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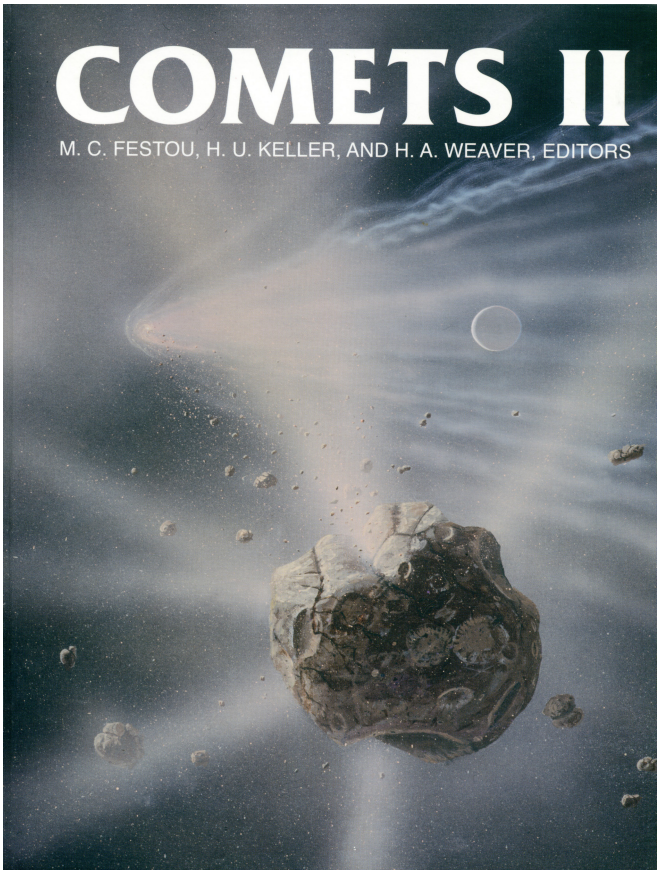
Book Review

Comets II, edited by M. C. Festou, H. U. Keller, and H. A. Weaver. Tucson, Arizona: The University of Arizona Press, 2004, 780 pp., $85.00, softcover (ISBN 0-8165-2450-5).



Comets are among the most challenging solar system objects to be studied. The 91 authors of *Comets II* have accepted the challenge to update our knowledge of these bodies and have produced a very nice-looking book. *Comets II* covers the present knowledge of cometary structure, physical properties, and the chemistry and origin of these fascinating astronomical objects. The book is a worthy successor to the 1982 book *Comets*, edited by Laurel Wilkening. We learned a lot from the publication of that first monographic on comets, and the second book comes at a special moment when our understanding of these bodies has increased significantly.

The book is comprised of seven parts: "A Global View on Cometary Science," "From the Interstellar Medium to the Solar Nebula," "Nature and Evolution of Cometary Orbits," "The Nucleus," "The Gas Coma," "Dust and Plasma," and "Interrelations." Every part contains several excellent reviews of related topics, for a total of 37 papers. Most of the papers contain numerous black-and-white illustrations that are very useful in following the general arguments. There is also a section with color diagrams and pictures at the end of the book.

In the first part of the book, the reader can discover that we still do not have a single measured mass (or density) for a cometary nucleus, although present estimates suggest that these bodies are extremely fragile. For example, Rickman (1986) found a density in the range of 0.1–0.2 g/cm^{-3} for comet P/Halley; however, the present estimates for several comets are closer to 0.5 g/cm^{-3} (cf. chapters by A'Hearn and Weissman et al.).

In the second part of the book, there are excellent reviews on the chemistry of the interstellar medium and its link with cometary chemistry (see the chapter by Irvine and Lunine, among others). The composition and evolution of interstellar clouds and the eventual transition to circumstellar disks is explained in full detail in a series of excellent reviews.

The third part of *Comets II* is dedicated to the orbital dynamics of these bodies. There are details on the progress made in the determination of non-gravitational forces and also in the computation of the dynamics and evolution of different cometary sources. Two important comet reservoirs have been identified. The first one, located between 40 and 50 AU from the Sun, is called the Kuiper Belt and is composed of ice-rich bodies formed in the vicinity of the giant planets, and characterized by low inclinations relative to the ecliptic plane. The second was theoretically proposed by Jan Oort in order to explain the continuous and random appearance of long-period comets (Oort 1950). Nowadays, the characteristics and structure of the Oort Cloud are constrained by the orbital distribution and dynamics of new and long-period comets (see the chapter by Dones et al.). Recent progress in the understanding of the Kuiper Belt structure from the first decade of observations and its link with the early evolution of the solar system is also described in the book (see the chapter by Morbidelli and Brown). These different sources are analyzed in detail in *Comets II* because there has been significant progress made in the last decade from the different search programs of minor bodies.

The fourth part of the book is dedicated to the study of cometary nuclei. It contains excellent reviews on the progress obtained from spacecraft missions (see the chapter by Keller

et al.), and a detailed compendium of the physical characteristics of comets (see the chapter by Lamy et al.). However, we don't know how representative the few objects are that have been studied thus far. It is therefore difficult to generalize about the physical properties of comets, especially for those that formed in different regions (Prialnik 2000).

Comets can provide clues to the physicochemical processes that occurred in the outer part of the protoplanetary nebula because they are a mixture of interstellar and processed solar material (see the chapter by Ehrenfreund et al.). For example, the fifth part of the book shows that the composition of cometary volatiles provides direct information about the chemical and physical properties of the outer solar nebula where comets formed. It is believed that some comets have remained pristine, whereas others look very evolved (see the chapter by Bockelée-Morvan et al.).

The last two parts of *Comets II* are also comprehensive reviews on cometary dust. The sixth part deals with the study of dust and plasma from cometary comae. In fact, remote observations give additional clues to the size, structure, and temperatures of the grains released from comets (see the chapter by Kolokolova et al.). The final part of the book explains the importance of several related fields that are providing interesting clues concerning the nature and evolution of comets. By using all possible techniques in the last two decades, we have learned how interesting comets are in a cosmochemical context. From remote studies of meteors and detailed analyses of interplanetary dust particles (IDPs) collected in the terrestrial atmosphere, it is possible to obtain additional physicochemical data on numerous comets (Rietmeijer 1998, 2005; Trigo-Rodríguez et al. 2003; the chapter by Sykes et al.; Borovička et al. 2005; Flynn 2005).

To conclude, *Comets II* is a useful book that should be on our desks. Researchers interested in the study of the interrelations between solar system minor bodies, their origin, formation conditions, and evolution should buy this book. It is an in-depth review of comets, well-conceived and produced by some of the best experts in these areas. Consequently, this book is an excellent step in understanding the chemical and isotopic composition of comets. It is especially relevant because these bodies were likely an important source of organic matter and water during the early stages of the Earth's formation (Oró 1961; Zahnle and Sleep 1997; Delsemme 2000).

REFERENCES

Borovička J., P., Spurný P., Bocek J., and Stork R. 2005. A survey of meteor spectra and orbits: Evidence for three populations of Na-free meteoroids. *Icarus* 174:15–30.

Delsemme A. 2000. 1999 Kuiper prize lecture cometary origin of the biosphere. *Icarus* 146:313–325.

Flynn G. J. 2005. Physical properties of meteorites and interplanetary dust particles: Clues to the properties of the meteors and their parent bodies. *Earth, Moon, and Planets*, doi:10.1007/s11038-005-9025-y.

Oort J. H. 1950. The structure of the cloud of comets surrounding the solar system and a hypothesis concerning its origin. *Bulletin of Astronomical Institutes of Netherlands* 11:91–110.

Oró J. 1961. Comets and the formation of biochemical compounds on the primitive Earth. *Nature* 190:389–390.

Prialnik D. 2000. Physical characteristics of distant comets. Proceedings, ESO Workshop on minor bodies in the outer solar system. pp. 33–49.

Rickman K. 1986. Masses and densities of comets Halley and Kopff. Proceedings, ESA Workshop on the Comet Nucleus Sample Return mission. pp. 195–205.

Rietmeijer F. J. M. 1998. Interplanetary dust particles. In *Planetary materials*, edited by Papike J. J. Washington, D.C: Mineralogical Society of America.

Rietmeijer F. J. M. 2005. Interplanetary dust and carbonaceous meteorites: Constraints on porosity, mineralogy and chemistry of meteors from Rubble-pile planetesimals. *Earth, Moon, and Planets*, doi: 10.1007/s11038-005-9037-7.

Trigo-Rodríguez J. M., Llorca J., Borovička J., and Fabregat J. 2003. Chemical abundances determined from meteor spectra: I. Ratios of the main chemical elements. *Meteoritics & Planetary Science* 38:1283–1294.

Wilkenning L. L., editor. 1982. *Comets*. Tucson, Arizona: The University of Arizona Press. 766 p.

Zahnle K. J. and Sleep N. H. 1997. Impacts and the early evolution of life. In *Comets and the origin and evolution of life*, edited by Thomas P. J., Chyba C. F., and McKay C. P., editors. New York: Springer. pp. 175–207.

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