and pronounces GIF with a hard G. Follow Brandon on Twitter *@bechter*.

2018 FRED Award Winner

Polymerization in Two Dimensions

Will Dichtel
Cottrell Scholar 2012
Department of Chemistry,
Northwestern University

Abstract: Polymer chemistry has long focused on the synthesis and applications of linear macromolecules and disordered infinite networks. As objects of commerce, the linear structures are known as thermoplastics, the networks are thermosets, and both dominate modern life. Expanding the concept of polymerization into repeating structures of higher dimensionality (2D grids and 3D scaffolds) is a longstanding gap that is only now developing as an exciting frontier. The most versatile 2D polymerization approach requires molecular building blocks to simultaneously assemble and react into materials known as "covalent organic frameworks," or COFs. Although successful, COF synthesis is poorly understood, requiring methods to be developed by trail-and-error for each new example and providing low-quality materials. I will describe our efforts to understand how COFs form so as to rationally improve their quality and unlock their potential applications.

Bio: Will was an undergraduate student at MIT, where he majored in chemistry and was fortunate to gain his first research experience working in the laboratory of Prof. Tim Swager. Will then moved to UC-Berkeley for graduate school, where he earned his Ph.D. for investigating light harvesting macromolecules under the supervision of Prof. Jean M. J. Fréchet. He next moved to Los Angeles for a joint postdoctoral appointment with Prof. Fraser Stoddart, then at UCLA, and Prof. Jim Heath at Caltech. There his research focused on developing efficient strategies for the synthesis of mechanically interlocked compounds and incorporating these molecules onto surfaces and into solid-state devices. Prof. Dichtel began his independent career in the Department of Chemistry and Chemical Biology at Cornell University in 2008 and was promoted to the rank of Associate Professor in 2014. He moved to Northwestern University in the summer of 2016 as the Robert L. Letsinger Professor of Chemistry.

His group's research has since been recognized with a number of National Awards, including a MacArthur Fellowship in 2015, the National Fresenius Award from the Phi Lambda Upsilon National Chemistry Honor Society, the Polymer International – IUPAC Award for for Creativity in Applied Polymer Science, the Camille Dreyfus Teacher-Scholar Award, an Arthur C. Cope Scholar Award from the American Chemical Society, a Cottrell Scholar Award from the Research Corporation for Science Advancement, the Sloan Research Fellowship, and a Beckman Young Investigator Award from the Arnold and Mabel Beckman Foundation.

2019 STAR Award Winners

Sarah Keller

Department of Chemistry,
University of Washington
Cottrell Scholar 2003

Sarah Keller is a biophysicist who investigates a wide range of research questions about self-assembly, complex fluids, and soft matter systems. Her research group's primary focus concerns how "simple" lipid mixtures within bilayer membranes give rise to rich and complex phase behavior. In 2011 she was named a Fellow of the American Physical Society and elected to the Washington State Academy of Sciences. Her most recent national/international honor was the 2017 Avanti Award from the Biophysical Society. Her teaching and research mentoring at UW have been recognized with UW's 2006 Distinguished Teaching Award and the UW Postdoctoral Association's 2012 Mentor Award. From 2010 to 2014 she served as the Associate Dean for Research Activities for the UW College of Arts and Sciences before reverting to her natural state as a full-time scientist.

Andrew Ellington

Center for Systems and Synthetic Biology,
University of Texas at Austin
Cottrell Scholar 1995

Andrew Ellington and his lab members use synthetic biology tools to augment living systems with novel chemistries. He is especially interested in expanding the genetic code to make new types of proteins and developing orthogonal neural receptors that can be used to probe and modulate pathways in the brain. In collaboration with Eric Anslyn, Ph.D., Ellington is working to establish training experiences for undergraduate and graduate chemistry and biochemistry majors, aimed at creating the next generation of scientist-leaders and/or scientist-entrepreneurs. He advocates for experiential and entrepreneurial education, especially the development of point-of-care diagnostics, where student-led approaches can result in new ways of monitoring for Zika virus and other pathogens, especially in resource-poor settings. Ellington was named an HHMI Professor in 2017.

Stephen Bradforth

Department of Chemistry,
University of Southern California
Cottrell Scholar 1999

As the divisional dean for natural sciences and mathematics, Professor of Chemistry Stephen Bradforth coordinates strategic planning, faculty appointments and research advancement within the USC Dornsife Division of Natural Sciences and Mathematics and collaborates with leadership within the College and across the university to support and enhance both research and education in basic science at USC.

Bradforth joined the Department of Chemistry in 1996 and has held numerous leadership positions within the department, including head of the physical and theoretical chemistry section, vice chair and chair until 2016. As a USC Dornsife faculty fellow, Bradforth designed a seminar to teach incoming freshmen about the Global Energy Crisis. He is active in recent national efforts, spearheaded by Research Corporation for Scientific Advancement and the Association of American Universities, to reform undergraduate STEM education in research-intensive universities.

Bradforth's lab designs experiments to gain a deeper understanding of how the inter-connected motions of molecules impact chemical reactions in complex but frequently encountered environments such as the aqueous milieu of cells or in functional molecular materials. His research applies ultrafast laser techniques to address contemporary scientific challenges that span multiple fields.

Bradforth's honors include a Dreyfus New Faculty award and a David and Lucile Packard Fellowship in Science and Engineering. He is a Cottrell Scholar, a Fellow of the American Physical Society (APS). He currently serves on the Executive Committee of the APS Division of Chemical Physics. At USC, he has been recognized with the Raubenheimer junior faculty award as well as the USC Mellon Mentoring award for mentoring faculty.

2019 IMPACT Award Winner

Keivan Stassun

Department of Physics and Astronomy,
Vanderbilt University
Cottrell Scholar 2006

One of the rarest events in astronomy is the discovery of an entirely new class of objects. Keivan Stassun and his collaborators made such a discovery in 2007 with the first detection of a brown dwarf eclipsing binary system. In a second outstanding research achievement, Stassun and a graduate student discovered the correlation between stellar "flicker" and the surface gravity of the corresponding star. These measurements promise to better constrain the properties of stars themselves, but they are also leading to better constraints on the properties of extrasolar planets. Meanwhile, in the field of education, Stassun is the prime architect of the highly successful Fisk-Vanderbilt Master's-to-Ph.D. Bridge program. It has triggered a revolution in the way science doctoral programs at research institutions deal with potential candidates among underrepresented minorities. Stassun's bridge program is now being emulated at the University of Michigan, Columbia University, MIT and Harvard. National Public Radio reports that since it began with a three-student cohort in 2004, "the Fisk-Vanderbilt Masters-to-Ph.D. Bridge Program has accepted 68 students, 55 of whom came from underrepresented minority backgrounds (namely African-American, Hispanic and Native American) and 46 percent of the students have been women." The program has a retention rate of 92 percent, with 100 percent job placement for those who complete the program. According to Stassun, as the program was starting up it greatly benefited from the visibility and imprimatur provided by RCSA as a respected national organization for advancing the physical sciences.

Presentations by Cottrell and Fulbright-Cottrell Scholars

2018 Cottrell Scholars

Claude-André Faucher-Giguére	Physics, Northwestern University
Garret Miyake	Chemistry, Colorado State University
Kater Murch	Physics, Washington University, St. Louis
Craig Nathaniel	Physics, University of California, Santa Barbara

2019 Cottrell Scholars

Victor Acosta	Physics, University of Arizona
Robbyn Anand	Chemistry, Iowa State University
Gordon Berman	Physics/Biology, Emory University
Dennis Cao	Chemistry, Macalester College
Caitlin Casey	Astronomy, University of Texas, Austin
Jonathan Foley	Chemistry, WIlliam Paterson University
Chenfeng Ke	Chemistry, Dartmouth College
Laura Lopez	Astronomy, Ohio State University
Ellen Matson	Chemistry, University of Rochester
Charles McCrory	Chemistry, University of Michigan
Ryan McGorty	Physics, University of San Diego
Katherine Mirica	Chemistry, Dartmouth College
Alison Narayan	Chemistry, University of Michigan
Kerstin Perez	Physics, Massachusetts Institute of Technology
Paul Raston	Chemistry, James Madison University
Emily Rauscher	Astronomy, University of Michigan
Shahir Rizk	Chemistry, Indiana University, South Bend
Tristan Smith	Physics, Swarthmore College
Kana Takematsu	Chemistry, Bowdoin College
Christina Vizcarra	Chemistry, Barnard College
Justin Wilson	Chemistry, Cornell University

2019 Fulbright-Cottrell Scholars

Dominik Munz	Chemistry, Friedrich Alexander Universität, Erlangen-Nürnberg
Hongbin Zhang	Physics, Technische Universität Darmstadt

Presentations by Cottrell Scholar Collaborative Teams

Development of a Faculty Empowerment Network for Tenure Track Faculty in Chemistry and Physics

Amanda Wolfe, Chemistry, University of North Carolina, Asheville

Cottrell Scholars Collaborative (CSC) for a Science Communication Enabled Community

Scott K. Shaw, Chemistry, University of Iowa

Catalyzing Joint Research between Predominantly Undergraduate (PUI) and Research (R1) Institutions through the Cottrell Scholars Collaborative

Mario Affatigato, Physics, Coe College

Training Faculty to Assist Students in Career Planning

Adam Urbach, Chemistry, Trinity University

Cottrell Scholar Regional Meeting at Emory University

Jennifer Heemstra, Chemistry, Emory University

Cottrell Scholar Collaborative Proposal Writing Rules

Successful proposals should have the potential to positively impact undergraduate and/or graduate science education in the classroom, at the departmental level or at the national level.

- Up to four $25,000 awards will be given to teams of Cottrell Scholars working collaboratively.
- Two-year awards made to a team formed at this conference.
- Members of the team are active or past Cottrell Scholars.
- Award could be for a new project that will expand the impact of existing funded collaborative projects. New collaborative projects are also welcome.
- Proposal should briefly explain an innovative approach for projects with potentially broad impact.
- Two-page proposal must be submitted through the RCSA online submission system by the end of the day on **July 26, 2019**.
- Awards will be announced within a month of submission.

Conference Evaluation Survey

An online conference survey will be available on **Friday, July 12, 2019**. To access and complete the survey, please go to: *http://www.surveymonkey.com/r/2019CSConferenceSurvey*

2019 Cottrell Scholars

Victor Acosta
Department of Physics and Astronomy, University of New Mexico

Hyperpolarization and Detection of Nuclear Magnetic Resonance Using Nitrogen Vacancy Centers in Diamond

The proposed research plan seeks to develop techniques for using Nitrogen-Vacancy (NV) centers in diamond to generate and detect nuclear magnetization in external fluids. NV-doped diamond films will be used to polarize analyte nuclear spins and detect their magnetic resonance signatures via pulsed optically detected magnetic resonance methods.

An outstanding challenge in this field is to overcome the small thermal polarization of ambient nuclear spins by transferring spin polarization from the diamond to external analyte (hyperpolarization). The proposed research plan will investigate new approaches to tackle this problem involving polarization transfer through intermediate spin systems. The results will improve our fundamental understanding of quantum sensing protocols and the flow of spin polarization across solid-liquid interfaces.

The proposed education plan seeks to develop a graduate study curriculum to train a diverse range of students for careers in computational optics and imaging. While there is strong demand for industrial and academic research in computational optics/imaging, there are presently barriers to collaboration between optical and computational scientists due to a lack of common language and training. My long-term goal is to implement a comprehensive computational optics/imaging graduate training program that includes students with computer science, physics, and engineering backgrounds. Towards this end, I will design a capstone course that includes crash courses on optics and computational methods and introduces students to current research topics in computational optics. I will teach portions of this course as one-credit summer classes and use preliminary assessment and feedback to refine plans and apply for major training grant funding.

Robbyn Anand
Department of Chemistry, Iowa State University

Extracting Kinetic Rate Constants from Bipolar Electrochemistry: AC Voltammetry of Electrically Coupled Faradaic Reactions

Biofuel cells convert unconventional fuels to sustainable energy. The discovery of oxidoreductase enzymes promises to expand the operating conditions and the classes of fuels accepted. As this field grows, the number of native and engineered enzymes to be tested for catalytic activity is a bottleneck to advancement. Further, as electron transfer at the biotic-abiotic interface is closely linked to immobilization chemistry, temperature, and fuel composition, the number of permutations is staggering. Our goal is to simultaneously probe the kinetic rate constants for hundreds to thousands of faradaic reactions, thus rapidly screening candidate enzymes as immobilized on underlying electrodes. Bipolar electrodes are wireless, lacking ohmic contact to a power supply, and are therefore readily arrayed. Bipolar electrodes have been leveraged previously to measure electrocatalytic activity in parallel. However, existing approaches yield relative activity instead of kinetic rate constants. We propose to develop alternating current voltammetry at bipolar electrodes that is capable of sensitively discriminating kinetic constants, thus allowing real time interrogation of the impact of experimental conditions on oxidoreductase activity. The proposed research will also advance bipolar electrochemistry through increased understanding of electrically coupled faradaic reactions under an alternating driving voltage.

Our educational goal is to address insufficient understanding and retention of electrochemical concepts by vertically integrating, into undergraduate chemistry curriculum, case study materials that teach core chemistry concepts through the lens of electrochemistry. This problem-based learning approach will expose students to current research in electrochemistry and better integrate electrochemical concepts with other areas of chemistry, thus increasing functional understanding.

Gordon Berman
Department of Biology, Emory University

Information Bottlenecks and the Neural Control of Behavior in Fruit Flies

Understanding links between brain and behavior is one of the key questions in neuroscience. In most animals, there exists a limited-capacity transmission channel between the brain and the muscles driving behavior, such as the spinal cord in vertebrates or the ventral nerve cord in arthropods. This project asks how such a constraint affects coding across the channel, searching for optimization principles that guide its organization. In the fruit fly, there are approximately 300 pairs of descending interneurons that project from the head to the rest of the body. We will decode how signals from the brain through this bottleneck translate into movement by analyzing data from neural stimulation experiments and developing theoretical and computational models. These results will also be used to shed light into the mechanisms of behavioral evolution between nearby species.

The concept of "big data" has become almost cliché, with accumulating reams of high-dimensional data becoming ubiquitous across fields. Despite this, educational techniques for coping with these data have been largely statistical or comparative and disconnected from modeling and theory. As a Cottrell Scholar I will develop a new class, "Data analysis in many dimensions," that will use inquiry-driven approaches to integrate model-and-theory-based analyses of large, high-dimensional data sets into the science curriculum across disciplines. In addition, I will develop a series of workshops aimed at increasing undergraduate skills in analyzing these types of data. Together, these will increased will encourage the transfer from "big data" to "big knowledge."

Dennis Cao
Department of Chemistry, Macalester College

Cationically Supercharged Electron Acceptors

This proposal outlines a three-year plan to investigate the incorporation of cationic charge into already electron-poor redox-active aromatic compounds with the goal of achieving ambient stability of the reduced states. The proposed work encompasses the optimization of our synthetic method, development of new molecular designs, and comprehensive characterization of the structural and photophysical properties of the accessible redox states of novel compounds we create. The targeted compound classes, namely rylene diimides and corannulenes, present fundamentally interesting platforms for answering questions about electron accumulation by organic redox systems, radical stabilization strategies, and the impacts of aromatic deformation on redox activity. This work's success will set the stage for future investigations into applications in which these compounds' stabilized reduced states can be leveraged for light-harvesting and spin-based organic electronic applications.

This proposal also describes a three-year educational plan to develop an introductory organic chemistry practice problem database, *RealOrganicChemistry.org*, composed entirely of reactions from the scientific literature. This compilation, which will be made freely available for access and iteration, will draw reaction examples from a variety of research contexts to demonstrate key concepts. The motivation for this effort is grounded in chemical education research findings which show: 1) course material that students perceive as relevant to their life and career is more likely to stimulate meaningful learning; and 2) the development of evidence-based reasoning ability is a crucial component of student success in STEM courses and careers.

2019 Cottrell Scholars Continued

Caitlin Casey

Department of Astronomy, University of Texas at Austin

Diverse Perspectives: the Impact of Dust and Gas on Cosmic History and Equity-Minded Inquiry-based Astronomy

The rich 14-billion year-old story of our Universe—from the gravitational collapse of matter, to the formation of galaxies, and the physics of the cosmos—has been pieced together using the world's most powerful telescopes. Predominantly, it is stellar light that has given us this story. And yet stars themselves only shed light on a small fraction of the cosmos. Diffuse gas makes up most baryonic material in the Universe, and dust, though negligible by mass, effectively obscures and reprocesses half of all stellar emission. My research team at UT Austin focuses on revising cosmic history from a new perspective: using millimeter-wave technology to take census of cold gas and dust in the first few billion years after the Big Bang. This proposal focuses on the census of dust-obscured star-forming galaxies in the first ~2Gyr, the assembly of galaxy clusters seen through dust and gas tracers, and improving precision cosmology using millimeter wavelengths. This work is rooted in the need to gain new perspective on old problems. This philosophy links closely to my educational goal of increasing retention for under-represented students in astronomy at UT Austin. I will work to design six special equity-minded inquiry-based learning activities that focus on both astronomy content and STEM practices/skills. The activities will be designed through UT's participation in the Institute for Scientist and Engineer Educators Professional Development Program and facilitated via the TAURUS summer research program. Austin astronomy undergraduate courses serve over 1,000 students annually.

Jonathan Foley

Department of Chemistry, William Patterson University

Polaritonic Chemistry with Hybrid Nanoparticles

Strong interactions between light and molecules can profoundly impact the properties of the underlying molecular degrees of freedom that dictate chemical structure and reactivity. Nanoparticles that can mediate such strong interactions between light and molecules are attracting considerable attention for their ability to facilitate efficient control of chemical reactivity for promising applications like solar-to-chemical energy conversion. The research plan will critically evaluate the potential for a novel class of hybrid nanoparticles to serve as a vehicle for facilitating a new regime of strong light-matter interactions, and for opening new opportunities to control chemical reactivity with earth abundant materials.

Chemists utilize spectroscopy in a variety of ways to extract quantitative information about chemical systems, and they use the foundational skill of quantitative reasoning to generate useful insights from this information. The education plan seeks to foster a new approach to developing students' quantitative reasoning skills while simultaneously facilitating deeper engagement with the fundamentals of spectroscopy. This education plan has synergy with the research plan and leverages the PI's expertise in the theory and modeling of light-matter interactions in nanoscale and molecular systems.

Benjamin Hunt
Department of Physics, Carnegie Mellon University

Broken Symmetry and Spin-Triplet Pairing in Two-Dimensional Superconductors

The concept of symmetry has given us the language to describe a vast array of physical phenomena. In the case of superconductors, the presence or absence of inversion symmetry in the underlying crystal can have profound consequences for the nature of the Cooper pairing in the superconductor. In particular, the absence of inversion symmetry implies that the Cooper pair wavefunctions are of mixed even- and odd-parity spatial character, with corresponding singlet and triplet spin states of the electron pairs. Spin-triplet superconductivity is rare in nature, but can give rise to one of the most important phenomena being investigated in contemporary condensed-matter research, namely topological superconductivity. In single layers of the transition-metal dichalcogenide (TMD) superconductors $NbSe_2$ and TaS_2, evidence for the existence of the putative spin-triplet Cooper pairs has been elusive. This proposal aims to provide definitive evidence of spin-triplet superconductivity through experiments sensitive to the spin susceptibility and the symmetry of the Cooper pair wavefunctions. The proposed experiments will be relevant to a larger class of 2D superconductors created from van der Waals layered materials.

The educational component of this proposal aims to improve the research experience of undergraduates and beginning graduate students who are interested in the kind of experimental condensed-matter research described above. A deficiency in the research experience has been identified, namely the high barrier to learning nanofabrication, and this proposal seeks to bridge this gap by (1) providing plans for a "Comprehensive Undergraduate Condensed-Matter Lab", and (2) planning a graduate course at Carnegie Mellon to take advantage of the newly-approved Nanofabrication Teaching Facility

Chenfeng Ke
Department of Chemistry, Dartmouth College

Smart Supramolecular 3D Printing Materials with Synchronized Molecular Motions

The overall aim of this proposal is to synergistically wed the precepts of supramolecular chemistry and polymer synthesis in 3D printing materials with interactive educational activities to promote undergraduate students' interest towards STEM career paths. The research effort aims to advance the development of stimuli-responsive and programmable smart 3D printing materials through the amplification of dynamic molecular events to the macroscale. By realizing temporal control in synchronizing molecular motions and achieving spatial control in 3D printing, two hypothesis-driven aims have been proposed herein, to develop (1) ultra-stretchable, tough and self-healable 3D printing materials; and (2) slide-ring-based 3D printing materials with spatiotemporally programmed mechanical properties. The research outcomes will greatly advance the development of next-generation 3D printing materials by utilizing the full potential of smart molecular systems.

The educational effort aims to strengthen students' skill proficiency, cultivate a collaborative interdisciplinary learning environment, and encourage students' interest and curiosity in chemistry and STEM fields. Our strategies include: (1) retaining undergraduate women's interest by designing chemistry-based interdisciplinary research projects in partnership with Dartmouth's Women in Science Program; (2) motivating students enrolled in organic chemistry class to pursue STEM careers by introducing real-life application-based interactive learning modules in an active learning class; (3) inspiring students of all backgrounds to consider chemistry and STEM career paths by offering a 3D printing workshop with a focus on interdisciplinary collaboration with a culture of inclusion.

2019 Cottrell Scholars Continued

Emily Levesque
Department of Astronomy, University of Washington

New Perspectives on Dying Stars

Massive stars are critical objects across astronomy. Massive stars serve as lighthouses during their explosive deaths as supernovae, drawing our attention to sites of recent star formation and even giving us fleeting glimpses of stars born in earlier eras of our universe. These same populations of massive stars can also be studied in incredible detail in the Milky Way and neighboring galaxies, which offer a treasure trove of nearby targets that can be used as local laboratories. For massive stars alone it is possible to detect the deaths of the earliest generations of these objects across the visible universe while also closely examining the physical properties of their evolutionary and chemical twins in our own cosmic backyard. However, despite their importance fundamental aspects of massive stars remain poorly understood. *My research proposal is focused on transforming our current understanding of dying massive stars.*

Introductory astronomy courses for non-majors offer enormous opportunities for science education beyond the nuts and bolts of the universe, teaching students scientific methodology and reasoning, how to evaluate the veracity of information resources, and why science and astronomy are valuable pursuits worthy of public support. While the reach of introductory astronomy courses is already impressive, there is considerable potential to be tapped in exploring the overlap between astronomy and fields such as history, economics, politics, social sciences, and the performing arts. *My education proposal is focused on developing multi-disciplinary introductory courses that will capitalize on the synergies between astronomy and fields outside of the natural sciences.*

Laura Lopez
Department of Astronomy, Ohio State University

Assessing Stellar Feedback in Massive Star-Forming Regions

I propose to address fundamental questions on the dynamical impact of stellar feedback, the injection of energy and momentum by stars. This comprehensive observational program will employ data from across the electromagnetic spectrum (radio, mm, infrared, optical, X-ray, and gamma-rays) and will focus on star-forming regions in the Milky Way and nearby galaxies, where feedback phenomena are best resolved. The primary objectives are 1) to assess the comparative role of many feedback mechanisms (radiation, photoionization, stellar winds, supernovae) in hundreds of star-forming regions; 2) to explore how dominant feedback modes change in different galactic conditions and with time; 3) to set observational constraints on cosmic-ray feedback and transport. Observational results will be compared to theoretical models to maximize the scientific return of this work.

In addition, I propose to address the lack of retention and the under-representation of women and racial minorities in astronomy through a two-pronged education plan. In particular, I propose 1) to start the Winter Astronomy Research Program (WARP) at Ohio State to introduce astronomy freshmen to research through inquiry-based activities, to teach computer programming skills, and to facilitate cohort building; and 2) to extend the currently existing Ohio State Masters-to-Ph.D. physics Bridge Program to the astronomy department to increase astronomy Ph.D. attainment of people of color.

Ellen Matson

Department of Chemistry, University of Rochester

Metal Oxide Clusters as Models for Investigating the Role of Oxygen Vacancies in Small Molecule Activation

The generation of oxygen vacancies at the surface of heterogeneous catalysts is critical for the production of chemical fuels from abundant inert substrates. Understanding how these reactive sites form will provide a template for the design of materials that rapidly undergo the reductive cleavage of interfacial metal-oxygen bonds sites. The Matson Laboratory is exploring the formation of oxygen vacancies through the reduction of molecular metal oxide clusters. Our early work has revealed that homogeneous polyoxovanadate clusters can serve as structural and functional models for vacancy formation at the surface of metal oxides. Over the course of the funding period, we will investigate the role of transition metal dopants in vacancy formation through comparative analysis of homo- and heterometallic polyoxovanadate-alkoxide clusters. Additionally, the reactivity of the reduced platforms with oxygenated substrates will be probed to model the role of oxygen vacancies in small molecule activation.

The use of active learning in the sciences is considered a best-practice for promoting conceptual development, understanding, and achievement for undergraduate STEM students. Laboratory courses provide students with "hands-on" scientific experiences, creating opportunities to engage with course-content. Despite their value, these classes do not support students in the development of essential skills in civic leadership and broad scientific communication. Throughout the "real-world", much of practiced science occurs outside of the laboratory, through interdisciplinary collaboration and communication with the public. During the funding period we will develop a course for undergraduate students targeting the development of soft-skills, specifically the communication of scientific principles to diverse audiences.

Charles McCrory

Department of Chemistry, University of Michigan

Selective Electrocatalysis by Polymer-Encapsulated Catalysts: the Role of Charge and Substrate Transport on Catalytic Efficiency

The discovery of systems that preferentially convert carbon dioxide to single products while suppressing competitive side reactions like hydrogen evolution is a critically important challenge in renewable energy storage and carbon dioxide remediation. Our research approach is to encapsulate molecular catalysts within hydrophobic coordinating polymers that influence the primary- and secondary-coordination spheres of the catalytic active site while inhibiting competitive side reactions by controlling substrate transport to promote selective CO_2 reduction. In the proposed research, we will directly quantify and modulate the roles of electron, H^+, and CO_2 transport on catalytic activity within polymer-encapsulated systems. These studies will be used to develop new catalyst systems that efficiently and selectively reduce carbon dioxide to single value-added products.

Concurrently, a comprehensive education plan has been designed to address the long-standing challenge in general chemistry education of helping students increase conceptual (rather than procedural) knowledge of chemistry topics. We propose a graduate student instructor (GSI) centered approach that restructures GSI-student interactions through 1) increasing GSI training in pedagogical content knowledge; 2) restructuring discussion sections to incorporate topic-specific peer-learning exercises; and 3) introducing a new "Outreach" section aimed at increasing conceptual and procedural problem-solving skills among students. The proposed education plan is specifically tailored to be both feasible and sustainable for the large-format general chemistry course at the University of Michigan.

2019 Cottrell Scholars Continued

Ryan McGorty
Department of Physics and Biophysics, University of San Diego

Optical Microscopy of Sheared Phase-Separating Soft Matter Systems

How can we control and manipulate matter and what are the mechanisms biological systems use to do so? These questions drive research across many fields, but particularly in the field of soft condensed matter where small perturbations, thermal fluctuations even, can alter the structure and where that structure is experimentally accessible given its mesoscopic scale. In this proposed work, a soft matter system comprised of temperature- responsive colloidal particles and of polymers will be manipulated through both flow and in situ changes to colloid volume fraction. Flow will affect the system's microstructure, and its microstructure influences how it flows. To interrogate this interplay between flow and microstructure we will develop novel instrumentation and methods. Central to our experimental plan is a light-sheet microscope capable of acquiring optically sectioned images of samples under shear. Combined with adaptive optics and Fourier microscopy techniques, we will probe flowing samples over a range of spatial and temporal scales. Importantly, the developed rheo-optical methods will be vastly more accessible than comparable state-of-the-art.

Accessible scientific instrumentation is a focus of the proposed educational plan. Capitalizing on movements to create open source scientific hardware and to build instruments for frugal science, the proposed educational plan will charge lower-division undergraduate students with designing and constructing optical tools to democratize science. This course will provide an authentic research experience to our students. Moreover, the nefit of accessible scientific tools will be stressed to students to promote interest in science and ownership of their projects.

Katherine Mirica
Department of Chemistry, Dartmouth College

Multifunctional Porous Scaffolds for Monitoring Neurochemicals

This proposal describes an integrated technical and pedagogical plan to transform conductive metal-organic frameworks into versatile and integral components of future electroanalytical devices. The technical plan focuses on merging modular multifunctional materials with seamless device integration to enable continuous monitoring of neurochemicals. The molecular design takes advantage of the emergent conductive behavior of two dimensional (2D) layered metal-organic frameworks (MOFs), and capitalizes on the fact that such molecularly homogeneous materials can be synthesized in an atomically precise manner. We propose to tailor the design of our materials to establish molecular hosts for unique physiologically relevant molecules within electronically-transduced sensing devices. This approach will overcome the limitations of available materials for electroanalytical applications and the lack of fundamental understanding of emergent structure-property relationships in new materials design.

This proposal synergistically merges research and pedagogy to improve the way we recruit, educate, and retain diverse workforce in materials chemistry. The pedagogical plan comprises two distinct initiatives focused on Wikipedia editing and research-style laboratory. The first initiative aims to develop and enhance critical thinking skills, and engage students in global conversation on a diverse set of topics in materials chemistry. The second initiative aims to address a significant gap in Dartmouth's curriculum in materials chemistry, which currently lacks any hands-on laboratory experience. Taken together, the outcome of the proposed work will provide the foundation for developing MOFs as a new class of materials for continuous electroanalysis and enhance training of students in materials chemistry.

Alison Narayan

Department of Chemistry, University of Michigan

Biocatalytic Reactions for Selective, Sustainable Synthesis and Engaging Graduate Student Instructors for Improved Outcomes in Organic Chemistry

Carbon–carbon biaryl bonds are a ubiquitous motif in compounds central to materials, pharmaceutical, and chemical biology research. Many current methods for biaryl C–C bond formation rely on prefunctionalization of each starting material to control the site of bond formation, adding to the number of synthetic steps required to reach a target compound. The proposed research plan describes the development of a biocatalytic method for biaryl C–C bond formation. This transformation does not require prefunctionalization at the site of bond formation, providing significantly more streamlined synthetic routes. The chiral environment of the enzyme active site confers exquisite site- and stereoselectivity, providing a single product from these biocatalytic oxidative coupling reactions. This efficient, sustainable method will be applied to the synthesis of complex bioactive natural products and fluorescent dyes for chemical biology applications.

Currently, graduate student instructors (GSI) teaching introductory organic chemistry are underprepared to teach this rigorous undergraduate course and are not viewed as a valuable resource by students. This impacts the GSIs teaching experience and also the learning outcome for the students. A three-part plan is proposed to remedy this problem: (1) increase GSI content knowledge, (2) improve GSI teaching strategies and (3) validate GSIs as a valuable course resource.

Kerstin Perez

Department of Physics, Massachusetts Institute of Technology

Closing in on Sterile Neutrino Dark Matter with NuSTAR

The particle nature of dark matter is a driving question of contemporary physics, with astrophysical experiments leading the search for dark matter annihilation or decay signatures. Sterile neutrinos, which could provide an elegant solution to the puzzle of the observed active neutrino masses and mixing, are among the most well- motivated dark matter candidates. The goal of this proposal is to optimize searches for astrophysical X-ray signatures of sterile neutrinos using the NuSTAR satellite observatory. This includes analysis of upcoming Galactic Center observations that were designed specifically to increase sensitivity to decaying dark matter, as well as developing additional targets and observation strategies that will maximize NuSTAR's sensitivity, providing the deepest search possible with this generation of X-ray instruments for the mass range ~10-50 keV.

The educational goal of this proposal is to increase the sense of "belonging" (as defined by the work of, e.g., Yeager and Walton) for women and under-represented/minoritized (URM) undergraduates in the MIT Physics Department, as a means to increase recruitment and retention of these students within the physics major and onwards into graduate education. This encompasses two separate activities: leveraging social-psychology/educational research to incorporate "affirmative interventions" in the first-year physics courses and building an undergraduate mentoring group for URM students in physics. This work builds on the PI's previous and ongoing collaborations with educational researchers to adapt introductory physics curricula to increase retention on underrepresented students.

2019 Cottrell Scholars Continued

Paul Raston
Department of Chemistry and Biochemistry, James Madison University

Laser Spectroscopic Investigation of Atmospherically Important Complexes at Ultra Low Temperature

This project aims to gain fundamental insight into the forces that drive atmospherically important reactions, and enhance the active-learning environment in undergraduate chemistry laboratories.

The research will explore the subtle interactions between atmospherically important molecules, such as O_3 and OH, in an effort to advance our understanding of the forces that drive atmospheric chemistry. In addition to synthesizing new species such as HOOOO, we plan to investigate the aqueous solvation of important atmospheric molecules (e.g., ClO), to understand the chemistry that occurs in/on cloud particles. An integrated approach will be employed that uses spectroscopy and quantum chemical calculations to determine the structure and energetics of these species. This will yield insights about atmospheric chemistry at the molecular level that may improve our predictive capabilities of the chemistry that occurs in Earth's atmosphere.

The educational component involves the development of software interfaces to control instrumentation used in undergraduate laboratory courses. These interfaces will have similar environments that reduce the learning curve associated with instrument-specific software, and will include "descriptive control" and "data analysis" features that allow for students to efficiently, and more independently, collect and analyze experimental data within the lab period. Students will gain confidence by not being so reliant on the instructor for technical guidance, which will allow for the instructor to focus more on guiding students towards understanding the chemistry. This approach has the potential to increase the amount of active learning in the lab, thus enhancing student engagement at a critical point in their education.

Emily Rauscher
Department of Astronomy, University of Michigan

Exo-Cartography: Resolving Three-Dimensional Images of Extrasolar Worlds

Remarkably, in 2012 astronomers were able to resolve a two-dimensional image of a planet outside of our solar system, using a technique called eclipse mapping. This method works by carefully measuring the change in light as a planet passes into eclipse behind its host star, as successive slices of the planet disk are obscured from view, and then again as the planet emerges from behind the star. However, this first exoplanet map was not the first of many—there was only one telescope sensitive enough and one planet bright enough for this technique to work. The highly anticipated launch of NASA's next great observatory, the James Webb Space Telescope, will enable ground-breaking new measurements across many fields of astrophysics. Its increased sensitivity will enable eclipse mapping of all of the brightest known transiting exoplanets and its spectral observations will probe different depths into the atmosphere, as gas is more or less opaque at different wavelengths. These data will thus contain three-dimensional information about planets' atmospheres, but we do not yet have the tools needed to reliably extract 3D images. Leveraging my robust (single-wavelength) eclipse mapping method, combined with my expertise in 3D modeling of exoplanet atmospheres, I propose to develop the framework necessary to resolve 3D maps of exoplanet atmospheres.

As someone interested in pushing forward our knowledge of the universe, and also in making the scientific pursuit more accessible to our students, I also propose to develop a research project component to add to my junior/senior-level Exoplanets course.

Shahir Rizk
Department of Chemistry and Biochemistry, Indiana University at South Bend

Reversible Self-Assembly of Bio-Responsive Nanostructures

The proposed research aims to use the ability of proteins to alternate between different conformations to engineer nanostructures that can reversibly self-assemble in response to their environment. Maltose binding protein (MBP) shifts from an open to a closed form in response to its ligand, maltose. Previously, we engineered antibody fragments (Fabs) that bind selectively to one conformation of MBP. In that manner, Fab and MBP associate only when maltose is added. Here, I propose using Fab-MBP fusions as the building blocks for large structures that can reversibly assemble in response to a ligand. This system is modular; by replacing MBP with a different ligand binding protein, the assembly/disassembly can be triggered by a different ligand, producing bio-responsive nanostructures that can act as biosensors. Additionally, I propose using bacteriophage as a scaffold to build mega-structures that can open and close in response to a chemical signal with the long-term goal of building shuttles for drug-delivery.

IUSB is a PUI with a large number of first-generation college students who have little contact with practicing scientists in their families or communities. My educational goal is to introduce students to the everyday aspects of practicing science and help them become more aware of the social and political impact of their chosen field. To accomplish this, I have dedicated discussion sections in upper-level courses to explore opposing views on current issues in science and technology, host seminars by guest lecturers, and prepare students to engage the public in meaningful conversations.

Tristan Smith
Department of Astronomy and Physics, Swarthmore College

Fundamental Tests of Gravity Across Time, Space, and Mass

One of the four fundamental forces of nature, gravity is unique in that it affects all matter and energy and is the weakest force. This makes gravity both ubiquitous and hard to measure. Einstein's theory of general relativity has been extensively tested over decades of research in our solar system, but gravitational effects on galactic and cosmological scales are still largely unknown. I am proposing to develop a new robust test of gravity by comparing the deflection of light around galaxies to the motion of stars within these galaxies. There are several gravity theories that attempt to explain the current period of accelerated expansion, match the predictions of general relativity in the solar system, but which make novel predictions on galactic and cosmological scales. The work proposed here will take advantage of recent advances in the observations of the dynamics of galaxies and utilize state-of-the-art simulations to apply these observations to viable alternative gravity theories.

Undergraduate education in the sciences generally focuses on training students on the methods of scientific inquiry, leaving little time to teach and practice essential communications skills. I propose to develop a science communication curriculum for summer research students at Swarthmore College. This work will build off of a curriculum I have already developed for a first-year physics course. Through this work I will develop resources that can be used by faculty members either during the regular semester or summer in order to bring a rich engagement with science communication to the undergraduate science curriculum.

2019 Cottrell Scholars Continued

Kana Takematsu
Department of Chemistry, Bowdoin College

Moving Multiple Charges with Light in Derivatized Naphthalene Photoacids

The controlled movement of charges is essential to redox processes in chemistry, including the harnessing of solar energy. The challenge of converting light energy into the motion of multiple charges resides in understanding how a single electronic excitation splits into driving orthogonal or sequential charge transfer processes. In nature, both the environment and substituents of the molecules involved in redox are optimized to drive the reactions. I propose to use a combination of spectroscopy and theory to investigate the proton dynamics of a novel family of naphthalene photoacids functionalized with substituents (OH, NH_2, CN, Br, Cl) to promote multiple proton transfer. The research will push our understanding of the effect of environment on proton dynamics by extending the reactions to an unconventional class of solvents, ionic liquids. These fundamental studies are critical for incorporating photoacids into applications such as photoactive polymers and catalysts.

The impacts of this work on public issues including energy and environmental sustainability, are broad, yet public engagement in the sciences is low. I propose to develop a nonmajors science course called "Chemistry and the Common Good" that builds on the community-based infrastructure of Bowdoin College to address this challenge. Over half of the students at the College participate in community service. Students in these programs match the relative diversity of Bowdoin, in contrast to the altered distribution of STEM majors. A nonmajors science course that connects chemical concepts to community issues would resonate with the student body and encourage participation among students traditionally underrepresented in STEM.

Weichao Tu
Department of Physics and Astronomy, West Virginia University

Understanding the Rapid Dropout of Killer Electrons in Earth's Radiation Belt with a New and Comprehensive Model

The fluxes of energetic "killer" electrons in Earth's outer radiation belt are observed to drop by orders of magnitudes on timescales of a few hours. Where do the electrons go during the dropout? This is one of the most important outstanding questions in radiation belt studies. The research objective of this application is to develop a new and comprehensive model, named Relativistic Electron Dropout (RED), to physically simulate the electron dropout and understand the governing processes. RED will include not only the traditional loss processes such as pitch angle diffusion, magnetopause shadowing, and outward radial diffusion, but also the new mechanism called drift orbit bifurcation. Physical quantification of these processes will be achieved based on realistic field and particle conditions. With these inputs, the RED model will simulate both the electron dropout observed at high altitudes and the electron precipitation observed at low altitudes to resolve the relative contribution of the different mechanisms.

Another urgent problem is that the topics of space science and space weather appear only adventitiously in formal instructional programs, and an appreciation of their importance is often lacking in current undergraduate curricula. To fill this gap, the educational objective of this application is to develop a new space science learning module, "Magnetospheres in the Solar System" (MiSS), for introductory undergraduate courses. The learning module will include interactive presentations, hands-on activities, and computer simulations. Assessment and state-wide dissemination will also be implemented to ensure the success and impact of the learning module.

Christina Vizcarra

Department of Chemistry, Barnard College

Small Molecule Inhibition of Formin Proteins: Specificity and Mechanisms of Action

Formins are a class of proteins that regulate the actin and microtubule cytoskeletons through complex mechanisms. Small molecules that target formins are a powerful way to probe cytoskeletal dynamics in cells. The small molecule formin inhibitor SMIFH2 has emerged as a mainstay of cytoskeletal research in the last decade. However, several fundamental questions about its mechanism of action remain unanswered. I propose to explore the specificity, structure-activity profile, and binding mode of SMIFH2. My research group will work with collaborators in using diverse experimental and computational techniques to build a detailed model of formin/inhibitor interaction. Such a comprehensive model will contribute fundamental knowledge about these proteins and also serve as a starting point for developing chemical probes to selectively target any formin isoform or function.

Integral to this project is a collaboration with the "Advanced Chemical Synthesis" laboratory course in our department. Together with my colleagues in organic chemistry, I am developing this project as a CURE in which advanced students learn multi-step organic synthesis and small molecule characterization in the context of a high-impact research program. In this proposal, I reflect on lessons learned from the pilot semesters of this CURE and propose ways to increase several important components of research-based education between students and bringing students into the discovery phase of research.

Justin Wilson

Department of Chemistry, Cornell University

Capturing the Heavy Alkaline Earth Elements: Ligand Design to Sequester Radioactive Strontium, Barium, and Radium

The heavy alkaline earth elements strontium, barium, and radium are environmental contaminants that negatively impact human health and industrial processing efforts. For example, radioactive isotopes of strontium and radium are widespread within nuclear waste repositories and in naturally occurring geological deposits of uranium, respectively. Barium presents an industrial problem, as the formation of insoluble $BaSO_4$ creates impervious clogs in petroleum-processing equipment. Despite the pervasive effects of these elements on society, few efforts have been undertaken to probe their coordination chemistry. *The objective of this proposal is to investigate the aqueous coordination chemistry of the heavy alkaline earth elements with the goal of finding new thermodynamically and kinetically stable chelating agents for these ions*. This research will be carried out through the accomplishment of three aims. First, new ligands based on the 18-membered diaza-18-crown-6 macrocycle will be synthesized. In the second aim, the alkaline earth ion-binding properties of these ligands will be systematically studied by assessing both thermodynamic and kinetic stabilities of their complexes. In the final aim, the utility of promising new ligands for sequestering radioactive ^{90}Sr and ^{226}Ra and for dissolving $BaSO_4$ will be investigated.

In response to the current shortage of trained nuclear chemists within the U.S., the educational plan of this proposal will incorporate nuclear chemistry into the curriculum at Cornell University and integrate this topic into K–12 outreach programs. Specifically, a new lab module on nuclear chemistry for use in Cornell's general chemistry courses will be developed, and K–12 outreach activities on this topic will be carried out by Cornell undergraduate and graduate students.

2019 Fulbright-Cottrell Scholars

Dominik Munz
Department of Chemistry, Friedrich-Alexander University

Synergy of Theory and Experiment for the Terminal Hydrocarbon Refinement

Novel catalytic protocols for redox catalysis are highly desirable in terms of economic and environmental considerations. I propose the synthesis of late transition metal compounds with multiple bonds to oxygen and nitrogen and their application in catalytic heteroatom transfer. Our research will delineate how to tame exceedingly reactive intermediates and how to harness their electronic properties to catalytically activate strong bonds.

Our synthetic efforts are always guided by computations. In general, computational methods have nowadays been matured to such an extent that even the *a priori* computational-rational design of novel catalysts appears feasible. However, the synthetic as well as theoretical communities are historically separated and the communication between the two remains a formidable challenge. My educational plan aims therefore at providing the synthetically oriented students the necessary insight to perform the modeling of their synthetic targets in synergy with their synthetic efforts. This integrated course involves an applied computational perspective on spectroscopic, electronic and mechanistic questions of interest in the department. It will feature original modified and/or own publications, which will guide the projects of the students. Overall, this course aims at stimulating creativity, critical thinking, independence, spontaneity, initiative and teamwork. Accordingly, I aim at providing the participants, which will have varying backgrounds, with a toolbox for computational approaches using freely available and easy to handle software for their own projects.

Hongbin Zhang
Department of Materials Science, Technical University of Darmstadt

In Silico Design of Functional Materials: An Integrated Paradigm Combining Quantum Mechanics and Thermodynamics

Data-driven materials design is an emergent field, comprising of high throughput screening, multi-scale modeling, and materials informatics. Density functional theory (DFT) plays a pivotal role within the theoretical framework, ensuring the predictive power. We aim at developing a new integrated paradigm to incorporate high throughput DFT calculations, machine learning, and CALPHAD phase diagram, to bridge the gap to multi-scale simulations and to experiments with mutual validation. While a particular goal falls on designing novel materials at the thermodynamic equilibrium with the competing phases, as well as explicit evaluation of the phase diagrams providing guidance to experimental synthesis, we also dedicate special attention to magnetic phase transitions where the underlying spin-lattice dynamics will be elucidated based on quantitative modeling with DFT accuracy.

From the teaching perspective, we are going to (a) implement the Teacher-Scholar model into the quantum mechanics courses; (b) develop hands-on Research Labs on quantum mechanics and thermodynamics to eliminate the barrier between fundamental principles and practical research; and (c) formulate efficient academic workflows based on digital tools. Such measures will help the students to transform from learning to doing research, enrich their scientific pictures and languages, and thus benefit their scientific lives. We aspire to establish a coherent model where teaching and research get simultaneously promoted, which can be implemented at an extensive scale in the future.

Conference Participants

Victor Acosta CS 2019
victormarcelacosta@gmail.com
Department of Physics & Astronomy,
University of New Mexico

My lab uses defects in diamond as quantum sensors for NMR and magnetic imaging. I am interested in developing a computational optics program that combines physicists, engineers, and CS students.

Mario Affatigato CS 1996
maffatig@coe.edu
Department of Physics, Coe College

I research glass and amorphous solids, novel fabrication methods (like levitation) and also spectroscopic techniques. Mostly all things glass. My educational interests focus primarily on undergraduate research, especially on materials. I have also looked at college retention.

Robbyn Anand CS 2019
rkanand@iastate.edu
Department of Chemistry, Iowa State University

Our goal is to simultaneously probe rate constants for hundreds of electrocatalytic reactions to rapidly advance sustainable energy. We create case studies that teach undergraduates core chemistry concepts through the lens of electrochemistry.

Sarbajit Banerjee CS 2010
banerjee@chem.tamu.edu
Department of Chemistry, Texas A&M University

Solid-state chemistry, energy storage, heterogeneous catalysis, electron correlation, X-ray spectroscopy, machine learning of synthesis. Diversity in STEM, first-year chemistry, undergraduate research, first-generation students, interdisciplinary graduate education.

Robert Berger CS 2017
Robert.Berger@wwu.edu
Department of Chemistry,
Western Washington University

I use DFT calculations to study relationships between crystal and electronic structure in solids. I teach undergraduate physical chemistry in a flipped classroom, including my own interactive computer simulation activities.

Gordon Berman CS 2019
gordon.berman@emory.edu
Department of Biology, Emory University

I study the physiological basis of animal behavior using techniques from nonlinear dynamics, statistical physics, and machine learning. I'm interested in improving student instruction in the analysis of high-dimensional scientific data.

Penny Beuning CS 2009
penny@neu.edu
Department of Chemistry, Northeastern University

DNA damage responses, DNA replication, and protein engineering, with applications in cancer, antibiotic resistance, and forensic science. Education interest in CUREs, undergraduate early research, classroom active learning, graduate student and faculty professional development.

Mishkatul Bhattacharya CS 2012
mb6154@gmail.com
Department of Physics,
Rochester Institute of Technology

My research is in theoretical quantum optics; I'm interested in atomic molecular and optical physics, superconductivity, superfluidity. I am interested in tools for making physics teaching effective at both undergraduate and graduate levels.

Karen Bjorkman CS 1999
karen.bjorkman@utoledo.edu
University of Toledo

Multi-wavelength observational astronomy, particularly circumstellar disks around massive stars; spectropolarimetry, spectroscopy, and photometry. Higher education administration and leadership; public outreach; diversity in STEM; engaging students in research and experiential learning.

Stephen Bradforth CS 1999
bradfort@usc.edu
Department of Chemistry,
University of Southern California

Ultrafast spectroscopy of liquid phase reaction dynamics, mechanisms of light harvesting in natural and artificial chromophore arrays. Implementing reform of undergraduate STEM education in research-intensive universities.

Richard Brutchey CS 2010
brutchey@usc.edu
Department of Chemistry,
University of Southern California

The Brutchey Group at USC works on the synthesis, surface chemistry, and application of nanocrystals for solar energy conversion, energy storage, and catalysis. Creating community college internships.

Mark Bussel CS 1994
mark.bussell@wwu.edu
Department of Chemistry,
Western Washington University

Thermal- and photo-catalysis over earth abundant metal phosphides. Building connections with community college faculty and students around energy and materials sciences.

Conference Participants Continued

Jeffery Byers CS 2015
jeffery.byers@bc.edu
Department of Chemistry, Boston College
I am interested in transition metal catalysis for the synthesis of new degradable polymers, assembly of biologically active molecules, and renewable fuels. I am interested in incorporating discrepant events in lectures and demonstrations and promoting active learning practices.

Luis Campos CS 2015
lcampos@columbia.edu
Department of Chemistry, Columbia University
Luis' research interests are rooted in Physical Macromolecular Chemistry. Luis is devoted to collaborative approaches to education, diversity and inclusion.

Dennis Cao CS 2019
dcao@macalester.edu
Department of Chemistry, Macalester College
The Cao Lab is pushing the limits of organic electronics by developing synthetic approaches toward novel molecular designs. I am building a database of real-world examples as a resource for evidence-based teaching of foundational organic chemistry concepts.

Caitlin Casey CS 2019
cmcasey@utexas.edu
Department of Astronomy, University of Texas at Austin
I study galaxy evolution from the perspective of gas and dust, from the formation of the earliest galaxies <1Gyr after the Big Bang to the present day. I'm interested in inquiry-based STEM pedagogy built within an equitable, inclusive framework.

John Cerne CS 2004
jcerne@buffalo.edu
Department of Physics, University at Buffalo, SUNY
Infrared polarization-sensitive spectroscopy to gain new insights into novel electronic materials ranging from superconductors to graphene. Increase engagement in large lecture classes and using radio-control flight to get students excited about science and technology.

Bert Chandler CS 2001
bert.chandler@trinity.edu
Department of Chemistry, Trinity University
The Chandler lab studies reactions over supported metal nanoparticle catalysts, especially reaction mechanisms, electronic effects, and bimetallic particles.

Louise Charkoudian CS 2018
lcharkou@haverford.edu
Department of Chemistry, Haverford College
Understanding protein interactions involved in natural product biosynthesis. Building rigorous and inclusive ways to engage undergraduate students in original research.

Eva-Maria Collins CS 2016
ecollin3@swarthmore.edu
Department of Biology, Swarthmore College
Role of biomechanics in Hydra regeneration and physiology; High-throughput developmental neurotoxicology; population diversity. Learning by doing; hands-on research; CURE.

Nathaniel Craig CS 2018
ncraig@ucsb.edu
Department of Physics,
University of California, Santa Barbara
My research focuses on understanding the fundamental properties of nature at the highest energies and shortest distances. I am keen to increase the instructional cross-section in courses with large and diverse enrollment.

Michael Dennin CS 2000
mdennin@uci.edu
Department of Physics, University of California, Irvine
The mechanical properties of foam and the behavior of emergent properties in complex systems. How to create and maintain cultural changes around teaching.

Will Dichtel CS 2012
wdichtel@northwestern.edu
Department of Chemistry, Northwestern University
Organic, polymer, and materials chemistry. Polymers with tiny holes that purify water or store electricity. Others rearrange bonds to be tough yet repairable. Encouraging students to love organic chemistry and appreciate its relevance; moving beyond student surveys for teaching evaluations.

Ashley Donovan
a_donovan@acs.org
Department of Education, American Chemical Society
Creating, highlighting, and facilitating professional development (teaching, research, service) opportunities for chemistry faculty at 2- and 4-year colleges. Introductory STEM.

Peter Dorhout CS 1994
dorhout@ksu.edu
Department of Chemistry, Kansas State University
Research in f-element solid state chemistry, understanding structure-function relationships. Preparing chemistry students for the workforce through safety and responsible conduct of research.

Conference Participants Continued

Brandon Echter
bechter@sciencefriday.com
Digital Department, Science Friday
I'm an expert in communicating science to the media and general public, as well as creating engaging strategies for science stories on the internet. I'm here to learn from all of you. I'm particularly interested in applied cephalopod science and how people engage with the internet.

Andrew Ellington CS 1995
ellingtonlab@gmail.com
Department of Synthetic Biology,
University of Texas at Austin
The Ellington lab works on synthetic biology, including the augmentation and directed evolution of proteins and organisms, and the development of facile biotechnologies, including point-of-care diagnostics. Dr. Ellington works on entrepreneurial outlets for education, key to both funding, and to retaining and expanding the interests of students.

Claude-André Faucher-Giguére CS 2018
cgiguere@northwestern.edu
Department of Physics and Astronomy,
Northwestern University
Galaxies, black holes, and the physics of cosmic structure formation. Cosmic structure formation.

Rafael Fernandes CS 2016
rfernand@umn.edu
Department of Physics and Astronomy,
University of Minnesota
I am interested in theoretical condensed matter physics, and particularly unconventional superconductivity. I am interested in applying active learning strategies to upper division Physics classes.

Edward Flagg CS 2017
edward.flagg@mail.wvu.edu
Department of Physics and Astronomy,
West Virginia University
I research solid-state quantum optics for quantum information: coherent photons, control of electron spins, and spin-photon interfaces. I'm interested in applying phys education research to upper-level undergrad courses: flipped classroom, peer instruction, problem solving.

Jonathan Foley CS 2019
jayfoley.iv@gmail.com
Department of Chemistry, William Patterson University
Designing materials to control light to control nanoscale energy flow and chemical reactivity. Fostering creative problem solving and quantitative reasoning in the next generation of chemists.

David Forbes CS 2000
dforbes@southalabama.edu
Department of Chemistry, University of South Alabama
Synthetic organic chemistry, ylide chemistry, methodology, small molecule prep/testing. Inquiry-based labs, team-based learning.

Kimberley Frederick
kfreder1@skidmore.edu
Department of Chemistry, Skidmore College
Paper and 3D printed microfluidic device development for environmental and biomedical applications. Active learning and course-based undergraduate research experience to improve success for diverse student populations.

Carla Frohlich CS 2014
cfrohli@ncsu.edu
Department of Physics, North Carolina State University
Computational multi-messenger astrophysics in supernovae and binary mergers: Explosions and their compact remnants, nucleosynthesis, neutrinos, gravitational waves, lightcurves and spectra. Professional development for junior faculty and students. Computational literacy for students. Teaching excellence in introductory physics.

Nathaniel Gabor CS 2017
nathaniel.gabor@ucr.edu
Department of Physics, University of California, Riverside
Lasers, circuits, quantum materials, and the rules of life. Big Data in the physical sciences to educate and mobilize the next generation of scientist-citizens.

John Gibbs CS 2018
john.gibbs@nau.edu
Department of Physics, Northern Arizona University
I am interested in the collective behavior of active colloidal matter and inorganic micro-swimmers.I am interested in developing new courses reflecting everyday realities of professional scientists.

John Gilbertson CS 2009
john.gilbertson@wwu.edu
Department of Chemistry,
Western Washington University
Small molecule activation, redox-activity, proton-responsivity. Active learning, course based undergraduate research.

David Ginger CS 2006
dginger@uw.edu
Department of Chemistry, University of Washington
We study next-generation solar energy and electronic materials by developing new methods to probe below the diffraction limit. I'm interested in modernizing interdisciplinary labs, teaching python to freshmen, and teaching our students to communicate science better.

Conference Participants Continued

Eilat Glikman CS 2017
eglikman@middlebury.edu
Department of Physics, Middlebury College

I study actively growing supermassive black holes (quasars) in distant merging galaxies. These systems help us understand galaxy evolution. I work with the STEM Posse program in a summer intensive that supports access to a talented yet underserved community of students.

Kamil Godula CS 2017
Kgodula@ucsd.edu
Department of Chemistry,
University of California, San Diego

Influencing of cellular functions through engineering of their sugar coating. Increasing fluency in topics related to carbohydrate biology among undergraduates.

Ian Gould CS 2001
igould@asu.edu
Department of Molecular Sciences,
Arizona State University

I study how the Earth does organic chemistry for applications in Green Chemistry and Origins of Life. I study socio-cognitive and socio-cultural factors that influence chemistry learning.

Noah Graham CS 2005
ngraham@middlebury.edu
Department of Physics, Middlebury College

Applications of scattering theory to quantum field theory and general relativity; nonlinear dynamics in cosmology; computational physics. Undergraduate teaching and mentoring, project-based learning, educational outreach, and science writing.

Kathryn Haas CS 2016
khaas@saintmarys.edu
Department of Chemistry, Saint Mary's College

How do extracellular proteins control Cu redox chemistry? Combining technology and research experiences to enhance undergraduate education in chemistry.

Bo Hammer
hammer@aip.org
American Institute of Physics

I am passionate about making science more diverse, equitable, and inclusive.

Amanda Hargrove CS 2017
amanda.hargrove@duke.edu
Department of Chemistry, Duke University

The Hargrove Lab explores RNA-biased small molecules and privileged RNA topologies for selective small molecule: RNA recognition. Hargrove Lab is implementing a CURE where students ID patterns in RNA recognition via VR, binding assays and principal component analysis.

Michael Hayden CS 1994
hayden@umbc.edu
Department of Physics,
University of Maryland, Baltimore County

Our research focuses on light-matter interactions on the sub-picosecond timescale. Our current interest is in carrier dynamics in 2D and organic semiconductors. My current educational interest is focused on hiring new faculty and mentoring/enabling them to be "teacher-scholars".

Jennifer Heemstra CS 2015
jen.heemstra@emory.edu
Department of Chemistry, Emory University

Bio-supramolecular chem: leveraging biomolecular recognition for applications in biosensing, bioimaging, and responsive architectures. Leveraging research to learn from failure, promote growth mindset, and cultivate future science leaders.

Ute Hellmich FCS 2017
u.hellmich@uni-mainz.de
Department of Pharmacy, Mainz University

Structure and dynamics of (membrane) proteins from microorganism to man—with a special focus on lipid and inhibitor interactions. Remind students of the original enthusiasm that prompted them to take up their studies, to make them enjoy learning about science.

Michael Hildreth CS 2003
mhildret@nd.edu
Department of Physics, University of Notre Dame

I am an experimental particle physicist studying the properties of the Higgs boson, searching for new physics, applying new computational techniques, and preserving data. I am a proponent of active learning at all levels and have been working in laboratory instruction and policies of insitutional change.

Benjamin Hunt CS 2019
bmhunt@andrew.cmu.edu
Department of Physics, Carnegie Mellon University

Two-dimensional materials: superconductors, topological insulators, ferroelectrics. Low-temperature measurements: transport, quantum capacitance, scanning tunneling microscopy. Improving the undergraduate research experience, especially in a condensed-matter laboratory.

William Jenks CS 1995
wsjenks@iastate.edu
Department of Chemistry, Iowa State University

I am a physical organic chemist, primarily interested in photochemistry and reactive intermediates. Promoting the cultural idea that classroom instruction needs the same care and prioritization as research, despite our reward structure.

Conference Participants Continued

Darren Johnson CS 2006
dwj@uoregon.edu
Department of Chemistry, University of Oregon
Our interests span from the fundamental science to the agricultural, environmental, and biomedical applications of ion and molecule recognition. Interests span inquiry-based techniques in phys-org chemistry, research "immersion" labs, and professional development in innovation.

Chengfeng Ke CS 2019
chenfeng.ke@dartmouth.edu
Department of Chemistry, Dartmouth College
We focus on developing smart materials for 3D/4D printing, and elastic crystalline porous organic materials for energy-related applications. We aim to retain female students in STEM, as well as motivating and inspiring students of all backgrounds considering STEM majors.

Sarah Keller CS 2003
slkeller@chem.washington.edu
Department of Chemistry, University of Washington
We focus on developing smart materials for 3D/4D printing, and elastic crystalline porous organic materials for energy-related applications. Chemical education research to determine if math preparation improves student learning. Improving communication between PIs and mentees.

Dusan Keres CS 2016
dkeres@physics.ucsd.edu
Department of Physics,
University of California, San Diego
Evolution of galaxies and circum-galactic medium, galactic gas flows, stellar feedback, cosmic rays and dark matter. Active learning, think-pair-share, project-based learning (including computation-based projects).

Minsu Kim CS 2017
minsu.kim@emory.edu
Department of Physics, Emory Washington
I want to understand how antibiotics kill cells. I want to develop a biophysics curriculum.

Evan Kirby CS 2018
enk@astro.caltech.edu
Department of Astronomy,
California Institute of Technology
How are elements created in supernovae and other astrophysical events? What happens to these elements after they are released into galaxies? How can active learning be used to increase classroom engagement and to enhance learning outcomes?

Kirill Korolev CS 2017
korolev@bu.edu
Department of Physics, Boston University
Statistical physics of population dynamics from microbial biofilms to invasive species data science and computational physics for undergraduate and graduate students.

Michelle Kovarik CS 2017
michelle.kovarik@trincoll.edu
Department of Chemistry, Trinity College
How can we measure chemical information in single cells? Is cellular variation in stress response adaptive? Can we adapt molecular and microfluidic tools to new applications? How can we engage undergraduates with the primary literature? Do students think of themselves as readers and writers as well as scientists?

Tim Kowalczyk CS 2018
Tim.Kowalczyk@wwu.edu
Department of Chemistry,
Western Washington University
Energy conversion and storage in light-absorbing materials; simulations of excited-state electronic structure in complex environments. Integrating multiple representations in students' engagement with energy in chemistry curricula; energy literacy in the community.

Janelle Leger CS 2009
janelle.leger@wwu.edu
Department of Physics, Western Washington University
Plasmonics, organic electronics and energy conversion devices. Undergraduate and masters level education in physics and materials science. Inclusive and student-centered instructional strategies.

Adam Leibovich CS 2006
akl2@pitt.edu
Department of Physics, University of Pittsburgh
I work on theoretical physics, in particular applications of effective field theory to heavy quark physics, jets, and gravitational waves. I have worked on a number of different projects, including introductory physics, using programming in intro physics, and graduate physics.

Laura Lopez CS 2019
lopez.513@osu.edu
Department of Astronomy, The Ohio State University
Studies the birth and death of stars and the interstellar medium using telescopes at all wavelengths. Interested in retention of diverse students through bridge programs and hands-on research experience.

Conference Participants Continued

Tyler Luchko CS 2017
tluchko@csun.edu
Department of Physics,
California State University, Northridge
Modeling solvation at biomolecular interfaces: solvation thermodynamics, protein-ligand and protein-protein binding, and liquid state theory. Improving graduation rates (undergraduate and graduate), active learning, and student learning skills.

Gina MacDonald CS 1997
Macdongx@jmu.edu
Department of Chemistry, James Madison University
Our research utilizes a variety of spectroscopic techniques to study proteins, small molecules and lipids. In particular we are interested in studying how altering solution conditions influences the stability, aggregation and solvation of these molecules. CURE's and active learning in large classrooms to increase student performance and inclusivity.

James Martin CS 1997
jim_martin@ncsu.edu
Department of Chemistry, North Carolina University
Structure and reaction mechanisms of condensed phase reactions. Critical thinking in curricula.

Ellen Matson CS 2019
matson@chem.rochester.edu
Department of Chemistry, Rochester University
Synthesis and reactivity of site-differentiated, metal-oxide clusters. Integration of outreach activities into undergraduate curriculum.

Charles McCrory CS 2019
cmccrory@umich.edu
Department of Chemistry, University of Michigan
We control an electrocatalyst's chemical environments to increase the system's activity and efficiency for energy-relevant transformations. My goal is to improve interactions between students and teaching assistants in large classes to promote development of conceptual knowledge.

Ryan McGorty CS 2019
rmcgorty@sandiego.edu
Department of Physics, University of San Diego
Soft matter & biophysics: phase transitions studied using colloids and diffusion in biomimetic settings. Developing new microscopy methods. Undergraduate research early and in and out of classroom. Democratizing science. Physics for life sciences, biophysics, optics.

Maiken Mikkelsen CS 2016
m.mikkelsen@duke.edu
Department of Physics, Duke University
Probing the interplay between nanoscale design and optical properties of materials. Making quantum physics come alive.

Emily Miller
emily.miller@aau.edu
Association of American Universities
Improving the quality and effectiveness of undergraduate and graduate education at research universities by addressing critical institutional barriers. Higher education leadership.

Katherine Mirica CS 2019
katherine.a.mirica@dartmouth.edu
Department of Chemistry, Dartmouth College
My research focuses on molecular engineering of multifunctional materials for chemical sensing, microelectronics, and energy challenges. My teaching interests include understanding creativity in science, implementation of active learning, and Wikipedia editing.

Garret Miyake CS 2018
garret.miyake@colostate.edu
Department of Chemistry, Colorado State University
We use light for the synthesis of small molecules and polymers and make nanostructured polymeric materials that reflect light. I am developing undergraduate laboratory and lecture courses focusing on polymer chemistry and organic materials.

James Moore
moore@fulbright.de
Department of Special Programs, Fulbright Germany
Turning nations into people.

Kathryn Mouzakis CS 2017
kathryn.mouzakis@lmu.edu
Department of Chemistry, Loyola Marymount University
Interested in how RNA structures fold in 3D and what components of those structures are most critical for functional outcomes. Lots of experience with CUREs. Very excited about adding intentional instruction on scientific communication to undergraduate education.

Karl Mueller CS 1996
karl.mueller@pnnl.gov
Physical and Computational Sciences,
Pacific Northwest National Laboratory
Magnetic resonance and multi-modal spectroscopic and imaging studies of energy storage materials.Identifying and training the next generation of pluridisciplinary leaders to conquer scientific grand challenges for the world.

Conference Participants Continued

Dominik Munz FCS 2019
dominik.munz@fau.de
Department of Chemistry, Friedrich-Alexander University
I love synthetic inorganic and organic chemistry and apply molecular modelling to isolate and study reactive intermediates for catalysis and optoelectronic organic materials. I want to promote enthusiasm, independent and critical thinking, and creativity.

Kater Murch CS 2018
murch@physics.wustl.edu
Department of Physics, Washington University
Quantum measurement with superconducting circuits. Modernizing teaching practices in advanced physics courses.

Alison Narayan CS 2019
arhardin@umich.edu
Department of Chemistry, University of Michigan
Harnessing the power of biosynthetic enzymes for organic synthesis. Demystifying organic chemistry.

James Neilson CS 2017
james.neilson@colostate.edu
Department of Chemistry, Colorado State University
Solid-state and materials chemistry. Kinetic control. Materials for energy. Undergraduate research, teaching general chemistry, flipping graduate classes.

Andriy Nevidomskyy CS 2014
nevidomskyy@rice.edu
Department of Physics, Rice University
Theoretical condensed matter physics, working on magnetism, superconductivity and topological phases of matter. Active learning in upper-level undergraduate classes; effective mentoring practices, including career advising for Ph.D. students.

Katie Orenstein
nevidomskyy@rice.edu
Founder and CEO, The OpEd Project
I am interested in who narrates our world.

David Patrick CS 1997
david.patrick@wwu.edu
Department of Chemistry,
Western Washington University
Molecular crystallization and growth; crystal engineering; optical materials and light management for solar energy harvesting. Analytical and materials chemistry; energy science.

Kerstin Perez CS 2019
kmperez@mit.edu
Department of Physics,
Massachusetts Institute of Technology
I am building instruments that use cosmic particles to look for beyond the Standard Model physics, in particular evidence of dark matter interactions. I am interested in modifying introductory courses to increase retention of students from underrepresented backgrounds in the physics major.

Nicola Pohl CS 2003
npohl@indiana.edu
Department of Chemistry, Indiana University
The Pohl labs are developing machine-assisted methods and uncovering chemical rules to make and analyze carbohydrates for vaccine design/immunology. I am incorporating cutting-edge research and all five senses into the undergraduate organic/analytical/biochemistry lab and lecture classes.

Paul Raston CS 2019
rastonpl@jmu.edu
Department of Chemistry, James Madison University
Laser spectroscopy of unstable molecules, preferably ones that play an important role in combustion, the atmosphere, or interstellar space. Teaching physical chemistry to undergrads in lecture and lab, and developing tools that help students with discovery-based experimentation.

Emily Rauscher CS 2019
erausche@umich.edu
Department of Astronomy, University of Michigan
I am an expert in 3D models of exoplanet atmospheres. I work on ways to observationally constrain complex, multi-dimensional properties. I want to implement course-based undergraduate research experiences in my own class. I care about equity and inclusivity in academia.

Shahir Rizk CS 2019
srizk@iusb.edu
Department of Chemistry, Indiana University South Bend
Engineering proteins for reversible self-assembly in response to biological signals for biosensor design and drug delivery applications. Providing students with critical thinking skills in the context of current issues in science policy to engage non-scientists in discussions.

Sean Roberts CS 2018
roberts@cm.utexas.edu
Department of Chemistry, University of Texas at Austin
Energy and charge migration in disordered materials. Spin Dynamics. Ultrafast Spectroscopy and nonlinear optics. Solar energy conversion. Building partnerships between four-year universities and local community colleges. Incorporating research into undergraduate curricula.

Conference Participants Continued

Michael Rose CS 2016
mrose@cm.utexas.edu
Department of Chemistry, University of Texas at Austin
Using inorganic synthesis, we study the structure and function of Bio-Inorganic systems (Hydrogenase and Nitrogenase), Heavy-atom (Sb, Bi) complexes of late 3d metals, and Silicon|Organic interfaces. Utilizing Undergraduates in outreach.

Jennifer Ross CS 2010
rossj@physics.umass.edu
Department of Physics,
University of Massachusetts, Amherst
Elucidating the physical principles of how cells organize their insides without a manager. Active learning, intentional teaching and mentoring, engaging students in independent research and projects.

Vincent Rotello CS 1996
rotello@chem.umass.edu
Department of Chemistry,
University of Massachusetts
We create nanomaterials to fight wound infections, treat cancer, edit genes, perform bioorthogonal catalysis, provide point of care diagnostics…I focus on creation of graduate curricula that address issues beyond the textbook, including career planning and soft skills.

Lisa Ryno CS 2018
lryno@oberlin.edu
Department of Chemistry, Oberlin College
We are studying the relationship between flagellar and curli signaling pathways during biofilm formation to find new targets for antibiofilm drug development. I'm interested in improving retention of underrepresented students in STEM through the creating of near-peer mentoring groups.

Steffen Schumann FCS 2017
steffen.schumann@phys.uni-goettingen.de
Department of Physics, University of Goettingen
Theoretical particle physicist dealing with the modelling of scattering events at high-energy colliders. I am eager to bring in numerical methods in our undergraduate education.

Benjamin Schwartz CS 1999
schwartz@chem.ucla.edu
Department of Chemistry,
University of California, Los Angeles
I am interested in electronic structure in complex environments, including solvated electrons and conjugated polymers. I am interested in methods that close the achievement gap for underrepresented students.

Susannah Scott CS 1997
sscott@ucsb.edu
Department of Chemistry,
University of California, Santa Barbara
I design catalysts and develop new kinetic and spectroscopic methods for studying reactions at interfaces. I use modern societal needs to teach freshman chemistry, and am piloting a graduate-level course on writing scientific manuscripts.

Mats Selen CS 1996
mats@illinois.edu
Department of Physics,
University of Illinois, Urbana-Champaign
Designing and assessing introductory physics labs focused on writing and scientific skills in classes of 1,000 students per semester. Sustainable implementation of our new skills-based intro physics labs for about 5,000 undergraduates and 100 TA's per year.

Scott Shaw CS 2016
scott-k-shaw@uiowa.edu
Department of Chemistry, University of Iowa
We measure molecules at surfaces and try to make them do fun tricks. I like talking with students rather than at them. I also like getting non-science public to understand the big picture benefits of science.

George Shields CS 1994
george.shields@furman.edu
Department of Chemistry, Furman University
Computational Chemistry, Physical Chemistry, Atmospheric Chemistry, Structural Biology. Science Education, Inclusive Excellence, Inclusive Pedagogy.

Natalia Shustova CS 2017
shustova@gmail.com
Department of Chemistry, University of South Carolina
Photophysics and electronic structure of hybrid materials including metal-organic frameworks and covalent-organic frameworks. Women-in-Science (Wi-Sci) Educational Network which goal is to create a supportive network for women in STEM disciplines.

Bradley Smith CS 1994
smith.115@nd.edu
Department of Chemistry, University of Notre Dame
Fluorescent probes for biomedical imaging. Supramolecular chemistry applied to biological systems. Undergraduate focuses on organic chemistry, with an interest on student learning concepts that are inherently three dimensional.

Conference Participants Continued

Tristan Smith CS 2019
tsmith2@swarthmore.edu
Department of Physics, Swarthmore College
Early universe cosmology and gravitational wave astrophysics. Undergraduate research/teaching and effective science communication.

Scott Snyder CS 2009
sasnyder@uchicago.edu
Department of Chemistry, University of Chicago
Development of new reagents, reactions, and strategies for the efficient chemical synthesis of complex natural products. To instill an appreciation of the power of organic chemistry to change society and a passion to explore new territory through scholarship.

Tom Solomon CS 1995
tsolomon@bucknell.edu
Department of Physics, Bucknell University
Chaotic fluid mixing and the effects of fluid flows on front propagation and on the motion of self-propelled tracers ("active mixing"). Active learning and reflection in introductory courses; undergraduate research; lessening the adverse effects of GPA in higher education.

Keivan Stassun CS 2006
keivan.stassun@vanderbilt.edu
Department of Physics, Vanderbilt University
Stellar astrophysics, exoplanets, data science. Diversity at the PhD level, including neurodiversity.

Grace Stokes CS 2018
gstokes@scu.edu
Department of Chemistry, Santa Clara University
I use nonlinear optical spectroscopies to study peptide-lipid interactions to predict human health impact of potential drugs. I integrate Python-based activities into p-chem and gen chem to teach quantitative skills and increase retention of first gen college students.

Joseph Subotnik CS 2014
subotnik@sas.upenn.edu
Department of Chemistry, University of Pennsylvania
I work on problems in theoretical chemistry, with a focus on energy conversion problems, including nuclear, electronic and photonic degrees of freedom. I am very interested in using computers and programming to teach undergrads how to be quantitative in general chemistry courses (and above).

Kana Takematsu CS 2019
ktakemat@bowdoin.edu
Department of Chemistry, Bowdoin College
Investigate how to move protons and electrons with light using photoactive compounds embedded in novel environments such as ionic liquids. Explore how to teach quantitative chemistry courses to diverse students and develop community-based science courses to promote inclusion.

Sarah Tolbert
tolbert@chem.ucla.edu
Department of Chemistry,
University of California, Los Angeles
I am interested in synthesizing nanostructured materials for applications in photovoltaics, energy storage, manipulated magnetism and thermal management. I have developed an outreach program bringing nanoscience experiments and concepts to LA area high schools.

Sheryl Tucker CS 1999
sheryl.tucker@okstate.edu
Academic Affairs, Oklahoma State University
Developing graduate education practices that provide access and opportunity for diverse student populations and promote timely degree completion. Implementing graduate education best practices that attract, retain and graduate students with critical skills for lifelong career success.

Adam Urbach CS 2005
aurbach@trinity.edu
Department of Chemistry, Trinity University
Fundamental and applied studies of the molecular recognition of peptides and proteins by synthetic receptors. Professional development of undergraduate students and postdoctoral scholars.

Brett VanVeller CS 2018
bvv@iastate.edu
Department of Chemistry, Iowa State University
Organic photochemistry. Chemical biology. Peptide chemistry. Comparative analysis as a model of learning.

Olalla Vázquez FCS 2016
vazquezv@staff.uni-marburg.de
Department of Chemistry, Philipps-Universität Marburg
Chemical Biology. Light-driven chemical tools to understand and manipulate biological process at molecular level. Epigenetic chemical probes. Research-based teaching strategies; multidisciplinary approaches and active learning.

Conference Participants Continued

Christina Vizcarra CS 2019
cvizcarr@barnard.edu
Department of Chemistry, Barnard University
The Vizcarra lab studies how drugs interact with multifunctional cytoskeletal regulatory proteins. The Vizcarra lab collaborates with undergraduate students in a chemical synthesis laboratory course to further education and research.

Barrett Wells CS 2002
barrett.wells@uconn.edu
Department of Physics, University of Connecticut
Synthesis and experiments on new materials with unconventional superconductivity, quantum phase transitions, weird structural transitions. Implementation of fully interactive, studio format teaching for large introductory courses leading to similar approaches for majors.

Timothy Wencewicz CS 2017
wencewicz@wustl.edu
Department of Chemistry,
Washington University in St. Louis
Non-traditional antibiotic strategies to overcome resistance. Focusing organic chemistry curriculum to engage diverse student groups.

Luisa Whittaker-Brooks CS 2018
luisa.whittaker@utah.edu
Department of Chemistry, University of Utah
Deep understanding of chemical processes and ion-migration in energy storage materials and devices via in situ and in operando techniques. Transforming the chemistry experience by replacing weed-out courses with more deep-root courses early on in student's college careers.

Michael Wilczek FCS 2018
michael.wilczek@ds.mpg.de
Department of Physics,
Max Planck Research Group Turbulent Flows
My research interests range from complex flows and turbulence to active matter. Examples include turbulence in the atmosphere and swarming behavior of microorganisms, which I am investigating with a combination of analytical computations and computer simulations. I'd like to learn more about modern teaching strategies and methods.

Justin Wilson CS 2019
jjw275@cornell.edu
Department of Chemistry, Cornell University
My group explores strategies to control labile metals ion in biological and industrial settings via the implementation of novel ligands. My education interests are focused on expanding the coverage of nuclear chemistry in the chemistry curriculum at different education levels.

Amanda Wolfe CS 2017
awolfe@unca.edu
Department of Chemistry,
University of North Carolina Asheville
The Wolfe lab works on the discovery and development of novel small molecule antibiotics. I am interested in improving undergraduate research experiences through better preparation in the curriculum.

Yan Xia CS 2017
yanx@stanford.edu
Department of Chemistry, Stanford University
Polymer Chemistry and Soft Materials, including Polymer Mechanochemistry, Microporous Polymer Membranes, Conjugated Materials, Polymer Networks and Complexes. Inquiry and problem based learning in a research-like active learning environment.

Di Xiao CS 2016
dixiao@cmu.edu
Department of Physics, Carnegie Mellon University
Theoretical condensed matter physics. Computer assisted learning.

Hongbin Zhang FCS 2019
hzhang@tmm.tu-darmstadt.de
Institute of Materials Science,
Technical University of Darmstadt
Our focus is to design functional materials based on high throughput density functional theory calculations and big data technologies, particularly on multiscale modeling of magnetic materials. The key problem I am thinking is how to bridge theoretical courses to actual researches

Research Corporation Participants

Danielle Dana
Board of Directors
danielle@sciencefriday.com

Kathy Eckert
Senior Program Assistant
keckert@rescorp.org

Laura Esham
Program Assistant, Post Awards Coordinator
lesham@rescorp.org

Andrew Feig
Program Director
afeig@rescorp.org

Danny Gasch
Vice President, Chief Financial Officer
dgasch@rescorp.org

Dan Huff
Communications Director
dhuff@rescorp.org

Kylie Johnson
Program Assistant, Event Coordinator
kjohnson@rescorp.org

Dan Linzer
President
dlinzer@rescorp.org

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sronco@rescorp.org

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rwiener@rescorp.org

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