PREFACE

This is the first time that the International Astronomical Union has held a symposium on objects of totally unknown nature. In fact, M. Rees has pointed out that the mass of the individual particles that make up the dark matter is unknown to > 70 orders of magnitude. Since dark matter appears to make up ~ 90 % of the mass of the Universe, it presents us with one of the most fundamental problems in astrophysics. IAU Symposium 117 on *Dark Matter in the Universe* was held on June 24 - 28, 1985. Our hosts were Princeton University and the Institute for Advanced Study, which together form one of the most active centers of work on the dark matter problem. There were ~ 190 participants from 16 countries. These proceedings include the 31 review and invited papers, 72 of the 85 poster papers, and the two general discussions.

The idea that the Universe might contain much more mass than we see in gas, stars and their remnants has been with us for over 50 years. In 1933, F. Zwicky pointed out that the Coma Cluster could be in equilibrium at the large observed velocity dispersion only if a great deal of unseen matter were present. However, in the absence of other evidence, the idea of "dark matter" was not widely pursued. Then in the mid-1970s it became clear that rotation curves of galaxies do not have the expected Keplerian declines at large radii; they stay flat as far out as we can observe them. The evidence became compelling when rotation curves were measured to very large radii. Other techniques of mass measurement were developed, based, e. g., on the confinement of X-ray halos; these also implied large amounts of DM. At about the same time J. Ostriker and P. J. E. Peebles pointed out that DM halos in galaxies could explain the observed stability of disks against the formation of bars. Also, large amounts of DM could close the Universe, an appealing possibility that was beginning to look unlikely as the inventory of visible matter was improved. The simultaneous appearance of a variety of observational and theoretical arguments resulted in a general acceptance of the existence and importance of DM. Questions about the amount of DM remained, and some degree of healthy skepticism about the existence of DM persists today. But a scientific revolution had begun.

Until recently we knew little more than that DM appears to exist; we had little systematic information about its properties. Only in the past several years have we progressed to the point that we can measure DM density distributions. For example, with accurate rotation curves extending over large ranges in radius, we can try to decompose the effects of visible and dark matter to measure DM density profiles. Already some regularities in DM behavior have

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turned up. We need to look for more. For example, we need to look for correlations of structure parameters similar to the Faber-Jackson relation for visible matter. Then we can look at the astrophysics of DM in more rigorous detail. In addition, there is growing evidence that some DM is not baryonic. If this consists of elementary particles created in the early Universe, then the DM problem is intimately related with current work in fundamental physics. In particular, Grand Unified Theories suggest the existence of various particles that would necessarily contribute importantly to the mass density of the Universe if they exist and have mass. Then DM observations and particle theories provide interesting constraints on each other. By the mid-1980s progress had become very rapid. The time had come to hold an IAU Symposium. The Scientific Organizing Committee (SOC) wanted to provide an opportunity for people in the very diverse fields now involved in DM work to get together. We did not expect to solve the problem of the composition of DM. However, we hoped that a successful meeting would stimulate further work and suggest the directions that would be most productive.

In planning the meeting, the SOC tried to emphasize a number of key issues; these are introduced in papers by S. Faber and V. Rubin. To allow the reviewers to be as thorough as possible, it was decided that all contributed papers would be posters. Similarly, the reviewers were given as many pages in the proceedings as possible to allow them to write papers that would be useful references. Posters are included as one-page abstracts. Long discussion periods were scheduled to allow participants to explore the issues; the session chairmen were M. Schmidt, M. Roberts, E. Salpeter, P. Shapiro, P. Schechter, A. Dekel, C. Norman, D. Lynden-Bell, G. Steigman, J. Peebles and S. Tremaine. The discussions are included in full, but were edited to reduce their length. We have tried to preserve the content and flavor of what was said; of course any errors that were introduced are our responsibility.

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A large number of people contributed to the success of the meeting. We thank the members of the SOC for their help with the planning. In addition, P. Schechter, A. Toomre and S. Tremaine gave very helpful advice at the time the program was defined. Much of the planning took place at a workshop on Dynamics Within Galaxies held at the Weizmann Institute of Science in 1984. JK thanks M. Milgrom and the Institute staff for their hospitality. In Princeton, the symposium was run by a very capable Local Organizing Committee; we thank them very much for their hard work. V. Nixon and W. Tankins provided invaluable assistance at registration. We are grateful to the students who handled the microphones and discussion sheets: S. Brown, W. Ewell, N. Katz, H. M. Lee, T. Quinn,

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