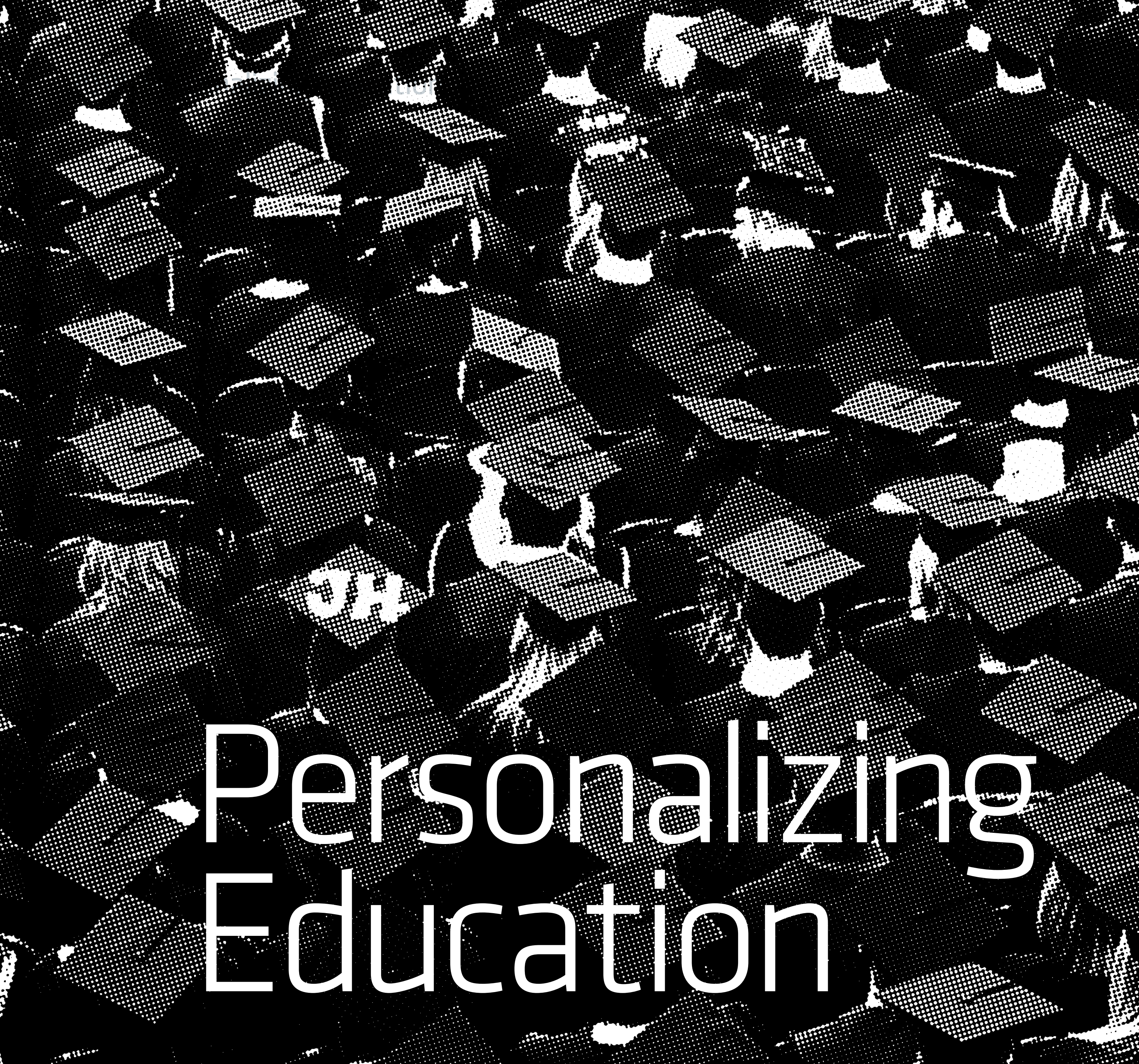

Personalizing Education

COTTRELL SCHOLAR CONFERENCE

RESEARCH CORPORATION *for* SCIENCE ADVANCEMENT

2018 Conference Planning Committee

Zachary Schultz, Chair
Department of Chemistry and Biochemistry,
The Ohio State University

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Department of Physics,
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Department of Chemistry,
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Department of Chemistry,
University of California, Irvine

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

Letter from the President	2
Letter from the Program Chairs	3
Conference Objectives, Survey, and Diversity and Inclusion Statement	4
Agenda and Meeting Room Maps	5
Conference Keynote Speaker	9
FRED Award Winner	10
TREE Award Winners	11
Presentations by Cottrell and Fulbright-Cottrell Scholars	13
Presentations by Cottrell Scholars Collaborative Teams	14
Cottrell Scholars Collaborative Proposal Writing Rules	14
Profiles of 2018 Cottrell Scholars	15
Profiles of 2018 Fulbright-Cottrell Scholars	27
Networking Directory	28
Conference Participants	36

From the President

I am delighted to welcome and join you at the 2018 Cottrell Scholar Conference, my first as President of Research Corporation for Science Advancement. Our 24 new Cottrell Scholars are now part of an amazing group of colleagues who are conducting path-breaking research, developing exciting ways to improve student learning, and serving in leadership roles within and beyond their home institutions.

As I have learned about the foundation this past year, I have been quite impressed with the Cottrell Scholar Program. Past and current Scholars have emphasized to me that this award is much more than recognition for a successful research record prior to moving into an independent position, which is often the primary criterion for early career faculty awards. It is also much more than the funding! Instead, Cottrell Scholars have pointed out that they value the:

- Community of faculty who share a deep commitment to both research and education;
- Opportunity to learn about teaching innovations that can be applied in their courses;
- Conversations across the physical sciences with exposure to complementary research fields and methods;
- Diversity of faculty, including faculty from different types of institutions and with a broad distribution across the country;
- Encouragement to identify collaborative initiatives that would benefit the Cottrell Scholar community, and other faculty in chemistry, physics, and astronomy;
- Deep engagement in an important issue at the annual conference;
- Introduction to, and mentoring by, past Cottrell Scholars and Senior Program Directors Silvia Ronco and Richard Wiener; and
- Membership in the RCSA family, which can lead to additional support for new research directions.

Over the past couple of decades, we have seen a shift in our approach to undergraduate education, moving the emphasis from how faculty teach to how students learn. As quantitative scientists, Cottrell Scholars are especially attuned to the importance of experimental design and data analytics, and we will have the chance over the next few days to take that scientific approach to questions of how students learn most effectively. I would like to thank Tim McKay, the Arthur F. Thurnau Professor of Physics, Astronomy, Education, and the Director of the Digital Innovation Greenhouse, for guiding us in this exploration.

I look forward to meeting each of you, and to sharing several days of talking about science research and science education with you. Enjoy the conference!

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

From the Program Directors

Welcome to the 2018 Cottrell Scholar Conference!

Student success, inclusion and diversity, and tailoring educational methods to students' backgrounds are key issues in STEM education today, and thus highly appropriate as the focus of our 24th-annual conference.

In his presentation, "*Equity in STEM Education—Personalizing Education for Student Success,*" keynote speaker Tim McKay (Arthur F. Thurnau Professor of Physics, Astronomy and Education, and Director of the Digital Innovation Greenhouse at the University of Michigan) will address these issues head-on and will encourage the audience to explore ways to implement change at their institutions.

We also have on hand a magnificent set of discussion facilitators with extensive experience on students' programs, mentoring, assessment and effective science curriculum. We're hoping the ideas generated from your interactions with these accomplished teacher-scholars—in Q&A sessions, during official breakout sessions, and in your numerous one-on-one conversations during the next two-and-a-half days—will lead to a new level of awareness of the need for effective methods for teaching and mentoring the next generation of scientists.

Inclusiveness and diversity begin with you. So listen, speak up, and, above all, network with conference participants. A main goal of the conference is to get to know each other!

A great way to pursue new ideas and quality projects is to participate in the Cottrell Scholars Collaborative. 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 a good way to develop your academic leadership skills.

We hope you find this event informative and stimulating. Please contact us with advice on how to make both the CS program and the conference even better!

Zachary Schultz
Associate Professor of Chemistry and Biochemistry
The Ohio State University

Silvia Ronco
Senior Program Director
Research Corporation for Science Advancement

Conference Objectives and Survey

To empower scholars to promote personalized educational methods and student success in academic settings, participants will:

- Discuss successful activities and approaches for engaging with students, colleagues, and administrators at different types of institutions.
- Learn how to work with colleagues and administrators to engender buy-in for educational change.
- Explore partnerships engaging diverse constituents.
- Become familiar with ongoing activities aimed at transforming STEM education at the national level.
- Identify tactics that enable collective action.
- Have the opportunity to form teams and become involved in educational projects of national impact.
- Engage in collaborative work that will continue throughout the year.

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.

Conference Evaluation Survey

An online conference survey will be available on **Friday, July 13, 2018**. To access and complete the survey, please go to: http://www.surveymonkey.com/r/2018CSConferenceSurvey

2018 Cottrell Scholar Conference Agenda

Personalizing Education:
Exploring Approaches and Resources to Promote Student Success
Westin La Paloma

Wednesday, July 11, 2018

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 - 5:00 pm	**Welcome and Introductions** Dan Linzer, RCSA President **Conference Overview and Goals** Silvia Ronco, Zachary Schultz **Introduction of Scholars**	Murphey
5:00 - 6:15 pm	**2018 Cottrell Scholar Presentations**	Murphey
6:30 - 8:30 pm	**Dinner**	Sonoran I
7:30 - 8:15 pm	**2018 FRED Award Presentation** Sara Skrabalak, Indiana University **Cottrell Scholar Trophy Ceremony**	

2018 Cottrell Scholar Conference Agenda

Personalizing Education:
Exploring Approaches and Resources to Promote Student Success
Westin La Paloma

Thursday, July 12, 2018

7:00 am	**Registration**	Finger Rock Foyer
7:30 - 8:30 am	**Breakfast**	Murphey Patio
8:30 - 10:00 am	**2018 Cottrell Scholar Presentations**	Murphey
10:00 - 10:15 am	**Morning Break**	Finger Rock Foyer
10:15 am - 12:00 pm	**Breakout Session I** *Defining Impact of Personalized Education* Diversity Retention Methodology Mentoring Students **Report Out**	Finger Rock I, II, III & Primrose
12:00 - 1:00 pm	**Lunch**	Sonoran
1:00 - 2:30 pm	**Keynote Presentation** *"Equity in STEM Education–Personalizing Education for Student Success"* Timothy McKay, Physics, University of Michigan **Discussion / Q&A**	Murphey
2:30 - 2:45 pm	**Afternoon Break**	Finger Rock Foyer
2:45 - 4:15 pm	**Breakout Session II** *Implementation–Different Settings* Large and small classes Lecture/Lab/CURE Assessment **Report Out**	Finger Rock I, II, III & Primrose Murphey
4:15 - 5:00 pm	**2018 TREE Award Presentation** Martin Gruebele, Chemistry, University of Illinois at Urbana-Champaign	Murphey
5:00 - 6:30 pm	**Pool Time** Swimming & Informal Discussions	
6:30 - 7:30 pm	**Reception Honoring New Scholars** Poster Session with Drinks & Light Hors d'Oeuvres	Sonoran
7:30 - 9:30 pm	**Dinner**	Sonoran
8:00 - 8:45 pm	**2018 TREE Award Presentation** Teri Odom, Chemistry, Northwestern University	Sonoran

2018 Cottrell Scholar Conference Agenda Continued

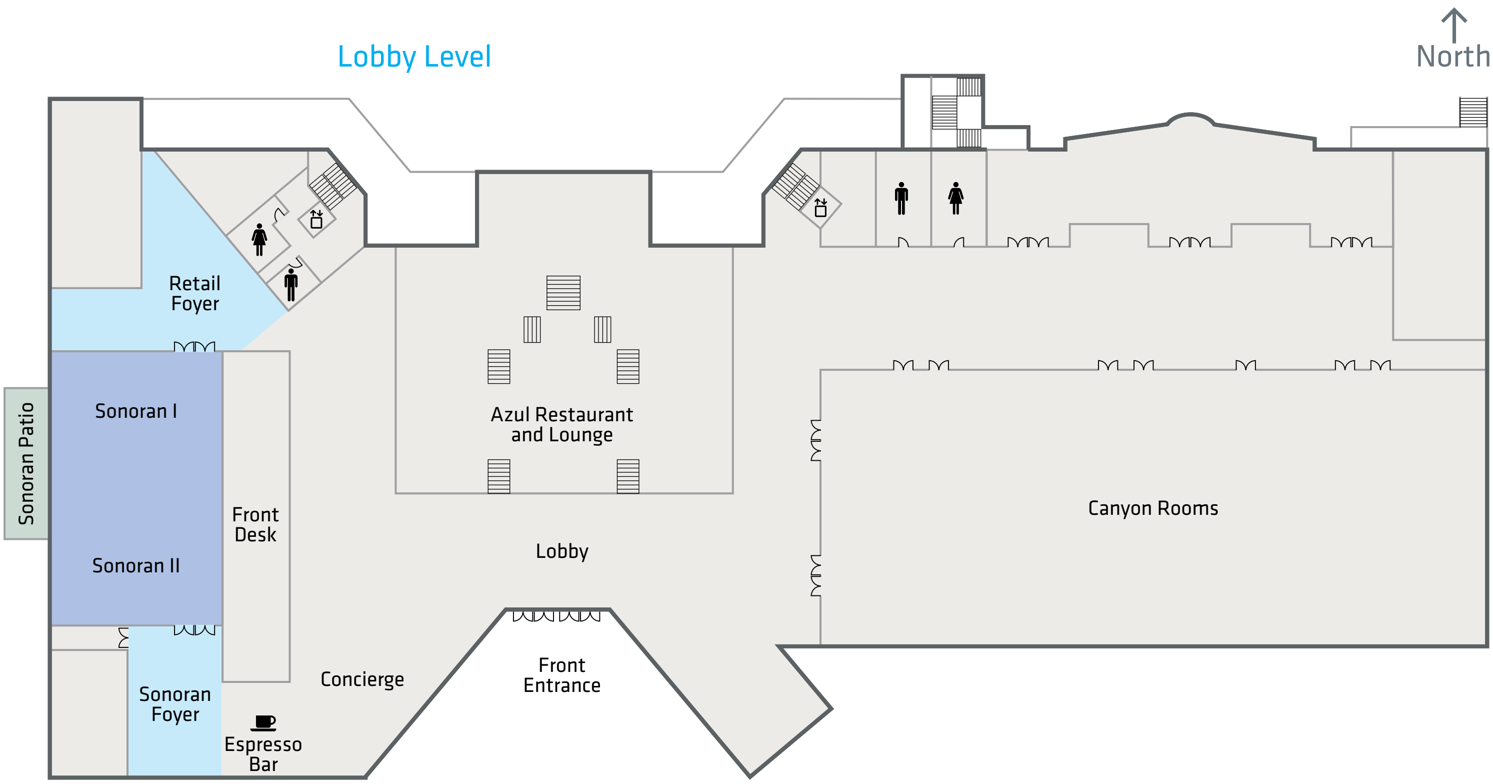
Personalizing Education:
Exploring Approaches and Resources to Promote Student Success
Westin La Paloma

Friday, July 13, 2018

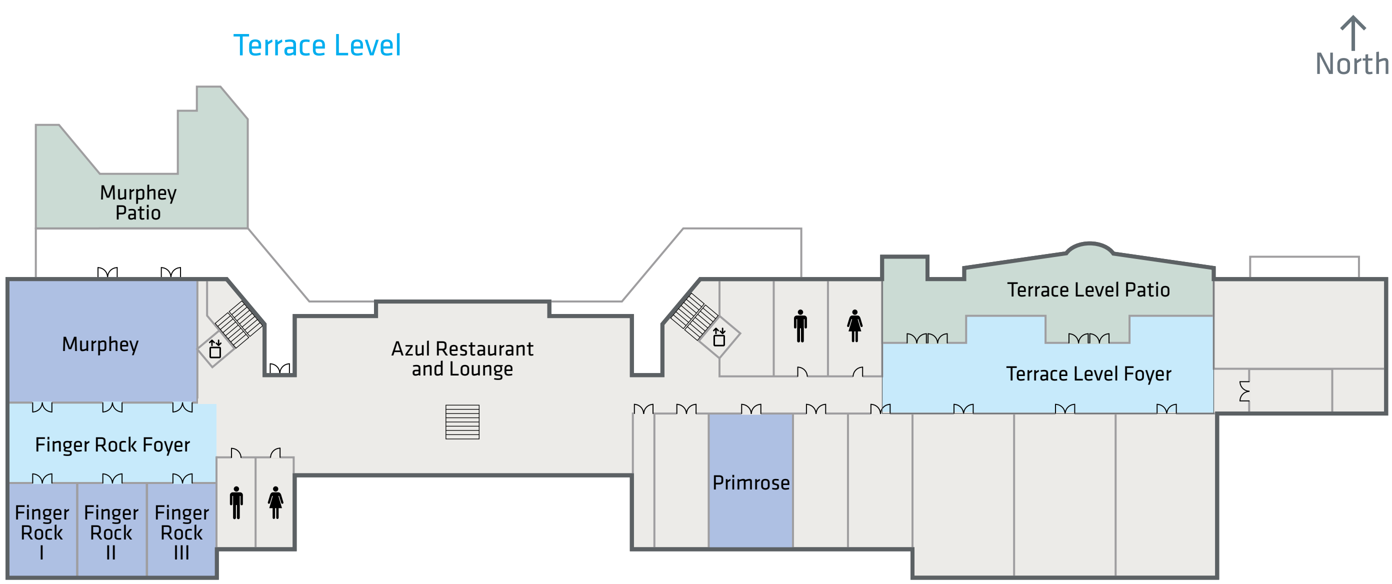
7:00 - 8:00 am	**Breakfast**	Murphey Patio
8:00 - 10:00 am	**Cottrell Scholar Collaborative Presentations**	Murphey
10:00 - 10:30 am	**Morning Break**	Finger Rock Foyer
10:30 am - 12:00 pm	**Breakout Session III** *Cottrell Scholars Working Together–Building Projects*	Finger Rock I, II, III & Primrose
	Report Out	Murphey
12:00 - 1:00 pm	**Lunch with Poster Session**	Sonoran I
1:00 - 1:45 pm	**2018 TREE Award Presentation** George Shields, Chemistry, Furman University	Murphey
1:45 - 4:30 pm	**Breakout Session IV** Unstructured Time to Work on Collaborative Projects	Finger Rock I, II, III & Primrose
4:30 - 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	**Dinner** All Guests are Invited to Join	Terrace Level Patio

Westin La Paloma Resort and Spa

Lobby Level



Terrace Level



Keynote Speaker

Equity in STEM Education– Personalizing Education for Student Success

Timothy McKay
Department of Physics,
University of Michigan

Abstract: Educational institutions hold equity and inclusion as central goals. Data can play a central role in achieving them. First, data are essential for probing equity. To provide an example, I will describe the discovery of a pattern of gendered performance differences in large foundational courses, both at Michigan and at an array of other Universities. Data can also help create solutions, as when we use tools like ECoach to personalize education. ECoach allows us both to learn more and to experiment with possible interventions. I will talk about how we're using data to connect research and practice in a 'learning laboratory', providing the evidence necessary to motivate change, and creating the sociotechnical conditions for sustained reform.

Bio: Timothy McKay is an Arthur F. Thurnau Professor of Physics with extensive and various experience drawing inference from large data sets. In astrophysics, his main research tools have been the Sloan Digital Sky Survey, the Dark Energy Survey and the simulations which support them both. He uses these tools to probe the growth and nature of cosmic structure as well as the expansion history of the universe, especially through studies of galaxy clusters. He has also studied astrophysical transients as part of the Robotic Optical Transient Search Experiment.

In recent years, he has turned most of his attention to Learning Analytics: using data to understand and improve teaching and learning. He is exploring grading patterns and performance disparities both at Michigan and across the CIC, developing a variety of data driven student support tools like E^{2}Coach through the Digital Innovation Greenhouse, an innovation space for exploring the personalization of education, and launching the NSF funded REBUILD project. REBUILD is an interdisciplinary collaboration, fostering the creation of intergenerational research teams including undergrads, grad students, postdocs, and faculty who will apply a scientific, evidence-based approach to teaching and learning in physics, chemistry, astronomy, biology and math.

2017 FRED Award Winner

A Student-Directed Adventure Toward Designer Metal Nanostructures for Anti-Counterfeit and Anti-Tamper Applications

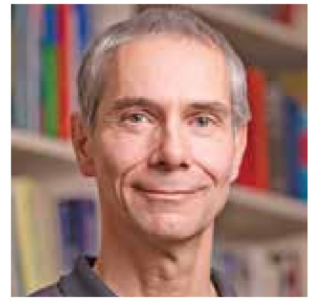
Sara Skrabalak
Department of Chemistry,
Indiana University Bloomington
Cottrell Scholar 2012

Abstract: Globally, trade of counterfeit goods is the second largest source of organized crime income and is surpassed only by the illicit drug trade. Counterfeit goods are pervasive across an array of markets, including apparel, currency, fuels, automotive components, pharmaceuticals, and microelectronics. In addition to the economic fallout that includes brand protection concerns, counterfeit goods in the latter two categories can have adverse secondary effects. For example, counterfeit microelectronics have caused the failure of a communication satellite and have been both found in the supply chain of and deployed in military devices. Collectively, the adverse economic, device reliability, and health effects of counterfeit goods create great demand for anti-counterfeit and anti-tamper labels. This presentation will outline how this demand can be met with designer metal nanostructures and their assemblies on account of their strong, stable, and tunable localized surface plasmon resonance. This presentation will also discuss the student-directed pathway to begin this research project and our new multi-institution collaboration focused on Achieving Scientifically Secured User Reassurance in Electronics (ASSURE), which was facilitated by the FRED award.

Bio: Dr. Sara Skrabalak received her B.A. in chemistry from Washington University in St. Louis in 2002 where she conducted research with Professor William E. Buhro. She then moved to the University of Illinois at Urbana-Champaign where she completed her Ph.D. in chemistry in fall of 2006 under the tutelage of Professor Kenneth S. Suslick. She then conducted postdoctoral research at the University of Washington-Seattle with professors Younan Xia and Xingde Li. She is the James H. Rudy Professor of Chemistry at Indiana University Bloomington and a recipient of both NSF CAREER and DOE Early Career Awards. She is a 2012 Research Corporation Cottrell Scholar, a 2013 Sloan Research Fellow, a 2014 Camille Dreyfus Teacher-Scholar, and 2017 Guggenheim and Fulbright fellows. In 2014, she received the ACS Award in Pure Chemistry. Her research group focuses on nanomaterial design and synthesis (http://www.indiana.edu/~skrablab/).

2018 TREE Award Winners

Martin Gruebele



Department of Chemistry,
University of Illinois at Urbana-Champaign
Cottrell Scholar 1995

Martin Gruebele was born in Stuttgart, Germany in 1964. He obtained his B.S. in 1984 and his Ph.D. in 1988 at UC Berkeley. He went on to do femtochemistry in the lab of Ahmed Zewail at Caltech, and then moved to the University of Illinois in 1992. He is currently the James R. Eiszner Professor of Chemistry, Professor of Physics, and Professor of Biophysics and Computational Biology. He is a Fellow of the American Physical, Chemical and Biophysical Societies, as well as a recipient of the Sacker International Prize in Biophysics, the ACS Nakanishi Prize, and the Wilhelm Bessel Prize, among others. He is a member of the German National Academy of Sciences, of the American Academy of Arts and Sciences, and of the National Academy of Sciences (NAS). He has served as Senior Editor at the Journal of Physical Chemistry, and as Associate Editor of the Journal of the American Chemical Society. His research includes protein and RNA folding, fast dynamics in live cells, vibrational energy flow in molecules, quantum computing and quantum control, optically assisted STM, glass dynamics, and vertebrate swimming behavior. The work is published in over 250 papers and reviews. Martin Gruebele is married to Nancy Makri, with two children, Alexander and Valerie.

Teri Odom

Department of Chemistry, Materials Science and Engineering,
Northwestern University
Cottrell Scholar 2005

Teri W. Odom is Charles E. and Emma H. Morrison Professor of Chemistry, Professor of Materials Science and Engineering, and Associate Director of the International Institute for Nanotechnology (IIN) at Northwestern University. She will chair the Chemistry Department starting in September 2018. She is an expert in designing structured nanoscale materials that exhibit extraordinary size and shape-dependent optical properties. Odom has pioneered a suite of multi-scale nanofabrication tools that has resulted in plasmon-based nanoscale lasers that can beat the diffraction limit and exhibit tunable color, flat optics that can manipulate light at the nanoscale, and hierarchical substrates that show controlled wetting and stretchable superhydrophobicity. She has also invented a class of biological nanoconstructs that are facilitating unique insight into nanoparticle-cell interactions and that show superior imaging and sensing properties because of their gold nanostar shape. A few of the numerous awards and honors Odom has received include: Senior Member of the Optical Society of America; a TREE Award from the Research Corporation; U.S. Department of Defense Vannevar Bush Faculty Fellow; Fellow of the American Chemical Society; Materials Research Society Fellow; Fellow of the Royal Society of Chemistry; the Carol Tyler Award from the International Precious Metals Institute; a Blavatnik Young Scientist Finalist (Chemistry + Physical Sciences and Engineering); a Radcliffe Institute for Advanced Study Fellowship at Harvard; the ACS Akron Section Award; an NIH Director's Pioneer Award; the MRS Outstanding Young Investigator Award; and the National Fresenius Award from Phi Lambda Upsilon.

2018 TREE Award Winners

George Shields
Office of Academic Affairs and Department of Chemistry,
Furman University
Cottrell Scholar 1994

George Shields is Vice President of Academic Affairs and Provost at Furman University. A national leader in undergraduate research, he has collaborated with more than 115 undergraduates in meaningful projects in the fields of computational chemistry, structural biochemistry and science education. His current research involves using computational methods to gain insights into biochemistry and environmental chemistry.

Since 1990, Shields has received approximately $5.5 million in external research grants from many foundations and funding agencies, including the National Science Foundation and National Institutes of Health. He has published 87 scientific articles, three educational papers, three book chapters, and a book, including 56 scientific papers with 57 undergraduates working in his research group since 1991. His undergraduates have received 32 national awards, and 85 percent of his research alumni have matriculated to graduate or professional programs of study.

Shields received the 2015 American Chemical Society (ACS) award for Research at an Undergraduate Institution, and the 2018 TREE Award from Research Corporation. He currently serves on the executive board of the Council on Undergraduate Research, the editorial advisory board of the ACS *Journal of Physical Chemistry*, and on the Science and Software Advisory Board of the Molecular Sciences Software Institute. He is a member of Omicron Delta Kappa, Sigma Xi, Phi Beta Kappa, and is a Research Corporation Cottrell Scholar.

He received bachelor's, master's, and doctoral degrees from the Georgia Institute of Technology. His postdoctoral research on protein-DNA interactions was conducted in the laboratory of Professor Thomas Steitz, the 2009 Chemistry Nobel Laureate.

Presentations by Cottrell and Fulbright-Cottrell Scholars

2017 Cottrell Scholar

Kirill Korolev	Physics, Boston University

2018 Cottrell Scholars

Ashleigh Baber	Chemistry, James Madison University
Louise Charkoudian	Chemistry, Haverford College
Jarrod French	Chemistry, Stony Brook University
John Gibbs	Physics, Northern Arizona University
Hayk Harutyunyan	Physics, Emory University
Meredith Hughes	Astronomy, Wesleyan University
Evan Kirby	Astronomy, California Institute of Technology
Tim Kowalczyk	Chemistry, Western Washington University
Kerstin Nordstrom	Physics, Mount Holyoke College
Stella Offner	Astronomy, University of Texas at Austin
Federico Rabuffetti	Chemistry, Wayne State University
Chad Risko	Chemistry, University of Kentucky
Sean Roberts	Chemistry, University of Texas at Austin
Eduardo Rozo	Physics, University of Arizona
Lisa Ryno	Chemistry, Oberlin College
Alexander Spokoyny	Chemistry, University of California, Los Angeles
Grace Stokes	Chemistry, Santa Clara University
Brett VanVeller	Chemistry, Iowa State University
Abigail Vieregg	Physics, University of Chicago
Luisa Whittaker-Brooks	Chemistry, University of Utah

2018 Fulbright-Cottrell Scholars

Michael Wilczek	Physics, Max Planck Institute for Dynamics and Self-Organization, Göttingen, Germany

Presentations by Cottrell Scholars Collaborative Teams

Development of Practical Tools for an Inclusive STEM Learning Environment Based on Student Views and Recommendations

Linda Columbus, Chemistry, University of Virginia

Learning to Build Authentic MSI/PWI Partnerships

Jordan Gerton, Physics, University of Utah

Training Faculty to Assist Students in Career Planning

Penny Beuning, Chemistry, Northeastern University

Teach Better Update

Penny Beuning, Chemistry, Northeastern University

Teacher Scholar Ambassadors for PUI-R1 Partnerships

Zachary Schultz, Chemistry, The Ohio State University

ACS/CSC New Faculty Workshops

Andrew Feig, Chemistry, Wayne State University

Ashley Donovan, American Chemical Society

Fulbright-Cottrell Second Junior Faculty Professional Development Workshop

Olalla Vazquez, Chemistry, University of Marburg, Germany

Cottrell Scholars 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 electronically to Silvia Ronco (sronco@rescorp.org) by the end of the day on **July 27, 2018**.

→ Awards will be announced within a month of submission.

2018 Cottrell Scholars

Ashleigh E. Baber
Department of Chemistry, James Madison University

Role of Surface Modifications on the Selectivity of Titania/Gold Inverse Model Catalysts

This proposal aims to catalyze both chemical reactions and student interest levels by answering the following questions: How does modifying 1) model catalyst surfaces influence reaction selectivity? 2) the classroom environment influence undergraduate learning?

TiO_2/Au(111) surfaces catalyze the transformation of small alcohols into both oxidized and reduced products, however, their reaction mechanisms have yet to be elucidated. As a result, the reactions yield alcohol–derived products with low selectivity. The proposed research will investigate the effect of surface preparation on chemical selectivity to elucidate the catalytic active sites and reaction mechanisms at play. Methods to control the surface conditions of TiO_2/Au(111) to enhance selectivity include: 1) Altering the coverage of TiO_2 nanoparticles on Au(111); 2) Controlling the oxidation state of TiO_x ($x \leq 2$) nanoparticles; 3) Annealing the TiO_2/Au(111) surface at different temperatures; 4) Introducing co-adsorbates (H_2O) prior to ethanol reaction. Atomic force microscopy (AFM) will be used to study the morphology of TiO_2/Au(111). Temperature programmed desorption (TPD) and X-ray photoelectron spectroscopy studies will be used to identify the active surfaces for the selective oxidation of ethanol to form acetaldehyde.

The creation of a *Preparatory Skills in Chemistry* course provides time, tools, and resources for students to learn the fundamentals of general chemistry. Within this course, new interactive tools and pedagogical techniques will be implemented to transition the class into an inquiry-driven, flipped classroom to enhance student enthusiasm, buy-in, and academic success thereby increasing the retention of students from diverse majors and underrepresented minorities in general chemistry courses.

Louise Charkoudian
Department of Chemistry, Haverford College

Capturing the Transient Interactions of Biosynthetic Proteins to Access New Chemical Diversity

The proposed work engages undergraduate students in the development of innovative tools to study protein-protein interactions involved in natural product biosynthesis. Acyl carrier proteins (ACPs) are the lynchpin of any engineered biosynthetic pathway, and the rational redesign of natural product enzyme machineries to build new chemical diversity depends on understanding the molecular features that guide ACP-protein interactions. However, the dynamic and transient nature of ACP interactions makes this important class of proteins particularly challenging to study. We propose to utilize a mechanism based vibrational spectroscopic probe to visualize and obtain ACP-protein interactions relevant to biocatalysis. We will apply this method to map the binding interface of the ACP-ketosynthase interaction involved in fatty acid biosynthesis with an eye towards using this information to engineer novel ACP-ketosynthase partnerships. We will study the mechanism of our innovative cross-linking strategy and develop vibrational probes that do not form covalent cross-links with functional enzyme partners, so that we expand the scope of our work to explore other enzymes relevant to fatty acid, polyketide, and non-ribosomal peptide biosynthesis.

These aims will be carried out in the context of the upper-level biochemistry course proposed in the Educational Proposal, thereby leveraging the Research Proposal as fertile ground to enhance student training at the chemistry-biology interface. We will develop a digital repository for documents related to integrating original research in undergraduate biochemistry laboratories thereby creating a community resource for the exchange of ideas and expanding the impact of our work well beyond the bounds of Haverford College.

2018 Cottrell Scholars Continued

Nathaniel Craig
Department of Physics, University of California, Santa Barbara

New Approaches to the Hierarchy Problem and Undergraduate Education

The discovery of the Higgs boson at the Large Hadron Collider (LHC) heralds a new era in particle physics. It marks the completion of the Standard Model, but also heightens a pressing puzzle known as the hierarchy problem: why is the Higgs so light when quantum corrections tie its mass to the highest energy scales? The hierarchy problem has long been a powerful motivator for physics beyond the Standard Model, but existing solutions are under increasing pressure from null results at the LHC. The proposed research program develops novel approaches to solving the hierarchy problem. These approaches include the expansion of existing solutions to alleviate their tension with experimental data; the development of new solutions involving new particles that remain invisible at the LHC; and the introduction of novel tools from quantum field theory to cast the hierarchy problem in entirely new light. By addressing one of the most pressing problems of the Standard Model, this research program aims to improve our understanding of the universe on the most fundamental level.

The proposed educational program addresses two key challenges faced by the UCSB physics department, namely (1) retaining instructional quality in the face of skyrocketing enrollment in the physics major and (2) improving STEM education for under-represented minorities as a Hispanic-Serving Institution. These challenges are addressed by the adoption of the Colorado Learning Assistant model in upper-division physics courses, bringing the interactive and collaborative environment typical of a small enrollment class into the instructor-centered environment of UCSB's large-enrollment courses.

Claude-Andre Faucher-Giguere
Department of Physics, Northwestern University

The Physics, Observational Signatures, and Consequences of Galactic Winds Driven by Active Galactic Nuclei

The Cottrell Scholar Award will support graduate students who will lead studies of the physics of galaxy-scale outflows driven by accreting supermassive black holes, their observational signatures, and their consequences for galaxy evolution. My group is ideally positioned to push the frontiers of this field by taking advantage of new and unique simulation tools that we have recently developed. These include algorithms for black hole feedback in simulations of realistic galaxies with a multiphase interstellar medium and with a comprehensive chemistry solver, necessary to model molecular outflows. Our simulations will range from ultra-high resolution simulations designed to understand key small-scale physics to fully cosmological galaxy formation simulations.

On the education front, I will develop a new course model designed to simultaneously improve learning outcomes, foster personal development of the students, and more effectively engage groups under-presented in STEM than traditional lectures.

The new course model will be based on incorporating research-like activities that approximate many benefits of a true research experience. Drawing on my own astrophysics research, my new course model will introduce students to order-of-magnitude estimation (invaluable to develop quantitative intuition), and incorporate computational problem solving (a complementary approach needed for accurate solutions to most real-world problems) and data visualization through quarter-long projects. To stimulate active learning, I will flip the classroom and use the "think-pair-share" approach. I will first test the new course model on several of my own courses, rigorously assess and refine it, then share the results with other instructors at Northwestern and beyond.

2018 Cottrell Scholars Continued

Jarrod B. French
Department of Chemistry, SUNY-Stony Brook University

Structural Dynamics of Photoactive Proteins, and Crowdsourcing Structural Biology

My long-term research goal is to elucidate the mechanisms that enable photoreceptors to translate ultrafast chemical changes into macromolecular reorganization on much slower timescales. In pursuit of this goal the research objective of this proposal is to determine the intrinsic molecular determinants and dynamic structural features that drive signaling events in blue-light using FAD (BLUF) proteins. We will implement a novel serial crystallography approach that makes use of surface acoustic waves to significantly increase efficiency and reduce sample usage. This time-resolved structural method will be complemented by static X-ray crystallography experiments and high sensitivity transient spectroscopy. This work will provide needed insights into the mechanism of photoreceptor activation. In addition, the methods developed during the project period will enable efficient time-resolved structural studies on a broad range of samples at any X-ray source.

The educational goal is to more fully integrate research experiences for high school, community college and undergraduate students with opportunities to conduct 'real' basic science research. In pursuit of this goal the educational objective of this proposal is to utilize a crowd-sourcing approach, involving groups of undergraduates and high school students, to generate a hybrid research/educational structural proteomics pipeline. In the long-term, we propose to establish a national student team competition where groups of students work to solve crystal structures. This approach will not only provide an opportunity for groups of students to conduct hands-on, 'real' research in a controlled setting, but will leverage the strength in numbers to address a fundamentally important research problem.

John G. Gibbs
Department of Physics, Northern Arizona University

Investigating Shape-Dependent Emergent Collective Behavior in Artificial Active Matter Systems

In this project my team and I will investigate the fundamental relationships between asymmetries in active colloidal matter and emergent collective phenomena of large numbers of self-propelled particles. We have developed a specialized system that allows for a much wider range of experimental investigations on this rapidly growing field of active soft matter physics than what has been introduced in the past. The system in particular employs long-range magnetic dipole-dipole interactions to align and prevent the particles from becoming jammed and immobilized in close-packed clusters and the strength of the propulsion can be altered in real-time using an external light source. Our initial results suggest this system is excellent for investigating the fundamental physics of the collective behavior of active matter at the mesoscale.

My main motivation for this project is to enhance my unit's MS degree by introducing our students to the day-to-day activities of a professional scientist. In particular, I will design and implement a class that includes a research project and focuses upon skills that every scientist needs in order to be successful in their career. The students will conduct a project related to the research herein in my lab, while simultaneously learning how to think and act like a professional scientist. This course will be developed and included in our MS program, and as Chair of the Curriculum Committee, I will take the necessary steps to have this programmatic change implemented.

2018 Cottrell Scholars Continued

Hayk Harutyunyan
Department of Physics, Emory University

Generation and Dynamics of Hot Electrons in Metal-Semiconductor Hybrid Nanosystems

Photoexcitation of charge carriers in materials is important for energy harvesting, photodetection, photochemistry, and nanoscopy. At nanoscale, the established framework describing the dynamics of nphotoexcited carriers fails, because of the new ultrafast electronic processes emerging due to the strong localization of light and matter. The proposed research will provide insight into these processes in the context of hot (energetic) carrier generation and injection in nanoscale metal-semiconductor (Schottky) junctions. Schottky junctions are particularly promising for hot carrier generation and injection, thanks to the electrostatic tenability of electronic states in semiconductors, and the flexibility provided by the continuum of states in metals. Unfortunately, in bulk materials the efficiency of hot carrier photo-injection in Schottky junctions is low. The understanding of the ultrafast processes underlying the injection dynamics, resulting from the proposed research, will enable enhanced-efficiency Schottky injection in a variety of applications.

Emory is a major research university with a long tradition of high-quality liberal arts education. However, unlike many other major research universities, it does not have an engineering school. It is proposed to develop a unique Engineering Sciences program that will provide both advanced research-like experience and a well-rounded undergraduate liberal arts education. A comprehensive academic curriculum will be developed that will provide scientific and technical background. It will be complemented by an advanced practical undergraduate training program. The successful completion of the educational plan will benefit the undergraduate research and education at Emory University, and will also provide a template for similar efforts in other schools nationwide.

A. Meredith Hughes
Department of Astronomy, Wesleyan University

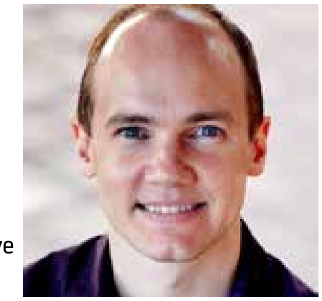
Using Debris Disks to Weigh Planetary Systems

Debris disks represent the end stage of planetary system evolution, with typical stellar ages corresponding to the epoch when giant planets in the Solar System were newly formed. Edge-on debris disks provide a unique opportunity to assess the mass inventory of a planetary system, since the vertical scale height encodes dynamical information about the mass of otherwise invisible bodies. By imaging the debris disk around nearby edge-on systems at multiple radio wavelengths, the PI will measure for the first time outside the Solar System whether the collisional velocities in debris disks are destructive or erosive, the total mass of large bodies in the system, and the strengths of the dust grains.

The PI's educational plan involves promoting efforts to improve STEM equity at Wesleyan through a two-pronged approach. The PI will serve as a liaison between the various STEM equity groups, which currently have a tendency to duplicate effort and divide along lines of race and gender. The PI will also introduce STEM equity into the curriculum through a half-credit course, which will include two components: (1) an introduction to the literature on STEM equity, and (2) a service-learning component that involves developing, evaluating, and implementing proposals for improving STEM equity at Wesleyan. This course will ensure that efforts to improve STEM equity are informed by the literature and have student buy-in and faculty follow-through, while also providing students with a source of funding and academic credit for the energetic and time-consuming work that they are already doing.

2018 Cottrell Scholars Continued

Evan N. Kirby
Department of Astronomy, California Institute of Technology



Identifying the Sites of Nucleosynthesis

Although it is well known that thermonuclear (Type Ia) supernovae produce copious amounts of iron-peak elements, the nature of those supernovae is hotly debated. Likewise, the creation site of the heaviest metals, like barium, could be supernovae, merging neutron stars, or something else. I propose develop innovative techniques to measure the amounts of iron, nickel, barium, and other elements in stars selected specifically to identify the sites of nucleosynthesis. I will use measurements of iron-peak elements in dwarf galaxies to constrain progenitor models for Type Ia supernovae, and I will use measurements of barium in globular clusters to support or rule out neutron star mergers as the origin of the heaviest elements in those systems.

I further propose to increase student engagement in undergraduate astronomy classes through active learning. I will develop 32 activities per course for four courses over three years, and I will make the 24 best activities available to professors at any institution. I will emphasize the ease of incorporating the activities into existing course plans to maximize the chance that astronomy classrooms at Caltech and beyond will become more active.

In order to augment the education of graduate students, I will develop an explicit plan for teaching the skill of mentoring. I will expand my existing program of original research for high school students by involving graduate student mentors. I will coach graduate students on how to be effective mentors, help them craft original research projects, and facilitate their mentoring of the high school students.

Tim Kowalczyk
Department of Chemistry, Western Washington University

Mechanism and Computational Design of Energy Storage and Release in Molecular Photoswitches

Organic photoswitches are exploited by nature and in the laboratory to impart light-driven control over molecular structure and function. These photoswitches also possess the basic chemical properties required for a renewable, closed-cycle solar thermal fuel (STF), but the energy density achievable in established photoswitches is uncompetitive with conventional battery technology. At a fundamental level, progress toward high energy density photoswitches for energy storage is hindered by a limited understanding of the photoswitching mechanism in condensed-phase chemical environments and by the time and resource constraints of experimental preparation and characterization of customized liquid- and solid-state photoswitches. Our research plan addresses the knowledge gap in condensed-phase photoswitching mechanisms through theoretical characterization of candidate STF performance based on ground- and excited-sate electronic structure methods including environmental effects. Machine learning (ML) models are then trained on performance criteria obtained from the theoretical characterization of a library of candidate STFs and used to identify new candidates with exceptional energy storage density.

Our education plan addresses challenges faced by chemistry and energy students in translating among multiple physical and mathematical representations of chemical energy conversion concepts. A collection of augmented molecular simulations reinforcing connections between symbolic, graphical, and particulate representations of selected chemical energy conversions will be developed, assessed, and disseminated through the web. The impact of the research and education plans will be amplified by the transformation of our recently established energy literacy outreach initiative (Energy Ambassadors) into a service learning program.

2018 Cottrell Scholars Continued

Garret M. Miyake
Department of Chemistry, Colorado State University

Design Principles of Strongly Reducing Visible-Light Organic Photoredox Catalysts

Synthetic polymers are amongst the most important materials to modern society. The tremendous importance of synthetic polymers in nearly every aspect of life necessitates the continued advancement of polymer chemistry in both research and education for the benefit of future generations. The goals of the PI are to develop energy efficient polymerizations and sustainable polymers as well as educate the next generation of scientists in polymer chemistry.

The overall objective of this research proposal is to develop strongly reducing visible light organic photoredox catalysts (PCs). Photoredox catalysis presents an ideal form of "green" chemistry, using natural sunlight to drive chemical transformations to synthesize challenging products under mild reaction conditions. Much of this work has focused on using precious metal polypyridyl ruthenium or iridium photoredox catalysts (PCs). However, ruthenium and iridium are amongst the rarest elements on earth. As such, organic PCs are sought as sustainable replacements. Although many organic PCs have been developed, few examples of strongly reducing, visible-light PCs exist. In particular, the PI's group designs strongly reducing organic PCs for employment in organocatalyzed atom transfer radical polymerization (O-ATRP).

The overall objective of this educational proposal is to develop the undergraduate polymer chemistry curriculum at Colorado State University. Although greater than 50% of employees in the chemical industry work in a field related to polymers, few universities offer undergraduate polymer chemistry courses. The PI will develop both a polymer chemistry lecture and a laboratory course for educating the next generation of scientists in polymer chemistry.

Kater Murch
Department of Physics, Washington University in St. Louis

Exploring Thermodynamics of Single Quantum Systems with Continuous Measurement

Thermodynamics plays a pivotal role in our understanding of physical systems, accurately describing the behavior of macroscopic systems consisting of an enormous number of constituents ranging from gases and liquids to superconductors and black holes. There is growing interest in extending the laws of thermodynamics to the quantum regime, where quantum coherent effects are present. I propose to use my ability to track individual quantum trajectories to study the production of entropy during quantum measurement evolution, defining and verifying fundamental fluctuation theorems akin to those which have been established in classical stochastic thermodynamics. My group will study reversibility in quantum measurement dynamics and introduce path probability as a method to characterize the entropy change in the environment.

For my educational plan, I propose to modernize physics teaching practices at Washington University, both in the lecture hall and the laboratory. I will work to expand the use of flipped classroom teaching techniques in the advanced physics curriculum. Building on my successful use of pre-class video lectures as a valuable teaching tool in my Introduction to Quantum Mechanics course, I will work with other physics faculty to apply these techniques in their courses. I will also modernize the undergraduate advanced laboratory course by incorporating the video lecture approach to provide deeper training on data analysis and presentation and by creating new hands-on laboratory experiments, including a room temperature quantum mechanics experiment. These educational improvements will ultimately benefit thousands of current and future physics students.

2018 Cottrell Scholars Continued

Kerstin Nordstrom

Department of Physics, Mount Holyoke College

Flow in Amorphous Systems: Understanding Dynamics Across Scales

Granular materials are ubiquitous and yet we still lack a complete understanding of them. My lab will take a multiscale approach to studying their clogging and flow. We can simultaneously measure the bulk flow and clogging statistics, particle motions, and the intermittent force network. It has been proposed that clogging may be akin to a phase transition, but more work is needed to discover the control parameters that govern this transition. Our hypothesis is that altering the topology of the contact network will change how the system flows and clogs. Our experiments will lay groundwork for testing the notion of the clogging phase diagram. Our particle-scale measurements will also let us confront old microscopic models that fit the data, but seem unphysical. Insight into granular flow often yields insight into other systems of crowded particles, such as traffic, blood flow, and pedestrians.

Physics is often criticized for its lack of gender diversity; indeed it is a field that is 80% male. The situation is much worse, though, for female underrepresented minorities (URMs). In fact, since it is such a small numbers game, even adding a few to the pipeline can make a significant difference in national statistics. I propose starting a pre-college program for women interested in physics, with the goal of increasing URM women in the field of physics. The program will introduce these women to hands-on work in physics, give them explicit career and college guidance, and help them start college with a strong physics network.

Stella Offner

Department of Astronomy, University of Texas at Austin

Unveiling the Life Cycle of Stars through Cosmic Time and Enhancing Inclusivity in Astronomy

This proposal explores a fundamental question in star formation: How do stellar masses depend on birth environment? Observations have shown the distribution of initial stellar masses is surprisingly similar across our Milky Way galaxy and others like it. However, recent measurements of old, massive galaxies have unveiled stellar populations that contain fewer Sun-like stars and more lower-mass stars. I propose to test how stellar masses and the interaction of stars with their natal environment ("feedback") changes as a function of gas density and metallicity, two properties that vary with cosmic time. I will perform state-of-the-art numerical simulations of forming star clusters and harness newly developed analysis techniques to compare with observational data. The three key science objectives are to 1) produce a suite of simulations spanning a range birth environments, 2) create synthetic observations of several molecular emission lines, and 3) apply a statistical toolkit to quantify differences between simulations and observed environments, thereby constraining the initial conditions of star formation.

This proposal aims to enhance undergraduate preparation for independent research and develop a mentoring program to increase the retention of women and under-represented minorities in astronomy. I will develop a new project-based sophomore-level course to teach fundamental analysis skills using public astronomy data archives. I will create a hierarchical mentoring program for undergraduates that pairs freshman with junior mentors, and juniors with graduate student mentors. The program will target under-represented groups in order to provide support and enhance inclusivity.

2018 Cottrell Scholars Continued

Federico A. Rabuffetti
Department of Chemistry, Wayne State University

Crystallochemical Principles of Energy Management in Solid-State Photoluminescent Materials

Phosphors are ubiquitous in energy systems. As functional materials, they experience time-dependent temperature changes that govern their luminescence response. Currently, no chemical and structural principles exist to enable the use of chemical composition and crystal structure as synthetic levers to control the phosphor's temperature-dependent response. We will employ a series of chemically and structurally flexible materials to identify these principles. We will build a library of luminescent oxides that share a common building block and incorporate rare-earth metals that serve as a chemical probe of energy-transfer processes relevant to photoluminescence. Composition-structure-luminescence relationships will be established and codified as a set of principles describing how the crystal-chemistry of the phosphor governs its temperature-dependent response. These principles are expected to enable the predictive synthesis of phosphors with tailored temperature-dependent response.

We will leverage our expertise in materials chemistry to implement a shift in the laboratory instruction format utilized at the earliest stage of the undergraduate chemistry curriculum. We will create an inquiry-based materials chemistry laboratory section in CHM1230 (Chemical Principles in the Laboratory), which is the first chemistry laboratory taken by freshmen students at Wayne State University. Laboratory activities will utilize an inductive approach and follow a two-stage progression in terms of their procedure and outcome. Implementation of this laboratory section is expected to positively impact the conceptual learning abilities of two cohorts of ~20 students each.

Chad M. Risko
Department of Chemistry, University of Kentucky

High Energy Density Metal Oxides for Energy Storage: In Silico Electrochemistry to Control Interface Chemistry

We will harness the power of modern computational chemistry to generate a first-principles understanding of the impact of metal-oxide surface structure and electrode composition on the chemical reactions and mass transport dynamics essential to electrochemical energy storage. Metal-oxide nanocrystals are widely used in electrochemical cell electrodes, though the elementary processes by which they operate remain unclear. Inhomogeneous electrode compositions and multicomponent electrolyte formulations result in a complex operating environment that stymies efforts to resolve the intimate electrochemical reactions that occur on the metal-oxide surface and, subsequently, at the broader electrode-electrolyte interface. We will exploit state-of-the-art electronic-structure methods and classical molecular-dynamics techniques to characterize essential physicochemical processes that occur on the surfaces of $LiNi_xMn_xCo_{1-2x}O_2$ (NMC), a high capacity cathode material, during electrochemical energy storage. These molecular-scale resolution provided by these investigations of electrochemical interfaces will refine our basic understanding of electrochemistry.

Though the concept of big data is seemingly everywhere, it is not in the undergraduate chemistry curriculum. I will develop a course-based undergraduate research experience (CURE) with specific focus on the application of computing and data science in chemistry—the *Big Data CURE*. The *Big Data CURE* will engage students in primary chemical research to build knowledge in scientific computing and big data analysis and visualization through collaborative (team-based), scientific inquiry. Through this CURE, students will develop essential skills and knowledge that will enable them to prosper in research, and careers beyond those traditional to chemistry, that are founded on computer science and big data.

2018 Cottrell Scholars Continued

Sean T. Roberts
Department of Chemistry, University of Texas at Austin

Tracking Singlet Fission with Ultrafast Time-resolved Microscopy and a Focused Research Experience for Community College Students

A primary challenge in solar energy conversion is mitigating losses from charge carrier thermalization, which occurs whenever a semiconductor solar cell absorbs a photon with energy above its bandgap. Integrating materials that undergo singlet fission (SF) with existing solar technologies can combat this challenge. During SF, a photoexcited spin-singlet exciton (electron-hole pair) divides its energy to form two spin triplet excitons on neighboring molecules. This process spreads a photon's energy among multiple charge carriers rather than allowing its dissipation as heat. However, improving solar cells via SF necessitates materials that both undergo quantitative SF and transport triplet excitons over large distances. These processes involve direct electron exchange between neighboring molecules, making them both sensitive to the presence of structural heterogeneity within a material. To address this issue, we will use transient absorption microscopy to observe SF within single domains of perylenediimide (PDI) thin films, a promising class of SF materials, to eliminate contributions from sample heterogeneity to measurements of SF rates and yields.

We will also explore how the addition of functional groups to PDIs and related SF materials can optimize their solid-state packing structure for SF. This will be done by students at Austin Community College through a new research-focused undergraduate course wherein students prepare and characterize a library of SF candidate compounds. This work will elucidate key design principles that can guide efforts to create SF materials suitable for solar energy conversion while simultaneously introducing students from groups underrepresented among STEM graduates to chemical research.

Eduardo Rozo
Department of Physics, University of Arizona

Shining a Light on the Dark Energy

The abundance of galaxy clusters has long been recognized as one of the most statistically powerful probes of dark energy. However, the error budget of all cluster abundance experiments to date has been limited by the ≈8% systematic uncertainty associated with cluster mass calibration. This proposal seeks to reduce the systematic uncertainty in cluster abundance studies to 2%. At this level of precision, the now on-going Dark Energy Survey (DES) experiment will be statistics limited, enabling a four-fold increase in the precision with which I can test the surprisingly successful LCDM model. Assuming the $\approx 2\sigma$ hints of tension between the Cosmic Microwave Background and previous weak lensing experiments is real, my analysis should provide smoking-gun evidence of either a breakdown of general relativity, or the existence of a dynamically active form of dark energy.

The use of Research-Based Instruction Strategies in the classroom has been proven to: improve student learning; lower the rate of failing students; reduce the achievement gap between disadvantaged students and their non-disadvantaged peers; and improve student retention and graduation rates. Despite this evidence, the University of Arizona (UA) Physics Department has been slow to incorporate these pedagogical techniques. Following the example set by previous successful initiatives designed to address this important deficiency, I propose to co-lead a physics-centered Faculty Learning Community in the Physics Department at UA. The direct expected outcome of this program is a higher utilization rate of RBIS by faculty in the Department, and the development of a departmental culture of reflective practice.

2018 Cottrell Scholars Continued

Lisa M. Ryno
Department of Chemistry, Oberlin College

Investigating the Impact of fliA Overexpression on the Formation and Composition of E. coli Biofilms at Different Temperatures

While the scientific community has spent decades working towards understanding biofilm formation and composition, the influence of signaling pathways and individual proteins on biofilm is still fertile ground for investigation. This proposal describes the development of a research program that utilizes the exogenous overexpression of specific signaling pathways to determine their impact on biofilm formation and maturation. We will characterize the impact of overexpressing fliA, a transcription factor, on biofilm by analyzing extracellular structures and biofilm composition, and the influence of the downstream target phosphodiesterase, yhjH, on c-di-GMP signaling and biofilm formation. This program will provide the field with a greater understanding of the relationship among specific signaling pathways and biofilm and a catalogue of targets that could be useful in the design of novel anti-biofilm agents.

To address the gap in retention between underrepresented minorities (e.g., students of color, Pell-eligible, first generation students and women) and their white peers in STEM majors, I propose to create a near-peer mentoring system that forms groups of college and local high school students whose interactions will be based around an interdisciplinary experience preparing students for entering a research laboratory. Student mentor-mentee groups will participate in biweekly discussions about recently published scientific literature, have informal meetings and group activities, and participate in a three-week short course preparing them for academic research. This inclusive community will help foster relationships among students and science faculty, work to build students' confidence, and increase the retention rate of underrepresented minorities in the sciences.

Alexander M. Spokoyny
Department of Chemistry, University of California, Los Angeles

Atomically-Precise Nanomaterials Based on Inorganic Clusters

Our proposed effort is characterized as a "nanoparticle total synthesis", where we are utilizing a bottom up approach for the synthesis of large hybrid molecules using atomically precise 3D inorganic clusters as rigid templates. Specifically, we propose a new strategy for building robust, atomically precise hybrid nanomolecules using air-stable inorganic clusters densely decorated with perfluoroaromatic groups. This strategy is very appealing given its similarity to the synthesis of AuNPs; however, in this case, the resulting structures maintain full atomic precision and exhibit dramatically improved *in vivo* stability due to the full covalency. We will use this strategy for facile attachment of receptor building blocks and positioning these in three-dimensions. We will work on developing multivalent species capable of binding and sensing biomolecules under biologically relevant conditions and understand how their topology affects "perfect" target binding.

Over twenty years ago, federal funding for higher education was cut from prisons nationwide. Hundreds of thousands of men and women were devastated. Those trying to change their lives during lengthy sentences and hoping to be better equipped to provide for their families upon release were left without access to a resource we are best equipped to provide. We are in the process of developing a comprehensive program, where UCLA can fulfill its commitment to academic freedom by helping to bring higher education back to the incarcerated.

Specifically, we are developing a general education course that will simultaneously expand a broad scientific literacy course to UCLA students and female members of the California Institution for Women.

2018 Cottrell Scholars Continued

Grace Y. Stokes

Department of Chemistry, Santa Clara University

Thermodynamic Studies of Peptoid-Lipid Interactions

To provide mechanistic insight into the therapeutic effects and toxicity of potential peptoid-based drugs, we propose in vitro studies that quantify the thermodynamic forces that govern peptoid–lipid interactions. We aim to distinguish the contributions of peptoid features (e.g., length, attached functional groups), as well as lipid variables such as lipid acyl chain length, packing density, head group charge, cholesterol content, and the presence of integral or peripheral proteins. We propose to use a model system, which allows membrane composition to be precisely controlled, so we can identify and quantify contributions from individual components. Second harmonic generation (SHG) monitored in 2-D combined with a microfluidic platform will provide a high-through-put screening approach to study peptoid libraries prepared by SCU undergraduate students in an organic chemistry teaching lab. We will use the thermodynamic datasets from these studies to inform and evaluate several predictive models.

To complement a research-based peptoid synthesis lab, we propose two education initiatives, which address the problem of low retention of first-generation college (FGC) students in STEM majors with computer-based problem-solving activities to improve FGC student performance in first-term general chemistry. In the first initiative, we engage FGC students in graphical exercises, which incorporate research-derived data, in a one-week workshop held prior to the start of classes. In the second, we incorporate guided inquiry modules related to "virtual lab" experiences into a section of general chemistry that is targeted to FGC students.

Brett VanVeller

Department of Chemistry, Iowa State University

Surfing the Excited-State Energy Surface Towards New Photoreaction Strategies

Our goal in this application is to study the effect that environmentally sensitive excited states have on the reactions of photocleavable protecting groups. Our central hypothesis is that environmentally sensitive deactivation of the molecular excited state can be used to selectively turn the photo-deprotection reaction ON and OFF. The specific objectives of this project will (1) identify new molecular designs and approaches to selectively turn the photo-deprotection reaction ON and OFF, and (2) identify approaches to independently activate different photocleavable protecting groups without regard to any overlap that might exist in their absorbance spectra. Our overall approach seeks a new application of excited state dynamics to unlock new possibilities in selective photo-deprotection. The outcomes of this work will broaden the application space of photocleavable protection groups, and thereby, serve to enhance our understanding of structural design and excited state processes.

In addition to the research plans summarized above, this proposal includes a study to improve student learning through quantitative evaluation of a new education model designed to scaffold how experts assess chemical problems. The approach is based on recent cognitive psychology research that points to comparative thinking as a particularly efficient means of learning and processing information. The expected outcome is that comparative models of teaching—and validation that these methods to increase student learning—will efficiently train students to construct models of reason that seasoned chemists take for granted.

2018 Cottrell Scholars Continued

Abigail G. Vieregg
Department of Physics, University of Chicago

An Interferometric Technique for Discovering the Highest Energy Neutrinos

I propose to develop an interferometric phased array trigger for radio detection of ultra-high energy neutrinos that will be able to discover the highest energy neutrinos in the universe and determine the physics inside the sources of astrophysical neutrinos. Through neutrino astrophysics, we explore the structure and evolution of the universe in a unique way and test our understanding of particle physics at energies much higher than at particle colliders. I will first test an 8-channel prototype interferometric phased array system with the Askaryan Radio Array (ARA) at the South Pole, and then expand the technology to accommodate O(100) channels, increasing the effective volume of the radio detection technique significantly and lowering the energy threshold. I will develop simulations to determine the optimal geometric configuration for neutrino experiments triggered by such a system.

I will address the sharp drop-off in the fraction of women undergraduate physics majors over their first year at the University of Chicago. Improving retention at this juncture is essential and will impact all subsequent levels. First, I will make targeted changes to our introductory mechanics course. I will introduce interactive problem-solving sessions, replacing the weekly lecture-style TA-led discussion section with an interactive session with 20 students each. I will also incorporate coding-based homework problems into the course to give first-year undergraduates a head start in learning the skills required to do scientific research. Second, I will start a near-peer mentoring program for first-year undergraduate students and senior undergraduates.

Luisa L. Whittaker-Brooks
Department of Chemistry, University of Utah

Manipulating Spin Dynamics at Organic-Inorganic Interfaces and Addressing the Disparity between General Chemistry and Reality

The field of spintronics is currently constrained by the ability to generate spin currents "on demand" due to difficulties in the control of electrical spin injection and optical spin alignment in materials. One possible solution involves the systematic development of structure-function correlations for the design of hybrid materials with strongly spin-dependent properties. Here, we propose to synthesize novel organic-inorganic hybrid materials and interfaces for use in spintronic applications. Elucidation of structural correlations to properties such as spin-orbit coupling, electron-phonon coupling, and solid-state crystal chemistry based on an iterative combination of materials and interfacial design, synthesis, and elucidation of "exact spin-Hamiltonian" parameters will help develop new functionality and facilitate breakthroughs in both fundamental materials design and manifestation of novel physical phenomena in well-defined organic-inorganic hybrid spintronic heterostructures.

The educational component of this submission addresses a strong need to actively engage students at an early stage of their undergraduate careers by designing an interdisciplinary general chemistry course that incorporates hands-on activities and evidence-based teaching methods while fostering a culture of inclusivity across the rapidly diversifying demographics at the University of Utah. This course seeks to provide students with the necessary learning tools, experiences, and personal and professional connections needed to succeed in a career in chemistry. These activities are in the right direction towards promoting student engagement, maximizing inclusivity leveraging the increasing diversity of U. Utah's student body and the PI's personal career trajectory, increasing the retention and broadening the recruitment of chemistry majors, and maximizing the learning gains of our students.

2018 Fulbright-Cottrell Scholars

Michael Wilczek
Department of Physics, Max Planck Research Group Turbulent Flows

Turbulence Meets Active Matter

Active matter systems, which consist of many interacting active agents, display a rich repertoire of emergent dynamical states such as swarming behavior and coherent dynamical patterns. When probing turbulent environments, the phenomenon becomes even richer as turbulence tends to reduce global order. In other settings, the collective behavior of active agents itself gives rise to turbulence-like phases of such active fluids, exhibiting complex spatio-temporal dynamics. In this project, we set out to explore what happens when turbulence meets active matter. We will investigate the repercussions of shape, size, motility and interaction of motile particles navigating turbulent flows as well as the non-equilibriums transition between collective states of active fluids. The project is located at the intersection of soft matter physics and biophysics with fluid dynamics and turbulence research, which offers a range of appealing topics for teaching. In an accompanying course, we will introduce students to the foundations of these subject and enable them to delve with us into this emerging field.

Yana Vaynzof
Department of Physics, University of Heidelberg

Probing the Thermal Properties of 2D Materials by Photothermal Deflection Spectroscopy

Modern research in condensed matter physics requires an interdisciplinary and multi-technique approach. Even the most comprehensive bachelor level physics education does not sufficiently prepare the students to tackle the complex and multi-domain challenges in this field. In the teaching project proposed here, I will offer a new course that will combine an introduction to state-of-the-art research in materials physics (focusing on emerging photovoltaics) with hand-on training on various advanced spectroscopic tools. The course will serve as a preparation for the bachelor thesis project of the students in which they are to pursue research in this field.

Apart from photovoltaics, another type of sustainable technology that holds enormous promise for more energy efficient development is the utilization of waste heat by thermoelectrics (TE). Specifically, 2D materials such as transition metal dichalcogenides, are of great interest for TE applications due to the negative correlation of their thermal and electrical conductivities. Despite this, much remains unknown about the thermal properties of these materials. The research project herein will apply an advanced spectroscopic method—photothermal deflection spectroscopy—as a new methodology to probe the thermal properties of 2D materials. This methodology will allow the direct measurement of the macroscopic through-plane thermal diffusivity (and thus, thermal conductivity) in the same configuration that can later be used for functional TE devices. Investigating the effect of a variety of parameters, including flake size and structure, film thickness and deposition method will enhance the fundamental understanding of the thermal properties of 2D materials in thin films.

Networking Directory

Mario Affatigato CS 1996
Department of Physics, Coe College
I am interested in all things glass, especially exotic and novel glasses. I am also interested in spectroscopy and containerless processing. I love materials science education, history of science, and anything involving undergraduate research.

Katherine Aidala CS 2009
Department of Physics, Mount Holyoke College
I use atomic force microscopy to study the electronic, magnetic, and mechanical properties of materials, presently focusing on organic semiconductors. I spend time thinking about inclusive pedagogy, including near peer mentor training.

Ashleigh Baber CS 2018
Department of Chemistry, James Madison University
Uncover role of surface modifications: oxidation state, presence of water, & surface preparation temp on ethanol chemistry over titania/gold model catalysts. Enhance retention of all students and especially underrepresented minorities in Gen Chem with study skills-centered Prep Skills course.

Lane Baker CS 2009
Department of Chemistry, Indiana University
Spatially resolved electrochemical measurements of biology and materials. First generation chemists from rural environments.

Emily Balskus CS 2015
Department of Chemistry, Harvard University
Emily trained in organic chemistry, enzymology, and microbiology. As a faculty member @HarvardCCB she investigates the amazing chemistry of the microbial world. Curriculum development at chemistry biology interface, expand undergraduate research opportunity, encourage broader participation in science.

Sarbajit Banerjee CS 2010
Department of Chemistry, Texas A&M University
Electron correlated solids; designing solid-state compounds for energy storage and energy conversion; Metastable compounds; synchrotron-based imaging,first-year chemistry curriculum, undergraduate research, engaging diverse communities.

Robert Berger CS 2017
Department of Chemistry,
Western Washington University
I study relationships between crystal and electronic structure in solids. This often involves DFT calculations of perovskite materials. I aim to blend conceptual and equation-based lessons in undergraduate physical chemistry, by designing interactive online homework modules.

Penny Beuning CS 2009
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
Department of Physics,
Rochester Institute of Technology
I explore the interaction of light with mechanical motion. Recent exciting results include realization of an optical tweezer phonon laser. I am interested in techniques at every level for increasing student interest in, and comprehension of, physics.

Fadi Bou-Abdallah CS 2008
Department of Chemistry,
State University of New York, Potsdam
Bioinorganic and Physical Chemistry of Biological Processes, Iron Protein Complexes, Metallobiochemistry, Toxic Metals and Pharmaceuticals in Drinking Water. My main educational interest is to motivate and inspire a diverse group of undergraduates to become the next generation of teacher scholars.

Mark Bussel CS 1994
Department of Chemistry,
Western Washington University
Development of new heterogeneous catalysts for energy conversion processes. Interdisciplinary curricula in materials and energy sciences; partnerships with community colleges around access to instrumentation.

James Cahoon CS 2015
Department of Chemistry,
University of North Carolina at Chapel Hill
Synthesis, spectroscopy, and fabrication of semiconductor nanomaterials with applications in electronics, photonics, and solar energy. Physical chemistry and materials chemistry undergraduate and graduate education developing applications of 3D printing for instruction.

Networking Directory Continued

Luis Campos CS 2015
Department of Chemistry, Columbia University
A physical macromolecular chemist, with interest in optoelectronic materials, self-assembly, and single-molecule electronics. Organic chemist, with an interest in active learning and the interface between chemistry and pop culture.

Erin Carlson CS 2012
Department of Chemistry, University of Minnesota
Discovery of the master regulators of bacterial growth and communication using tools at the interface of chemistry and biology. Expand access to interdisciplinary content to give students a better appreciation of modern science.

Louise Charkoudian CS 2018
Department of Chemistry, Haverford College
Capturing transient interactions involved in natural product biosynthesis. Harnessing the classroom to engage students in original research and the biochemical community.

Timothy Clark CS 2007
Department of Chemistry, University of San Diego
Organoboron chemistry: from metal-catalyzed borylation reactions to synthetic transformations involving the organoboron products. Outreach to high school students through student and teacher research experiences and teacher professional development.

Linda Columbus CS 2010
Department of Chemistry, University of Virginia
Membrane protein structure, dynamics, and function. Inclusive curracular redesigns of gateway courses.

Janice DeCosmo
Undergraduate Academic Affairs,
University of Washington
Air-sea exchange of momentum, heat, and water vapor in high wind conditions and implications for developing weather systems and climate. Assessing the impact of undergraduate research, effective mentoring, and integrating active learning strategies into curricula.

Michael Dennin CS 2000
Department of Physics, University of California, Irvine
Studies of complex fluids with a focus on aqueous foam and ice melange in fjords. Institutional support of faculty utilization of evidence based teaching.

Victoria DeRose CS 1998
Department of Chemistry, University of Oregon
My group studies metals in biology with a focus on metal-nucleic acid interactions. Developing cross-disciplinary courses such as 'Bioinorganic Chemistry' and 'Oxygen'; broadening participation in STEM.

Will Dichtel CS 2012
Department of Chemistry, Northwestern University
I study organic polymers, particularly ordered networks and porous polymers. Applications of interest include water purification and energy storage. I am interested in teaching large-format undergraduate organic chemistry in an engaging and effective way.

Kelling Donald CS 2008
Department of Chemistry, University of Richmond
Problems in structure and bonding from across the periodic table, applications for weak interactions and the implications of unusual bonding modes in molecules for structure prediction in solids. Fostering agency and empowerment for students in inclusive learning spaces. How to consider ethical questions in science classrooms.

Ashley Donovan
American Chemical Society
Faculty professional development opportunities related to teaching, research, and/or service. Chemical education.

Charles Doret CS 2017
Department of Physics, Williams College
Applications of simple atomic systems; quantum simulation and precision measurements with trapped ions. Effectively conveying quantitative problem-solving skills to make the sciences (and physics in particular) more approachable.

Lisa Elfring
Office of Instruction and Assessment,
University of Arizona
My work helps instructors to use evidence-based teaching practices and formative-assessment evidence to improve task design and improve student learning. I teach large-enrollment biology courses as a laboratory to explore teaching methods that improve student learning.

Networking Directory Continued

Tim Elgren
Administration, Oberlin College
I am a bio-inorganic chemist interested in metalloprotein structure and function, functional bio-materials and assessing exposure to toxins. Overall curricular coherence and curriculum development to support undergraduate research and civic engagement.

Andrew Feig CS 2002
Department of Chemistry, Wayne State University
Andrew studies biochemistry and biophysics of Toxins A & B from Clostridium difficile, inhibitors of the Toxins and potential biotechnology derived from repurposing them. @Afeig_novi studies faculty adoption of evidence-based teaching and issues of diversity, equity and inclusion in higher education.

Jarrod French CS 2018
Department of Chemistry, Stony Brook University
Determining signal transduction mechanisms of photoreceptors. Crowdsourcing structural biology.

Jordan Gerton CS 2007
Department of Physics, University of Utah
We develop novel techniques to study optical properties of materials and interaction of light and matter on deep sub-wavelength scales. Current projects include modernizing introductory physics labs and creating inclusive STEM pathways for diverse populations.

John Gibbs CS 2018
Department of Physics, Northern Arizona University
We are investigating shape-dependent collective behavior of light-activated soft matter systems. I'm interested in focusing upon educating students about the day-to-day activities of being a professional scientist.

Jason Gillmore CS 2006
Department of Chemistry, Hope College
Organic synthesis, photochemistry, electrochemistry & computation with undergrad—responsive materials using photochromes for more than color change. Mentoring new & future faculty, CUREs, (Peer-Led) Team Learning, using undergrad research to bridge 2YC-4YC transfers.

Boyd Goodson CS 2005
Department of Chemistry, Southern Illinois University
Hyperpolarization-enhanced NMR and MRI, where sensitivity is enhanced using either laser light or parahydrogen as the source of spin order. Honors general chemistry; group theory; statistical mechanics; clickers; modules in p-chem lab; REU and undergrad research; assessment.

David Gorin CS 2016
Department of Chemistry, Smith College
Use DNA aptamers to direct site-selective reactions. 2) Find alternatives to hazardous, widely-used reagents, especially for methylation. Teach mostly organic chem, some chemical biology. Interests: assessment (the "pHunger Games"), course-based research, use of research lit.

Martin Gruebele CS 1995
Department of Chemistry,
University of Illinois at Urbana-Champaign
Nuclear fusion, live cell RNA and protein dynamics, glass dynamics, imaging excited states, fish and bacterial swimming behavior. Making quantum mechanics accessible in gen chem and upper division courses, project-based classes.

Terry Gustafson
Department of Chemistry, The Ohio State University
Ultrafast spectroscopy. Metacognition.

Kathryn Haas CS 2016
Department of Chemistry, Saint Mary's College
Bioinorganic Chemistry, specifically in human copper homeostasis and in using spectroscopic studies of model peptides as tools for understanding metal-protein interactions. Technology-enhanced teaching, development of classroom undergraduate research experiences, and interdisciplinary lower-division courses that spark student interest in STEM.

Bo Hammer
American Institute of Physics
I am interested in strategies to increase the representation of African Americans in physics and astronomy. www.aip.org/TEAMUP.

Amanda Hargrove CS 2017
Department of Chemistry, Duke University
The Hargrove Lab explores RNA-biased small molecules and privileged RNA topologies for selective small molecule: RNA recognition. Hargrove is working on a CURE lab where students ID patterns in RNA recognition via VR, binding assays and principal component analysis.

Networking Directory Continued

Hayk Harutyunyan CS 2018
Department of Physics, Emory University
We are interested in understanding how light interacts with nanoscale matter. Engineering Sciences undergraduate program.

Jennifer Heemstra CS 2015
Department of Chemistry, Emory University
Bio-supramolecular chemistry–harnessing molecular recognition and self-assembly for applications in medicine and environmental science. Creating and assessing interventions using mindset and fear of failure frameworks. Promoting CUREs and inclusive pedagogical practices.

Eric Hegg CS 2002
Department of Biochemistry, Michigan State University
I am interested in the enzymes involved in lignocellulosic biomass deconstruction, N2O production, heme biosynthesis, and H2 metabolism. Education & Outreach at Great Lakes Bioenergy includes summer undergraduate research programs as well as many public outreach events.

Rigoberto Hernandez CS 1999
Department of Chemistry, Johns Hopkins University
Nonequilibrium chemical dynamics coarse-graining from molecular to human scales: proteins, sustainable nanomaterials, solvated chemical reactions. Implementing multimedia active learning in the classroom; advancing discipline-based diversity solutions to advance a broad STEM workforce.

Michael Hildreth CS 2003
Department of Physics, University of Notre Dame
Experimental Particle Physics at the LHC with the CMS Experiment: Higgs boson properties, searches for New Physics; Knowledge Preservation/Reproducibility; Distributed Computing. How to overcome barriers to acceptance of best-practice; How to help under-prepared students catch up.

Justin Hines CS 2012
Department of Chemistry, Lafayette College
I study the protein-protein interactions between molecular chaperones and amyloid aggregates known as "yeast prions". I write case studies in biology and chemistry for publication and for use with textbooks; I teach Gen Chem and Biochem.

Meredith Hughes CS 2018
Department of Astronomy, Wesleyan University
I study how planets form around nearby stars by observing disks of gas and dust around young stars using radio telescopes. I teach in a masters-level department at a PUI. I am particularly interested in STEM equity and inclusion, and astronomical ethics.

Eliza Kempton CS 2016
Department of Astronomy, University of Maryland
Exoplanet atmosphere modeling and characterization, super-Earths. Peer mentoring, spatial reasoning, active learning.

Evan Kirby CS 2018
Department of Astronomy, California Institute of Technology
I study the origin of the elements: how they were created in supernova explosions and how their ratios change as galaxies evolve. I am interested in active learning in the classroom and in teaching mentoring to graduate students by involving high school researchers.

Kirill Korolev CS 2017
Department of Physics, Boston University
I study the statistical physics of populations: spatial patterns in microbial populations and evolution during spatial spreading. I am interested in teaching biophysics and mathematical and computational skills to undergraduate and graduate students.

Dmytro Kosenkov CS 2016
Department of Chemistry and Physics, Monmouth University
Modeling excitation energy transfer in light-harvesting proteins, mechanisms of fluorescence quenching under protein/DNA binding, and DNA-ligand docking. Course-based undergraduate research experiences (CUREs), integration of research projects into physical chemistry curricula.

Tim Kowalczyk CS 2018
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.

Daniel Lambrecht CS 2017
Department of Chemistry, University of Pittsburgh
Computational prediction of structure-spectra relations, rational design of stimuli-responsive molecules. Technology-enhanced physical chemistry education, computation across the curriculum, enhancing inclusion.

Networking Directory Continued

Moses Lee CS 1994
M.J. Murdock Charitable Trust
Small molecule-DNA and -protein interactions, malaria vaccine, and anticancer drug development. Undergraduate research: collaborative, interdisciplinary, summer, academic year, and curricular-based.

Janelle Leger CS 2009
Department of Physics,
Western Washington University
Organic electronics, iontronic and electrochemical devices, plasmonics, and applications including photovoltaic devices and biosensors. Interdisciplinary curriculum development (materials science), and inclusive, student-centered and interactive teaching techniques.

Adam Leibovich CS 2006
Department of Physics, University of Pittsburgh
I work with effective field theories in a variety of theoretical particle and gravitational wave physics settings. I am currently focusing on connections between physics and students from the creative arts.

Mariangela Lisanti CS 2017
Department of Physics, Princeton University
I am an astroparticle theorist interested in the nature of dark matter. Increasing the diversity of the physics classroom, especially through innovations to freshman/sophomore curriculum.

Casey Londergan CS 2008
Department of Chemistry, Haverford College
Biophysical chemistry and vibrational spectroscopy of protein dynamics. Inquiry- and research-based labs and flipped classroom and active learning techniques (especially for physical chemistry).

Gina MacDonald CS 1997
Department of Chemistry, James Madison University
Spectroscopic characterization of ion and metal induced changes in protein, peptides and models drugs. Infrared, fluorescence and circular dichroism studies are used to characterize how ions induce changes in structure, solvation and aggregation of model systems that include the model drug, caffeine and the Alzheimer's A-beta peptide. Utilizing CUREs to enhance undergraduate lectures and laboratory experiences.

Thomas Maimone CS 2016
Department of Chemistry,
University of California, Berkeley
Synthetic organic chemistry. The chemistry and biology of natural products. Improving the transfer student experience.

Thomas Markland CS 2015
Department of Chemistry, Stanford University.
Modelling chemical reactivity in the condensed phase by developing and applying efficient quantum dynamics approaches. Increasing the use of molecular simulation and visualization in chemical education and developing MATLAB simulation experiences.

Matt McIntosh CS 1999
Department of Chemistry, University of Arkansas
Our research area is organic synthesis. In the last few years, we've focused on the development of low (e.g. ambient to 100 °C) temperature radical homolysis of nominally strong sigma bonds, and their application to organic synthesis. Our main focus has been increasing the involvement of undergraduates in research through a variety of initiatives.

Timothy McKay
Department of Physics, University of Michigan
I was trained in astroparticle physics, worked for 25 years in big data cosmology, and now use data to explore education at scale. I am committed to making large introductory STEM courses inclusive, equitable, and excellent.

Jill Millstone CS 2015
Department of Chemistry, University of Pittsburgh
Our interests encompass all aspects of observing, defining, and leveraging the chemical mechanisms underpinning inorganic nanoparticle formation, surface chemistry, and optoelectronic behaviors. Using Wikimedia, we develop logistically and conceptually accessible curriculum modules for a broad range of students and educators.

Kathryn Mouzakis CS 2017
Department of Chemistry, Fort Lewis College
Viral RNA structure and function. Developing and implementing course-based undergraduate research experiences.

Kerstin Nordstrom CS 2018
Department of Physics, Mount Holyoke College
I am interested in the mechanical behavior of amorphous materials—how they flow and jam. We specifically study micro/mesoscale features in the structure and dynamics. Best practices for inclusion and diversity, physics for life sciences, statistical mechanics, robophysics.

Networking Directory Continued

Teri Odom CS 2005
Department of Chemistry, Northwestern University
Nanoscale alchemy; multi-scale fabrication of hard and soft materials; manipulation of light and water at the nanoscale. Creating nanoscale experts; integrating multi-media tools in freshman chemistry.

Stella Offner CS 2018
Department of Astronomy, University of Texas at Austin
I study how stars are born, how they interact with their surroundings and how different environments can influence stellar properties. I am interested in enhancing undergraduate research preparation and enhancing representation of women and minorities.

Gregory O'Neil CS 2008
Department of Chemistry,
Western Washington University
My research focuses on organic synthesis. More recently we have also been investigating certain algae bioproducts. Organic chemistry lecture and laboratory, natural products, organic spectroscopy, biofuels.

David Patrick CS 1997
Department of Chemistry,
Western Washington University
I use theory and experiments to study nucleation and growth mechanisms in crystalline organic semiconductor thin films. Goal: growing designer crystals and films with tailored structure and function. Undergraduate-level materials chemistry and energy science curricula.

William Pomerantz CS 2016
Department of Chemistry, University of Minnesota
My lab is interested in developing chemical tools for perturbing protein-protein interactions involved in epigenetics. One notable approach is our Protein-observed Fluorine NMR (PrOF NMR) method. CUREs in organic chemistry, and implementing Massive-In-Class-Assessments (MICAs).

Jennifer Prescher CS 2014
Department of Chemistry, University of California, Irvine
My group develops custom probes to spy on cells in their native habitats and decipher cell-to-cell communications. Cross-disciplinary experiments for large undergraduate courses, forging R1-PUI collaborative networks.

Federico Rabuffetti CS 2018
Department of Chemistry, Wayne State University
Impact of chemical composition and crystal structure on temperature-dependent light emission of inorganic materials. Implement inquiry-based laboratories at early stages of the undergraduate chemistry curriculum.

Chad Risko CS 2018
Department of Chemistry, University of Kentucky
Our research is inspired by synthetic materials for electronics and power generation and storage and realizing in silico materials design. Data + chemistry: training students to better understand, curate, and represent their data to tell compelling stories.

Sean Roberts CS 2018
Department of Chemistry, University of Texas at Austin
Developing materials that manipulate energy by altering electron spin and spectroscopic tools for following energy and charge transport. Increasing community engagement by universities and STEM researchers by building partnership programs with Community Colleges.

Rae Roberts-Anderson CS 2010
Department of Physics, University of San Diego
Molecular-level mechanics of biopolymer networks and soft materials, precision optical techniques, bio-inspired material design. Undergraduate education focused on interdisciplinary curriculum, research-intensive courses and programs, and mentored independent research.

Michael Rose CS 2016
Department of Chemistry, University of Texas at Austin
Rose research group is interested in the synthesis of transition metal complexes and clusters for energy-related chemical transformations. We developed an Undergraduate Outreach Corps to involve undergraduates in outreach programs in the Rose group and Chem Dept.

Eduardo Rozo CS 2018
Department of Physics, University of Arizona
I am a cosmologist. We have discovered the Universe is ripping itself apart, and I'd like to know why. I am interested in implementing research based teaching practices.

Lisa Ryno CS 2018
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.

Networking Directory Continued

Monika Schleier-Smith CS 2017
Department of Physics, Stanford University
Quantum engineering and quantum simulation with laser-cooled atoms. Active learning and early exposure to 21st-century physics.

Zachary Schultz CS 2013
Department of Chemistry, The Ohio State University
Instrument development for the characterization of biochemical, interfacial, and materials. Active learning methodologies and assessment of student learning.

Mats Selen CS 1996
Department of Physics,
University of Illinois at Urbana-Champaign
Physics Education Research. Development and assessment of educational technologies that promote student engagement and increase faculty buy-in.

Scott Shaw CS 2016
Department of Chemistry, University of Iowa
We combine analytical and physical chemistry methods to create new understanding of chemical interfaces, and press the extents to which they can be controlled. We hope our experiments will lead to guided molecular self-assembly to create new molecular architectures. We work to improve scientific awareness, literacy, and self-efficacy of people living and learning in remote and rural communities.

George Shields CS 1994
Office of Academic Affairs and Department of Chemistry, Furman University
Science Education and Undergraduate Research.

Steve Singleton
Department of Chemistry, Coe College
How do micro- and meso-scale structural features influence the physical and optical properties of glassy/amorphous materials? Does a process-oriented inquiry-base pedagogy improve student learning outcomes?

Sara Skrabalak CS 2012
Department of Chemistry,
Indiana University Bloomington
Synthesis of nanomaterials with size, shape, and compositional control. Engaging nonscientists in scientific inquiry.

Tobin Smith
Association of American Universities
Science & tech policy; higher education policy; research compliance & costs; tech transfer; scientific openness & security. Undergrad STEM education improvement & reform; institutional change; sci communications; broader impacts; & public engagement in STEM.

Alexander Spokoyny CS 2018
Department of Chemistry,
University of California, Los Angeles
Our group is interested in developing atomically-precise hybrid nanoparticles featuring multivalent capabilities. I am interested in teaching science to non-scientists and marginalized groups in the society.

Grace Stokes CS 2018
Department of Chemistry, Santa Clara University
I study the mechanisms and thermodynamics of peptoid-lipid interactions towards predicting how peptoids may behave within the human body. My educational plan integrates Python-based problem-solving activities into chemistry to improve retention of 1st gen college students.

Mark Tuominen CS 1996
College of Natural Sciences,
University of Massachusetts Amherst
Nanophysics, biological electron transport, magnetism, self-assembly, self-organization. Cultivating student-directed, interdisciplinary team-based, real-world problem-based research learning.

David Vanden Bout CS 2000
College of Natural Sciences and Department of Chemistry, University of Texas at Austin
Understanding the role of molecular conformation on the excited states of conjugated polymers and aggregates via single molecule spectroscopy. Bringing science practice into science education.

Brett VanVeller CS 2018
Department of Chemistry, Iowa State University
Channeling excited-state energy of org molecules to turn photoreactions on/off. Fluorescent materials, peptides, polymers, other stuff too. New education models, founded in cog psych/comparative thinking, to construct models of reason that seasoned chemists take for granted.

Networking Directory Continued

Olalla Vázquez CFS 2016
Department of Chemistry,
Philipps-Universität Marburg, Germany
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.

Abigail Vieregg CS 2018
Department of Physics, University of Chicago
My research is in particle astrophysics and cosmology, experimentally probing the highest energy phenomena in the universe. Implementing methods to increase retention among undergraduate physics majors, especially women and minority students.

Lauren Waters CS 2016
Department of Chemistry,
University of Wisconsin-Oshkosh
My interests are biochemical mechanisms of metal ion homeostasis in bacteria, as well as regulatory RNAs and bacterial stress responses. My interests are active learning, critical thinking skills, research-embedded lab courses, and first-generation/non-traditional students.

Donald Watson CS 2013
Department of Chemistry, University of Delaware
Our group is focused on organic chemistry and chemical synthesis, transition metal catalysis, new reaction methodology, and mechanistic studies. We are interested in broadening participation in STEM fields, and early childhood outreach activities.

Timothy Wencewicz CS 2017
Department of Chemistry,
Western Washington University
Non-traditional antibiotic strategies to overcome antibiotic resistance. Focusing organic chemistry curriculum to engage diverse student groups.

Jodi Wesemann
Department of Education, American Chemical Society
Fostering the use of effective practices in the chemistry community using research on education, mentoring, and career development. Providing research-based resources that help students, faculty, and programs be more successful.

Luisa Whittaker-Brook CS 2018
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 CFS 2018
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.

Amanda Wolfe CS 2017
Department of Chemistry,
University of North Carolina Asheville
Isolation, characterization, and SAR evaluation of novel antibiotics produced by bacteria. Development of course based undergraduate research experiences in interdisciplinary upper level teaching laboratories.

Jeff Yarger CS 2001
School of Molecular Sciences,
Arizona State University
My research interests are in biophysical chemistry, nano-materials, biopolymers and the general field of disordered or amorphous materials. My educational interests are in biophysical chemistry and general online STEM education.

Yan Yu CS 2016
Department of Chemistry, Indiana University
Exploiting nanomaterials to understand and modulate immune functions. Promote critical thinking in undergraduate education.

Conference Participants

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