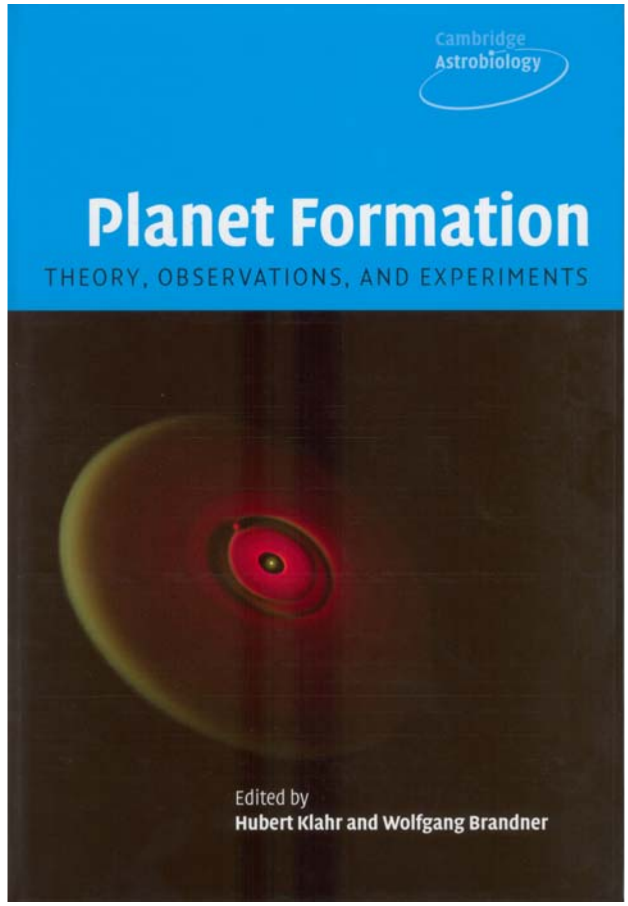
The Meteoritical Society

Meteoritics & Planetary Science 42, Nr 3, 467–468 (2007)
http://meteoritics.org

Book Review

Planet formation: Theory, observations, and experiments, by Hubert Klahr and Wolfgang Brandner. Cambridge University Press, 2006, 318 p., $120, hardcover (ISBN 0-521-86015-6).



This is the first book in the Cambridge Astrobiology series, which aims to "foster the development of scientists conversant in the wide array of disciplines needed to carry astrobiology forward," through books pitched at graduate students and researchers, and intended to be "accessible to scientists working outside the specific area covered." The volume is an excellent start for such a series. It results from a workshop in December 2004 that brought together theorists, observers, meteoriticists, and experimentalists. It is a timely addition to the many recent reviews of meteoritical evidence (e.g., *Meteorites and the early solar system II,* Treatise on Geochemistry, volume 1, and *Chondrites and the protoplanetary disk*).

The editors are Hubert Klahr, Head of the Theory Group for Planet and Star Formation, and Wolfgang Brandner, Head of the Adaptive Optics Lab, both at the Max Planck Institute for Astronomy in Heidelberg. The volume is correspondingly weighted heavily toward theory and observation. The stated goals are to provide sufficient information for newcomers (explicitly physicists) starting work in the field of solar and extrasolar planets, and also to explore the current understanding of the state of the art in this subject. They succeed in both these goals. The bulk of the volume concerns physics rather than chemistry, providing a context for, but only one chapter about, the evidence in meteorites.

The volume provides a useful, well-organized review of recent work in several fast-moving fields. An introductory chapter (Bodenheimer) briefly outlines key concepts of disk physics from Descartes through Jeans, von Weizsäcker, Kuiper, Alfvén, Safronov, Hoyle, Toomre, Cameron, Wetherill, Shu, and others. The early work on planet searches is also reviewed. A chapter by Bouwman et al. places the solar system in the general context of stellar evolution by review of recent observations of young stars and disks (IRAS, ISO, Spitzer).

These are followed by chapters on photoevaporative disk destruction (Richling et al.) and turbulence as a driver of planet formation (Klahr et al.). Klahr et al. present many of the basic equations of disk viscosity and magnetohydrodynamics (MHD); however, the uninitiated will not be satisfied by their descriptions of basic phenomena such as ohmic dissipation and ambipolar diffusion. Meteoriticists will, nevertheless, gain an appreciation of the complex dynamic environment in which disk solids formed and accreted.

Klahr et al.'s combined discussion of MHD turbulence, radial mixing, layered disks, and dust dynamics leads nicely into the chapters most directly related to meteoritics. Trieloff and Palme place Ca-, Al-rich inclusions and chondrules in astrophysical context. They review the implications of chondrite compositions and isotopic heterogeneity for the origin and fate of solids in the solar disk. They concisely review important recent radionuclide chronometry, and the consistency of meteoritic evidence with theory and observations of disk processes, before presenting their summary of the origins of solids and planets in our solar system. This is an impressive synthesis of existing chemical and isotopic data into a coherent story, which I found quite informative.

Wurm and Blum then provide a concise, thorough review of recent experimental work on collisional particle growth and fragmentation. Their chapter will interest meteoriticists unfamiliar with this important line of systematic research, which closely links observations with theory. The following chapter (Henning et al.) covers grain growth in protoplanetary disks inferred from observations, how such inferences are made, and the modeling of dust coagulation. Their summary of different mechanisms of dust movement and coagulation will be particularly useful to the nonspecialist.

The next ten chapters cover theoretical and observational aspects of giant planet accretion, extrasolar planets, disk-planet interactions, and the brown dwarf–planet relation. The book provides a snapshot of these interesting and timely astrophysical topics, but it is too early for a clear connection to meteoritics and terrestrial-type planets to emerge.

The book is well integrated with cross-chapter references and a single 36-page citation list. Referencing is idiosyncratic and reflects chapter authors' predilections. Some important compilations (e.g., *Meteorites and the early solar system II*) are listed under general editors (e.g., Lauretta et al.) while individual papers are cited from others (e.g., Lecavelier et al. in *Circumstellar dust disks and planet formation*). The three-page index is sparse but adequate (e.g., chondrules but not "chondrite," initial mass function but not "solar composition," asteroids but not "comet"—oh, "comets" is alphabetically misplaced).

This book will be of interest to meteoriticists seeking a succinct overview of the modern astrophysical context of disks. I learned a lot from reading it. The student with a physics or chemistry background will also find a selective synthesis of meteoritical evidence by a leader in the field. Astronomical observation and theory are closely woven together, and the importance of space-based observations is made clear. The problem of planet formation is enormously complex. This book is a valuable step in the right direction: the integration of clues from extraterrestrial samples, planetary geology, laboratory experiments, astronomical observations, and astrophysical models.

Denton S. Ebel
American Museum of Natural History
Department of Eath & Planetary Sciences
Central Park West at 79th Street
New York, New York 10024–5192, USA