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fine-structure constant α may not have been the existence of many other, more or less equally simple ratios of group volumes close to α and involving integers and π , as David Gross claims in his Reference Frame column. Rather, the rejection may have stemmed from Wyler's failure to demonstrate any clear relationship between the group volumes and any physical theory dealing with broader physical questions.

In fact, after Wyler's initial publications of group-volume ratio formulas for α , he was invited to the Institute for Advanced Study at Princeton to continue his work. The hope, understood to be a long shot, was that work at the institute might lead to some indication of a relationship between the group volumes and physical theory. At the end of Wyler's term at the institute he was no closer to physical theory than he had been at the beginning, so his formula for α was rejected as unphysical mathematics.

The point is that the institute gave Wyler a chance to develop his theory. Unfortunately, his failure to do so seems to have given a "black eye" to other attempts to relate group volumes to physical theory.

Nowadays, institutes comparable to the Institute for Advanced Study circa 1971 are reluctant to take a long-shot chance that such unconventional approaches might be useful. The result is that conventional approaches (such as, currently, superstrings) are not merely dominant, but in practice the only way to go. If fashion happens to be wrong, and a long shot happens to be right, then physics is the loser.

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GROSS REPLIES: I agree completely with Ibrahim Adawi that some of the greatest discoveries have been made following false leads. Paul Dirac's analysis of the role of magnetic monopoles in quantum electrodynamics gave the first explanation of the quantization of the electric charge, although it provided no clue as to the value of the charge quanta. In current theory, charge quantization emerges when truly unified theories combine the electric charge as part of a non-Abelian group whose representations are labeled by quantized integers. Not surprisingly, this is related to Dirac's analysis of magnetic monopoles, since these theories necessarily contain monopoles with a charge given by Dirac's formula.

Paul S. Wesson accuses me of being ungracious and discourteous to

Arthur Eddington. Perhaps, but no more so than his contemporaries, who knew enough in the 1930s to be able to dismiss Eddington's theory of the fundamental constants. (See, for example, the harsh attacks on Eddington at the Warsaw conference on New Theories in Physics held in 1938, where Eddington gave a rare presentation of his ideas before an audience of his peers.)

My main criticism is that Eddington's approach to these issues was nonscientific. I totally disagree with the comparison of Eddington's work on α to the speculation of Dirac and others that the gravitational constant may be time dependent. The suggestion that this was a logical possibility was good science that led to new experimental observations and tests. Eddington's theory was numerology, not science, and led nowhere. This, of course, should not detract from our admiration of Eddington's important contributions to astrophysics and cosmology.

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How Supernova Shock Revival Was Revealed

In my article "Supernovae" (September, page 24) I stated that James Wilson discovered the revival of the supernova shock after accidentally leaving his computer on overnight. Actually, Wilson had worked for many months to extend the computation from about 0.05 second after collapse of the star to about 1 second. (This was a difficult problem, and its solution has only been matched about six years later, by one other scientist.) After the shock could be pursued for this long time, it showed revival, which Wilson interpreted as being due to the absorption of the neutrinos emanating from the core.

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Is Chernobyl News Contaminated?

I found William Sweet's news story "Chernobyl Aftermath to be Assessed by International Team" (July, page 62) very interesting and informative, but somewhat alarmist.

The basic question is the following: Should we trust all news about the Chernobyl accident that appears in the Soviet press? I think we have to be very cautious. Thanks to *glasnost*,

the Soviet mass (nonprofessional) media abound today with all kinds of information. Not surprisingly, we have a tendency to consider this information accurate, without realizing that much of it is highly suspect, and some grossly incorrect.

What about official government information? The Soviet government, particularly in the early days after the accident, has been very secretive about the accident and its effects. For us in the West, it is reasonable to assume that the Soviets are hiding something, presumably some very bad consequences or mistakes their professionals and politicians have made, both before and after the accident.

Sweet reports: "The Byelorussian government has asked for international help to relocate and medically treat people living in areas affected by the accident. A Byelorussian diplomat is reported to have said in Brussels that two million Byelorussians live in such areas.

"... the Ukrainian government reported that more than 1600 villages and towns, with more than 1.5 million inhabitants, were located in the contaminated area.... The Ukrainian republic has established special accounts for the deposit of foreign donations."

When Soviet officials are admitting bad things, we in the West automatically believe that the particular event is at least as bad as admitted. But in view of recent changes in the Soviet Union, we should ask whether our old stereotypes are still correct. I do not believe so, at least not in the case of Chernobyl.

Many of the "official" reports about Chernobyl (including those quoted by Sweet) contain very little, if any, quantitative information. What do the words "affected" and "contaminated" mean? We should also notice that it is mainly (only?) Byelorussian and Ukrainian government officials making these statements, while Soviet (federal) officials and professionals are not. Could it be that some officials from the Ukraine and Byelorussia, republics that have strong independence movements, are exaggerating Chernobyl's consequences to further their political aims? There are strong indications that this is indeed the case.

Naturally, the Western media have no expertise to separate sense from nonsense; thus they pick up all these reports (some of which are quite "juicy") and spread them around the world. Since nobody challenges them (admittedly, some Soviet professionals do, but they have a very uphill battle to fight), these reports appear

to present proven scientific facts, which they certainly do not. The triumph of misinformation and ignorance is so complete that even many physicists believe these stories. As far as the public and politicians are concerned, they are, of course, thoroughly convinced. Shutting down the nuclear industry in many countries around the world is only a natural and reasonable consequence.

Sweet explained that the Soviet government has asked the International Atomic Energy Agency to assess the Chernobyl situation. Apparently, rather than crack down on *glasnost* and stifle all criticism (both inappropriate and appropriate), the Soviet government has decided to fight the *glasnost*-engendered misinformation by soliciting help from the international professional community. The IAEA will be issuing a report, probably before the end of the year. I personally expect that this assessment will be very useful, will clarify many issues and will reduce the flow of misinformation. But I do not believe that this assessment will be the final word: The project has a limited scope (for instance, it will not look at the causes and physics of the accident), and its operation will be limited in time. Is there something else our profession could and should do?

I believe so. I think that we should study the accident in a systematic manner. Those of us in the West should try to do this as much as possible together with our Soviet colleagues, hoping that the new winds in the Soviet Union will eventually open all the books and records about the accident and that any remaining mysteries will get explained.

Now is the right time for AIP to form a special committee to study the causes and consequences of the Chernobyl accident. The proposed AIP study would build on the IAEA results, rather than be in redundant competition with it. Also, the IAEA assessment is being done by an international organization whose mandate is, among other things, to promote the peaceful uses of nuclear power. Future critics of the IAEA project will not overlook this fact. An AIP study would be free from this difficulty.

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9/90

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Salvaging Small Science

There is a worsening crisis in university-based scientific research, one

that has been aggravated by recent trends in Federal research funding. Traditionally, much of the funding has been in the form of small research grants to individual investigators, referred to as SIPs (single-investigator projects) by NSF and some other funding agencies. In contrast, recent trends have been to cut back on SIPs and to direct funding instead toward what might be called GULPs—grandiose, unnecessary, large projects. The largest GULPs are the obvious multibillion-dollar projects such as the SSC, the manned space station and “Star Wars.” Even NSF, which used to provide the mainstay of SIPs, is now one of the leading GULPERS; witness the Science and Technology Centers, the Engineering Research Centers, the new Laser Interferometer Gravitational Radiation Observatory and the new National High Magnetic Field Facility.

Science is a creative enterprise, and as such it cannot be effectively and efficiently managed on a large scale. Only SIPs have the flexibility to respond quickly to new research discoveries and new opportunities. This advantage is enhanced within American culture, with its emphasis on individual initiative. The bureaucratic organization of GULPs may be appropriate for large-scale production engineering, but it is not appropriate for creative science. GULPs are not even appropriate for technology transfer, which in our system is best achieved by collaborations of individual researchers with small startup companies.

Clearly, each GULP must eliminate a large number of SIPs, and that is indeed what has happened. However, the cutback in SIPs appears to have escaped the attention of most of our political leaders in Washington, who seem only to look at the bottom line—how much Federal money, in total, is going to “scientific research.” In addition, heavily politicized special interests have developed in support of a number of the GULPs. To change this trend, we must individually and collectively contact elected representatives and other policy-making officials, and get across this simple but powerful message: SIPs are better than GULPs when it comes to scientific research. There may still be time to prevent major and irreversible damage to the base of scientific research in our universities.

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4/90

The existence of PhD programs at our universities is in jeopardy be-

cause of the universities' overwhelming preoccupation with securing grants for the continuation of research programs. Most universities push their faculty members to apply for grants rather than work on projects of their own and their students' interest. As a result, design and development projects sponsored on the basis of shortsighted needs of funders dominate some university programs. Administrators, professors and even junior faculty are sometimes hired not so much for their merit and vision but rather because of their success in securing financial support.

If we let this continue, the country will lose its intellectual base in engineering and applied sciences. We need to face the questions: Are we producing salespeople or scientists? Are we planning to import our engineers and scientists from the other side of the Pacific?

There are many people who are concerned about this situation. The president of the National Academy of Sciences has proposed pooling the fundamental research programs and making them accessible to proposals from the general scientific community. We would like to propose a different solution.

Most of the great scientific and engineering discoveries have appeared as results of the curiosity, insight and motivation of the researchers, not of their sponsors. We believe that basic research is a personal matter. Therefore we propose government funding of relatively small projects on the basis of the researchers' personal merits. Support people, not projects! Persons who have repeatedly demonstrated their capability to produce interesting ideas or solutions and can pass the scrutiny of their peers must be trusted to use their allocated funds to work toward goals they set for themselves. PhD students and younger faculty could be supported either through the people selected this way or directly, based on evaluations of their potential.

The implementation of our proposal would automatically ensure support for the best faculty, relieve them from the continuous and time-consuming burden of grant hunting and make it possible to attract the best students to PhD programs. Is it not worth a try?

The present system of funding works well for big projects: Both government and industry have the right and obligation to sponsor projects of their interest. It is, however, the utmost duty of the government to