THE FEW BODY PROBLEM

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PREFACE

Coinciding with the 300th anniversary of the publication of Newton's Principia The International Astronomical Union organized the colloquium No. 96 "The Few Body Problem" in Turku, Finland, June 14.-19.1987. It provided an opportunity to review the progress in the very field which caused Newton a headache, as Victor Szebehely reminded the audience in his introductory remarks. It is a measure of the difficulty and complication of the few body problem that even after 300 years so many aspects of the problem are still unsolved. To quote Szebehely again, "Sir Isaac established the rules, Poincaré presented the challenges". Many of these challenges are reviewed in the present proceedings.

The gravitational few body problem cuts across the borders of established disciplines. The participants of the colloquium came from departments as different as Aerospace Engineering, Astronomy, Theoretical Physics, Physics, Mathematics, Applied Mathematics, Computer Science, Planetology, Geodesy, Celestial Mechanics and Space Science. The few body problem is a problem of practical significance in many fields and the main aim of the colloquium was to bring together people with research interests in this area, many of whom normally attend different conferences.

The scientific Organizing Committee was: V.A. Brumberg (Chairman, USSR), G. Contopoulos (Greece), M.G. Fracastoro (Italy), R.S. Harrington (U.S.A.), D.C. Heggie (U.K.), J. Kovalevsky (France), J.J. Monaghan (Australia), M. Scholl (F.R.G.), V.G. Szebehely (U.S.A.) and M. Valtonen (Finland). The colloquium was sponsored by the IAU Commission No 7 (Celestial Mechanics) together with Commissions No 20 (Minor Planets, Comets and Satellites), No 33 (Structure of the Galactic System) and No 37 (Star Clusters and Associations). The local arrangements were carried out by the Department of Physical Sciences of the University Turku, with financial assistance from the Ministry of Education of Finland, Turku University Foundation, NORDITA (Copenhagen), the city of Turku as well as the IAU. The bulk of the work in the Local Organizing Committee was carried out by Dr. Aimo Niemi, Dr. Esko Valtaoja, Mrs. Leena Valtaoja and Mr. Mats-Olof Snåre, to whom thanks are due. Dr. Tian-yi Huang and Dr. Jarmo Hietarinta brought valuable know-how to the LOC.

As the following pages testify, one of the major topics of the conference was the question of chaotic motions in Newtonian mechanics. A round table discussion on the matter was organized and is briefly reported in this volume. Jack Wisdom showed a movie illustrating the chaotic and ordered motions of minor planets. There were also movies by Dick Miller and Joanna Anosova, showing the evolution of a galaxy and a three-body system, respectively. The opportunity to see a "live" show of

the Newtonian mechanics in action was much appreciated by the participants.

The other topic of much interest was the long-term evolution of the solar system. The time span of the calculations of outer planets has now reached the 200 million year mark, and it is expected that in near future many aspects of the evolution will be revealed over the whole age of the system. There are still many mysteries in the solar system, such as the origin of asteroid families. The present stage of understanding these questions is reviewed in this volume.

Many papers were given on the stellar many body problem. This, unlike the solar system problem, deals with bodies of equal or comparable mass. The three-body problem is fundamental in evolutionary studies of small stellar systems and in recent years also the four-body problem has been extensively studied. More and more quantitative data is now becoming available with the improvements in numerical integration methods.

Finally, in the last part of the conference, few body methods were applied to galactic systems. The interaction between galaxies has been recognized for a long time, but only recently its high frequency of occurrence and relevance to many astrophysical processes have been realized. The basic physics of the interaction is exhaustively summarized in this volume and the usefulness of the few-body method is evaluated. This has been the major question mark in many earlier studies: how much could one learn about the interaction of two systems of (say) 10^{11} stars each by applying three-body methods. The answer appears to be, surprisingly, that we learn quite a lot. This is borne out by studies with fully interacting N-body systems, with $N \approx 10^5$, which are also extensively reported in this volume.

The proceedings contain a few papers which were sent to the colloquium by authors who could not come to the meeting. These papers were displayed during the conference. A few participants who gave talks in the colloquium, could not prepare their contributions in written form within the time limits of these proceedings. Discussions are recorded only when the parties involved wrote down their questions and answers. Therefore much of the lively discussions are unfortunately not included in the proceedings.

A final quote from Szebehely: "After studying the papers, the reader will feel like the playmate of Newton playing on the seashore and finding a smoother pebble or prettier shell. The totality of the contributions presented at this meeting allows us not only to enjoy viewing the pretty shells but also brings us closer to the discovery of the great ocean of Truth, paraphrasing once again Sir Isaac."

Mauri Valtonen

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