

PREFACE

The emphasis in these proceedings of IAU Symposium No. 113, *Dynamics of Star Clusters*, and the main reason for organizing the symposium in the spring of 1984, was the rapid increase during the preceding year in our understanding of core collapse. The last I.A.U. Symposium to discuss the dynamics of star clusters at length was No.69, *Dynamics of Stellar Systems*, held in Besançon in 1974. For a few years afterwards, globular clusters received much attention due to the discovery of X-ray bursters and the mounting evidence that X-ray sources in globular clusters were formed in completely different ways than those within our galaxy. Globular clusters, which until this time had a reputation for sedate old age, turned out to lead violent private lives at high energies.

However, in the early 80's globular clusters seemed to lose some of the glamor of the 70's. The grand speculations of heavy black holes lurking in their centers had to make way for a variety of observational evidence which indicated that the X-ray sources are low-mass close binaries instead. But, though dynamical fashion turned to heavy galactic halos and so on, some of the unsolved theoretical problems regarding the evolution of star clusters kept their fascination for a number of relatively isolated workers. After several years of inconspicuous labor, a number of preprints suddenly appeared in the spring of 1983 that studied the evolution of globular clusters *after* core collapse. This problem had been recognized clearly in the heyday of X-ray enthusiasm, but with the notable exception of early work by Hénon, all previous attempts to model post-collapse evolution posited the existence of a massive central black hole.

With the appearance of detailed models of the post-collapse regime, a renaissance in globular cluster evolutionary calculations occurred, comparable to the rapid progress in stellar evolution in the late 50's. It was this development which led us to propose this symposium. The international scientific organizing committee decided to organize the symposium in a slightly unusual fashion. Recognizing the many developments which had been taking place during the ten years since the previous IAU symposium in Besançon, the committee expressed their intention that the new symposium play a double role: to review those past developments; and to provide a forum for discussion of future directions of research, both theoretical and observational. The feeling of the organizers was that these goals could best be reached by scheduling only a limited number of invited speakers, together with a larger number of participants in poster sessions. In this way two objectives could be realized: the many new lines of research could be reviewed in a less hectic and more coherent way than would be possible if time were

divided equally among all participants, and more time would be available between the talks for informal discussion. We will leave it to the participants and to the readers of these proceedings to judge the success of this plan.

We regret that Dr. L. M. Ozernoy was not able to attend the symposium and deliver his invited lecture, due to circumstances beyond his control. Although he informed us that he intended to submit the invited paper for the proceedings, we unfortunately had not yet received his contribution by the time these proceedings went to press.

We editors do appreciate the many positive reactions we received at the end of the symposium; the enthusiasm of the participants was all the more gratifying because of the nearly incessant rain that they suffered and that obscured a near-total eclipse. (The group photograph included here gives an utterly false impression of the usual weather, as any participant will admit.)

Those of you who actually read prefaces, and especially those who work on open clusters, may have noticed a bias in favor of globular clusters. The main reason for this is that much recent progress has been made in understanding the latter objects, whereas the dynamics of open clusters have been less well explored, both theoretically and observationally. In many ways the dynamics of open clusters are more difficult to study than those of globular clusters: theoretically, because the combination of the lower number of stars and the younger age of open clusters make a statistical description much more difficult and its validity more questionable; and observationally, because the velocity dispersion in an open cluster is typically an order of magnitude lower than that in a globular cluster. These difficulties notwithstanding, significant progress has been made recently and is reported in these proceedings, and it is possible that in another ten years the study of open clusters may dominate a future star cluster symposium, in part because this study promises to increase our understanding of star formation in the galactic disk.

We express our hope that in the coming years the proceedings of this symposium will prove to be as valuable as those of its predecessor, I.A.U. Symposium 69, as a reference work for research on the dynamics of star clusters. To this end we urged all invited speakers to make a broad survey of their topics. In addition, on the final day of the symposium a discussion was held among a panel of six wise men to assess the scientific progress revealed by the conference and to identify the most promising directions for future research, a summary of which has been included here.

Four appendices have been added. The first contains an English translation of a classic paper by Ambartsumian, in which he showed for the first time that the evolution of an isolated self-gravitating star cluster under the influence of two-body relaxation does not cease with the establishment of a Maxwellian velocity distribution. The second appendix is a translation of that seminal paper by V.A. Antonov which led eventually to our present understanding of the gravothermal instability. We would have liked to include a translation of Michel Hénon's (1961) Ph.D. thesis, which has been much neglected but predicted many of

the essential phenomena of cluster evolution after core collapse; we felt, however, that the paper was too long to include in this already lengthy volume. To honor Hénon's fundamental contributions, we have instead reproduced one of the illustrations which appeared in his thesis, side to side with a new calculation (reported in these proceedings by Stodolkiewicz) confirming many of the results obtained by Hénon nearly a quarter century ago. We hope that his thesis will soon appear in translation elsewhere and thereby become accessible to a larger fraction of those working presently on the dynamics of star clusters.

The third appendix contains a list of observed parameters of globular clusters with the original references, compiled by Webbink, and a similar list for open clusters, by van Leeuwen, forms the fourth appendix. These appendices should increase the long-term value of this book sufficiently, even with the inevitable increase of the volume and thereby the price of the present proceedings. A detailed index of names and subjects follows. This index covers all papers and discussions included in these proceedings with the exception of the appendices which are already written in the form of compilations.

We must apologize to the reader for our failure to correct many small errors of grammar and spelling (sometimes even in the spelling of names) in the camera-ready manuscripts; we felt that since none of these errors is likely to cause confusion, our limited resources and the importance of publishing the proceedings quickly required that we let them pass. For errors in the organization of the book and in the indices we are, of course, wholly responsible.

We acknowledge the assistance which we received from many people, without whose help this symposium would not have been possible. We thank John Bahcall, Jeremiah Ostriker and Lyman Spitzer for their enthusiastic support of our early plans to organize this symposium. We thank Harry Woolf and the Institute for Advanced Study for their hospitality. We thank Mary Wisnovsky, the conference coordinator, for her administrative expertise and enthusiastic support. We thank all the participants for their contributions, and especially the panel members who were rounded up at the last moment to give their impromptu comments. We thank Jens Verner Villumsen and Robert Lupton for their efficient and smooth organization of local affairs, scientifically and culturally. We thank Nels Anderson, Web Ewell, Steve Ratcliff and Tom Statler for their untiring operation of audiovisual aids. We thank Donald Lynden-Bell, Stuart Shapiro and Lyman Spitzer for supplying us with copies of originals and translations of the material in the first two appendices. The first appendix has been translated by Ludmilla Wightman, whose cheerful help we happily acknowledge. The second appendix is a revision by Ludmilla Wightman of a translation by the British Admiralty Translation Service. We thank Ron Webbink and Floor van Leeuwen for delivering custom-made appendices, number three and four, respectively, on short notice. We thank Grace Rapp, Marge Barbosa and Barbara Pinkham for their indefatigable assistance in the various stages of organizing the symposium and preparing these proceedings. Finally we express our thanks to the California Institute for Technology and especially to the Institute for Advanced Study, for bearing the expenses of both com-

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puter time and secretarial assistance needed for the preparation of these proceedings.

The members of the Scientific and Local Organizing Committees are listed below. We are grateful to them for their contribution to the success of this symposium.

Scientific Organizing Committee:

T.A. Agekian, K.C. Freeman, D.C. Heggie, P. Hut (Chairman),
S. Inagaki, I.R. King, L.M. Ozernoy, L. Spitzer,
J. Stodolkiewicz, R. Wielen.

Local Organizing Committee:

J.N. Bahcall, R. Lupton, J.V. Villumsen (Chairman),
M. Wisnovsky.

The Editors,

Jeremy Goodman & Piet Hut