

in *Classical and Modern Physics*. The present work, however, focuses primarily on formulations of the issues in the recent literature and points up the fact that these issues are still the subjects of contentious debate.

Jammer's subsequent discussion of gravitational mass includes the distinctions between inertial mass and active and passive gravitational mass, and formulations of the equivalence principle as applied to these distinctions. This latter material is new, deriving from the resurgence of interest in tests of general relativity during the 1960's in the work of Clifford Will and colleagues and in the subsequent development of the Parameterized Post-Newtonian (PPN) formalism.

The final chapter of the book is on theories of the origin and nature of mass. Jammer considers local dynamical theories, such as the electromagnetic theory (again, given a more detailed historical treatment in the 1964 book), global dynamical theories motivated by Mach's principle, quantum field-theoretic analyses such as the Higgs mechanism in electroweak theory, and the recent Haisch-Rueda-Puthoff theory of inertial mass as a reaction to the quantum vacuum. The book ends with a brief mention of the notion of mass in string theory.

Concepts of Mass in Contemporary Physics and Philosophy is also significant in its weaving into the discussion of various topics in the philosophy of science. In the context of inertial mass, Jammer considers the structuralist approach to theories and the manner in which structuralism distinguishes between theoretical concepts and observational concepts. He considers the notion of incommensurability in the context of competing views on the relationship between relativistic and classical mass, and he touches on the nature of scientific explanation in the context of the claim that general relativity explains the equality between inertial mass and (passive) gravitational mass. Such topics are grist for the mill of the practicing philosopher of science, but they still may not be all that familiar to the practicing physicist.

Physicists and philosophers of science will both benefit greatly from the book. It provides an invaluable source and commentary on the relevant contemporary literature. While the minimal use of technical exposition makes the book very readable to the nonspecialist, enough mathematical detail is provided to satisfy the curiosity of the expert. Jammer is unique in his experience as a physicist with a philo-

sophical bent and as a philosopher with a physicist's training. His contributions to the conceptual foundations of physics have been, and continue to be, both fruitful and enlightening.

JONATHAN BAIN

*Polytechnic University
Brooklyn, New York*

The Accelerating Universe: Infinite Expansion, the Cosmological Constant, and the Beauty of the Cosmos

▶ Mario Livio
Wiley, New York, 2000. 274 pp.
\$27.95 hc ISBN 0-471-32969-X

One of the most surprising recent results from observational cosmology is the evidence that the expansion of the universe is accelerating. If gravity were the only force acting to alter the expansion rate, then the universe would be expected to be decelerating or, in the extreme case of a universe with essentially zero mass, expanding at a constant rate. Acceleration implies that the cosmological constant postulated and then discarded by Einstein is in fact not zero.

The initial evidence for acceleration came from a particular type of supernova explosion that in all cases reaches a uniform (or at least easily calibrated) intrinsic luminosity. Observations show that the most distant examples of this type of supernova are intrinsically about 20% fainter than those nearby. This observation is easily explained, if the universal expansion is accelerating: Our motion away from the distant supernovae has speeded up since the light left them, sweeping us farther away than we would be in a universe with a constant or decelerating rate of expansion.

Naturally, astronomers sought other explanations for the faintness of these distant supernovae. Intervening dust would also dim the light, for example. But no observational support has been found for any such alternative explanations. More important, in the past two years several other lines of evidence have emerged to support the conclusion that we live in a low-mass universe (matter density about one-third the critical value) that is accelerating and is flat. These include measurements of the cosmic microwave background and estimates of the amount of matter in all its

forms—bright, dark, and baryonic.

Mario Livio's *The Accelerating Universe*, which was written primarily for the interested layperson, covers the work on supernovae but was completed before much of the supporting evidence became available. However, the book covers a much broader range of subjects than is suggested by its title. The author has set himself the task of showing how the search for beauty has shaped the development of physical theories of the universe.

He starts by defining what constitutes beauty in theory: symmetry, simplicity, and adherence to the Copernican principle that we do not occupy a privileged place in the universe. He then goes through basic cosmology in nontechnical terms, describing what we know about the universal expansion, dark matter, inflation, and so on. He concludes with a discussion of the recent discoveries of other planetary systems and an exploration of the anthropic principle—the hypothesis that certain physical constants and other properties of the universe, for which we as yet have no fundamental explanation, may have the properties that they do because we are here to measure them. Other equally arbitrary values would not have allowed carbon-based life forms such as ourselves to evolve, but such forms might well exist in other universes.

This book is clear, well written, and a pleasure to read. Livio's interest in the concept of beauty, and more specifically in the visual arts, manifests itself in well-chosen analogies that help the nonastronomer develop a mental image of what is implied by various physical theories.

At the same time, the book contains an enormous amount of information, sometimes with only the most superficial explanation. As a nonartist, I was familiar with only some of the paintings to which Livio refers in his discussions of beauty. Nonscientists are likely to have a similar problem with the discussions of astronomy. For example, in three pages, Livio covers stellar evolution; nuclear reactions; the equivalence between mass and energy; the inverse relation between mass and stellar lifetime; the Pauli exclusion principle; the Chandrasekhar limit; evolution from the main sequence to red giants; and brown dwarfs and white dwarfs. How much of this can the reader truly follow and remember unless most of the material is already familiar?

Because of this concern, I think the book would be most useful for teachers of introductory college astronomy

who will appreciate and use the elegant explanations. The book would also be an excellent choice for students who have had an introductory astronomy course and want to delve a little deeper into this rapidly developing field. And any scientist with some basic knowledge of astronomy and physics would find that the lively writing makes this book very pleasant reading.

SIDNEY C. WOLFF

*National Optical Astronomy Observatory
Tucson, Arizona*

An Introduction to Econophysics: Correlations and Complexity in Finance

▶ Rosario N. Mantegna and
H. Eugene Stanley
Cambridge U. P., New York, 2000.
148 pp. \$34.95 hc
ISBN 0-521-62008-2

In *An Introduction to Econophysics*, Rosario N. Mantegna and H. Eugene Stanley seek to discuss the application to financial markets "of such concepts as power-law distributions, correlations, scaling, unpredictable time series, and random processes." These are concepts that have had considerable impact on the physical sciences. The implicit suggestion is that there is a field called "econophysics," which is the application of mathematical techniques to the modeling and analysis of financial markets and economic systems. The book is an overview and introduction to the field by two respected physicists—Mantegna, of Palermo University in Italy and Stanley, of Boston University—presumably written for physics or mathematics professionals with limited knowledge of finance.

How should we judge *An Introduction to Econophysics* as a book and econophysics as a field? A quick glance at the bibliography reveals a large volume of work devoted to the field, generally culled from physics journals, a few finance journals, and a number of basic books on physics. A single page of the bibliography contains titles as diverse as "Turbulence and Financial Markets" (published by the authors in *Nature*, "Dynamical Optimization Theory of a Diversified Portfolio" published in *Physica A*, and Mandan Mehta's *Random Matrices* (Academic, 1990). The evidence suggests a lot of activity in the field, but the question is: Does this mean the field is impor-

tant? To judge, we have to investigate the aims of modern financial theory and whether econophysics supports these aims.

The aim of modern financial theory (or at least that part of modern finance having to do with financial markets) might be described as an attempt to produce theoretical models describing the behavior of financial markets, with an eye toward causal mechanisms, statistical laws, and even predictive power. Starting with assumptions about the behavior of rational economic agents, one makes restrictions on the set of possible laws describing financial markets. Adding simplifying assumptions such as frictionless markets, an absence of transaction costs, and unlimited short selling, the analysis is brought into the realm of the tractable. By observing the behavior of actual financial markets, through the collection and analysis of time series of financial data, one ultimately eliminates many models that are *a priori* possible but contrary to observed behavior. From these observations theories are refined and advanced, while all along there are opportunities for missteps, debates, and outright bad science. In the process of analysis, tools and methodologies from a number of sciences may be brought to bear on the problem as well.

Unfortunately, *An Introduction to Econophysics* completely ignores questions of financial theory and a great deal of the vast financial literature on capital markets and option pricing produced over the past 30 years. Moreover, it never attempts to establish the contribution of its methods to the field of finance. Rather, it positions itself as a field that can lend insight to the workings of financial markets. Yet many chapters end with conclusions as fuzzy as that of chapter 11: "Indeed no analog of the 2/3 law appears to hold for price dynamics."

As to the field itself, one would hope that the toolchest of analytic techniques developed for studying physical systems would have application to finance. However, such applications must be measured in terms that are useful to finance itself. *An Introduction to Econophysics* fails to deliver a cogent argument as to why this is so. Why it might be so is firmly established, but this is not enough.

The book also fails to discuss some fundamental and important differences between physics and finance, such as the inability to produce financial laws that persist over time, as compared to the constancy of physical

laws (drop a rock off a tower 400 years ago and the rock obeys the same physical laws as it does today). In the end, the reader is left with the impression that the authors, both capable and accomplished in their fields, are in the midst of creating a new field, one that exists alongside traditional finance while, at the same time, is outside of it. The question remains whether this new field will be interesting to an audience broader than physicists, and in particular whether practitioners of mainstream finance will find useful the tools offered by econophysics.

NEIL A. CHRISS

*Courant Institute of Mathematical Sciences
and ICor Brokerage Inc
New York, New York*

The Sky Is Not the Limit: Adventures of an Urban Astrophysicist

▶ Neil de Grasse Tyson
Doubleday, New York, 2000. 191
pp. \$23.95 hc ISBN 0-385-48838-6

One Universe: At Home in the Cosmos

▶ Neil de Grasse Tyson, Charles Liu,
and Robert Irion
*Joseph Henry Press, Washington,
DC, 2000.* 217 pp. \$40.00 hc
ISBN 0-309-06488-0

Bold changes have taken place at 81st Street and Central Park West in New York City. The old Hayden Planetarium, where so many awe-struck visitors met the wonders of the cosmos for the first time, is no more. In its place is a glass box containing an enormous suspended sphere reminiscent of a 1930s vision of a madman's Van de Graaff generator—an edifice of glass and steel and high-tech wizardry that is the new, improved Hayden Planetarium, a modern—even post-modern—reconfiguration of a venerable New York landmark.

At the helm of this startling, reconfigured Hayden Planetarium is Neil de Grasse Tyson, a charismatic astrophysicist who happens to be African American.

Under Tyson's leadership, the Hayden Planetarium Space Theater, now within the Rose Center for Earth and Space, and its associated exhibitry, offer the public new and provocative ways to explore the universe. Its mission is not merely to reveal the wonders of the universe, but to take you