

of science and education in Russia, we believe that Russian physics will survive regardless of Western help, as it survived after the Bolshevik revolution. It should also be noticed that physicists were greatly overproduced in the Soviet Union. A substantial migration of physicists to other occupations, which Sagdeev calls "internal emigration," would now be natural and, probably, inevitable.

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six alumni who are not on the list, and I do not know personally anybody on the list. It would be reasonable to guess that only 10% of those alumni residing outside the FSU are on the list. That would give us a 6% drain rate for the younger (less than 35 years old) generation of Soviet physicists. This number looks impressive if one takes into account traditional Soviet xenophobia and the fact that travel abroad by individuals in the FSU is still subject to a number of restrictions. For obvious reasons, the older generation of physicists is less "mobile," and their drain rate is less.

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5/92

FSU's Brain Drain: How Fast a Flow?

The plight of science in the former Soviet Union came again into focus in the May 1992 issue of *PHYSICS TODAY* through the articles by Roald Z. Sagdeev (page 22) and Evgenii L. Feinberg (page 30). A brain drain of physicists is often presented as an important manifestation of a decay process. Exact numbers on the brain drain from the FSU are not available, so an attempt to give a semiquantitative estimate of the problem is of some interest. I have made such an estimate based on a list of alumni of the Moscow Physico-Technical Institute residing outside the FSU and accessible via e-mail. This list was originally compiled and is maintained by Alexander Kaplan of the Johns Hopkins University. (FizTech alumni are encouraged to contact Kaplan and join the list by sending an e-mail message to sasha@super.ece.jhu.edu.)

FizTech is probably the best of the institutions that trained Soviet physicists. Each year about 700–800 students are graduated from eight FizTech departments with a degree equivalent to an MSc in physics. FizTech graduates were considered to be the *crème de la crème* among young Soviet physicists, and they are (or at least were) widely sought by the Academy of Sciences and by military and industrial research establishments.

In the updated list, covering the US, Canada, Israel and Western Europe, there are about 90 FizTech alumni, of whom 54 graduated in 1980 or later. This constitutes about 0.6% of those who graduated during those years. A large uncertainty is obviously involved in estimating the probability that a FizTech alumnus who works outside the FSU is on the list. For example, I know personally

What Gas Lies Behind GreenH₂Ouse Effect?

Alison Campbell (February 1992, page 123) is mistaken when she states, "Were it not for atmospheric CO₂, the mean temperature at the Earth's surface would be substantially below zero." CO₂ is a minor greenhouse gas, so its disappearance from the atmosphere would, in fact, have a minor impact on the average global temperature.

Information given in the Search and Discovery department (February 1990, page 17) allows a crude estimate of what the cooling would be. The news item says, "A doubling of CO₂ would increase the atmospheric trapping of long-wavelength radiation by about 4 W/m², compared to the trapping of about 150 W/m² in today's atmosphere." Evidently CO₂ contributes only 3% to the greenhouse effect. Furthermore, if a doubling of atmospheric CO₂ would increase the greenhouse effect by 3%, then conversely its disappearance would decrease the greenhouse effect by 3%.

The step from here to the corresponding decrease in global warming is uncertain because of our far-from-complete understanding of global climate. *Theoretical* models of global climate typically include a positive feedback loop due to water vapor, which magnifies the effects of changes in the CO₂ level. It is unclear (to this writer, at least), however, whether the models also include the *negative* feedback due to the direct linkage between water vapor, average global cloud cover and the Earth's albedo. To make an order-of-magnitude estimate, let us smash through this positive-versus-negative-feedback roadblock with the not unreasonable approximation that the amount of global warming is directly

proportional to the amount of greenhouse effect. Global warming, which is the difference between the 15 °C average global temperature and the bracing –18 °C temperature that would prevail if the Earth's atmosphere were perfectly transparent at infrared wavelengths, stands at 33 °C. With the aid of our low-tech direct-proportionality argument we see that if by some magic all CO₂ were removed from the atmosphere, the 3% decrease in the greenhouse effect would lead to a 1 °C decrease in global warming.

One may use the much publicized models of global climate to check this crude estimate. These models typically predict¹ that if the concentration of CO₂ were to double, global warming would increase by somewhere between 1.5 and 4.5 °C, so conversely the complete removal of CO₂ from the atmosphere would *decrease* global warming by the same amount. Evidently, although the global climate models cannot tell us what the precise temperature decrease would be, they confirm that it would be of order 1 °C. In other words the disappearance of CO₂ from the atmosphere would fall far short of plunging the average global temperature below freezing.

Campbell's mistake stems from her implicit assumption that CO₂ is the major greenhouse gas. So if CO₂ is not the major greenhouse gas, what is? Plain old all-natural water vapor!

Her CO₂ illusion puts her, however, in good company. In an impromptu survey I asked ten of my fellow astronomers, "What is the major greenhouse gas?" Six said, "CO₂." One said: "CO₂. Er, er, but isn't water vapor in there?" Two said, "Water vapor." And one said, "Don't know." (The department chairman was one of the CO₂'s.) Evidently a surprisingly large number of astronomers also think that CO₂ is the major greenhouse gas—this in spite of the fact that astronomers need to know how the Earth's atmosphere stamps its spectral imprint on the radiation from heavenly bodies. In other scientific disciplines that do not deal with the Earth's atmosphere on a professional basis, the illusion that CO₂ is the major greenhouse gas is probably even more prevalent. Among the general public it must be almost universal.

This means that most people must also be under the impression that the rate of increase of the CO₂ concentration in the atmosphere causes an equal rate of increase in the greenhouse effect. In fact, as shown by the numbers quoted above, the greenhouse effect's rate of increase is dilut-

ed to about 0.03 of CO₂'s rate of increase. This is not to say that we should ignore the rising level of CO₂. It is, however, pretty clear that the real greenhouse effect is less torrid than the one the dominant culture promotes.

Reference

1. Natl. Acad. Sci., *Changing Climate: Report of the Carbon Dioxide Assessment Committee*, Natl. Acad. P., Washington, D. C. (1983).

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Naysaying the Neutron Scattering Society

The news story announcing the establishment of the Neutron Scattering Society of America (June, page 73) raises a number of questions, and further information furnished on request by members of the NSSA steering committee raises more questions.

The first question concerns the significance of the words "neutron scattering." The information furnished thus far indicates that the interests of the steering committee are confined to the use of coherent neutron scattering techniques as a tool of materials studies, and that therefore the neutron scattering that will be of interest is confined to the lowest end of the neutron energy spectrum. The neutron energy spectrum above that lowest end, often referred to as fast-neutron physics, falls outside the announced interests of NSSA. "Coherent Neutron Scattering Society of America" or "American Society for Neutron Diffraction Studies" would thus be a more accurate name.

A second question concerns the impact that the new society might have on neutron studies generally and on physics generally. Will it encourage formation of other spin-off groups promoting their special interests—for example, an American Society for Fast-Neutron Physics? Will the science of physics as a whole be enriched, or will we be witnessing a further stage in what Jack Wilson has called "the Balkanization of physics,"¹ with more intensive concentration on relatively narrow specialties and subspecialties?

A third question concerns what the NSSA founders refer to as the society's "national" perspective. This seems to run counter to the emergence of international physics as a forum of The American Physical Society.

A fourth question concerns the role of NSSA as a lobbying agency seeking

to influence Congressional funding in favor of its special interests, and the further politicalization of the American scientific community.

These questions should concern not just prospective members of NSSA but all members of The American Physical Society. As one who strongly opposed the APS constitutional changes of 1966 (see my letter in PHYSICS TODAY, September 1966, page 10), which changed the society from one unified in the pursuit of physics as an integrated discipline to a federation of specialists, NSSA seems to me to be another step in the wrong direction. I urge that NSSA reconsider not only its name but its organizational form and apply to APS for admission as a topical group. It also should recognize that the tax-exempt status of APS bars it from political activity, and that includes lobbying Congress for special funds.

Reference

1. AAPT Announcer 19(1), 20 (1989).

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THE SECRETARY AND CHAIRMAN OF THE STEERING COMMITTEE OF THE NEUTRON SCATTERING SOCIETY OF AMERICA REPLY: At its inaugural meeting in January 1992, NSSA identified the following goals:

- ▷ To identify and bring together the neutron scattering community of the US
- ▷ To identify the needs of the neutron scattering community, including future requirements for instrumentation and sources, and to represent those needs to the neutron facilities and funding agencies
- ▷ To stimulate, promote and broaden the use of neutron scattering in science and technology
- ▷ To carry out educational activities that support the above goals.

Fundamentally, the scientists and engineers who use neutron scattering in their research come from a wide range of fields, from structural biology through polymer films to weld testing in engineering practice. Indeed, the group stretches well beyond physics, incorporating, for example, pharmacology, biology, chemistry and engineering. The aim of NSSA is to bring this diverse group together based on the common use of neutron scattering as a research tool. It is not at all to promote the Balkanization of physics.

NSSA members are primarily interested in thermal-neutron scattering because thermal neutrons have the same wavelength and energy, approximately, as matter at room

temperature. This makes thermal neutrons ideal for studying a wide range of materials. Lawrence Cranberg is apparently interested in fast-neutron scattering. Fast-neutron scattering is certainly interesting, and we hope that Cranberg will join NSSA and develop this field.

By a "national" perspective we meant that we hope to include everyone in the country who uses neutron scattering. Certainly, in terms of both science and the use of facilities, NSSA takes an international perspective.

NSSA has no plans to be a lobbying agency, either to Congress or to other political bodies. However, under the second goal above, we do intend to identify the needs of the neutron scattering community and represent these to national laboratories and funding agencies when appropriate. As an example, NSSA recently presented a brief on behalf of the community to a panel on neutron sources set up by the basic energy sciences advisory committee of the Department of Energy. The brief was based on solicited views from members.

Finally, we would enjoy a close relationship with The American Physical Society, but it does not seem appropriate for us to become a topical group of APS.

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9/92

Westerners Should Go to China Meetings

With reference to the news story "Beijing Meeting Remains on Track—amid Continued Concern" (May 1992, page 55), I would like to give my opinion, as a Chinese national who has been studying and working in the US, on whether Western scientists should go to conferences in China. I think that as long as the conferences do not carry strong political overtones, Western scientists should participate in them as they normally would, for two reasons.

First, unlike the Soviet scientist-dissidents who called for boycotts by Western scientists as a gesture of disapproval of human rights conditions in the Soviet Union, most scientists in China welcome the relatively rare opportunities to interact with their foreign counterparts at conferences. True, there are Chinese scien-

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