and politics that will not be unfamiliar to the students of the history of physics in this period. DeVorkin links these patterns of patronage to earlier military sponsorship of scientific expeditions and to the postwar support of science by the military services. In the latter, he shows, the military mission and scientific programs tended to present a more problematic relationship for the scientists involved. Following the postwar fortunes of Project Helios, a manned ballooning program sponsored by the Office of Naval Research in which the indefatigable Jean Piccard was again a prominent actor, DeVorkin traces the evolution of military motives and missions to exploit new technological opportunities offered by improved materials and the scientific interest in cosmic rays and other stratospheric phenomena. In these enterprises the Navy ultimately disappointed Piccard and his colleagues by failing to support manned stratospheric flight.

In his concluding chapters, DeVorkin strives to erect historical parallels with the manned space flight programs of the 1960s, especially the Apollo program. The disparate scope of these programs, the bureaucratic formality of NASA, and the greater eminence of the scientific promoters of space science, however, make these parallels less striking. Though it is true that the Apollo program depended, like manned stratospheric flight, on the human presence for glamor and support, it is not clear that its scientific purposes were sincere self-delusions, stimulated solely to justify the funding of manned flight, as were those of the balloonist-savants. If the selling of manned ballooning was mission-oriented and shortsighted, as DeVorkin maintains, it involved a much smaller expenditure of the national treasure than the program Kennedy proposed. And if, like Apollo, manned stratospheric flights teamed the romantic drive to explore with the need to reestablish national pride, much more was at stake in the ICBM era.

Regardless of whether one agrees wholeheartedly with DeVorkin's comparisons of manned stratospheric flight and manned space flight, his book makes heuristic use of the parallels and sheds new light on a hitherto neglected area of the history of science and technology. By weaving patronage, politics, physics and aerostatics together in his narrative, DeVorkin makes what had previously been regarded as a sideshow in the history of American science an exemplar of the interactions of science and American Society.

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Planetary Science

Origin and Evolution of Planetary and Satellite Atmospheres. S. K. ATREYA, J. B. POLLACK, and M. S. MATTHEWS, Eds. University of Arizona Press, Tucson, 1989. xii, 881 pp., illus. $45. Space Science Series.

In one way or another, more people study planetary atmospheres than any other aspect of planets. Accessibility of information could be part of the reason, but the richness of phenomena is a better explanation since it acknowledges the large number of disciplinary niches that scientists occupy in this area. There is one aspect of atmospheres, however, that commands the attention of all scientists who like to know how things came to be (and shouldn't that be all of us?). This aspect, origin and evolution, is amply covered in this new contribution to the University of Arizona's Space Science Series, a collection of books that threatens to overwhelm the bookshelves of planetary scientists everywhere.

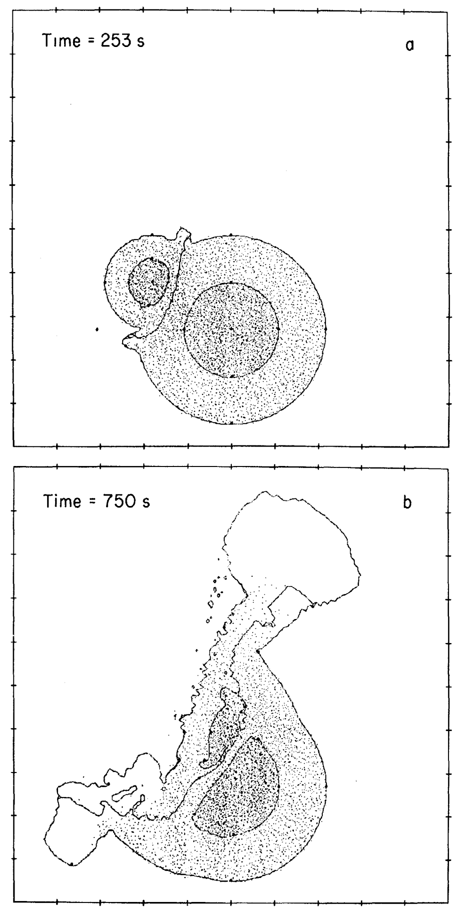
How can such a small fraction of a planet be so important? Three prominent reasons are the ability of an atmosphere to regulate the thermal regime of the planetary surface or even interior, the tendency of an atmosphere to store information about the dynamic and chemical history of the planet by being a repository for volatile species, and the likelihood that an atmosphere's composition can tell us about the material from which the planet formed, perhaps even how it formed. This book demonstrates the progress on these issues as well as the distance we have yet to cover.

The genesis of the book was a conference, some 50 of whose participants wrote the 22 review chapters making up the final text. Not only is scattered information well collected, many authors organized their thoughts in accordance with the theme, sometimes in collaborations that might otherwise not have occurred. I would judge that about half of the chapters are successful in telling a story that is not just a rehash of stories previously told.

I see three big stories in this area, each well developed but with much more research required. One is the growing sophistication of efforts to understand climate evolution on Venus, Earth, and Mars. Particularly in the chapter by Kasting and Toon, but also in related chapters, we see the growing awareness of the complex interplay of volatile abundances, impacts, volcanism, weathering, liquid water, and biology (at least on Earth, perhaps even on Mars). Why is Venus so different from Earth? For how long did Mars have a warm, wet climate? How much carbonate is there on Mars? When did Earth become habitable? Some of these questions are old, but satisfying or at least provocative answers are only beginning to crystallize. It is notable that some of the best work on the early climate of Earth is being done by people who approach the problem from a planetary perspective.

Another developing yet long-standing story concerns noble gases and their isotopic patterns in the atmospheres of Earth, Venus, and Mars. In the chapters by Pepin and by Hunten and others, we see the approach toward a quantitative understanding of the partitioning of gas species and isotopes during hydrodynamic escape from the ultraviolet-irradiated atmospheres of protoplanets. No unique story emerges, but the existence of any physically plausible story for the xenon isotope pattern (for example) is a major advance.

The third story concerns the newest information: The abundance patterns in the atmospheres of giant planets (chapters by



Computer simulation by Kipp and Melosh (1986) of the impact of a Mars-sized planetesimal on the proto-Earth 253 seconds (a) and 750 seconds (b) after contact. "Any primordial atmosphere that had evolved up until the point of the impact would be expected to be blown away, and a substantial amount of new outgassing would result." [From P. R. Weissman's chapter in *Origin and Evolution of Planetary and Satellite Atmospheres*]

Gautier and Owen, Pollack and Bodenheimer) and their attendant large satellites (chapter by Lunine and others). Here, we see tantalizing clues of the accumulation process for most of the planetary mass in our solar system, a process that we hope to understand better through the emerging, exciting field of extra–solar-system planetary detection.

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A Synaptic System

Plasticity of the Neuromuscular System. DAVID EVERED and JULIE WHELAN, Eds. Wiley-Interscience, New York, 1988. x, 273 pp., illus. $54.95. Ciba Foundation Symposium, vol. 138. From a symposium, London, U.K., Jan. 1988.

One of the central questions in neurobiology is how nerves regulate the properties of the target cells they innervate and how they are in turn regulated by their targets. To attempt to answer such questions in a system as complex as the mammalian central nervous system would be a Herculean task. Neuroscientists have therefore adopted reductionist approaches, exploring these interactions in the relatively simple nervous systems of invertebrates or in isolated synaptic systems. For this purpose, the neuromuscular system is nearly ideal; the neuromuscular junction is by far the most thoroughly studied and best-understood mammalian synapse. There is a vast body of knowledge about its structure, function, chemistry, and pharmacology, and it is readily accessible to experimental manipulation. Yet some of the apparently simplest questions about nerve-muscle interactions, which seemed on the brink of solution long ago, have not yet been fully resolved:

1) How do motor nerves form appropriate connections with muscles? Are the connections predetermined, or are they adjusted during development?

2) How do nerves establish a monogamous relationship with muscles (one branch to one muscle cell)?

3) How are the contractile and metabolic properties of muscle cells regulated? Are they preprogrammed or under neural control? How do nerves modify these properties?

4) How are acetylcholine receptors up-regulated at neuromuscular junctions (where they are densely concentrated) and down-regulated away from the junction (where they are sparse)?

5) How do muscle cells influence the life or death of nerve cells during development so as to assure the survival of just the right number of motor neurons? And how do muscle cells instruct nerves when to sprout?

These are some of the questions explored in the Ciba Foundation symposium that led to *Plasticity of the Neuromuscular System*.

Overall, many of the phenomena examined now appear to be far more complex than they once did, even in this relatively simple synaptic system. In almost all cases, multiple influences regulate each property of the muscle cell. One instructive example concerns "slow" and "fast" muscles. Nearly three decades ago, Arthur Buller (who chaired this meeting) suggested that motor nerves play the chief role in determining the contractile properties of the muscles they innervate, resulting in "slow" or "fast" muscles, characterized by their speed of contraction and related biochemical properties. Though this concept has been extremely useful, it is now evident that it was an oversimplification. There is actually a vast array of muscle types with a spectrum of contractile protein isotypes and varied patterns of metabolic enzymes. These patterns result from regulation of gene families and their products at multiple levels of transcription, translation, and assembly. Moreover, the final pattern is determined not only by neurally triggered activity but also by intrinsic genetic programs and hormonal influences.

The revelation of this and other complexities results from the methods of molecular biology now being applied to the phenomena of nerve-target interactions. These methods are likely to bring us closer to understanding the mechanisms of regulation. Thus, for example, much is currently being learned about the mechanisms that regulate acetylcholine receptors. The genes for all of its subunits have been cloned, probes have been made, and the regulatory regions outlined in this volume have recently been even more rigorously identified.

Less encouraging is the fact that some of the old semantic confusion still exists. "Activity," which plays an important role in regulation of many muscle properties, is still ill-defined. Does it mean mechanical contraction, electrical conduction, acetylcholine transmission, or all of those? Few of the contributors to the book make these crucial distinctions. Moreover, for this reviewer, it is disappointing that the important regulatory role of neurotransmission is not represented. Indeed, the book presents little if any new information about how the nerve transmits its regulatory influence to muscle. This important key to the cellular biology of nerve-target interactions almost seems to be on hold.

This small book offers a glimpse of the study of nerve-target interactions through the window of the neuromuscular system. Despite the notably uneven quality of the contributions and the terse style, which makes for slow going, there is much to be gleaned. The informal comments, particularly those of Nadal-Ginard, provide some illuminating insights. *Plasticity of the Neuromuscular System* marks a nodal point in the progress of the field when it has become obvious that molecular biology is being applied effectively and has enormous potential for answering many important questions.

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Laser-Molecule Interactions

Lasers, Molecules, and Methods. JOSEPH O. HIRSCHFELDER, ROBERT E. WYATT, and ROB D. COALSON, Eds. Wiley-Interscience, New York, 1989. xviii, 1022 pp., illus. $125. Advances in Chemical Physics, vol. 73. Based on a symposium, Los Alamos, NM, July 1986.

The theoretical and computational description of the interaction of electromagnetic fields with molecules is an enterprise that engages chemistry, physics, applied mathematics, and several branches of engineering. Despite the common focus, however, these disciplines have been only loosely coupled in their research on this topic. *Lasers, Molecules, and Methods* is a welcome attempt at breaking down the disciplinary boundaries by providing a broad survey of the methods used in describing laser-molecule interactions. This survey consists of 23 papers representing all the above-mentioned disciplines. Many of the papers give lengthy reviews of mathematical concepts and methods that have generally not appeared in the nonmathematical literature.

Perhaps the most important strength of this book lies in synergisms that are developed through the presence of a common set of themes. Matrix methods for determining transition amplitudes (the Lanczos algorithm, recursive residue generation) provide one such theme, showing up in applications to multiphoton excitation, spectra, relaxation dynamics, scattering, eigenvalues, and many other problems. Other recurrent themes include methods for solving the time-dependent Schrödinger and Liouville equations, high-intensity and short-duration laser pulses and their interaction with molecules, and the nonlinear dynamics of Hamiltonian and dissipative systems.