

Cosmic Dust

Edited by

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The Great Comet West of 1976. The intricate structure of the ion tail (right) guided by the chaotic magnetic plasma of the solar wind contrasts with the diffuse appearance of the dust tail (left). Comet West was unusually dusty, generating a dust tail much stronger and broader than the nearly straight ion tail. (Courtesy Jack W. Harvey of the Kitt Peak National Observatory in Arizona)

To: Louise, Michael, and Roger

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Foreword

Hannes Alfvén

As long as astronomers relied exclusively on naked-eye observations, the outermost planets, the asteroids, and the satellite systems were inaccessible. However, there were three phenomena related to dust and small bodies, *viz.*, comets, meteors, and the zodiacal light which could be observed.

The introduction of the optical telescope introduced a new era in the studies of planets and satellites, but it did not have a similar impact on the knowledge of the small bodies, because it was not very well suited for studying them. With the exception of spectroscopic studies of the cometary comas and tails the field did not advance very much. In the early part of this century, it was largely Fred Whipple's enthusiasm which rescued it from oblivion.

The lack of impact of new observational results gave little inspiration to new theories, and much of the thinking has until recently been dominated by the two-century old concept of a 'Laplacean' nebula, which was supposed to condense in thermodynamic equilibrium. In fact, the field was insulated from adjacent fields of research to such an extent that the introduction of magnetohydrodynamics and plasma physics a quarter of a century ago was almost completely unnoticed by those investigating the formation and evolution of small bodies. The only example of an important contact with other fields was Biermann's discovery of the solar wind by the study of cometary tails.

Similarly, space research has produced only a limited stimulation. In part this is due to the fact that neither meteoroids nor the zodiacal light particles are very easy to detect from a spacecraft and in part to the regrettable absence of a space mission to a comet.

However we have now entered a period of rapid and revolutionary change. The advance of cosmical plasma physics which has led to the Ip-Mendis theory of comet tails, the Baxter-Thompson 'negative diffusion' of particles in Kepler orbits and the associated jet stream concept, the realization that the chemical composition of the 'solar nebula' was strongly inhomogeneous, and that the condensation took place under nonequilibrium conditions are some examples of new results which are drastically changing our views of the small-body population. Of special importance for the advance of this field is its key position for the understanding of the planetesimal accretion of the large bodies in the solar system.

It is obviously very difficult to write a book on a subject which is in a state of such rapid change, because much of what was 'generally accepted' when it was written is necessarily controversial and some may even be obsolete when it reaches the reader. But this is the same in several other fields of science. To every reader it is a stimulating challenge to compare what he finds from different sources. I share the hope of the authors that this volume will be in the centre of scientific discussion and draw the attention to a field which has too long been neglected. In fact, the understanding that dust in space is normally electrically charged and often is magnetically trapped in a plasma has led to the study of dusty plasmas. Probably the medium which fills interplanetary space, interstellar space, and even possibly intergalactic space, should be treated as a dusty plasma. This will bring cosmic dust investigations into the mainstream of cosmic plasma physics.

January 1977

Preface

First conceived over a cup of coffee in the Space Sciences Laboratory at Canterbury, the concept of *Cosmic Dust* was one which gathered momentum rapidly. The absence of any comprehensive publication in the field gave sufficient reason alone to justify its launch, but a more important aim behind the publication has been the coherent presentation to the student and science community of the 'state of the art' in the nine sub-areas of research studying the very same object, cosmic dust.

Multiple authorship of such a treatise was considered to be a necessary requirement in the attainment of a uniformly high standard across the field, but inherent in this approach may be a somewhat varied standard of assumed knowledge for the new reader. In response, one might question which reader, if any, could claim to have a uniform standard across the field? As a norm, all chapters have been written so as to be confidently approached by a final year student studying for the degree of Bachelor of Science. This should certainly prove quite realistic for the student astronomer, astrophysicist, or planetary scientist, and provide a good basis there for course material. It should be within the full reach and comprehensive understanding for graduate students in any of the astronomically inclined Sciences. They should find an introduction to the histories of these fields, full presentation of the current state of the research and techniques in the field and also future trends. A glossary of symbols and units is not included, but where necessary the reader may usually decipher such mysteries by reference to a text such as *Astrophysical Quantities* by C. W. Allen.

Seasoned research workers in cosmic dust will find that much of the information in the chapters is new, either in the form of new results or in the collation and interpretation and review of the field. It is hoped that they will find the philosophical discussions of each chapter a useful benchmark in their own fields and enjoy the viewpoints of other associated research fields studying the very same cosmic dust.

In wishing success to this publication I must record my appreciation of the efforts of contributors, in the standard achieved and in their unassuming submission to my exhortations on deadlines. I pay every possible tribute to the chapter reviewers listed overleaf, who accepted the task without reward.

Their impressive response to the hard work was heartening; their detailed comments have led to considerable strengthening of the content, presentation, and standard.

J. A. M. McDonnell

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