books

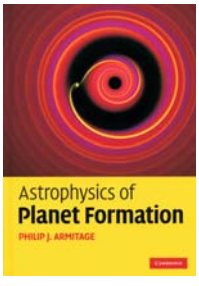
Worlds emerging from the clouds

Astrophysics of Planet Formation

Philip J. Armitage
Cambridge U. Press, New York, 2010. $65.00 (284 pp.).
ISBN 978-0-521-88745-8

Reviewed by Diana Valencia

The foundations of planet formation research were established from the late 1960s through the 1980s by such noted patriarchs of the field as Chushiro Hayashi, Viktor Safronov, and Stuart Weidenschilling. However, planet formation theories have been invigorated during the past 15 years by an explosion in the discovery of exoplanets, which provide an expanded and exciting playground and a new set of constraints.



The goal of a planet formation theory is to understand the numerous, complex, and interdependent steps between collapse of the nebular cloud and the emergence of giant planets, small planets, and planetoids. In *Astrophysics of Planet Formation*, Philip Armitage lays out a concise introduction to the most important theoretical concepts in planet formation. He describes or derives the governing equations; gives, when possible, results from numerical modeling; and discusses observational constraints. In a nutshell, the book provides the young astrophysicist with the necessary background and elements to move on to more advanced work.

Astrophysics of Planet Formation is organized into self-contained but connected chapters that generally follow the chronology of planet formation: disk characteristics and evolution, planetesimal formation, terrestrial planet formation, and giant planet formation. The book concludes with a brief chapter on the dynamics of planetary systems. Two pedagogical approaches make it an outstanding introductory text: Armitage concentrates on the essentials rather than getting lost in the details, and he carefully walks the reader through the derivation of equations, highlighting their physical meaning. He also gives technical references for in-depth reading at the end of each chapter.

Several chapters stress unresolved challenges and clearly state where and why difficulties arise in such issues as modeling the transport of angular momentum in a disk or understanding how dust particles grow into planetesimals. Armitage has brought his extensive knowledge in modeling the structure and evolution of astrophysical disks and applies that knowledge to problems in planet formation. But he does not fall short on other topics: For example, in the appendix, he discusses the technical aspects of *N*-body methods—used to predict the motion of gravitationally interacting celestial objects—to demystify the complexity behind astrophysical numerical methods, which are often obscure to those outside the field.

Overall, Armitage delivers on the book's aim to "provide a concise introduction to the classical theory of planet formation and to more recent developments spurred by new observations." *Astrophysics of Planet Formation* would be an excellent main text for a course in astronomy, astrophysics, or planetary science.

Diana Valencia is a Carl Sagan postdoctoral research fellow at MIT in Cambridge. Her research interests include the structure and composition of super-Earths and the thermal evolution of icy terrestrial planets.

Time

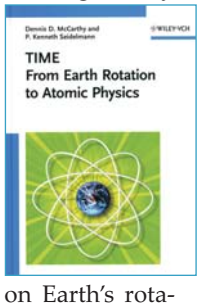
From Earth Rotation to Atomic Physics

Dennis D. McCarthy and P. Kenneth Seidelmann
Wiley-VCH, Weinheim, Germany, 2009. $145.00 (351 pp.).
ISBN 978-3-527-40780-4

For nearly all of recorded history, and particularly the modern era, the interrelationship between timekeeping and astronomy has been a subject of interest. For example, the 18th-century "longitude problem" involved comparing the rotation angle of Earth to the time kept by mechanical devices that allowed precise navigation over long distances; the need to solve that problem led to a race between astronomers and mechanical clockmakers. As the astronomers discovered more details of Earth's rotation, the clockmakers were inspired to build clocks whose rates were in sync with astronomical time.

An excellent look at the astronomical side of timekeeping is presented in *Time: From Earth Rotation to Atomic Physics* by Dennis McCarthy and Kenneth Seidelmann. The authors are recognized experts in Earth orientation, time scales, and timekeeping. More importantly, they write very well.

Time begins with a brief historical review of clocks and timekeeping, then moves into a discussion of how Earth rotation was used as the basis of time. The authors gently but rigorously explain the theory of Earth rotation and describe the progressive refinements of the physics used to define and model our planet's motion. They also trace the historical progression of time scales, first moving from those based on Earth's rotational rate to ephemeris time, which is based on Earth's position in its yearly orbit. The reader learns how ephemeris time was briefly used to define the second and how it was soon abandoned when the early generation of the atomic clock was shown to be a more stable measurement reference.



Astronomical timekeeping is clearly the authors' first love, and they devote roughly half the book to the topic. That half is well researched and was a delight to read, as it expertly, thoroughly, and lucidly describes the challenges involved in developing and

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