# Incentivizing Cultural Change

The 29th Annual Cottrell Scholar Conference July 19-21, 2023







## **Objectives**

#### To empower scholars to build community and participate in information exchange, participants will:

- Welcome the members of the 2023 Cottrell Scholar class and facilitate their interactions with other members of the community
- > Engage in community building by celebrating Holland and STAR/IMPACT awardees
- > Engage in authentic dialogue with the goal of identifying pressing issues affecting academic environments
- > Discuss successful activities and approaches for making STEM more equitable
- > Identify topics that may lead to successful Cottrell Scholar Collaborative projects
- > Have the opportunity to form teams and become involved in STEM education projects with national impact

#### **Diversity, Inclusion and No Harassment**

Research Corporation for Science Advancement fosters an inclusive and respectful environment for listening in which the different identities, backgrounds, and perspectives of all participants are valued, and in which everyone is empowered to share ideas 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.

**Read RCSA's Code of Conduct** 





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#### **From the President**

Cottrell Scholars play a vital role in bringing about changes that reflect our shared values of excellence in both research and education, of a more diverse and inclusive community of physical scientists, and of service and leadership locally, nationally, and globally. This year, I am especially thankful for the work of Cottrell Scholars through the Cottrell Scholar Program Committee and through Cottrell Scholar Collaboratives to promote even more strongly our commitment to diversity, equity, and inclusion.



We welcome to this conference and to the Cottrell Scholars our inaugural group of Holland Award recipients, established to recognize our former Board Director, Bob Holland, and to bring into our community colleagues who have excelled in their research and in their DEI initiatives. We also welcome our new Program Director, 1995 Cottrell Scholar Eileen, who will take the lead in moving the Cottrell Scholar Collaborative designed to provide underrepresented postdoctoral fellows with experience interviewing for faculty positions from a short-term experiment to a larger, ongoing program.

The development of a thriving community of very busy teacher-scholars requires the commitment of time and energy from all the Cottrell Scholars, especially in coming to Tucson for this annual conference. My thanks to all of you for carving out this time in your schedules and for your enthusiastic participation in the discussions that will take place over the next few days. My thanks, also, to Senior Program Director **Silvia Ronco**, who with Senior Program Directors **Richard Wiener** and **Andrew Feig** builds and nurtures this wonderful community through her caring about each Cottrell Scholar and through her passion for this remarkable program.

I wish you all the best for an enjoyable and stimulating conference.

**Daniel Linzer** President Research Corporation for Science Advancement



#### **From the Program Director**

Welcome to the 2023 Cottrell Scholar Conference!

We are delighted to host you in Tucson! This year's conference, *Incentivizing Cultural Change*, is co-chaired by Cottrell Scholars **Jen Heemstra (CS 2015)** and **Tehshik Yoon (CS 2008)**. The conference program was planned to foster thoughtful discussions on the synergetic relationship between reward systems and nurturing environments. Two exceptional keynote speakers, **Kerstin Perez** 



and **Holden Thorp**, will set the stage for thought-provoking breakouts aimed at generating innovative ideas for implementation on your campuses and beyond.

A central goal of the 2023 CS Conference is to extend a warm welcome to the newest class of Cottrell Scholars. To our 2023 Cottrell Scholars, please know that you were selected for your impressive research and educational programs, as well as your strong potential to actively contribute to the Cottrell Scholar family. To our returning Scholars, we encourage you to introduce yourself to the newcomers and embrace them as part of this remarkable community.

Community building is the heart and soul of the Cottrell Scholar Program! At this year's conference, we will celebrate the inaugural class of six outstanding Holland awardees who were selected to join the CS community due to the strength of their research programs and their contributions to diversity, equity, and inclusion. We will also showcase the exemplary work and leadership of our 2023 Cottrell STAR and IMPACT award recipients.

A great way to explore new educational ideas with potential national impact is to participate in a project with the Cottrell Scholars Collaborative (CSC), a diverse, cross-disciplinary network of Cottrell Scholars working together to improve science education at colleges and universities across the U.S. and Canada. Engaging with the CSC provides inspiration to improve your own work and an excellent opportunity to interact with other Cottrell Scholars.

We hope this event is a refreshing, informative, and intellectually stimulating experience. We look forward to working with you!

Silvia Ronco Senior Program Director Research Corporation for Science Advancement



# 2023 Cottrell Scholar Conference Agenda

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# Wednesday, July 19

2:00 – 6:00 pm	Registration	Retail Foyer
3:00 – 4:00 pm	Opening Reception	Murphey Patio
	Drinks and Light Hors d'Oeuvres	
4:00 – 4:30 pm	Welcome and Introductions	Murphey
	Dan Linzer, Silvia Ronco,	
	Jen Heemstra and Tehshik Yoon	
4:30 – 6:00 pm	2023 Cottrell Scholar Presentations	Murphey
6:15 – 7:15 pm	Dinner	Sonoran
7:15 – 8:30 pm	2023 STAR Award Presentation	Sonoran
	Daniel Crawford	

**Cottrell Scholar Trophy Ceremony** 



# 2023 Cottrell Scholar Conference Agenda

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# Thursday, July 20

7 am	Registration	Finger Rock Foyer
7:00 – 8:00 am	Breakfast	Murphey Patio
8:00 – 9:15 am	2023 Cottrell Scholar Presentations	Murphey
9:15 – 9:30 am	Morning Break	Finger Rock Foyer
9:30 – 10:45 am	Keynote Presentation	Murphey
	Kerstin Perez	
	"Building Lifeboats without Sinking Yourself:	
	Cultural Change on the Tenure Track"	
10:45 am – 12:00 pm	Breakout Session I	Finger Rock I, II, III
	"Interrogating Current Reward Structure"	and Primrose
12:00 – 12:30 pm	Report Out	Murphey
12:30 – 1:30 pm	Lunch	Sonoran
1:30 – 2:45 pm	Keynote Presentation	Murphey
	Holden Thorp	
	"Truth During Chaos: Science in a Time	
	When Facts Don't Matter"	
2:45 – 4:00 pm	Breakout Session II	Finger Rock I, II, III
	"Creating Cultural Change"	and Primrose
4:00 – 4:15 pm	Report Out	Murphey
4:15 – 6:00 pm	Informal Networking	
·	Swimming, Azul Bar/Lounge	
6:00 – 7:00 pm	Reception Honoring New Community Members	Sonoran Foyer
	and Cottrell Scholar Collaborative Roundtable	
	Drinks and Light Hors d'Oeuvres	
7:00 – 8:30 pm	Dinner	Sonoran
	Holland Award Presentations	



# 2023 Cottrell Scholar Conference Agenda

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# Friday, July 21

7:00 – 8:30 am	Breakfast	Murphey Patio
8:30 – 9:45 am	STAR and IMPACT Presentations	Murphey
	Linua Columbus and Mark Bussen	
9:45 – 10:15 am	Morning Break	Finger Rock Foyer
10:15 – 11:30 am	Breakout Session III	Finger Rock I, II, III
	"Defining Outcomes and Assessing Impact"	and Primrose
11:30 am – 12:00 pm	Report Out	Murphey
12:00 – 1:30 pm	Lunch	Sonoran
1:30 – 3:30 pm	Breakout Session IV	Finger Rock I, II, III
	Unstructured Time to Work on Educational	and Primrose
	Collaborations; Teamwork	
3:30 – 4:00 pm	Conference Wrap-up & Survey	Murphey
4:00 – 6:00 pm	Informal Networking	
	Swimming, Azul Bar/Lounge	
6:00 – 7:00 pm	Reception	Terrace Level Foyer
	Drinks and Light Hors d'Oeuvres	
7:00 – 9:30 pm	Family Dinner	Terrace Level Patio
	All guests are invited to join!	



# Westin La Paloma Resort and Spa





#### **Keynote Speaker**

# Building Lifeboats without Sinking Yourself: Cultural Change on the Tenure Track

#### **Kerstin Perez**

Associate Professor of Physics Lavine Family Associate Professor of Natural Sciences Columbia University in the City of New York



**Abstract**: For academic faculty on the tenure-track, "cultural change" is not in our job descriptions. How can we perform and support the labor of instituting positive cultural change — which is not only undervalued in tenure and promotion, but can be interpreted as evidence that we are not adequately committed to our scientific research — while also ensuring compensation for ourselves and those that come after us? In this talk, I will share my experience, across different institutions and career stages, with the uneasy work of balancing support for students with advocacy for my own personal and professional success. In particular, I will discuss my experience both building classroom communities that foster the recruitment and retention of students within undergraduate physics majors, and advocating for compensation for these and similar efforts.

**Bio**: Kerstin Perez is originally from West Philadelphia and earned her B.A. in physics from Columbia University. She received her Ph.D. from Caltech for research using the ATLAS detector at the LHC. She then returned to Columbia University as an NSF Astronomy and Astrophysics Postdoctoral Fellow. She was appointed as an Assistant Professor of Physics at Haverford College, before joining MIT as an Assistant Professor of Physics in 2016 and an Associate Professor of Physics in 2021. She returned once again to Columbia University as faculty in 2022. She has won numerous awards, including a Sloan Research Fellowship, 2019 Cottrell Scholar Award, APS DPF Early Career Instrumentation Award, and MIT School of Science Teaching Prize for Undergraduate Education.



#### **Keynote Speaker**

# Truth During Chaos: Science in a Time When Facts Don't Matter

#### **Holden Thorp**

Editor-in-Chief, Science Family of Journals American Association for the Advancement of Science



**Abstract**: It is a challenging time to do research. Political actors have developed sophisticated methods to undermine the public's understanding of science, and anti-science rhetoric has become prominent in the national discourse. In parallel, efforts to undermine inclusion in science are gaining steam precisely at the time when significant evidence has accumulated showing that it matters who does research. This talk will outline how we got here and pose some questions about how we might move forward.

Bio: Holden Thorp became Editor-in-Chief of the Science family of journals on October 28, 2019. He came to Science from Washington University, where he was provost from 2013 to 2019 and where he is Rita Levi-Montalcini Distinguished University Professor and holds appointments in both chemistry and medicine. Thorp joined Washington University after spending three decades at the University of North Carolina at Chapel Hill (UNC), where he served as the 10th chancellor from 2008 through 2013. A North Carolina native, Thorp started at UNC as an undergraduate student and earned a bachelor of science degree in chemistry in 1986. He earned a doctorate in chemistry in 1989 at the California Institute of Technology, working with Harry B. Gray on inorganic photochemistry. He completed postdoctoral work at Yale University with Gary W. Brudvig, working on model compounds and reactions for the manganese cluster in the photosynthetic reaction center. He holds an honorary doctor of laws degree from North Carolina Wesleyan College and is a fellow of the American Academy of Arts and Sciences, the National Academy of Inventors, and the American Association for the Advancement of Science. In his research career, Thorp studied electron-transfer reactions of nucleic acids, developed technology for electronic DNA chips, and cofounded Viamet Pharmaceuticals, which developed VIVJOA (oteseconazole), now approved by the FDA and marketed by Mycovia Pharmaceuticals. Thorp is a venture partner at Hatteras Venture Partners, a consultant to Ancora, and is on the board of directors of PBS, the College Advising Corps, and Artizan Biosciences. Thorp is the coauthor, with Buck Goldstein, of two books on higher education: Engines of Innovation: The Entrepreneurial University in the Twenty-First Century and Our Higher Calling: Rebuilding the Partnership Between America and its Colleges and Universities, both from UNC Press.



#### 2023 STAR Award



# T. Daniel Crawford

Department of Chemistry Virginia Polytechnic Institute and State University

Daniel Crawford (CS 2003) is recognized as an intellectual leader in advancing electronic structure theory whose educational efforts extend well beyond the Virginia Tech campus. His research has focused on the development and application of robust, reliable, and efficient quantum mechanical models of chemical compounds and reactions, particularly those of chiral molecules. His principal educational focus has been the training of the next generation of computational molecular scientists, developing and teaching curricula spanning high-school, undergraduate, graduate, and postdoctoral levels of instruction and reaching tens of thousands of students worldwide. Crawford is a lead developer of the open-source quantum chemical program package PSI, which is freely available to the global community of computational scientists, and in 2016 founded the MolSSI, which serves and enhances the software development efforts of the global computational molecular sciences community by providing software infrastructure, and by enabling the adoption of standards and best practices.



#### 2023 STAR Award



Linda Columbus Department of Chemistry University of Virginia

Linda Columbus (CS 2010) is a tireless advocate of equity in the classroom and an internationally recognized researcher whose creative and pioneering work on membrane proteins and membranes has inspired others in the field to adapt her approaches. In addition to leading a top research program in biophysical chemistry of function, structure, and dynamics of difficult-to-characterize but important systems, Columbus has driven the effort to redesign the undergraduate curriculum at the University of Virginia to reduce inequities within STEM disciplines. Her redesign of two introductory chemistry courses -- which decreased the performance gaps between first-generation and continuing generations, underrepresented minority and majority, and transfer and four-year students from 15-20% to less than 2% -- led her to inspire, encourage and support others to take on the quest for parity in curriculum. Columbus has been appointed director of a new UVA program to empower STEM faculty to make their courses and programs more equitable.



#### 2023 IMPACT Award



## Mark Bussell Department of Chemistry Western Washington University

Mark Bussell (CS 1994) is a champion of undergraduate research who has helped build research-rich science programs at a range of institutions and organizations at the regional, national, and international levels. Since joining the faculty of Western Washington University in 1990, Bussell has played a foundational and sustained role in transforming the WWU Chemistry Department into a national model with student participation in faculty-mentored research at its core. His commitment to enabling students to be productive scientists is demonstrated by the well-funded and internationally recognized research program he has led for over 32 years in the fundamental surface chemistry and reactivity of heterogeneous catalysts. Bussell's advocacy for high-impact research opportunities for undergraduates has included serving as an external consultant to the Council on Undergraduate Research (CUR) Transformations Project in its efforts to infuse course-based undergraduate research experiences (CUREs) and other research skill building activities into the chemistry curriculum. Bussell has provided his expertise to various research universities and primarily undergraduate institutions seeking to grow undergraduate research on their campuses, including the experimental liberal arts institution Yale-NUS College in Singapore. Bussell also served two terms on the Advisory Board of the American Chemical Society – Petroleum Research Fund.

#### **2023 Holland Awards**



## **Raychelle Burks**

Department of Chemistry, American University

Associate Professor of Chemistry at American University, Raychelle Burks is an outstanding researcher at the interface of chemistry and forensic science, as well as a national award-winning science communicator and dynamic educator. She is a 2020 recipient of the Grady-Stack Award, a national American Chemical Society (ACS) award for interpreting science for the public, and was named by



BBC Science Focus Magazine as one of the "6 women who are changing chemistry as we know it." Her research team, all undergraduates, works to create more reliable field portable sensing systems for forensic applications to minimize false results that can dramatically impact people's lives. By invitation, she contributed chapters on presumptive tests and field-deployable devices to the latest edition of the Encyclopedia of Forensic Sciences and has given numerous high-profile talks. She serves on a joint National Institute of Justice - Organization of Scientific Area Committees (OSAC) for the Forensic Science subcommittee tasked with revising technical standards for seized drug testing. She co-created and co-leads the National Science Foundation-funded Digital Imaging and Vision Applications in Science (DIVAS) Project, which helps students develop computational skills within an inclusive community of practice, and she was one of the researchers highlighted in the movie *Picture a Scientist*.

#### Luis A. Colón

Department of Chemistry, University at Buffalo

State University of New York Distinguished Professor and A. Conger Goodyear Professor of Chemistry at the University at Buffalo, Luis Colón has been called one of the "unsung heroes of chemistry" for the outsized impact of his programs on the increase in underrepresented minority faculty hired in chemistry departments in recent years. Beyond establishing a successful research program



in separation science, including seminal contributions to ultra-high-pressure liquid chromatography and selective separations, he is a committed teacher and mentor who is deeply engaged in the education and professional growth of students. The pipeline program he designed more than 25 years ago to engage Puerto Rican students in research has been replicated at multiple institutions and has inspired scores of students to pursue doctoral degrees in chemistry. He is a Fellow of the ACS, the American Association for the Advancement of Science (AAAS), and the Royal Society of Chemistry (RSC), and in 2015 he was honored by President Barack Obama with the Presidential Award for Excellence in Science, Mathematics and Engineering Mentoring (PAESMEM).

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#### 2023 Holland Awards Continued

#### **Robert Gilliard**

Department of Chemistry, Massachusetts Institute of Technology

Novartis Associate Professor of Chemistry at the Massachusetts Institute of Technology and a Scialog: Negative Emissions Science award recipient, Robert Gilliard is a world-class researcher, thoughtful educator, and a champion of underrepresented voices in chemistry. His research team, which focuses on

application-enabling fundamental science with a specialization in main-group element, organometallic chemical synthesis, has produced at least 40 peer-reviewed publications and has been recognized by leading national and international news outlets. Their discovery of the first crystalline beryllium radical was highlighted as one of the Chemistry & Engineering News "Molecules of the Year." His commitment to teaching and innovative course design is demonstrated by an upper-level laboratory course he created to modernize students' exposure to synthetic chemistry, giving them conceptual and technical skills using equipment for air-sensitive chemistry they need to enter graduate school or join the workforce. Gilliard and his laboratory have also been instrumental in providing mentoring, research, and career development opportunities to students from underrepresented groups, including those who transfer to four-year institutions from community colleges.

#### **Ted Goodson**

Department of Chemistry, University of Michigan

Richard Barry Bernstein Collegiate Professor of Chemistry at the University of Michigan, Ted Goodson is a world-renowned researcher in light-matter interactions with numerous applications in quantum information transfer, energy storage, and biomedical science. Recently elected a Fellow of both the

ACS and the American Institute of Medical and Biological Engineering, he was also the 2011 recipient of the Julian Percy award from the National Organization for the Professional Advancement of Black Chemists and Chemical Engineers, the organization's most prestigious award, and is currently the chair of the National Academy of Science Committee on Chemistry in Quantum Information Science Research and Education. The basic science advances from his lab have led to numerous patents and industry collaborations, and his commitment to teaching and mentorship, with a focus on diversity and inclusion, has spanned hosting and mentoring of high school students in his laboratory to outreach and recruitment of students at historically black colleges, leading many of these young researchers to pursue advanced studies. Serving for many years as a Senior Editor of the Journal of Physical Chemistry, Goodson has leveraged this position to focus on inviting and editing perspective articles by prominent scientists of color in chemistry.









#### Malika Jeffries-El

Department of Chemistry, Boston University

Professor of Chemistry and Associate Dean of the Graduate School of Arts and Sciences at Boston University, Malika Jeffries-El is a stellar scientist leading an interdisciplinary program on the development of organic electronic materials. She is also an administrator who works to increase access for underrepresented

students. At the national level, she is known for her efforts to increase diversity in the chemical sciences and mitigate bias in peer review. An active ACS member, she has served on numerous local and national committees and editorial and advisory boards including COACh, College Board, OXIDE, and the National Academies of Science, Engineering, and Medicine chemical sciences roundtable. She has held editorial positions at the Journal of Materials Chemistry C and at Materials Advances, and presently serves as an associate editor for the Royal Society of Chemistry flagship journal Chemical Advances. A recipient of the ACS Stanley Israel Award for Increasing Diversity in the Chemical Sciences, she is a sought-after speaker and an engaging science communicator who was featured in a NOVA "Beyond the Elements" segment sharing her excitement for polymers. She was recently named a 2022 AAAS Fellow.

#### Jane M. Liu

Department of Chemistry, Pomona College

Associate Professor at Pomona College, Jane Liu is a dedicated teacher-scholar and role model whose pedagogical efforts to make learning spaces on campus more equitable are having an impact beyond her own students and institution. Her ongoing research areas include investigating regulatory RNAs and proteins in Vibrio cholerae, engineering novel RNA-based biosensors, and experimenting



and assessing different ways of engaging undergraduate students in science that are centered around inclusion and equity. In late 2020, Liu developed an approach to integrate discussions of antiracism, social justice, and equity throughout the entire semester of an undergraduate biochemistry course. This work was published in the Journal of Chemical Education in 2022 and has since been implemented at several other institutions. She has also incorporated activities centered on diversity, equity, and inclusion into all the chemistry courses she teaches. She is committed to motivating students to pursue life-long careers in science and graduating scientifically literate students who can make rational and informed decisions at the intersection of health, science, and society.





# **Cottrell Scholar Collaborative Proposal Writing Guidelines**

# 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 are made to a team formed at this conference.
- > Members of the team are Cottrell Scholars, Fulbright-Cottrell Scholars, or Holland awardees.
- Award could be for a new project that will expand the impact of existing funded collaborative projects. New collaborative projects are also welcome.
- CSC proposals consist of two pages plus an optional third page with references. Proposals must include a statement of the problem, a working plan, anticipated impact, how the outcomes will be broadly disseminated, and a brief budget justification.
- CSC proposals must be submitted through the RCSA online submission system (PRISM, <u>https://prism.rescorp.org</u>) by 11:59 PM Pacific on August 4, 2023.
- > Awards will be announced within a month of submission. The tentative start date is October 1, 2023.

#### **Conference Evaluation Survey**

An online conference survey will be available on Friday, July 21, 2023. To access and complete the survey, please go to: <u>https://www.surveymonkey.com/r/2023\_CS\_Conference</u>



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#### **2023 Cottrell Scholars**

#### **Daniel Anglés-Alcázar**

Astronomy, University of Connecticut Multi-Scale Physics of Supermassive Black Hole Growth and Feedback in Galaxies and Fundamental Implications in Cosmology

The Cottrell Scholar Award will support graduate students to lead the development of novel computational approaches to (1) understand the detailed physics of supermassive

black hole growth in galaxies and the impact of black hole-driven winds; and (2) extract the maximum amount of information from cosmological surveys while marginalizing over uncertainties in supermassive black hole physics. We are ideally positioned to carry out these projects by leveraging state-of-the-art tools including (1) a new class of cosmological hyper-refinement simulations that for the first time explicitly resolve black hole accretion and feedback on sub-pc scales while including a realistic cosmological galaxy formation context; and (2) a suite of thousands of cosmological large-volume simulations designed to train machine learning algorithms and separate the intrinsic signatures of cosmology from those of uncertain galaxy formation physics. This award will also support a multi-component educational program aimed at increasing the retention and success of underrepresented ethnic/racial minorities (URMs) in Physics at UConn, including (1) a peer-mentoring program designed to support students through the many challenges of graduate school, with emphasis on improving the sense of belonging and the physics identity of URM students; (2) a redesign of our graduate and undergraduate courses in Computational Physics to incorporate more effective active learning approaches that help reduce achievement gaps and offer disproportionate benefits for URMs; and (3) a new proposed "Colors of Astrophysics" undergraduate program that will provide mentoring and financial support for URM students in STEM to participate in semester-long data visualization projects using Python programming tools.

#### Sarah Ballard

# Astronomy, University of Florida A Window into Day and Night: Constraining Nodal Precession of Temperate Planets Around Small Stars

M dwarfs comprise the vast majority of stars in the Milky Way, and host small planets in an abundance four times greater than Sunlike stars. Yet, the proximity of the "habitable zone" to small M dwarf hosts means that tidal effects play an outsized role in determining their hospitability to life. I propose, via both an observational campaign and suite of

numerical simulations, to investigate the nodal precession rate of known multiple planet systems orbiting M dwarfs. In the decade-long baseline since discovery, we now expect transit duration variations on detectable timescales. There exist two competing hypotheses for how these precession rates should behave, and the result has important implications for understanding day-and-night cycles on the surface of the Galaxy's most common planets. The educational component of this project will support graduate student effort in the implementation of a supplemental summer research institute for undergraduate astronomers of color at the University of Florida. The goal of this program is to mitigate the pipeline leak from the bachelor's degree in astronomy to Ph.D. study. Through this program, we aim to (i) increase the likelihood that each cohort of students will successfully apply to and matriculate into Ph.D. programs and (ii) equip students with a cognitive tool set to act as a buffer against the chronic identity threat often experienced by scientists of color. The proposed support will add a layer of support at the graduate level, compensating Ph.D. students within UF astronomy for mentoring and teaching the students within the cohort.







#### **Cacey Bester**

# Physics, Swarthmore College Creep Across Scales: The Role of Disturbances on Creep in Disordered Media

Creep is the slow flow and deformation in a granular material, such as sand or soil, due to the applied stress and the disordered nature of its grain-scale interactions. Creep in granular media shares striking similarities with the behavior of thermal systems, like glasses, due to their common feature of disorder across their different scales. I propose to

use photoelasticity, an effective experimental tool of granular systems, to probe the mechanisms of creep of disordered materials near yield. This work will address signatures of failure in disordered solids, the role of mechanical noise, and the connection to thermal and athermal systems at scales up to geological phenomena.

The goal of making physics and astronomy more equitable and inclusive can be achieved through choosing pedagogical approaches that appropriately fit the student identities and preparation levels that students bring to our classrooms. I propose to design a coherent set of interventions and instructional approaches for our undergraduate physics and astronomy major program. This wide-reaching project will foster a sense of belonging, physics identity, and academic citizenship through coordinated practices across our curriculum and department activities. Through this work our department will become a more inclusive and equitable community where all students, particularly those from historically marginalized identities in physics, can thrive.

#### Ambika Bhagi-Damodaran

Chemistry, University of Minnesota Twin Cities Reprogramming Hypoxia Signaling in Laboratory and Inorganic Chemistry Education in Classrooms

Cells utilize iron-dependent enzymatic circuitries to sense oxygen concentrations in their microenvironment and make metabolic decisions. Under hypoxic (low oxygen) conditions, mammalian cells arrest their cellular division processes and transform into a slow metabolic state. Such hypoxia-induced signaling and cellular transformation is highly

upregulated in cancer cells resulting in chemotherapy resistance in tumors. Our lab is asking a paradigm shifting question in this domain – Can we rationally and systematically enhance the catalytic efficiency of enzymatic hypoxia sensors and reprogram hypoxia signaling and hypoxic adaptation of cells? This proposal focuses on utilizing a combination of computational protein design, inorganic and bio-inorganic spectroscopy, and structural and cellular biology approaches to answer this question. Accomplishing the goals of this research will not only provide fundamental knowledge on the structure, function, and reaction mechanism of non-heme iron enzymes, but also answer long-standing questions in cellular signaling and cancer biology. The educational focus of this proposal is to revamp an inorganic chemistry laboratory course for senior undergraduates. The PI will collaborate with education experts in academia and industry to reprogram the content, pedagogical methodologies, and lab-report writing style of the lab course. Specifically, the PI will use her expertise as a non-traditional inorganic chemistry. At the same time, PI will add elements of technical skill development and industrial style reporting in student-generated lab reports to make the course more suited with professional aspirations of chemistry undergraduates at the University of Minnesota.









# Matthew Caplan

Physics, Illinois State University Impacts of Central Primordial Black Holes on Stellar Evolution

Primordial black holes with masses comparable to asteroids may have been produced in the early universe and are a popular but poorly constrained dark matter candidate. If these exist some may have been captured by compact bodies including stars, motivating us to study stellar evolution with microscopic central black holes. In this work, we will (i) develop new capabilities for the MESA stellar evolution code, (ii) simulate the evolution of

the sun including a central microscopic black hole and (iii) determine the impact on helioseismology and solar neutrinos. (iv) This work will be generalized to study the impact of central black holes on main sequence stars of other masses and (v) the impact of a compact core of dark matter on stars, including our sun.

The nuclear dimensions of the Russian invasion of Ukraine demonstrate the urgent need for a new national dialogue surrounding the continued existence of nuclear weapons. This need will be addressed by developing a new interdisciplinary general education course, Nuclear Weapons and Nuclear War, at Illinois State University which employs student-centric pedagogies. This course will survey modern topics in nuclear weapons, such as the effects of testing and mining on indigenous peoples, the new arms race, and non-western nuclear states such as Pakistan and India. Students recruited through this course and research assistantships will participate in mass media apprenticeships where they will write scripts for video content which will be produced with industry partners such as PBS Digital Studios and Kurzgesagt GmbH.

# **Javier Duarte**

Physics, University of California, San Diego Building a Better Foundation: Teaching Physicists and Machines

# How to Learn from Data

Measuring Higgs boson (H) interactions is necessary to confirm the validity of the standard model (SM), and any deviations may give a critical hint for new physics beyond the SM. Robust and accurate artificial intelligence models are necessary to detect H pair

production, enabling us to measure the H self-interaction. However, large simulated data samples are necessary to train these models, and their adaptability to real data is dependent on the fidelity of that simulation. In contrast, foundation models (FMs), large-scale models trained using massive unlabeled data sets, have led to major advances in natural language and computer vision tasks. For high energy physics (HEP), they may also improve the transferability to real data. I propose to use FMs for modeling particle jets to learn the underlying physics directly from real data, advance HEP research by improving data-simulation agreement, and measure the H self-interaction as precisely as possible.

The need for training physics students in advanced computational techniques is growing. Data science, the study of extracting value from data, and machine learning, which uses data to automatically construct programs for particular tasks, merit additional emphasis in formal curricula. Despite this, these topics are missing from many physics departments. Another major issue facing physics departments is a lack of Black, Brown, and women students earning degrees. I propose to develop a new course on data science and machine learning for physicists, which will build on new introductory courses, emphasize authentic collaboration among students, and create an inclusive learning environment.







#### **Christopher Durr**

Chemistry, Amherst College Exploring the Synthesis and Mechanism of Single-Site and Cationic Group V Catalysts for the Production of Biodegradable Polymers

Of the myriad metal catalysts in the literature studied for the ring-opening polymerization (ROP) of cyclic esters very little attention has been focused on group V metals. Titanium,

tin, zinc, aluminum and others have been studied in detail, but very little is known about niobium and tantalum catalysts. However, a handful of studies, including a recent one of our own, suggests that these systems are capable of ROP, and their activity can potentially be optimized through catalyst design and a more thorough understanding of their mechanism. This proposal lays out two project that aim to expand what we know about group V ROP by 1) designing a flexible single-site catalyst platform that is finely tuned through a dual-ligand system, and 2) targeting cationic catalysts to determine the effect metal charge has on ROP activity. Both projects will advance our understanding of these rarely studied systems while also shining light on a variety of fundamental aspects of group V chemistry. Concurrently, I will execute my educational plan - adapting the STEM Incubator model I codeveloped during my time at Amherst into an upper-level Inorganic Chemistry course. This model will teach students the fundamentals of chemical research over the semester. Students will get a chance to explore different research fields within inorganic chemistry while building technical as well as professional skills in a curriculum designed to prepare them for a research career.

#### **Megan Fieser**

# Chemistry, University of Southern California Controlling the Product Selectivity for the Catalytic Dechlorination of Poly (Vinyl Chloride)

Environmentally friendly strategies for the chemical recycling of commercial polymers is a critical research area to address growing accumulation of plastic waste. Although Poly(vinyl chloride) (PVC) is the third-most produced polymer, strategies to convert to

useful chlorinated and organic products are still in their infancy. This program seeks out catalytic strategies to convert all PVC into useful products, such as polyethylene, functionalized polymers, and small molecule olefins. We will show that reactions conditions can be altered to be highly selective for different pathways, such as dichlorination,

dehydrochlorination and substitution. A combination of molecular mimic studies and studies with PVC materials themselves will illucidate the requirements needed to for commercially viable chemical upcycling methods.

As plastic (polymer) pollution is becoming one of the critical environmental concerns of this world, introducing the problem and the diverse skills to address these problems must occur before graduate school. This program seeks to introduce USC undergraduate students to an interdisciplinary minor for the education of plastic circularity. This minor will bring chemistry and chemical engineering majors together to build a knowledge base beyond the STEM classes that are often prioritized. This approach will not only teach students about the directed topic, plastic circularity, but also skills that will be relevant to sustainability of products in general. Development of a polymer sustainability lab course will teach students skills in polymer characterization, as well as sustainable production, use and end-of-life of these materials. Short programs will be developed to introduce career and research opportunities to address plastic pollution.









# **Ronit Freeman**

Chemistry, University of North Carolina at Chapel Hill Forming Connections: From Interacting Self-Assembled Hubs to TACtICS (Teaching Convergence to Increase Innovation in Science) for Undergraduates

Living cells communicate to produce the emergent properties of tissues and gain adaptability by interacting at interfaces to sense and transmit information. Analogously,

the interface and exchange of information between different branches of science catalyze innovation that is greater than the sum of its parts. Interestingly, our ability to recapitulate this interaction and connectivity in synthetic materials, through chemical design; as well as in the way we train undergraduate and graduate students in the physical sciences to connect chemical/physical processes to broader context applications, will require a similar systems chemistry approach to: (1) establish relationships between multiple constituents (study areas) and (2) examine how systems-level phenomena emerge from interactions between the system's parts. With support from the Cottrell Award, we will focus on these research and education frontiers. For the research, we will develop a chemical framework based on peptide-DNA nanotechnology to enable design and synthesis of complex systems with lifelike functions. We envision the final products of this work to be functional communities of materials capable of dynamic, biomimetic shape responses to external or internal triggers. On the educational frontier, we will contribute towards a convergent educational framework and develop a course to better interconnect common chemical and physical concepts taught in undergraduate chemistry and physics programs while simultaneously equipping learners with understanding on how these concepts impact and propel contemporary societal and environmental issues. We will also develop content in the form of innovative activities and study aids to enable educators to teach classes with a convergent mindset.

# Graham Giovanetti

# Physics, Williams College A Study of Single Electron Backgrounds in a Low-Threshold

# Argon Detector

The development of large-mass, low-threshold detectors for dark matter and neutrino experiments is an active area of research within the particle physics community. Dual-phase argon time projection chambers (TPCs) are scalable and have a demonstrated ability

to trigger on single ionized electrons. However, these detectors suffer a high rate of spurious electron background events, necessitating effective analysis thresholds much higher than a single electron. Understanding the origin of these spurious electrons and developing techniques for removing them would dramatically improve the sensitivity of argon TPCs, opening new low-mass parameter space in the search for dark matter. I propose to build a small, dual-phase argon TPC optimized for detecting single electrons in my laboratory. I will use this detector to study the generation of single electron backgrounds as a function of argon impurity type and identify methods for eliminating them. Our current introductory physics curriculum at Williams does not serve students who have interest in physics but weaker high school science and math preparation. My educational proposal is to develop a new pathway into the physics major that supports these students. This new option will build on an existing algebra-based introductory physics course and will take advantage of the small class sizes at Williams to include a tutorial-style weekly meeting, where students will meet in a small group with the professor and receive personalized instruction to improve problem solving skills, achieve mastery of the introductory physics material, and foster a belonging mindset.









#### Vera Gluscevic

## Astronomy, University of Southern California Discovering Dark Matter with Cosmology

The observed universe is dominated by dark matter whose particle constituents are unknown and point to new fundamental physics. With the imminent advent of large observational surveys, the next three years are critical for deploying a framework that can assemble all the empirical evidence and tease out dark matter signals from the new data. I will create this framework by (1) developing a new emulator tool for fast modeling of the

local universe in cosmologies where dark matter behaves in novel ways, and by (2) enabling a comprehensive probabilistic inference to combine data from the early universe with observations of the population of small galaxies, never before analyzed in conjunction. These two capabilities will uniquely enable dark matter discovery. Their combination will revolutionize our capability to scan the universe for new physics and allow me to ultimately generate a new understanding of matter itself. The educational proposal involves creation of a Physics Discovery Practicum at USC, in direct response to the immediate needs identified in our Physics and Astronomy climate survey. The Practicum aims to address a programmatic gap with regard to data fluency for our starting physics and astronomy majors, increase the relevance of the overall course curriculum, and boost students' sense of belonging and community. The expected outcomes include increased student retention and representation of women and URM in physics and astronomy at USC, as well as increased student self-efficacy and academic success later on.

#### Ling Hao

Chemistry, George Washington University Capturing Molecular Communications Using Mass Spectrometry and Enhancing Science Communication in Chemistry Education

Research: Molecular interactions and communications are fundamental aspects of chemistry and life processes. Despite advances in understanding diverse functions and stable interactions of biomolecules in cells and organisms, capturing the dynamic and

transient communications between biomolecules is still technically challenging, particularly in a high-throughput fashion. The goal of this research proposal is to design novel proximity labeling chemistry and reagents to enable new mass spectrometry-based analytical chemistry methods and decipher both stable and transient protein-protein, protein-peptides, and protein-small molecular interactions as well as interaction sites. This project will address critical knowledge and technical gaps in proximity labeling and provide new analytical chemistry methods for understanding molecular communications in living cells. Education: Scientists need to become more skilled at effective and impactful communication to fight against science misinformation, increase public awareness, influence public decision-making, and support their own career development. As major goals in its strategic plan, the George Washington University's (GW) chemistry department is making a great effort to enrich student experience and increase chemistry student population. This education plan will address a critical gap in the current curriculum by developing a new science communication course for both undergraduate and graduate students. In addition, the education plan aims to formalize the mentoring relationship between undergraduate and graduate students, enhancing undergraduate research experience, equipping graduate students with leadership and mentorship skills, and promoting a more inclusive and diverse academic environment within the department.







# COTTRELL SCHOLAR

#### 2023 Cottrell Scholars Continued

#### **Mark Herzik**

# Chemistry, University of California, San Diego Next-Generation Electron Microscopy – Visualizing Enzymes in

# Action and Development of Hands-on Curriculum

Single-particle cryogenic electron microscopy (cryoEM) can be used to visualize structurally heterogeneous macromolecular complexes at high resolution. As the field of cryoEM continues to expand, there remains a need for improvements in data analysis

strategies necessary to in silico purify transient states of these dynamic macromolecules. Here, I propose to use several protein complexes to develop cryoEM sample preparation, data acquisition, and data processing strategies to visualize these enzymes under catalytic turnover conditions. Not only will this approach allow for the direct visualization of the complex conformational landscape enzymes traverse during catalytically relevant transitions within a single cryoEM experiment, but it affords the unique opportunity to visualize transient states that would be too labile using other structural techniques. Additionally, there is a critical need for the development of hands-on training materials for the next generation of cryoEM practitioners. Although dedicated cryoEM workshops are currently available, the limited capacity and shortened format results in substantial oversubscription and an inability to train new cryoEM users en masse. In my cryoEM course, I will implement self-paced modular hands-on curricula focusing on data analysis and manipulation. This includes the use of a precalculated data processing simulator hosted on a cloud desktop environment, whereby students will be allowed to "process" a cryoEM dataset from raw movies to final ~2.4 Å structure within a classroom setting within near instantaneous feedback on their decision paths. Additionally, I will implement hands-on learning using Jupyter lab notebooks that will allow students to engage and manipulate cryoEM data.

# Mark Ilton Physics, Harvey Mudd College The Physical Principles Governing High-Rate and Large Deformation Elastic Recoil

Some organisms use elastic mechanisms to drive ultra-fast and repeatable movements, but the materials physics principles that govern elastic recoil dynamics at high rates and large deformations are relatively unexplored. Current experimental approaches to

measure elastic recoil of polymeric materials neglect their viscoelasticity and underlying polymer physics. I propose an approach that combines recoil experiments with viscoelastic wave propagation simulations to uncover when viscoelasticity is important for these movements. Further, I will use well-controlled model materials with tunable elastic and viscoelastic properties that connect directly to their underlying polymer architecture. This connection will enable the discovery of polymer physics principles that control elastic performance at high-rates and large deformations. The proposed work contributes to fundamental scientific knowledge and has potential to inform future design of efficient elastic actuators. One of my goals as a teacher-scholar is to expand access to undergraduate research opportunities, particularly for students with historically-excluded identities in physics. Consistent with that theme, I will redesign Harvey Mudd College's introductory physics lab to include elements of course-based undergraduate research experiences. Grounded in physics education research, the course backbone will consist of a series of modules that focus on developing experimental skills. Over top of this structure, I will then develop experiments with discovery-based outcomes in areas of active physics research. The modular structure will enable future instructors to refresh experimental content without completely revising the course. The redesigned course will improve learning outcomes and foster the physics identity of a diverse group of students early in their academic careers.





#### Sarah King

Chemistry, University of Chicago Directing Energy and Charge Transfer in Molecular Moiré

# **Materials**

Designing Moiré materials with the capabilities of molecular tuning could usher in new material opportunities based on strong-correlation between electrons, holes, and excitons such as exciton condensation, correlated insulators, and superconductivity. While

candidate materials have been developed, transition metal dichalcogenide 2D materials layered with perylene dyes, these materials are polycrystalline making probing the fundamental properties of the candidate materials extremely challenging using conventional optical methods. This proposal aims to use ultrafast electron microscopy techniques to probe the electronic structure, electron transport, and phonon transport properties of molecular Moiré materials on the nanoscale. Through incorporation of active learning science communication modules into standard chemistry coursework, the educational proposal seeks to make science communication continuously part of the chemistry curriculum and improve acquisition and retention of science communication skills compared to conventional dedicated science communication classes. By utilizing an active learning approach to science communication within existing coursework the educational plan also seeks to increase self-efficacy and retention of undergraduate students in chemistry, critical for the broader impact of increasing participation of underrepresented minorities and women in STEM.

#### Lydia Kisley

Physics, Case Western Reserve University Imaging the Physical Dynamics of Analytes in Commercial Separation Materials and Using Core Facilities in the Classroom

Studying separations from the bottom-up — one molecule at a time — can identify rare events that lead to the failure of challenging purifications that are hidden in conventional experiments. Single-molecule fluorescence microscopy resolves the spatiotemporal

dynamics that occur in separations and has previously detected the causes of common problems in some types of chromatography. Yet, the prior samples used overly-simplified model substrates and low concentrations of a single analyte, limiting the impact of the findings. Here, we will expand single molecule microscopy to quantify analyte dynamics on commercial chiral stationary phase particles in high analyte concentrations and within mixtures. We will map the adsorption sites of peptide enantiomer analytes in 3D over at ~10 nm resolutions to probe both kinetics and thermodynamics. We will test the hypothesis that highly-selective sites will be more affected by thermodynamic overloading at high concentrations. In education, I will incorporate core facility instrumentation in two physics classes to expand the methods students learn about and can have access to. While laboratory courses lay the foundation for student understanding of experimental science, students are limited to methods that are conducive to a classroom environment and miss learning about advanced instrumental techniques that are used in interdisciplinary and emerging research areas. I will extend the classroom efforts beyond Case Western Reserve University with remote engagement of similar classes at PUIs. Overall, core facilities in the classroom will improve students' knowledge of instrumentation that they may otherwise be unaware of, better preparing students for research and careers.









#### **David Leitch**

Chemistry, University of Victoria Building Universal Quantitative Models for Catalysis from the Bottom Up, and Building Connections in Undergraduate Organic **Chemistry Education** 

Research: Quantitative predictions of chemical reactivity/selectivity are a crucial component of next generation computer assisted synthetic planning tools. Our approach

to building these predictive models for catalytic reactions is to study the individual steps of catalytic mechanisms. By combining high-throughput experimental design with computational chemistry and statistical analysis, we will create robust and accurate correlations between descriptor-based molecular representations and relative reaction rates for large libraries of substrates and catalysts. Specific targets include a complete map of oxidative addition reactivity as a function of substrate and catalyst structure, and corresponding maps for transmetalation, amination, and C-H activation by Pd(II) complexes. Educational: Success in organic chemistry education relies on "making connections" – between the different representations of Johnstone's triangle, between the content and the context, and between science and society. We propose to develop a set of new resources for our undergraduate program that focuses on representations in chemistry and their broader connections. Specific targets are an augmented reality app – MoleculAR – for converting symbolic representations into models, a context-based reorganization of our 200-level organic chemistry course, and a complete redesign of our 400/500-level Industrial Chemistry course to modernize, recontextualize, and decolonize the course content.

#### **Allegra Liberman-Martin**

# Chemistry, Chapman University Broadening Applications of the Weakly Coordinating Triflimidate Anion in Main Group Catalysis

Research: There is an ongoing need for efficient and robust catalysts based on earthabundant elements as replacements for precious metal catalysts. The use of main group compounds as Lewis acid catalysts has emerged as a powerful strategy for sustainable organic transformations. In the proposed work, undergraduate students in the Liberman-

Martin Group will study main group Lewis acids featuring the weakly coordinating triflimidate anion, N(SO2CF3)2-. Research projects are structured to provide insight into the role of main group element identity, compound geometry, and anion structure on Lewis acidity and catalytic activity. Simultaneously, the proposed work will provide new methods to transform commodity alkene, alcohol, and carbonyl substrates. Teaching: Argumentation involves supporting claims with convincing evidence. Although scientific argumentation has cognitive and social benefits for students, pedagogical practices to support students' construction of arguments are not widely implemented. The PI proposes to infuse scaffolded training in argumentation across the organic chemistry curriculum at Chapman University. Organic chemistry is well-suited to these interventions, as over-reliance on memorization in organic chemistry courses leaves students ill-equipped to solve mechanism or reactivity problems. In introductory organic chemistry courses, the PI will incorporate scaffolded argumentation practice across in-class worksheets, problem sets, and exams. In an elective advanced organic chemistry course, students will be further challenged to interpret experimental data when constructing arguments. The emphasis on scientific argumentation is designed to help students develop critical thinking skills and engage in scientific practices.











# COTTRELL SCHOLAR

## 2023 Cottrell Scholars Continued

#### **Kristen McQuinn**

Astronomy, Rutgers University - New Brunswick The Smallest Galaxies Hold the Biggest Clues for Understanding

# Galaxy Formation and Cosmology

Our understanding of galaxies is built on the high-surface brightness universe, where systems are relatively readily detected at all distances. Yet the majority of galaxies are low-mass, low-surface brightness systems. It is little surprise that when studied, low-mass

galaxies have properties that are challenging for our galaxy formation and evolution theories to match, based on the standard Lambda Cold Dark matter (LCDM) cosmology mainly tuned to bright galaxies. While it is clear empirical constraints from low-mass systems are key to advancing our current cosmological model, finding intrinsically faint galaxies in a very big sky has been a fierce barrier to overcome until now. This proposal focuses on finding and characterizing isolated, very low mass galaxies and will transform our understanding of the galaxy formation process at cosmic dawn, the coupling of baryonic and dark matter, and the nature of dark matter itself. Its specific aims include: (i) discovering low-mass galaxies, predicted to be ubiquitous, using novel techniques that have proven successful at finding galaxies previously overlooked in existing surveys; (ii) creating an empirical framework for model comparisons with datasets; and (iii) determining the impact of reionization on low-mass structures. The education plan focuses on the retention of under-represented minority students in STEM by engaging them in research during their first semester at college and connecting them with a multi-tiered mentoring network. This effort builds on the Rutgers Undergraduate Pipeline to Research & Education in Physics (RU-PREP) and offers new professional-development workshops that will benefit from my non-traditional path into science.

# Alison Patteson Physics, Syracuse University Soft Matter Physics of Biofilm Growth: A New Role of Substrate Viscoelasticity in Biofilm Growth

Biofilms have great importance for infectious diseases, industrial biofouling, and environmental ecosystems, and their growth depends on their ability to attach to and remodel a variety of different surface types. Our recent work has developed a new set of quantitative tools to measure the forces that growing biofilms exert on their substrate and

define how the mechanical properties of the substrate control biofilm growth. We have preliminary data that indicates substrate viscoelasticity in particular is essential to understanding how biofilms develop. Based on this work, I will combine physical and computational approaches to develop a unifying framework that describes the mechanical effects of substrates on biofilm growth, potentially identifying new design rules for materials to promote or hinder biofilm growth. We will study both how bacteria move on elastic and viscoelastic substrates and how stress evolves through the substrate, then build a model that defines the reciprocal relation between the substrate and biofilm. To continue to significantly advance soft-matter physics and biophysics, a workforce drawn from a greater diversity of disciplines and perspectives than is currently available is needed. This requires recruiting, training, and retaining students from underrepresented groups in STEM. My Cottrell Scholar education plan will build an inclusive and diverse community of physics students within Syracuse University in three steps: 1) bolster access and mentoring for Syracuse City high school students; 2) create a culture of open discussion for all physics undergraduate students, and 3) develop a new undergraduate and graduate Public Engagement in Physics and STEM course.







#### William Pfalzgraff

Chemistry, Chatham University Enhancing Reactivity and Selectivity at Polarized Interfaces

Two major challenges in chemical synthesis are to accelerate reaction rates and to precisely control which products are made in a reaction. Recent experimental work has shown that local electric fields, created by the proximity of ions at polarized interfaces, can give rise to selectivity and rate enhancements of up to two orders of magnitude. Our proposed work will use theory and simulation to elucidate recently developed



experimental setups for performing reactions at polarized interfaces. By combining electronic structure with molecular dynamics, we will model how different experimental factors, such as solvent, ions, and transition states, contribute to this effect, and thus develop design principles for optimizing experiments that exploit local electric fields. Our work integrates closely with experiment, allowing for insights gained from our simulations to be efficiently implemented and tested to develop this evolving area of synthesis. We will also leverage our expertise in modeling complex systems in our educational proposal, which is for the creation of a new course where second-year students create and interpret global climate models, including learning the necessary programming skills from the ground up. We have found in a pilot version of the proposed course that students can code their own climate model in Python, and then analyze, interpret, and present their results, allowing them to obtain a hands-on, quantitative understanding of climate change. Support for this proposal will be used to develop the course, assess the improvements in students' knowledge of geoscience and climate change, and disseminate the materials widely.

#### **Chanda Prescod-Weinstein**

Physics, University of New Hampshire

#### Searching for a Vibrant Dark Sector

This innovative work employs novel analytic and numerical techniques to investigate the dynamics between light dark matter candidates, not just through gravity but also through direct couplings. A principal outcome of this research program is the development of particle physics models and numerical simulations that will provide insight into the astrophysical phenomenology of multi-component dark matter. Hypothetical axion-like

particles (ALPs) are an increasingly popular dark matter candidate, and they are well-motivated by both standard model physics and quantum gravity. Tests of ALPs using large-scale structure are particularly valuable just as extensive new data is becoming available from new facilities such as the Vera C. Rubin Observatory. This program explores for the first time how self-interacting axiverse-like models comprised of multiple ALPs affect the evolution of large-scale structure. The objective of the educational work in this program is to support thriving and vibrant Black and other traditionally minoritized intellectual communities by teaching students to situate the work of a physicist in social context through a new departmental course that will be jointly offered to upper-level undergraduates and graduate students. The PI is in the process of writing a peer-reviewed book that develops social theory that explains the structural problems in the physics profession which lead to the exclusion of minoritized scholars. The PI will use drafts of book chapters to support other readings in a physics department-based course, cross-listed with women's and gender studies, which will support upper-level undergrad and grad students' understanding of how physics works, both technically and socially.





#### **Noel Richardson**

Astronomy, Embry-Riddle Aeronautical University Massive Binaries Have an Important Impact on Both Their

## Environments and on Undergraduate Education

Massive stars end their lives in spectacular supernova explosions. The stars are usually formed in binary star systems, where a majority (70%) of them interact with their companions prior to their explosive death. In this proposal, the research will concentrate

on the determination of stellar parameters of massive binaries so that the system's evolutionary status can be ascertained through comparisons to binary evolution models. These comparisons have recently led to new and exciting findings, such as the necessary interactions that lead to ultra-stripped supernovae or the pathways to creation of certain classes of massive binaries. Further work will be done to study the types of stars that could have formed dust in the early Universe with multi-wavelength techniques, elucidating details of the ways in which these systems form and evolve. For the educational portion of this proposal, the PI will develop a curriculum-based undergraduate research experience in a required course for astronomy majors: Observational Techniques of Astronomy. In the last two years, the PI pivoted the course to be an intensive semester-long research project where students measure spectra that they collect on an eclipsing binary with our local observatory. With the combination of the spectroscopy, TESS photometry, and PHOEBE software, the students derive stellar masses and radii for massive stars. The inclusion of research into a sophomore-level course for astronomy majors guarantees that these students have an equitable chance for research while promoting a more diverse student body that engages in research.

#### Daniel Tabor

# Chemistry, Texas A&M University Intelligent Optimization of Organic Photophysical

# **Chemical Spaces**

The research objective of this proposal is to combine techniques in model Hamiltonian development, optimization algorithms, generative models, and molecular representations to inversely design organic molecules with tailored spectral properties. To accomplish our

overall objective, we will 1) develop an interpretable model Hamiltonian representation for organic electronic spectroscopy, 2) demonstrate through Bayesian optimization how the spectra for these molecules can be rationally interpreted, and 3) leverage our developed tools in combination with chemical space optimization algorithms. The proposed model Hamiltonian framework has previously been demonstrated in vibrational problems to retain the accuracy of higher-level calculations while offering additional interpretability and substantially reduced cost. This interpretability will be utilized to help develop design principles for molecules that are predicted to have desired spectroscopic properties. The education objective of this proposal focuses on the building of instruction modules that integrate spectroscopic modeling and fundamentals of data science. The proposed activities emphasize the development of education modules that can be adapted from the undergraduate to the graduate level. The data science education components on the undergraduate and graduate level will emphasize FAIR data principles and contemporary concerns about data equity and biases that can exist in datasets. The final part of the education proposal focuses on further developing the culture of mentoring at Texas A&M University.







#### **Julian West**

Chemistry, Rice University Sustainable Difunctionalization of Alkenes Via Bio-Inspired Radical Ligand Transfer and Training Scientists to Engage with the Greater Public

Alkene Difunctionalization is a powerful approach to synthesize the molecules of modern life, from pharmaceuticals to next-generation materials. However, current, organometallic

methods often rely on precious metals and are prone to undesirable side reactions. Here we propose a new, radical approach to alkene difunctionalization taking advantage of two powerful elementary steps: light-driven ligand-to-metal charge transfer (LMCT) and bio-inspired radical ligand transfer (RLT). Fortuitously, both underexplored reaction pathways are possible using simple salts of sustainable iron and preliminary results reveal that several alkene difunctionalizations are possible using this approach. Here we propose building on these results to develop a suite of powerful alkene difunctionalization reactions that will enable the synthesis of critical molecules across science and society. Realizing the benefits scientific research to society requires the greater public to both understand the value of new discoveries and trust the underlying methods used to generate them. The COVID-19 pandemic has revealed that general understanding and trust of science are at a critically low level, leading to tragic and preventable outcomes. Research has shown public Science Communication to be a powerful tool to engage the lay public and build this essential trust and understanding; however, opportunities to develop the necessary skills are sorely lacking in traditional universaity science curricula. Here I propose developing a new workshop series that leverages my experience in newspaper and magazine writing to grow public science writing abilities and help train the next generation of science communicators to reengage the public.

# Christopher Whidbey Chemistry, Seattle University Illuminating the Dark Proteome: ABPP for High-Throughput Experimental Characterization of Proteins

Genome sequencing offers unprecedented insight into complex biological systems such as the vaginal microbiome. In order to transform genomic data into meaningful conclusions however, it is necessary to predict the functions of the proteins encoded by those

genomes. Currently, this relies on computational prediction which is insufficient to assign function to novel proteins that lack sufficient homology to proteins that have already been characterized. This results in a substantial proportion of genomes encoding proteins of unknown function (PUFs), and leaving drug targets, therapeutic agents, and new biochemical activities hidden as a 'dark' proteome. To annotate PUFs, experimental characterization is necessary. Current approaches to experimental functional annotation however, are low-throughput and slow. Here, I propose an activity-based protein profiling approach for multiplexed, high-throughput experimental functional annotation. I will use this pipeline to annotate the proteomes of three important but poorly characterized organisms, including the vaginal microbe Lactobacillus iners which is associated with bacterial vaginosis and infection-associated preterm birth. My educational plan offers undergraduates, especially those from underrepresented minority (URM) groups, increased opportunities to conduct and engage with interdisciplinary research. Leveraging new opportunities including the co-location of Chemistry, Biology, and Computer Science in the recently opened Sinegal Center for Science and Innovation, I will develop an interdisciplinary seminar series and implement an early-career focused undergraduate research course. I will intentionally engage URM scholars and students with the goal of enabling students to develop skills and sense of belonging to persist in STEM majors, find further research opportunities, and increase STEM career placement.







#### **Conference Participants**

#### Mario Affatigato CS 1996

maffatig@coe.edu Physics, Coe College Glass science, amorphous materials, spectroscopy including Raman, AFM, mass spectrometry, calorimetry, SEM/XRF. Undergraduate research, with a special interest in student research on materials. Also physics pedagogy, broadly defined.

#### Kathy Aidala CS 2009

kaidala@mtholyoke.edu

#### Physics, Mount Holyoke College

My expertise is atomic force microscopy, particularly electrical measurements on organic semiconductors, 2D materials, and dielectrics. My interests include undergraduate research, teaching to diverse populations, and infusing the lib arts curriculum with STEM experiences.

#### Jeanine Amacher CS 2021

#### Jeanine.Amacher@wwu.edu

Chemistry, Western Washington University My lab uses protein biochemistry and structural biology to investigate the selectivity determinants of peptide-binding domains. My educational interests are in professional development, and creating nearpeer mentoring opportunities at our PUI.

#### Daniel Anglés-Alcázar CS 2023

#### angles-alcazar@uconn.edu

Physics, University of Connecticut I am broadly interested in galaxy evolution, from supermassive black holes to the large scale structure of the Universe. I aim to develop teaching and mentoring strategies to increase the retention and success of women and underrepresented minorities in physics.

#### Carlos Baiz CS 2020

#### cbaiz@cm.utexas.edu

Chemistry, University of Texas at Austin Spectroscopy, simulations, biophysics, protein dynamics, lipid membranes. Machine learning. Physical chemistry, biophysics, quantum mechanics. Success in grad school. Mental health.

#### Lane Baker CS 2009

lane.baker@tamu.edu

Chemistry, Texas A&M University The Baker research group is broadly interested in nanoscale electrochemistry and small-scale mass spectrometry. Integration of measurement science and data science in undergraduate and graduate curriculums.

#### Sarah Ballard CS 2023

#### sarahballard@ufl.edu

Astronomy, University of Florida I'm interested in all kinds of planets and their properties, especially planets orbiting small stars. I want to create small, intentional networks of faculty, with the aim of providing multiple advisors/mentors for the network's Ph.D. students.

#### Jeff Bandar CS 2021 jeff.bandar@colostate.edu

Chemistry, Colorado State University Synthetic organic chemistry and catalysis for small molecule synthesis. Teaching in an interactive, inclusive and supportive manner to undergraduate and graduate students in the areas of organic

# chemistry.

#### Darcy Barron CS 2022

#### dbarron2@unm.edu

Physics and Astronomy, University of New Mexico I study our universe with measurements of the cosmic microwave background, from building instruments to understanding the data they produce. I'm interested in bringing elements of research and discovery into physics courses, to give a broader audience access to these experiences.

#### Rob Berger CS 2017

#### bergerr@wwu.edu

Chemistry, Western Washington University My group uses DFT calculations to study structure/property relationships in solids (especially perovskites) for energy applications. I am interested in developing curricular materials (including computer simulations) for flipped physical chemistry courses.



#### Cacey Bester CS 2023

#### cbester1@swarthmore.edu

Physics and Astronomy, Swarthmore College Soft matter project using photoelasticity, an experimental tool of granular systems, to probe mechanisms of disordered materials near yield. DEI project to foster sense of belonging through coordinated practices and instruction across physics curriculum and department activities.

#### Penny Beuning CS 2009

#### P.Beuning@northeastern.edu

Chemistry and Chemical Biology, 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.

#### Rachel Bezanson CS 2021

#### rachel.bezanson@pitt.edu

Physics and Astronomy, University of Pittsburgh I study the formation and evolution of massive galaxies across cosmic time with multi-wavelength observations including the new JWST. I am working on strengthening undergrad and grad student mentoring and bolstering the APS Bridge Program at the University of Pittsburgh.

# Ambika Bhagi-Damodaran CS 2023

#### ambikab@umn.edu

Chemistry, University of Minnesota Twin Cities Engineering iron enzymes to reprogram biological signaling and advance sustainable chemical catalysis Chemical biology, inorganic chemistry. Specific focus on making the curriculum more suited to professional aspirations of students.

#### Karen Bjorkman CS 1999

#### karen.bjorkman@utoledo.edu

Physics and Astronomy, University of Toledo Observational astronomer using multiwavelength spectra and spectropolarimetry to study massive stars, variable stars, & circumstellar disks. Introductory astronomy, and undergraduate/graduate astrophysics. Engaging students interactively. Public outreach to the broader community.

#### Laura Blecha CS 2021 Iblecha@ufl.edu

Physics, University of Florida I use multi-scale simulations to study the evolution of supermassive black holes and galaxies, including gravitational-wave sources. I am expanding scientific computing opportunities for undergrad and high school students, focusing on historically excluded groups in STEM.

#### Fadi Bou-Abdallah CS 2008 bouabdf@potsdam.edu

Chemistry, State University of New York at Potsdam My research interests are in the area of iron protein biochemistry, protein biophysics, and iron homeostasis. Training undergraduate students for careers in STEM, research and scholarships, and fostering critical thinking and student engagement.

#### Raychelle Burks HOL 2023

burks@american.edu

Chemistry, American University Developing targeted, tech-tunable sensing systems for a spectrum of forensic testing environments. Developing inclusive pedagogical practices that support lifelong learning.



#### Mark Bussell CS 1994

#### mark.bussell@wwu.edu

Chemistry, Western Washington University Development of metal phosphide-based heterogeneous catalysts for selective hydrogenation and photocatalytic CO2 hydrogenation reactions. Renewable energy focused CUREs developed in collaboration with community college faculty for use in general chemistry courses.

#### Dennis Cao CS 2019

#### dcao@macalester.edu

Chemistry, Macalester College Synthesis of novel electron-poor aromatic compounds of relevance to materials applications. Elevating the use of real-world examples in teaching organic chemistry by collation of reactions. (RealOrganicChemistry.org)

#### Justin Caram CS 2021

jcaram@chem.ucla.edu Chemistry and Biochemistry, University of California, Los Angeles My group makes and studies molecules and materials that show extreme and unusual photophysics. I am interested in replacing remedial coursework in general chemistry with intensive guided group work.

#### Bert Chandler CS 2001

#### bert.chandler@psu.edu

Chemical Engineering and Chemistry, Pennsylvania State University

Fundamentals of heterogeneous catalysis; chemistry at the metal-support interface; hydrogen utilization & storage; polyolefin upcycling. Serving socioeconomically disadvantaged communities; communicating data treatment to broader communities; undergraduate research.

#### Laura Chomiuk CS 2017

#### chomiuk@pa.msu.edu

Physics and Astronomy, Michigan State University Energetic astrophysics taking advantage of the whole electromagnetic spectrum to understand novae, supernovae, and accreting compact objects. Supporting, engaging, and retaining large numbers of diverse undergrads in research and public outreach!

#### Ilse Cleeves CS 2022

#### lic3f@virginia.edu

University of Virginia, University of Virginia I study the formation environments of planets through the use of astrochemical/astrophysical modeling and radio and infrared telescopes. I am interested in incorporating real world skills into seemingly esoteric topics for the benefit of nonmajors (and majors alike).

#### Luis Colón HOL 2023

#### lacolon@buffalo.edu

Chemistry, State University of New York at Buffalo Development and characterization of new materials with particular application in separation science/chemical analysis. Advance educational opportunities to increase diversity in the chemical sciences.

#### Linda Columbus CS 2010

#### columbus@virginia.edu

Chemistry, University of Virginia

the driving forces that determine membrane protein stability, structure, dynamics, and interactions with lipids and other proteins. I am interested in course changes that increase learning and reduce performance gaps between different demographics.



#### Daniel Crawford CS 2003

#### crawdad@vt.edu

Chemistry, Virginia Polytechnic Institute and State University

The development of accurate quantum mechanical models for simulating the optical and vibrational spectra of chiral molecules. Training the next generation of computational molecular scientists, developing curricula reaching tens of thousands of students worldwide.

#### Ryan Davis CS 2022

#### rddavis@sandia.gov

Materials, Physical, and Chemical Science Center, University of New Mexico and Sandia National Laboratories

Analytical and physical characterization of materials, with a particularly interest in aerosol particles. Providing undergraduate students with research opportunities and virtual collaborations

#### Julio de Paula CS 1994

#### jdepaula@lclark.edu

Chemistry, Lewis & Clark College Nanoscience, photochemistry, archaeometry. Physical and biophysical chemistry, environmental chemistry, general chemistry, science for nonmajors.

#### Joel Destino CS 2021

#### joeldestino@creighton.edu

#### Chemistry, Creighton University

Colloids, hybrid & solid-state glass materials, 3D printing, luminescent chemical sensors, and spectroscopy. Inclusive undergrad research mentorship & active learning that informs social consciousness, connecting the classroom to the world.

### Charlie Doret CS 2017

scd2@williams.edu

Physics, Williams College We are interested in atom-based-tests of physics beyond the standard model & quantum simulation of thermodynamic phenomena. I am interested in bringing a broad range of backgrounds into physics and supporting making and computation throughout the STEM curriculum.

#### Javier Duarte CS 2023

#### jduarte@ucsd.edu

Physics, University of California, San Diego I develop artificial intelligence techniques for high energy physics to measure elementary particles and search for new physics. I aim to inclusively teach modern computational techniques, including artificial intelligence, to diverse physics students.

# Chris Durr CS 2023

#### cdurr@amherst.edu

Chemistry, Amherst College My research is focused on developing and understanding next generation polymeric materials through design of new inorganic catalysts. I'm interested in making connections between inorganic chemistry and other courses students have taken throughout their careers.

#### Serena Eley CS 2022

#### serename@uw.edu

Physics, University of Washington I am interested in designing quantum materials for a variety of applications. I am interested in precollege outreach as the main tool for broadening participation in the sciences, and in quantum workforce development.



#### Deven Estes FCS 2023

deven.estes@itc.uni-stuttgart.de Institute of Technical Chemistry, Universität Stuttgart Surface Chemistry, heterogeneous catalysis, organometallic chemistry. Visualizing 3D molecular structures, expanding chemical education.

#### Ben Feldman CS 2022

#### bef@stanford.edu

Physics, Stanford University

Developing new techniques to engineer and study emergent quantum electronic phases in reduced dimensional systems. Enhancing undergraduate research opportunities as well as developing active learning and inquiry-based coursework.

#### Daniela Fera CS 2021

#### dfera1@swarthmore.edu

Chemistry and Biochemistry, Swarthmore College We seek to understand how kinases are regulated and how they interact with other proteins in the cell to ensure proper immune responses. I'm interested in active learning approaches that engage a variety of students in both introductory and advanced biochemistry courses.

#### Megan Fieser CS 2023

#### fieser@usc.edu

Chemistry, University of Southern California My interests include inorganic chemistry, catalysis, polymer science and mechanistic studies, with an emphasis on polymer circularity. My interests are targeted to course and workshop design that prepares students for cutting-edge topics in sustainability.

#### Kate Follette CS 2022

#### kfollette@amherst.edu

Physics and Astronomy, Amherst College I am an observational astronomer working to understand planet formation and growth by characterizing young (proto)planets and brown dwarfs. I study whether general education science courses can help students improve real-world math skills and lower barriers to entry to STEM.

#### Wen-fai Fong CS 2022

#### wfong@northwestern.edu

Physics and Astronomy, Northwestern University I use observations across the EM spectrum to follow explosive cosmic phenomena, including neutron star mergers and fast radio bursts. I am interested in programming which furthers the persistence of underrepresented groups in STEM at the college level.

#### Alex Frañó CS 2021

#### afrano@ucsd.edu

Physics, University of California, San Diego Experimental condensed matter physics, quantum materials, neuromorphic computing. Researchoriented physics (STEM) education.

#### Ronit Freeman CS 2023 ronifree@email.unc.edu

Applied Physical Sciences, University of North Carolina at Chapel Hill

I am interested in supramolecular self-assembly for next-generation sensors, nano robots, drug breakthroughs, and clinical tools. I am developing convergent educational frameworks to interconnect common chemical and physical concepts taught in undergraduate chem program

#### Stephen Fried CS 2022 sdfried@jhu.edu

Chemistry and Biophysics, Johns Hopkins University Mass spectrometry, proteomics, protein folding. Interested in how folding intersects with cell biology, ageing, and origins of life. Including first-generation undergraduates in the research experience. Modernizing physical chemistry education.

#### Carla Fröhlich CS 2014

#### cfrohli@ncsu.edu

Physics, North Carolina State University Simulations of supernovae & binary mergers for astrophysical multi-messenger predictions. Neutrino flavor transformations. Machine-learning. Growth mind set, resilience, and career development. Cofounder of the "Building Bridges" workshop in Germany.



#### Jordan Gerton CS 2007

#### jordan.gerton@utah.edu

Physics and Astronomy, University of Utah Nanophotonics; student sensemaking in labs; student reasoning in quantum mechanics; faculty reasoning in retention and promotion decisions. Intro physics labs; alternative assessment and grading; curriculum reform; building supportive student communities.

#### John Gibbs CS 2018

#### john.gibbs@nau.edu

Applied Physics and Materials Science, Northern Arizona University Nanomaterials, plasmonics, active matter, chiral metamaterials. Undergraduate research opportunities.

#### Robert Gilliard HOL 2023

#### gilliard@mit.edu

Chemistry, Massachusetts Institute of Technology Synthetic Inorganic, Organic, and Main-Group Chemistry; Small Molecule Activation; Luminescent Molecular Materials; Redox Chemistry. Chemical Synthesis, Inorganic and Organic Chemistry, Main-Group Chemistry.

#### Jason G. Gillmore CS 2006

#### gillmore@hope.edu

Chemistry, Hope College

#JGGgrp undergraduate research: organic photochemistry, electrochemistry, synthesis, computation, a focus on organic dyes & photochromes. CUREs, PLTL, mentoring junior and future faculty, teaching organic, general, nonmajors, and upper-level elective undergrad courses.

#### Graham Giovanetti CS 2023

#### gkg1@williams.edu

#### Physics, Williams College

I am an experimental particle and nuclear physicist, primarily focused on "rare-event" searches. I am interested in ways we can support students and improve our retention within the physics major, particularly in introductory courses.

#### Eilat Glikman CS 2017

#### eglikman@middlebury.edu

Physics, Middlebury College

I study how black holes grow and impact their host galaxy's evolution. I focus on dust reddened quasars involving galaxy mergers. I teach astronomy and physics to liberal arts students across disciplines, focusing on numeracy and a connection to the art and humanities.

#### Vera Gluscevic CS 2023

vera.gluscevic@usc.edu

Physics and Astronomy, University of Southern California

Cosmological and astrophysical probes of new physics; dark matter; CMB theory and analysis; 21cm cosmology; cosmological simulations. Inclusivity, equity, and diversity; active learning; studio classroom; computational tools; astronomy and physics graduate curriculum.

#### Boyd M. Goodson CS 2005

#### bgoodson@chem.siu.edu

Chemical & Biomolecular Sciences, Southern Illinois University Carbondale

Hyperpolarization-enhanced NMR & MRI; low-field NMR & MRI; agents for pre-/clinical molecular imaging; polarized targets for neutron science. General chemistry; clickers; introducing undergrads to research; STEM outreach; physical chemistry; supporting grad students.

#### Ted Goodson HOL 2023

tgoodson@umich.edu

Chemistry, University of Michigan Physical Chemistry of organic, biological, and inorganic materials with quantum optical and timeresolved spectroscopic methods. Mentoring undergraduate and graduate students in chemistry and physics and materials, mentoring in academia, and junior scientists.



#### Natalie Gosnell CS 2021

ngosnell@coloradocollege.edu Physics, Colorado College I am an astrophysicist interested in how binary stars impact stellar evolution, especially magnetically active evolved binaries. I'm investigating incorporating creativity exercises into intro physics to strengthen student physics identity and increase belongingness.

#### Kathryn Haas CS 2016

#### kathryn.haas@duke.edu

Chemistry, Duke University I use spectroscopy to shine light on the biocoordination and biophysical chemistry of copper chaperones in human body fluids. I teach advanced chemistry labs using CUREs and develop open educational resources for Inorganic, Analytical, and Physical Chemistry.

#### Christine Hagan CS 2022

#### chagan@holycross.edu

Chemistry, College of the Holy Cross Mechanisms of protein toxin transport across the membranes of Gram-negative bacteria. Developing course-based research experiences that integrate chemical and biological concepts at the introductory level.

#### Ling Hao CS 2023

#### linghao@gwu.edu

Chemistry, George Washington University Developing mass spectrometry-based bioanalytical chemistry strategies to capture the dynamic protein interactions and networks in neurons. Enhancing science communication in chemistry education and formalizing graduate-undergraduate mentoring relationship.

#### Amanda Hargrove CS 2017

#### amanda.hargrove@duke.edu

Chemistry, Duke University The Hargrove Lab explores RNA-biased small molecules and privileged RNA topologies for selective modulation of RNA conformation and function. Hargrove has developed a CURE as a freshman seminar course where students ID patterns in RNA recognition.

#### Jen Heemstra CS 2015 heemstra@wustl.edu

Chemistry, Washington University in St. Louis We build with biomolecules to address unmet needs in human health and the environment. We seek to understand how intrapersonal factors (e.g. fear of failure, belonging) impact student success and retention in STEM.

#### Rigoberto Hernandez CS 1999

#### r.hernandez@jhu.edu

Chemistry, Johns Hopkins University Nonequilibrium statistical mechanics, chemical dynamics in complex environments, discipline-based diversity research (DBER), and OXIDE. Inclusive classrooms, active learning, and academic leadership training (ALT).

# Mark Herzik CS 2023

#### mherzik@ucsd.edu

Chemistry and Biochemistry, University of California, San Diego CryoEM of dynamic macromolecular assemblies involved in protein biogenesis, nitrogen fixation, and molecular transport. Developing choose-your-ownadventure style learning materials for (under)graduate education.

#### Mike Hildreth CS 2003

#### hildreth.2@nd.edu

Graduate School, University of Notre Dame Experimental Particle Physics, Undergraduate and Graduate pedagogy, Graduate mentoring.



#### Frank Huo CS 2020

#### huo@chem.rochester.edu

Chemistry, University of Rochester PhotoChemistry, Excited State Quantum Dynamics, Light-Matter Coupling, Cavity QED, Polariton Chemistry Undergraduate and Graduate level Physical Chemistry (quantum, Statistical Mechanics).

#### Mark Ilton CS 2023

#### milton@g.hmc.edu

Physics, Harvey Mudd College Soft matter physics, biomechanics, elastic mechanisms, bottlebrush elastomers, bioinspired design, fluid mechanics. Broadening participation in physics, including authentic research experience in undergraduate curriculum.

#### Malika Jeffries-EL HOL 2023 malikaj@bu.edu

# Chemistry, Boston University

Our lab focuses on the development of molecular and polymeric organic semiconductors for use in light-emitting diodes and solar cells. I am interested in inclusive excellence and broadening participation pf learners from underrepresented groups.

#### Chenfeng Ke CS 2019

#### chenfeng.ke@dartmouth.edu

Chemistry, Dartmouth College

The Ke group focuses on developing 3D-printing hydrogels and porous organic frameworks. The PI has implemented active learning class designs for organic chemistry I and II classes, and developed Women in Science Projects.

#### Catherine Kealhofer CS 2020

#### ck12@williams.edu

Physics, Williams College

I work on developing novel ultrafast electron sources for time-resolved electron diffraction. I am interested in ways of incorporating physics research papers in introductory and advanced courses.

# Sarah Keane CS 2022

#### sckeane@umich.edu

Chemistry and Biophysics, University of Michigan The Keane lab investigates the role of RNA structure, dynamics, and protein/small molecule interactions in regulating RNA function. I'm interested in providing students with authentic learning experiences both in the classroom and lab.

# Daniel Keedy CS 2022

#### dkeedy@gc.cuny.edu

Structural Biology Initiative, Research Foundation of CUNY- Advanced Science Research Center The Keedy lab studies 3D protein structures and how they are manipulated by small molecules or mutations to control biological function. I aim to motivate diverse undergraduate STEM students by integrating prospective experiments into classroom group biochemistry projects.

#### Lydia Kisley CS 2023

#### lydia.kisley@case.edu

Physics and Chemistry, Case Western Reserve University

Developing new fluorescence microscopy and imaging methods to understand (bio)materials. Getting students to think beyond the "black box" of instrumentation through use of core facilities.

#### Alexis Komor CS 2021

#### akomor@ucsd.edu

Chemistry and Biochemistry, University of California, San Diego My lab develops new genome editing methodologies and applies them to better understand human genetic variation. I aim to provide students with a practical understanding of the genome editing field to aid with their research endeavors.



#### Lena Koslover CS 2020

ekoslover@physics.ucsd.edu

Physics, University of California, San Diego We use a combination of theoretical techniques with imaging data analysis to understand how components are transported through living cells. I try to improve relevance of introductory physics for life sciences courses, and run a "Young Scientist Club" at a local elementary school.

#### Tim Kowalczyk CS 2018

#### kowalct2@wwu.edu

Chemistry, Western Washington University I am interested in computational and data-driven approaches to excited state processes and energy storage in organic materials. I am eager to promote students' fluency across symbolic/graph/visual representations in chemistry and to promote community energy literacy.

## Adam Leibovich CS 2006

#### akl2@pitt.edu

Physics, University of Pittsburgh Theoretical Physics. Improving educational experiences for both undergraduate and graduate students.

#### Dave Leitch CS 2023

#### dcleitch@uvic.ca

Chemistry, University of Victoria The Leitch lab focuses on mapping chemical structure and reactivity space in organic chemistry using high-throughput experimentation. I am passionate about teaching chemistry, particularly organic and industrial chemistry, and building connections to societal impacts.

#### Eli Levenson-Falk CS 2021

#### elevenso@usc.edu

Physics & Astronomy, University of Southern California

I conduct experiments with superconducting circuits for quantum computing, precision sensing, and quantum foundations research applictions. I am interested in removing barriers to advancement by creating materials that help students transition into research careers.

#### Allegra Liberman-Martin CS 2023 libermanmartin@chapman.edu

Chemistry and Biochemistry, Chapman University The Liberman-Martin Group develops main-group catalysts for organic and polymer synthesis. Allegra is interested in flipped classrooms and incorporating scientific argumentation training into organic chemistry courses.

#### Jane M. Liu HOL 2023

#### Jane.Liu@pomona.edu

Chemistry, Pomona College I study genetic regulation in bacteria in response to new inputs, nucleic acid-based biosensors, and small molecule drug discovery. I focus on centering equity and inclusion in all undergraduate chemistry courses and exposing students to empowering research experiences.

#### Casey Londergan CS 2008

clonderg@haverford.edu Chemistry, Haverford College Protein dynamics and vibrational spectroscopy. Active learning, course-based undergraduate research experiences, and physical chemistry curricular reform.



#### Gina MacDonald CS 1997

macdongx@jmu.edu

Chemistry & Biochemistry, James Madison University

Using spectroscopy to study how environmental conditions alter protein structure, function, stability and aggregation. My education interests have focused on incorporating active learning techniques and using undergraduate research to diversify the science.

#### Sabetta Matsumoto CS 2020

#### sabetta@gatech.edu

Physics, Georgia Institute of Technology Knitting, Virtual Reality, Geometry and Topology, Mechanics of Materials, Soft Materials. Using art, creativity and making to promote diversity and equity in STEM classrooms. Antiracist and inclusive teaching practices.

#### Charles McCrory CS 2019

#### cmccrory@umich.edu

Chemistry, University of Michigan Electrocatalysis for Solar Energy Conversion (e.g. Solar Fuels) and Wastewater Remediation. Improving conceptual knowledge development in large-format undergraduate courses.

#### Krystle McLaughlin CS 2022

#### kmclaughlin@vassar.edu

Chemistry, Vassar College Structural investigation of microbial proteins, including the relaxosome, a key complex involved in the transfer of antibiotic resistance. Bringing protein crystallography to the undergraduate curriculum using a biochemistry Course-based Undergraduate Research Experience (CURE).

#### **Emily Miller**

#### emily.miller@aau.edu

Association of American Universities Evidence-informed innovations in edu; academic work & faculty reward structures; systemic org change to advance equity & community. Advancing transformational organizational change initiatives in undergraduate and graduate education as well as the research enterprise.

#### Katie Mouzakis CS 2017

#### kathryn.mouzakis@lmu.edu

Chemistry and Biochemistry, Loyola Marymount University

I am a biochemist who studies viral RNA structures that regulate translation. I am very interested in integrating course-based undergraduate research experiences into the biochemistry curriculum

#### Karl Mueller CS 1996

#### drktmueller@gmail.com

Physical and Computational Sciences, Pacific Northwest National Laboratory Electrochemical energy storage and related chemical/materials sciences; application of nuclear magnetic resonance to complex problems. Teaming with minority serving institutions and underrepresented communities in the physical and computational sciences.

#### Glen O'Neil CS 2020

#### oneilg@montclair.edu

Chemistry & Biochemistry, Montclair State University

We use scanning electrochemical and photoelectrochemical methods to study electrochemical reactions at the micro- and nanoscale. We're interested in developing communities to integrate and retain community college transfer students.



#### Zak Page CS 2022

zpage@utexas.edu

Chemistry, University of Texas at Austin Polymer chemistry, photochemistry, and additive manufacturing. Organic chemistry, polymer chemistry, and psychology of learning

#### Amanda Patrick CS 2022

#### apatrick@chemistry.msstate.edu

Chemistry, Mississippi State University Fundamentals and applications of mass spectrometry for small molecules, with focus on isomer differentiation and ionic liquid degradation. Educational interests include integrating research and education, scientific communication, and demystifying the hidden curriculum.

#### Ali Patteson CS 2023

#### aepattes@syr.edu

Physics, Syracuse University Soft matter physics, biophysics, mechanobiology, biofilms, cytoskeleton, cell motility active learning, high school students, community engagement, diversity, equity, and inclusion

#### Orit Peleg CS 2022

#### orit.peleg@colorado.edu

Computer Science and BioFrontiers Institute, University of Colorado Boulder Biological signals: high-dimensional encoding and low-dimensional patterns in insect swarms. Exploring the intersection of physics, AI, and generative art through a class on agent-based models.

#### Kerstin Perez CS 2019

kerstin@astro.columbia.edu Physics, Columbia University

I use cosmic particles to look beyond the Standard Model physics, in particular evidence of dark matter interactions. I work to expand the adoption of classroom practices that retain women and/or minoritized students in undergrad physics majors.

#### Aurora Pribram-Jones CS 2022

apj@ucmerced.edu

Chemistry and Biochemistry, University of California, Merced

I study how interaction strength, temperature, and density impact our understanding of electronic structure in molecules and materials. I am a "liminal criminal." I aim to subvert unjust barriers, examine structures of scholarly identity, and explore reflective practices.

#### Emily Rauscher CS 2019 erausche@umich.edu

Astronomy, University of Michigan Three-dimensional numerical models of exoplanet atmospheres and how observations can constrain them. Incorporating research-like experiences in undergraduate classes; making our field more equitable and inclusive.

#### Noel Richardson CS 2023

#### noel.richardson@erau.edu

Physics and Astronomy, Embry-Riddle Aeronautical University

I study massive stars with observations across the electromagnetic spectrum, and then try to place them in evolutionary context. I am interested in improving equity and access to research through inclusion of research and writing in the curriculum.

#### Chad Risko CS 2018

#### chad.risko@uky.edu

Chemistry, University of Kentucky Computational materials chemistry, from quantum mechanics and classical dynamics through dataenabled discovery and machine learning. Physical and computational chemistry learning through course-based research experiences.



#### Shahir Rizk CS 2019

srizk@iusb.edu

Chemistry and Biochemistry, Indiana University South Bend

Engineering proteins with new function and communicating science to the public through art and storytelling to address misinformation. Introducing students to science policy issues and helping them become better science communicators and advocates for change.

#### Rae Robertson-Anderson CS 2010

#### randerson@sandiego.edu

Physics and Biophysics, University of San Diego Designing and understanding the physics of squishy "living" materials inspired by biology. Interdisciplinary research-based curriculum.

#### Jenny Ross CS 2010

#### jlross@syr.edu

Physics, Syracuse University How does the cell organize its insides without a manager? Entropy and energy sculpting at the molecular scale in the cell. Active learning and interventions to bring excellent physics education to all.

#### Brenda Rubenstein CS 2020

#### brenda\_rubenstein@brown.edu

Chemistry and Physics, Brown University Quantum materials, stochastic methods, biophysics, alternative computing. Lowering barriers to access, physical chemistry, condensed matter physics.

#### Zac Schultz CS 2013

#### schultz.133@osu.edu

Chemistry, Ohio State University My research uses spectroscopy for trace detection and imaging. I am particularly interested in the interaction of light and nanomaterials. I want all students to believe they can succeed and are valued in STEM.

#### Scott Shaw CS 2016

#### scott-k-shaw@uiowa.edu

Chemistry, University of Iowa Analytical Chemistry of surfaces and interfaces. Mostly interested in problems involving environmental, energy, and materials sciences. Love teaching laboratory courses, how to use instruments to solve problems, including debate-centered instruction when possible.

#### Juliane Simmchen FCS 2021

#### juliane.simmchen@tu-dresden.de

Physical Chemistry, Technische Universität Dresden Active matter, colloids, analytical chemistry, green chemistry biophysics. I believe that involving undergraduates in research projects is the best way to teach them.

#### Grace Stokes CS 2018

#### gstokes@scu.edu

Chemistry & Biochemistry, Santa Clara University I use surface-specific spectroscopy methods to study drug binding to lipids and transmembrane proteins. I integrate Python-based activities into physical and general chemistry to increase retention of 1st generation college students in STEM.

#### Ruby Sullan CS 2021

#### ruby.sullan@utoronto.ca

Physical and Environmental Sciences, University of Toronto Scarborough

Smart nanomaterial design, and nanoscale quantitative characterization of bacteria and bacterial biofilms (and its interactions). Providing early undergraduate students with a nontraditional, experiential learning experience.



#### Daniel Tabor CS 2023

daniel\_tabor@tamu.edu

Chemistry, Texas A&M University Our group is interested in developing new methods to accelerate computational materials design and spectroscopy simulations. We are interested in making data science more accessible for all types of students, especially those loosely connected to "big data."

#### Kana Takematsu CS 2019

#### ktakemat@bowdoin.edu

Chemistry & Biochemistry, Bowdoin College Controlling reactions and charge/energy transfer processes using light; photoacids; ionic liquids and unique solvent environments. Innovative and inclusive physical chemistry teaching approaches; building community and student belonging; undergraduate research

#### Guenther Thiele FCS 2020

#### guenther.thiele@fu-berlin.de

Chemistry, Biology and Pharmacy, Freie Universität Berlin

Inorganic synthesis of sulfur based electron rich semiconductor salts for spintronic and electrochemical applications. Augmented and virtual reality technologies in university teaching.

#### **Holden Thorp**

#### hthorp@aaas.org

Science, American Association for the Advancement of Science

Scientific process, interaction of science and politics. Bioinorganic chemistry, science and politics.

#### Claire Till CS 2020

#### claire.till@humboldt.edu

Chemistry, Humboldt State University I'm interested in metals, particularly micronutrient ones. Which metals can substitute for each other under what conditions? I'm interested in enabling students who don't have confidence in their skills or abilities. I want to help them see their vast capabilities!

## Ryan Trainor CS 2022

#### ryan.trainor@fandm.edu

Physics & Astronomy, Franklin & Marshall College I study galaxy formation and the circumgalactic medium using infrared and optical imaging and spectroscopy. I'm interested in astronomy and physics education, with an emphasis on applications of Python programming and sociology of science.

#### Olalla Vazquez FCS 2016

#### vazquezv@staff.uni-marburg.de

Chemistry, Philipps-Universität Marburg Chemical Biology. Light-driven chemical tools to understand and manipulate biological process at molecular level. Epigenetic chemical probes. CUREs; Teaching strategies; multidisciplinary approaches and active learning.

#### Alexandra Velian CS 2021 avelian@uw.edu

Chemistry, University of Washington We apply molecular strategies to synthesize and study single-site catalysts anchored on chemically non-innocent supports. Increasing access and inclusion of undergraduate students from underprivileged backgrounds to chemistry research and higher education.

#### Ross Wang CS 2021 rosswang@temple.edu

Chemistry, Temple University Chemical Biology, Probes and Cell Biology related to Post-Translational Modifications. Research Integrated Teaching and Education of Future Generations.

#### Rory Waterman CS 2009

rory.waterman@uvm.edu

Chemistry, University of Vermont I like making molecules. Catalysts make molecules faster and more efficiently, so we make molecules that way. Light can help, too. We need to bring science to more people who have not had access.



#### Jess Werk CS 2020

#### jwerk@uw.edu

Astronomy, University of Washington I study the cosmic baryon cycle by observing matter on the smallest, atomic scales as it courses through the vast spaces between galaxies. I am interested developing a sustainable, scalable framework for meaningful undergraduate research.

#### Julian West CS 2023

#### jgwest@rice.edu

#### Chemistry, Rice University

Our lab is primarily interested in sustainable catalysis using earth abundant elements, light energy, and radicals. I am particularly interested in science communication and evidence-based approaches to mentorship and leadership.

#### Chris Whidbey CS 2023

#### whidbeyc@seattleu.edu

Chemistry, Seattle University I am a chemical microbiologist focused on hostmicrobe interactions in the context of public health. I teach introductory chemistry and advanced biochemistry. I am very interested in bringing research opportunities to URM students.

#### Luisa Whittaker-Brooks CS 2018

#### luisa.whittaker@utah.edu

Chemistry, University of Utah Understanding spin and charge transport and ionmigration in energy and quantum materials and devices using diffraction and spectroscopy. Transforming the chemistry experience by replacing weed-out courses with deep-root and applied courses early on in students' careers.

#### Amanda Wolfe CS 2017

#### awolfe@unca.edu

Chemistry and Biochemistry, University of North Carolina at Asheville

The Wolfe laboratory focuses on the development of novel antibiotics and antibiotic adjuvants that target Pseudomonas aeruginosa. My focus is on the integration of research and teaching in the undergraduate chemistry curriculum.

#### Tehshik Yoon CS 2008

#### tyoon@chem.wisc.edu

Chemistry, University of Wisconsin - Madison Synthetic chemist and photochemist, specifically interested in the use of catalysts to control the outcome of complex photoreactions. Active learning in large and small classroom environments, centering equity in graduate admissions.

#### Joe Zadrozny CS 2021

#### joe.zadrozny@colostate.edu

Chemistry, Colorado State University I am interested in controlling (by design) the magnetic and quantum properties associated with electron and nuclear spin in molecules. I am interested in ways of bringing cutting edge research into classes to foster interest.

# Gail Zasowski CS 2021

# gail.zasowski@gmail.com

Physics & Astronomy, University of Utah Stars, gas, and dust, oh my! -- what nearby galaxies can teach us about how the Universe enriched itself since the Big Bang. Making complex ideas accessible, helping students play active roles in learning, and building confidence through mentoring at all levels.

## 2023 Conference Planning Committee

**Lou Charkoudian** Chemistry Haverford College

Jennifer Heemstra Chemistry Washington University in St. Louis

Gina MacDonald Chemistry and Biochemistry James Madison University

Scott Shaw Chemistry University of Iowa

**Tom Solomon** Physics Bucknell University

**Tehshik Yoon** Chemistry University of Wisconsin – Madison

#### **Research Corporation Participants**

Jennifer Dukes Program & Award Administrator, Senior jdukes@rescorp.org

Laura Esham Program Assistant lesham@rescorp.org

Andrew Feig CS 2002 Senior Program Director afeig@rescorp.org

Gene Flood Jr. Chair, RCSA Board of Directors Managing Partner of A Cappella Partners eugene.flood@acappellapartners.com

#### **Research Corporation Participants Continued**

COTTRELL SCHOLAR

Danny Gasch Chief Financial Officer dgasch@rescorp.org

Angela Hagen Communications Director ahagen@rescorp.org

Brent Iverson RCSA Board of Directors Professor, University of Texas at Austin iversonb@austin.utexas.edu

Dan Linzer President dlinzer@rescorp.org

Meg Martin Director of Program & Award Administration mmartin@rescorp.org

Aileen Quezada Program & Award Administrator aquezada@rescorp.org

Silvia Ronco Senior Program Director sronco@rescorp.org

**Eileen Spain CS 1995** Program Director aspain@rescorp.org

Abhishek Shivaram Data Analytics Specialist ashivaram@rescorp.org

**Richard Wiener** Senior Program Director rwiener@rescorp.org



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