

INTRODUCTION

THE MEETING

The IAU Symposium 160 *ASTEROIDS COMETS METEORS 1993* has been held at Villa Carlotta in Belgirate, on the shore of Lago Maggiore (Italy), from June 14 to June 18, 1993. It has been organized by the Astronomical Observatory of Torino and by the Lunar and Planetary Institute of Houston. It has been a very large meeting, with 323 registered participants from 38 countries. The scientific program included 29 invited reviews, 106 oral communications, and 215 posters. The subjects covered included all the aspects of the studies of the minor bodies of the solar system, including asteroids, comets, meteors, meteorites, interplanetary dust, with special focus on the interrelationships between these.

The meeting was structured as follows. 5 morning plenary sessions have been devoted to invited reviews on: (1) search programs (2) populations of small bodies (3) dynamics (4) physical observations and modelling (5) origin and evolution. Two afternoon plenary sessions have been devoted to space missions to small bodies and to interrelationships between the different populations. The afternoon parallel sessions have been devoted to: dynamics of comets; Toutatis, Ida, Gaspra; physical processes in cometary comae and tails; meteorites; the cosmogonic message from cometary nuclei; physics of asteroids; the interplanetary dust complex; comet nuclei; meteors; composition and material properties of comets; dynamics of asteroids.

Judging from the opinion expressed by many participants the meeting has been superb from the organization point of view, and very successful scientifically. We would like to take this opportunity to thank the members of the Scientific and Local Organizing Committees, but especially the man who was responsible for the overall organization of the meeting, Vincenzo Zappalà. Without him, all this would not have been possible.

HIGHLIGHTS

This meeting has been the last of a series of *Asteroids Comets Meteors* conferences held in Uppsala (1983, 1985, 1989) and in Flagstaff (1991); it also follows a number of important meetings devoted to more specific topics, like *Asteroids II* (Tucson, 1988), *Comets in the Post-Halley Era* (Bamberg, 1989), *Origin and Evolution of Interplanetary Dust* (Kyoto, 1990) and *Meteoroids and their Parent Bodies* (Bratislava, 1992). There is no doubt on the existence of a large community of dedicated scientists producing results on the different aspects of the small bodies; the ACM93 meeting has been one of the largest for attendance among the recent IAU Symposia. The question is, is this attendance and production of papers a manifestation of normal science (in the sense of Kuhn)? There have been, in the short time elapsed from all these other meetings, enough new discoveries and new ideas to justify such a large attendance

and such a large number of papers?

Our opinion is that this meeting, apart from being a successful social event, was really necessary to spread a number of new ideas and information. The last few years have been especially interesting for the study of the minor bodies of the solar system. We cannot quote here all the new discoveries and conceptual achievements, which are recorded in the proceedings volumes, but we would like to stress two major changes occurred in our field very recently.

Until few years ago, the perception of this subject was that there are many different populations of small bodies, with such different properties and histories that their study required different technical and conceptual tools; as a result, the scientific communities studying asteroids, comets, meteors, dust, meteorites, and collisional phenomena were largely separated. We now understand that the exchanges and transitions between the objects responsible for such a variety of phenomena are the rule rather than the exception, e.g. an asteroid orbiting in the outer solar system can exhibit cometary activity if its orbit changes, a comet can become inactive and be called an asteroid, dust and meteoroids can have both asteroidal and cometary origin, craters of different sizes are excavated by any one of these populations, meteorites in the museums are samples from the asteroid belt, possibly after having been observed as meteors. All these interrelationships had been proposed long time ago, but now we have the theoretical and experimental evidence to prove their occurrence and to give quantitative estimates of their relevance. The discussion of these interrelationships and exchanges has been one of the focal points of ACM93, and this has also been the result of the choice done by the Scientific Organizing Committee, by which all the plenary sessions have included presentations on all the different populations of small bodies. This has been a significant change from what was customary before, and we have the impression it has been well received by the participants, who have had the possibility to appreciate the general scenario.

Another fundamental improvement occurred in this field in the last few years has been the enormous increase in the availability, accessibility and reliability of the relevant data. Until recently, not only the observational data were scanty, because the small bodies are dim and the necessarily powerful instruments are not easily available, but also the existing data were either not accessible or very difficult to use. This limitation is very serious in our field, since the main properties of the small bodies populations are statistical ones, and the detailed study of a few examples cannot give all the answers. It is therefore essential to have enough data collected in a systematic and unbiased way, to have them processed, to check their reliability by comparison with other data and theoretical models, and to archive all the available information where it can be accessed by the entire scientific community. In the last few years a major effort has been done to generate, maintain and make available much larger data sets. This is the result of many factors, including the space missions (Giotto, Vega, Galileo), the availability of new detector technology, and the progress in computer and networks, but also of the dedicated work of many scientists who have recognized the strategic value of such endeavour. As a result, the proceedings of this meeting contain

many papers discussing the global, statistical properties of entire populations. In this volume we have done a special effort to contribute to the availability of homogeneous and reliable data sets on small bodies. The last section of this book is specifically devoted to the presentation of data bases, some of which have been made available to the entire community as a result of our specific request. The easy availability of these data sets will make research in our field a fully international enterprise, to which even scientists not belonging to the best equipped institutions can take part; it will make easier to fulfill the fundamental requirement of reproducibility of the results, by making possible the comparison of different data sets and the testing of the theories with homogeneous observational data.

We would like to quote some of the highlights of the meeting, of course without pretending to be exhaustive, but just providing some examples of the most important discoveries of the last 2–3 years. We have seen at ACM93 the images of the asteroid *951 Gaspra*, as observed by the Galileo spacecraft (after the meeting we have also received the images of *243 Ida*; the review paper by Chapman gives some preliminary results also on this second encounter). We have seen the images of the comet *Shoemaker–Levy 9* split into more than 20 pieces, and the radar images of *4179 Toutatis*. We have heard many conceptual achievements about the problem of the influx of cosmic material on the Earth, as well as data about the spectacular fireball seen over northern Italy on January 19, 1993 and about material recovered from the Tunguska impactor. We have finally begun to understand the entire process leading from the astrometric observations of asteroids, through the computation of proper elements and the identification of asteroid families, to the transport of meteoroids and the identification of a recovered meteorite with its parent body. We have heard about the surveys, which have been very successful in discovering new bodies, including some belonging to the formerly hypothetical Kuiper belt and some with the highest probability of interacting with the Earth. The subject of interplanetary dust, of its origin, dynamics, and optical properties has been widely discussed. New progress has been reported on the identification of the chemical and mineralogical composition for both asteroids and comets. We have even learned about the evidence for the existence of populations of small bodies (dust, asteroids and comets) around other stars.

We believe the ACM93 meeting has shown that the small bodies are a very active and rapidly changing field of research in planetary science, and that such large and interdisciplinary meetings are very productive.

THE PROCEEDINGS

For a large meeting like ACM93, the publication of the proceedings is an important but difficult task. To keep the size and complexity of the publications within acceptable limits, it was decided to split the proceedings into several separately edited volumes. The abstracts received before the meeting have been published in a volume edited by the Lunar and Planetary Institute (LPI Contribution no. 810), which was distributed to all participants at the meeting; it contains 329 abstracts. The invited reviews and

the presentations of the data bases are collected in this volume, edited by Kluwer under the sponsorship of the IAU. The authors of contributed papers have been invited to submit their manuscripts to the journal *Planetary and Space Science*; they will be undergo the usual refereeing procedure of the journal, and will be published in a number of special issues (we understand from the editor in chief, M. Coradini, and from the subject editor on small bodies, M. Fulchignoni, that more than 100 papers have been submitted). These special issues of *PPS* will appear by the end of the year 1994.

As for this volume, we had originally planned to include all the invited review papers presented in the 5 morning sessions of the meeting, plus the data base presentations. This implies that originally the list of authors was chosen by the Scientific Organizing Committee. With respect to this original list, we have been forced to introduce some changes. Some of the invited speakers could not attend the meeting; some others presented a talk, but did not submit a paper. We tried to replace at least some of these missing papers with review articles written by other recognized specialists who had presented contributed papers on the same topics. In some cases, we have asked the authors of related reviews to slightly extend the scope of their paper to cover the missing topics. We have also added a paper on the space mission *Rosetta*, which was presented at the meeting by several speakers, and was later (November 1993) formally accepted by the European Space Agency as the next *cornerstone* mission.

We are aware that it is not possible to cover in a single volume all the aspects of the small bodies science; we understand that some omissions could be criticized, but we have done our best to give the most comprehensive possible survey of the state of the art. Each paper published in this book has been reviewed by at least two referees, and the content as published is the result of a debate between at least four people, including also some of the editors. However, we acknowledge that in many cases the points of view presented in the papers of this book reflect the opinion of the authors, and are not always universally accepted. We could have insisted more, and put more pressure upon the authors, to force them to give a more balanced account of the current debate on the many controversial issues. We have decided on the contrary to allow the authors to express themselves, and we have accepted in some cases the presentation of theories and interpretations which are not well established. On the other hand, the goal of this book –as well as the goal of the review sessions at the meeting– was to give an overview of the research going on at present, and to open a debate on the current ideas, rather than obtaining a perfectly “objective”, and frozen, view of perfectly established results. The invited review speakers have been chosen among the most active in their field in the last 2–3 years; this guarantees that the work presented is up to date, but necessarily implies that the authors may emphasize their own point of view and their own work.

Andrea Milani, Mario Di Martino, Alberto Cellino