Telling tails

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Physics and Chemistry of Comets. Edited by W. F. Heubner. *Springer: 1990. Pp.392. £35, $59.*

SMALL, frigid, charcoal-black bodies composed of ice and dust, comets are as enigmatic as they are remote. Normally too distant for detailed study, they are observed only during relatively close passage to the Sun, where heat-liberated gas and dust forms a vast coma and tail complex, the largest visible structures in the Solar System. Solar-induced activity unfortunately also obscures the nucleus and, until recently, the true nature of the actual cometary body could only be inferred from observed coma and tail properties. An enormous increase in information on comets occurred in 1986 when five spacecraft from Europe, the Soviet Union and Japan encountered comet Halley on its thirtieth known passage through the inner Solar System. Some of these fly-by missions provided the first direct images of a comet nucleus and they penetrated deep into the coma where direct *in situ* measurements were made of dust and gaseous species. These mission data, along with results from Earth-based and even Venus-based observations and generally intensified attention to comets produced a *bona fide* quantum leap in our knowledge about them.

The general premise that comets are primitive, irregular bodies predominantly composed of water, ice and silicate-bearing dust was confirmed, at least for Halley, although in many ways it now appears that comets are more complex and even more interesting than previously believed. Complications include bi-axial rotation, a largely inert surface that is only active in localized regions, coma grains that fragment in space, components that are volatile when as far from the Sun as Saturn, a possible mass dominance of rock over ice, a 'depletion' of carbon and nitrogen in ice phases, and the presence of material intermediate in volatility between ice and dust that decomposes in the coma to produce a distributed source of carbon monoxide, formaldehyde and other compounds. Although there is a new realization that the pristine nature of comets has been somewhat degraded by thermal processes associated with internal heating and encounters with the Sun and other stars, most of the new results and modelling studies support the general belief that comets are the best preserved relics from the formation of the Solar System and that they preserve materials and precious records of chemical and physical processes that occurred in the cold regions of the solar nebula and possibly even in environments that preceded it.

There is a substantial body of recent literature on comets, but gaining a balanced overview of the subject is difficult even for those specializing in this interdisciplinary field. Several problems complicate the synthesis of comet data. One is the traditional problem of temporally fragmented observations of highly variable objects. Special limitations of the Halley *in situ* results are a consequence of data collection from a spacecraft travelling at 70 kilometres per second during a close fly-by of a ten-kilometre object. With the need for synthesis in mind, *Physics and Chemistry of Comets* is a very timely book. The time delay following the Halley encounters has allowed the data to be properly reduced, analysed, contemplated and cross-correlated. The resulting book provides a superlative overview of comets and cometary processes. The editor and ten well-chosen experts covering the breadth of cometary disciplines have produced a wonderfully comprehensive and yet concise overview of cometary physics and chemistry.

Each chapter is a review paper that provides a reasonably balanced view of its subject. The coverage and continuity is very good and is evidence of careful editorial direction to minimize overlaps and to broaden the coverage to include some information on various cometary subjects that are of only peripheral importance to the physics and chemistry. The main chapters cover the nucleus, plasma, the neutral coma, dust, orbital evolution and comet formation and evolution. The final chapter is an overview, plus a discussion of the role of comets in the evolution of life and a discussion of major problems and directions of future research. This is not a compendium of a large number of research papers, and there are aspects of cometary research that are only lightly treated, but the great value of the book is that it provides a concise and detailed review of the major issues related to the chemistry and physics of comets. Unlike many other modern works on Solar System topics, this one is a slim, concisely crafted reference that easily fits in a briefcase.

With its excellent reviews, a chapter by J. H. Oort on the Oort cloud and a preface by F. L. Whipple this book is essential for those working on comets, and with 776 references it is a highly recommended resource for anyone who needs up-to-date information on the fundamental aspects of comets. Many of the chapters contain summaries that can provide even a casual reader with a quick review of each subject. Comets are unique objects that provide a potential link between studies of primitive materials of the Solar System and pre-solar matter. Although many of the most important properties of comets remain unexplored and elusive, *Physics and Chemistry of Comets* provides an important resource for the next generation of comet studies, which will hopefully include new observational methods and spacecraft missions that will both rendezvous with a nucleus and return samples to the Earth for laboratory analysis. □

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Comet Giacobini-Zinner — released dust has formed two tails.

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