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# Sigma Xi Today

A NEWSLETTER OF SIGMA XI, THE SCIENTIFIC RESEARCH HONOR SOCIETY

## Abstracts Accepted for the Student Research Showcase

Students can submit an abstract by February 22 for the 2019 Student Research Showcase, Sigma Xi's online science communication competition. The seventh annual online competition will challenge high school through graduate school students to create a website containing a slideshow, video, and abstract about their research.

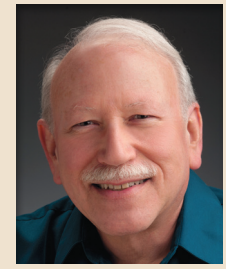
The showcase accepts students with research projects in the following categories: agriculture, soil, and natural resources; anthropology; cell biology and biochemistry; chemistry; ecology and evolutionary biology; engineering; environmental sciences; geosciences; human behavioral and social sciences; math and computer science; microbiology and molecular biology; physics and astronomy; and physiology and immunology.

Students whose abstracts are accepted must submit presentation websites and register by March 22, and judging will occur April 15–29. Judges will select the top presenters in the high school, undergraduate, and graduate divisions; each winner will receive awards up to $500. Judges will also select top presenters in each research category. A public vote will select one presentation for a $250 People's Choice Award. All participants receive a certificate of participation. Sigma Xi members are invited to serve as judges. Participating students receive feedback from professional researchers. They also develop science communication skills by crafting pieces of their presentation for different audiences, from the technical to the nontechnical.

*Learn more at www.sigmaxi.org/srs.*

## From the President

### Developing Scientific Intuition



**Joel Primack**

Experienced scientists can often quickly guess the likely answers to scientific questions. They may even have good judgment regarding the promise of new avenues of research. Such intuition, together with broad knowledge, can make their scientific careers more successful and allow them to provide helpful guidance to junior researchers.

How can such intuitive understanding be nurtured? I was fortunate to have had a wonderful professor in honors freshman physics, John Archibald Wheeler, who taught not only physics but also how to develop one's scientific intuition. Wheeler's rule was that when confronted with any scientific question, even just a homework problem, first make a guess about the answer before working it out in detail or learning the answer in some other way. Then keep track of how well the guess agreed with the correct answer. After many years of doing this, a scientist can become quite good at prediction in his or her field.

In his book *Thinking, Fast and Slow,* the eminent psychologist Daniel Kahneman warns about overreliance on intuition. Such fast thinking can easily go astray, leading to incorrect assertions based on too little information. Associative memory can generate compelling intuitions that are false, so subjective confidence is not a good diagnostic of accuracy. People are particularly bad at statistical thinking, which requires careful weighing of evidence by the slower analytic mind.

Kahneman describes an "adversarial collaboration"—in which experts who disagree on the science agree to do research and write a jointly authored paper—he had with Gary Klein, whose book *Sources of Power* analyzed how experienced professionals develop intuitive skills. Klein had studied decision making by people such as firefighters who can acquire reliable skill at what they do, whereas Kahneman had studied people such as financial stock pickers who try to make decisions about nearly random phenomena. Although Kahneman and Klein had developed different attitudes, emotions, and tastes that changed little over the years of their collaboration, they ultimately agreed on the criteria that determine whether intuition can be trusted. The ability depends on whether the subject under study is sufficiently regular to be predictable and whether a person has had an opportunity to learn these regularities through prolonged practice.

For a field to be considered scientific, its predictions must generally be confirmed. It is precisely in such scientific fields that experience can lead to reliable expert intuition. But this process doesn't happen by accident; just as Wheeler taught, developing reliable scientific intuition requires people to pay careful attention and keep track of the success of their initial guesses. Thus combinations of fast and slow thinking about many examples can help scientists develop intuitive understanding of their fields.

**Joel Primack**

## GIAR Award Recipient Profile: Brendan Talwar

*Sigma Xi's Grants-in-Aid of Research (GIAR) program awards research grants to undergraduate and graduate students. Application deadlines are March 15 and October 1 annually.*

**Grant recipient:** Brendan Talwar

**Grant awarded:** Spring 2015

**Education level at the time of grant:** Master's student

**Project results:** Talwar and his collaborators successfully estimated the postrelease survivorship of two focal species, the Cuban dogfish and the gulper shark, after deep-sea longline capture. They found that postrelease mortality is high for deep-sea sharks and recommended that fisheries carefully consider that finding when deciding whether or not to discard these animals. More than 300 students participated in the fieldwork. The project's results were published in *Marine Ecology Progress Series, ICES Journal of Marine Science* for the International Council for the Exploration of the Sea, and *Conservation Physiology.*

**How this project influenced him as a scientist:** "The opportunity to develop research ideas from the fundraising stage to publication has been invaluable. Thanks to support from groups like Sigma Xi, I've been able to meet my goals in outreach, teaching, and research and am now excited to continue my education in pursuit of a PhD."

**Where is he now?** Talwar graduated from Florida State University in May 2016 with a master's degree in ecology and evolutionary biology. He taught a shark studies course in Fiji and in 2017 accepted the Sea Grant Knauss Fellowship in marine policy from the National Oceanic and Atmospheric Administration, serving in Washington, D.C., for a year before returning to the Bahamas, where he currently conducts research and teaches at The Island School and Cape Eleuthera Institute. He is also pursuing a PhD in biology at Florida International University.

## Sigma Xi Members Win Nobel and Riksbank Prizes

The Royal Swedish Academy of Sciences awarded half of the 2018 Nobel Prize in Physics to Sigma Xi member Arthur Ashkin.

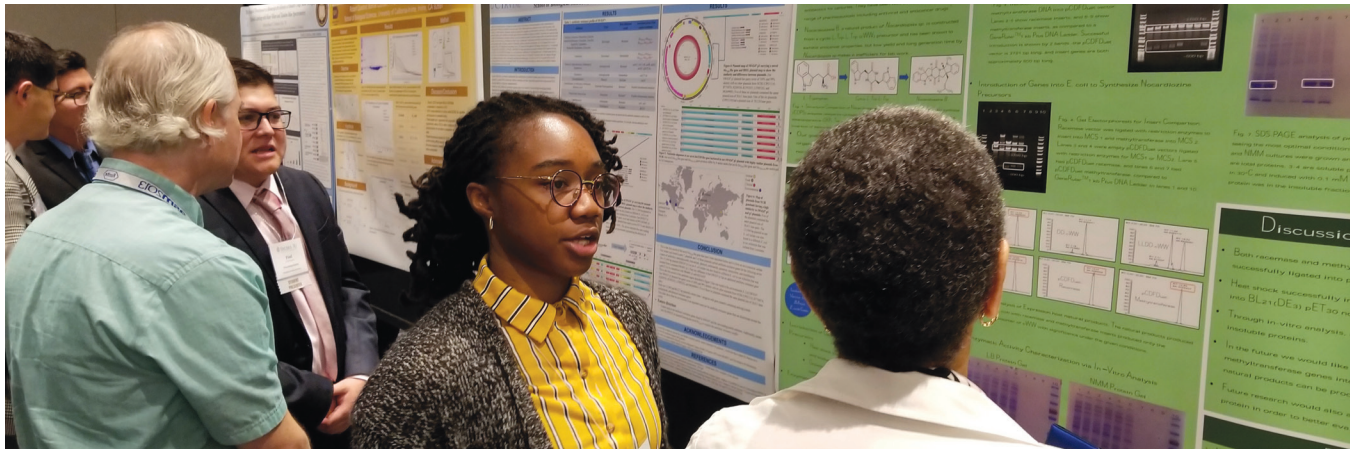
Ashkin, who is retired from Bell Laboratories, was selected for the prize in October for his invention of optical tweezers that grab particles, atoms, viruses, and other living cells with its laser beam fingers. Using the radiation pressure of light to move physical objects, Ashkin succeeded in getting laser light to push small particles toward the center of the beam and hold them there. These tweezers are now widely used to investigate the machinery of life. Ashkin was elected to membership in Sigma Xi in 1949 while he was at Cornell University.

Sigma Xi member William D. Nordhaus of Yale University received half of the 2018 Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel, also presented by the Royal Swedish Academy of Sciences, for integrating climate change into long-run macroeconomic analysis.

In the mid-1990s, Nordhaus became the first person to create an integrated assessment model that describes the global interplay between the economy and the climate. His model integrates theories and empirical results from physics, chemistry, and economics. It is now used widely to simulate how the economy and the climate co-evolve and to examine the consequences of climate policy interventions, such as carbon taxes. Nordhaus was inducted into Sigma Xi in 1988.

Sigma Xi Today is managed by Heather Thorstensen and designed by Justin Storms.

# Big Data and the Future of Research, Ethics, and Science Communication Highlighted at the Annual Meeting



**Students presented research posters to judges during the Student Research Conference, held in conjunction with the Annual Meeting. (Photo courtesy of Deanna Welker.)**

Sigma Xi members, science supporters, and students came together October 25–28 for the 2018 Sigma Xi Annual Meeting and Student Research Conference. The theme of this year's meeting, "Big Data and the Future of Research," affects all areas of science and engineering.

The event, held at the Hyatt Regency San Francisco Airport hotel in Burlingame, California, began with a business meeting for delegates, who were Sigma Xi chapter representatives. The 132-year-old honor society for scientists and engineers has chapters around the world at colleges, universities, government laboratories, industry research centers, and areas that cover multiple institutions. Sigma Xi leaders and president-elect candidates provided updates, and delegates discussed how to improve their programming. The Society recognized chapter award winners and the chapters that initiated the most new members in the past year.

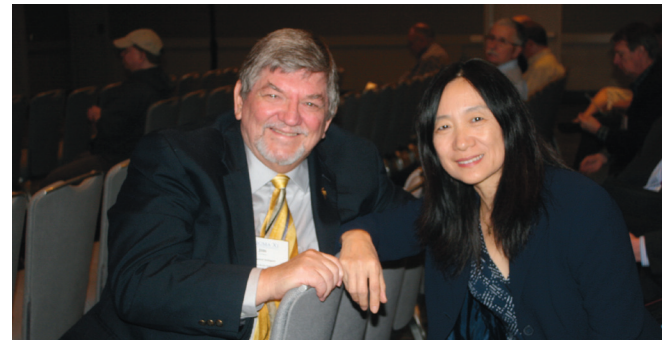
Plenary speakers included Jeff Dean, head of Artificial Intelligence at Google, who discussed Google's research accomplishments through the use of machine learning and robotics. Steve Ritz, a professor of physics at the University of California, Santa Cruz, described how big data that is driven by new technology affects astrophysics. Sigma Xi's 2018 award winners also spoke to the gathering.

Breakout sessions included symposia on the effects of big data on many areas—including biology and medicine; physics and astronomy; and climate, energy, and the environment—as well as sessions about science communication, professional development, and the responsible conduct of research. SAS Institute demonstrated a new product, professional researchers shared posters about their work, and evening entertainment included Science Cafés and a show by science comedian Brian Malow.

Approximately 140 high school, undergraduate, and graduate students attended the meeting and most presented their research during a poster session. Sigma Xi members judged the students on their scientific thought, method, and communication skills. Judges selected top presenters for awards and nomination to Sigma Xi membership, with the initiation fee and first year's dues paid.

*The 2019 Annual Meeting and Student Research Conference will be held November 14–17 at the Monona Terrace Convention Center in Madison, Wisconsin. Register online at www.sigmaxi.org/amsrc19.*

**Jeff Dean, head of Artificial Intelligence at Google, spoke at the Sigma Xi Annual Meeting about Google's research accomplishments. (Photo courtesy of Scott Buschman Photography.)**



**Past Sigma Xi President and Greenbrier Valley Chapter Delegate James Baur, on left, and Board of Directors member Tieli (Tilly) Wang at the Assembly of Delegates. (Photo courtesy of Cristina Gouin.)**

# Teaching Award Honors Texas A&M Provost

The 2018 Sigma Xi Monie A. Ferst Award has been given to Carol A. Fierke, the provost and executive vice president of Texas A&M University. The award, which has been presented since 1977, honors science and engineering teachers who have made notable contributions to motivating and encouraging research by educating students. It is sponsored by the Georgia Institute of Technology Chapter. Fierke received a medal and $10,000 at a daylong symposium that focused on the achievements of her former students; the event was held November 6 at the Georgia Institute of Technology.

Fierke, who is also a professor of chemistry and biochemistry at Texas A&M University, runs a research group with the goal of understanding the structure, function, and biological relevance of metalloenzymes and RNA catalysts and the development of enzyme inhibitors as therapeutic agents.

She was previously the chemistry department chair and vice provost and dean for graduate studies at the University of Michigan. Among her other awards is the 2016 American Chemical Society's Award for Encouraging Women into Careers in the Chemical Sciences.

*The chapter is accepting nominations for the 2019 award through April 1. Learn more at www.sigmaxi.org/ferstaward.*

**Carol A. Fierke**

# To Reduce Climate Change, Sigma Xi Calls for Support of Climate Scientists, Global Cooperation, and Investments in Research

*In November 2017 at its Symposium on Atmospheric Chemistry, Climate, and Health, Sigma Xi convened its members and the public to discuss the global threat of climate change. At the meeting, the Society's board of directors agreed to reaffirm its commitment to finding a solution. They published the following statement on October 8, 2018—the same day that the United Nations' Intergovernmental Panel on Climate Change released a special report indicating that we can avoid several climate change effects by limiting global warming to 1.5 degrees Celsius above preindustrial levels. The report, however, also stated that limiting global warming to this level would require unprecedented changes in society.*

Scientific evidence continues to confirm that human activities are contributing to the warming of our planet. The byproducts of industrial development including carbon dioxide and other greenhouse gases have risen dramatically in recent decades leading to an overall increase in air and sea temperatures. The effects of this warming can be observed in increasing sea levels and atmospheric water vapor and decreases in mountain glacier and arctic ice mass, snow cover, and permafrost. Extreme weather-related events, such as droughts, heat waves, wildfires, large magnitude and intensity storms, floods, and blizzards, also appear to be associated with global warming. Left unresolved, the impact on ecosystems and human quality of life may be devastating.

Whereas human civilization and activity has occurred during a period of what we now know has been a tolerable and relatively stable climate, the scale and efficiency with which we are extracting and burning carbon-rich fuel sources have created conditions outside the range of modern human experience. Risks to human health are among the most threatening of global warming-associated climate change, and are accelerating. These concerns in conjunction with impacts on ecosystems, urbanized areas, and community infrastructure contribute to heightened compulsion to act.

The escalating urgency of responding to anthropogenic climate change underscores the critical need to support:

1. climate scientists as they monitor and warn us of an ever-more unstable climate regime and to plan for the extreme consequences that will inevitably follow on the present path
2. global cooperation and collaboration on research and education to collectively reduce carbon emissions through technology and behavioral choices
3. policies and investments that enable technological solutions to be developed and deployed

Sigma Xi's commitment to improving the human condition through science and engineering necessitates that we call on national and international leaders to pursue aggressive actions to reduce carbon emissions and to develop adaptive measures to protect all people from the threats associated with global warming.