letters

Superconducting Super Collider

I would like to make several observations concerning the "selling" of SSC by Sheldon Glashow and Leon Lederman (March 1985, page 28) and the ensuing defense of SSC by Glashow (February, page 11).

They have defended SSC against its critics by emphasizing the truly fundamental nature of the research SSC will carry out. And the wonderful contributions made by the big accelerators to our basic understanding of nature certainly lend credence to their arguments. A vigorous experimental program must be an integral part of any further pursuit of a fundamental physical theory.

Unfortunately, they and the entire high-energy-physics community have made the unstated assumption that SSC is the preferred, indeed essential tool for conducting experimental research of a fundamental nature. What the high-energy-physics community has not questioned is whether SSC is the best way to conduct fundamental research. As an argument for SSC they simply state an unassailable fact: SSC will do fundamental research.

More and more, it would appear there is potential for fundamental experimental discoveries in efforts not requiring the big accelerators. The electrifying effect the physics community felt on the possible discovery of the magnetic monopole is one example. Ongoing experiments to demonstrate the decay of the proton are another. In fact, cosmic-ray physics has the potential to detect events far more energetic than any accelerator can ever hope to produce. In astrophysics, recent observations even suggest evidence for the existence of superstrings.

There is nothing essentially wrong with constructing SSC. What is wrong is that the costs and benefits of SSC have not been compared with an alternative, namely, spreading the same money over a whole range of nonaccelerator experiments that could have fundamental impact. The physics community desperately needs to move debate away from the merits of SSC vis-à-vis less-fundamental research toward the relative merits of SSC and alternative fundamental research. Until this is done, can any of us be sure that SSC is the best way to spend our dwindling funds for the exciting and essential pursuit of a basic theory of nature?

CHARLES J. HAILEY
3/86 *Ann Arbor, Michigan*

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Sheldon L. Glashow's snappy response to Clarence A. Gall's comment (February, page 11) was worthy of a stand-up comedian. PHYSICS TODAY provides great lunchtime entertainment!

Glashow implied that Werner Heisenberg and his friends long ago taught us all we need to know about the interplay among many atoms. Apparently a satisfying way to answer a question is simply to close one's mind to it. Let's go back beyond even Heisenberg. Does anyone fundamentally understand Planck's constant h? A more basic question might be, does anyone fundamentally understand $h/2\pi$? That's what we mean by fundamental.

Glashow said that the proton is a composite of quarks held together by the color force. Is that final? Perhaps after probing more deeply into the structure of matter he will tell us convincingly what an electron is, and what a photon is. Heisenberg's friends didn't finish the job.

Glashow then gave us a definition of a correct, complete and consistent theory: a theory that has too many adjustable parameters.

Do we have a jargon problem?

Unlike SSC scientists, we yearn for theory that will explain our experimental results better.

GORDON R. FREEMAN
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4/86 *Edmonton, Alberta, Canada*

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I find the use of the word "fundamental" by Sheldon L. Glashow (February, page 11) rather misleading. If by fundamental one means that "we don't quite know what we are doing nor where it will lead," it obviously applies, to one degree or another, to almost any branch of science and certainly to molecular biology. Surely the Super-

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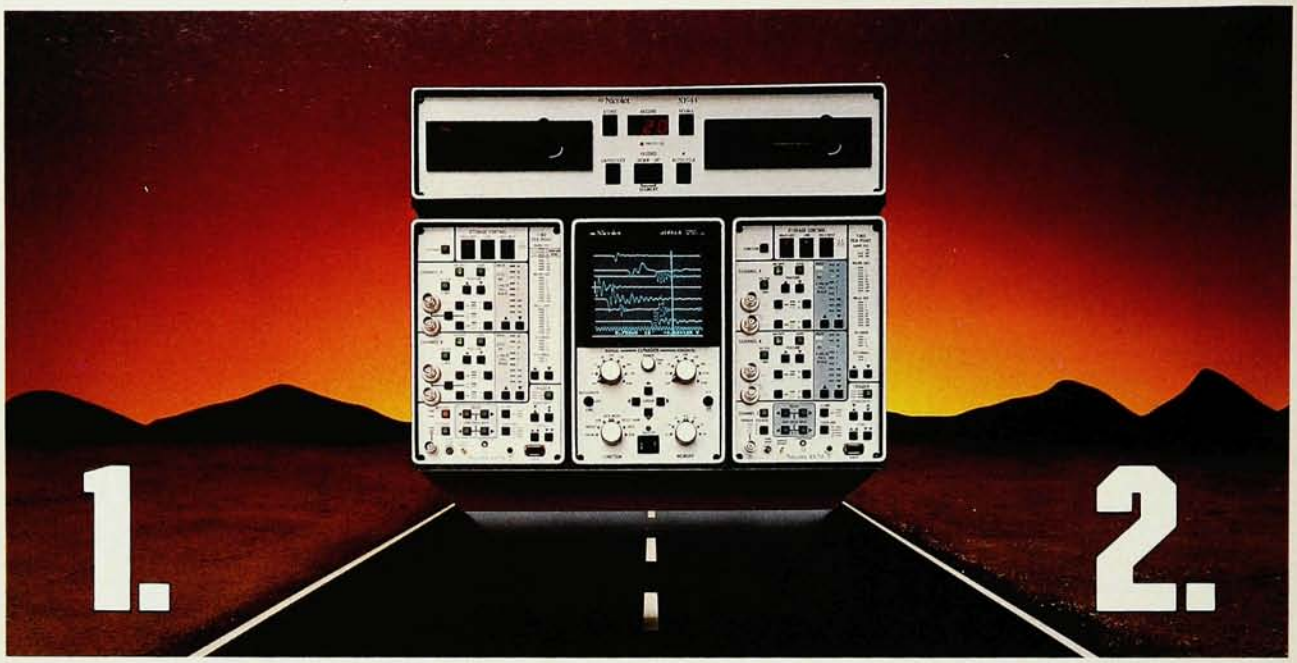

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conducting Super Collider cause does not need to rely on the reductionist use of "fundamental." Wouldn't it be a healthier and more apt use of the word to recognize that understanding is organized on various levels, each with its own laws and concepts fundamental at that level? I, for one, certainly would agree with Volker Heine's words at the opening of the NATO Advanced Study Institute on electronic-structure dynamics and quantum structural properties of condensed matter:

> The word "fundamental" is often misused. I have heard high-energy particle physicists claim that their subject is fundamental, but I do not find it fundamental to materials science, geology, biology or hardly anything on this Earth except in a rather empty sense which philosophers call reductionism. . . . The second law of thermodynamics can be derived from statistical mechanisms but that does not affect its role as a fundamental law within that important and coherent collection of concepts and relationships which we call thermodynamics.

The quest for knowledge—and I am aware of the difficulty of achieving the delicate balance among available funds and different types of research and interests—might be a good enough reason to defend SSC without depriving other areas of science of their fundamental character. Besides, when will we be sure that we have reached a level of experimentation at which we may be confident that we have grasped "the fundamental"? Surely new possibilities, in many different directions, will always lie ahead of us, so that we must be prepared to face an inexhaustible search. In this SSC has its place.

Pedro M. Echenique
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Cambridge, England

3/86

Glashow replies: Perhaps Charles J. Hailey is right and great surprises await us in passive, nonaccelerator experiments. Perhaps not. Cygnus X-3 once seemed to be an inexplicable source of muons, but more careful studies abroad show that the Swan is dead. As for cosmic strings, the evidence has evaporated and they have nothing in common with the superstring but a name. The Valentine's Day magnetic-monopole candidate was followed by five years of electrifying silence. Far more ambitious monopole searches are needed and will be launched at the lushly appointed Italian Underground Laboratory, the same place where the Germans will do the gallium experiment to resolve the solar-neutrino puzzle. Meanwhile, the Japanese plan to build an order of magnitude bigger and better proton-decay detector, because we "ain't found nothin' " in Ohio. The Swiss tritium experiment has foiled Russian claims of nonzero neutrino mass, so a nonaccelerator frontier, should there be one, seems to lie across the oceans blue.

Pions, muons, positrons and strange particles were first seen in cosmic rays. So was charm—so faintly that hardly anyone noticed. Some cosmic-ray collisions do have center-of-mass energies equal to or greater than those of the proposed SSC. The flux of these very energetic particles is about 10^{-13} m^{-2} sec^{-1}, corresponding to a whole-Earth luminance of 50 sec^{-1}. Hailey could instrument all the lands and seas only to get a millionth of the event rate of SSC, with no room left to windsurf or grow bananas. That is one reason why the High-Energy-Physics Advisory Panel, after carefully analyzing many options, announced in 1983 its primary and unanimous recommendation for "the immediate initiation of a multi-TeV high-luminosity proton–proton collider project," and it is also why 252 participants in the subsequent Snowmass meeting took 851 pages to "simply state" that SSC is preferable and essential.

We need SSC if we ever are to tell Gordon R. Freeman why the muon/electron mass ratio is 206.768, whether there are widgets inside quarks and what the photon is. However, even if we SSC scientists are successful beyond our wildest dreams, we will never be able to explain the results of his chemistry experiments, just as he will never succeed in teaching biologists why there are rabbits. Nor should we be expected to do so. For this he ought to stop yearning and go back to Heisenberg.

Proudly reductionist, I must quibble with Pedro M. Echenique. It seems to me that questions such as "Is there a Higgs boson?" and "What is the electroweak gauge group?" which SSC will address, are different in their very essence from the central questions of such fields as materials science. The second law of thermodynamics follows from statistical mechanics, and is thereby once removed in fundamentality. Statistical physics itself derives from more fundamental microphysical laws that are themselves consequences of quantum chromodynamics and the electroweak theory. When these laws are encompassed within a deeper underlying structure (such as the superstring), then they too will be deprived of their essential fundamentality. Our questions, and their unknown

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but more fundamental successors, are directed toward the ultimate nature and origin of matter, and hence to everything on or off this Earth.

SHELDON L. GLASHOW
Harvard University
Cambridge, Massachusetts

9/86

Supercomputer access

I wish to express my strong opposition, as a member of APS for some 34 years, to the APS statement on supercomputer access (PHYSICS TODAY, December 1985, page 53) and to the editorial by Robert L. Park on the same topic (December 1985, page 144). Let there be a referendum, a vote by the membership on this topic, before APS issues such a sweeping, controversial statement!

Justice Oliver Wendell Holmes of the US Supreme Court once remarked, "To think is not less than to feel!" Having been an associate professor of physics I can understand the instinctive reaction by many physicists at universities that any restriction intrudes into the "pure" intellectual life of a community of scholars isolated from the world. However, this cherished independence from the rest of America is wholly imaginary.

Let me point out that the tax-free status of university property, buildings and gifts and the enormous direct and indirect largess from all levels of government as well as the private sector imply a responsibility too. The elected representatives of all the people may not be the favorites of the generally very liberal physics faculties but they do represent the people of the United States. If they conclude, on the basis of overwhelming evidence, that the Soviet Union's direct, long-term, hands-on access to the latest US supercomputers is a threat to our national defense, whether the computers are on campus or off, then APS is irrational to assert its undying opposition to restrictions on access for nationals from countries that are obvious potential enemies.

The danger of the enormous military build-up by the Soviet Union and its satellite countries—giant Typhoon submarines as part of a submarine fleet three times the size of ours, new SS-24 and SS-25 ICBMs (the latter in violation of sworn treaties), the huge Krasnoyarsk phased-array radar (an obvious violation), the six-year-old war to decimate the heroic Afghan people, the vast Soviet war supplies flowing to Angola, Vietnam, Cuba, Nicaragua, Ethiopia (while we send food they send guns), Libya, the PLO and so on—should make even the most isolated physicist aware that we must protect any lead we have left.

Fortunately, for the time being, the Soviets appear to have trouble making the large supercomputers so useful for designing and analyzing complex military high-technology systems, such as missiles and nuclear weapons. That is why the KGB would be delighted with long-term access to Cray and other machines for Soviet-bloc scientists, the majority of whom are forced to carry out KGB missions when abroad. That is why Evgeny Velikhov is pushing so hard for a "joint controlled thermonuclear-fusion-reactor project"—to enable the Soviets to have hands-on access to the superb Magnetic Fusion Energy Computing Center Cray supercomputer. (This is the same Velikhov who, while heading the huge Soviet Star Wars effort, blandly assures us that SDI is futile and unworkable.)

It is the same thirst for long-term Soviet access to US supercomputers that causes Roald Z. Sagdeev to ask audaciously for a satellite data link from a US supercomputer to the USSR to do some "fundamental research." Of course if some US citizen wished to run an extremely interesting Soviet basic-research calculation, that could be arranged, but in my opinion, hands-on access by Soviet-bloc scientists should be barred until the international situation changes drastically.

Do any APS Council members remember the ongoing intense persecution of our brilliant, freedom-loving Russian colleague, Andrei Sakharov? Do they recall the persecution of Anatoly Shcharansky and Yuri Orlov and the torture of Soviet psychiatrist Anatoly Koryagin for daring to deny that a dissident worker was insane? Are the sufferings of hundreds of refusenik scientists and tens of thousands of others in the Gulag, so eloquently portrayed by Alexander Solzhenitsyn, to be forgotten in a mad rush to aid the Soviet war machine by providing untrammeled access to supercomputers? Do APS members still care about Soviet denial of the most elementary human rights? (I hope and believe they do.) Let's have the referendum.

HOWARD D. GREYBER
Department of Defense
Washington, DC

1/86

THE EXECUTIVE DIRECTOR OF THE APS OFFICE OF PUBLIC AFFAIRS REPLIES: It is made clear in the opening sentence of the statement on supercomputer access that the views are those of the elected Council of The American Physical Society. In 1968 the APS membership decisively rejected a proposed constitutional amendment that would have required "any matter of concern to the society" to be brought to a vote by the entire membership via formal resolu-

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