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