TEACHING OF ASTRONOMY

Donat G. Wentzel

*Tata Institute of Fundamental Research, Bombay, and University of Maryland, College Park, Maryland, U. S. A.**

During my four month visit to India, I have had the pleasure of both giving popular astronomy lectures, mostly at Madras Christian College, and discussing astronomy teaching in India during visits to several universities and institutes. I have also been associated with some of the renewed efforts to improve astronomy education in the United States of America. Dr. G. Verschuur and I are co-chairmen of the Task Group on Education in Astronomy set up by the American Astronomical Society. In this article I wish to outline some aspects of the efforts in the U.S.A. that might be of use in enhancing astronomy teaching in India.

Traditionally, college astronomy courses in the U.S.A. have followed the lead of the textbooks and covered "everything" in astronomy, as if the students were actually to become astronomers, or at least assuming that this book knowledge would be useful to the student in later life. Yet the teachers of these courses know that their students will avoid science in their later life to the best of their ability, with very few exceptions. Now the reduction in federal research support has made more astronomers aware that wooing the non-scientific population is an integral part of scientific activities. Simultaneously, and essentially without astronomers' help, several hundred planetariums have been constructed in North America within the last decade. Many are staffed by teachers who leave audience with the impression that astronomy is nothing more than positional astronomy. Analogously, in India there must be several hundred colleges offering a course in "mathematical astronomy" that leave college students with that same belief. Should not astronomers try to counteract this situation?

The trend in the U.S.A. is to present astronomy as a more humanitarian science. Astronomy appeals to both the layman and the scientist because it touches closely upon our imagination. How did the Universe originate? The birth and death of the stars, and the origin of the elements are popular subjects once people know that astronomers even consider such questions. Some religions believe in (a happier?) after life on other planets. Is there life on other planets? What can astronomy contribute toward this question? It is fortunate that even laymen can appreciate the current topics of research in astronomy, such as the Big Bang, and follow the current progress of various space programmes. Even a modest amount of physics in college course permits rather intensive study of some of these subjects. The increased emphasis on the popular topics has occurred primarily in college courses for non-science students. At the University of Maryland, our course now attracts about 4000 students per year (Wentzel 1971). It is an easy course, devoid of all mathematics but with emphasis on current scientific events. I believe that students learn more from a well presented easy course than from one in which myriads of poorly understood facts are memorized merely for the purpose of an examination. This and similar courses have led to the appearance of textbooks aimed more directly at the non-science students (cf Jastrow and Thompson 1972). I hope that Astronomy courses for non-science students will become possible in India. Another project to increase public awareness of astronomy is the writing of small brochures on limited astronomical topics, for instance "Atoms in Space". These brochures are to be used as units within physics or chemistry courses that otherwise make no mention of astronomy.

A selection of the more popular topics is also important for astronomy courses within Indian B.Sc. or M.Sc. science programmes, for the following reason. India has a number of telescopes planned, under construction or in initial working stages, and it also supports expanding radio astronomy and infrared programmes. These will prosper only if the very best science students are attracted to astronomy and astrophysics. They will be attracted only if they hear that astronomy is an interesting subject. In the U.S.A., astrophysics has been privileged to attract many of the outstanding physics students during the last decade. Frequently, they were attracted after they took one or two rather general astronomy courses toward the end of their B.S. or even M.S. programmes. In India, even among the science students, few ever hear of astronomy as a vital and exciting subject. As long as astronomy is taught almost only where professional astronomers are being trained, there is no basis by which astronomy can attract India's best students.

It seems essential for the prosperity of Indian astronomy that many colleges introduce an attractive astronomy course for their physics, chemistry and mathematics students. A single course emphasizing the popular topics is quite sufficient. Indeed, a series of astronomy courses would be counter productive because it would not hold the interest of either students or faculty in many colleges. I am aware that inserting even a single course into Indian college science programmes is difficult, but it can and has been done. It might be one of several choices for an optional paper, it might be part of an honours programme (especially if the good students are to be attracted), or it might be part of a space-science series. Most important, astronomers could well urge the replacement of "mathematical" astronomy courses by "descriptive" astronomy courses. An equivalent course is given in several astronomy departments in the U.S.A. as well as in numerous colleges. Under a title such as "astronomy for scientists and engineers" it is causing the appearance of several textbooks aimed at the college physics students (cf Smith and Jacobs 1973).

The level of difficulty in a "descriptive" course can be quite high. For instance, a series of problems

* Permanent address

in which the student determines the effects of reddening on the age of our Galaxy or on intergalcatic distances can be quite demanding. However, a great danger is that the level of such a course either is low, or decreases with time as the original interested faculty are replaced. Then the good physics student considers the course not worth his or her careful scrutiny. Fortunately, astronomy is unusual among the physical sciences in that even the layman can make personal observations and discoveries. Such observations provide not only excitement but also an appreciation of the personal aspect of scientific activity, a realization that experience and care are necessary for the more advanced observations and their interpretations. Usually, "observation" implies looking through a telescope, which is lacking in most Indian colleges. In fact, almost no professional astronomer makes discoveries by actually looking through a telescope. If astronomers use photographs to study the sky, why cannot physics students do so? Practical exercises involving photographs have been prepared at several universities (see resource section below). Some are aimed at science students, but so far rather few. At Maryland, our non-science students use six selected prints from the Palomar Sky Survey to study galaxies, seek a planetary and reflection nebulae, estimate ages and distances of various nebulae (Wentzel 1973); they use Lunar Orbiter photographs to study lunar history and they trace solar activity in its various appearances from the photosphere to the corona using photographs at various wavelengths taken on the day of the eclipse 7 March 1970.* The level of sophistication can easily be increased for science students. Note, however, that the photographic exercises in the U.S.A. have come about not because of sudden technical availability but because some astronomers have spent time and ingenuity, carefully selecting truly useful photographs and writing materials such that students find the photographs both stimulating and effective for their course.

The prime difficulty with practicals and students' discoveries appears to be the need to examine the students. The Indian examination system truly stymies me, but I gather that practicals can be evaluated on the basis of class performance and written materials. In my own course, with mere 50-minute sessions for the photographic exercises, I examine primarily that the student has gone through the routine, plus one or two deductions not appearing in class work, and I hope that he or she learned more than I ask in the examination. Gratifyingly, my students occasionally meet me some two years later and tell me what they liked in the course. Generally, it is a non-examined aspect. If the course taught them to read science articles in the newspapers, I consider this accomplishment more worthwhile than anything I ask on the examination.

The introduction of a descriptive astronomy course into many Indian college science programmes is possible only if a "package course" becomes available. The expertise to construct such a course certainly exists among Indian astronomers, but time and cooperation are also needed, perhaps at a summer school, to produce a text, practicals, materials for the practicals, and examinations; also to train teachers in the colleges and to try out the materials with subsequent improvements. The organization of this effort could be a major achievement for the Astronomical Society of India.

* A photograph of this eclipse, taken by the members of the Indian Institute of Astrophysics, was on the cover of the first issue of the Bulletin.

SOME LISTS OF ASTRONOMY EDUCATION RESOURCES:

Dr. K. D. Abhyankar (Osmania University) is the Indian Representative to the Education Commission of the International Astronomical Union. He has one copy of "Astronomy Education Materials" which lists books, atlases, handbooks, lecture notes, films, slides and photographs suitable for various levels of specialization, including sources, compiled in 1970 and updated in 1973. This copy is intended to be available to all Indian astronomers on a loan basis.

"Resource Letter EMAA-1: Educational Materials in Astronomy and Astrophysics" appeared in the American Journal of Physics **41**, 783, 1973, by R. Berendzen and D. DeVorkin. It lists commercially available items (books, journals, films and other teaching resources). Reprints are available from A.A. Strassenburg, American Association of Physics Teachers, Drawer AW, Stony Brook, New York 11790, U.S.A.

Two newsletters (supported by the American Astronomical Society) are available (at no cost, by sea mail) from TGER, Astronomy Program, University of Maryland, College Park, Maryland 20742, USA. The first (January 1973) contains, in part, a list of resources colleted at an astronomy education conference in 1972, including teaching aids and ideas; also a brief outline of the "Keller" method of individualized instruction and sources of materials for such courses. The second newsletter (Summer 1973), probably more useful in India, is an annotated list of practical exercises at various colleges in the U.S.A. and Canada, including information how to obtain students' and teachers' materials. It is compiled by Dr. H. Kruglak, Western Michigan University.

One set of the photographic exercises used at the University of Maryland, outlined in the text, exists at Madras Christian College (Dr. G. Abraham). My lecture notes (available from Dr. Abraham upon payment of postage) contain a short list of commercially available Lunar Orbiter, Apollo, and Mariner 9 slides. The "set of six prints from the Palomar Sky Survey" is available from CalTech Bookstore, Pasadena, California 91109, U. S. A. for $14.25.

Acknowledgment: I appreciate the hospitality extended to me at Madras Christian College and at Punjabi University and specially valuable discussions with Dr. S. M. R. Ansari.

References:

Smith, E. and Jacobs, K. 1973, *Introduction to Astronomy and Astrophysics*, (W. B. Saunders Co.).

Jastrow, R. and Thompson, M. 1972, *Astronomy: Fundamentals and Frontiers*, (Wiley).

Wentzel, D. G. 1971, *Am. J. Phys.*, **39**, 27.

Wentzel, D. G. 1973, *Mercury*, **2**, 13.