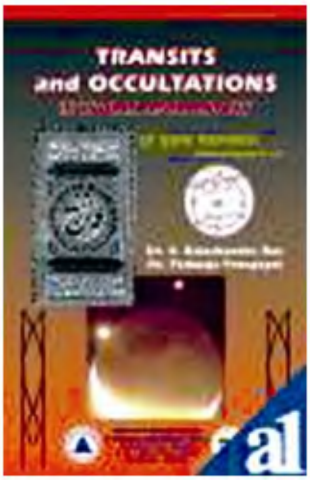

Transits and Occultations in Indian Astronomy. S. Balachandra Rao and Padmaja Venugopal. Bhavan's Gandhi Centre of Science and Human Values, #43/1, Race Course Road, Bangalore 560 001, India. 2009. xii + 118 pp. Price: Rs 75.

This is a short, interesting and useful book, priced very reasonably, on the study of a class of astronomical phenomena in ancient and relatively recent Indian astronomy. The authors are mathematicians who have for long studied Indian astronomy as historically practised, and the senior author has written several books on the subject in English and Kannada.

A transit is simply the eclipse of the Sun by one of the two inner planets, Mercury and Venus. When seen with the help of a small telescope (with adequate protection for the eye!), a transit is a beautiful sight with a small, dark, perfectly round object moving slowly across the bright disc of the Sun. This is in complete contrast to the awesome spectacle of the total Solar eclipse, in which the Sun is completely and exactly covered by the shadow of the Moon. In this case, the phenomenon is wholly dependent on the accidental equality of the size of the Moon and the Sun as seen in the sky. The two, of course, have very different physical sizes, but they are also at vastly different distances, which are just right for the two to have equal angular sizes. Such an accident is very rare, and it is unlikely to have a counterpart amongst the hundreds of extra-Solar planets which have already been discovered, or in the many millions that surely exist. Moreover, as tides drag together the revolving objects, the angular sizes will change, and a total Solar eclipse will no more be visible in the distant future. We truly live at a fortuitous time, in this one respect at least.

Transits occur because the planets revolve round the Sun in nearly the same plane, which is not an accident. The planets were formed from the matter which rotated round the Sun in a disk, after the star itself was formed, and they move (nearly) in a plane dictated by the angular momentum of the disk. It is only the two inner planets which can be seen between the Earth and the Sun, and when this happens is completely predictable, given the laws of planetary motion. That can be done in a flash by modern computers, but was a major exercise in the 17th century, when Johannes Kepler, who discovered the laws, predicted that transits of Mercury and Venus would occur in 1631. The transit of Mercury was indeed observed, but not by Kepler, who died the previous year. Kepler had missed from his calculations that another transit of Venus would occur eight years later. This was discovered by a young student in Cambridge from his own calculations, and he observed the transit, even given the extremely unpredictable weather, and his need to leave his telescope from time to time, possibly to attend to Church services (the book under review mentions just an important assignment). Transits are interesting to predict and observe, but they can also provide important scientific data. For example, the same transit observed from different locations on the Earth leads to a measurement of the angle subtended at the Sun between those points. The known distance between the points, and this angle, together provide the distance to the Sun, which is known as the Astronomical Unit. This, in turn, provides the scale for all other distance measurements in the solar system. More accurate methods for this measurement are now available, but the fascination with observing transits remains, especially in the community of amateur astronomers, because of the rarity of the event. The transits of Venus alternatively occur with long and short intervals. The short ones are always eight years, while the long ones alternate between 121.5 and 105.5 years. Only six have been observed so far, after the first one predicted by Kepler for 1631 having been missed. The last occurred on 5 June 2004, which the reviewer was fortunate enough to observe, and the next one will be in 2012, after which there will be a long gap of 105 years. The transits of Mercury are more frequent, 13 having occurred in the previous century. Transits have recently come of their own in discovering planets outside the solar system. When such planets pass between their parent star and the Earth, they cause tiny, time-dependent change in intensity, which modern large telescopes and instruments can detect, leading to the discovery of the otherwise invisible planet.

The first eight chapters of the book provide accounts of transits of Venus mainly (these are the more important ones scientifically, and the rarer). After a description of the first observation from England, the authors recount various observations made from India, including the two abortive attempts by the French astronomer le Gentil, who left France for Pondicherry in 1761, and returned only in 1771, after undergoing, amongst other hardships, two ship wrecks. There are accounts of transit observations by Indian astronomers, and the nice pedagogical description of the transit of Venus (in the fourth chapter) is based on a pamphlet produced for the transit of 1874 by C. Raghunathachary. Everyone should find these chapters interesting, and even inspiring.

The book changes course in the remaining six chapters, describing other astronomical events where objects come close to each other: Occultations, where the Moon during its passage in the sky covers stars which are close to its path; conjunctions, where planets come close to each other or to other stars, and so on. These events are all visible to the naked eye, and have therefore been observed and studied from ancient times. They lack the rarity of the transits of Venus, but occasionally produce pleasing patterns in the sky, like the conjunction between Mars, Jupiter and the horned Moon observed nearly a year ago. Some of these events can be of great use to astronomers and historians. It is pointed out in the book that patterns described in the *Mahabharata* and by Varahamihira, are impossible to achieve, given the shapes and orientations of planetary orbits. These were described, presumably, to accommodate poetic fancies in the first case and astrological necessity in the second. The first quasar was discovered in 1961 using the occultation of the associated radio source by the Moon to

obtain its position very accurately, with the discovery leading to a paradigm changing shift in astronomy. Interesting patterns in the sky, which have been reported from ancient times, can occasionally be reliably dated using computers to track back in time the positions of the objects involved.

In the six chapters which treat the associations, the authors adopt a somewhat more technical tone, freely using nomenclature (like Siddhantic astronomy, which K. D. Abhyankar has said originated with the works of Aryabhata I and Varahamihira around 500 AD) and concepts which most readers would not be familiar with. Various calculations done using ancient formulations, and sometimes their more recent counterparts, are presented to show that the results obtained compare favourably with results which follow from modern techniques. These chapters would be accessible only to those with some knowledge of astronomy, but the results and facts should be of interest to historians and others.

In summary, the book is an interesting, manageably brief and mostly readable account of a class of astronomical phenomena from the ancient perspective. The style and content of the book is unlikely to appeal to young students of astronomy and physics, but the more mature reader with some interest in the history of astronomy and science, as practiced in India of long ago, should surely find it useful. More such books are needed to be written in India, so that we have the opportunity to examine and understand the enormous contribution made by our ancestors, and their place in the development of modern thought and civilization.

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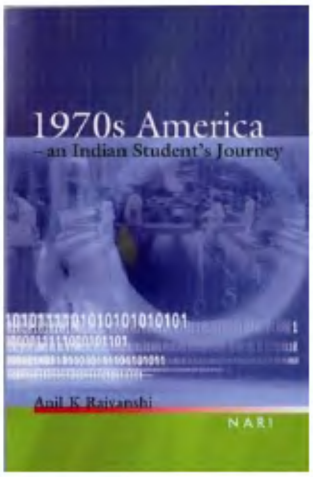

1970s America – An Indian Student's Journey. Anil K. Rajvanshi. Nimbkar Agricultural Research Institute, P.O. Box 44, Phaltan 415 523, India. 2007. 166 pp. Price: Rs 150/US$ 15.

A young IIT graduate engineer goes to USA to study for a Ph D; works at the height of energy crisis in 1970s, with the best experts in the world, on energy generation from alternate sources and falls in love with an American born Indian graduate student. The married couple finish their Ph Ds and our hero starts managing a large energy related international project in USA. Soon he gets very attractive offers from the top organizations in USA and India, Bell Labs, Tatas, CSIR, US Government programs, many universities, etc. But the young couple heads to a very small town in Maharashtra, India in the early 1980s. Our adamant hero continues with his wife to struggle for the next 25 years and builds up a research lab practically from scratch, to help farmers to generate energy using modern technologies. Is it a plot of an idealistic Hindi commercial Movie? No! this is real life. This is the autobiographical saga of Professor Anil K. Rajvanshi.

Rajvanshi has an engaging and polite style. The whole book unfolds like a novel. Rajvanshi's simplicity, eagerness to learn and use any new technology, spiritualism and all at the same time mixed with Indian style of a detached observer of his own life makes his sketch quite engrossing. Parts of the book and specially this mixture remind you of classics like *My Experiments with Truth* by Mahatma Gandhi or *Wings of Fire* by Abdul Kalam.

Our national labs, universities, top government and private organizations are full of people like Anil Rajvanshi. Many of them, after their stay in western countries in the decades of mid-twentieth century following our independence, because of their own convictions, came back to India on meagre salaries and yet spent and enjoyed next decades working quietly in their environment. This is the silent majority of intellectuals, administrators and researchers from India. They will immediately identify with Anil, although Anil is still a little different. He and his wife chose to stay and struggle in a very small town and work in a research lab with almost no facilities.

Rajvanshi is a technologist researcher. He is at his best when he describes how he analysed his engineering problems and experimented in University of Florida at Gainesville. Generally people not familiar with researchers tend to believe that scientists live in their ivory towers and have nothing to do with nature. Reality is opposite. Most good researchers, irrespective of whether they do Mathematics, Physics, or Engineering, get their inspiration and guidance from the nature and sometimes even from spiritual aspects. Anil is no different. Nature provided him clues for his engineering problems.

So when he wanted to create solar collectors that could follow the sun for maximum interception of solar energy, he went to botany professors and tried to learn how sunflowers follow sun and plants manage their energy. When he wanted to use high DC voltage and flip flops to break bonds of water molecules for increasing the evaporation, he went to electrical engineering department and tried to learn how evaporation is increased by high voltages created during lightning. When he wanted to create temperature sensors, he asked how nature sensed temperature and found out that infrared sensors (IRS) of rattle snakes are fantastic and can sense difference in temperature up to 0.010C to help them in catching their prey. When he wanted to save water, he tried to learn from biochemists how beetle in Namibian desert collected dew on its backside and used that water to survive in the harsh atmosphere of the desert. He then went on setting up three experiments based on these ideas on roofs of three different labs in his university.

Anil had gone to Florida on a scholarship given by the Government of India. Here was a person who was not even getting any official money from the univer-