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COMETS

Nature, Dynamics, Origin, and their
Cosmogonical Relevance

by

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Image "Wild2a.jpg" : Artist concept depicting a view of comet Wild 2 as seen from NASA's Stardust spacecraft during its flyby of the comet on January 2, 2004
(Courtesy NASA/JPL-Caltech)

Image "Wild2b.jpg" : Composite image of comet Wild 2 taken by the navigation camera of Stardust on January 2, 2004 flyby. A short exposure image showing the nucleus with great surface detail is overlain on a long exposure image, taken just 10 sec later, that could pick details of the faint coma and jets surrounding the nucleus
(Courtesy NASA/JPL-Caltech)

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Preface

Comets are small bodies, but of great cosmic relevance. Given its pristine nature, they may preserve valuable and unique information on the chemical and physical processes that took place in the early solar system, and that may be occurring in the formation of other planetary systems. They might have even played a very important role in the origin of life on Earth. Beyond that, since ancient times comets have inspired awe, superstition, and also curiosity and debate. Their sudden apparitions challenged the long-held view of the immutability of the heavens, which triggered a long debate on whether comets had a heavenly or terrestrial nature. Therefore, comets have a prominent role in the history of scientific thought, that goes back to the most ancient civilizations.

The last apparition of comet Halley in 1986 was a landmark since it arouse a great expectation in the scientific community and in the public at large. For the first time, a flotilla of spacecrafts visited a comet. A great number of popular and technical books were written on Halley, and comets in general, around the mid-eighties. The interest in comets never subsided after Halley's passage which is reflected in the large volume of printed material on these bodies. I have taken the challenge to write a new book on comets that summarizes most of the recent advances on the subject, including my own work developed during the last 25 years. I tried to cover dynamical as well as physical aspects of comets, highlighting their importance as relics of the accretion processes in the early solar system and, perhaps, as carriers of water and organics that permitted the development of life on our planet.

The book has perhaps a major emphasis on dynamical aspects, following my own main work on the subject. I also think that dynamical studies have so far been the best tool to learn about the origin and location of comet reservoirs. Despite the major emphasis on dynamics, I tried to also cover the physics and chemistry of comets, since this is a field in which we are rapidly gaining new insight thanks to the use of new ground-based and space-based observatories, as well as *in-situ* data gathered by spacecrafts during flyby missions. Yet, the physics of ion tails and their interaction with the solar wind and interplanetary magnetic field has not been covered - except for a brief introduction - since this is a very specific topic that somewhat departs from the main focus of the book.

The book contains some mathematical analysis of topics that I consider relevant, and that in general have not been treated in detail in other books. In particular, I develop in some extent the dynamics of Oort cloud comets, subject for which I do not know of any comprehensive treatment elsewhere. Whenever I deemed it convenient, I included an explanation of some technical terms, or demonstrated how a formula was obtained. I tried to cover the recent literature as much as possible, as well as some classical papers of several decades ago, or even earlier. Yet, given the huge production rate of papers on comets, it is possible that some relevant material could have been overlooked so, if that occurred, I present my apologies since now. The book also contains several tables with useful data. It may be suitable as a textbook for graduate students with some basic knowledge of celestial mechanics and astrophysics, as well as a consult book for comet researchers, or researchers from other related fields willing to start working on comets or get an updated view of the subject.

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Julio Angel Fernández
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