

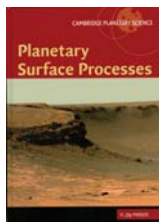
Skin-deep observations with profound implications

Planetary Surface Processes

H. Jay Melosh
Cambridge U. Press, New York, 2011.
\$80.00 (500 pp.).
ISBN 978-0-521-51418-7

Reviewed by J. Taylor Perron

The NASA rover, Curiosity, which is currently traversing the Martian surface, is emblematic of the renaissance in planetary exploration that began in the 1990s. Recent spacecraft missions, like those of the cold war era, have brought a flood of new insights about planetary surfaces, the easiest part of a planetary body to observe, and in many ways the most charismatic.



That deluge of data has come at a time when the study of Earth's surface has grown increasingly quantitative. The opportunity to apply terrestrial theory to analogous planetary settings is an exciting prospect for the terrestrial geologist who is unable to perform field experiments within a geologically meaningful time interval. Also, planetary landscapes have offered up unexpected and occasionally baffling phenomena that are forcing students of Earth's surface to expand their perspective on what defines a landscape and how a planet's surface evolves over time.

For those reasons, H. Jay Melosh's *Planetary Surface Processes* is a timely contribution. The book is an expanded, formalized version of a popular course taught for more than two decades by the author, one of the foremost statesmen of planetary tectonics and impact cratering. The front matter sets the ambitious goal of providing an overview of "the full range of geological processes that shape the surfaces of planetary-scale bodies." The ensuing text manages to deliver on that promise

while maintaining a jocular tone that makes it engaging without sacrificing quantitative rigor.

It would be easy to fill a volume with a catalog of the varied observations returned by spacecraft missions. But make no mistake: *Planetary Surface Processes* is not a bestiary of planetary landforms. Rather, it is a summary of many years of progress in geology and geophysics that is organized by physical process and interspersed with examples of quantitative, often comparative planetary applications. The book is peppered with historical anecdotes such as those relating G. K. Gilbert's ambitious flume experiments at the University of California, Berkeley, and the initial disappointment over the Moon-like appearance of Mercury's surface observed during the *Mariner 10* mission.

Following a brief tour of the solar system and the planetary surfaces that have attracted the most exploration and attention, the book continues with a chapter on planetary shape and large-scale topography. It then proceeds to describe physical processes of progressively finer scale and rarer occurrence. The book truly shines in the middle chapters on material strength and topography, tectonics, and impact cratering, the subjects on which the author's own research has made indelible marks. Volcanism is naturally also included among the most widely observed processes. The chapter on regoliths and weathering signals the transition from large-scale to finer-scale processes that modify surfaces. Experts may notice the relatively concise treatment of topics, such as fluvial processes, that have received a large share of attention in the literature. This is, after all, a text about all the terrestrial and icy bodies; rivers, while fascinating, are relatively rare in the solar system. Nonetheless, the closing chapters on mass movement, wind, liquid water, and ice cover the essential principles that mission scientists are using to interpret what Curiosity sees near its landing site in Mars's Gale Crater.

Planetary Surface Processes is aimed at advanced undergraduates, beginning graduate students, and planetary scientists working outside their immediate specialty who need a quick introduc-

tion or refresher. Even for those who do not need a primer, the book will function as a useful reference. Each chapter provides an annotated list of suggestions for further reading, though a few passages in the text would have benefited from additional references to the literature they summarize. For example, the explanation in chapter 10 of the work performed on a landscape by a distribution of floods could direct readers either to the classic 1960 paper by M. Gordon Wolman and John Miller or to more recent reviews that provide an entry point into the literature. Solutions to end-of-chapter exercises are left to the reader; that should not pose much of a problem for course instructors, but it may challenge students working independently of an organized course.

This book overlaps little with existing texts, such as Imke de Pater and Jack Lissauer's *Planetary Sciences* (2nd edition, Cambridge University Press, 2010), which covers a wider range of phenomena and provides an advanced introduction to planetary science. But as the first systematic, quantitative treatment of its subject matter at an introductory level, *Planetary Surface Processes* is poised to become the standard text for planetary surface geology and will make an essential addition to the bookshelves of students and researchers alike.

Scale Invariance From Phase Transitions to Turbulence

Annick Lesne and Michel Laguës
Springer, New York, 2012. \$99.00
(397 pp.). ISBN 978-3-642-15122-4

The remarkable scale invariance exhibited in many objects and processes has profound implications for numerous problems in modern physics and on the analytical methods used to solve those problems. In *Scale Invariance: From Phase Transitions to Turbulence*, Annick Lesne and Michel Laguës show how scale invariance is exhibited in such physical processes as diffusion, turbulence, and superconductivity and in such systems as polymer solutions. That



undertaking is a bold one, since each example presented requires significant explanation of its own physics, even before the issue of scale invariance is discussed. The reader will be surprised by the level of breadth and depth attained in this book of less than 400 pages.

The book begins with an introduction to scale invariance in the context of critical behaviors. Chapter 2 provides an overview of fractals and introduces self-similarity concepts. In chapter 3, the authors describe scaling relations and the renormalization group and its use in predicting critical behaviors. Subsequent chapters address scale invariance in specific physical phenomena.

In addition to the high quality of its numerous diagrams and plots and the admirable readability of its equations and fonts, *Scale Invariance* is well written and surprisingly engaging. Particularly so is chapter 4, which contains a fine presentation of anomalous diffusion. The authors also do an excellent job of including the history of the topics they present; they make wise decisions about when to include significant historical details and when to blur over them. Occasionally, though, the writing seems overwrought. For example, relatively simple points are often delivered in an unnecessarily complicated fashion, and sentences can be much longer than necessary. Perhaps the translation of the original from French to English is partly to blame.

The discussion of turbulence, its appearance in the book's title notwithstanding, is relegated to one section in the chapter on chaotic dynamics, which appears near the end of the book. Unusual as that seems, it is perhaps appropriate: Although turbulence is a problem of great importance, it is also a largely unsolved phenomenon, and the authors generally focus on topics in which greater understanding has been attained.

The diligent reader will benefit from *Scale Invariance*, but as can be expected for a book covering a broad range of topics, an exhaustive explanation of each topic is not possible. Significant overlap exists between *Scale Invariance* and various books on chaotic dynamics and universality. *Universality in Chaos* (2nd edition, Taylor & Francis, 1984), edited by Predrag Cvitanović, comes to mind. Its focus is different, but both books include such topics as fractal geometry, strange attractors, turbulence, and Lyapunov exponents.

The authors provide detail on each

topic, but not enough to adequately educate the novice or to satisfy the expert. For their type of presentation to work, it is crucial that the authors focus on the book's unifying theme of scale invariance. And, to be fair, they do return to that theme in each chapter; but at times they don't emphasize the idea strongly enough, and some of the chapters tend toward becoming merely a survey of the topic under discussion.

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Field Theory of Non-Equilibrium Systems

Alex Kamenev
Cambridge U. Press, New York, 2011.
\$80.00 (341 pp.).
ISBN 978-0-521-76082-9

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