lous for comfort.

Still, Smolin should be commended for adding a fertile idea to the rich witches' brew of speculative cosmology. Given the inherent interest in the subject, cosmology must be indulged with an exemption from the caution with which scientists approach more mundane subjects. One can hardly criticize Lee Smolin for borrowing a sublime idea from biology to create a scheme that opens the door to investigations that could be worthwhile, even if his proposition ultimately fails to pass muster.

**Robert H. March**
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# Biochemical Oscillations and Cellular Rhythms: The Molecular Bases of Periodic and Chaotic Behaviour

Albert Goldbeter
*Cambridge U. P., New York, 1997. 605 pp. $44.95 pb*
*ISBN 0-521-59946-6*

Some time ago, Albert Goldbeter happened across a painting by Gottfreid Wiegand entitled *The Doppel Handler*. This painting, a reproduction of which now graces the cover of Goldbeter's *Biochemical Oscillations and Cellular Rhythms*, depicts a man who with his right hand appears to be plotting a phase plane trajectory of the oscillations that his left hand is simultaneously sketching in time. The cover sets the stage for the central theme of the book: how to understand rhythms in cell physiology using the same type of mathematical approach that has been applied successfully to complex phenomena in physics.

Goldbeter is one of the pioneers in the application of physics and chemistry to cell biology. Despite an early association with the Brussels school, Goldbeter set out a quarter of a century ago to immerse himself in real cell biology. The result of this close contact with experimental biology has been a body of work dealing with a broad scope of rhythmic phenomena ranging from oscillations of intermediates in glucose metabolism to circadian rhythms in the fruit fly. Goldbeter's book provides a thorough summary of his contributions in these areas. In addition, it provides a bibliography of over 1000 research papers, which should serve as a springboard to the extensive literature in this field.

The book is divided into seven parts, each dealing with an important problem in experimental cell physiology—for example, the oscillations of the signaling molecule cAMP (adenosine 3′,5′-cyclic phosphate) in the slime mold *Dictyostelium*. These remarkable cells participate in a complex life cycle that starts with an aggregated, colonial form producing fruiting bodies from which single-celled amoeba for the next generation arise. After a period of starvation, these free-moving amoebas reaggregate by way of chemotaxis, an intercellular signaling process that produces target- and spiral-like waves of cAMP. These facts have been known for some time, and were they the sum total of available information, molecular–kinetic modeling of this phenomenon would not be possible. What makes *Dictyostelium* appropriate for kinetic modeling is the mechanistic information about regulation of the membrane-bound receptor that transduces the cAMP signal into cell movement. Goldbeter's presentation provides both the background motivation for the modeling and the sequence of models proposed over the years to describe aggregation.

In addition to numerous specific problems, each important in its own right, Goldbeter's exposition provides the real flavor of how the best work in this field is done. Thus, he does not hide the fact that some of the early models were incorrect or misinformed by experiment. Indeed, it is a truism that the facts in biology are often a function of time. This makes the role of a theorist in biology similar to that of a theoretical physicist prior to the advent of quantum theory. Because even quantitative data are not always complete, and because the mechanisms that govern cellular function are myriad and still being uncovered, theories are useful only when developed in close contact with experiment.

The book could have included a few additional topics, which would have increased its audience. For example, there is no summary of dynamical systems concepts, and spatial gradients and waves are touched on only briefly. Nonetheless, the book should have broad appeal. It would be an excellent addition to the library of both the expert and the nonexpert reader.

**Joel Keizer**
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*The Doppel Handler:* Cover illustration for *Biochemical Oscillations and Cellular Rhythms.*

# The NASA Atlas of the Solar System

Ronald Greeley
and Raymond Batson
*Cambridge U. P., New York, 1997. 369 pp. $150.00 hc*
*ISBN 0-521-56127-2*

Looking like it belongs on a coffee table, the beautifully produced *NASA Atlas of the Solar System* is a research tool in disguise. Noted planetary geologist Ronald Greeley has joined with Raymond Batson, a leading planetary cartographer, to put together an atlas of the solid-surface planetary objects examined to date through the US space program. One can hardly think of a better team for this effort. The atlas reflects the life's worth of research each author has devoted to the field.

Greeley and Batson have done a real service in presenting a set of maps for 26 Solar System objects, from the terrestrial planets to the icy moons of the outer planets, all in a uniform format. The airbrush-shaded maps developed over the years by the US Geological Survey and the National Aeronautics and Space Administration are a combination of art and science that truly brings out the detailed topography of each planetary surface. Supplemented by spacecraft images and geological or other specialized maps (multispectral maps of the Moon, for example), each planetary object is presented in its full pictorial glory, along with a short text summarizing what is known about the planet's geological evolution. The text is up-to-date yet does not get bogged down in too much detail; it can be understood by a motivated lay reader, with the help of the book's glossary. The general introduction to the atlas offers a good enough overview of planetary science that it could almost be used as a (very short) beginning text.

The authors describe the special difficulties encountered in planetary mapping. (What does one use for "sea level"? It is hard enough to represent a spherical surface on a flat sheet of paper, so how does one deal with such a potato-shaped object as Phobos?) While it is sensible to rule out producing maps of the rapidly changing giant planets, which do not even have solid surfaces, the authors also recognize that even a solid-surface object like Io can be geologically active enough to require remapping every time it is observed in detail.

The specialist will appreciate the ease with which one can look up geological or topographic features of individual planets and see where they lie with respect to other regions of interest on that planet (Where is Ares Vallis in relation to Mars's "Grand Canyon," Valles Marineris?) or how they compare with similar features on other planets. The edges of the maps are dimmed where the projections become highly distorted; this is not only useful for keeping track of the scales, but it also gives a visual sense of three-dimensionality that is striking even for the familiar Earth maps. A gazetteer lists the accepted International Astronomical Union names for planetary objects and features, giving name, location, a short description and, when appropriate, a page reference within the atlas (many names are for features too small to be included in the maps).

Will this atlas quickly be superseded by new planetary missions or by the availability of planetary maps over the Internet? I believe not. We are at a unique time in history, when maps are available for the first time for all the solid planetary objects of the Solar System (except the Pluto–Charon system, which is unlikely to be mapped for several years to come). Planetary missions are now going well beyond the initial mapping stage, in most cases revealing greater detail of surface topography than could be accommodated on planet-scale maps (as is the case for Earth) or quantifying atmospheric and other planetary processes rather than planetary appearance. Yet the maps still provide the reference frame needed for describing and often understanding these processes. The atlas offers better resolution and shorter access time than the Internet; in fact, there is really no comparison between the two. To browse through Greeley and Batson's book is simply an outstanding experience.

**Raymond Jeanloz**
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# Chiral Nuclear Dynamics

Maciej A. Nowak, Mannque Rho and Ismail Zahed
*World Scientific, River Edge, N.J., 1996. 528 pp. $68.00 hc*
*ISBN 981-02-1000-0*

*Chiral Nuclear Dynamics* by Maciej A. Nowak, Mannque Rho and Ismail Zahed has come along at a very interesting point in the development of theoretical nuclear physics at low and intermediate momentum scales (say, below 1 GeV). The subject historically has been firmly grounded in phenomenology. Particular models were developed to describe a limited class of phenomena in terms of relevant degrees of freedom; the parameters were fitted to experiment. In this traditional development, an overall qualitative picture of a broad range of phenomena emerges, in the sense that the parameters of an effective description at one level may be crudely obtained from detailed calculations at a more fundamental—but still largely phenomenological—level.

The overall picture that emerges from these nested sets of models is, I think, at least roughly correct. On the other hand, the success of quantum chromodynamics in describing large momentum physics has led to the belief that QCD is the only viable candidate for a fundamental theory of strong interactions. Thus, in some ultimate sense, all nuclear and hadronic phenomena come from QCD. The present state of affairs is unsettling in that we cannot describe the low momentum phenomena directly in terms of QCD, nor can we derive the effective models from QCD. Perhaps the most fundamental problem confronting low-energy nuclear and hadronic physics is the relation of the observed phenomena to QCD.

One way to connect QCD to phenomenology is through symmetry—particularly, approximate chiral symmetry. Observation of the phenomenological consequences of spontaneously broken approximate chiral symmetry in hadronic physics predates the formulation of QCD. However, the connection of chiral symmetry to QCD is clear: The QCD Lagrangian is invariant under chiral symmetry if the quark masses are taken to be zero.

For quite some time now there has been intense theoretical activity relating chiral symmetry to an extremely broad range of nuclear and hadronic phenomena. Indeed, it has been one of the main guiding principles in the field. Some of this work has been rigorous and systematic, other work has been based on simplified models that embody the symmetries and may help provide qualitative insights, and some of the work has been quite speculative. Given the breadth of the field, a book such as *Chiral Nuclear Dynamics*, which pulls together many of the disparate threads, is highly useful.

The book contains good sections reviewing many of the standard topics in the field, such as current algebra, systematic power-counting in chiral perturbation theory, topological soliton models and so on. Its real strength, however, is in the exploration of many of the smaller byways of the field.

As stressed by the authors in the introduction, the book is not intended as a systematic review of the entire discipline. Rather, it filters the field through the prejudices of the three authors, strongly reflecting their tastes and interests. This is fortunate, since the authors, in addition to being among the leading researchers in the field, have interesting and occasionally unusual perspectives.

Much of the charm of *Chiral Nuclear Dynamics* lies in its exploration of these points of view. For example, while the book discusses the conventional treatment of chiral perturbation theory for interactions among pions, it also includes the so-called master-equation approach recently championed by Zahed. Another example is the extensive discussion of Brown–Rho scaling—the notion advanced by Mannque Rho and Gerald E. Brown that at finite temperature or density, where chiral symmetry is partially restored, all hadronic masses (except that of the pion) are reduced more or less in proportion to the chiral order parameter; many phenomenological effects are attributed to this scaling.

The book is rather sophisticated and elegant mathematically. This is often helpful, in that many of the issues discussed require the use of powerful mathematical machinery. Moreover, there is considerable mathematical beauty in the subject. There is a cost to this relatively high level of sophistication, however. The book is not as accessible to novices in the field as it might have been. A beginning graduate student may find parts of the book a bit intimidating and will have to work hard to get much out of it. Nevertheless, *Chiral Nuclear Dynamics* should prove valuable to students as well as