describes. Was she attributing emotions such as fear, joy, and anger, etc., on the basis of morphological similarity to the human repertoire or on the basis of other contexts (as, for example, we do when deciding the meaning of an alien expression like a cat's purr)? This is a fundamental omission. Indeed, a final major value of *Infant Chimpanzee and Human Child* is that today's students and other thoughtful readers should find in it an intriguing challenge: Much might be gained by convincingly filling the gap between the richness of the objective descriptions laid so generously before them and the justification of legitimate bases for ascribing particular states of emotion to these behaviors.

BOOKS: PLANETARY SCIENCE

Photochemical Smog Hides an Icy World

Darrell F. Strobel

Lifting Titan's Veil is an account of the exploration of Titan, Saturn's largest moon, and the joint effort by the European Space Agency (ESA) and NASA to reveal its secrets with the Cassini-Huygens mission. Why Titan? It is the solar system's second largest moon, with a radius about 60 km smaller than that of Jupiter's Ganymede. Whereas Ganymede's atmosphere is measured in picobars (10^{-12} times the surface pressure of Earth's atmosphere), the nitrogen atmosphere of Titan is about 1.5 bar. What really distinguishes Titan's atmosphere is its mildly reducing character, conditions similar to those many believe characterized Earth's prebiotic atmosphere, and its large suite of hydrocarbons, organic molecules, and nitriles. Among the nitriles, hydrogen cyanide is a known precursor of α-amino acids and nucleic-acid bases; thus, Titan's environment is of great importance for understanding chemical evolution in Earth's early atmosphere. Present-day Titan could be a natural laboratory for chemical synthesis analogous to the pioneering laboratory experiments on the origin of life that Urey and Miller carried out in the 1950s. As a result, Titan has been an object of intense interest to exobiologists and planetary scientists for more than three decades. Such considerations convinced European governments and the United States to fund the Cassini-Huygens project at a total cost of approximately $3 billion. The book documents what is so special about Titan, and what researchers hope to accomplish after Cassini reaches Saturn in 2004 and after the Huygens probe enters Titan's atmosphere the next year.

Lifting Titan's Veil
Exploring the Giant Moon of Saturn
by Ralph Lorenz and Jacqueline Mitton
Cambridge University Press, Cambridge, 2002. 268 pp. $29, £19.95. ISBN 0-521-79348-3.

Author Ralph Lorenz started with the Huygens project as an engineer. After returning to university to obtain his doctorate, he rejoined the project as a scientist, with an accompanying demotion from business class travel to discount economy travel. Lorenz's experiences, amplified in passages labeled "Ralph's Log," lend the book a personal flavor and give the reader insight into the inner workings of these complex missions. Coauthor Jacqueline Mitton is an astrophysicist, who now devotes her time to writing and media consulting in the field of astronomy. Their prose is, accordingly, lively and captivating.

The book begins with a brief historical sketch that covers the 1655 discovery of Titan by the Dutch scientist Christiaan Huygens and essential aspects of planetary science (especially the satellites of Jupiter and Saturn). In the early 1980s, the scientific discoveries of the two Voyager spacecraft rewrote the textbooks on Titan by revealing a world completely shrouded in a photochemical haze. This smog elevates Titan's optical limb (the edge of its visible disk) some 200 km above the surface and prevented the Voyager cameras from seeing the surface. Although the Hubble Space Telescope and adaptive optics on the largest ground-based telescopes have offered glimpses of what might be on Titan's surface, the parting of this veil will fall to the Huygens probe and to the radar and remote sensing systems on the Cassini spacecraft. The last third of the book is devoted to this mission: its genesis, political aspects, design and construction, launch, operations; the plans for probing Titan and touring the Saturn system; and the problems with the radio relay that link Huygens with Cassini.

The authors also provide interesting discussions about what the mission may reveal. Titan's atmosphere, meteorology, and landscape each merit a chapter in the book. Based on our current knowledge, these chapters represent a progression from fact to speculation.

The economy of presentation required by the book's brief length means that details must be glossed over. For example, the authors are forced to omit many important details that a historian writing on the Cassini-Huygens mission would want for background. Some of us consider it a miracle that a spacecraft was delivered and launched, because ESA and NASA entered this cooperative mission in the "sink or swim together" mode. The book has very few glaring errors of the magnitude of the claim that "Voyager 1 reached Saturn in November 1980 after a journey lasting just over 13 years," which would be news to all who viewed the launch in the fall of 1977. Even the 2600-kg Cassini spacecraft, which needed three gravity assists by Venus and Earth before going on to Jupiter, will take only seven years to reach Saturn. On a more irritating level, I found the rekindling of the debate on the level of methane saturation at the tropopause and in the stratosphere (which I and my colleagues Michael Summers and Xun Zhu had sparked in a 1992 paper in *Icarus*) attributed to a French colleague, Régis Courtin. (During a 1993–94 Paris sabbatical, I had convinced Régis to reanalyze infrared data from the Voyager missions.)

The authors present some material at the level of *Scientific American* or *Sky and Telescope*, but most of the text would be appropriate in an introduction to astronomy for nonscientists. Consequently, the book is accessible to a wide audience despite a few figures, taken from research articles, that might not be understood by all readers. And even the professional scientist who wants a brief overview on Titan or an abbreviated history of the Cassini-Huygens mission will find the book worthwhile.

I recommend *Lifting Titan's Veil* to anyone having an interest in planetary exploration. With fewer than two years remaining until the arrival of the Cassini spacecraft and its insertion into orbit around Saturn, however, the book comes with a sunset clause. We expect exciting new discoveries and look forward to the authors reporting them in an equally informative sequel.

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Image not available for online use.

Smoggy moon. The hydrocarbons in Titan's atmosphere give the moon an orange hue.

CREDIT: VOYAGER 2/NASA

Other articles where Photochemical smog is discussed: smog: Photochemical smog, which is also known as â€œLos Angeles smog,â€ occurs most prominently in urban areas that have large numbers of automobiles. It requires neither smoke nor fog. This type of smog has its origin in the nitrogen oxides and hydrocarbon vapours emitted by automobilesâ€¦Â Photochemical smog, which is also known as â€œLos Angeles smog,â€ occurs most prominently in urban areas that have large numbers of automobiles. It requires neither smoke nor fog. This type of smog has its origin in the nitrogen oxides and hydrocarbon vapours emitted by automobilesâ€¦ Read More. role of nitric oxide. In nitric oxide. â€¦photochemical oxidants, which make up photochemical smog. Photochemical smog forms from a complex process, however the source of it is quite apparent. The largest contributor is automobiles, while coal-fired power plants and some other power plants also produce the necessary pollutants to facilitate its production. Due to its abundance in areas of warmer temperatures, photochemical smog is most common in the summer.[3]. It forms in the morning when a tremendous number people are driving their vehicles to work.Â Hotter days mean more photochemical smog, especially in the densely populated cities such as those mentioned above. As more and more urban populations arise around the globe, this problem is only expected to increase.[4]. Composition. Photochemical smog can have an effect on the environment, on peopleâ€™s health and even on various materials. The main visible effect is the brown haze that can be seen above many cities. The brown tinge is caused by very small liquid and solid particles scattering the light.Â Ozone, even in small quantities, can achieve this, but PAN is even more toxic to plants than ozone. Health. The biggest concern about photochemical smog is the effect it has on peopleâ€™s health. The effects of the major primary and secondary pollutants in smog are given in Table 1. Table 1. Health effects of pollutants involved in photochemical smog. Pollutant Nitrogen oxides Volatile organic compounds (VOCs) Ozone. Peroxyacetyl nitrate (PAN). Smog is a type of air pollutant. The word "smog" was coined in the early 20th century as a portmanteau of the words smoke and fog to refer to smoky fog, its opacity, and odour. The word was then intended to refer to what was sometimes known as pea soup fog, a familiar and serious problem in London from the 19th century to the mid 20th century. This kind of visible air pollution is composed of nitrogen oxides, sulphur oxides, ozone, smoke or dirt particles and particulates among others (less visible