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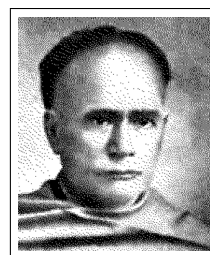
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Attacks on Our Higher Educational Institutions

Academics and well-meaning people in India and around the world were shocked to see the recent attacks on the democratically protesting students of the leading universities of India, like the Jawaharlal Nehru University (JNU), Jamia Milia Islamia University and Aligarh Muslim University. The students of JNU were peacefully protesting against fees hike when they were brutally attacked by masked people wielding iron rods, wooden clubs and stones. Even the teachers who tried to protect the students were severely attacked. The police who were present in the University premises did not intervene to protect the attacked students and staff. In the other two incidents, police entered Jamia Milia Islamia University and Aligarh Muslim University campuses and pounced upon the students who were democratically protesting against the new citizenship law, which is discriminatory and against the secular ethos of our constitution. These incidents have bought widespread condemnation from across the globe as reflected in the article titled 'Protect India's Universities' published in the 16th January 2020 edition of the journal 'Nature'.

Campuses are places where students not only study but also get exposed to various societal issues—national as well as international, take a stand, and get to voice their opinions. Students were always in the forefront of social movements that brought radical changes in society. Responding to the call of Gandhiji, they played an active role in the civil disobedience movement during our freedom struggle. Students played decisive roles in many progressive movements across the world like the anti-apartheid movement in Africa, the French

uprising of the 1960s and the Arab Spring uprisings that saw the end of autocratic rule in Egypt and other countries. The Global Climate Strike of September 2019, a movement to protect our Earth, was spearheaded by an organization of students called 'Fridays for Future' initiated by a school student, Greta Thunberg. Students shall be allowed to play their role in the progress of the society and their voice shall not be suppressed by force.

It is essential to maintain a democratic atmosphere in the campuses to allow dissent and debate and to develop a questioning mindset among students, a prerequisite for learning science and advancing scientific knowledge through research, which are directly linked to the progress of society. History has shown that education, research, science, and scientific temper cannot flourish in a society where the freedom of expression is curtailed and the atmosphere is vitiated by fear and hatred.

Our universities and other higher education institutions are facing many serious problems primarily caused by the inadequate fund allocation by the government. Instead of addressing such issues and developing them as advanced centres of teaching, learning and research, the government is interfering in their internal affairs, subverting autonomy, fanning communalism and casteism, spreading fear and hatred, thereby destroying the academic atmosphere in these institutions. It is sad that the centres of scientific, secular and democratic education envisioned by the stalwarts like Ishwar Chandra Vidyasagar and many other leaders of Indian renaissance are being systematically destroyed.

We appeal to the people especially the academic community to stand united to protect the democratic atmosphere in our educational and research institutions. □

Vidyasagar and Scientific Education

Dhrubajyoti Mukhopadhyay*

Nineteenth century Bengal was a society in transition. Thousands of years old feudal political system was replaced by the British colonial rule. The Hindu society, which was groaning under the shackles of outmoded religious injunctions, superstitions, caste oppressions and vile social practices was yearning for deliverance. The British put in place a rapacious exploitative system, but at the same time through them, like a breath of fresh wind, wafted the liberal democratic thoughts of the European Renaissance, the ideals of liberty, equality, and fraternity. The sharp contradiction between the conservatives committed to hold on to the old system and those aspiring to bring in a new society with new ideals was churning the social system.

The harbinger of the new dawn was Raja Rammohan Roy. He devoted his life in the struggle to reform the Hindu religion and make it more humane and syncretic, to eradicate inhuman social practices like the *Sati*, and to usher in a scientific, modern education system.

In pre-British India elementary education was imparted to the children in the pathshalas where the lessons consisted of elementary Bengali and only simple arithmetic necessary for daily life. The Hindu pupils could go to *tols* and *chatuspathis* for higher learning where lessons were given in Sanskrit grammar and literature, theology, logic and metaphysics, but only the upper

castes had access to such an education. Muslims could go to Madrasas for training in Arabic and Persian. After the advent of the British and the consolidation of colonial rule, the well-to-do Indians, mostly traders, businessmen and landowners were increasingly feeling the necessity of learning English to deal with the British community. The British rulers also wanted, in their own administrative interest, to set up an education system for the Indians.

From the beginning there was a great controversy on what should be the nature of this education. 'Orientalists' were all for exclusive pursuit of oriental studies, while the 'Anglicists'—Rammohan was one of them—wanted modern English education. In 1817 the Anglicists established the Hindu College to impart instruction in English literature, modern science and philosophy. However, the Government was favourable to the orientalist view and in 1823 announced the decision to establish the Sanskrit College under Hindu Pundits in Calcutta. This invited a sharp reaction from Rammohan, expressed in the celebrated letter to Lord Amherst, the then Governor-General of India. In the letter he expressed profound regret that the Government was proposing to establish a Sanskrit College "to impart such knowledge as is current in India. This seminary (similar in character to those which existed in Europe before the time of Lord Bacon) can only be expected to load the minds of youth with grammatical niceties and metaphysical distinctions of little or no practical use

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to possessors or to society. The pupils will there acquire what was known two thousand years ago, with the addition of vain and empty subtleties since produced by speculative men."

He continued, "I beg leave to state ... that if the plan now adopted be followed, it will completely defeat the object proposed; since no improvement can be expected from inducing young men to consume a dozen years of the most valuable period of their lives in acquiring the niceties of *Byakarun* or Sanskrit grammar ... Neither can much improvement arise from such speculations as the following, which are the themes suggested by the Vedanta — in what manner is the soul absorbed in the Deity? What relation does it bear to the Divine Essence? Nor will youths be fitted to be better members of society by the Vedantic doctrines which teach them to believe that all visible things have no real existence, that as father, brother &c., have no actual entity they consequently deserve no real affection, and therefore the sooner we escape from them and leave the world the better."

He wrote, "If it had been intended to keep the British nation in ignorance of real knowledge, the Baconian philosophy would not have been allowed to displace the system of the schoolmen which was the best calculated to perpetuate ignorance. In the same manner the Sanskrit system of education would be the best calculated to keep this country in darkness."

What he wanted instead was, "a more liberal and enlightened system of instruction, embracing mathematics, natural philosophy, chemistry, anatomy, with other useful sciences."

But in spite of his appreciation of the Baconian scientific philosophy Rammohan could not free himself from spiritualism. He had deep attraction towards Vedantic

philosophy. On the one hand he advocated a scientific outlook about the world around us, and on the other hand he tried to establish the superiority of the Indian monotheistic tradition and took the help of Vedanta for this purpose. He wanted to reform the Hindu religion and founded the *Brahmo* religion.

Vidyasagar: a secular humanist

After the pioneering efforts of Rammohan came Iswarchandra Vidyasagar, one of the brightest stars in the firmament of the Indian Renaissance. With his agnostic philosophical outlook, militant secular humanism, strength of character, personality, strong sense of individuality and unbounded love for humanity, Vidyasagar can be placed alongside the giants of the European Renaissance. He carried the uncompromising secular humanist thoughts of the Renaissance and in this sense represents a break from Rammohan.

The common public perception of Vidyasagar is that he was a great Sanskrit scholar, an erudite pundit well versed in the scriptures, a kind and compassionate, charitable philanthropist. He was all of these, but more than anything else he was a spirited secular humanist. As Rabindranath remarked, "Neither compassion, nor erudition, the crowning glory of Iswarchandra Vidyasagar's character was his indomitable manhood, his enduring humanity."

In his outward way of life Vidyasagar was thoroughly Indian, but he absorbed the real essence of the Renaissance, and was absolutely modern in his thinking. His life and work bring out his uncompromising secular scientific outlook. Philosophically he was an agnostic, if not an atheist. In his writings he has remained remarkably silent on questions about religion. He kept himself aloof from the acrimonious verbal duel

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between the Brahmos, the Young Bengal, the conservative Hindus and the Christian Missionaries. Probably to his rationalist mind fighting for or against a religious system appeared to be merely wastage of energy. He is reported to have said, "As things stand now, it is not possible for man to know what religion is, nor is it necessary to know this."

In the letter of 29 August, 1853 to the Council of Education, Government of Bengal he wrote, "... we should not at all interfere with the learned of the country. We do not require to get them reconciled because we do not require their assistance in any shape. We need not fear the opposition of a body declining in their reputation. Their voice is gradually becoming more and more feeble. There is little chance of their regaining their former ascendancy. To whatever part of Bengal is the influence of education extending, there the learned of the country are losing their ground."

His contemporaries have recorded many of his satirical remarks, which show that he had no great respect for traditional Hindu religious scriptures and practices and had not much faith in religious rites.

In the early part of his life he became associated with the *Tattwabodhini Patrika* along with Akshay Kumar Datta and Debendranath Thakur. While Debendranath wanted to make it a forum for the propagation of spiritualism, particularly of the Brahmo religion, Vidyasagar wanted to make it an organ for fighting social evils and for preaching the scientific way of thinking. This was ever a source of friction between the two and ultimately he severed his connection with the magazine.

There are many anecdotal stories about Vidyasagar's attitude towards god and religion. He used to say, "What is the use of invoking god? When Chengis Khan started pillaging, he imprisoned many peo-

ple, till finally there were almost a hundred thousand prisoners ... Then Chengis Khan ordered 'kill them all' ... God must have seen this mass killing, but nevertheless he did not prevent any of these. So even if he exists, I have no need for him."

He once said, "My countrymen will witness people dying of starvation in front of them; diseases, ill health and pestilence are decimating the population, still the people blindly go on chanting the name of god. I, for one do not have such love of god. My god resides on this Earth. I do not want to go to heaven, I do not want salvation, I pray that I be born again and again in this mortal land of Bengal."

In the textbooks he had written for the school children he did not include any essay on God or religion. There is a remarkable story about the book *Bodhodoy* that he authored. In the first two editions of the book there was no mention of God, and on this count severe criticism of the book came from the Christian Missionaries. John Murdoch a Christian Missionary and educationist wrote that in the book *Bodhodoy* by Vidyasagar which is based on the book *Rudiments of Knowledge*, published by Messrs Chambers those specific portions of the original book were omitted where the Bible was mentioned as "the word of God", and where "duty to love God" and immortality of soul were discussed. Furthermore, the explanation of the senses or the sensations through sense organs which 'Bodhodoy' provided "seems to teach rank materialism."

He further remarked, "The writer (Murdoch) described the above books not simply as prepared by a secularist, but as secularist. He did so because the author deliberately struck out the injunction to worship God; because his moral teaching has no reference to God's will but simply to what people around would think or do;

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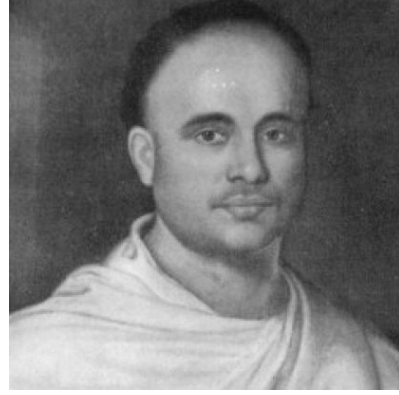
because he omitted all passages teaching the immortality of soul, the responsibility of man, and the difference between him and the brutes that perish. If it is “misleading” to describe such books as ‘Secularist’, the writer confesses that he does not know the meaning of the term.”

Finally he mentions, “It is earnestly hoped that soon such books will be excluded from Mission schools.” The publication of Bodhoday was nearly stopped by the Government. Compelled by the circumstances and on the advice of his friends Vidyasagar wrote a chapter on ‘God’ in the third edition of the book, but this was written with indifference and in a rather unintelligible manner. The book began with a discussion on ‘matter’ followed by an essay on ‘God’.

Vidyasagar’s eclectic outlook is evident from the books he chose for his personal library and the Sanskrit College library. These include ‘History of the English Revolution’ by Guizot, Smith’s ‘History of the French Revolution’, Johnston’s ‘Atlas, Newton’s ‘Principia’, Euclid’s ‘Geometry’, works by Shelley and Koran.

Vidyasagar and secular, scientific education

After studying for 12 years at the Sanskrit College Ishwarchandra earned the title of Vidyasagar (ocean of knowledge) in recognition of his academic brilliance, and this sobriquet stayed with him ever after. Immediately after leaving college in 1841 he joined the Bengali Department of the Fort William College as Head Pundit. His task was to teach the British civil servants Hindi and Bengali. He took his task so seriously that he took lessons from private tutors to master the languages of Hindi and English; but the Britishers were not so interested in learning the native languages and many of them failed in the examinations. The



Portrait of Vidyasagar at a young age.

authorities asked Vidyasagar to be not so strict, but Vidyasagar refused and even offered to resign. The authorities gave in and Vidyasagar continued with his job. The incident presages Vidyasagar’s uncompromising adherence to principles.

After working for five years at the Fort William College, Vidyasagar resigned from the post in 1846 and joined as Assistant Secretary of the Sanskrit College. In those days discipline was lax at the College. The teachers used to arrive late and much of their time inside the classroom was spent in sleeping. Many of them were even Vidyasagar’s teachers. In a gentle and tactful way Vidyasagar made the teachers and students to come on time and to not leave before the scheduled time without permission from the Secretary. The well known incident of Vidyasagar receiving Mr. John Kerr, Principal of the Hindu College, in his room with his slippered feet on the table happened during this time.

Vidyasagar had many plans for the improvement of the Sanskrit College. He was then a young man of 26 years. Even at that young age he had a clear vision that the upliftment of his superstitious and custom-ridden countrymen could only come through inculcating rationality and scientific outlook. To accomplish this the

higher thoughts from the West would have to be conveyed to them through education. If this education is to reach the masses, and not remain a matter for the elites only it has to be imparted through the Vernacular language. For this the Vernacular language will have to be developed. Only those who are well versed in English and Sanskrit could carry out this task. Therefore, Sanskrit education has to be combined with English education to acquaint the students with the higher thoughts of Western science and civilization.

In his scheme for improvement of the Sanskrit College he wrote, "I have carefully studied the working of the system, and the suggestions made are brought forward with the view of facilitating the acquirement of the largest store of sound Sanskrit and English learning combined, under the impression that such a training is likely to produce men who will be highly useful in the work of imbuing our vernacular dialects with the science and civilization of the Western world."

He submitted his proposals in writing and made many verbal proposals to the Secretary Rasamoy Datta. But Datta neither took any action himself nor forwarded them to the Education Department. Vidyasagar got increasingly frustrated and resigned from the job, stating in clear terms in his resignation letter, "My reason for resigning is that I do not find those opportunities of being useful in anticipation of which I applied for the appointment."

His relatives, friends and well wishers had advised him against taking such a step. When asked how he would make a living he replied that he would live by selling vegetables rather than continue with a job in which his honour was violated.

After resigning he set up a printing press taking loans and started to write and publish books in Bengali and thus con-

tributed to the development of an elegant Bengali style. After three years, in 1850 the Government brought him back to the Sanskrit College as Head of the Department of Sanskrit Literature and soon created the post of Principal for him. Vidyasagar became the first Principal of the Sanskrit College. After joining the Sanskrit College he took effective steps to tighten up the administration and to ensure timely attendance of students and teachers. Previously only Brahmins and Vaidyas were admitted to the Sanskrit College. On Vidyasagar's recommendation "boys of all respectable classes of Hindoos" were granted admission. As Principal he sent several notes to the Government for improving the teaching at the College, which reflect his thoughts on education and his concern for modernizing the content of education. He dreamt of building a new education system for the country.

Deep feeling for the poor and the oppressed was the fountainhead of all his thoughts of reform. He realized that to imbibe modern thoughts his countrymen must be freed from all the old outmoded thoughts and religious bigotry. He also knew that this change could not be brought in from without simply by launching a tirade against Hindu orthodoxy. The change must come from within; change must take place in the mental make-up of the people. This was the driving force that led Vidyasagar to devote himself to the cause of modern education based on science and rationality, an education that could inspire the people in their life-struggle and change their outlook. Such an education was not to produce either erudite Sanskrit pundits or rootless copiers of Westernization; it was to make the people imbued with self-respect, dignity and social obligation. This called for new curricula, new text books to propagate the

new thoughts, and a band of teachers equipped with scientific and rational mode of thinking. Development of vernacular language and literature was necessary to carry education to every household, to lift people up from the morass of illiteracy, and to enlighten them with modern thoughts. Therefore, he proposed that in the Sanskrit College teaching of Sanskrit must be combined with teaching of English, modern mathematics, science and modern European philosophy.

In his famous Report on the Sanskrit College sent to F. J. Mouat, Secretary to the Council of Education sent on 16 December 1850 he wrote, "The period of study in the Sanskrit College is 15 years. One is expected to have a perfect knowledge of Sanskrit learning in so long a period. But no one may be considered to have such knowledge who is not familiar with all the systems of philosophy prevalent in India. True it is that the most part of the Hindu Systems of Philosophy do not tally with the advanced ideas of modern times, yet it is undeniable that to a good Sanskrit scholar their knowledge is absolutely required. By the time that the students come to the *Darshana* or Philosophy class their acquirements in English will enable them to study the modern Philosophy of Europe. Thus they shall have an ample opportunity of comparing the systems of Philosophy of their own with the new Philosophy of Western World. Young men thus educated will be better able to expose the errors of ancient Hindu Philosophy than if they were to derive their knowledge of Philosophy simply from European sources. One of the principal reasons why I have ventured to suggest the study of all the prevalent systems of Philosophy in India is that the student will clearly see that the propounders of different systems have attacked each other and have pointed out each other's errors

and fallacies. Thus he will be able to judge for himself. His knowledge of European Philosophy shall be to him an invaluable guide to the understanding of the merits of the different systems.

... Should the Council be pleased to adopt these suggestions, I have sanguine hopes that the happy and speedy results, under an efficient and steady supervision, will be that the college will become a seat of pure and profound Sanskrit learning, and at the same time a nursery of improved vernacular literature and of teachers thoroughly qualified to disseminate that literature amongst the masses of their fellow-countrymen."

What he wanted to do and why he wanted to do it are expressed with remarkable clarity. Even though he prescribed teaching of Sanskrit he was not a classicist; he advocated education to be a purveyor of modern thoughts. On 12 April, 1852, at the request of F J Halliday, later the Lieutenant Governor of Bengal, Vidyasagar drafted another 'Notes on the Sanskrit College' in which he lucidly elaborated his plans. First, he outlined the rationale for combining Sanskrit education with English teaching:

- 'The creation of an enlightened Bengali literature should be the first object of those who are entrusted with the superintendence of education in Bengal'.
- 'Such a literature cannot be formed by the exertions of those who are not competent to collect the materials from European sources and to dress them in elegant expressive idiomatic Bengali'.
- 'An elegant expressive idiomatic Bengali style cannot be at the command of those who are not good Sanskrit scholars. Hence the necessity of making Sanskrit scholars well versed in English language and literature'.
- 'Experience proves that mere English scholars are altogether incapable of ex-

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pressing their ideas in elegant and idiomatic Bengali. They are so much anglicized that it seems almost impossible for them, even if they make Sanskrit their afterstudy, to express their ideas in an idiomatic and elegant Bengali style’.

- ‘It is very clear then that if the students of Sanskrit College be made familiar with English literature, they will prove the ablest contributors to an enlightened Bengali literature’.

He continued in elaboration of the content of the courses,

- ‘The students of the Sanskrit College be should be thoroughly instructed in Grammar and Literature—the latter including poems, dramas, and prose works.’
- ‘The study of Grammar, Literature and Rhetoric will enable the student to acquire a complete mastery of the Sanskrit Language’.
- ‘The study of these (Manu, Metakshara etc. – D.M.) is sufficient to make one conversant with the Hindu Laws current in almost every part of India’.
- ‘In mathematics, *Lilavati* and *Vijaganita* are the text books. *Lilavati* treats of arithmetic and mensuration and *Vijaganita* of Algebra. These two works are very meager. ... The examples are very few. The fact is the study of Sanskrit mathematics is not only nearly useless in itself, but it interferes largely with other studies and engrosses a great deal of time and labour which might be employed in far more useful pursuits. The study of mathematics in Sanskrit should be discontinued. It is not to be understood from this that I undervalue a knowledge of Mathematics as an essential element of a complete education. Far from it. I wish to substitute the pursuit of it in English,

whence in less than half the time now given to it an intelligent student will acquire more than double the amount of sound information that he could obtain by the most perfect acquaintance of all that exists in Sanskrit language in the subject’.

He explained that Indian philosophy would be of no help for social progress; for that Western philosophy and Western science are necessary. Through education he wanted to develop the logical faculty of the students: “There are six prominent schools in Hindu Philosophy namely Nyaya, Vaisheshika, Sankhya, Patanjala, Vedanta and Mimansa”. ... “At present the following are the subjects for the Senior Scholarship Examinations in the Sanskrit College: Literature, Rhetoric, Mathematics, Law or Philosophy, Sanskrit Prose Essay, Sanskrit Poetical Essay and Bengali Essay. These should be thus modified. Literature and Rhetoric should form our subject. Mathematics in Sanskrit and Sanskrit Essay should be dispensed with, and in their stead three branches in English namely, History, Mathematics and Natural Philosophy should form each a subject of Senior Scholarship Examination in the Sanskrit College. Moral and Mental Philosophy, Logic and Political Economy should form also subjects of the same examination being in turn selected every succeeding year.”

Thus, what Vidyasagar visualized was a complete overhaul of the education system, and to replace an archaic fossilized system by a modern, scientific, forward-looking system. It is tragic that now more than 150 years later the present protagonists of Hindutva want to bring in subjects like Vedic Mathematics and Astrology at the University level and are propagating many unscientific, obscurantist thoughts. How much more modern and advanced Vidyasagar was! Through a new education

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system he wanted to uproot the superstitious and bigoted thoughts from the society and instil among the people a rational, scientific, progressive outlook.

Vidyasagar was not merely a dreamer thinking about an ideal curriculum and syllabus, he was a doer and worked out the number of additional teachers that would be necessary to teach the changed curriculum, and the additional funds that would be required. In 1853, 16 July he wrote a letter to the Council of Education making a strong case for the sanction of additional teachers and allocation of necessary funds for implementing the suggested reforms. To implement the new system new teachers would be necessary, and accordingly he drafted and recommended an advanced level curriculum for the training of teachers that included Natural History, Modern Mathematics, in addition to History, Political Economy and Philosophy.

About the qualification of the teachers he wrote in a letter to the Council of Education on 7 September, 1853, "What we require is to extend the benefit of education to the mass of the people. Let us establish a number of vernacular schools, let us prepare a series of vernacular class-books on useful and instructive subjects, let us raise up a band of men qualified to undertake the responsible duty of teachers and the object is accomplished. The qualification of these teachers should be of this nature. They should be perfect masters of their own language, possess a considerable amount of useful information and free from the prejudices of their country."

The Council of Education invited Dr. J. R. Ballantyne, Principal of the Sanskrit College of Benares to inspect the Sanskrit College, Calcutta and give his opinion on Vidyasagar's proposals. Dr. Ballantyne after inspection and discussions with Vidyasagar submitted his report in which



Iswarchandra Vidyasagar
(26 September 1820 – 29 July 1891).

he appreciated Vidyasagar's proposals, but suggested some changes. In August 1853 the Government forwarded Ballantyne's letter to Vidyasagar. Vidyasagar did not agree with Ballantyne's recommendations and sent his rebuttal on 7th September.

Ballantyne recommended the teaching of idealist philosopher Bishop Berkeley's 'Inquiry' to demonstrate the similarity between the Indian and Western systems of philosophy. Vidyasagar totally disagreed and wrote to the Council of Education, "With regard to Bishop Berkeley's Inquiry, I beg leave to remark that the introduction of it as a class book would beget more mischief than advantage. For certain reasons, which is needless to state here, we are obliged to continue the teaching of Vedanta and Sankhya in the Sanscrit College. That the Vedanta and Sankhya are false systems of philosophy is no more a matter of dispute. These systems, false as they are, command unbound reverence from the Hindus. Whilst teaching these in the Sanscrit course, we should oppose them by sound philosophy in the English course to counteract their influence. Bishop Berkeley's Inquiry, which has arrived at similar or identical conclusions with the Vedanta or Sankhya and which is no more considered

in Europe as a sound system of philosophy, will not serve the purpose. On the contrary, when, by the perusal of the book, the Hindu students of Sanscrit will find that the theories advanced by the Sankhya and Vedanta systems are corroborated by a philosopher of Europe, their reverence for these two systems may increase instead of being diminished." Elsewhere in the same letter he said, "It must be confessed, however, that there are many passages in Hindu philosophy which cannot be rendered into English with ease and sufficient intelligibility only because there is nothing substantial in them."

In those days these were revolutionary utterances and it needed a lot of courage and conviction on Vidyasagar's part to openly proclaim them. Berkeley's subjective idealism was repugnant to Vidyasagar. Berkeley's philosophy is akin to Shankaracharya's *mayavada* (illusionism), and Vidyasagar was aware how Shankaracharya's philosophy acted as a deterrent in the scientific study of the material world. So he wanted to teach Mill's 'Logic' in the original, and not an abridged version of it as recommended by Ballantyne. Mill was a philosopher who was an empiricist relying on concrete, experience-based knowledge and was a protagonist of individuality and freedom of man. He also stressed on social obligation of individuals and condemned 'selfish indifference to society' in the name of personal freedom. Vidyasagar, with his emphasis on Western science appreciated Mill's empiricism.

Ballantyne further commented, "it is desirable to train up a body of men qualified to understand both the learned of India and the learned of Europe, and to interpret between the two, removing unnecessary prejudice by pointing out real agreement where there was seeming discordance and conciliating acceptance for the advancing

science of Europe by showing that European science recognizes all those elementary truths that had been reached by Hindu speculation."

Vidyasagar's scathing response to this confused mishmash was, "It appears to me to be a hopeless task to conciliate the learned of India to the acceptance of the advancing science of Europe. They are a body of men whose longstanding prejudices are unshakable. Any idea when brought to their notice either in the form of a new or in the form of the expansion of truths, the germs of which their Shastras contain, they will not accept. It is but natural they would obstinately adhere to their old prejudices." Mentioning about the wooden-headedness of the Arab General who ordered the destruction of the famous library at Alexandria, Vidyasagar continued, "The bigotry of the learned of India, I am ashamed to state, is not in the least inferior to that of the Arab. They believe that their Shastras have all emanated from omniscient Rishis and, therefore, cannot but be infallible. When in the course of discussion or in the course of conversation any new truth advanced by European science is presented before them they laugh and ridicule. Lately a feeling is manifesting among the learned of this part of India, especially in Calcutta and its neighbourhood, that when they hear of a scientific truth, the germs of which may be traced out in their Shastras, instead of showing any regard for that truth, they triumph and the superstitious regard for their own Shastras is redoubled. From these considerations, I regret to say that I cannot persuade myself to believe that there is any hope of reconciling the learned of India to the reception of new scientific truths."

No compromise with regressive tradition for this venerable Pundit! Vidyasagar rightly understood the mind-set of the

conservative heads in the social hierarchy and was forthright in his criticisms. No wonder that the present day protagonists of Hindutva never mention Vidyasagar in their tracts on education.

In the same letter there is a remarkable utterance which testifies to the modernity of Vidyasagar's philosophical outlook. Ballantyne commented that in teaching both Sanskrit and English courses, care should be taken for "obviating the danger that the two courses may end in persuading the learner that 'truth is double'." Vidyasagar's response was, "Truth is truth if properly perceived. To believe that 'truth is double' is but the effect of an imperfect perception of truth itself—an effect which I am sure to see removed by the improved courses of studies we have adopted at this institution." There is clear negation of any notion of plurality of truth.

Vidyasagar and Mass-education

Vidyasagar wanted the spread of English education because he realized that the progress of the country and the all round development of the people could only come through acquiring a knowledge of the progressive modern thoughts and the latest developments in science and philosophy. About the importance of English education he wrote in the above-mentioned 1852 document, "It is very clear that if the students of the Sanskrit College be made familiar with English Literature, they will prove the best and ablest contributors to an enlightened Bengali Literature. The students of the Sanskrit College while they are in the Grammar and Literature classes should direct their attention principally to Sanskrit studies devoting two thirds of the time to the Sanskrit and one third to the English. While they are in the Rhetoric, Law and Philosophy classes their chief attention should be directed to English devoting two

thirds of the time to this important branch of Education."

He elaborated his ideas in a letter dated 5 October, 1853, to Dr. F. J. Mouat of the Council of education, "Leave me to teach Sanskrit for the leading purpose of thoroughly mastering the vernacular and let me superadd to it the acquisition of sound knowledge through the medium of the English and you may rest assured that before a few years are over I shall be enabled if supported and encouraged by the Council, to furnish you with a body of young men who will be better qualified by their writings and teaching to disseminate widely among the people sound information than it has hitherto been possible to accomplish through the instrumentality of the educated selves of any of your colleges, whether English or oriental."

Vidyasagar was clear in his mind that if education is to convey higher thoughts to the people these are to be carried through the medium of their own language. At this time the government was thinking of introducing a system of Vernacular-based education and starting some vernacular schools. The Lieutenant Governor of Bengal F J Halliday was an admirer of Vidyasagar, and he requested the latter draw up a plan. Accordingly Vidyasagar drew up a plan for vernacular education and submitted it to Mr Halliday who forwarded it to the Government of India with his recommendations. Already he had asked Vidyasagar to identify the localities for the establishment of the vernacular schools. In 1855 at Halliday's insistence Vidyasagar was offered the appointment as Assistant Inspector of Schools in addition to this position as the Principal of the Sanskrit College.

The British rulers' outlook towards education was to train up a sufficient number of clerks and lower level administrators who would help a smooth running of the

Government machinery. But Vidyasagar had the noble objective of uplifting the downtrodden Indian people. So he wanted the vernacular education to be comprehensive covering all branches of knowledge and not merely teaching the three R's. In the plan submitted to Mr Halliday on 7 February 1854 he wrote,

1. "Vernacular Education on an extensive scale, and on an efficient footing, is highly desirable, for it is by this means alone that the condition of mass of the people can be ameliorated."
2. "Mere reading and writing, and a little arithmetic should not comprise the whole of this Education; Geography, History, Biography, Arithmetic, Geometry, Natural Philosophy, Moral Philosophy, Political Economy and Physiology should be taught to render it complete."

He wrote in his Report for 1856-57 as the Assistant Secretary of Schools, "I am aware that this course would be considered by many persons as high for pupils of Vernacular Schools. They think that the course of Instruction should be a very limited one. This opinion appears to have been formed under an impression that the students of those schools are generally children of the working classes, who cannot afford to keep them there for the period necessary to complete any extensive course. This impression is certainly erroneous. There are three different classes of pupils in the Vernacular Schools, viz. the children of the higher, middling and lower classes. The first class having means at command will generally withdraw their children from the Vernacular Schools after they have acquired a tolerable knowledge of Bengali and transfer them to English Schools or Colleges. The third class, from straitened circumstances, will, in many cases, not be able to keep their children in school for

the whole time required to complete the course, and will generally withdraw them as soon as they are able to read and write and have learnt a little of Arithmetic and Mensuration. But the second class, whose children constitute the majority of pupils in the Vernacular Schools, have the will to give them a tolerably complete education, which, however, for want of means, they can never do in English. They must, therefore, continue their children in the Vernacular Schools to finish a complete course, and for this mass of pupils the aforesaid course, in my humble opinion, seems to be absolutely necessary."

Both at the Sanskrit College and while establishing the vernacular schools in rural Bengal, Vidyasagar keenly felt the absence of suitable text-books. He always thought about how to improve the Bengali language, so that it could express the finest philosophical and scientific ideas. He himself penned a number of Bengali books to set a high standard for "elegant expressive idiomatic Bengali". While writing these books and polemical essays Vidyasagar created a new enriched Bengali language. About Vidyasagar's contribution to Bengali language Rabindranath wrote, "He was the first true artist of the Bengali language. The Bengali prose literature originated before his advent, but it was he who first invested it with artistic subtleties. He set examples to show that language is not just a container of ideas and it is not enough to cram it with a handful of statements without relevance or due order. He pointed out that whatever is to be expressed must be stated in simple, beautiful and well-coordinated way. This will hardly seem a task today. But just as social organization is essential for the flowering of humanity, a language can also become productive of true literature only when it is guided by aesthetic norms. Men in mass are self-

divisive and self-repellent, they are hard to lead. They cannot be expected by themselves alone to carry on a battle, it is for an army to do it. Vidyasagar classified, arranged, refined and controlled the mob-like disorganized elements of the Bengali prose with great competence, thereby imparting to it easy fluency and effectiveness. By utilizing these elements many an army-chief may now overcome hurdles in the way of self-expression and find and conquer fresh literary territories. But the laurels of victory should first be awarded to the initial builder of this army.”

He undertook the task of writing textbooks for all stages right from early childhood. Generations of Bengali children started their first lessons with Vidyasagar's *Varnaparichay*. He wrote a new grammar book for Sanskrit, *Upakramanika* and compiled a selection of Sanskrit prose and poetry *Rijupath*. He translated from English a few suitable works and wrote books for study in simple, lucid and effective Bengali language. He wrote books with biographies of scientists, philosophers, educationists and reformers and penned simple stories to convey moral values to students.

Moral teaching had an important place in Vidyasagar's scheme. Through simple stories in books like *Bodhodoy*, *Akhyamanjari*, *Kathamala*, *Charitabali* etc., he tried to inculcate a sense of moral values like sense of duty, responsibility, sincerity, kind-heartedness, truthfulness in students of different ages, beginning right from the primary stage. Even in *Varnaparichay*, a primer for introducing infants to alphabets and simple sentences, Vidyasagar, in his simple lucid language upheld moral values. But nowhere in his books did he compromise with his secular outlook. That is why John Murdoch, a Christian Missionary and educationist, remarked that Vidyasagar's textbooks should be excluded from the

Mission schools, because these lack in “religious and moral teaching”. There is not “a single allusion to God or a future state”.

Vidyasagar was also keen to coin appropriate technical words in Bengali language. In his 1852 ‘Notes’ mentioned earlier he wrote, “Another advantage is, that students so prepared, wishing to transfer the philosophy of the West into a native dress will possess a stock of technical words already in some degree familiar to intelligent natives.”

In a recommendation letter for a brilliant student, Kaliprasanna Ghosh he wrote, “It is certainly very desirable that students like Callyprasanno should enter the Medical College, as with their knowledge of Sanscrit and the vernacular they will surely become very useful in supplying a great want, viz. the compilation in the vernacular of words on such sciences as Physiology, Chemistry, Botany, Natural History etc.”

It is also remarkable that a man of Vidyasagar's caliber, a front-ranking intellectual and erudite scholar, a man who had reached the philosophical height rare among the secular humanists, did not write any treatise on philosophy. With his knowledge, wisdom and intellect he could have chosen to rise to fame and prosperity as a leading philosopher of his time. But he was ridiculed as ‘only a Primer maker’ without any claim to a high place as an author even by the eminent litterateur Bankimchandra. But this is a glowing testimony of his commitment to the cause as he realized it. He earnestly desired his poor, illiterate countrymen to be educated and realize their place in the sun. This was his life's mission and any other consideration was subservient to it.

What a high ethical standard Vidyasagar carried is evident from his response in 1873 to the request from the Government to be a member of the School Book Committee whose job it was to prescribe text books

for the schools and colleges. He wrote, "I beg to inform you that I would have gladly accepted your invitation to serve in the School Book Committee, but on two considerations I feel constrained to decline it. As an author I am directly interested in the decision of the committee, and I do not therefore think it right to take a part in their deliberations. Besides, I am inclined to think that my presence in the committee may interfere with a free and unreserved discussion of the merits and demerits of the books."

Vidyasagar's contribution to the spread of education in the country remains unmatched. F J Halliday, Lieutenant Governor of Bengal was a great admirer of Vidyasagar and in 1854 he gave Vidyasagar the charge to select the locations for establishment of model Vernacular schools in South Bengal. Vidyasagar toured extensively in the different districts and visited Shiyakhala, Radhanagar, Krishnagar, Kshirpai, Chandrakona, Sripur, Kamarpukur, Ramjibanpur, Mayapur, Maloypur, Pantihal in Hooghly District, and also enquired about suitable localities in the districts of Nadia, Bardhaman and 24 Parganas. He discussed with the local people about setting up the schools, and noted their keen interest for the proposed schools and they were even ready to provide the necessary land and school houses. He submitted a Report to the Government, and in 1855 he was given the appointment as Assistant Inspector of Schools. Vidyasagar set out to take up his job of setting up the model vernacular schools in right earnest. With astonishing energy and drive within the period from August 1855 to January 1856, he set up 20 model schools, five each in the four districts of Nadia, Bardhaman, Hooghly and Medinipur. The prime task was to train the vernacular teachers to the desired level of competence. For this

purpose a Normal School was set up at the Sanskrit College with 71 students. His correspondence with Governments bears eloquent testimony to his meticulous planning and attention to details. As Assistant Inspector of Schools Vidyasagar visited many villages in the different districts of south Bengal. He not only paid attention to the teaching, but also to the other necessities of the poor students.

In his native village Birsingha he founded a free school with his own resources. The Inspector of Schools Mr. Lodge wrote about the school, "The boys are educated free and supplied with all sorts of books, and what is still more to be admired, the poor students, about 30 in number, are constantly boarded and lodged in his family mansion and now and then supplied with clothes, etc., when considered necessary. Careful medical attendance is also secured for them ..."

In his Report of 1856 Vidyasagar wrote, "The pupils in general are remarkable for their zeal and pay great attention to their studies. ... The inhabitants of nearly all the villages, where the Schools have been established, take a lively interest in them. The elders frequently visit the Schools and sit for hours together, hearing the boys read and explain their lessons, and appear greatly pleased with the mode of tuition, the new class-books, orderly arrangement of the boys in their respective classes etc. ... This state of things certainly augurs well for the future prosperity of the Model Schools."

There was a proposal from the Government to set up a large number of schools in rural areas with the limited expenditure of Rupees 5 to 7 a month for each school. The ostensible purpose was to spread education among the masses, but the real motive was to keep the standard of education for the common masses at a very low level. Vidyasagar was quick to realize this and

opposed the move by pointing out that no worthwhile system of education could be introduced with such limited expenditure and such education would not in any way “extend to the masses.” He observed in his letter to the Junior Secretary of the Government of Bengal on 29 September, 1959, “To educate a whole people is certainly very desirable, but this is a task which, it is doubtful, whether any Government can undertake or fulfil.” With great insight he commented, “Notwithstanding the high state of civilization in England, the masses there are no better than their brethren in this country on the point of education.” Of course, the successful experiment in Soviet Russia to educate the whole people was still in the future.

He further remarked, “The condition of the labouring classes ... is generally so low that they cannot afford to incur any charge on account of the education of their children. Neither can they continue their boys in School, after the latter have attained that age when they become fit for any sort of work, which would secure some kind of remuneration however trifling it may be. They think, and perhaps rightly, that if the children learnt a little of reading and writing, it will not better their condition, and therefore they feel no inducement whatsoever in sending them to School. It is too much to expect that they would educate their children merely for the sake of knowledge, when even the higher classes do not yet properly appreciate the benefits of education. Under such circumstances it is needless to attempt the education of the laboring classes. But should it be in the contemplation of the Government to try the experiment it must be prepared for giving education free of all charges.”

He continued, “At the best, if not the only practicable means of promoting education in Bengal, the Government should,

in my humble opinion, confine itself to the education of the higher classes in a comprehensive basis. ... by educating one boy in a proper style the Government does more towards the real education of the people, than by teaching a hundred children mere reading, writing and a little of Arithmetic.”

In an earlier Report of 1856-57 as Assistant Inspector of Schools he remarked, “Labour in this country is so cheap that the earnings of the working class are scarcely sufficient for their maintenance. They cannot, therefore, be expected to incur extra charges for the education of their children. If these classes are to be educated, the education must be imparted to them gratis so long as their condition is not bettered; otherwise, it is not reasonable to expect those classes will reap any material advantage under the system in force in the Vernacular School.”

Some criticize that Vidyasagar’s ideas on education revolved only around the middle class; he did not think of education for the masses. But this is a misguided criticism. Vidyasagar was a realist and not a utopian dreamer. He was aware of the problems of child labour and the economic compulsions of the parents of poor families to send their children to work and earn some money rather than to send them to school. He also rightly perceived that in a country like India, it is the middle class, if properly equipped, which would act as the main driver for social change. It is true that Vidyasagar’s thoughts on education were primarily centred on the middle class. But this was his historical limitation. India was at that time at the historical stage of the rise and development of the bourgeois class as the anti-thesis of the feudal class, and Vidyasagar was the most powerful exponent of the bourgeois class thinking. The core of the philosophy of the rising bourgeois

class is the development of the individual, and this constituted the focal point of Vidyasagar's education policy. But we have already shown that he was not indifferent to the problem of education of the masses, nor was it his intention to deprive them of opportunities of education. He demanded that the Government take the only feasible step of making education totally free to ensure education for the masses.

After Vidyasagar resigned from the post of Principal of the Sanskrit College and the Special Inspector of Schools because of differences with the authorities, he continued to travel extensively and on his own initiative established model schools and normal schools. He built the Metropolitan Institution in Calcutta for English-based higher education. There were many skeptics who thought that without British professors the institute would flounder, but Vidyasagar was steadfast in his resolve. In the very first year, students from the Metropolitan Institution did extremely well in the First Arts Examinations of the Calcutta University. Principal Sutcliffe of the Presidency College had to admit, "The Pandit had done wonders." Soon the Institution earned a name as one of the finest institutions in the field of higher education. The institutions Vidyasagar built were the first steps to mass education in our country. The future generations are still enjoying the benefits of the movement which Vidyasagar set in motion.

Vidyasagar and Women's Education

The wretched condition of women in the contemporary patriarchal society stirred deep emotions in him. The social history of Bengal has clearly revealed how the moral atmosphere of the entire society was vitiated by the hold of *Koolinism* (codes governing the intermarriages between the different Brahminical denominations) and how

the basic rights of women were trampled by the patriarchal society. Vidyasagar's humanism rebelled against the humiliation and indignity of women in the feudal society. He cherished the idea of women asserting their own rights as individuals. He had clearly perceived that emancipation of women would only be realized if they receive education. He viewed this as a social necessity and hence education of girls became one of the prime objectives of his life.

The conservative Hindu society was dead against sending young girls to school and spread vile propaganda about the evils of female education, that imparting education to women would bring misfortune to the family, would bring early death to the husband, would lead the women astray. Facing stiff opposition, J Drinkwater Bethune, aided by Madan Mohan Tarkalankar, Ramgopal Ghosh and Dakshinaranjan Mukhopadhyay established a girls' school in Calcutta in 1849. In 1850 Vidyasagar was chosen as the Secretary of Bethune Girls' School. After Bethune expired in 1851, the Government undertook the responsibility of bearing all the expenses. In 1856 the Government set up a School Committee with Vidyasagar as the Secretary for the administration of the school. Vidyasagar framed the rules and the curriculum. The education was free with free supply of books. Arrangements were also made for transport of the girls from their residence to school and back; Vidyasagar arranged to inscribe on the walls of the vans a quotation from the *Mahanirban Tantra*, "*kanyapyebam palaneeyaa shikshaneeyatnatatah*" (while bringing up daughters give them education with care).

While Vidyasagar was busy establishing the Model Vernacular Schools in the districts of south Bengal he felt the necessity

Cover Article

to start female schools also in rural Bengal, because he realized that women's education is an imperative necessity not only to lift them from their miserable situation but also to rid the society from superstitions and bigotry. Governor Halliday encouraged Vidyasagar for his mission for women's education in Bengal. In 1857 Vidyasagar took the initiative to establish a few female schools in the villages with the sanction of the Government.

In anticipation of the sanction of the Government for more schools, by May 1858 Vidyasagar established 35 female schools in Hooghly, Bardhaman, Medinipur and Nadia districts; but the Supreme Government refused to grant any aid to the schools. Vidyasagar wrote in the Report for 1857-58, "The schools were established on the understanding that the inhabitants would provide suitable School Houses, the expenses for their maintenance being defrayed by the Government. These conditions were approved by His Honour the Lieutenant Governor and strongly recommended by him; but the Supreme Government unfortunately took a different view and refused their sanction to their establishment except under the Grant-in-aid rules. My labours have thus become fruitless and the interesting little Schools will have to be closed immediately."

Vidyasagar felt humiliated and tendered his resignation in 1858. In his resignation letter he stated, "The unceasing mental exertion required by the discharge of my public duties has now so seriously affected my general health, as to compel me to tender my resignation of the Education service to the Hon'ble Lieutenant Governor of Bengal. ... Among the minor causes that have led to my taking so serious a step, are the absence of all further prospects of advancement and the want of that immediate personal sympathy with the present system

of education, which every conscientious servant of the Department should possess."

Even after resigning Vidyasagar continued in his effort to spread female education and tried to run the female schools with private donations. He was also engaged with the affairs of the Bethune School as the Secretary of the School Committee. In 1866 Mary Carpenter who was a strong proponent of female education and a friend of India came to Calcutta and met Vidyasagar. She visited a few female schools accompanied by Vidyasagar. She wanted to start a Female Normal School to train female teachers. Vidyasagar was not very keen on it as he thought that because of the strong social prejudices such an endeavor would not be successful.

But the Government did not accept Vidyasagar's opinions and started a Female Normal School in Bethune School. As apprehended by Vidyasagar the experiment did not succeed and the Normal School in Bethune School had to close down in 1872.

Modern education system in our country is a legacy from Vidyasagar. More than 125 years have passed since the demise of Vidyasagar, and we still marvel at how surprisingly modern and foresightful Vidyasagar was in his outlook on education and how much he could accomplish within so short a time span. Vidyasagar's dream for a secular, scientific education for the masses still remains unfulfilled.

On the contrary, we are now witnessing a rise in obscurantism, bigotry and superstitions in the educational field and the social life. The situation demands a dedicated endeavour for a thorough study of the life and works of this great humanist and educationist. We still derive inspiration from him to chart out a right course and engage ourselves in the struggle. □

Climate Change: The Possible Role of Astronomy

Amitabha Ghosh *

Abstract: 'Climate change' has, of late, become a very hot topic and considerable amount of political agenda is associated with this subject. An international body IPCC (Intergovernmental Panel on Climate Change) has been formed to oversee the various aspects of the observed climate change. According to IPCC the human activities (primarily industrial) are responsible for a 'global warming' that threatens the future of the world and the human race. This article presents the possible contributions of the periodic variations of some important astronomical parameters to the observed climate change in the past. The article shows that in the past the world has experienced major climate changes primarily due to astronomical reasons.

Introduction

In a simple language 'climate' is the long term state of weather at a location (or a region, to be more precise) on the Earth. The main parameters which identify the climate of a region are (i) temperature and its fluctuation, (ii) the rainfall pattern and (iii) the wind flow characteristics. Since the climate depends on a very complex interplay of atmosphere, ocean and the land mass in interacting with the incoming solar radiation (Insolation) the phenomenon is extremely complicated and is not fully understood. It should be remembered that the Earth receives energy from the sun at

the approximate rate of 6×10^{24} J/yr of which about 4×10^{24} J/yr is absorbed. In comparison the total amount of energy produced by human activity is approximately 5×10^{20} J/yr, i.e. about 0.01% of the energy received from the sun. Besides, one has to keep in mind other major natural disturbance like volcanic eruption which not only brings out heat energy from the Earth's interior but also releases a considerable amount of dust and smoke into the atmosphere. Since this article is intended for general readers the presentation will be restricted to the most important factors like average global temperature.

Global Climate

Before starting the discussion on climate change it is desirable to have some idea about some very basic issues which contribute to a climate pattern in the world. The most important factor that results in the observed climate pattern is the unequal intensity of heating of the Earth's surface by the sun. Fig. 1 shows the Earth at four important locations in its orbit—the summer solstice day, the autumn equinox day, the winter solstice day and the spring equinox day.

The axis of the Earth, about which the globe rotates making one rotation in 23hrs 56min, is tilted from a position that is perpendicular to the plane of the Earth's orbit around the sun. The angle of the tilt currently is 23.5° . On the summer solstice

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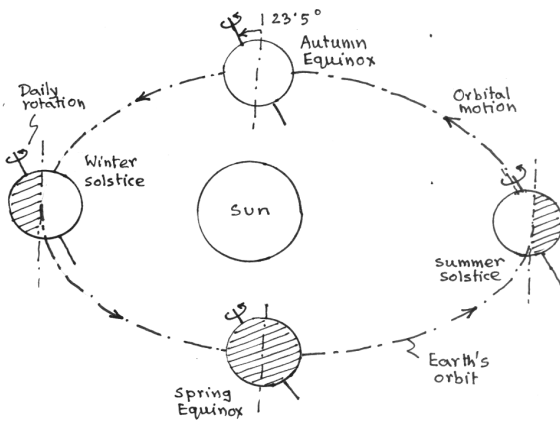


Figure 1: The Earth at four important locations in its orbit—the summer solstice, the autumn equinox, the winter solstice and the spring equinox

day the duration of daylight is maximum in the northern hemisphere whereas it is the shortest on the winter solstice day as is evident from Fig. 2. Thus during a year the energy received by each hemisphere varies. This makes a difference because the land mass distribution in the two hemispheres is unsymmetrical, the northern hemisphere containing more land mass. The radiation absorption capability of land and water being different this is a matter requiring redistribution of the received heat energy. Another matter that causes redistribution of the received heat through solar radiation is the unequal intensity of heating of the polar and the tropical regions.

Fig. 3 shows that a particular beam of sunlight falls on a larger area in the polar region than the area which a similar beam will illuminate near the equator. So, the same amount of sun's radiation energy is distributed over a larger area in the polar region causing a lower intensity of heating. This is the primary reason why the polar regions are cold and the tropical region is warm. This also leads to redistribution of heat.

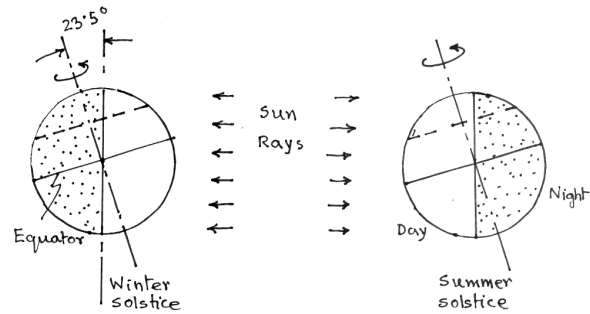


Figure 2: Duration of the day during the summer and the winter solstices

The redistribution of heat is achieved through both the wind flow (a major source of which is the rotation of the Earth) and the ocean currents. There are two types of ocean currents—surface currents which are driven by the wind and also the rotation of the Earth and the deep ocean major currents. Fig. 4 shows the basic features of these two types of current. It can be easily understood why the phenomenon of world climate is so complex to understand completely. Fig. 5 indicates the gross wind flow pattern. Thus, the extreme complexity of the phenomenon of world climate is obvious. Fortunately, there is one single parameter that plays the role of world climate indicator—the average global

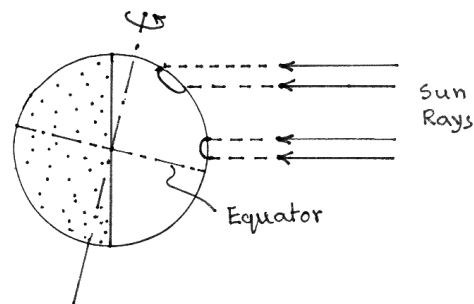


Figure 3: The sunlight falls on a larger area in the polar region than the area which a similar beam will illuminate near the equator

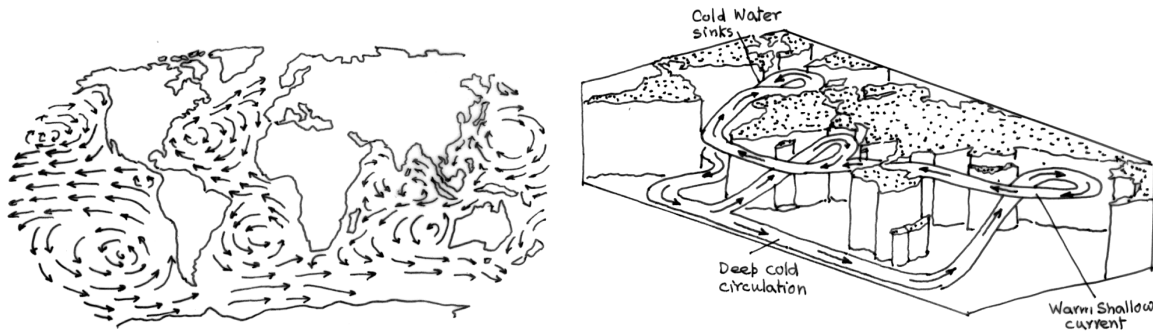


Figure 4: Two types of ocean currents

temperature. A brief discussion on global temperature may be in order.

Global temperature and the greenhouse effect

The average temperature of the Earth is obviously the result of an equilibrium between the energy received by the Earth surface from the sun, insolation, and the heat loss by the Earth through infrared radiation. It is obvious that if the heat loss is reduced due to some effects in the Earth's atmosphere the equilibrium temperature will rise to bring an equilibrium between

the insolation and heat loss by infrared radiation. Though a major part of the insolation is in the form of visible light the outgoing radiation from the Earth's surface is in the form of infrared radiation as the Earth's surface temperature is far less than that to produce visible radiation. It is important to note that there are primarily three gases in our atmosphere which allow visible radiation to come in but do not allow infrared radiation to pass completely. These are (i) carbon dioxide, (ii) methane and (iii) water vapour.

Fig. 6 diagrammatically indicates the situation. So, if the concentration of these gases (called 'green house' gases) is more, more heat will be trapped by the atmosphere causing the equilibrium temperature to rise as what happens in green houses. In case of green houses the role of trapping is played by the glass cover which allows visible sunlight to pass through but prevents the infrared radiation to leave the enclosure. But the matter is further complicated by many secondary and feedback effects. Some of the major issues regarding the feedback effects can be presented in simple manner as follows:

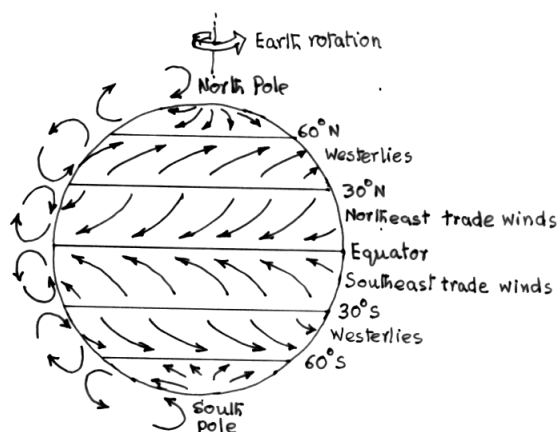


Figure 5: Gross wind flow pattern across Earth

1. **Positive feedback:** Higher level of carbon dioxide results in higher global temperature. Higher temperature leads to

faster decomposition of all dead organic matter which, in turn, boosts the addition of carbon dioxide to the atmosphere.

2. **Negative feedback:** With larger amount of carbon dioxide in the atmosphere the plant growth rate receives a boost. But the increased plants growth results in increased absorption of carbon dioxide from the atmosphere causing a fall in the level of carbon dioxide in the atmosphere.

3. There is another important feedback effect: Once an ice sheet cover starts forming, more sunlight gets reflected instead of getting absorbed. This enhances the process of ice-age build up.

These are just a few examples of the complicating factors which make a reliable and accurate modeling of the world climate very difficult if not impossible. There are many more issues involved which are omitted here.

Hence it is clear that a gross idea can be obtained regarding global climate by the average temperature of the Earth which depends on two major parameters: (i) the insolation and (ii) the content of the green house gases in the atmosphere. To verify any theory regarding world climate it is essential to learn about the past climate of the Earth which is called 'paleoclimate'. In the recent times paleoclimatic information for the past millions of years has been obtained from the gas bubbles trapped in the ice sheets of the arctic region. By drilling, ice cores are brought up from varying depths (deeper the region older is the ice) and the entrapped gases are analyzed those reveal information about the concentration of green house gases and the contemporaneous temperature of the world¹.

¹There are quite a few other techniques for paleoclimatic study.

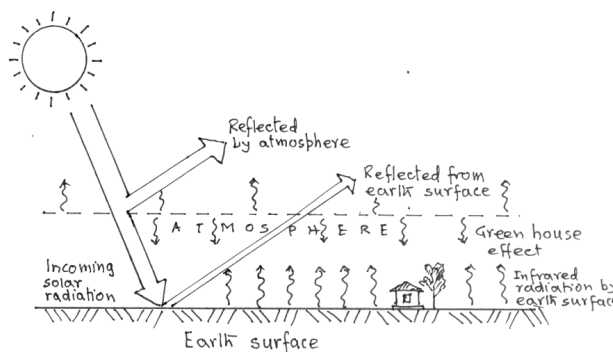


Figure 6: Greenhouse effect

Fig. 7 shows the results of such a paleoclimatic study. The influence of the green house gases like carbon dioxide is quite obvious. This is the main reason why IPCC is sending warning signals regarding the increased industrial activity resulting in increased carbon dioxide in the atmosphere and agricultural and associated pastoral activities leading to higher level of methane.

But, Fig. 7, which shows the paleoclimate for the past 600,000 years, also reveals an interesting fact. It shows that the world climate has always undergone periodic fluctuations between warm and cold climates. Obviously, the warming up in the past could not have been due to human activities. Such cooling and warming are natural

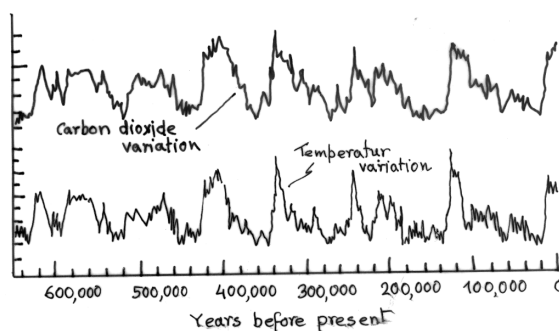


Figure 7: Paleoclimate for the past 600,000 years

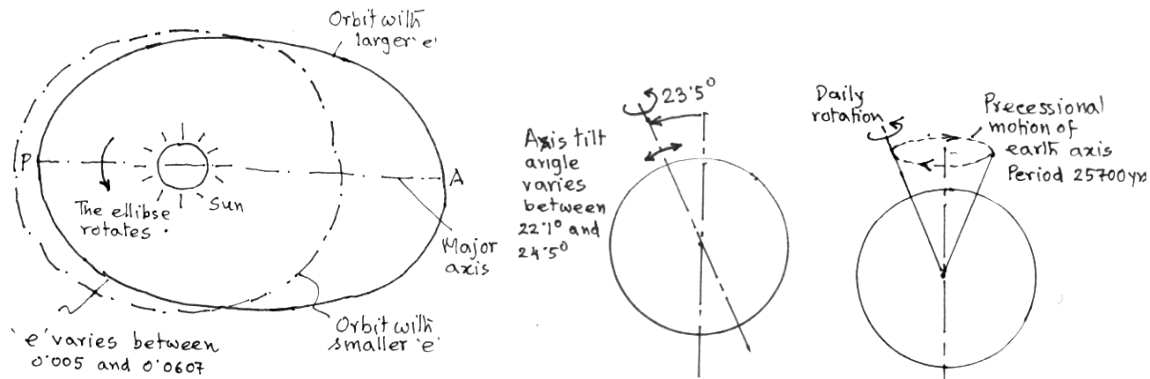


Figure 8: The sun-Earth system and the precession of the Earth

processes, and, in all probability are due to the periodic variations in the astronomical parameters causing variations in insolation. Many agree that the variations in the astronomical parameters resulting in varying the insolation distribution pattern on the Earth's surface can trigger some major climate changes.

Though the astronomical reasons for climate change are not universally accepted by geologists and climatologists, more and more proof on its support is being received based on increasing amount of observational results from paleoclimatic studies.

Relevant astronomical parameters

The important parameters of the sun-Earth system which play predominant roles in creating periodic variations in insolation and oscillating world climate need to be identified first. Fig. 8 shows the sun-Earth system and the important parameters are (i) eccentricity ' e ' of the Earth, (ii) tilt angle ' i ' of the Earth's axis, (iii) orientation of the axis and (iv) the spatial orientation of the orbital major axis, P represents the 'perihelion' (nearest to the sun) and A indicates the 'aphelion' (farthest from the sun) position in the elliptic orbit. This line AP rotates in the orbital plane taking about 14000 years to

complete one rotation. The axis of Earth's rotation also precesses (like a spinning top) taking approximately 25,800 years for one complete precession. The ellipticity (or eccentricity) ' e ' of the orbit varies between 0.005 to 0.0607 in a complex manner with three periods of approximately 4,13,000 years, 1,23,000 years and 95,000 years as indicated in Fig. 9(a). The tilt angle of the Earth's axis, ' i ', also oscillates between 22.1° and 24.5° with a period of 41,000 years as shown in Fig. 9(b).

Without going into the details the effects of the variation of each parameter will be as follows: According to celestial mechanics, the Earth moves faster in its orbit when it is nearer to the sun and vice versa. The Earth also is closer to the sun at perihelion receiving more sunlight. So, depending on the direction of the tilt of the Earth's axis the amount of solar energy received (say, by the northern hemisphere) will vary. If it is winter solstice near the perihelion position the amount of solar energy received during a whole year will be more than the situation when the summer solstice is near the perihelion position. This is so as the Earth moves quicker at the winter position and the summer is of longer period. But for a more circular orbit (i.e. with lesser

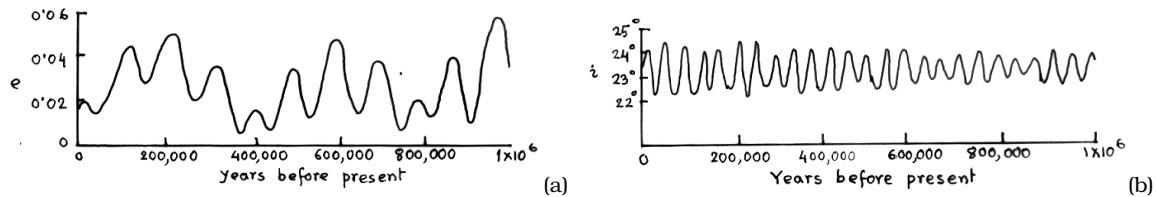


Figure 9: The variation in (a) ellipticity (e) and (b) the tilt angle (i) of the Earth over time

' e ') this variation will be less pronounced. Similarly, when the tilt angle ' i ' is more, the degree of seasonality is more². Hence a combination of higher value of ' i ' and a larger ' e ' will lead to stronger seasonality. As the landmass in the northern hemisphere is more and landmass radiates heat more quickly (losing temperature) a combination of the above type results in an overall colder climate in the Earth that leads to the ice ages. The gross effect is explained through Fig. 10. This figure shows the ice age and warm period of the recent past (up to 60,000 BC) and also of the near future (up to 60,000 AD).

It is seen that a combination of larger e and higher i leads to the onset of ice ages. Conversely, when both are lowest the climate becomes warm. However, these overall characteristics are superimposed upon by other short term effects due to the advance of the perihelion position and the precession of the Earth's axis. But many short term fluctuations are superimposed over and above this gross picture, when the advance of perihelion and precession of Earth's axis is taken into account.

Astronomical theory of climate change

The first hint of a possible connection between the variations in astronomical parameters and the climate change was given by Louis Agassiz in a meeting of the Swiss Society of Natural Sciences in

1837. Subsequently the year 1842, J. Adhémar proposed a theory linking the slow variations in the Earth's orbital parameters and the climate change by altering the duration of the seasons. J. Croll reaffirmed in 1875 that substantial changes in the climate could be a result of the variations in the orbital parameters. However, no definite progress could be made in this direction primarily because of the lack of more detailed astronomical information.

Interest in the topic was renewed when a Serbian mathematician M. Milankovitch computed the long term variation in the insolation because of astronomical reasons in the year 1924. In 1955 geologists rejected the Milankovitch theory based on their contemporaneous observational results; but since 1970 the theory received

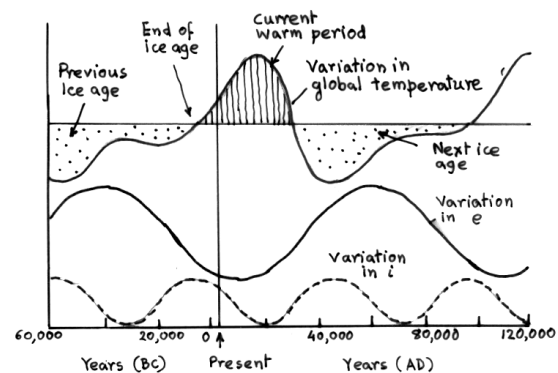


Figure 10: The ice age and warm period of the recent past (up to 60,000 BC) and also of the near future (up to 60,000 AD)

²when i is zero there will be no seasonal variation

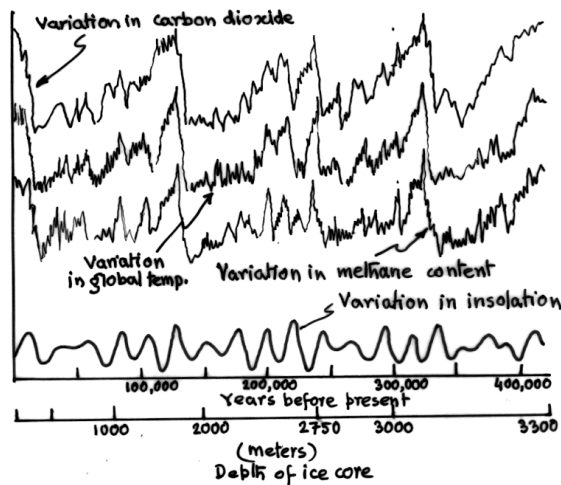


Figure 11: The computed insolation at 65°N latitude for the past 400,000 years and the corresponding world temperature, atmospheric carbon dioxide and methane determined from the ice core studies

renewed impetus. Of course, further validation of his computation had to wait till the subject 'paleoclimatic' study using ice cores in the arctic region reached maturity. Fig. 11 shows the computed insolation at 65°N latitude for the past 400,000 years and the corresponding world temperature, atmospheric carbon dioxide and methane determined from the ice core studies.

In spite of the superimposed short period fluctuations due to short term astronomical reasons (and other non-astronomical reasons like major volcanic eruptions, meteorite hits, sun spot activity etc.) the overall agreement with computed insolation is quite clear. Accounting for the precessional motion of the axis and the rotation of the orbital major axis is also possible and many of the relatively short term signatures can be explained. Another important parameter, the sun spot activity (with an 11 year period) can be also incorporated, though with lesser accuracy. More recent modeling of paleoclimate and the corresponding sea level and ice volume are shown in Fig. 12. It

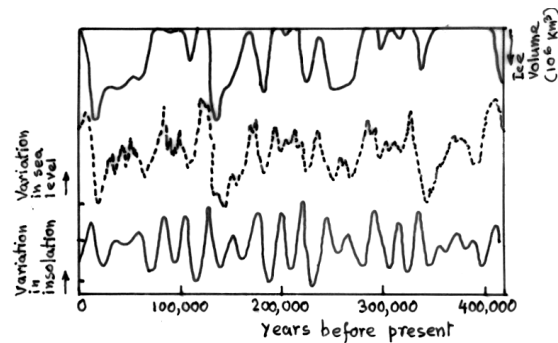


Figure 12: Recent modeling of paleoclimate and the corresponding sea level and ice volume

should be noted that the plot of ice volume is inverted so that its matching with the sea level can be readily recognized.

Global warming

A considerable amount of activity is taking place and the formation of the Intergovernmental Panel on Climate Change (IPCC) is a result of that. Climate change protagonists are issuing severe warnings about a doomed future if immediate steps are not taken by the international community to stop carbon dioxide and methane generation. Some even suggest that the world climate has already reached an irreversible stage and any way the future of the civilization is already doomed. On the other hand there are a few establishments claiming that the current observed global warming is a part of the natural climate change process. Without entering into any of the controversial issues it may be desirable for a general reader to have a look into some general basic information.

Figs. 13 (a) and (b) show the global temperature for the last 5000 years and the average sea surface temperatures for the last 3000 years. The short term warm and cold periods are clear from the plots. Fig. 14 shows the recent temperature variation record and the future prediction

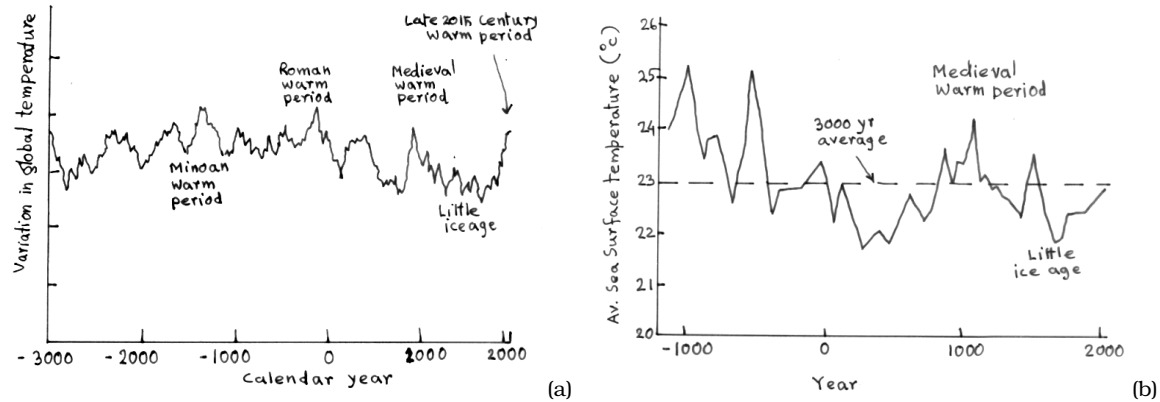


Figure 13: Global temperature for the last 5000 years and the average sea surface temperatures for the last 3000 years. The short term warm and cold periods are clear from the plots.

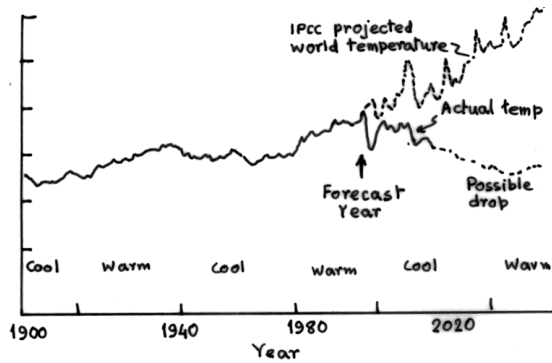


Figure 14: recent temperature variation record and the future prediction for the world temperature by the IPCC.

study of the paleoclimatic records. Normally it is believed that an increase in the atmospheric carbon dioxide (one of the major green house gases) leads to the increase in temperature. But the past record shows that increase in temperature always precedes the increase in atmospheric carbon dioxide, the lead period being of the order of about 800 years! It is still not clearly understood why that happened in the past. Thus, pointing finger to atmospheric carbon dioxide as the primary culprit for increase in global temperature may not be fully justified.

for the world temperature by the IPCC. It is found that the prediction was made in the year 1989, but the actually measured temperature record is not matching with the predicted trend.

It is suggested by most climatologists and geologists that presently the world is towards the end of the current interglacial warm period and if the past trend continues the temperature should start coming down in near future (in a geological time scale).

Another interesting phenomenon is revealed through a closer and more accurate

Concluding remarks

Since the world climate affects all human beings it is but natural that the general public needs to possess some information on climate change. The matters are extremely complex and beyond complete understanding; but this article may bring some relevant points to the knowledge of the general public. It is highly desirable to keep our atmosphere as healthy and clean as possible but the need for pushing the panic button should be carefully considered. □

Science, superstitions, and the role of scientists

An interview with Prof Jayant Vishnu Narlikar*

Krishnan: You spent your childhood in the lovely surroundings of the Banaras Hindu University where your father was teaching. The University at that time was perhaps a less frenetic place than it is today. It wasn't in any case a haven of criminals that it later became. Tell me about those days.

Narlikar: It was indeed a lovely place. It is lovely to look at, to live in, even today, but in the fifties the academic environment was not contaminated. It was scholastic and serene. Only towards the end of my days there did the troubles begin. Even then these were exceptions rather than the rule. Well, the deterioration has been rather steep all these years. Everyone has contributed towards it. BHU can't after all isolate itself from what is happening in Uttar Pradesh. My father used to tell me that during the Quit India movement the Governor of the then United Province wanted to send police inside the campus, but the then Vice Chancellor, Dr. Radhakrishnan put his foot down. Today the University can't be run without the active support of the police.

Krishnan: You belong to the great astronomical tradition that began in the Vedic times with the Vedanga Jyodisha of Lagadha and continued with such illustrious names as Aryabhata, Bhaskara, and

Brahma Gupta. Does this tradition weigh heavily on you?

Narlikar: I don't look upon myself belonging to a tradition of this kind. In my opinion, this tradition, the so called Sidhantic astronomy, that began with Aryabhata more or less ended with Bhaskara. I belong to the school of telescopic astronomy started by Galileo. We are all in a way his disciples.

Krishnan: It is understandable that we don't have many eminent experimental physicists in the country. It is perhaps due to lack of facilities. But how do you explain the paucity of theoretical physicists of international repute? After all we had, during the colonial times, such great physicists as Raman, Saha and Bose.

Narlikar: The main reason for this that we had allowed our Universities to run down. The major research institutions are outside the university system and they have hardly any connection with the student community. Bright students have no chance of watching top-notch researchers at work and hence they don't get inspired. The momentum that the universities had gained during the initial days of independence has dissipated. How then do you expect good physicists from this system?

Krishnan: Is astrology a science? Does it conform to the discipline of science? This is a very important question because the most crowded corners in major bookshops in Chennai are the ones stacking books on

*Excerpts of an interview of the eminent physicist Prof J V Narlikar by Mr P A Krishnan, reprinted with permission from <http://pakrishnan.com/2018/02/20/the-narlikar-interview/>

Interview

astrology. Let us first examine the arguments that supporters of astrology make when astrology is projected as a science. These are usually of the following kind:

- A. Astrology makes use of the positions of planets obtained by scientific observations, just as astronomy does. So if astronomy is a science, why not astrology?
- B. There is always someone who has heard of an astrologer whose predictions have come true. At least the astrology practiced by that astrologer must be termed science.
- C. Look at meteorology and medicine. Weather forecasts do go wrong, medical diagnosis is known to fail, and may vary from doctor to doctor. If these subjects are considered sciences, why not astrology?
- D. Some astrologers fail because they are bad practitioners of the subject: it is unfortunate that there are charlatans in the field, whereas the subject itself is fully scientific.
- E. Scientists are an arrogant lot who have rejected astrology without studying it or testing it.

Narlikar: To deal with these objections it is necessary to spell out what is required of a subject to be called a 'science'. Science has evolved over the centuries through a process of theorizing (T), experimentation (E) and observation (O). The process is ideally cyclical, rather like a winding staircase, where, one goes through the endless process and the rise denotes progress towards a better understanding of nature. In practice there are many slips and wrong turnings. The history of science is littered with falsified theories and misleading experiments or wrong observations. A scientist will be the first to admit this fact. He will also admit that at

no time can science claim to have solved everything. Rather, experience has shown that when you progress up the staircase new questions come before you that you were unaware of previously simply because your understanding was not sufficient to grasp them as questions.

So what is the strength of what we call science? It is its self-imposed discipline which works in the following way. A scientific theory must clearly state its basic assumptions, and these must be consistent with the evidence to date. Based on these it should present a logical framework of arguments leading to *falsifiable* predictions. The theory should not indulge in tautology, nor should it change its basic tenets each time it is called upon to make a prediction. In other words there is uniqueness about its assumptions. The predictions are subject to tests, which require experiments and observations. Now these have a built-in objectivity ... it is not the case that only scientist X can find the required result, while scientists Y, Z, ... can't repeat his experiment or observations. The experiment and observations should be designed in a controlled fashion so that their findings can be interpreted by statistical analysis. And with all these safeguards, no theory can claim to be perfect. Newton's law of gravitation was improved upon by Einstein's general relativity; but only after a large number of controlled experiments could this claim be acknowledged. Despite these successes no scientist today believes that relativity represents the last word on gravitation. Quantum gravity lies as the next challenge to be surmounted by any theory claiming to improve on general relativity.

Let us now come to astrology. Take (A) first. Astronomy follows the rigorous discipline of science described above; does astrology do so? Are there a unique set of basic rules for astrology? Is there a logical

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set of rules for interpreting data that is fully objective and not depend on a specific astrologer? Are failed predictions accepted as disproofs of the theory? The answers to all these questions is "No". Rather the attitude of supporters of astrology has been that their subject is perfect, and if it fails, it is because it is wrongly interpreted. So does interpretation vary from person to person? How then would you design textbooks for the proposed course or find teachers who agree upon a uniform approach?

Regarding (B), astrologers have probably not heard of Karl Popper, and if they have they choose to ignore what he said about a scientific theory. The Popperian view is that a scientific theory has to be abandoned if it fails on a single prediction. Thus successful predictions are necessary but not sufficient for the survival of the theory. If you ask that 'someone' how many unsuccessful predictions that astrologer made, he would not have the answer.

On (C), it is admitted that weather forecasts and medical diagnosis are not perfect; however, these subjects do follow the disciplines of science. In weather forecasting a complex calculation of the various conditions in the atmosphere and even on the ground are involved, with the forces controlling them getting better and better understood. So are the observations of the atmospheric conditions by man made satellites. Even detractors of meteorology as a science will admit that the quality of weather forecasting has steadily improved because of more sophisticated theory and observations. Medical science also does not claim to be perfect, but as with progress in biology and biotechnology, we understand the human body better, its diagnosis and treatment have consistently improved. It is to be noted that whenever a new drug is put on the market, it is tested under controlled conditions, for several years if need be.

Has astrology shown any improvement in its performance with inputs of science and technology?

(D) has already been considered. If the stand is that every time a correct prediction is made, astrology is a science, but a wrong prediction means that the astrologer is a charlatan, then there is no astrologer left who cannot be branded thus. Is it not time that the practitioners of the subject take a critical look at what they preach?

The last criticism (E) is unfair to the considerable body of work that already exists in literature about how scientists have studied and examined astrology and how each and every study conducted to verify the correctness of astrological predictions has failed to give a positive result in favour of astrology.

Consider by way of example, the study conducted by Bernie Silverman, a psychologist at the Michigan State University to test the astrological claim that matching or compatibility of horoscopes of couples has any bearing on the success or otherwise of their married life. The study picked 2978 couples who were happily married and 478 who were divorced. Their horoscopes were given to two established astrologers (who were not informed as to whom these horoscopes belonged), to agree between themselves as to which of the horoscopes were compatible and which were not. Their selection and the factual situation had no significant overlap as judged by standard statistical tests.

Krishnan: Still, astrology is enormously popular in our country.

Narlikar: One of the important reasons why astrology has survived scientific debunking is that it is looked upon as a psychotherapeutic exercise, which brings solace to human mind when confronted with moments of decision making, sorrow, disappointment, etc. Rather than worry

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Prof J V Narlikar

or brood upon difficult issues, it helps to delegate the responsibility to planets, or to someone who claims to interpret their effects. On such occasions logic is the last thing in one's mind.

There is another psychological aspect that goes under the name Barnum Effect. When P.T. Barnum, the owner of Barnum and Bailey's Circus was asked the secret of his success, he replied that his circus contained a diversity of acts and so even if different people in the audience liked different acts, everyone went away satisfied that he or she saw something worthwhile! Likewise, from the astrological 'predictions' the human mind picks up selectively those items that apply to the individual and ignores the discordant part. And astrological predictions are frequently worded in such a way that almost everything applies to anybody.

It could be argued that astrology will continue to exist and flourish, just because people seek solace in it and find it an aid to decision making. However, if man wishes to lay claims to the title of a 'rational animal', then one needs to worry; for there has so far been no rational justification for astrological statements. Indeed promoting it as part of higher education and encouraging its decision making process for architecture, weather forecasting, stock market investments, etc. is a giant leap backwards in time. In the West, belief in

astrology is more by way of fun, and does not enjoy the stamp of respectability. In our country, it is taken seriously in all walks of society and transcends all divisions with respect to caste, education, income, politics, etc. People consult astrologers for fixing marriages, for inducting ministries, for starting new businesses. In a country, which is trying to catch up on the developed nations, a rational and efficient management of human resources is essential. This could hardly be achieved by making them more superstitious.

Krishnan: How do you explain some gurus materializing objects out of the air?

Narlikar: I have no reason to disbelieve P.C. Sirkar who says that he can perform every act that a guru does. Gurus have never performed under controlled conditions.

Krishnan: There is this story about Niels Bohr. He had at the entrance of his laboratory a rabbit's foot hanging, which was supposed to be a good luck charm. When somebody asked Bohr whether he believed in such charms his reply was, "no, I don't. But they say it works even if I don't believe in it." Such stories are very amusing no doubt, but in our country superstitions have caused incalculable harm and hampered the intellectual and material progress of the people. How do we fight this monster of superstition?

Narlikar: It is very difficult. At the one end you have people who believe in fancy shastras, like the Vaastu Shastra. If we tell them that there is no scientific basis for it, their answer is may be there isn't any, but then we don't want to take any risk. At the other end we have persons practising horrifying rituals to propitiate deities. The only way to combat them is through constant propaganda and education. In Maharashtra, for instance, there is this people's movement called Andha Shraddha

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Nirmoolan Samiti. Its volunteers go from village to village and perform various acts of magic and explain to the people the principles behind them. The idea is to explain to them that there is absolutely nothing supernatural about these acts. They also offer to stay at night in houses that are supposed to be haunted. But the battle against superstition should begin at the primary school level and teachers have a big role in it. In fact the school syllabus should also be restructured to include lessons on combating superstition.

Krishnan: We have this infuriating inability to tell chaff from grain. This has caused incalculable harm to the almost inexhaustible storehouse of traditional knowledge that our country possesses – especially in the field of medicine. For instance there is a regular programme in one of the Tamil channels that has a person with funny degrees tailing his name grandly announcing every week that he has medicine for every disease known to mankind. How are you going to rescue such traditional skills from such sharp practitioners and subject them to scientific rigour?

Narlikar: There are aspects that are excellent in the traditional systems and there are aspects that should be immediately discarded. It is for the scientific community to undertake this exercise, subject traditional systems to scientific rigour, and separate grain from chaff. This has to be done carefully, on a sustained basis, without alienating the true practitioners of these systems. Charlatans will of course be there and only through constant education and effort can they be isolated.

Krishnan: You speak of the story of Kukudmi from Bhagavatam in your book *Seven Wonders of Cosmos* and quote it as one of the oldest stories that you know of wherein the concept of time passing at

different rates for different people or places plays a key role. For some people this information is just a short step to jump to the conclusion that our forefathers know Einstein's general theory of relativity. There is a poem in Purnanuru – a Tamil Kavya – which speaks of Valavan Eva vanurdi – a sky chariot without a charioteer to guide it. I can bring before you a number Tamil scholars who will swear that this poem is ample proof that the Tamils had an advanced knowledge of aviation technology. Similar is the case with the astras that our heroes fire in our epics. How do you propose to educate such people?

Narlikar: Every traditional society has this failing. They seem to forget that it is one thing to imagine and quite another thing to make a scientific invention or a law out of that imagination. It is not enough to state that Earth attracts moon; one has to give a quantitative law to make a scientific principle out of the statement. No scientific invention happens all of a sudden. It is usually the culmination of a long struggle that might have taken years and used up the time of generations of scientists. For instance take aircraft. It would not have become a reality without a proper propellant, without a light metal, or without a thorough understanding of the principles of aerodynamics.

Krishnan: Education in our country is in an advanced stage of decay. Barring a few exceptions, Universities today produce graduates who are virtually unemployable. Teachers in rural schools are barely literate. The chasm between the colleges and schools in the metros on the one hand and those in the rural areas and the small towns on the other is widening so fast that it may become unbridgeable. How are we to arrest this trend?

Narlikar: The only way to arrest this

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trend is to bring the National laboratories and Institutes close to the Universities. The scientists working there should interact regularly with the students and the students should be free to visit the laboratories and conduct experiments there. This will motivate the students and in the long run you will get better teachers. As regards primary and secondary education, the answer lies in training the teachers, paying them well, constantly interacting with them and updating their knowledge. This should be taken up at the National level and sustained for a long period say, twenty or twenty five years. The fruits of this effort will perhaps benefit our grandchildren. But a beginning should be made today. Of course education is inextricably linked with employment. Educating people without finding them right vocation can't be sustained at all.

Krishnan: The general view among the academics in India is that it is a consistent practice in our Universities to stifle, kill or, at worst, ignore academic excellence. The system is structured in such a way that only charlatans rise up the academic ladder. What are your views on this? Why is that papers written by Indians find it very difficult to get into reputed academic journals?

Narlikar: This happens because even academic and scientific institutions follow the bureaucratic way of giving promotions without seriously considering the merit of the person. They play safe and safety kills excellence. The academics and scientists who have willingly embraced this system should be blamed for the state of affairs. The universities and the scientific institutions should no doubt be untied from bureaucratic tethers but if this is attempted the academics and scientists will be the first to object because most of them are happy doing nothing and they have a vested

interest in the present system to continue.

Krishnan: The students are happy with a basic knowledge of the English language at the college level. They are not aware of the immense joy that the world of literature can provide. They just don't realise that good literature expands one's frontiers of imagination. Don't you think there is a need to give students a holistic education? Even to students of medicine and engineering?

Narlikar: I agree that language skills are very important even for a student of science and these skills are acquired only through a study of the extant literature of that language. Thus there is indeed a need to give the students a holistic education. Even to the students of medicine and engineering.

Krishnan: Do you believe in God?

Narlikar: The notion of 'God' is so variable from person to person that an answer of the yes/no type will be grossly misleading. Is a scientist expected to 'prove' the existence of God by demonstrating how well ordered the working of the universe is? Does it help him in understanding why there are laws of science? Judged purely by scientific logic, a fresh postulate that simply justifies only what is already known is no advance in one's understanding. Surely the 'God' that the seers from different religions experienced was different from the above scientific postulate. In other words, in my opinion putting the above question to a scientist – because he is a scientist – is unfair. Questions like 'Why is the universe governed by laws of science?', or 'What 'agency' decided that these and no other laws shall operate?' are beyond the scope of science. Simply postulating 'God' to answer these questions does not take us very far. But the basic faith a scientist has, that keeps him/her in business, is that there are some basic laws governing nature and the declared aim of science is to find them.

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Beyond that any other belief relating to 'Is there God?' may be answered by the scientist not in the role of a scientist but as a human being.

Einstein says:

Though I have asserted that in truth a legitimate conflict between religion and science cannot exist, I must nevertheless qualify this assertion once again on an essential point, with reference to the actual content of historical religions. This qualification has to do with the concept of God. During the youthful period of mankind's spiritual evolution, human fantasy created gods in man's own image, who, by the operations of their will, were supposed to determine, or at any rate to influence, the phenomenal world. Man sought to alter the disposition of these gods in his own favour by means of magic and prayer. The idea of gods in the religions taught at present is a sublimation of that old conception of gods. Its anthropomorphic character is shown, for example, by the fact that men appeal to the Divine Being in prayers and plead for the fulfillment of their wishes.

Imagine the following everyday situation. College student A does not study regularly and as the examination approaches, he realizes that he cannot get the high percentage of marks that he needs for his future career. So A goes to a temple and makes an offering to the deity so that he may get the requisite high marks. Student B, who is in a similar predicament, is more down to earth. He discovers who the examiners are, goes and bribes them so that he may score high marks. Are the expectations of A about the morality of his God any different from those of B with respect to the examiners? If God indeed fulfills the prayers of A is He not doing injustice to student C who has worked hard and prepared well for the examination? Why should A get the same marks as C?

Einstein had objections to a 'God' of this kind. He urged:

... In their struggle for the ethical good, teachers of religion must have the stature to give up the doctrine of a personal God, that is, give up that source of fear and hope which in the past placed such vast power in the hands of priests ...

Instead, he hoped that religions would come forward to the aid of science as it searches further for the truth behind the regularity of the universe from the very microscopic level to the grandest level. A great deal remains to be learnt to understand the mystery behind the observed rationality of the operations of nature.

However, not everything in our experience can be reduced to regularity and symmetry of scientific information. The role of the perceiving individual cannot be altogether ignored. Another great intellect of this century, Rabindranath Tagore describes his childhood experience when he came across a rhymed sentence loosely translated thus: 'It rains, the leaves tremble', in these words:

At once I came to a world where I recovered my full meaning. My mind touched the creative realm of expression ... The rhythmic picture of tremulous leaves beaten by the rain opened before my mind the world which does not merely carry information, but a harmony with my being. The unmeaning fragments lost their individual isolation and my mind revelled in the unity of vision. I felt sure that some Being who comprehended me and my world was seeking his best expression in all my experiences, uniting them into an ever widening individuality which was a spiritual work of art.

These examples illustrate but by no means exhaust the differing perspectives on the question. So, when someone asks me the question: "As a scientist do you believe in God? I reply: "It is too difficult a question for me to answer; and even if

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I tried to answer the question, it might be misleading, for you will interpret my reply within your perception of God which may be totally different from mine.”

Krishnan: You were one of the 1500 scientists worldwide who had signed a warning to humanity. I read excerpts from it:

“Human beings and the natural world are on a collision course. Human activities inflict harsh and often irreversible damage the environment and on critical resources. If not checked, many of our current practices put at serious risk the future that we wish for human society and the plant and animal kingdoms, and may so alter the living world that it will be unable to sustain life in the manner that we know. Fundamental changes are urgent if we are to avoid the collision our present course will bring about.

“We the undersigned, senior members of the world’s scientific community, hereby warn all humanity of what lies ahead. A great change in our stewardship of the earth and the life on it, is required, if vast human misery is to be avoided and our global home on this planet is not to be irretrievably mutilated.

“Success in this global endeavour will require a great reduction in violence and war. Resources now devoted to the preparation and conduct of war-amounting to over \$1 trillion annually-will be badly needed in the new tasks and should be diverted to the new challenges. A new ethic is required-a new attitude towards discharging our responsibility for caring for ourselves and for the earth. We must recognise the earth’s limited capacity to provide for us. We must recognise its fragility. We must no longer allow it to be ravaged. This ethic must motivate a great movement, convince reluctant leaders and reluctant governments and reluctant peoples themselves to effect the needed changes. The scientists issuing this warning hope that our message will

reach and affect people everywhere.”

There is another side of yours. You are also one of the defenders of India’s nuclear test. Don’t you see contradiction in assuming such mutually irreconcilable positions?

Narlikar: Let me explain. I am totally against nuclear weapons of all kind and I fully stand by the statement from which you have just quoted. What I said after the Pokhran blast was that the test was a great technical achievement. This can’t be twisted to mean that I am a defender of the nuclear test. My congratulations were to the scientists for carrying out in an exemplary way the task assigned to them and not to the political class that took the decision to make the bomb.

Krishnan: You were also one of the signatories – Baba Amte and Arundhati Roy were among them – to a petition that highlighted the misery caused in the lives of tribal people by the Sardar Sarovar dam across Narmada. The petition was ignored, wasn’t it? The urban India is blind to the misery of such rural victims of progress. Recently more than 200,000 workers lost their jobs in Delhi, which didn’t even cause a ripple in the newspapers. The rich are blind to the sufferings of the millions and millions of poor who inhabit this country. How will you make them see?

Narlikar: I don’t know how effective such petitions are, but I think I should not shun away from signing such petitions merely on the premise that it may not achieve what it seeks to achieve. Every small gesture counts in all such causes. Yes, the urban India is blind to the sufferings of the rural India and the urban rich don’t bother about the urban poor. It is therefore all the more important that persons whose voices will possibly be heard should highlight their causes. □

Organizational News

All Bengal Science Conference

The 7th All Bengal Science Conference was held on 18-19 January in the Purulia town. More than five hundred delegates from different districts of West Bengal participated in this conference.

There were two scientific sessions: one on 'Science and Scientific Outlook', and another on 'Problems of Environmental and Solutions'. Professor Partha Pratim Chatterjee, Director, NIFFT Ranchi, Professor Sirshendu De, a Bhatnagar Awardee from IIT Kharagpur, Professor Dibyendu Maity of the Delhi School of Economics, Professor Adinpunya Mitra of IIT Kharagpur, Professor Dhrubajyoti Mukhopadhyay, President, BSS All India Committee, Professor Soumitro Banerjee, General Secretary, BSS All India Committee, Professor Nilesh Ranjan Maiti and Shri Debasish Roy spoke in different sessions in the conference.

A new committee was elected with Professor Amitabha Datta as President, and Professor Nilesh Ranjan Maiti as Working President. Dr Radhakanta Koner was elected as Secretary, and Dr Nirmal Duari and Dr Subhraprakash Kajli, as Assistant Secretaries. Asish Samanta was re-elected as Treasurer and Pratyush Sikdar was elected as Office Secretary.

Mass Observation of the Annular Solar Eclipse

The Annular solar eclipse on 26 Dec 2019 offered a spectacular sight to people, particularly in those areas in Kerala and Tamil

Nadu falling under the belt of annularity. The Breakthrough Science Society had made elaborate preparations more than a month in advance to make people aware about this celestial spectacle and to facilitate safe viewing. Workshops explaining the science behind the eclipse, the ways to view the eclipse safely, to make simple devices for safe observation (like ball and mirror projector, pin hole camera, etc.) were conducted extensively in schools, colleges and localities in several states. These awareness programs evoked great enthusiasm among the students and general public. The eclipse provided a great opportunity to take science to the common people in a big way. A booklet in English 'Observe Annular Solar Eclipse—A Celestial Spectacle' was published on the occasion. The All India Committee of *Breakthrough Science Society* made arrangements to mass-produce safe sun filters using imported black polymer and distributed nearly one lakh filters all over the country. A brief summary of programs held in different states follows.

Kerala

The path of totality of the eclipse passed through mainly Kerala and Tamilnadu. The Kerala chapter of BSS made elaborate preparations organizing workshops and awareness programs all over the state. A science bulletin in Malayalam was also published and widely circulated. The BSS chapter of Kerala distributed approximately 32000 sun filters. In association with leading science popularisation agencies like

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People viewing the eclipse at Kozhikode, Kerala, which was on the belt of annularity

Kerala state Science and Technology Museum (KSSTM), Thiruvananthapuram and Regional Planetarium, Kozhikode, BSS organized many grass-root level observation programs. Compared to previous eclipses, the public turnout was large which points to weakened influence of superstitious beliefs. Hundreds of new volunteers came forward to take up the cause of the science movement.

Thiruvananthapuram: Two workshops were organized in the Planetarium for the volunteers. Many school/college students attended the workshops and came forward to take classes in other schools. 37 classes and 3 workshops were conducted. 4 observation booths were set up including the observation booth in Central Stadium where more than 5000 people assembled.

Kollam: In association with the Kollam Collectorate, a big observation event was organized at Kollam beach. Prior to that, 7 workshops and 18 classes were conducted. Totally 7 observation centres were set up on the eclipse day.

Pathanamthitta: 12 observation centres were organised, in which thousands of people observed the eclipse through sun filters. One workshop and 5 classes in institutions were conducted prior to the eclipse.

Idukky: Classes were conducted in MES College Nedunkandam, Newman col-

lege Thodupuzha, and Al Asar College Thodupuzha. One workshop for volunteers was organized and the student volunteers from Newman college conducted classes in 3 institutions. 4 observation centres were organised.

Kottayam: Throughout the district, 73 observation centres were organized. In Devamatha college Kuravilangad, along with KSSTM, and the Physics Department of the college, BSS organized eclipse observation event in which more than 2500 people participated. In Galileo Science Centre, Kottayam, observation with telescope was arranged. 8 workshops and 54 classes were conducted. The students of BCM college took 4 classes.

Alleppey: On Dec 26, observation centre was set up at Netaji centre Muttom in Alappuzha Dist. The BSS district chapter conducted 33 awareness programmes in educational institutions and 16 programmes in libraries, residential areas clubs etc. 1400 sun filters and 396 bulletins were sold.

Ernakulam: More than 30 awareness classes were conducted in schools, colleges and residential areas in which more than 3000 people participated. On Dec 26, public viewing program was organized at Durbar hall ground in Ernakulam with telescope arrangements where more than 1500 people viewed the eclipse. Observation centres were set up at Tripunithura and

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Koothattukulam towns also.

Trissur: Two workshops and 15 awareness classes were conducted. 2500 sun filters and 300 books were sold. On Dec 26, public viewing programs were organized in 4 places. BSS also joined hands with the Kerala State Science and Technology Museum to set up the eclipse viewing centre at Chalakudy.

Palaghat: A workshop in Government Sanskrit College Pattamby was organized in association with the Regional Science Centre Kozhikode. 15 classes and 5 observation centres were organized.

Malappuram: On the eclipse day, hundreds of people assembled in Malappuram town to view the annular eclipse. Three classes were conducted in institutions.

Wayanad: Public booths were set up in different towns through which thousands of sun filters were distributed. 1 workshop, 4 classes and 6 observation centres were organised.

Kozhikode: The Kerala State Science and technology Museum (KSSTM) in association with BSS organized the biggest eclipse observation centre in Kerala where the assembly was more than ten thousand. In association with the Regional Planetarium Kozhikode, two workshops with participation of more than 100 and 13 awareness classes were organized prior to the eclipse.

Kannur: Thousands of people observed the eclipse through the sun filters. More than 500 people assembled at the Police Maidan on the 26th December to view the eclipse. One workshop and 5 classes were organized.

Kasargod: One workshop was conducted at Government College Kasargod and sun filters were distributed.

Tamilnadu

A major portion of the path of annularity of the eclipse passed through the central

part of Tamilnadu. Large-scale awareness programs in the form of workshops, demonstrations and lectures were organised. About 60 awareness programs were held in the state covering Chennai, Perungalathur, Madurai, Theni, Andipatti, Batlagundu, Coimbatore, Ooty, Mayiladuthurai, Thiruchengodu, Thirupur, Erode, Karur, Sivakasi, Pattukkottai and Perambalore. The BSS Tamilnadu chapter published a booklet on eclipse in Tamil. 4000 Tamil books, 1000 English books, and 5000 sun filters were distributed in schools and colleges in the state. BSS participated in the joint initiative of Vigyan Prasar outreach programs along with Institute of Mathematical Sciences (IMSc), Astronomical Society of India (ASI), Tamilnadu Science Forum (TNSF) and other science clubs and organisations in the state.

Public viewing was organised on the day of Eclipse in residential complexes, beach, school/college grounds and market areas. In several places people themselves arranged public viewing using our sun-filters. The awareness program as well as the public viewing on the day of the eclipse were covered well by the media. Our volunteers also participated in live TV discussions and debates during the eclipse on the 26th morning.

Andhra and Telangana

BSS Hyderabad chapter organised Solar eclipse viewing program at Necklace Road People's plaza. Dr K Babu Rao (Retd. Chief Scientist IICT) and Mr R Gangadhara (Convener BSS Telangana chapter) spoke on various aspects of eclipse. Hundreds of students and general public participated in the viewing program.

Karnataka

The Annular Solar Eclipse event was witnessed across 10 districts. The event

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was widely campaigned across state with seminars and workshops. A video was also prepared in Kannada to understand the eclipse phenomenon, which was made available through social media. On 26th December, public viewing programs were organized at: Bangalore (RPA Grounds Rajajinagar, Navrang Ground Rajajinagar, HMT grounds RT Nagar, Laggere Rakshasi Halla, Florence Grounds Basaveshwarana-gar, Ganesha grounds Kengeri); Gulbarga (SBR school grounds, Proudha Devaraya PU college premises, Public garden); Dharwad (SS college); Davangere (HighSchool Grounds; Chitradurga (Chitradurga Science College, Vishwamanava Residential School, Rockfort High School, Kabeer-ananda Ashrama school); Raichur (10 places); Bijapur; Mysore and Kollegala. The event was well received across the state.

As a follow up to the eclipse observation programs, a Science Fest was organized at Seshadripuram College Kengeri in association with the college on Jan 7, 2020. Prof Jayant Murthy (Senior Professor, Indian Institute of Astrophysics) inaugurated the festival. Mr G Sathish Kumar (President, BSS Karnataka) also spoke. The fest featured science models exhibits from various schools, followed by a seminar on Space Astronomy by Prof Jayant Murthy.

Gujarat

The Universe Science Forum (USF) affiliated to Breakthrough Science Society organized seminars and awareness talks in Vidhyana-gar High School, Republic High School and Shalin Vidyalay in Ahmedabad. The USF volunteers also used posters, e-media and 'Vigyan Chetna' (Gujarati e-magazine) to spread awareness about the event.

On the day of the eclipse the Astronomy Club of St. Xavier's College, Navrangpura, Ahmedabad in association with USF organized a viewing program on the college

terrace using three telescopes and sun filters. The Vadodara chapter of USF organized viewing program at Jay Ambe School. Around 1000 students and teachers joined the observation. Apart from organizing eclipse viewing at various places in Ahmedabad city, viewing programs were organized at 17 places in various districts of Gujarat state: Bhaipura, Dhiraj Housing, Naroda GIDC, Usmanpura Garden, Mithakhali, Gujarat Vidyapith Campus, Hari Om high School, Nutan School, St. Xavier's college, Vidyanagar School, Republic High School and Shalin Vidyalay (Ahmedabad); Jay Ambe School, Tarsali (Vadodara); Sanskar School (Palanpur); Mehsana city; S.S. Agrawal College (Navsari).

Jharkhand

Awareness programs were conducted throughout the state. On the day of the eclipse viewing was organized in the following districts. **Hazaribag:** Saraswati Vidyamandir, Ideal Children School, Pasai, Bakaspura, Gandhi Maidan, Matwari, Okani and Masratu; **Jamshedpur:** Aambagan maidan, Badsha maidan, Mango, Baridih basti and Baliguma; **Aditpur:** Football maidan; **Chaibasa:** Chota Nimdih, Jagannathpur, Kamarhatu, Shishu Mandir Ground and Jhinkpani; **Chandil:** Omega Coaching center; **Bokaro:** Chandrapura football ground, Kalapathar; **Ranchi:** Ranchi town; Gadwa: Nagar Uttari and Vishnupura; **Godda:** Godda town; **Ghatshila:** Ghatsila, Kashida, Laldih, Dahigora, Gopalpur, Panchpandav, Netaji palli, Fldungri, Kadamdih, Chandabila, Kogda (Asonboni), Haldaju (Dhalbhumghar), Colpara, Jamua, Galudih, Kitadih, Premnagar, Deoshol, Kharbanda, Dakhshinashole, Dhandoa, Purnapani, Tilamura, Karaduba, Kalapather, Mahlisole, Jagannathpur, Chandanpur, Kamarigora (Chakulia),

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Kendua, Bankati, Kendadih, Bandhdih, Bhalki, Pungora, Dhadkidi (Galudih), Biram, Amdangra, jhaprishol, Mosabani, barajuri, nutandih, Sundardih, Sorodabar, Ragdih, Bakra, Charchaka, Dewli, Study center, Bhalupatra, Pathargora, Hendaljuri, Saheed mess, Nababkoti, Rekha mam mess, Tamokpal, Mahulia, Hathibari, Kandrapara, Latia, Galudih (4 places), Manusmuria, Belboria, Jamua, Chakri, Dongra, Banmakri, Pungora (Niche tola) and New colony Mosabani.

Chhattisgarh

Awareness programs were held in several places. On Dec 26, eclipse observation centres were set up at 9 places including Bilaspur, Durg and Raipur towns.

West Bengal

Widespread awareness programs were conducted all over the state. On the day of the eclipse, several observation camps were organised in all the districts of West Bengal. Along with the sun filters, in many of the camps telescopes were arranged. Exhibitions and discussions were held, and people took food during the eclipse.

Observation camps were organized in the following places. **Kolkata:** Deshbandhu Park, College Square, Jatin Das Park Metro Station (Hazra More), Jadavpur 8B, Bamsdroni, Sonali Park, Nimta Alipur Ground, Kestopur More, Oxford Mission Ground (Sakherbazar), KFR Ground (Behala); **East Midnapore:** Tamluk, Panskura, Haldia, Mahisadal, Contai, Egra, Bajkul, Mughberia, Nimtouri, Thekua, Nandigram; **Purulia:** Raghunathpur, Gorada High School, Bandwan, Purulia Town, Baram High School, Kenda; **Birbhum:** Bolpur, Siuri; **Malda:** Malda Town (College ground), Bhootni More, Alampur, Harishchandrapur;

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