Sanctions

I appreciate the issues raised in the editorial entitled 'Sanctions' (*Curr. Sci.*, 1999, **76**, 1171). But I am compelled to respond to the broader topics raised. I speak for myself and not for the American Physical Society (which has a long and proud history advocating for freedom in the conduct of science).

While quoting my editorial on 'The University of Science', lamenting the danger posed by the current regime of sanctions triggered by the Indian and Pakistani nuclear tests (published in the 19 March issue of *Science*), the *Current Science* editorial fails to take note of the host of other activities imperiled by the closing down of scientific exchange; especially the loss of dialogue among scientists aimed at reducing tensions and providing workable schemes for arms control and weapons reductions.

I would challenge the assertion that the reaction of scientists, learned societies and the international unions have been muted. Many of us have protested such restrictions and I have heard from several societies and both ICSU and our own National Academy of Sciences concerning their opposition to travel restraints and other impediments to scientific exchange.

There is a continuing dialogue in the US between scientists, their organizations, and government officials at all levels and in all branches to find ways to limit the damage to intellectual discourse. And, in fact, I have invited the institute directors in India to inform me of the details as problems arise so that we may take timely action.

But we are equally adamant that scientists bear a heavy burden in both the scientific and policy arena for their contributions to the development and deployment of weapons of mass destruction. And here I hasten to point out that I am not condemning the Indian or Pakistani nuclear policy. My personal view is that these weapons are horrendous and degrade the security of all those who deploy them.

Rather, my concern is that scientists meet their moral and ethical obligations to enhance the security of society and find ways to prevent and limit nuclear confrontation. The current environment in the US and India has made this very difficult. In the US and Europe, we have an extensive history of scientific participation in arms control and development of safeguards mechanisms through such instruments as Pugwash and meetings of Academy bodies. These interactions resulted in the atmospheric test ban, force reductions and similar initiatives and may be the avenue to the eventual disappearance of nuclear arsenals. Such are the fruits of free and open dialogue.

This past March, at the Centennial meeting of the American Physical Society, we organized an arms control forum chaired by W. K. H. 'Pief' Panofsky, which called on Indian, Pakistani, Israeli, Argentinian, Brazilian and American experts to define the issues confronting the world since the enlargement of the world nuclear club. Unfortunately, the Indian representative was denied permission by his institute director to attend this meeting (and join with 12,000 fellow physicists from all over the world in one of the greatest intellectual festivals ever organized).

So, while we are all outraged by limitations on our ability to freely travel and traffic in scientific ideas, we must also be outraged when we are obstructed from pursuing our moral obligation to make the world safe for those who follow.

We must all work very hard to assure that the international scientific enterprise is not damaged beyond repair. There need not be any worry about the resolve of colleagues in the United States.

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Beri principle

May I commend to the scientific community adoption of the following working principle, enunciated by fashion designer Ritu Beri: "I didn't want to show them (the West) 'See, I can do what you can do.' I wanted to say I'm different, and you should do what I do'. (Beri, R., Interview, *Express Newsline*, 1 August 1999).

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The ultimate goal of science

J. Chandrasekhar is being simplistic and maybe unfair to both theoreticians and experimentalists (*Curr. Sci.*, 1999, **76**, 1526–1528), when he says, in connection with the unusually short C=C bond length in 3-ethynylcyclopropene, that 'It is perhaps preferable to first identify which one of them is wrong and by how much in the present case'. In the present case, it is more likely that the theoretical and/or experimental studies of Boese/Haley/Siegel (Baldridge *et al.*, *Chem. Commun.*, 1998, 1137) and Schleyer/Schaefer (Wesolowski *et al.*, *Chem. Commun.*, 1999, 439) are merely inadequate to cope with the problem at hand.

At the outset, there is very little doubt that both studies are at the state-of-the-art level, and that no obvious errors have been committed in either case. Yet, the bond length discrepancy (0.041 Å) is quite large and this is what makes this case unusual, even exotic. It is therefore dangerous to assume as Wesolowski *et al.* seem to have done that simply because the value obtained by high level theory is 'normal', it must be correct. Again, suspecting the X-ray technique is unlikely to lead to a resolution of this dilemma. Chandrasekhar speaks of the 'needle of suspicion', while Schleyer/Schaefer are more daring and refer to the experimental work as a 'highly suspicious crystal structure', and that too in the title of their paper. Suspicion is warranted only in cases of wrongdoing, and is justified only when the accuser is fully confident as to what is 'right'.

Right and wrong are relative terms even in the cloisters of science, and it would be fairer to both experimentalists and theoreticians if one were to acknowledge that both groups of scientists attempt to extract what is 'right', using the methods available to them, and in the most rigorous ways possible. In rare cases like the present one, what is 'right' with one method appears to be 'wrong' when scrutinized with another. Eventually of course, one progresses a bit towards something that is 'more right' than what one has at present. But then, is not this the ultimate goal of science?

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Deep petroleum and the non-organic theory

The recent 'Research News' item published in *Current Science*, summarizing the discovery of hydrocarbons in Archaean rocks[1] rightly highlights the significance of this event. In this letter, I wish to point out that these developments find a natural explanation within the framework of a theory that had been reviewed in the same journal earlier[2].

The discovery of petroleum in source rocks of Archaean age was somewhat unexpected from the viewpoint of the classical organic theory. As per this model, petroleum is of organic origin, being the decomposed remains of plankton. Since life was not abundant in the early periods of the Earth's history, it was thought that there was very little petroleum produced in this manner. Moreover, this petroleum was considered unlikely to have survived the thermal stress which virtually all Pre-Cambrian sediments have undergone. Hence, little prospecting was undertaken in Archaean rocks.

This view persisted despite the discovery of a few Proterozoic oil fields in Oman, China and Siberia. The situation changed when recent work[3] uncovered the existence of oil in sandstone 3000 m.y. old from the Kaapvaal craton in South Africa and the Lake Superior craton in Canada. Source rocks in the form of hydrocarbon-bearing mudstones have been identified, making an organic origin possible. However, within the framework of the non-organic theory this development is entirely expected, for petroleum is seen here as primordial, representing ancient hydrocarbons incorporated into the Earth. It has thus existed since the early days of the Earth, and its occurrence in Archaean rocks is trivially expected in this model.

In recent years, evidence of hydrocarbons in asteroids and comets has continued to accumulate. In the non-organic framework, these petroliferous asteroids/comets are the progenitors of the Earths oil. Hence, the occurrence of primordial petroleum in large quantities is expected. In this light, the recent discoveries of hydrocarbon ice on objects in the Kuiper belt, a band of objects just beyond the orbit of Neptune, is an indication of the substantial amounts of extraterrestrial hydrocarbons[4].

In fact, with these large quantities of hydrocarbon having been dumped on the Earth during its formation, the question is reversed. If the petroleum on the Earth is entirely of an organic origin why has all this primordial hydrocarbon only been a silent spectator?

Although all investigators[1] considered these Archaean petroleum findings to be of ancient biological origin, a non-organic origin is equally plausible. Thus, the petroleum oil occurs in fluid inclusions lying within healed microfractures confined to individual quartz grains. This indicates that the oil was emplaced prior to Archaean metamorphism. This is consistent with the non-organic theory, with the oil being emplaced as a result of upwelling under pressure, with the creation of fractures and the emplacement of oil into the fractures. However, organic petroleum migrating upwards from deep source rocks also provides a plausible explanation.

The Australian occurrence in the Macarthur basin dates to 1400–1700 m.y.[5] coinciding with the appearance of the unicellular organisms called eukaryotes that, as per the organic theory, constitute the major source of oil. However, the discovery of petroleum much older, that is 3.0–2.75 b.y. old[3] pre-dates the origin of such organisms.

The discovery of deep bacteria at depths heretofore unsuspected[6] has come at the same time as the discovery of ancient petroleum. The organic theory views these as representing survivals of organisms entombed since Archaean times. In the non-organic theory, these bacteria were incorporated into the forming Earth, and are ascendng from the depths to the surface. Hence, the non-organic theory can explain most aspects of the recently-discovered Archaean petroleum as well as the deep bacteria as consistently as the organic theory can.

No wonder the non-organic theory is slowly gaining wider acceptance as an alternative to the organic theory. Robert O. Russell, a wellsite geologist at the first well in North America (at Fort McMurray, Alberta, Canada) drilled into crystalline basement granitic shield rocks for the express purpose of commercial hydrocarbon exploration, has pointed out that there are more than 400 wells and fields worldwide, both off-shore and on-shore that produce or have recently produced oil from igneous