by 28,230 million barrels of oil. The 46-odd hot-springs alone have temperature high enough (>150°C) to generate electricity amounting to 1838 million watts for a period of 30 years. All that is needed to be done is to directly convey the superheated dry stream to power plants or injecting surface water into fractured rocks through deep wells in geothermal areas, and bring it back in a vapourized form to power plants. And 60-odd springs of intermediate range (150–90°C) have the potential of generating electricity through the use of binary cycle-heat exchangers containing liquid with a low-boiling point which is immersed in underground wells.

Why does India not embark upon this venture, in order to supplement its energy needs, when New Zealand, Iceland and USA, among many nations, are successfully doing this?

Those who are looking for alternative sources of energy and those who care for the environment of the land and sky, would find this book useful.

K. S. VALDIYA

Jawaharlal Nehru Centre for Advanced Scientific Research,
Jakkur,
Bangalore 560 064, India
e-mail: valdiya@jncasr.ac.in

The Moon That Wasn't – The Saga of Venus' Spurious Satellite. Helge Kragh (with the assistance of Kurt Moeller Pedersen), Birkhauser Verlag AG, Basel, 2008. 199 pp. Price: US$ 39.95. ISBN 978-3-7643-8908-6.

The renowned Danish historian of science, Helge Kragh is well known for his various books[1,2]. His present book deals with the spurious moon/s of the planet Venus, which were supposedly seen by astronomers like Fancesco Fontana (Italian), Jean Dominique Cassini (Italian), Peder Roedkiaer (Danish) and Frédric Petit (French). This book consists of seven chapters and an extensive bibliography covering literature published during the last 350 years. Also, short biographies of the related astronomers are given. The book also contains more than 30 figures, which provide information of the subject matter, such as the pictures of Venus and its moon/s as seen by different observers.

In the 'Introduction', the reader finds information about the origin of terms 'Venus' and 'Satellite'. The number of discovered satellites (25) until 1910 is also listed (p. 4). In the same chapter, the author justifies his work as follows: 'The case of Venus' supposed satellite is not well known, not even to modern historians of astronomy. Thus, one looks in vain for it in most accounts of the history of planetary astronomy, and it also does not appear in modern works on the history of the Venus transit' (p. 6).

From the chapter 'A moon or not? A century of confusion', the reader learns that Fontana was the first to have observed the moons of Venus in December 1645. The German natural philosopher and engineer Otto von Guericke believed Fontana's observations. In 1672, he published a book and assigned two moons to Venus. Surprisingly, Cassini who observed the moon of Venus in 1672 and 1686, did not mention Fontana's results. Being a reputed astronomer during the 18th century, Cassini's name was attached to the discovery. In 1702 David Gregory, an astronomy professor at Oxford, referred to these observations in the introduction of a book. The Roman Francesco Bianchini published the first book on Venus in 1728. He reported that Fontana might have observed a satellite of Venus or some other object. In 1740, James Short-Scotsman observed a small star near Venus. But he was careful to call it a moon of Venus. However, Joseph J. Lalande (French) while compiling an encyclopaedia gave an account of Venus and interpreted Short's observation as one of the best to establish the existence of Venus' moon. In 1759, the German Andreas Meyer – a professor of mathematics, physics and astronomy – also observed a moon of Venus. It is also indicated that some scientists were of the opinion that 'God has created moons to bring light to the planets so that their inhabitants could praise and admire the power and goodness of the creator' (p. 25). In 1854 the well-known physicist, David Brewster described the moons as domestic lamps, which light the primary planets in the absence of the sun.

In the chapter 'From climax to anticlimax', we see that until 1760 eight observations related to the supposed moon of Venus were reported. The first transition of Venus was observed in 1639. Johannes Kepler predicted the next transition in 1761. This was going to be a special case, as Edmond Halley had shown that the passage of Venus could be used to measure the distance of the earth from the sun. The transition of 1761 was a unique opportunity to confirm the hypothesis. During the transit of 1761, some astronomers saw the supposed moon. The chapter ends with the following questions: 'Had they seen a satellite of Venus? If not, what had they seen?'. Such questions at the end of the chapters leave the readers guessing.

As the title 'Contemporary analysis and criticism' suggests, the author discusses the pros and cons of the issue. To start with he shows that at that time there was no theory to approve or disapprove existence of the supposed moon. On the experimental side, some astronomers observed the moon. J. J. Mairan and Lalande from France defended the moon. They argued that under certain conditions the solar atmosphere makes it impossible to observe the moon all times. The mathematician Johann Heinrich Lambert calculated the motion of the satellite and showed that it was impossible to observe the moon during the transition of either 1761 or 1769. However, astrophysicist Maximilian Hell (Vienna) and Roger Boscovich (Croatia) showed that what Cassini and Short saw were optical illusions in the telescopes. In 'A spurious but persistent satellite', we learn that in the 1780s it was generally accepted that Venus had no moon. However, interest in the subject did not vanish. William Herschel studied Venus thoroughly and suggested that the planet had a dense atmosphere to shield the inhabitants from the extreme heat of the sun. In spite of criticism, many were not completely convinced. For instance, in France the famous physicist and astronomer Francois Arago wrote that the 'moon of Venus belongs to the domain of the possible' (p. 102).

The revival of Venus' moon is discussed in 'Closure: the discussion of the 1880s'. It is suggested that probably this was due to the transit of Venus in 1874 and 1882, and more importantly, the discovery of the two unexpected satellites of Mars by the American astronomer Asaph Hall in 1877. It forced the scientists to rethink about Venus. In this chapter we also see that apart from astronomers, artists, mathematicians, poets and writers also considered the issue. However, the later astronomers found it difficult to be-

lieve that experts like Fontana, Cassini and Christian Horrebow (Danish) could have made a mistake. Joseph Bertrand, a mathematician and physicist, argued that what they had observed were most likely asteroids. In 1884, Camille Falmmarion, a French astronomer expressed similar views. Astronomer Jean-Charles Houzeau de Lehaie suggested that: what they had observed might have been an intramercurial planet. With numerological reasoning, he then came to the conclusion that what Fontana, Cassini, Short and others saw was a real moon. He named it Neith. Paul Stroobant (Belgium) compared the observations of Peder Roedkiaer (Denmark) with the Argelander's star catalogue and showed that the observed moons were some particular stars. However, he could not explain all the observations, and in the rest of the cases he suggested the optical illusion hypothesis. Kragh shows that even in the middle of the 20th century British astronomer Partick Moore did not discard the possibility of a tiny moon of Venus (p. 141).

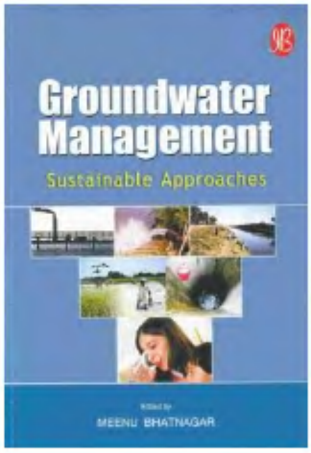
In 'Conclusion, and a note on the satellite of Uranus', various observations and explanations about the issue are summarized. The author explains the appearance and disappearance of the supposed moon from different points of view. First, he discusses the case of 'believing is seeing'. He shows that 'either for psychological, social or instrumental reasons', a scientist sees what he wants to see (p. 147). For that he quotes various examples, including the discovery of the supposed N-rays in France. Second, he shows that in establishing new ideas the authority of the scientists plays a great role. 'The case of the six moons of Uranus, say about 1820, was not much stronger than the case for Venus' moon had been fifty years earlier, and yet the astronomical community responded very differently in the two cases. Whatever the reasons, there is no doubt that Herschel's reputation counted very highly – even more highly than Cassini's in the case of the Venus moon' (p. 154). For that he quotes the case of the German–Danish astronomer William Herschel, who possessed the best telescope of the day. In 1787, he discovered two satellites of Uranus. At the end of 1790s, he announced the discovery of four more satellites. No astronomer until 1830s doubted Herschel's six satellites. In 1851, British amateur astronomer William Lassell (who discovered the moon around Neptune) proved that only four moons exist for Uranus. The remaining two moons discovered by Herschel were fixed stars. In 1870, Herschel's supporter Richard Proctor came up with the argument that Uranus has eight moons. Six discovered by Herschel and two by Lassell.

The present book is a landmark in the history of planetary astronomy. It is of interest not only to scientists and historians, but also to general public interested in the planetary system.

1. Kragh, H., *Conceptions of Cosmos: From Myths to the Accelerating Universe. A History of Cosmology*, Oxford University Press, Oxford, 2007.
2. Kragh, H., *Quantum Generations: A History of Physics in the Twentieth Century*, Princeton University Press, Princeton, 1999.

RAJINDER SINGH

University of Oldenburg,
Faculty V, Institute of Physics,
Research Group: Physics Education,
History and Philosophy of Science,
P.O. Box 2503,
D-26111 Oldenburg,
Germany
e-mail: rajinder.singh@uni-oldenburg.de



Groundwater Management – Sustainable Approaches. Meenu Bhatnagar (ed.). The Icfai University Press, 52, Nagarjuna Hills, Punjagutta, Hyderabad 500 082. 2008. 305 pp. Price: US$ 20.

At many places in the world, due to unplanned anthropogenic activities, imbalances between water demand and supply, and competition among water users, dependency on groundwater and its disproportionate abstraction increased significantly. Indiscriminate groundwater use has crossed the sustainable limits, caused by improper land use. In different parts, environmental problems are evident, such as, declining groundwater levels and productivity of wells, more seepage from canals, increasing salinity and pollution, intermixing of contaminated water with freshwater, etc. Groundwater issues, such as potential exploitation and sustainable yield, got linked intricately and inextricably in a complex manner with widespread depletion and degradation of groundwater.

While the urban clusters look for low to moderate volumes of high-quality water, rural clusters look for large quantity of high-quality water in inefficient field distribution and drainage systems. In many areas of India, due to rise in water demand for irrigation and other purposes, and inadequate availability of surface water supply, groundwater will continue to be used intensively. Farmers adopt groundwater irrigation due to apparent reliability of storage and flexibility of groundwater exploitation.

The story of each region or city may be different, but the main reasons for the water crisis are common, such as increasing demand, zonal disparity in distribution of water supply, lack of ethical framework, inadequate knowledge and resources. A disconnect between groundwater management and imbalanced supply–demand relationships now threatens Indian groundwater. Thus, the issue of water management is multidimensional, related to reliable assessment of available water, its supply and scope for augmentation, distribution, reuse/recycling, its existing depletion, degradation, pollution and its protection from depletion and degradation.

However, not much concerted efforts have been made for management of the hidden underground water resources. This calls for comprehensive assessment of these linkages, preparing groundwater vulnerability maps at regular intervals, and introducing regulatory measures and strict enforcement mechanisms to restrict groundwater withdrawal and control leaching from diffused sources. Sustainable safe water availability will be guided by the policies, plans and technologies at our disposal, in addition to political, socio-economical and other