

Physicist Steven Koonin takes on a new role as DOE's 'technical conscience'

According to the Department of Energy's organizational chart, Steven Koonin, the undersecretary for science, is responsible only for the Office of Science, the basic research arm of the agency. But the theoretical physicist, whom BP lured away from Caltech to become the oil company's chief scientist, says he will play a major role in shaping all DOE programs having a scientific component. Koonin was on the faculty of Caltech from 1975 through 2006 and served the last nine years as provost. Now in his first stint at DOE, he has previously delved into many of the nuclear weapons and security challenges DOE faces; Koonin is a longtime member of JASON, the club of eminent scientists who spend their summers in southern California each year examining technical questions posed by DOE, the Pentagon, and other federal agencies. Whereas Koonin's predecessor as undersecretary, Raymond Orbach, wore a second hat as director of the Office of Science, the Obama administration split the two functions, appointing retired Bell Labs executive William Brinkman to the director post. *PHYSICS TODAY* spoke with Koonin on 20 July.

PT: Energy Secretary Steven Chu has spoken about making the national laboratories resemble the old Bell Labs. What do you think their role should be?

KOONIN: The national labs have several roles and functions, one of which is to do the research that the private sector wouldn't do because it might be too risky and too expensive. Another very important function is to operate major user facilities—whether synchrotron sources, neutron sources, or sequencing facilities—that would be inappropriate for a university or private industry to operate. And finally, to produce some research that universities are not supposed to take on either, perhaps because [it] might be a little too repetitive and not suitable for PhD theses. Making the national labs more like Bell Labs refers to the independence, the autonomy, and the ability for self-direction that existed at Bell Labs, as well as to the coupling of basic and applied research.

PT: In what ways do you think that the DOE labs might be reshaped to do that?

KOONIN: The secretary has made it a goal to reform and revitalize the relationships between the department and the laboratory contractors, to streamline the business processes, to appropri-

ately balance risk against efficiency, and to generally give the scientists more of a hand in setting their agenda and being able to pursue their research.

PT: Are you talking about increasing the level of discretionary research funding available to the labs—laboratory-directed R&D?

KOONIN: Whether it's LDRD or other mechanisms, the secretary and I have seen the wonderful things that flexible funding in the hands of working scientists can produce. The secretary likes to talk about how Glenn Seaborg ran his part of the Manhattan Project during World War II. Even though [Seaborg] was a manager, his notes contained a detailed accounting of what every researcher in his group was doing. [There was] a shutting off of dead-ends and initiation of new projects more or less on the spot, without having to check back with some program manager. I myself was for roughly a decade running a large-block NSF grant at Caltech: the [W. K.] Kellogg Radiation Laboratory in nuclear physics and nuclear astrophysics. And I had a good deal of autonomy in how I shaped the program. [It] produced a Nobel Prize—to Willie Fowler—and benefited from sustained periods of funding good people to do interesting things.

PT: Is that a model that could be replicated at the DOE labs?

KOONIN: We think there are certainly elements of that culture that we would like to see more of in the Department of Energy, both at the labs and the universities.

PT: Some of the Office of Science's programs, such as high-energy physics and fusion energy, have lost the preeminence that came with having the top facilities in the world. Will these programs continue to be run as they have in the past?

KOONIN: We need to evolve the Office of Science's programs as the scientific landscape evolves, and certainly the mix of programs today is rather different than it was 20 years ago. And I expect that it will be different 10–20 years in the future. With respect to high-energy physics, we are in a very exciting time in the United States right now: Fermilab has a good chance of resolving what's going on in the Higgs region, and it's the first to do that. We're putting a lot of at-

tention and effort into running [Fermilab's Tevatron]. There's also some very exciting work in what Fermilab calls the intensity frontier, in long-baseline neutrino experiments, and in very sensitive experiments underground at DUSEL [the Deep Underground Science and Engineering Laboratory]. What happens after the LHC [Large Hadron Collider] starts producing data and whether the ILC [International Linear Collider] will be on the horizon or not, we're going to have to see how the physics plays out.

But it's pretty clear that the scale of accelerator-based particle physics has rapidly gotten to the point where international collaboration is very important in moving the field forward.

PT: What about fusion?

KOONIN: Speaking for myself, I'd like to see more focus and drive in our fusion programs than we've had in the past. ITER is going to turn on in perhaps 2020-something, in terms of [achieving] a real burning plasma. That's too long. We should be looking for ways to accelerate that, or perhaps exploring other methods to get at fusion energy. Inertial fusion energy is another option that the department is pursuing through the NNSA [National Nuclear Security Administration] and at the National Ignition Facility. I would keep an eye on NIF as perhaps offering an alternative route to fusion energy.

PT: What's your take on energy in the years ahead?

KOONIN: There is a menu of technologies that for, let us say, the next 15 to 20 years, pretty much everyone agrees are things that need to be demonstrated and deployed. In the transportation sector, it's improving vehicle efficiency. Liquid hydrocarbons are going to be around for quite a while because of their energy density, their availability, and the ease with which we can use them. We just need to find ways to use them more efficiently in vehicles. The technologies exist; we can make an internal combustion engine 30% or 40% more efficient than it is currently by deploying technologies like HCCI [homogeneous charge compression ignition], exhaust gas recycling, cylinder deactivation, and so on. It's just a question of how much more expensive you are willing to make the engine. Beyond that, if we want to enhance energy security and lower greenhouse gas emissions



from transport, then we go to advanced biofuels. There, the obstacles are pretty well elucidated and covered, and the department is pursuing them with vigor, as are many in the private sector.

PT: By advanced biofuels, you mean something other than ethanol?

KOONIN: Ethanol is a pretty lousy motor fuel. It's hygroscopic, corrosive, and has 70% of the energy density of gasoline. Other alcohols are better. Butanol is one that BP happens to be pursuing; it has 90% of the energy density of gasoline and is not hygroscopic. Of course, coaxing the bugs to make butanol is not as easy as making ethanol. Beyond that, with modern biology techniques, we can certainly imagine producing other fuel molecules of interest. There was an announcement by Exxon Mobil and Synthetic Genomics [in July] of their intention to pursue a partnership in algal biofuels. Further out, as battery technologies get better, we'll see a succession of hybrids and plug-in hybrids and maybe eventually battery-operated vehicles. But those will also take a long time to come in.

PT: How long is long?

KOONIN: Most of the new car sales by 2020 will probably be hybrids of one kind or another. But that's only the sales, and remember that the fleet takes a longer time to turn over. So you might see a significant fraction of the fleet by 2030 being ordinary hybrids; the plug-ins will take longer, barring some breakthrough in battery technology, because the battery technology isn't there yet.

PT: What about electricity generation?

KOONIN: We need things that are material, economic, and low-emission. When you put that filter on, there are a couple in the near term. Wind is now 2% of electricity generated in the US; that's pretty good. It will probably get to 20%, but then you start getting to issues of intermittency and transmission. The wind blows where people aren't, usually. Beyond that, I think there are two [other] material options: nuclear fission power and carbon capture and storage. Nuclear power has certainly demonstrated that it is economic, low-emission, and certainly can be made safe, and we know how to deal with the waste. It's just a question of society deciding to implement it, I believe. Carbon capture and storage is a plausible technology, but it's yet to be demonstrated in an integrated way; we need to come down the learning curve.

Then we need to fix the grid; a smart grid will enable better load-balancing and customer choices about demand management and will enable renewables to be integrated into the grid.

These are all things that are under way, and the government is putting a lot of money into research programs and deployments.

PT: There has been a lot of concern at other science agencies, like the National Institutes of Health and NSF, that the peer review of research grant proposals has become overly conservative and is preventing many young academic researchers from getting their foot in the door. Is this a problem at DOE?

KOONIN: I've had long experience with the peer-review system in DOE, except for the last few years. I think it's running pretty well in the Office of Science. Often for the big projects, there is a community consensus that builds up, and I don't think that suffers from over-conservatism. I would like to see a more wide-ranging use of peer review in the energy technology area and also in NNSA. Both present their own set of problems in doing that, but we can certainly try to up the quality of the program selection in those areas.

PT: You're talking about the proposals that come in response to a solicitation?

KOONIN: Right, in fossil energy, or nuclear energy, or EERE [energy efficiency and renewable energy]. Even at NNSA, where open solicitations are a much smaller fraction of the program, there is certainly scientific work that needs to be, and has occasionally been, scrutinized by outsiders.

PT: And this review now is done internally?

KOONIN: More internally certainly than in other parts of the department, such as the Office of Science. ARPA-E [Advanced Research Projects Agency-Energy] is another experiment, or new organization, in the department's firmament. It is meant to provide nimble, quick-hit funding of innovative proposals in energy broadly defined. We've gotten the first round of concept papers in, and they've been looked over, and now we're proceeding to the proposal stage.

PT: All 3500 submissions have been looked over already?

KOONIN: Not all of them will be encouraged to submit proposals, but some number will. And those will be reviewed very thoroughly by informed, independent folks. I can tell you that those of us at the leadership level—undersecretary [Kristina] Johnson and myself, Dr. Brinkman, and the secretary—are all very much interested in the review process and making sure that we do get the very best in this first round.

PT: How do you define a technology that's suitable for ARPA-E? How would it differ from something that would be

supported by one of the energy offices, like fossil energy or nuclear energy?

KOONIN: Basically, it's something with a material impact on energy issues, whether it's security, supplies, or greenhouse gas emissions, that could be brought far along with somewhere between three and five years of funding and that are not currently being pursued in any of the existing [DOE] programs. Now can I say that all 3500 met those criteria? Obviously not.

PT: Where do you draw the line between clean energy research sponsored by the Office of Science and the applied energy research that's traditionally been funded by the various energy offices at DOE, such as fossil energy, energy efficiency and renewable energy, and nuclear energy?

KOONIN: I think the line is a bit too sharp, and of course it depends on the specifics of any given technology, but I think we need to do a better job of connecting up basic materials research and simulation research to their applications in the energy technologies. Take a materials scientist who might be doing basic research on membranes. We could provide a bit more motivation for that research. For example, oxygen separation membranes might be relevant for a carbon capture and storage plant. Many basic scientists are energized and respond to seeing a real-world application of their work.

Not all basic scientists are like that, of course. There are some areas of DOE research that are very fundamental and very basic, and in my mind are kind of a national trust, [such as] high-energy physics and some nuclear science. But many other fields, particularly materials science, computing, and plasma science, start to verge on very important areas of applications. The times being what they are, the importance of the energy and nuclear security challenges that society faces demand a better coupling between basic research and applications.

PT: So it sounds like you will be involved in a lot more than just the Office of Science.

KOONIN: If you read the job description, it really is meant to try to synthesize, coordinate technical matters across the department, and provide technical advice to the senior leadership. In some ways, I feel like I am the technical conscience of the department. I'm here because I think this is a very special time at the Department of Energy. The energy problems that are facing us are significant, the nuclear security problems that are facing us are significant, and at the same time, we've got wonderful opportunities in basic

research that the department funds. We've got a secretary and other colleagues in the leadership team with the kind of background and quality in the technical areas that we just have not seen in this department for a long time. And we've got the attention of the administration and the Congress in the things that we're being asked to do. It's a very interesting time to be here. And I'm also having a good time.

David Kramer

Mexico hosts physics olympiad

For the first time in the history of the International Physics Olympiad, a girl was the top scorer in this annual competition of high-school students. She was Shi Handuo of China (see top photo).

It was only the fourth time the Chinese team included girls—there were two this year—and, as is typical, the team took home all golds; it was the only team to do so and had the highest overall score. Some 316 students from 72 countries competed in the 40th physics olympiad, which was held in

Mérida, Mexico, 12–19 July.

South Korea, India, and the US, with total scores in descending order, each took home four gold and one silver medal. The US competitors were David Field (silver medal; center in bottom photo) of Andover, Massachusetts, and, from California, Bowei Liu and Marianna Mao (flanking Field), a sophomore and senior, respectively, at the same high school in Fremont; Anand Natarajan of San Jose (far left); and Joshua Oremán of Los Angeles.

The theoretical questions this year concerned the size of stars, laser cooling and optical molasses, and the growing distance between the Moon and Earth as tidal torques transfer angular momentum to the Moon. The experimental portion of the exam involved using a razor blade to measure the wavelength of a laser and then determining the birefringence of a mica crystal. "This was fantastic," says Paul Stanley, one of the coaches for the US team. "It was not a question of following cookbook instructions—plug in the wire, turn the dial, close the box, write down the measurements." Instead, Stanley says, "This year's experimental exam involved not only finesse at measuring but also in setting up the experiment. They had to think."

The 2010 olympiad will be held 17–25 July in Zagreb, Croatia.

Toni Feder

news notes

Industry forum spotlights cancer. Frontiers in quantitative imaging for cancer detection

and treatment was the theme of this year's Industrial Physics Forum (IPF). The meeting, sponsored by the American Institute of Physics, was embedded in the American Association of Physicists in Medicine conference in Anaheim, California, in July. Among the topics covered were the role of computers in medicine, advances in breast imaging, advances in ultrasound, and nanotechnology in imaging and therapy.

Jerry Hobbs, one of the event's organizers, notes that in meshing the IPF with a society meeting, "it boosts scientific content and ends up being an additional draw" for people to attend the host meeting.

One of the highlights at the annual IPF meeting is a session on frontier areas of physics—in any field. This year the session included talks on real-time DNA sequencing; opto-genetics; and breakthroughs in high-energy accelerators and the implications for smaller, cheaper medical accelerators.

The next IPF, which will be held in conjunction with the Optical Society of America's fall 2010 meeting in Rochester, New York, will celebrate the 50th anniversary of the invention of the laser by focusing on advances in lasers and laser-related products.

TF ■

ORGANIZATION COMMITTEE OF THE IPO2009



PAUL STANLEY



web watch

To suggest topics or sites for Web Watch, please visit <http://www.physicstoday.org/suggestwebwatch.html>. Compiled and edited by Charles Day

<http://www.anacapasociety.org>



Named after a Californian island that features a natural rock bridge, the **Anacapa Society** aims to help physicists at liberal arts colleges and other primarily undergraduate institutions

(PUIs) carry out research in all areas of theoretical and computational physics. To meet that goal, the society helps theorists at PUIs collaborate with each other and with physicists at research universities. Its first workshop was held last month at Amherst College.

<http://vjaqf.aip.org/aqf>

The American Institute of Physics and the American Physical Society have teamed up to publish **Virtual Journal of Atomic Quantum Fluids**. Like AIP's other virtual journals, VJAQF compiles in one online location articles published elsewhere on specific topics of broad interest. Articles are selected for inclusion in VJAQF by a panel of expert editors.

Atomic Quantum Fluids

<http://www.jpl.nasa.gov/asteroidwatch>



Asteroid Watch is NASA's new online resource for news and other information about asteroids, comets, and other near-Earth objects. The Jet Propulsion Laboratory created and maintains the site, which includes a Twitter feed for the latest alerts.