After the Eclipse

The cover of this issue shows pictures of the total solar eclipse which was visible in northern India on October 24th, 1995. Much has been written about the eclipse in newspapers and magazines, bringing out the awe-inspiring natural beauty of the phenomenon. But it is also of real scientific benefit to astronomers who study the sun. Can one not get the same results even at other times, by blocking the direct rays from the sun with a suitable disc placed in the telescope? No! While one can block the direct rays from the sun, there are rays which arrive from other directions because of scattering in the atmosphere or in the instrument. If one looks in a direction away from the sun, one sees the blue light of the daytime sky, which is nothing but scattered sunlight. The intensity is only about one millionth of what one sees when looking directly at the sun. But the corona of the sun (the glowing region surrounding the moon in the pictures of the eclipse) is even fainter than this! It cannot be seen from the earth under normal (non-eclipse) conditions. During a total solar eclipse, however, the atmosphere for nearly a hundred kilometres around the observer receives no sunlight. The sky is practically like that at night, and the faint outer layers of the sun are, all too briefly, available for study. This situation may be compared to the driver of a car being glared by the headlights of an oncoming vehicle. She can block the direct rays by placing a hand in the way. But if the glass of the windscreen is scratched or dusty, it appears bright due to scattered light. It is then difficult to make out dim objects on the road. The eclipse corresponds to the (rare!) situation when the driver of the oncoming vehicle turns off its headlight, and the whole windscreen is in darkness.

The chemical element helium was first detected during an eclipse in a spectrum of the sun's outer layers taken in the nineteenth century by English astronomers. The site was in the tobacco fields of Guntur, in Andhra Pradesh. Even though eclipse studies have been carried out for a long time, instruments become more sophisticated and more portable with each passing year. Further, the sun changes in its properties over a cycle of roughly eleven years, during which the number of sunspots, the magnetic field, and other properties vary. Therefore, eclipse studies still have their role in solar astronomy, even in an age of space instrumentation. The cost of an eclipse expedition is still far less than that of a high altitude observatory or a space mission.

One marvellous use of eclipses is in dating historical events. A solar eclipse is visible from a given point on earth only once every five hundred years or so. When Babylonian astronomers observed an eclipse, they recorded the precise date- in their calendar! The conversion to our calendar is not known accurately. But it is enough to know it with an error of less than a few hundred years. One can then work out which solar eclipse was seen by them, and thereby obtain the conversion to the exact day. One fascinating byproduct of this calculation is that while the sun, moon and earth were

aligned on that day, it appears that Babylon was on the night side of the earth! The fact that the eclipse was indeed visible from Babylon means that something had gone wrong with the calculation. The total angle turned by the earth in about three thousand years had been underestimated by a hundred degrees, leading to an error of several hours in the predicted time. Astronomers believe that the discrepancy is because the earth has not been rotating at a fixed rate. It was spinning slightly faster in the past, and the day was a few hundredths of a second shorter a few thousand years ago than it is now.

Other studies during an eclipse have been made in the atmospheric and biological sciences. The removal of solar heating can cause some interesting effects in the atmosphere. So much of life is tuned to the regular cycles of light and darkness that it can be influenced in strange ways by the abnormal pattern. The general question one can ask about any study carried out during an eclipse is whether it could have been done more simply even without an eclipse, i.e. when the sun sets. Some of the results claimed and even reported in the press come under this category! Results obtained from a location where the eclipse was partial are open to a similar criticism. Such experiments do not exploit the unique circumstances which prevail during a total solar eclipse.

The total eclipse is possible because the angular size of both the moon and the sun are nearly the same, about half a degree. This matching is quite accurate. In fact, when the moon is at the furthest point of its elliptic orbit around the earth, its angular size can become slightly smaller than that of the sun. If there is an eclipse at this position, the moon is unable to cover the sun fully, causing the rare 'annular eclipse' in which a bright ring of sunlight peeps out all around the moon.

There is no physical or astronomical principle which requires these two angular sizes to be so nearly equal. We should regard it as an astronomical accident that we are able to enjoy this spectacle. And we should enjoy it while we can!. According to astronomers, the spinning earth is gradually being twisted backwards, i.e. its rotation is being 'braked' by the friction of the two tidal bulges raised in the oceans by the moon. Newton's law of action and reaction then tells us that the moon must be pushed forward in its orbit. It will therefore gradually recede from the earth. A billion years from now, there may be no total eclipses to gape at. And a hundred million years ago, the dinosaurs enjoyed slightly longer eclipses than we do today!

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The eclipse photographs which appear on the cover page were taken by Mr Dilip Kumar, a member of the Association of Bangalore Amateur Astronomers. It may be noted that he ground and polished a special mirror just to take these photos. Mr Dilip Kumar, who holds a diploma in electrical engineering works in the Inspection Department of ITI, Bangalore. His hobbies are astronomy and photography.