attractive as models. In short, as the characteristics of our technology draw closer to those of nature's, nature may provide us with evermore guidance.

The histories of both science and technology are full of cases in which someone with an unusual background or outlook – an outsider – solved a long-standing problem by taking a fresh look at it. Perhaps the most potent outcome of a careful look at nature's technology is to provide an analogously fresh perspective on our own, to allow some useful distance from immediate problems, to bring into view possibilities that might otherwise escape our notice, to do something even more valuable than providing models for specific items that we might make.

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International interactions in science – The Indian experience*

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Historical perspective

Modern science is essentially European in origin although it owes a great deal to the contributions of earlier civilizations. Science in India, as it is being practised today, arose through contacts with the West[1]. We are aware of our ancient scientific traditions. But the scientific enterprise in modern India has no direct connection with those traditions. The main springs of those traditions had dried up or were in the process of drying up when Europeans, particularly the British, came to India with their commercial and colonial agenda. Of course, promoting education and science in India was not part of that agenda. But they used them to the extent necessary to promote their interests. It is not an accident that geological survey was the major scientific enterprise undertaken by the British authorities in India. Naturally, it was important to have an accurate picture of the land mass of this country to exploit it. The scientific survey of India which began in 1761 led to the establishment of the Geological Survey of India in 1951. India is a land of monsoon and the British established the India Meteorological Department in 1875. India is rich in plant resources and the exploitation of these resources was of considerable importance. Thus the Royal Botanical Garden at Calcutta was established in 1787 and the Botanical Survey of India in 1890. In the meantime, the

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Asiatic Society was established in 1784 at Calcutta and Archeological Survey of India came into being in 1861. Substantial progress was also made in setting up telegraphic and railway networks in the country.

Several institutions for scientific research and training also came up during the late 19th century and the early 20th century. Some of them, like the Indian Association for the Cultivation of Science, Calcutta, established by Mahendra Lal Sircar and the Indian Institute of Science, Bangalore, founded by Jamshedji Tata, resulted from enlightened Indian leadership.

When we discuss the impact of international interactions on Indian science in the present times, it is important to remember that modern science in India is essentially a product of international impact. Many of our well-established institutions are also modelled on western, particularly British, institutions. For example, the Indian Science Congress Association, established in 1914, is modelled on the British Association for the Advancement of Science. The functioning of the Indian National Science Academy in many ways parallels that of the Royal Society.

Serious scientific research, as we understand it today, started in India in the late 19th century. The first established scientists of the modern era in the country were Jagadish Chandra Bose and Prafulla Chandra Ray. They worked during the late 19th century and the early 20th century. J. C. Bose was a physicist. He made outstanding contributions in biology as well. P. C. Ray was a distinguished chemist. Bose and Ray were soon followed by C. V. Raman, the Nobel Laureate. Much of his contributions, including the work that led to the Nobel Prize, were done at Calcutta. Indeed, Calcutta was the cradle of Indian science. Subsequently, he continued his many-faceted researches at Bangalore. Raman was entirely self made and he had no foreign training whatsoever. He went abroad only after he was well-established. There were other giants as well in the first half of this century like Meghnad Saha, K. S. Krishnan and S. N. Bose. All of them were great patriots. They were well recognized internationally, but their moorings were undoubtedly in India.

Post-war, post-independence scenario

The nature of the scientific enterprise changed dramatically after the Second World War. Science and technology played an extremely important role in the prosecution of the war. The Governments and the public were impressed by what science could deliver. The couple of decades that followed the end of the Second World War were the heydays of science and scientists. The manner of doing science also changed dramatically. The days of big science had come; science became a highly organized enterprise based on expensive machinery. The Government support and, perhaps to a lesser extent, industry support became vital for doing science. Leading scientists became not only good researchers but also good managers of men and money.

This global change coincided with the dawn of Indian independence. India was blessed with Jawaharlal Nehru, a great visionary and man of action, as its first Prime Minister. He had a passion for science and promoted it vigorously with the involvement of eminent scientists and science managers like Bhabha and Bhatnagar. Chains of laboratories under various agencies were established across the country. A firm infrastructural basis for Indian science was laid in those days. The support for science progressively increased and enlightened political leadership encouraged scientific research. Science in turn directly or indirectly contributed to the development of the country. The green revolution is perhaps the most spectacular example of science in service of society. The establishment of the Department of Science and Technology was another landmark in the development of science in the country. The establishment of many other science departments followed. Despite its many drawbacks, Indian science had begun to become internationally competitive. This was the situation when globalization and liberalization were formally ushered-in in the early nineties.

It must be emphasized that well before globalization became a buzzword in the nineties, Indian science had already been globalized. In any case, science is a global enterprise. Most often scientific research does not make sense unless it is related to what is happening in the relevant area in the rest of the world. Of course, India was, and still is, far away from the centre of gravity of global scientific efforts. But Indian scientists have not been too isolated. International contacts have been very much part of the scientific effort. Almost all leading Indian scientists have worked at one time or the other in western laboratories. Performance in major laboratories in India has generally been assessed in the context of international efforts.

Avenues and modes of international interactions

At this stage, it is perhaps desirable to examine the avenues and modes of international interactions available to us and, indeed, to scientists all over the world. They can be broadly classified as follows:

1. Exposure to international science and training abroad.
2. Dissemination and exchange of information and ideas.
3. Formulation of policies and guidelines.
4. Use of large facilities.
5. Collaborative research.

Naturally these different types of interactions do not form water-tight compartments. There is substantial overlap among them. Different types of interactions are being pursued informally on a person-to-person basis and also within the framework of formal bilateral and multilateral arrangements. A plethora of such arrangements exists. They are handled by a large number of Government agencies and other organizations. To the best of my knowledge, a comprehensive compendium of such interactions is not readily available. Therefore, those arrangements which I refer to do not constitute an exhaustive list.

I think the element of international interactions which has the maximum impact on Indian science continues to be exposure to international science and training abroad. The centre of gravity of science continues to be in the West where mostly things happen. Therefore, although avenues for excellent research training exist in India in many areas of science, exposure of young scientists to good laboratories in advanced countries certainly has a beneficial effect on Indian science. This of course is a two-way street. Indian research students and post-doctoral fellows contribute substantially to the research effort of the western countries where they work. In fact, in the United States, if the Indian and the Chinese graduate students and post-doctoral fellows suddenly cease to be available, that would very seriously affect the edifice of American science. Therefore, it is a mutually satisfactory arrangement. If the brain drain is also taken into account, one might argue that the developed countries are benefited more than India is through the work of young scientists abroad. However, in general, some experience of working in a good laboratory abroad is an important component in the development of a young Indian scientist. There are several formal programmes for training abroad like the Boyscast Programme of the DST, Overseas Fellowship Programme of the DBT, Commonwealth Exhibition and Jawaharlal Nehru Fellowships tenable in Great Britain, the Humbolt Fellowship, the Fulbright Fellowship and so on. Many bilateral agreements also have a training component. But I think this element of international interactions is dominated by informal person to person arrangements. Most of the Indian post-doctoral fellows in the US and other western countries are hired by individual professors and scientists using their research grants. The effect of globalization in this area has not been very substantial.

The most important medium for dissemination of research results is undoubtedly publication in peer reviewed journals. This is not a formally organized activity as far as the contributors are concerned. It is an individual effort. Most of the important papers emanating from India continue to be published in foreign journals. Similarly, the most widely read scientific journals in India are of foreign origin and it is these journals that often set the tenor of research in the country.

The other avenues for exchange of information and ideas include visits by scientists, and national and international meetings. Many of these also take place on an individual initiative. But the proportion of visits and meetings under formal bilateral and multi-lateral arrangements is substantial. For example, the Indian National Science Academy has a vigorous programme of exchange visits with professional bodies in a large number of countries[2]. Such programmes are administered by other national bodies as well. Many bilateral agreements for scientific collaboration also have a strong component of exchange visits. The same is true about organization of symposia, seminars, etc. The role of ICSU in such modes of exchange of information and ideas, deserves special mention[3]. ICSU, established in 1931, is the acronym for the International Council of Scientific Unions. The full name has been changed in 1998 to the International Council for Science. But the acronym has been retained. Academies or other corresponding bodies of about 100 countries adhere to ICSU. Twenty-five International Scientific Unions are also members of ICSU (Box 1). Each Union has in turn a large number of national adhering bodies. ICSU is a multifaceted organization with enormous reach. Though non-governmental, it enjoys considerable prestige. Its role in exchange of

Box 1. Scientific union members of ICSU

International Union of Anthropological and Ethnological Sciences (IUAES)
International Astronomical Union (IAU)
International Union of Biochemistry and Molecular Biology (IUBMB)
International Union of Biological Sciences (IUBS)
International Union of Pure and Applied Biophysics (IUPAB)
International Brain Research Organization (IBRO)
International Union of Pure and Applied Chemistry (IUPAC)
International Union of Crystallography (IUCr)
International Union of Food Science and Technology (IUFoST)
International Union of Geodesy and Geophysics (IUGG)
International Geographical Union (IGU)
International Union of Geological Sciences (IUGS)
International Union of the History and Philosophy of Science (IUHPS)
International Union of Immunological Societies (IUIS)
International Mathematical Union (IMU)
International Union of Theoretical and Applied Mechanics (IUTAM)
International Union of Microbiological Societies (IUMS)
International Union of Nutritional Sciences (IUNS)
International Union of Pharmacology (IUPHAR)
International Union for Pure and Applied Physics (IUPAP)
International Union of Physiological Sciences (IUPS)
International Union of Psychological Science (IUPsyS)
Union Radio Scientifique International (URSI)
International Union of Soil Science (IUSS)
International Union of Toxicology (IUTOX)

information and ideas has indeed been very important. There are other international and regional organizations as well performing this role. In the Indian context, the Third World Academy of Sciences merits special mention. The International Centre for Theoretical Physics and associated organizations located at Trieste also have been playing a significant role in exchange of information and training[4].

ICSU plays a major role in the formulation of policies and guidelines as well. It concerns itself with all scientific and science-related problems and works in close association with other international organizations and intergovernmental bodies such as UNESCO. There are several other international organizations dealing with environment, biodiversity, IPR-related issues, atmosphere, atomic energy, space applications, etc. They have varying levels of Indian participation.

In most scientific investigations, in-house facilities are made use of. There are others in which large national facilities are used. There are some areas in which the instrumentation is so expensive that most countries cannot afford it. Astronomy, for example, is one such area. Indian astronomers use, for example, radio telescopes in USA and Australia. Hubble space telescope is another such major facility. Indian facilities are used by astronomers from abroad also. High energy physics is another area in which large facilities in other countries are made use of.

Now I come to the last component, namely collaborative research. International collaboration assumes different forms. There are large multi-national programmes dealing with global concerns such as the atmosphere, oceans, plate tectonics, etc. Then there are smaller collaborative projects under different formal bilateral Government-to-Government agreements. In addition, a great deal of international collaborative research takes place informally on a person-to-person basis. It is difficult to work out the ratio between the three different types of collaborative research activities. It has been shown that 14% of India's journal publications in 1991 was internationally co-authored[5]. Thus research involving international collaboration constitutes a small, but significant, segment of our overall research effort. It is not possible to readily work out from publications how many of these result from collaboration under formal arrangements and how many from informal contacts. Even at the Indian Institute of Science (IISc), Bangalore, which at present is involved in more than 300 sponsored research projects with an outlay of well over Rs 50 crores, formal collaborative projects account, in number and outlay, for only well below 10% of the total. Thus, a substantial proportion of international collaboration is likely to be based on informal person to person contacts.

India has strong bilateral scientific agreements with several countries[6]. These agreements involve training, dissemination and exchange of information and use of facilities. Interactions with the US have been fuelled primarily by the PL480 rupee funds and have involved a variety of scientific areas[7]. The Indo-German interactions involve a number of agencies in both the countries[8]. In addition to research projects, the award of Humboldt and DAAD Fellowships has been an important feature of these interactions. The Indo-French Centre for Promotion of Advanced Research (IFCPAR) has rendered commendable service in promoting scientific collaboration between France and India[9]. There are several avenues for scientific interaction between India and the UK. Much of the Indo-Russian collaborative endeavours has been carried out under the Integrated Long Term Programme (ILTP)[10]. Arrangements for scientific collaboration with the European Union exist. Another example of a bilateral programme is the India–Japan Cooperative Science Programme (IJCSP) under the aegis of the India–Japan Science Council. A number of arrangements with several other countries are also in operation.

Asymmetry in relationships

All the above arrangements and other avenues for international interactions of different types have been made use of by Indian scientists. In fact, the best of Indian science is reasonably well-integrated with international science. But still, in most instances, the pace is set by the West. The number of instances where we have led the world is still few and far between. As far as science is concerned, we are certainly a major presence in the Third World, but we are not counted among the world leaders. However, the quality of Indian scientists is well recognized the world over. Given a chance, Indian scientists have performed well.

Independent India could have certainly done better in science, but the overall performance has been reasonably good in the available situation. As all of us are aware, Indian scientists work under difficult circumstances in comparison to those in the West. In addition to the internal problems, still there is great psychological asymmetry in our relationship with the West. Neither they nor we have entirely gotten over the colonial hangover. India's share in scientific publications in the world is estimated to be about 2% which in itself is low[11,12]. But the impact of Indian publications, as measured by the number of times they are quoted by others, the so-called impact factor, is still lower. Admittedly this is partly because, on an average, the quality of our publications is somewhat lower than that of the western scientist. But that is not the whole story. There is a strong tendency in the West to ignore Third World contributions[13]. The same paper, submitted from India and the West, often receives different types of treatment.

This is not an entirely new phenomenon. This tendency always existed. Perhaps, a striking example of this attitude is provided by the story of the collagen structure discovered by G. N. Ramachandran, undoubtedly the most distinguished post-independent scientist of India. Collagen is an important complex biological macromolecule. Many distinguished scientists including Linus Pauling and Francis Crick have been working on it in the early fifties. But it turned out that essentially the correct structure was elucidated by Ramachandran and Kartha at Madras in 1953. Much of the West simply chose to ignore the importance of Ramachandran's contributions for a long time or shrouded it in controversies on small details. Such things still continue to happen, not necessarily always due to conscious decision, but through habit or differential visibility.

Conditions in different laboratories in India vary very widely. So does the calibre of Indian scientists. This is reflected in our international interactions as well. As far as our collaborative scientific interactions with the rest of the world is concerned, I think broadly they are of three types. There are collaborations in which we benefit more than the other party. There are collaborations in which both parties are nearly equally benefited. Then there are collaborations like those between the washerman and the donkey. You know who usually turns out to be the donkey. It is the last type that should be avoided. It demeans Indian science, it affects our morale and it does not bring benefits to the country except nick-nacks like an occasional free trip for the investigator to the West.

Green revolution – A spectacular example of international interactions

There are many good examples of fruitful international interactions. The research that led to the Green Revolution in the sixties and the seventies is one such. Of course, the Green Revolution involved very much more than international collaboration. It involved a dedicated and coordinated effort encompassing scientists, extension workers, political leadership, farmers and media[14]. However, international collaboration was a very crucial element in the whole process. A chief architect of this revolution, M. S. Swaminathan, is still active. In his youth he worked extensively in Holland, England and the United States. A world-renowned scientist, he always maintained a high level of international contacts. He is incidentally a man equally at ease among scientists, politicians and farmers, with a heart in the right place. The Green Revolution, like any other very major enterprise, has had some ill-effects as well. But it certainly was a water-shed in the history of modern India. We should also remember that we could assimilate and adapt scientific and technological inputs from abroad, only because we had a good scientific infrastructure. We need a good broad-based scientific infrastructure not only to develop our own science and technology, but also to make use of science and technology developed elsewhere.

Case study of a modest effort

International contacts constitute one of the life lines of science. But international collaboration is not necessarily always a desirable or necessary activity. There are certain areas of science and technology, such as some involving space, nuclear power and defence, where international collaboration is not available. Even in open areas of science where it is available, I believe international collaboration should be used judiciously. The development of macromolecular crystallography in the country provides a good example to illustrate the point that I wish to make. Macromolecular crystallography is the most important component of what in modern parlance is called structural biology. It is concerned with the structure determination of biological macromolecules such as proteins and nucleic acids using X-ray crystallography, and is an indispensable component of modern biology. A necessary, but not always sufficient, condition for understanding how a protein works, is a knowledge of its three-dimensional structure. Furthermore, macromolecular crystallography plays an important role in drug development, understanding pathogenesis and so on.

When our laboratory was identified for support by the DST in the early eighties under its Thrust Area Programme, our mandate was not only to develop a vibrant activity in macromolecular crystallography at Bangalore, but also to serve as a national nucleus for the development of the area in the country. In those days, each macromolecular crystallography project was a major undertaking. It called for a multi-disciplinary team, good funding, high technology, great perseverence and high intellectual inputs. We received considerable encouragement from many quarters. But, there were colleagues who were concerned whether we would be able to do it in India all by ourselves. We could have easily made arrangements to do part of the work in India and part of it abroad under collaborative arrangements. But we decided to do all of it in India. In situations which involve development of capability and, equally importantly, demonstration of capability, there is some merit in standing on our own feet, although it is the hard way to build up capability. That gives us great self-confidence. That enables us to build up strong traditions and schools. We felt that we should enter into international collaborations only when we are in a position to deal with our western counterparts on equal terms. Now of course that phase is over. There are now about a dozen macromolecular crystallography groups supported by DST, DBT and other agencies in different parts of India, a majority of them led by scientists trained at Bangalore, and we are reasonably internationally competitive. Several projects involving international collaboration are also in place.

I am not suggesting for a moment that the course we followed is the ideal one. It appeared, and I hope it proved to be, the correct course for the particular area of research in the given circumstances. All I wish to say is that international collaboration needs to be used judiciously. The balance of strength being what it is, it is all too easy for us to slip into a position of subordinate outstation members of strong research groups in advanced countries. That should be avoided. We should collaborate on equal terms. Collaboration should be on the basis of mutual benefit and equality. In the present state of the world, I believe that any national endeavour, economic, political or scientific, should have an element of standing up to the advanced countries. I do not mean that we should get into quarrels with them or be hostile to them. I myself have had the good fortune to learn the fundamentals of my area of research at the feet of a great English woman and have very dear friends and colleagues in different parts of the world. The personal and professional interactions with these friends and colleagues are very precious. What I mean is that we should strive to ensure that our interactions with the advanced world are on equal terms, particularly because we are still the underdog. In that sense, I believe that a measure of nationalism is a positive force in the present state of development of India.

Impact of globalization

We should first take note of the globalization that has taken place as a result of the scientific and technological revolution in communication. Internet and electronic communication in general have become an integral part of the scientific endeavour. The nature and the impact of this communication revolution have been discussed in such great detail in so many fora that I need not dwell on it here. We may however note that what was started as an intellectual adventure meant primarily for dissemination and exchange of information is in the process of being converted substantially into a commercial enterprise.

The past decade has been the decade of globalization and liberalization. The move towards globalization gathered tremendous momentum after the collapse of the Soviet Union and the East European socialist states. It has almost become the official ideology of the unipolar world. On the face of it, globalization and liberalization, in the literal meaning of the terms, are unexceptionable. But as an ideology, as it is advocated now, they involve the recognition of the global market place as the final arbiter of everything. I do not wish to discuss globalization *per se* as that would involve digressing too much from the topic of this talk. I shall confine myself to its impact on science and science-related issues with particular reference to India.

In India globalization and liberalization became the official government policy in the early nineties. Its most visible impact was the drastic reduction in the government support for science. From the time of independence till the late eighties, the support for science steadily increased in India. In the eighties the R&D expenditure in the country climbed to about 1.2% of the GNP. The dawn of the era of globalization and liberalization marked the reversal of this trend. The R&D expenditure in India now hovers around 0.8% of the GNP. There was a perceptible attitudinal change as well, which manifested in several small and big ways. The then prevalent compact between science and society appeared to have been breached. The most strident advice that scientists and scientific institutions heard from the Government at the onset of globalization and liberalization was to make money at the market place from private sources. At the same time, there was no let up in the bureaucratic government control of scientific institutions. If at all, the controls became more stringent. Thus it appeared that science and scientists were expected to swim in the ocean of the market with their hands tied behind them. The advocacy of the so-called globalization and liberalization of science has now become less strident, but there appears to be no evidence for a drastic change in the general approach.

Globalization has in effect meant, to a substantial extent, following the West, if not imitating it. In this context, there is a misconception that government support for science in the advanced countries is small. Industrial research sponsored by private companies does form a substantial component of the total research activity. However, the main support for basic scientific research is provided by the state. In fact, of late, the support for science in the advanced countries has increased substantially[15–18]. In some sectors, like the university sector, they are actually concerned about the growing industrial component of the total budget. In terms of real amounts and as a proportion of the GNP, the government funding for science in the advanced countries is much higher than that in India. We do need private industrial funding for research. It has to increase substantially from the present level. But it should be in addition to, and not instead of, government support. Both government support and industry support have to increase substantially. A firm scientific base is essential for development. Tampering with it through inadequate support on the basis of erroneously perceived notions on what happens in the West, is a sure prescription for disaster. Ultimately, science is the responsibility of society and science is responsible to society[19].

Globalization has also brought about an extremely commercial approach to science. As a western colleague remarked at the recent Glasgow IUCr Congress, science is no longer part of culture, it is part of commerce. Secrecy is a basic component of the commercial approach. On the contrary, secrecy is alien to science. It is through free exchange of information and ideas that major developments have taken place. What a scientist likes to do most is to talk to peers about one's own results. In fact, many leading thinkers and scientists are beginning to get worried about the long-term implications of secrecy in science. Had there been so much secrecy dictated by commercial interests in the last few decades during the growth phase of molecular biology and structural biology, modern biotechnology, as it exists today, would not have come into being. Undue secrecy in scientific enterprise amounts to jettisoning a bright future for the present narrow commercial interests. In any case, as most of the major scientific contributions emanate from advanced countries, inadequate access to the information resulting from them is deleterious to the Indian and Third World cause.

Another issue which has assumed considerable importance in recent years is the Intellectual Property Rights regime. The concept of intellectual property is of course a very complex one. The creation of new knowledge is always on the basis of the existing knowledge accumulated over centuries. Therefore, it is often difficult to fix the absolute value of new knowledge. On the other hand, creation of new knowledge or a product like a drug often involves enormous investment. Expectation of just returns on the investment is justifiable. And there are unconventional forms of intellectual property like that involved in indigenous or tribal medicine. Of course, the question of intellectual property is not an academic question. It is a practical problem of enormous consequences. Undoubtedly, a substantial component of the global intellectual property regime is directed towards domination of the weak by the strong. While resisting it, we cannot ignore the ground realities. There is no way we can opt out of the system. The new IPR regime is a complex basket involving Trade Related Intellectual Property Rights (TRIPS), Convention of Biological Diversity (CBD) and so on. I have no special expertise in this area, but it is clear that there are dangers as well as opportunities in the system[20]. We should try to skirt the dangers and make use of the opportunities. We have to learn the rules of the rich man's game and play it. All the same, we should be constantly aware of the predatory nature of much of the regime and combat it. We have to strengthen ourselves and we have to be versatile.

Lessons from the west – positive and negative

As is well known and as I mentioned at the beginning, modern science is western in origin and the centre of gravity of science still lies in the West. In addition to new developments in science in the West, there is much that we can learn on the conduct of science from the West. For example, science in the West is relatively free of unnecessary bureaucratic control. Just the opposite is the situation in India. I believe that a major impediment in the progress of science in India is the bureaucratic stranglehold on it. This stranglehold, if anything, has only become tighter in the years of globalization and liberalization. Secondly, in most of the advanced countries, the expenditure on R&D is around 2% of the GNP or more. In India, it is much less than 1%. Furthermore, much of the provision is taken up by Defence, Atomic Energy and Space. What is left for other agencies is very little. The life line of the scientific effort is competitive research supported by funding agencies. The total amount available for the funding of such competitive research by all agencies put together is around Rs 200 crores per year or less. This is a ridiculously small amount. Even an increase by Rs 100 crores on this account will make a perceptible difference to Indian science. There are also other aspects of the conduct of science in which we can learn much from the West. The Indian scientific establishment is very hierarchical and we revere authority. People often perceive those occupying high administrative positions in the scientific establishment as scientists and real scientists remain unknown. Strong hierarchy does not serve free thought and expression, so important for the growth of science. Western science is substantially free from hierarchy and we can emulate them with profit in this respect. We have also much to learn from their professionalism and ability to work together.

We should also avoid some of the undesirable traits of modern western science. There is too much of competition and unnecessary duplication of effort which is wasteful. We cannot afford to follow this path. For work within India, the accent should be on cooperation than on competition. There is again much hype in western science which we can do without. In certain areas, excessive commercialization also has had its bad effects. This is again a matter on which we need to be careful.

We can learn science from the advanced countries, we can adopt the good aspects of western science and reject the bad aspects, but we have to set our own agenda, choose our own problems and conduct science in a way that is suitable to our conditions. Excessive dependence on the West for ideas and inspiration does not serve the cause of Indian science. We should develop our own strong scientific traditions and capabilities. We should have strong international interactions. We should certainly collaborate with scientists abroad, but should do so on equal terms. Strength recognizes and respects strength. Strength in science can be built up only through conscious effort.

Search for an alternative paradigm

Science, like any other human activity, has an economic and social context. The context of present-day western science is a developmental paradigm based on consumerism. Globalization to some extent involves the adoption of this paradigm. But it is easy to see that if the Indians and the Chinese begin to consume as much as the Americans do, the world could become uninhabitable in a short time. A universal consumerist society is unsustainable. As Mahatma Gandhi has remarked, the earth has enough for everybody's need but not for everybody's greed. The consumerist paradigm almost inevitably implies a rich few and a poor many. That is what appears to have happened during the current period of globalization and liberalization. The gap between the rich countries and the poor countries has widened. And within the country the rich have become richer and the poor have become poorer. Such a situation cannot be stable. Therefore, while striving to strengthen our science and technology within the existing framework, we should also seek to evolve a new paradigm of development, which is just, equitable and sustainable and which should encompass a new framework for the pursuit of science and technology.

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