

The Scientific Enterprise

11. Science in the Modern Indian Context

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Brief Note on Science History

When we look at the heavens on a clear moonlit night, the twinkling stars and the silvery moon seem to be staring at us. It is no less exciting to reflect upon the fact that millennia ago, in China and India, in Babylon and Africa and in ancient Greece, human beings like ourselves gazed at those same stars and wondered about them also. The same human spirit, encased in different frames, scanned the same skies and made similar efforts to understand what it was all about. It is the elaboration of this realization that constitutes the history of science.

Like all history, the history of science is an exploration into past events and accomplishments. Science in various forms and shapes found expression and developed in a hundred ways in different cultures at different times. Therefore, it is impossible to dissociate this study from specific peoples and periods. This is inevitable in the context of ancient times when there was far less communication and collaboration among various peoples and cultures, and the scientific enterprise grew in different ways in different regions of the world.

The history of science is a recapturing of the glories and blunders of our ancestors. But, unlike most other histories, it transcends, or ought to transcend, national boundaries. At least in its more universal aspects, it searches for the trials and triumphs of the human spirit, rather than for national pride and cultural commendations, though this latter urges often takes over.

Human beings have been able to develop science because of certain intrinsic capacities that they have as a biological species. One of these is the capacity for wonderment. Most children have it, and scientists may be looked upon as adults who have nourished and developed this capacity. Another important power of the human mind is abstraction. It is important to be able to conceptualize and think in abstract terms in order to do science. Then again, to do science one should be able to communicate. This, in turn, is related to the development of sophisticated language and other means of communication. Finally, there is the human capacity to doubt, which is the ability (or propensity) to question any answer and probe beyond what seems to be superficially true.

The ancients offered a variety of explanations for natural phenomena and for the origin of the world. Sometimes these explanations were in terms of superior and invisible beings which caused things to happen. Sometimes they were in terms of non-anthropomorphic forces and



principles. Human beings have also been trying to harness matter and motion, water and fire, for their convenience and betterment. This is what technology is all about. The two, namely understanding and explanation on the one hand (science), and the contrivance of useful devices and techniques (technology) on the other, have existed since time immemorial, though they were often unrelated in ancient times.

A study of the history of science reveals that the scientific spirit has been there in all cultures and peoples, but its expression and successful exploitation have varied in quantity and quality from people to people, and from epoch to epoch. Indeed, there is reason to believe that all the capacities for science are fairly universally distributed in the human family. Hence the potential for science is there everywhere.

However, material and cultural conditions foster or curb the expression of these capacities. This is one important reason for the non-uniform growth of science in time and in place among the peoples of the world.

The Indian Context

India has a rich and ancient history. Over the ages thinkers in India have grappled with some of the most difficult questions that intrigue the human spirit. Keen Indian minds explored questions relating to the origin of the world and the why of human existence to the nature of human thought and consciousness and the uneven distribution of good and ill fortune in the world. Their answers to some of these questions formed a meaningful and ever expanding framework for Indic civilization. Sure, some of the elements in this framework need to be modified and fine-tuned to bring them in harmony with the modern world, but it would be unfortunate if they are erased or replaced altogether from the collective Indian memory.

In the eighteenth and nineteenth centuries scholarship (initiated in Europe) began to probe systematically into the scientific dimensions of Indic culture. Such studies had considerable cultural bias when they began, but they have grown in scope and content from the labors of Indian scholars. They reveal that since ancient times, investigators in India also probed the physical world and developed complex technologies. From ayurveda and alchemy to metallurgy and craftsmanship Indian ingenuity found expression in myriad ingenious ways. Ancient Indian astronomers charted the skies and predicted planetary periodicities, and arrived at important mathematical results. They innovated the insightful mathematical concept of zero. The discoveries of some classical Hindu mathematicians were of the highest order. (See, for example, G G Joseph, *The crest of the peacock*, Princeton University Press, Princeton NJ, 2000). Nor should it be forgotten that India was economically and industrially quite advanced in the era prior to British colonialism. (See, for example Dharampal's *Indian Science and*



Technology in the Eighteenth Century, Other India Press, 2000). Or again, in some practical fields such as plastic surgery and inoculation, India was far ahead of Europe at one time. (See, for example, Claude Alvares, *Decolonizing History: Technology and Culture in India, China and the West 1492 to the Present Day*, Apex Press, 1991.)

So we remember our Aryabhatas and Bhaskaras, our Shushrutas and Charakas, and the many more who shine in the firmament of classical Indian science. A good many scientists in India, and of Indian origin elsewhere, have become international scientists who continue to expand human knowledge in important ways. It is appropriate that we take note of them, we name buildings after them, and commemorate them in different ways. We must remind our school children of the achievements of Indian scientists, both ancient and modern, so that they come to understand India's scientific legacy as well. (See, in this context, V V Raman, *Glimpses of India Science and Scientists*, Samvad India Foundation, New Delhi, 2006.) In the words of Kenneth Patton, "It is not easy to give thanks to five hundred generations, from whom we have received our customs and our arts, our laws and our learning and our civility."

Ancient Creativity and Modern Science

Indic creativity was as much in poetry and literature as in concrete sciences and meticulous ritual practices. In our epics and puranas, Indian thinkers articulated astounding and far-reaching ideas as to what is possible in the physical world. They spoke of flying machines and long-range missiles, of teleportation and weapons of mass destruction, of organ transplants and long distance seeing, and more. Other ancient mythologies, notably Greek and Roman, narrate similar stories as well. Like modern Greeks and Romans, Babylonians and Chinese, the people of India can be justly proud of the legacy of their ancestors.

It is not uncommon for human history to witness the rise and fall of civilizations, and (as we now witness) the resurgence of some of these. So there came a time when Indian scientific and technological creativity faded (as happened in Egypt and Greece and Rome and China). Then it was Western Europe's turn. It was in Western Europe that modern science first emerged, though it took inspiration from the legacies of more ancient cultures. In a span of four and odd centuries, modern science has made some of the most remarkable breakthroughs, extending human knowledge to realms never before imagined. It has made humanity aware of aspects of the physical universe of which no culture or civilization had any inkling before, such as invisible gases and radiation, spiral galaxies and star clusters, protozoa and genes and more. Universal physical laws, the quantitative features of the world, invisible microorganisms and intangible entities, chemical elements and evolving species: all these are just a few of the countless significant new knowledge that modern science has brought to light, let alone the fantastic insights and technologies that have resulted from them.



In due course this modern science of Western vintage swept the world like a global religion, as it were, drawing in its fold people from every region, race, and religion from every nation in the world. In so far as it conjures up a totally different and independent worldview, science does resemble religions. Those who enter into the precincts of modern science are fascinated by its enormously fruitful methodology. So, the first Indian initiates into modern science were so enriched by its modes that they soon became active participants in this enterprise. The power and prestige of modern science arises from its extraordinary successes in various domains of intellectual inquiry, and its uniqueness lies in its universality. In no other field of human endeavor, not in art or in music, not in religion or in politics, not in literature, sports or philosophy, do people from virtually every part of the world come together as comrades in a common undertaking to unscramble the complexities of the physical, astronomical, biological, and psychological world.

Errors in the Appraisal of Science

Ancient science emerged in different lands in different cultures. It grew from the efforts of men and women of ages long past, speaking different languages, forging and living with worldviews which were very different from our own. Their legacies are to be found in the relics and documents and books which have been unearthed and interpreted by modern historians, scholars, and archaeologists.

In the appraisal of science, we are apt to fall victims to three kinds of errors which I will describe as *temporal*, *cultural*, and *nostalgic* errors.

Temporal error lies in the impression that our generation is intrinsically superior because it has more science. This error arises from the awareness of the many positive achievements of our own times, but it ignores the fact that we are equipped with considerably more knowledge and information in our exploration of the world. It does not follow from this that we are in any way superior to our ancestors. Temporal error was common among some European thinkers during the seventeenth century, soon after the emergence of modern science. Francis Bacon, for example, had the utmost contempt for the scientific prejudices of Aristotle who had great influence on Western thought for 2000 years. He regarded the ancients as children and immature, and stated that medieval thinkers had been wasting their time with what he called “the borrowed light” from Aristotle. René Descartes, one of the founders of modern science, also held the view that there was little to be gained from a study of the ancients who had been consistently wrong on all questions.

On the other hand, there are still many people all over the world who, in spite of the advances that humanity has made in the field of science, are unwilling or unable to let go of their ancient



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ancestral worldviews. This would suggest that intelligence-wise the people of our times are not necessarily better-off than people of the distant past. Some thinkers in India hold the view that modern science is essentially Western, and that India should develop her own science based on (or salvaged from) ancient philosophical systems.

Cultural error attributes the *capacity for enlightened thought* only to particular cultures. There were periods in history when the Chinese thought they alone did science, Hindus thought likewise of themselves, as did the Greeks and the Arabs in their turn. Not so long ago, it was a firm belief of some European thinkers that science was essentially a Western capability, and that even if it has roots in the past in other cultures, Non-Western peoples are intrinsically incapable of rational analysis. This view is shared, explicitly or implicitly, by some scientists and commentators who refer to modern science as Western science. Narrower expressions of such views have existed within the confines of Western culture: some have maintained that clear thinking is an essentially French trait; others that the empirical skill, so essential for science, is characteristically British; yet others have argued that true science requires the keen mind of the Aryan (Germanic) race.

We are fortunate that for the most part many (at least practicing scientists) in the twenty-first century have grown up and freed themselves from such narrowness. But we should not forget that barely seventy years ago (in the 1930s), some three hundred years after the rise of modern science, many people in Nazi Germany preached and accepted a preposterous and malicious thesis to the effect that some scientific theories were false because they had been proposed by members of the Jewish race. In recent decades variants of this chauvinistic arrogance has been emerging among self-glorifying cultural patriots in many groups all over the world.

The third type of error, which I have called nostalgic, is of more recent vintage. It involves the conviction that the ancients of one's own tradition were well aware of the most recent findings of science. It is based on the belief that the holy books of one's religion embody truths revealed by higher powers to extraordinary individuals who have thus come to know about the subtlest results of the latest science. Defenders of such views from practically every religious tradition have come up with interesting arguments which sound very convincing to members of their own group.

All these errors persist in various forms and to various degrees because they add to the emotional satisfaction of those who entertain them. It should be noted that while cultural error is plain wrong and hurtful, temporal error encourages new explorations, and nostalgic error tends to impede the growth of science within a culture.



Context of the Development of Modern Science, and Consequences

Modern science emerged and developed during a period when some Western nations were becoming politically aggressive and economically exploitative vis-à-vis many peoples of the world. It may be recalled that Arab science emerged and developed under similar circumstances of Islamic imperialism and global expansionism. But since that was a thousand years ago, one seldom talks about it in the context of today's Western hegemony. But the hurt that European colonialism inflicted on the Non-West engendered a rancor that lingers on to this day, decades after Western powers were booted out of Non-Western soil, including India. An aftermath of British domination of India is that negative impressions of science have been formed in the psyche of many people, and these are being reinforced by a number of modern writers.

This has had two rather contrasting consequences. Given that so much science was created by the West, and that one was now persuaded to accept that science (ignore modern science and technology, and society can be catapulted back to a primitive phase), a feeling was generated to the effect that the West was intrinsically superior. To counteract this, there was the urge to claim that whatever the West had discovered had been there in ancient Non-Western science also, often clothed in a different garb. This belief has led to a vast body of an imaginative, if questionable, genre of writing whose goal is to show that the results of modern science, from gravitation and thermodynamics to genetics and quantum mechanics were latent in ancient Sanskrit aphorisms, in the Torah and in the Holy Qur'an.

In the case of India, even some creations of modern technology were believed to have existed in ancient India, for which proof is provided by referring to puranic literature. This perspective was inspired by some nineteenth century religious leaders in their commendable and contextually relevant effort to infuse the overwhelmed Hindu heart with the self-respect and dignity that was being eroded by the raw material power of the intruder. This was understandable, indeed essential, and it did serve a positive purpose. But it has no place in today's world where India is a free and great nation in its own right, equal to any and surpassing many in good many areas. If anything, such claims do disservice to the legitimate contributions of ancient Indians, besides provoking amusement in those familiar with what modern science is all about.

Another reaction to Western dominance in science has been to embrace and extrapolate the thesis of Western post-modernists to the effect that modern science is just a social construct, and has no intrinsic ontological validity. In one version of this view, science is merely a scheme concocted by Western Man to gain control over the rest of humanity. This thesis would imply that Kepler racked his brain about the orbit of Mars, Newton proposed his theory of gravitation, the French Academy of Science sent expeditions to the equator and the poles to determine if the



Earth was flattened in one region or the other, that Faraday investigated electromagnetism and Le Verrier calculated the possible position of Neptune, so that the West could spread its imperialist wings all over the world. This is more paranoid thinking than historical insight.

In another postmodernist view, science is just one mode, among many, for understanding reality. There are, in fact, other equally valid ways of apprehending the physical world, such as Hindu spirituality and nature poetry. In the free-for-all of internet exchanges and free-flowing essays, inspired again by Western models, there are now vigorous discussions on God and Science, Brahman and quantum mechanics, Vaishnava epistemology and big-bang cosmology, and such. These can be useful in analyzing and refining the bases of our theological framework. Many Hindu thinkers also take inspiration from Western authors who publish books explaining that the icon of Nataraja symbolizes the creation and annihilation of leptons and hadrons, and that Vedic astrology is as much science as modern astronomy. It may be good to recognize all interpretations and perspectives, but it would be risky to subscribe to the view that all sciences are equally valid, that geomancy¹ and numerology, jyotisha and phlogiston deserve the same knowledge status as geology and electromagnetic theory, astrophysics and quantum electrodynamics.

Categorical Distinction

It is important to distinguish between wisdom, insight, and common sense on the one hand and science on the other. That there are multiple paths to spiritual fulfillment, as enunciated in an oft-quoted Vedic aphorism (*ekam sat viprâh bahudâ vadanti* – Rg Veda: 1.164.46), is doctrinal wisdom; that there are six quarks and six leptons, as stated in the Standard Model, is science. That it is impossible to grasp anything intellectually unless there is an interaction between the human mind and the entity grasped, as revealed in Vedanta, is deep insight; but that in the process of observation the position or momentum of an elementary particle will be affected per well-defined mathematical constraints, as stated by Werner Heisenberg, is science. That all bodies thrown upwards fall back to the ground, as recognized by many ancients, is common sense and that this happens because of their intrinsic quality (*svabhâva*), as stated by some ancient Hindu thinkers, is an interesting idea; that every mass in the universe exerts an attractive force towards itself on every other mass as per the inverse square law, as formulated by Isaac Newton, is science.

Confounding one for the other may boost one's ego, but it does justice neither to the past nor to the present. Wisdom, deep insights, and intuitive grasp come from the minds of keen thinkers and spiritual disciplines. The results of modern science have arisen from meticulous observations, mounds of carefully collected data, precise measuring devices, carefully constructed

¹ It refers to the ancient pseudo-science (practiced in China) of predicting things by observing places on Earth.



concepts, coherent theories, sophisticated mathematics, criticisms from peers, and other such factors that were simply not present in ancient scientific efforts. The results of modern science have not arisen from the utterances of revered authorities, nor do they rely on sacred texts. They are periodically subjected to revision, re-formulation, or even rejection. To cling to ancient visions in the context of science or to justify them in the framework and jargon of modern science is unwarranted and futile.

Introduction of Modern Science in India

When modern science was introduced into India via the universities founded by the British in Calcutta, Bombay, and Madras (as these cities used to be called) a number of Indians quickly acquired and embraced that science. Soon they became experts in various fields, just as medieval West adopted India's decimal system of numeration and as many in the modern West are accepting and mastering yoga and meditation which are enriching offerings of India to the world for a healthy, sane, and awakened life. In due course, Indian scientists began to make significant discoveries in international (modern) science. Thus, in less than a century the world of physics was studded with terms like Bose-Einstein statistics, Saha equation, Ramanujan's theorems, Raman effect, boson, Harish-Chandra homomorphism, Chandrasekhar limit, etc. The scientists associated with these terms and their many followers in India today did not differentiate between Western science and Indian science in the modern context any more than their Chinese, Korean, Japanese and other Non-Western colleagues did. When it comes to physics, Lee and Madame Wu, Sudarshan and Weinberg, Salam and Yukawa, all belong to the same species. The illustrious pioneers of modern science in the India of the first half of the twentieth century would be writhing in pain if they read some of the proclamations on science that are made by non-practitioners on science in modern India.

Most current Indian scientists seem to prefer to be silent on these issues. Aside from the fact that many of them would rather spend their time doing real science, one reason for this could be that proponents of no-nonsense views on science become targets of ad hominem attacks to the effect that they are brain-washed Macaulayites, that they are lackeys of the West, that they have no respect for their own culture, etc. It is of little consolation to know that similar pejorative epithets are and have been attributed to advocates of modern science in other cultural and religious traditions as well, especially Christian and Islamic.

Outlook for the Future

Fortunately for India, thanks largely to her early leaders like Pundit Jawaharlal Nehru and Meghnad Saha, modern science was given tremendous moral, financial, and governmental boost in independent India. As a result, science education has made significant strides here.



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Countless scientists have been groomed in Indian universities and national laboratories. It is a great blessing that modern sciences flourish in India. Thanks to modern universities, India is producing large numbers of engineers and doctors, technologists and mathematicians, many of whom have moved into the world arena where they make their mark in industries, places of learning and laboratories. Some day, perhaps, every town and village in India will have not only a library, but a mini-science center with a small telescope and microscopes, star charts and pictures of galaxies to initiate the common people into the worldviews of modern science, along with large size pictures of eminent Indian scientists to inspire the people. The establishment of such centres could well be a project for the Indian Academy of Sciences which, with proper funding from the government as well as prospering Indian industrialists all over the world, could also employ science graduates to man them.

There is little doubt that the cultural richness of India, as manifested in abundant art and poetry, in sculpture and philosophy, in music and movies will continue to grow unhindered in the decades and centuries to come. We may also hope that with greater scientific awakening and spread of general scientific knowledge, enlightened worldviews will seep into the minds of the populace and eventually dissipate the darkness and distortions of anachronistic worldviews, which range from mythical interpretations of eclipses to the belief that the gods can be appeased by slaughtering animals at a temple altars, let alone the birth-based hierarchical social strata that continues to disfigure the fair face of modern India.

Today, Indian scientists are playing a major role in the development of the country and are serving the nation more meaningfully than intellectuals who argue in their e-mail posts for a Hindu science or insist that our ancestors knew all about gluons and galaxies. With their stupendous manpower and enormously rich heritage we may hope that in due course many Indian thinkers will shake off their chauvinistic shackles, and that India will become a leading nation in the field of science also, even as she is inching towards preeminence in the fields of economics, industry, and international politics.

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