The Enigmatic Moon

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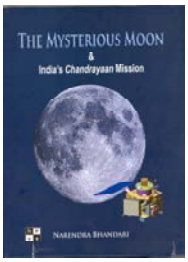

The Mysterious Moon & India's Chandrayaan Mission
N Bhandari
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It may come as a surprise to many to hear that astronomers talk about the origin of the universe with more conviction than that of the Moon, our nearest neighbour in space. We hear of 'precision cosmology' by the methods of which the contents of the universe are being weighed to high accuracy. But the origin, content, structure and evolution of our lone satellite still remain shrouded in mystery.

And yet the most surprising thing is that these little known aspects and the enigmatic side of the Moon are not taught in our schools— our science text books are written as though everything is known in the universe, and whatever is not known is not worth mentioning. It is no wonder then that most people are surprised by the plan to launch a mission to the moon by India. What's there to know about the Moon? Didn't the Apollo astronauts walk on the moon and bring back rock samples? Why send a spacecraft just to take some more photographs? They ask and fret about the cost of the mission.

Amazingly enough, the biggest puzzle about the Moon was discovered just about fifteen years ago, long after the flurry of lunar missions in the 70s. The American spacecraft *Clementine* discovered the biggest crater on the Moon, which is now called the South Pole-Aitken basin, because it stretches from the lunar south pole to a crater called Aitken. As a matter of fact, it is the largest of all impact craters in the solar system, being roughly 2500 kilometers in diameter and 13 kilometers deep. The object whose impact with the Moon created it must have been huge, and one wonders how the Moon survived the impact. If the basin is deep, then does its surface show characteristics of the crust, or the mantle beneath the crust? Is there water-ice in the permanently shadowed part of the basin? All these questions remain unanswered till today. The two sides of the Moon – one facing us and another looking the other way – are very different in their topography and mineral composition. There are more craters on the other side whereas the near-side (facing us) has more deep basins (darkened with lava). When and how did this difference develop?

Vigyan Prasar has published a book written by Narendra Bhandari, a renowned authority on lunar sciences, to mark the launch of the Indian mission to the moon, Chandrayaan-1. The author and the publisher both deserve praise for the lucidly written and well illustrated book, which tells the story of the moon, what the scientists have found out so far and the puzzles that still remain, in a language

which will appeal to everyone from school students to curious lay readers. One of the aims of the Indian mission to the moon is to enthuse students into studying science and partaking in scientific research. The surge of space missions after the 60s did see a growth of research in astronomy in the Western world, and one hopes that Chandrayaan-1 will make Indian students curious about science, especially in the times when the brightest of our students appear to chose careers in money laundering in the name of investment banking or tinkering with softwares produced elsewhere in the name of information technology. If this goal of the Indian mission is to come true, then scientists must attempt to reach out to the general public and tell them about the necessity of a mission like Chandrayaan. 'The Mysterious Moon' by Bhandari does precisely this, and successfully too.

Bhandari begins by pointing out the uniqueness of our Moon amongst the objects in the solar system. No other planet has a satellite so big compared to the planet. It does not seem to have been captured like those of Mars, and it could not have originated alongside the Earth, because the average density of the lunar material is smaller than that of the Earth. The Moon is also special in that it is neither too large to have trapped the heat generated inside it and produced volcanoes, nor too small to avoid melting the inside altogether. There are signs of lava on its surface (the dark patches), yet it does not have plate tectonics or magnetic activity. The moon therefore is a unique laboratory to understand the origin and evolution of objects in the solar system.

Bhandari's style of exposition is laudable in that he does not simplify unnecessarily, and yet conveys the crux of the matter, and the excitement of scientists working on the Moon. He explains difficult concepts in an easy language. For example, he says that most objects in the solar system have similar content, yet a small piece of rock that is an asteroid is vastly different from a much bigger piece of rock that is a planet like our Earth. He explains how size dictates how an object should evolve with time.

After discussing the present status of our knowledge of the Moon, he discusses the possible origin, and the problems with all existing hypotheses. The difference in average density of lunar and terrestrial material implies that the Moon could not have originated by the side of the Earth. Yet, similar ratios of isotopes of elements like Oxygen show that they do share a common, parent material. The most probable scenario is that a large object, perhaps a residue from the planet formation era, hit the nascent Earth and threw off a large amount of debris from its upper part, and the debris then came together due to gravity to form the Moon. There are some negative points of this hypothesis. The high temperature generated by the collision would have led to different ratios of isotopes in lunar and earth material, but observations show the opposite. Scientists still need to know a lot about the moon to be convinced by this idea

though. For example, one still does not know if there is a core, or how various elements are distributed on the moon.

Bhandari then reviews all past missions to the moon, and lays the ground for the Indian mission. Why send another mission to the moon? Chandrayaan-1 will map the terrain of the moon, in three dimensions, more accurately than all previous missions. It will also have a unique high energy X-ray detector – which is a niche area of research of Indian astronomers, who will soon send a satellite with a high energy X-ray telescope in space (named ASTROSAT, scheduled to be launched in 2010). The X-ray mission on Chandrayaan will detect and analyze the X-rays scattered by lunar material, and will be able to map the content of the lunar crust. In particular, it will look for decay product elements from radioactive nuclei buried in the lunar soil, and therefore, it will be able to date various parts of the moon which will help sketch the history of the moon. Bhandari's book then gives a detailed inventory of all the instruments aboard Chandrayaan-1 and the experiments they will help to carry out. This is explained in the perspective of what other countries are doing and plan to do in the near future, as well as the plans of future Indian missions to the moon. There are plans to send Chandrayaan-2 which will probably land on the moon, analyze the mineral composition, and probe the suitability of a lunar base.

Bhandari has written a timely book that will whet the appetite of everyone curious about the Indian mission to the moon in particular, and about the Moon in general. The quality of paper, printing and editing are excellent, and the cover illustration is attractive. The publishers have not only given the Indian readers a chance to take a peek at what our space scientists are up to, but they have also solved our problem for looking for a suitable gift in the New Year season.

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