PLANET FORMATION

Theory, Observations, and Experiments

It is just over ten years since the first planet outside our Solar System was detected. Since then, much work has been done to try to understand how extrasolar planets may form. This volume addresses fundamental questions concerning the formation of planetary systems in general, and of our Solar System in particular. Drawing from recent advances in observational, experimental, and theoretical research, it summarizes our current understanding of the planet formation processes, and addresses major open questions and research issues. Chapters are written by leading experts in the field of planet formation and extrasolar planet studies. The book is based on a meeting held in 2004 at Ringberg Castle in Bavaria, where experts gathered together to present and exchange their ideas and findings. It is a comprehensive resource for graduate students and researchers, and is written to be accessible to newcomers to the field.

The Cambridge Astrobiology series aims to facilitate the communication of recent advances in astrobiology, and to foster the development of scientists conversant in the wide array of disciplines needed to carry astrobiology forward. Books in the series are at a level suitable for graduate students and researchers, and are written to be accessible to scientists working outside the specific area covered by the book.

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Theory, Observations, and Experiments

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Dedicated to the one and only true planet formation specialist
Slartibartfast of Magrathea and his father D. N. Adams.

Contents

Preface

With the words "Twas the night before Christmas . . . " does a good old story start. In December 2004, just a couple of days before Christmas, not three wise men but more than 60 wise men and women came to a castle in the Bavarian mountains. They traveled through a strong snow storm, but no-one turned back; all of them arrived. They had a noble goal in mind: to discuss the current understanding of the formation of planets. The meeting took place December 19–22, 2004 at the Ringberg castle of the Max-Planck-Society. Anyone who has had the chance to attend a meeting there knows what a friendly and stimulating atmosphere for a workshop it provides.

About a year beforehand we had called them, and now they came. The idea was to have a wonderful conference at the romantic Ringberg castle and to bring together theorists and observers, as well as meteoriticists and experimental astrophysicists. Only then, we thought, could we obtain a global picture of the ideas we have about how our planetary system came into life. We wanted to collect not only the accepted ideas, but also the speculative and competing ideas.

We were quickly convinced that this conference, unique in its composition, should generate a permanent record in the form of a proceedings book. But this book should not be just one more useless compendium of unrefereed papers, but should provide a concise and accurate picture of current planet formation theory, experiment, and observation. Based on a suggestion by Alan Boss, Cambridge University Press became interested in publishing the proceedings as part of its new astrobiology series. So we convinced some of the major league players in the planet-formation and extrasolar-planet business not only to come and give presentations but also to write overview chapters on their special field of expertise. These chapters were then publicly discussed at Ringberg and also refereed by some independent experts in the field.

Participants of the Ringberg workshop on planet formation December 19–22, 2004.

PLANET FORMATION addresses fundamental questions concerning the formation of planetary systems in general and of our Solar System in particular. Drawing from recent advances in observational, experimental, and theoretical research, it summarizes our current understanding of these processes and addresses major open questions and research issues. We want this book to be, for students and other newcomers to the field, a detailed summary which, if studied along with the references contained herein, will provide sufficient information to start their work in the field of solar and extrasolar planets. At the same time we want to explore the current understanding of the state of the art of this subject ten years after the detection of the first extrasolar planets around Sun-like stars. The chapters of this book have been written by the leading scientists in the field, who have made significant contributions to the subject of planets and their formation. We aim for a comprehensive and meaningful overview including observations of exoplanets and circumstellar disks, the latest findings about our own Solar System, experiments on grain growth, and finally on the competing theories on planet formation.

If we continue to attract the brightest physicists to this field of astrophysics we hope that one day we will reach our two-fold goal: first, to understand the origin of our Solar System and of our blue Mother Earth, the only place in the universe where we are sure about the existence of life, and second, to learn how exquisite or general the conditions for life are in the rest of the vast universe, based on our predictions on how many Earth-like, potentially life-harboring planets are out there.

Acknowledgments

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