

SCIENCE POPULARISATION : A PERSONAL ACCOUNT*

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This lecture presents a personal account of the author's efforts at science popularisation against the prevailing background of society's struggle to adjust to the rapid new inputs of science and technology. The continuing apathy towards science and the manifest lack of the scientific temper are harmful for the long term well-being of our country. It is argued that there is a great need for people from all walks of life to enter the field and make contributions through lectures, demonstrations, articles, films radio and TV as well as classroom teaching.

The Indira Gandhi Award of INSA has brought great happiness to me for reasons I will elaborate on in the course of this talk. I consider it a great honour to receive an award named after a Prime Minister who cared so much about science in so many different ways. In her talks before INSA and on various other forums, wherever possible, Indira Gandhi referred with missionary zeal to the importance of the scientific temper for a country like ours. It is very appropriate, therefore, that INSA has chosen to perpetuate her memory through an award for science popularisation.

I was in something of a dilemma as to the topic, I should choose for this lecture. It is not a technical topic in my research field in which I could at least pretend to say a few wise words. For me science popularisation is a hobby, something I enjoy doing in my spare time. I have derived inspiration from a few leaders in the field. I have tried to improvise and experiment, not always with success. I have learnt a few lessons and at the risk of appearing immodest, I am wiser today than when I first entered the field.

Taking all this into account, I felt that I could not do better than share with you a personal account of the trials and tribulations, joys and anguish, frustration and job satisfaction that lie in this path. In principle they are no different from those of a creative scientist or a creative artist, although their manifestations may be different. The bottom line of my account is that for me science popularisation has proved to be an extremely worthwhile activity and I recommend it to my fellow scientists.

The Early Days

My first attempt to deliver a popular lecture in cosmology dates back to 1960 when I was on a summer vacation visit from Cambridge. My talk was arranged in the Mathematics and Statistics Department of Poona University with Sir R. P. Paranjpye in the Chair. That imposing and august personality inspired great awe not only because of the many important posts he had held throughout his career but also (and especially to youngsters from Cambridge like

* Text of the Lecture for the Indira Gandhi Award for Science Popularisation of the Indian National Science Academy, delivered at Indore, on August 8th 1990.

me, because of his brilliant performance as India's first Senior Wrangler. As a schoolboy I had once been lectured by him on the importance of proper accent while speaking English. And here I was lecturing in his presence.

Surprisingly, I enjoyed the experience and could feel that I was able to communicate to the audience some of the excitement of cosmology. And being absorbed in the subject-matter I had ceased to worry about accent or syntax. Of course, what I had not realized then was that my task had been made easier because the audience was composed of mathematicians and scientists in general.

In 1963 the British science magazine *Discovery* asked me to write an article on *Gravitational Collapse*. Those were the days of the discovery of the quasistellar objects and the realization by astrophysicists that the source of energy of such objects lay in gravity whose strength mounts as the object contracts. It was this discovery that inspired an international meeting in December 1963 of astronomers, astrophysicists and general relativists in Dallas, Texas, to discuss the emerging frontier areas of relativistic astrophysics. I finished the first draft of the article after returning from the Texas Conference, and sent it to the Editor for comments. The response was encouraging although he pointed out several areas where I had assumed too much technical knowledge on the part of the reader.

It was then that I realized how difficult it is to write a nontechnical article on a technical subject. The final version of my article that appeared in the magazine was, however, successful enough to generate a good feedback from readers. Several non-scientists spoke to me upon reading the article expressing their wonderment at the strange effects of strong gravity.

If one may adopt the Sherlock Holmes maxim, the author of a popular article or the speaker delivering a popular lecture on a scientific topic should put himself in the reader's or the listener's place and examine whether the subject-matter as presented would be understandable. This is

not an easy exercise and I would find it easier to give a technical seminar on a topic in my own research field to an audience of technical experts than to give a nontechnical or popular talk to a wide cross-section of the general public.

Undergraduate Clubs and Societies

In the universities of Cambridge and Oxford there are several clubs and societies run by students to give expression to their various hobbies and interests. As a freshman, I visited the Societies' Fair organized in the beginning of the academic year, where more than a hundred such clubs had set up stalls to attract new members. Their interests spanned a wide range, from roof-climbing and archery to mathematics and physics.

The mathematical societies like the Archimedians, the Pythagorians and the Quintics had evening public lectures by mathematicians all over the country. The famous $\Delta^2\sqrt{\quad}$ club boasts of several distinguished speakers on its list. Its membership is hard to acquire and it lapses if you miss three consecutive meetings.

Such clubs serve the very useful purpose not only of widening a student's interests beyond his limited curriculum, but also of providing opportunities to experts to talk about the latest exciting development in their field. Some of my own experiences in public lecturing were acquired at the meetings of these clubs both as a listener and as a speaker.

It is unfortunate that such clubs and societies are rare on our college and university campuses. Partly this arises from an overburdened curriculum and spoonfeeding that leaves no time for anything else. Why should a student indulge in meetings of a club that provides no backup for this preparation for examinations? He would rather join a coaching class and perfect the technique of answering exam questions. Just as getting a driving license and ability to drive are two different things in our country, so are the technique of answering questions and

understanding of the subject two uncorrelated attributes.

Audience Responses

That there is interest in the student community in learning about the exciting developments in sciences and technology is not in doubt. Whenever I have delivered popular lectures in schools and colleges or IIT campuses the response has been overwhelming. There are big audiences and intelligent questions as well as follow-up correspondence from quite a few.

To some extent my own areas of research, astronomy and astrophysics, find echos of interests amongst the laymen, the general public. Typical topics generating curiosity are expressed through questions like these :

1. What are black holes ?
2. How was the universe created ?
3. Why does the sun shine ?
4. What are quasars ?
5. Is astrology a science ?
6. Is there life elsewhere in the universe ?

Answer to each of these questions can form the topic of a public lecture.

It is a common misunderstanding that such topics are too sophisticated for all but campus audiences. In fact the general public not only in the urban areas but also in rural or semi-urban areas shows a great desire to know more about the cosmos. In this connection I may cite my experience of a lecture series in Nanded, in Maharashtra.

For my first lecture, the auditorium (large by any standards) was not only full but overflowing so that the organisers had to arrange impromptu loudspeakers for listeners outside. They, however, felt that the second lecture will have a more limited audience since only the really interested ones would remain. The opposite

happened. The crowd was bigger for the next lecture and there was criticism of the organizers as to why the lecture was not shifted to an outdoor venue. The organizers then decided to hold the third lecture on an open ground with arrangements for slide projection on a large white cloth. My own rough estimate of the crowd strength for this third and last lecture (corroborated by others) was 10,000. And this crowd contained people from neighbouring villages as well.

I may cite another experience of lecturing in Raipur where the three lectures were arranged on the university campus that is somewhat away from the town. Here too the response was overwhelming. The organizers were surprised that the last lecture on a Sunday evening had a large attendance inspite of the usual Hindi movie on the TV as a counter attraction.

I should point out here that my lectures in Nanded were in Marathi and those in Raipur in Hindi. This is an important consideration often ignored by most of us who have been educated in the West or who think of science only through the medium of English. Science communication at the popular level goes down well if it is in the language of the region.

To many of us this presents an apparently unsurmountable barrier. Those who don't want to do it will keep on pointing to the difficulties — of technical vocabulary, of communication of ideas, of lack of practice and so on. To those motivated enough to attempt the task I can only say that practice makes one perfect. My first public lecture in Marathi was first written by me in English, then translated by me laboriously by using Marathi dictionaries and then read out from the manuscript. From then on it was a steady evolution towards a direct extempore talk in Marathi based on points only — an evolution that took about four to five years. It called for a special effort that was proved worthwhile by the audience response.

Whether it is public speaking or public writing, the aims of science popularisation are best

served by choosing the language of the target group. Mother tongue is the strongest mode of communicating ideas, of presenting arguments of channelling thinking along new lines. For mass communication in India, English has a very limited role. Unfortunately for science communication through Indian languages, while the scope is unlimited, the efforts being spent are very limited.

In passing I may mention my views on the medium of instruction for science. Because we have learnt science from the West, we naturally tend to the view that English is the language of primary instruction for science. This fallacious argument has one correct premise that knowledge of English for reading, writing as well as speaking is desirable if one wishes to assimilate and add to the rapidly growing information content of science & technology. I accept this premise and support it myself. However, when one is newly entering the field of science as in a primary school, the natural mode of exchange of information is the mother tongue spoken by the teacher and the pupil. If that language happens to be Hindi, for example, the pupil has to make additional efforts to understand a statement made in English. He takes the easy way of memorising the statement for reproduction. I have seen primary school children diverting away from true path of science — of asking questions — by this cruel imposition of English at an early stage.

My own instruction in science was in Hindi right upto standard X. It was the language of the region that I could speak fluently. English was taught as a second language from standard III. The change over to English as the medium of instruction came in what is now called the Junior College by which stage I had sufficient command of English to understand and assimilate lectures on science delivered in English. I could read extra-curricular books like Gamow's 'One, Two, Three, Infinity' and enjoy them. Can we not adopt such a pattern in our $10 + 2 + 3$ system ?

Modes and Aims of Science Popularisation

What should be the objectives behind one's efforts to popularise science ? The objectives can be many.

The first and foremost : there is need to prepare the society at large to learn to live with science and technology, to appreciate the benefits they are capable of bringing and to exert control on their harmful effects. Alvin Toffler talks of the future shock, of the numbering effect the rapid inputs from science and technology have on human society. In India we should talk of the present shock with the society decades to centuries behind in its mental outlook. There are numerous ways in which our society needs to be brought to the present. I shall discuss some shortly.

The second, no less important aim should be to inculcate the scientific temper amongst the masses. Here the masses include scientists also ! For, these practitioners of science often seem to forget the methods of science when it comes to their daily chores. I know a director of a planetarium who instead of using the opportunity for astronomical observations followed the traditional rituals at the time of the total Solar Eclipse in 1980. Why blame the rural population for traditional prejudices when the entire city of Bombay had a deserted look that day ? The scientific outlook is badly needed at all strata of our society. A practical minded farmer who would use new seeds only if he is convinced of their productivity possesses more scientific outlook than a fellow of a science academy who genuinely believes that sacred ash and gold watches can materialise out of thin air.

These problems are present in advanced countries also. Their nature is somewhat different in India because of the large heterogeneity of our population. It would be hard to find the kind of social mix we have in India anywhere else, let alone in an advanced country.

The disparity of incomes and living conditions, of opportunities for education and training, of the assimilation of science and technology in society... cannot be found elsewhere. On the one hand we have advanced computers, rockets and satellites, state of the art medical and surgical equipments while on the other, we have child marriages, prejudice based on sex and caste and quack medicines.

In 1977 I wrote science fiction story highlighting the prevalent preference for a male child. The plot briefly is as follows. A research scientist develops a treatment that can preferentially produce the child of the desired sex. Solution A, let us say, guaranteed a male child and solution B, a female child. The solutions get stolen and substituted with water by an unscrupulous character who masquerades as a holy man whose blessings are supposed to guarantee the wishes of a devotee with regard to the sex of his child. The Swamy gets immense popularity (and other material benefits that go with it) while the scientist finds that his trial treatments are continuing to be unsuccessful. He discovers the cause of failure and finally tracks down the culprit. The Swamy in confidence freely confesses his guilt. However, the scientist is puzzled. "My solutions were enough for hardly a hundred cases. How do you continue to be successful with more than a thousand?" he asks. The Swamy tells him that his stolen solution A ran out long ago but he now dispenses pure water as the magic solution with the caveat: "I don't take any credit for success. It all rests on your faith in the treatment". He tells the scientist, "The client blames himself on failure but comes back with presents if there is success... So long as there are gullible people it is a 'no-lose' situation". As he leaves the scientist asks: "You mentioned Solution A; What about Solution B?" The Swamy hands him a bottle "Here is your Solution B intact. You see, nobody wanted a daughter". This sets the scientist thinking about the consequences of his discovery and ultimately prompts him to destroy his formula as being potentially so harmful.

That the story was not out of touch with reality was soon demonstrated by the way amniocentesis is being practised in India by the unscrupulous. And this is only the beginning: what would happen when the magic formula of the story really becomes a reality and accessible to the public?

I mentioned this story to make two points. The first is that some discoveries of science can be harmful to the society if the society does not consciously take charge of them. The catastrophes of Hiroshima and Nagasaki, by their shocking impact brought home to us the evils of nuclear energy if used destructively. A biological discovery that allows a mating couple the choice of the child to be produced is equally disastrous in the long run if the society does not control it at the outset.

My second intention in bringing up the story was to highlight the impact a science fiction story can have. This story was scripted and broadcast on radio and TV and had been well received by lay audiences.

Science fiction need not be all space travel and encounters with aliens. It can be down to Earth. It can be a medium of highlighting the impact of science on society. It can be an exercise in futurology to the extent it helps us today in planning for tomorrow. As such science fiction can be an effective tool of science popularisation.

What other modes are there? As I mentioned earlier, public lectures with questions and answers can be extremely effective in conveying the excitement of the present age of science. As opposed to that, a well written article in a newspaper or a science magazine cannot generate an on-the-spot feedback, although it has the advantage of reaching out to a larger cross-section of the society.

The instant feedback has proved to be very effective in the lectures and demonstrations carried out by the various 'people' science move-

ments on their science 'jathas'. To debunk miracles there is no more effective way than explaining how it is done. I recall one series of such demonstrations in Maharashtra where one group went to a village to perform miracles and the other followed a few hours later and explained the mystery behind them in terms of science.

Another target group for special attention is that of school children, the generation to dominate the society in the future. Adults are hard to convince that the beliefs they have uncritically accepted may be wrong. Children can be more easily encouraged to keep an open mind.

And it is here, that we need to popularise mathematics, the queen of sciences. Rote learning, uninspired teaching and bad text-books have created a bugbear of maths in the child's mind. The logical reasoning, the exact nature, the beauty of establishing the result from a set of premises, the all pervading applicability of these results etc., are assets of mathematics. Instead they end up as its liabilities in terms of understanding.

Even in the advanced countries the irrational fear of mathematics continues inspite of experiments by educationists. There are a few organizations in India which are presently addressing their efforts towards mitigating the magnitude of the problem. They need more help, more ideas and more manpower. The commonality of the problem worldwide and the need for a multi-directional attack on it were highlighted in an Indo-US Workshop on Mathematical Education held in Goa in 1989.

Who ?

I wish to end with the most important question : Who is to do science popularisation in our country ?

With its claim of 'third largest manpower' in science and technology, why is India so far

behind ? Are professional scientists doing it ? No; because, they argue that it would cut into their research. Are journalists doing it ? No; because, they argue that their publishers are not interested in it. Are people with a flair for public speaking and a command over language doing it ? No, because they argue that they do not have the scientific training for doing it. So, science popularisation has remained the hobby of a motivated few, coming from a wide cross-section of the society. Some of them work alone, some through voluntary organizations. There are project funds, recognitions and rewards to be won in this field as in any other field where one tries for excellence. These motivated few have demonstrated that the fears and reservations cited before are not well founded: there is enough work here for everyone regardless of profession — a part-time hobby that may provide greater satisfaction than the full time job.

(*Contd. from page no. 75*)

high scoring and low scoring examinees on the post-test only. The pre-test-post-test method of item analysis for CRTs aims at an item's contribution to the instructional sensitivity of a CRT, but the Seddon method aims at an item's contribution to achieve the maximum agreement between the observed and true (domain) scores on a CRT. As the pre-test-post-test method has some "reputed" limitations (see Harris and subkoviak, 1986), if a CRT is to be used to describe examinee's performance in terms of a domain score, the Seddon method seems a better choice.

However, a more complex plan of research is needed to resolve the problem of item analysis for CRTs.

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