

Commentary: Science and tech policy needs scientists' input

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Commentary

Science and tech policy needs scientists' input

Research and development investments, particularly in science and technology (S&T), have direct and collateral effects that help drive economic growth. The US has been a global leader in those investments, but its dominance is slipping as other developed and emerging economies are increasing their R&D investments much more rapidly. Traditionally, the US government has invested in basic research and has relied on industry to transfer research into viable commercial products. However, industry's increasing reluctance to take the financial risks involved in technology transfer has resulted in lower return on investment for US government funding for basic research. The lack of technology transfer results in fewer companies and jobs created, fewer products to market, and lower overall economic benefit. The dilemma facing Congress now is whether to address technology transfer in their funding strategy—a fundamental shift in US government policy.

Increased federal investments and public-private partnerships are needed for effective technology transfer. By participating in policy and funding development, scientists and engineers can help promote R&D investment and the resulting economic growth. Legislators and their staffers may not have the expertise that scientists and engineers have to evaluate S&T portions of bills. Furthermore, without an S&T background, they may not have the passion. Therefore, experts, volunteers, and full-time personnel from S&T fields are needed to provide scientific counsel and guidance to government, especially to Congress.

Letters and commentary are encouraged and should be sent by email to ptletters@aip.org (using your surname as the Subject line), or by standard mail to Letters, PHYSICS TODAY, American Center for Physics, One Physics Ellipse, College Park, MD 20740-3842. Please include your name, work affiliation, mailing address, email address, and daytime phone number on your letter and attachments. You can also contact us online at <http://contact.physicstoday.org>. We reserve the right to edit submissions.

My broad background of more than 35 years in the S&T industry and academia made me suited to tackling extensive issues of S&T policy in Congress. In the 2013 and 2014 federal legislative sessions, I was sponsored by the American Society of Mechanical Engineers to serve as a congressional fellow on S&T policy. I was assigned for a year to the subcommittee on research and technology of the House Committee on Science, Space, and Technology. The subcommittee's areas of concern are funding for NSF, NIST, the Office of Science and Technology Policy, technology transfer, and programs related to STEM (science, technology, engineering, and mathematics). Because of my expertise in information technology and nanotechnology, I also had various assignments with two other House committees.

Legislative staff and fellows conduct investigations and hearings on various bills and subjects of interest to the committees. They help with preparing legislative documents, selecting witnesses for hearings, developing questions, and occasionally writing opinion pieces and overviews of state-of-the-art research. I organized three such hearings for committees, including briefing committee and legislative leadership.

Some of my duties included working on the attempted reauthorization of the 21st Century Nanotechnology Research and Development Act. I wrote a background paper on nanotechnology, produced critiques of all National Nanotechnology Initiative reviews, and articulated to the committee the need for informational hearings and reauthorization.

Considering the political implications of an action is an important part of achieving S&T policy goals in Congress. I conducted independent research to strengthen the case for reauthorization, including writing a summary of every college and university that awarded degrees in nanotechnology, of all R&D funding and capital investments, and of the act's economic impact on all of the committee members' districts, regardless of party affiliation. I helped to strategically select expert witnesses from the districts of the chairs of the full committee and subcommittee. I also put together the public

announcement—the hearing charter—that informs the public of the content and purpose of the hearing. Finally, I helped prepare the hearing documents, including a long list of potential questions, to be used by my committee.

As another example, my supervisor asked me to research the administration of large prizes in S&T and how funding agencies handled them. I wrote a white-paper overview of what I perceived as the benefits and drawbacks of large-prize competitions for technological innovation, and my supervisor encouraged me to pursue the topic for a hearing. I drafted the hearing request and charter, helped select witnesses, and assisted in developing questions.

Of course, the political climate in 2013–14 was not conducive to passing new laws and regulations. The partisan divide could not be bridged, and these two initiatives were unfortunate victims. However, the job of educating legislators and the public was carried out; it was then up to Congress to act on the information that I and other fellows brought to them.

For me, the experience was an incredible education on the legislative process and the need for scientific expertise to support relevant legislation. The ways for fellows to get involved are many and varied and are limited only by their interest and persistence.

Congressional members face exceedingly broad topics that they are called to legislate, and they have many demands on their time. They rely on staff not only to manage day-to-day business but to educate them on topics in which they may have no background or understanding. Due to the fast-paced, competitive, often adversarial environment and the varied nature of their work, staffers are often expected to demonstrate expertise that they themselves do not possess. They may feel overconfident discussing topics that they do not fully comprehend. Because staff members have the ear of their congressperson, a fellow needs to work closely with them. Navigating that relationship can be delicate. It is up to the fellow to balance the need to educate the staff—and thereby the congressperson—on critical issues with the personalities and egos

of all parties. Yet, it is vital that scientists and engineers from academia and industry spend the time to make those connections.

It is my hope that some fellows will stay on as regular staff and continue to contribute, particularly on bills pertinent to S&T. In addition, I hope that some scientists and engineers will feel called to run for elected office in order to have a direct influence on shaping policy and law. Incidentally, in the 2013–14 legislative session, only approximately 10 legislators had S&T degrees.

In my experience, congressional fellows come to understand the legislative process and the role of lobbyists and stakeholders, and they begin to comprehend not only the party divide but also the intricate nature of relationships on Capitol Hill. With that understanding, fellows can influence policy decisions constructively and initiate new legislation. In addition, congressional staff members gain a better appreciation for working with scientists, and the ties they develop become invaluable contacts for future communication. An academic who serves as a fellow can return to the classroom better equipped to inspire students to pursue S&T policy careers and to encourage future scientists to get involved in the making of policy. Further, an academic, inspired as I have been by the experience of being a congressional fellow, may pursue cross-campus collaborations and affiliations between academic S&T and public policy departments, and may even find ways to establish joint academic programs. Finally, as S&T professionals, we have a social and professional responsibility to participate in the development of national science policy.

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Letters

Predicting the CMB: The hazards of being first

John Carlstrom, Tom Crawford, and Lloyd Knox, in their PHYSICS TODAY article (March 2015, page 28), present some of the recent fascinating observational data on quantum fluctuations in the early universe. Those fluctuations are now detectable in the heterogeneous and anisotropic variations in the cosmic microwave background (CMB). Fifty years have passed since the most widely

acknowledged observation of the CMB, at 1080 MHz, was made by radio astronomers Arno Penzias and Robert Wilson, who received the 1978 Nobel Prize in Physics for that work. Scientists developing new theory and empirical tests have had a starting point for serious study of the early universe and developing structures in it. Fifty years after Penzias and Wilson, physicists are leading the way to deeper understanding of galaxies and other important structures in the observable universe, dark matter, and gravity. This is an exciting time in physical cosmology.

In the opening paragraph of their article, Carlstrom and coauthors state that the isotropic signal reported by Penzias and Wilson “was quickly interpreted as coming from thermal radiation left over from a much hotter and earlier period in our universe’s history, and the Big Bang was established as the dominant cosmological paradigm.” That statement is misleading. The signal’s origin was not immediately understood as relict radiation from a “big bang.” And actually, the leftover radiation had been predicted in detail 17 years earlier.

Ralph Alpher, in his doctoral dissertation in 1948, first suggested that the early universe was likely dominated by radiation. That suggestion made the notion of observable relict radiation reasonable. The Big Bang interpretation of relict radiation was worked out in physical detail by Alpher and Robert Herman^{1,2} in 1948 and 1949. Their work was followed by several peer-reviewed publications through 1953. However, Alpher and Herman were not able to convince anyone in the early days of radio astronomy to look for it.³ Using the best available values for various physical parameters, they consistently calculated that the relict radiation should be observable at around 5 K. They reviewed the history of their contributions to cosmology in a major article in PHYSICS TODAY (August 1988, page 24).

A quick library trip by Penzias and Wilson would have sorted this history out in a cosmological context in 1965. Alpher and Herman’s work appeared in mainstream physics journals—for example, *Physical Review*, *Nature*, and *Reviews of Modern Physics*. Physical cosmology had already taken a major turn in 1948 to become part of mainstream physical science, according to Helge Kragh, a leading historian of cosmology, in a paper he presented at the Fifth Biennial History of Astronomy Workshop in July 2001 at the University of Notre Dame. The change Kragh de-

scribed was in large part due to Alpher and Herman’s contributions to formulating Big Bang cosmology.

As presented by Carlstrom and coauthors, the history of two of the most important theoretical and observational events in modern physical cosmology is misleading, but that is hardly unique. Unfortunately, the notion that the pivotal year for Big Bang cosmology was 1965 has been repeated in classrooms, textbooks, and peer-reviewed journals for half a century. The views on scholarship of generations of scientists and cosmology enthusiasts as to what is possible—technically and theoretically—have been distorted into near dogma. This correction to the history of cosmology can be made again where it should be, in the pages of PHYSICS TODAY.

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■ **Carlstrom, Crawford, and Knox reply:** Victor Alpher indeed points out an important part of the story, one that we included in an earlier version of our article, but in our efforts to drastically shorten the manuscript it was relegated to a single reference. The earlier draft read, “That Arno Penzias and Robert Wilson’s signal was so quickly and correctly interpreted is a consequence of some of the earliest connections between particle physics and cosmology. In the 1940s Ralph Alpher and George Gamow were considering the hot, dense, early universe as a possible site for nucleosynthesis. They found that in order to produce the amount of helium observed in the local universe, there had to be about 10^{10} thermal photons for every nucleon and correctly predicted that this background of photons would persist to the present day as a thermal bath at a few kelvin. When Robert Dicke and his collaborators at Princeton University—who also predicted the existence of the cosmic microwave background—learned of the measurement at nearby Bell Labs, they immediately understood the significance.”

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