much. Christianson speaks of Newton's mathematics but offers no substantive examples of it; one reads that Newton invented the calculus of fluxions, but one never encounters a fluxion. Christianson devotes a chapter to the circumstances of Newton's writing the *Principia* but sets forth from the work itself no more than statements of the three laws of motion. Though Christianson extols the power and elegance of Newton's demonstrations there, the reader never actually sees what one looked like. He speaks of how Newton's case for his celestial mechanics rested on the reconciliation of Kepler's laws of planetary motion with those of falling bodies on earth, yet the account of Book Three of the *Principia* skips over Newton's induction of universal gravitation from Kepler's third law and his demonstration that an inverse-square force acting on bodies close to the earth's surface yields Galileo's laws of fall. Even when such things are noted, they are not shown. The reader who does not understand them already will not learn them from Christianson. Only Newton's optics receives a treatment detailed enough to reveal both what Newton did and how he did it.

In the Presence of the Creator is a book for readers who, knowing the technical aspects of science in the late 17th century, wish to learn about its English setting. For that, Christianson offers a useful and readable synthesis of recent scholarship. For the science, one should turn elsewhere.

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Solar Eclipses

Total Eclipses of the Sun. J. B. ZIRKER. Van Nostrand Reinhold, New York, 1984. xii, 210 pp., illus. $22.50.

Laypersons who view a total eclipse of the sun are left with indelible impressions of one of nature's grandest spectacles. They may also remember those scientists who came from afar to carry out experiments.

So what are these experiments, how good are they, and, in point of fact, what has been learned from eclipse expeditions in recent years? This is the subject of Zirker's book. And such a treatment is long overdue; the last book on the subject was the somewhat anecdotal *Eclipses of the Sun* by S. A. Mitchell, the fifth edition of which was published in 1951.

Zirker is a solar physicist whose specialty is the chromosphere. But in *Total Eclipses of the Sun* his special interests are put aside and the discussion is far-ranging. Topics include astrometry (is the gravitational constant G temporally invariant?), solar physics (what heats the corona?), atmospheric physics (are global-scale gravity waves induced by the eclipse event?), relativity (what is the deflection angle of starlight as it passes close to the sun?), interplanetary dust (is the primordial solar nebula still with us?), and even biorhythms (do eclipses upset us?).

Our author has concentrated on experiments whose findings advanced our knowledge in significant ways. Of course eclipse observations may be but one approach, with space probes and outside eclipse studies supplementing, or even overwhelming, the eclipse technique—as for instance when radio interferometry proved more accurate than photography for the measurement of starlight deflection. Then there are experiments that fail because they are ill-conceived. Zirker gives those short shrift. Good experiments that give negative results get more attention.

Does the gravitational constant G vary with time as P. A. M. Dirac proposed in 1937, or is G time-invariant? Data on lunar acceleration can provide an answer. Acceleration of the moon's orbital motion occurs as a consequence of tidal friction. The value of lunar acceleration can be deduced from historic eclipse timings and from lunar laser ranging. The eclipse method depends on ephemeris time and involves G. The laser method depends on atomic clocks and is independent of G. According to P. Muller, the two measurements disagree and this discord can be taken as evidence for a change in G. At this juncture another decade of lunar ranging is needed to specify adequately $G(t)$.

Everyone knows that an early confirmation of Einstein's general theory was the observed deflection of starlight near the sun at eclipses. However, these photographic findings proved inadequate to distinguish between the predictions of Einstein and those of Brans and Dicke. In 1973 the century's longest eclipse took place in Africa, and a team from the University of Texas at Austin and Princeton University planned an unprecedented attack on the deflection question. An elaborate, temperature-controlled telescope was installed at Chinguetti, Mauritania. Unfortunately a vicious sandstorm reduced visibility at eclipse time to 18 percent of that expected. Even so, the team's findings proved the most accurate ever, giving the deflection at the sun's limb with 90 percent accuracy, but not good enough to distinguish between the two theories, for which better than 92 percent accuracy is needed. At this point radio astronomers took up the challenge and, by the use of microwave interferometry, confirmed Einstein with 99 percent accuracy. Presumably the eclipse technique is now outdated for this question.

What are the future prospects for eclipse observing? Certainly better work can often be done from spacecraft, which allow the measurement of those ultraviolet and x-ray wavelengths that are especially important to the chromosphere-corona regions. Nevertheless, there is a domain from the sun's surface out to one radius where the total eclipse remains supreme for the study of the corona. Diffraction from occulting disks and scattered light seriously limits coronal detection by space-borne coronagraphs. The cost of observing eclipses is a tenth, or less, that of spacecraft experiments, although clouds can escalate the cost:return ratio. There will always be opportunities for clever experimenters, and Zirker is optimistic that eclipse work will remain healthy.

Total Eclipses of the Sun is a succinctly written, up-to-date summary of the scientific return from the eclipse experience. The book is recommended for the advanced amateur and the professional astronomer.

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Planetary Atmospheres

Planets and Their Atmospheres. Origin and Evolution. JOHN S. LEWIS and RONALD G. PRINN. Academic Press, Orlando, Fla., 1984. x, 470 pp., illus. Paper, $29.50. International Geophysics Series, vol. 33.

Harold Urey single-handedly transformed the planetary sciences by injecting chemical insights into the arguments about the processes and boundary conditions occurring within the solar system, both present and past. Now, in an academic lineal descent, a "son" and a "grandson" have carried on his tradition with this important book about planetary atmospheres. The authors have based the book on their courses at MIT during the years 1968 to 1982. This does not mean that the book is ideal for teaching the subject; indeed, it is not, since the authors plunge right into the most complex of subjects. A newcomer to the field will find rather little of a tutorial approach and can benefit from the book by doing some preliminary reading in simpler textbooks. On the other hand, for the experienced worker in planetary sciences, the book is a gold mine. The thorough scholarship, combined with the high quality of the discussion, guarantees that the book will have an important influence for some considerable time.

The book deals with three principal subjects, in chapters 2, 3, and 4 (chapters 1 and 5 are brief and largely philosophical). Chapter 2 (50 pages) deals with the retention of volatiles by planets. Its basic orientation is to the chemical abundances, both of the solar nebula and of apparent condensation products of the nebula, primarily meteorites. However, there is also an extensive discussion of the probable primordial atmospheres of the planets as they accumulated within the solar nebula.

Chapter 3 (49 pages) deals with evolutionary processes. In the evolutionary sense it can be considered the successor to chapter 2. Here we learn about input and output processes and how as a result of these an atmosphere can change with time. The output processes consist of escape from an atmosphere, both thermal and nonthermal, and absorption by the body of the planet, both by dissolution and chemistry. The input processes include outgassing from the body of the planet and chemical reactions. The chemistry of interest on most planets results from the atmosphere-lithosphere interaction, but on Earth it includes biochemical processes as well.

The bulk of the book is in chapter 4 (264 pages). Major subsections deal individually with the four terrestrial planets. The remaining subsections deal collectively with the Jovian planets, with lunar-sized objects, and with asteroids. There is much discussion of photochemistry and of atmospheric structure and composition, but relatively little discussion of atmospheric dynamics. The discussion of Earth is much concerned with biochemical evolutionary effects on the atmosphere (and vice versa). Venus, Earth, and Mars receive extended treatment because there is a large body of observational data on them. The discussion of the Jovian planets is briefer and much more theoretical, as befits planets for which observational data are as yet sparse. From the observational point of view the most important lunar-sized bodies are Io and Titan, although only the latter has a substantial atmosphere, about which our knowledge is still rather rudimentary. The asteroids do not have atmospheres, and the discussion of them is mostly concerned with compositions and with inferences about their original interactions with the gas of the solar nebula.

With the high cost of the printed word today, there are very few books that I think are essential components of the bookshelves of working planetary scientists. This is one of them.

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Genetics of Fishes

Evolutionary Genetics of Fishes. BRUCE J. TURNER, Ed. Plenum, New York, 1984. xx, 636 pp., illus. $85. Monographs in Evolutionary Biology.

This is a book more on Mendelian variation (mostly allozymes) than on evolutionary genetics. Although one of its purposes is to "demonstrate the power of integrated genetic approaches to ichthyological problems," most of the 12 chapters are very narrow. The book is aimed at "classical ichthyologists and molecular biologists" as well as evolutionists, but lack of integration and jargon will make it heavy going. However, it is a useful extension to Kirpichnikov's *Genetic Bases of Fish Selection* and to volume 4 ("Vertebrates of Genetic Interest") of the *Handbook of Genetics*.

Morizot and Siciliano report that allozyme linkage relationships appear to be remarkably stable among fishes, as in mammals, and might even be stable among all vertebrates. The extensive data on poeciliid color pattern genes are ignored, but an examination of Borowsky's chapter, and of papers by Kallman and Yamamoto in the *Handbook of Genetics* volume, suggests that these linkage groups may also be conserved.

The genetics of the tetraploid families Catostomidae and Salmonidae is dealt with by Ferris and by Allendorf and Thorgaard. These authors summarize well the genetic consequences of gene duplications and speculate on how gene regulation and polyploidy coevolve. Salmonids are slow-growing, have much DNA, and develop at low temperatures. (J. P. Grime has found a similar pattern in plants.) Unlike most of the contributors, Ferris gives a good discussion of the strengths and weaknesses of methods and of interpretations. He also compares phylogenies derived from morphological and molecular data. It would have been interesting to use morphological phylogeny to deduce the sequence of changes in molecular gene duplication and regulation during salmonid evolution. Buth's chapter provides a useful commentary on the strengths and weaknesses of allozyme data in systematics and should be read by everyone doing systematic electrophoresis.

Kornfield describes allozyme and karyotypic variation in the Cichlidae, which are very diverse in morphology and ecology. Allozyme and karyotypic variation appears to be nearly independent of speciation and morphological divergence. Many cases are known of full sexual isolation among groups with identical allozymes or karyotypes; genetic markers do not always reveal sibling species. Curiously, there are significant frequency differences between sexes in one allozyme locus of *Oreochromis saka*, and there is spatial segregation of sexes following breeding. Kornfield does not detail the fascinating work on evolutionary genetics and ecology of feeding polymorphs of *Cichlasoma*, and the editor does not summarize his own parallel work on *Ilyodon*.

Borowsky discusses two *Xiphophorus* species, providing another example of the independence of morphological and allozyme variation. There is some evidence that tailspot loci are associated with differences in O_2 consumption and growth rates, which, in conjunction with stream dynamics, may explain variation at some color pattern loci. But sample sizes are small, critical tests are incomplete, and the studies ignore predation, which has major effects on color pattern genes in other peociliids. Williams and Koehn discuss eels (*Anguilla*) and argue from allozyme and morphological data that the American and European eels are a single panmictic population. If this is true, then the latitudinal clines found in three American eel allozymes result from natural selection. Proof awaits the discovery of the exact breeding sites of each population. Breeding adults have not been found; they may segregate by demes, as do many other Atlantic and North Sea fishes.

Kallman provides a discussion of the heretofore confusing subject of sex determination in Poeciliidae that will be useful for many years. Three chapters deal with asexually reproducing species and show that asexuality is not an evolu-