

proceeding from the discovery of planets in our own solar system (which makes up the first quarter of the book) to the discovery in 1983 of shells around the stars Beta Pictoris and Vega, the totally unexpected discovery of planets around a pulsar in 1992 and, finally, the "harvest of planets" that began in 1995. Goldsmith, by contrast, proceeds thematically, beginning with the discovery of the new planets then proceeding to the question of life, the formation of planetary systems and the techniques for their discovery, before going further afield than Crowell to discuss the Drake equation and other aspects of life in the universe. (Curiously, Crowell's publisher is the Free Press, whose trademark is fp , which in the Drake equation represents the fraction of stars that form planets!) Halpern is broadest of all, devoting, for example, a whole chapter to Mars and sacrificing some depth in the process.

The hallmark of Crowell's book is his use of interviews with many of the participants in the discoveries, a technique that makes us feel as if we were present at those discoveries and lays bare the controversies over the differences between brown dwarfs and stars, brown dwarfs and planets, the formation of planets extremely close to their parent star and the very existence of pulsar planets. The books by Goldsmith and Halpern do a good job of describing the techniques for future searches in addition to describing the techniques now in use. (We can have only the greatest admiration for those who have toiled to measure 3 m/s radial velocities, milliarcsecond positions and extremely small magnitude changes in the search for planets and who are now toiling with interferometers, micro-lensing, adaptive optics and spaceborne instrumentation to find ever more planets of ever smaller mass.) All three books are worthwhile for the view they give of scientists tackling a subject of great import while struggling through the inevitable problems of functioning at the limits of their science.

There are some missed opportunities in all three books: Despite the attention given to our own solar system as a benchmark against which to measure others, none of the three discusses how the giant outer planets were discovered to be gaseous, an interesting and relevant story, given that most of the current extrasolar planets are probably gas giants.

Nor do any of the three make much of the earlier history of the search for extrasolar planets prior to Peter van de Kamp's announcement in the early 1960s of a planet (now believed to be spurious) around Barnard's star. This early history includes, for example, the

published suggestions of Lick astronomers William W. Campbell and Heber D. Curtis in 1905 (in connection with their observation of spectroscopic binaries) that radial-velocity might be used for planet detection, Otto Struve's proposal in 1952 for a high-precision radial velocity search for extrasolar planets, and the excitement in the 1940s over the announcement that such planets had been detected. And none of the books goes beyond the bare essentials of the amazing and accelerating discoveries of circumstellar disks, which as planetary systems forming or formed bear just as strongly on the question of what fraction of stars have planetary systems as do the actual extrasolar planets announced.

All three books are well produced and affordable, and they will go a long way toward satisfying the public's seemingly inexhaustible interest in other planets and the likelihood of life elsewhere in the universe. With an ever-expanding array of techniques, and the impetus provided by NASA's Origins program in supporting both ground-based and space-based activities as set forth in its Exploration of Neighboring Planetary Systems Plan, planetary-systems science and the search for extraterrestrial life are sure to constitute major themes in 21st-century astronomy.

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Gravity Currents in the Environment and the Laboratory

John E. Simpson
Cambridge U. P., New York, 1997
[1987]. 244 pp. \$74.95 hc
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Gravity currents, flows caused by an intrinsic density difference between two fluids, are common in nature. Anyone not already convinced of their ubiquity need only spend some time with this beautifully illustrated book by John Simpson in order to appreciate the importance and prevalence of gravity currents in the everyday world.

In *Gravity Currents in the Environment and the Laboratory*, Simpson covers gravity currents involved in synthetic and natural phenomena with industrial, geological, oceanographic and atmospheric implications. Special topics include the flow of suspensions and the effects of rotation and stratification. Well chosen examples provide the impetus for understanding the dynamics quantitatively and are gener-

ally placed in a suitable context: Lahars and spills of dense gases are presented from a hazards point of view; analyses of air flow in buildings and termite mounds are presented as engineering problems. Certain topics and examples are notably absent, however: There is mention of neither currents in porous materials (applications to contaminant plumes) nor solidifying currents (applications to lava flows), and only a passing mention is made of currents in which interfacial tension is important.

The most engaging aspect of the book is that it is long on beautiful pictures, illustrations and physical explanations and short on mathematical analysis. Examples of gravity currents are typically illustrated with photographs of laboratory experiments, many of which come from Simpson's own studies; when appropriate, there are pictures of natural phenomena or figures showing measurements. To complement the photographs, there are clear sketches and schematic illustrations of important ideas. In many ways this book can be read by looking at the pictures alone.

Gravity currents are among the most approachable topics in fluid mechanics because they are commonly observed and can be understood physically in a straightforward manner. The mathematical analysis of gravity-current dynamics lends itself to scaling analysis and elegant similarity solutions for certain types of problems, and it is this particular aspect of the topic that is least developed by Simpson. For example, the time^{1/8} spreading of a liquid on a flat surface at low Reynolds numbers (a result that is simply cited on page 215) can be obtained by balancing viscous and buoyancy stresses and assuming conservation of mass. Despite the simplicity of elementary gravity-current analysis, only a few such results are derived, such as the speed obtained by equating potential energy loss and kinetic energy gain and the energy loss at a bore. This is unfortunate, as force balances, scaling and even similarity solutions are not beyond the understanding of undergraduates and could be included without compromising the accessibility of the material.

The concluding chapter on numerical solutions is unnecessary and out of date (it was not revised since the first edition in 1987). Despite Simpson's statement that "the time of writing is one of rapid development of numerical models," only works published in 1968, 1977, 1980 and 1985 are considered in this chapter. Much more insightful would have been an analytical and mathematical treatment of currents.

For example, the Navier–Stokes equations could be presented, and the force balances, scaling and analytical results that apply in different limits could be derived.

Undergraduates at any level should be able to follow the book if they have a background in high school physics and elementary calculus. Dimensionless numbers, such as the Reynolds number, Froude number and Rossby number, are defined for the reader, and quantities such as the Coriolis force and potential temperature are carefully explained.

I have used this book successfully as a reference for an undergraduate class in geological and environmental fluid mechanics. Because of the interesting applications and the absence of advanced math and physics, this book might even be useful as a guide for a freshman seminar.

In summary, this book is well written and thoughtfully motivated and has clear explanations. Its great strength is in the physical insight it provides into many commonly occurring flows and phenomena. As a testimony to the contagion of Simpson's fascination with gravity currents, I now seem to notice these phenomena everywhere and appreciate the physical processes they represent, such as the spreading of syrup on my pancakes, a low Reynolds number current spreading on a porous surface.

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Signals, Sound, and Sensation

▶ William M. Hartmann
AIP, Woodbury, N.Y., 1997.
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Psychophysics is the study of the relationship between the magnitude of a stimulus measured in conventional units and the magnitude of the sensation as perceived by the brain. In *Signals, Sound, and Sensation*, William Hartmann provides a comprehensive treatment of the theory and methods used by psychophysicists to study the perception of sound, and he introduces the reader to the quantitative methods of psychoacoustics.

The story begins with an explanation of the importance of a pure tone and the use of decibels to quantify measurements of power and intensity. The reader is assumed to know basic calculus and is provided with other mathematical tools as needed. The connection to psychoacoustics is firmly

established in chapter 4 with a discussion of the relationship between intensity and loudness. The chapters on signal theory present topics such as Fourier analysis and filters in the same systematic manner that you would expect to find in an engineering text, although the style is somewhat friendlier. Key concepts and results from psychophysics are interspersed throughout, at appropriate places.

The cochlea's fundamental role as a frequency analyzer is discussed primarily in terms of auditory filters. There is very little discussion of auditory physiology here. Auditory filters in psychoacoustics are idealized as having rectangular, "roex" and "gamma-tone" shapes. The critical band, described as the "single most dominant concept in auditory theory," is a channel for processing auditory information, and its bandwidth is measured by psychoacoustic methods. Tones separated in frequency by less than a critical band interact with each other much more than do tones that are further separated.

The chapter on music theory covers mainly the mathematics of musical intervals. This is followed by a discussion of the psychoacoustics of pitch perception. More advanced topics in the book include correlation, probability density functions, modulation, nonlinear distortion, noise and signal-detection theory. Signal-detection theory has become the hallmark of modern psychophysics. For the most part, variables describing perceived quantities are best thought of as random variables.

Hartmann's many years of teaching acoustics and physics are evident in the confident manner in which he presents this material. He covers a wide range of topics in a clear, authoritative and easy-to-read style. The material is most appropriate for the student who has an interest in the science of hearing and who wishes to acquire familiarity with acoustics and signal theory.

Signals, Sound, and Sensation is intended to be used as a text for a second course in psychoacoustics. For this purpose, the coverage of relevant topics is very thorough. The exercises at the end of each chapter are generally easy to do and are used to introduce additional material. The book would also be a useful reference for anyone interested in the study of auditory perception. Readers who already have an acquaintance with signal theory may appreciate the sensible style of the discussions of such psychoacoustic topics as loudness and pitch perception. Numerous references to the journal literature are included for those seeking further details.

As a hearing-research scientist with a background in physics and electrical engineering, I appreciated the direct, accessible style of Hartmann's book and found it a pleasure to read. It should be considered by anyone wanting to teach signal theory to students with an interest in psychoacoustics.

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The Dancing Universe: From Creation Myths to the Big Bang

▶ Marcelo Gleiser
Dutton (Penguin), New York,
1997. 352 pp. \$25.95 hc
ISBN 0-525-94112-6

The publication of books about the relationships among myth, religion and science is a booming cottage industry. Physicists and cosmologists are particularly eager to explain their esoteric attempts to understand creation and to tie them to other belief systems. Some cosmologists even believe that they have pushed science right up to the edge of faith.

Much of modern cosmology, when simplified for presentation to the lay public, reads much like a creation myth. Even the big-bang and steady-state universes, and closed vs. open universes, have parallels in ancient belief systems.

Consider the Maori myth of the Creation:

*From Nothing, the begetting
From nothing, the increase
From nothing, the abundance
The power of increasing the
living breath.*

*It dwelt with the empty space,
And produced the atmosphere
which is above us,
The atmosphere which floats
above the Earth;
The great firmament above us
dwelt with the early dawn,
And the Moon sprang forth.
The atmosphere above us dwelt
with the heat.*

There is no Being behind this creation; things appear from nothing, simply due to an inexorable urge to be. Does this sound familiar? The Roman poet Ovid wrote in 8 AD, in *Metamorphoses*:

*Before the Ocean was, or Earth,
or Heaven,
Nature was all alike, a
shapelessness,
Chaos, so-called, all ruse and*