

who will also read it, the book includes an appendix describing the major discoveries and surprises of the mission in more technical detail. For me, the biggest surprise is Pluto's internal heat, which drives still-active surface geologic and atmospheric processes. The source of that heat is a puzzle that might only be solvable if we return to Pluto.

Is Pluto a planet, as Tombaugh claimed and schoolkids throughout the 20th century were taught? Stern and Grinspoon

make the case that it is, despite the poorly managed decision of the International Astronomical Union's leadership to demote it to dwarf planet status back in 2006. That demotion was based partly on the discovery of so many other Pluto-sized KBOs.

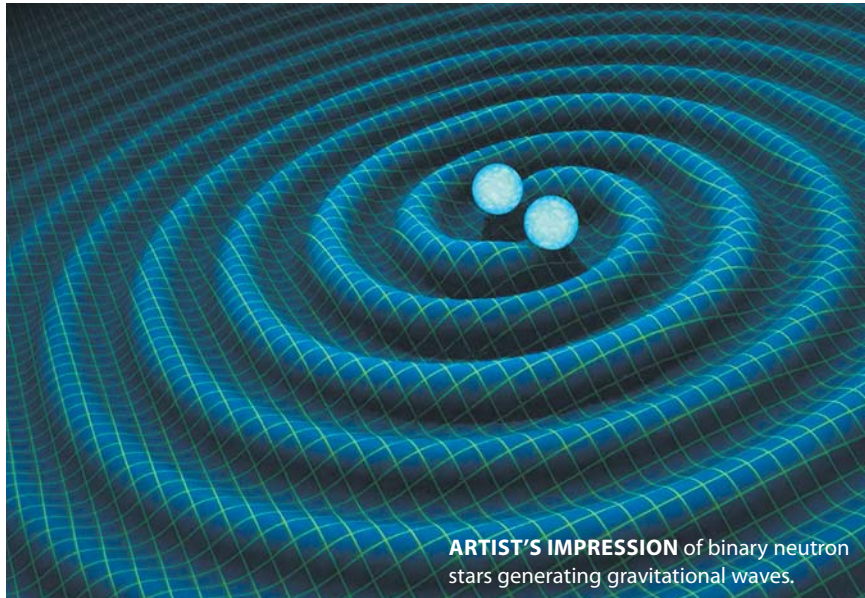
But I agree with the authors that planets should be judged on what they are like, not where they happen to be. I believe that many—perhaps most—planetary scientists would classify the small but

supremely interesting and dynamic world of Pluto as a full-fledged planet, and I would include large KBOs beyond Pluto, the large moons of the giant planets, and Pluto's own moon Charon in that category as well. Plutophiles, and the fans of the 40 or so other should-be planets that we know of so far in our solar system, should not give up the fight.

Jim Bell

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ARTIST'S IMPRESSION of binary neutron stars generating gravitational waves.

A hefty textbook for an ever-changing discipline

Kip Thorne and Roger Blandford's new textbook, *Modern Classical Physics: Optics, Fluids, Plasmas, Elasticity, Relativity, and Statistical Physics*, is a tour through macroscopic physics that features modern treatments of classical topics and insightful treatments of modern ones. If you are looking for a classical mechanics book whose subject matter ranges from nonlinear optics to the difficulties of controlled fusion and the detection of gravitational waves, this is the book for you.

Explaining their rationale and emphasis, the authors write that although the 20th century was largely the century of quantum mechanics, "classical physics has not stood still while the quantum

world was being explored. In scope and in practice, it has exploded on many fronts and would now be quite unrecognizable to a Helmholtz, a Rayleigh, or a Gibbs. In this book we have tried to emphasize these contemporary developments and applications at the expense of historical choices, and this is the reason for our seemingly oxymoronic title, *Modern Classical Physics*."

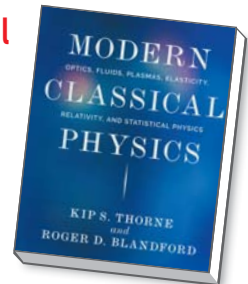
At 1500 oversized pages, *Modern Classical Physics* exceeds in length (by about 20%) even the prior opus of one of the authors, the textbook *Gravitation* (1st ed., 1973), an introduction to general relativity that Thorne wrote with Charles W. Misner and John A. Wheeler. The present work is more straightforward in tone and ap-

Modern Classical Physics

Optics, Fluids, Plasmas, Elasticity, Relativity, and Statistical Physics

Kip S. Thorne and Roger D. Blandford

Princeton U. Press, 2017.
\$125.00



proach, though in spots you'll see an attenuated version of the flair and exuberance for which *Gravitation* is known.

The presentation in *Modern Classical Physics* demands that readers have considerable prior knowledge. As acknowledged in the preface, they are presumed to have an undergraduate-level command of classical mechanics, electromagnetism, thermodynamics, and applied mathematics. After a rather sophisticated introductory section describing Newtonian kinematics and special relativity, the book moves on to six sections that survey the six areas of physics enumerated in the subtitle.

Readers can learn a lot here, though in places they will have to work hard for the lessons. The breadth of topics challenges what can be fully explained even in 1500 pages, and although many of the explanations are detailed and useful, some are less thorough. Given the scope of the work, though, it seems pointless to quibble over omissions or rare points of disagreement.

As the authors explain in the acknowledgments, the book developed from graduate courses they taught over decades, mostly at Caltech. Their students must have learned a great deal. Certainly graduate students in physics typically do not get such a thorough grounding in most of the topics treated

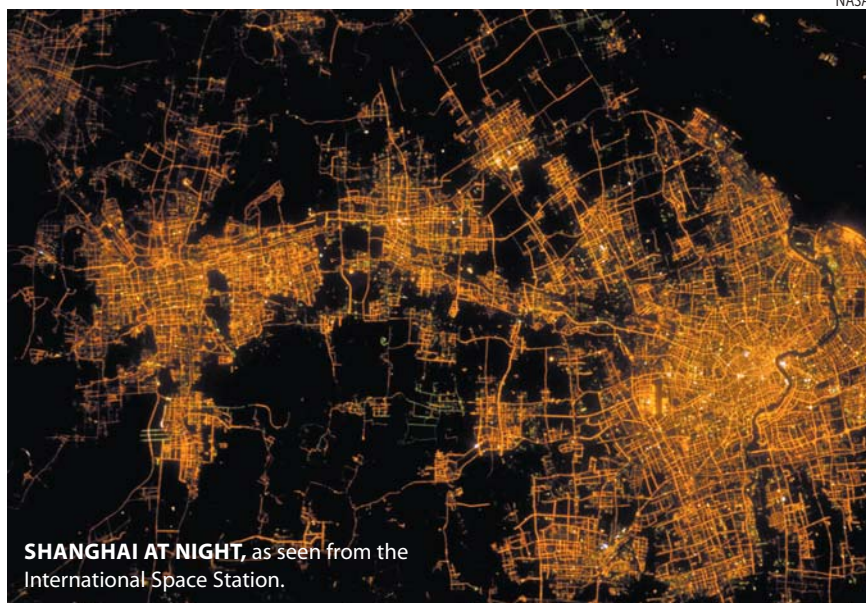
by Thorne and Blandford. A faculty member could plan a graduate course based on selected parts of the book, though it would take several courses to cover the entire text.

Given world enough and time, most of us would do well to put everything else aside for a couple of months, study *Modern Classical Physics* systematically, and come back with our knowledge well

refreshed. Short of that, we could satisfy our curiosity—or possibly pique it further—on many topics. And certainly, many of us would appreciate this book as a reference. On the whole, *Modern Classical Physics* is a magnificent achievement.

Edward Witten

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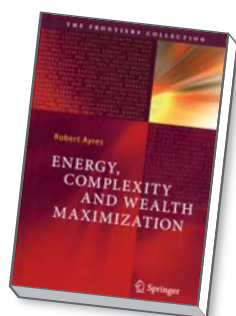
SHANGHAI AT NIGHT, as seen from the International Space Station.

Thermodynamics of economic growth

In his wide-ranging new book *Energy, Complexity and Wealth Maximization*, physicist and economist Robert Ayres considers how the science of thermodynamics can be applied to economic growth and wealth creation. Ayres's thesis is that "wealth in human society is the result of conscious and deliberate reformulation and dissipation of energy and materials." The difference between that notion and standard descriptions of wealth is that in Ayres's analysis, economic wealth stems not from the mere existence of valuable resources but from the transformation of existing energy and raw materials into the goods and services on which we depend. We burn oil. We mine ores and smelt them into metals, which we fashion into goods. But we do so at the expense of the depletion

Energy, Complexity and Wealth Maximization

Robert Ayres
Springer, 2016.
\$79.99



of those irreplaceable natural resources.

Ayres encapsulates decades of his own research and that by colleagues Benjamin Warr, Reiner Kümmel, and many others to ground mainstream economics in physical law. He concentrates especially on their efforts to incorporate thermodynamics into economic growth theory because, he writes, "the laws of thermodynamics are central to everything that happens." Moreover, he continues, "the core ideas of economic theory (up to now) have never included, or even touched

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