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Books and Multimedia Reviews

New Cosmic Horizons by David Leverington. Cambridge University Press, New York, New York, 2000, 469 pp., $29.95 paperback (ISBN 0-521-65833-0).

New Cosmic Horizons covers space-based astronomy from the period 1946 to 1996. Author David Leverington thoroughly examines the political, financial, and scientific aspects of the USA, USSR/Russian, and European space programs. The book is well illustrated, extensively researched, and easy to read. Written for the reader with a basic understanding of astronomy, *New Cosmic Horizons* is a valuable reference book for those interested in history of astronomy, but because of Leverington's storytelling style, it is also a fun read for the casually curious. From this book, one will gain both a broad and detailed understanding of spacecraft astronomy. Teachers and lecturers of almost any branch of astronomy can find information that will deepen their lecture material.

A brief biographical sketch about the author reveals why this book is solidly substantial. David Leverington received his degree in Physics from Oxford University in 1963. Working for the European Space Agency (ESA) in 1969, he managed the design of *Geos*, Europe's first geosynchronous scientific spacecraft. He became program manager of *Meteosat*, ESA's meteorological satellite system, in 1977. From 1981 until 1989 Leverington headed Spacecraft Engineering at British Aerospace in Bristol. During that time he was responsible for the *Giotto* spacecraft that intercepted Halley's comet. He also worked on the Photon Detector Assembly and solar arrays for Hubble Space Telescope. He became project director of a mobile phone system in 1989, and in 1991 he became Deputy Managing Director of British Aerospace Communications. David Leverington has written many scientific papers on space science and astronomy, including the book *A History of Astronomy from 1890 to the Present*, published by Springer in 1995 and 1996. In 1995 he retired early and returned to graduate school to study the cost-effectiveness of ground- and space-based astronomical facilities. Leverington was awarded a Ph.D. in 1997, he is a fellow of the Royal Astronomical Society, and he lives in Essex, England.

With credentials like these, it is not surprising that David Leverington's new book is such a *tour de force*. Clearly, he has done some thorough research into spacecraft history. His book strikes a wonderful balance between the two themes of scientific results and spacecraft technology and development issues.

The first half of the book is devoted to solar system space-based astronomy, and the other half to spacecraft astronomy of more distant objects. Topics include the sounding rocket era, early work with the V2, *Sputnik*, the formation of NASA, the first missions to Mars and Venus, the Soviet and American lunar exploration programs, *Mariner*, *Venera*, *Viking*, *Pioneer*, the Halley encounters, *Vega*, *Magellan*, *Phobos*, *Mars Observer*, *Voyager*, *Skylab*, *Solar Max*, *Yohkoh*, *Ulysses*, SOHO, *Explorer 11*, *Uhuru*, *Copernicus*, ANS, *Ariel 5*, *Herculis*, HEAO, SS 433, IUE, IRAS, *Exosat*, COBE, *Rosat*, *Compton GRO*, *Geminga*, *Extreme Ultraviolet Explorer*, ISO, and *Hubble*. In short, this book offers fantastic coverage of space astronomy greats! The table of contents is not exhaustive, but it is thorough. A particularly rare aspect of the book is Leverington's fair treatment of the contributions of nations besides the United States.

My favorite chapter was the one on solar exploration. Leverington begins with a presentation of pre-space age understanding of the Sun, and then chronologically introduces each spacecraft mission. Finally, he offers an interesting description of how each of the missions contributed to our current understanding of the Sun. It is easy to learn something new from this book—either about science or the history of science. For example, Leverington offers some insight into the ESA/NASA relationship as he tells the story of the development and launch of the *Ulysses* spacecraft. This was a story I had never heard before, and it explained a lot of mysteries!

Such treatment of the topic at hand is typical of each chapter. Leverington begins with science and describes what was known. He then discusses the funding situation and the whims of politicians. Next he touches on the technology development. Then he finishes with the launch and the excitement of the early results. Without being too rigid and predictable, this organization draws the reader irrevocably into the historical perspective and excites anticipation for those first results!

Here is an episode from Chapter 5, "Mars and Venus: Early Results". In this brief excerpt we get an idea of Leverington's writing style, and of the excitement when Mars was first viewed up close:

> "Most spacecraft have idiosyncrasies of some sort and *Mariner 4* was no exception, as its star sensor often lost lock on Canopus... but these problems apart the spacecraft behaved perfectly *en route* to Mars. When *Mariner 4* was 17,000 km from the planet, it began its 22 image picture taking sequence of Mars, which continued on 14th July 1965... The images received were stored on the tape recorder and successfully transmitted back to Earth,... requiring about 8 1/2 hours to transmit each image. The results caused a sensation.
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> At first everything seemed normal as the images were slowly received, with astronomers, physicists and engineers peering at the first relatively indistinct images, trying to make out surface features, but with only limited success. Then image number 7 was received and what it showed stopped everyone in their tracks, as craters began to appear.

Whenever surprises occur, there is always a review to see if anyone had predicted what had been found. In this case, craters had apparently been seen on Mars by E. Barnard in 1892 using the Lick 36" refractor, and by J. Mellish in 1917 using the Yerkes 40" refractor. Their existence had been predicted by D. L. Cyr in 1944, C. Tombaugh, E. Opik and, most recently, F. Whipple of the Smithsonian Astrophysical Observatory. Nevertheless, the discovery of craters on Mars was a major surprise to the astronomical community as a whole..."

I can happily recommend this hefty book (paperback, 469 pages) to anyone interested in the history of astronomy. I enjoyed it very much, although I admit that I tended to read it one chapter at a time. *New Cosmic Horizons* is more of a reference source than a story that unfolds with each chapter. In fact, I found that each chapter stands alone quite nicely, and each is absorbing and informative.

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Chronology and Evolution of Mars edited by R. Kallenbach, J. Geiss and W. K. Hartmann. Kluwer Academic Publishers, Dordrecht, The Netherlands, 2001, 458 pp., $165.00 hardcover (ISBN 0-7923-7051-1).

This well-written, impressive publication is the outcome of a series of planetary science workshops held at the International Space Science Institute, Bern, Switzerland, between 1999 and 2000. The book has very broad themes, and comprises 18 multi-authored chapters, including an introduction and an epilogue. The book aims to summarize recent developments and significant advances which have been made in constraining timescales and geological processes in the evolution of Mars, and furthermore, outlines future directions regarding martian research.

The first five chapters consider well-dated cratered lunar surfaces to establish a chronology of cratered geological units on Mars. Stöffler and Ryder present a revised lunar impact flux curve using isotope ages of lunar samples and new considerations of lunar stratigraphy. Such calibration curves are extremely important and serve as a reference for inner solar system bodies such as Mars. The authors cite several problems with ages used earlier for determining the lunar flux curves. Furthermore, for the Eratosthenian and Copernican periods (about 3–1 Ga), the authors point out that reliable absolute ages are needed to better constrain the lunar flux curve for this time. Neukem and colleagues use size-frequency distributions for lunar craters to provide estimates of the size-frequency distribution for projectiles which formed craters on terrestrial planets and on asteroids, and this lunar production function is later used by Ivanov to estimate the frequency of impacts for a particular size of a formed crater on Mars.

The mineralogical, geochemical characteristics, and crystallisation ages of 16 SNC martian meteorites (*i.e.*, shergottites, nakhlites, Chassigny and the orthopyroxenite Allan Hills 84001) are discussed by Nyquist and colleagues in the following chapter. The crystallisation ages suggest that martian volcanism occurred over most of its geological history, and that volcanic activity probably continues till the present day. The ages of martian surfaces are determined by Hartmann and Neukum using crater counts and the results of Neukum and colleagues, and that of Ivanov. This chronology indicates that volcanic and fluvial activity was more intense in the first third of martian history, and that such activity has persisted until even as late as 3 Ma ago.

Part II of the book discusses the petrological evolutionary history of Mars. First, Halliday and colleagues discuss the present understanding of how Mars accreted and the early development of Mars. From Tungsten, Ba/W and Re/Os isotope ratios in martian meteorites, they propose that Mars has undergone rapid accretion, and that it differentiated in the first 20 Ma of solar history. Next, geophysical constraints on martian evolution are presented by Spohn and others using data from Mars Global Surveyor (MGS) and Mars Pathfinder missions, thermal history modelling, and chemistry of martian meteorites. The authors also discuss the MGS discovery of strong magnetization in the oldest parts of the martian crust, suggesting that the strength of the planet's surface magnetic field might have been comparable to that on Earth at some time. Head and colleagues present an overview on the reconstruction of the geological history of Mars using stratigraphical relationships and geological mapping using imaging data. They draw attention to the lack of direct and compelling evidence for an early warm and wet Mars. Furthermore, they recommend that absolute ages be determined for several broad, homogeneous martian surface units for an improved understanding of the rates and timing of geological processes on Mars. In the concluding chapters of Part II, Bibring and Erard summarize present efforts to investigate the surface composition of Mars, whereas Wänke and colleagues discuss a petrogenetic model which presumes that Mars possesses 50% basaltic and 50% andesitic igneous rocks.

The final part of this book examines the volatile evolutionary history of Mars. Masson and colleagues discuss various geomorphological landforms which suggest that liquid water might have flowed on the martian surface at some time. They emphasize the need for high-resolution stereoscopic imaging data with wider areal coverage to resolve ongoing debates regarding the origin of the valleys networks and outflow channels. Bridges and colleagues discuss various models which explain the formation of the SNC secondary phases, and discuss evidence for near-surface liquid water conditions during early martian times. The fundamentals of