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research abroad, and that was because, as he bluntly replied when pressed, China didn't really need sophisticated physicists, so graduate students like me should return after finishing their doctoral work. I was puzzled by his answer. Why should we return if the country does not need us? Well, it didn't take too long before I puzzled out what he was really implying. It seems that the government cares more about exercising its control over students abroad than worrying about the "brain drain."

The second factor influencing our decisions whether to return home or not, namely the lack of respect of basic civil rights, is perhaps more important to some of us. The views of Fang Lizhi [former vice president of the University of Science and Technology in Hefei, dismissed in early 1987] are widely shared by the vast majority of Chinese students both at home and abroad. While Fang's call to us to speak out and to live up to our responsibility as scientists has had a tremendous impact on the Chinese student community, many of us are more concerned with some of the specific issues confronting the daily life of every Chinese citizen. In practice, there is no freedom of speech, no freedom of association, no freedom of travel, not even freedom of thought, even though these basic rights are nominally guaranteed by our constitution. In many respects, our ability to work as scientists inside China is intimately related to the degree of political democratization. For instance, traveling abroad is strictly regulated. While travel restrictions are considerably looser for those with privileges and for established senior scientists, it can sometimes take months or even years for young researchers with few connections to be permitted to visit another country. These travel restrictions ought to be completely abolished, for they seriously reduce channels of communication between researchers in China and the rest of the world. Many of us fear that we may never be allowed to visit the US or to attend international academic conferences once we return home.

Moreover, as physicists, freedom of speech and freedom of thought are of vital importance to us, since we are trained to challenge things that are irrational and not to accept any "traditional" dogma without critical examination. The fact that China has not been able to produce research worthy of consideration for a Nobel Prize is not unrelated to the fact that

independent thought deviating from the official line has been suppressed. It reflects the so-called "tradition" of following the standard. It is debatable, however, whether this lack of creativity can be attributed solely to government policy. Nevertheless I contend that the government should move beyond verbal promises and take decisive actions to improve the living conditions of intellectuals in the middle class, not just those with high rank. It must allow diversity of thought, even "perverse" thought, and fully recognize the individual. Until China's government alters its fundamental attitude toward the intelligentsia, both economically and politically, any attractive promises it makes will be met with deep suspicion.

Some of us are eager to contribute our scientific knowledge, as well as what we have learned of Western culture, to the modernization of our country. Some of us wish to stay abroad, for various reasons. For example, those who have aggressive personalities and strong motivations for success in their scientific careers may find it difficult just to survive the relatively close society in China, where individuality is yet to be fully recognized, let alone pursue a vigorous scientific career. Because they adopt Western life styles more easily and tend to be more self-centered, they are often condemned as having been corrupted by bourgeois liberalism. They are most likely to be resented by colleagues and treated with suspicion not only by their political supervisors but also, and perhaps more frequently, by the people in their immediate surroundings. Unfortunately, such scientists are the people that my country needs most if China is to catch up with the developed Western nations and regain its position as a world power. In any case, it is a citizen's basic right to choose a place to live if one can, and the government does not necessarily have, in my opinion, the right to prevent citizens from traveling abroad at their own expense. The only sensible policy is to create an atmosphere in which scientists and intellectuals are free to voice their opinions and exchange ideas with their colleagues both inside China and abroad. It is the government's duty to improve the poor living conditions of intellectuals and to guarantee every citizen the basic civil rights granted by the constitution, rather than to impose various limitations aimed at controlling students abroad. Any coercive policy is doomed to fail.

7/88 NAME WITHHELD BY REQUEST

SSC Costs: Compare and Contrast

Each issue of *PHYSICS TODAY* adds another chapter. Virtually every colloquium, seminar or even conversation inevitably turns in its direction.

Five billion dollars (or is it \$4.2 or \$6.3 billion?) is a large expenditure and apparently of great concern to many. But is it really the figure of merit for the SSC?

Spread over the 8- to 10-year projected construction period, the project can be viewed as costing approximately \$500 million per year, a relatively modest sum, especially to those of us jaded by a \$5.2 billion nuclear plant that won't open, multi-giga-dollar submarines and aircraft carriers, and a Stealth bomber rated at \$500 million per flying wing. In addition, the \$250 million estimated yearly operating budget (1988 dollars?) seems positively trivial.

The academic arguments have been amply aired and debated and seem fairly straightforward. When the subject came up at the meeting of physics chairs in Arlington, Virginia, on 19-20 February, I was pleased to add my name to the significant support expressed by that group. If the project is vetoed, one might contemplate, in a decade or so, a subscription to the relevant organ of the Physical Society of Japan for timely reports on the Japanese Super Collider located 50 miles south of . . .

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6/88

One aspect of your insert (May 1988, page 70) briefly describing the seven remaining proposed sites for the SSC caught my eye. Only one site was characterized as having a life-cycle cost slightly higher than those for other sites, one had a cost about equal to the average, and the remaining five had below-average costs. I couldn't help being reminded of Garrison Keillor's "Prairie Home Companion" characterization of Lake Wobegon, "where all the children are above average."

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Of Particles, Pyramids and Piper-paying

Having just finished reading the Letters column in *PHYSICS TODAY* of May 1988 and the articles on space science, I happened to pick up Aristotle's *Politics*. In book V, chapter 11, I read the following: "As examples of works

instituted in order to keep subjects perpetually at work and in poverty we may mention the pyramids of Egypt, the numerous offerings made by the Cypselids, the building of the temple of Zeus Olympius by the Peisistradae, and public works under Polycrates of Samos. Subjects are also kept poor by taxation, as at Syracuse under Dionysius, where in five years the value of the entire private property was paid in."

Three megascience programs for which the public is taxed at the multi-billion-dollar level today are space science, controlled thermonuclear fusion and high-energy particle physics. What benefit to they give to the public? Space science provides satellite television, weather surveillance, spectacular views of the outer planets and, of course, security from surprise attacks by enemy forces. Controlled thermonuclear fusion promises abundant safe nuclear power. Since it doesn't work, the promise of safety is fulfilled. Like Achilles racing with the tortoise, the program forever gets closer and closer to the tortoise without catching it. Some public utilities are having trouble running nuclear fission reactors, so how could they run the much more complicated controlled fusion reactors even if they worked? Still, if the project succeeded it would benefit the public that is taxed to support it.

Now to high-energy particle physics! Like the pyramids of Egypt, that program is of no earthly use to the taxpaying public or to any other branch of science. Its practitioners say that they must "probe deeply into the structure of matter." Isn't it hilarious that the structure of matter that makes the program technically possible is superconductors? That discovery was made by people working on small budgets in laboratory rooms where they could go in and shut the door on program managers.

Sometime we must stop building ever-larger pyramids for the high-energy particle physics community. Why not now? I suggest giving a medal, a prize and perhaps a splendid uniform to all top-level program managers in high-energy particle physics. That is really what they are working for anyway. The facilities should be put on a shutdown ramp over two fiscal years to complete all work now in progress. The funds and personnel would, over those two years, be divided among the first two megascience programs. The rest of the world would think we were on to something and would be totally confused! Actually, we would only be implementing the wisdom of Aristotle!

(P.S. I am working in molecular biology, a program that pays its piper.)

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5/88

SDI: Some Darker Implications

Greg Blonder (January 1988, page 126) has pointed out, through a clever and simple analogy, the subtle mutability between defensive and offensive weapons. However, there is no need for analogizing, since copious examples can be found in the public domain of SDI's "darker side."

On 14 January 1986 the *Los Angeles Times* announced in an editorial that a local "think tank," RDA-Logicon Inc, had concluded from its own research that not only were the high-energy laser systems being planned for SDI extremely potent offensive weapons, they were also capable of rapidly igniting combustible urban materials in sufficient quantities that it appeared possible to catalyze a "laser winter" with the same catastrophic effects predicted to accompany a "nuclear winter."

At the time I was a staff member at the Jet Propulsion Laboratory in Pasadena, and I contacted RDA-Logicon to obtain a copy of the report. I was told that the report had been classified "proprietary" and was not available to the general public. Subsequently I contacted a physicist at Argonne National Labs who had published a paper shortly thereafter in the open literature predicting the laser winter effect. I suggested a collaboration to further refine the technical issues of laser physics, beam propagation and laser winter effects, but I was told in no uncertain terms that the Argonne management had communicated their displeasure upon learning that an employee was investigating such a politically volatile topic, and that further research was officially discouraged.

Apart from a single paper presented at an APS conference last year and personal communications with a private research organization in Los Angeles, I am unaware of any other ongoing investigations along these quite controversial lines, but I would greatly appreciate hearing from any readers who are.

Just prior to President Reagan's March 1983 "Star Wars" speech, the president's science adviser, George Keyworth, and the deputy national security adviser, Robert McFarlane, discussed the possibility of using high-

energy lasers to assassinate leaders like Muammar el-Qaddafi (*Bulletin of the Atomic Scientists*, October 1987, page 20). In light of the APS study of directed-energy weapons (see *PHYSICS TODAY*, May 1987, page 51), I think it's safe to assume that Qaddafi is not losing sleep over this prospect.

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3/88

The Light Quantum, Viewed in Hindsight

Giorgio Margaritondo's article "100 Years of Photoemission" (April 1988, page 66) conveys the false picture that only Einstein's 1905 quantum theory explained the photoelectric effect and that the experiments of Robert Millikan and other physicists confirmed Einstein's theory of light quanta. Although this picture makes sense to a modern reader, it has no foundation in history. It is not true, for example, that Philipp Lenard's discovery of a maximum kinetic energy of photoelectrons (independent of the intensity of light) remained unexplained until Einstein solved the matter. Lenard explained the result by means of a "triggering hypothesis," which was developed by many other physicists and enjoyed general respect. Lenard's result was not considered to be particularly puzzling and certainly not in need of the sort of explanation Einstein could offer. The triggering hypothesis may not seem satisfactory to a modern physicist, but at the time it was regarded as a much better explanation than Einstein's strange alternative.

As to the experimental confirmation of the photoelectric law, one should distinguish sharply between Einstein's equation $E = h\nu - W$ and Einstein's theory. Margaritondo fails to make this distinction and thus claims that about 1916, experiments definitely established the idea of the light quantum. The facts are that Einstein's theory was almost unanimously rejected and that the experiments did not lead to acceptance of the theory. In his celebrated 1916 paper, Millikan argues that the Einstein equation was now verified but that the light quantum theory was "wholly untenable," a view he repeated the following year in his book *The Electron*. Millikan may not have understood Einstein's theory, which he saw as a modification of J.J. Thomson's ether-string theory, but he