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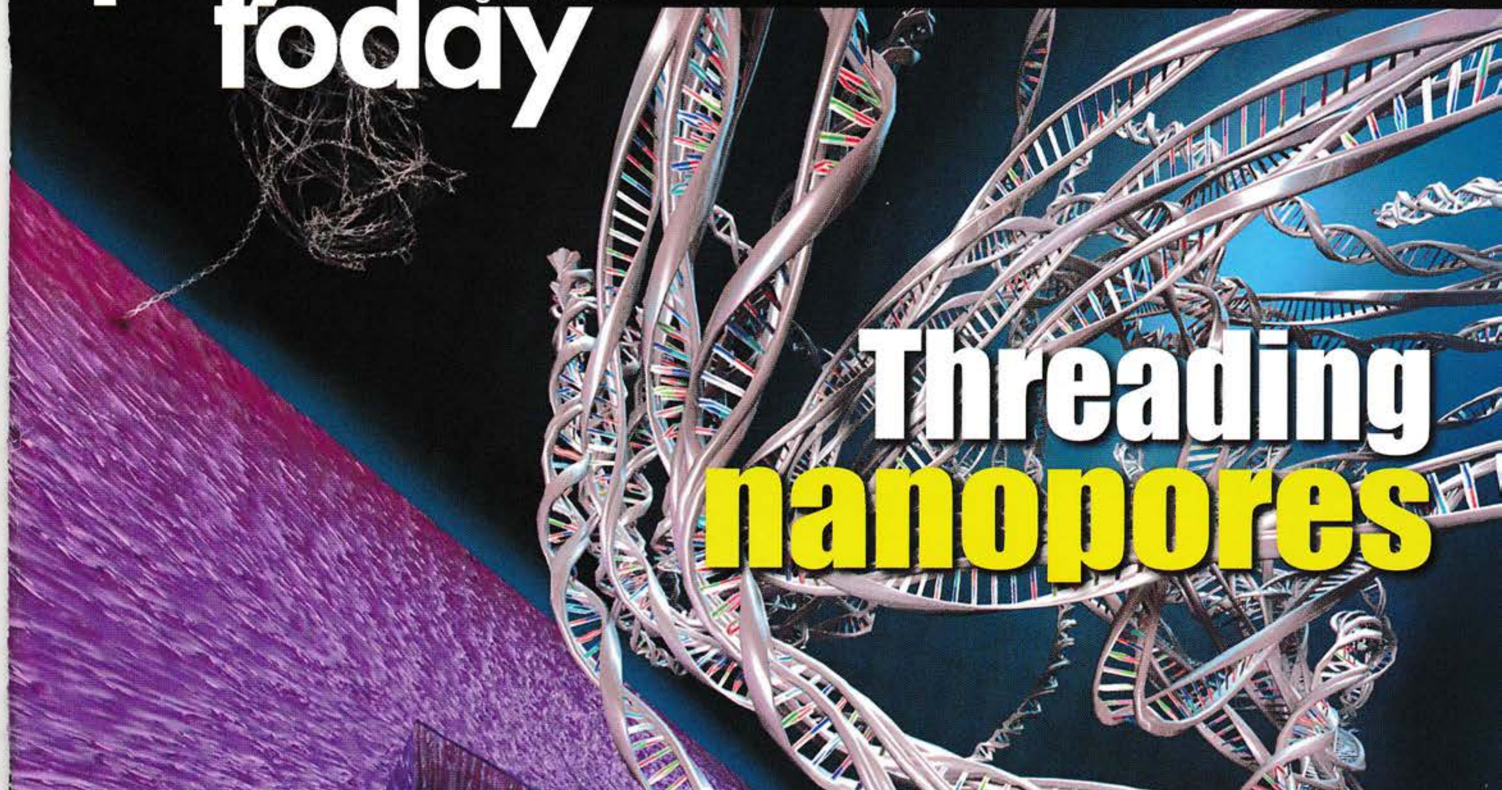

Threading nanopores

also:

- Displaced physicists in Ukraine
- Behemoth telescopes
- Superheavy elements

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.

Bharat Bhushan
(bhushan.2@osu.edu)
Ohio State University
Columbus, Ohio

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 described 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.

References

1. R. A. Alpher, R. C. Herman, *Nature* **162**, 774 (1948).
2. R. A. Alpher, R. C. Herman, *Phys. Rev.* **75**, 1089 (1949).
3. V. S. Alpher, *Phys. Perspect.* **14**, 300 (2012).

Victor S. Alpher
(alphervs@gmail.com)
Austin, Texas

■ **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."

John Carlstrom
(jc@kicp.uchicago.edu)
Tom Crawford
Kavli Institute for Cosmological Physics
University of Chicago
Lloyd Knox
University of California, Davis