transfers and opens a world of questions about the factors governing host shifts that remain to be explored. Abundant though host transfers may be, there is yet a strong phylogenetic component in parasite-host associations that any study of parasite ecology and evolution must take into account.

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High Energy Cosmic Photons

Gamma-Ray Astronomy. POOLLA V. RAMANA MURTHY and ARNOLD W. WOLFENDALE. Cambridge University Press, New York, 1986. x, 248 pp., illus. $49.50. Cambridge Astrophysics Series.

Like modern cosmology, gamma-ray astronomy depends on the marriage of high energy physics and astronomy. The offspring of such unions can be dramatic new insights and revelations. However, the field of gamma-ray astronomy has been slow to come of age. As full of promise as a Kentucky foal in spring, patiently nurtured by a few pioneering researchers through difficult technical and budgetary periods, this area of research offers much promise for a future generation of astronomers. Ramana Murthy and Wolfendale's up-to-date monograph on the subject can provide a useful function by helping to educate the future investigators.

Despite the paucity of cosmic photons of gamma-ray energies and the subsequent difficulty and expense of detecting them, there has been theoretical interest in the subject for almost four decades. The astronomy of the highest energy region of the electromagnetic spectrum can provide fundamental information that is unavailable to other branches of astronomy (except perhaps the less developed and more difficult field of neutrino astronomy). The questions that can be addressed by gamma-ray observers and theorists relate to the origin of cosmic rays and the highest energy physics of astronomical sources of violent activity such as quasars, pulsars, supernovas, black holes, and x-ray binary stellar systems. Owing to the strong penetrating power of gamma rays, their astronomy can also tell us about the structure of the Galaxy. Reaching us from a distant past, gamma rays from redshifts beyond those accessible in other parts of the electromagnetic spectrum (excepting the primordial cosmic microwave background radiation) will enable us to probe the nature of the young universe and the violent astronomical objects that populated it. Studies of the cosmic background gamma radiation may also help to determine whether antimatter plays a large-scale role in the makeup of our universe.

Ramana Murthy of the Tata Institute of Fundamental Research in Bombay, India, has been involved in experiments using the earth's atmosphere to detect very high energy cosmic gamma rays. Wolfendale of the University of Durham, United Kingdom, has long been interested in the interpretative and theoretical aspects of high energy astrophysics and gamma-ray astronomy. Their book provides an introductory survey of gamma-ray astronomy for students with backgrounds in basic physics. It can be integrated into a graduate-level course in high energy astrophysics.

The book is divided into relatively self-contained chapters that delineate the major subfields of gamma-ray astronomy: gamma-ray spectral line astronomy, "gamma-ray bursts," medium energy (30 MeV to 5 GeV) astronomy, and ultrahigh energy gamma-ray astronomy, which uses the techniques of detecting atmospheric air showers produced by incoming cosmic photons having energies greater than about 1000 GeV. The last two topics are the special interests of Wolfendale and Ramana Murthy, respectively. A brief, rather sketchy introduction outlining the basic physical processes that are responsible for the production of astronomical gamma rays is provided. For a deeper theoretical background, some readers will find it useful to consult the previously published books to which the authors refer (*Cosmic Gamma Rays* by F. W. Stecker, Mono, Baltimore, 1971; *Gamma-Ray Astronomy* by E. L. Chupp, Reidel, Dordrecht, Holland, 1976).

In the other four chapters of the book, the material is presented in a form reminiscent of traditional review articles, with extensive reference to the published literature. In this manner, the authors survey the entire subject of extra–solar-system gamma-ray astronomy. However, the interpretative material in the chapter on medium energy gamma rays is heavily weighted with the work of the Durham University group on this subject. Because there has been a rather lively controversy involving other researchers about the interpretation of the Galactic gamma-ray flux, and because of the implications of this discussion for the origin of cosmic rays, it would have been useful to bring in more of the recent theoretical work of the other groups involved in the debate.

The introduction to the techniques of air-shower detection of ultrahigh energy gamma rays and the accompanying discussion of the Cygnus X-3 binary system are timely, given the recent excitement over this mysterious source. The gamma-ray results imply that this source, by itself, could supply a significant fraction of the high energy cosmic rays in the Galaxy. In addition, reports of unexpected fluxes of high energy muons coming from Cygnus X-3 have caused it to become a subject of much speculation and the plaything of theoretical astrophysicists and particle physicists alike.

A significant fraction of the volume is devoted to a review of gamma-ray bursts, a phenomenon about which we have a plethora of observational information and no real understanding. This again reflects the state of the art in a field that has begun to yield important results and that, though still in its infancy, has great potential.

One of the earliest scheduled scientific missions of a renewed space shuttle program will be the launching of the next generation of gamma-ray telescopes aboard the Gamma Ray Observatory. This event should occur within the next few years. Experimental activity on the "ultrahigh energy air-shower" end of the spectrum is brisk. An exciting future awaits. Students interested in finding out more about gamma-ray astronomy can get a taste of where we are at present from reading this book.

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Ancient Soils

Paleosols. Their Recognition and Interpretation. V. PAUL WRIGHT, Ed. Princeton University Press, Princeton, NJ, 1987. xiv, 315 pp., illus. $42.

Quaternary paleosols have been widely recognized, studied intensively, and used for stratigraphic correlations and to interpret paleoclimates. This collection of papers is an admirable attempt to draw attention to pre-Quaternary paleosols, detailed study of which has been much less common. Several of the papers are particularly notable.

The introduction provides a concise overview not only of the contents of the book but of ancient paleosols in general. It convinced me that pre-Quaternary paleosols are much more abundant than I had believed and that careful study of them can yield valuable information.

In chapter 1, Retallack presents a thought-provoking account of the fossil record of soils. Several lines of circumstantial evidence for the early development of life in soils are presented. The reasons for preferring a "primordial sludge" to a "primordial

soup" include relative abundances of common cations (Co^{2+}, Mg^{2+}, Na^{+}, K^{+}) that are closer to those of animals than are those in seawater, the similarity of Precambrian microfossils to modern soil microbes, and the presence of very ancient soils that are more oxidized than one would expect. In addition, the presence of clays to act as catalysts and templates for complexing reactions and the greater protection from ultraviolet radiation also favor soils.

Retallack also thoroughly reviews the sequence of soil types in the geologic record. Although some paleosols may represent extinct kinds of soil, it appears that the increase of soil types with time is the result of addition of new types rather than replacement of earlier types. Paleosols can be considered as trace fossils of ecosystems because of the importance of organisms to the formation of soils. The increase in soil types and soil features results from a diversification of life with time; therefore, soils can provide evidence of former ecosystems independent of other fossils.

In chapter 4, Francis describes the formation of a series of paleosols, the Jurassic Dirt Beds, on the margin of the Purbeck Basin. The intertidal zone algal sediments were periodically exposed for varying lengths of time, which resulted in the development of several soils. Francis's suggestion that similar algal horizons in other basin margin sequences might contain paleosols should stimulate investigators to look for them and use them to recognize environmental fluctuations.

In chapter 5, Atkinson presents an insightful discussion of paleosols in the Eocene Capella Formation of northern Spain. An alluvial fan model is used to explain the sedimentation in the basin, and soil-forming factors are evaluated in that context. The lateral variations of the soils across the area are interpreted as a "catena" produced by the relief implied by the fan model and modified by preferential eastern upthrow on fault zones. Interpretations of these soils have contributed to an understanding of basin tectonics.

Sedimentologists, particularly those working in alluvial sequences, will find Kraus and Bown's chapter 6 on paleosols and time resolution in alluvial stratigraphy most interesting. Floodplain environments are dominated by long intervals of stasis during which soil formation occurs, rather than by periods of deposition or erosion. Careful investigation of soils present in the fluvial sequences of the Eocene Willwood Formation of Wyoming and the Upper Triassic Chinle Formation of Arizona enabled the authors to draw conclusions on sedimentation rates, episodic base-level fluctuations, and evolutionary rates of fossil organisms. They contend that most ancient successions of overbank deposits are very complete with only minor local time gaps and that fossils in paleosols are scavenged time-lag accumulations that represent longer spans of time than the enclosing sediments.

The book has a few shortcomings. Several photographs are too dark or have been reduced too much to effectively illustrate the features depicted. In one instance, figure 14, the photo is misoriented. The glossary is helpful, but many technical terms specific to the British literature or soil sciences are not defined.

The book achieves the goals stated in the preface: to provide a focus for interest, a database, and a stimulus for future work. Scientists with various specific interests will find many ideas to apply or test in their own research. In addition to furnishing examples of methods to follow and techniques to use, these papers are certain to spur creative thinking and new approaches.

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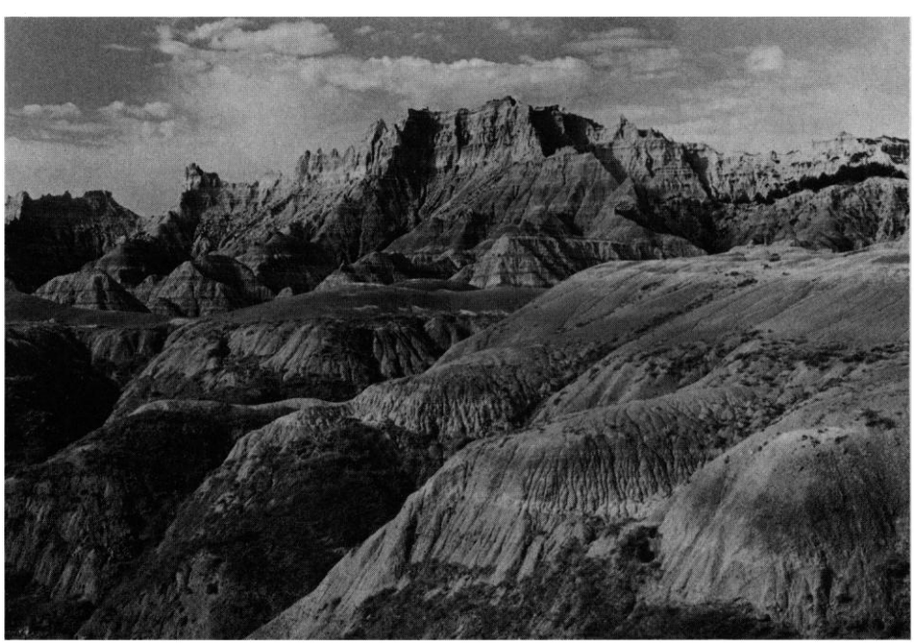

"The Pinnacles area, Badlands National Park, South Dakota, USA. Above the weathered Cretaceous marine shale (lower foreground) are 87 superimposed paleosols of Late Eocene and Oligocene age within 143 m of alluvial deposits." [From G. J. Retallack's chapter in *Paleosols*]

Ion Transport

Proteins of Excitable Membranes. BERTIL HILLE and DOUGLAS M. FAMBROUGH, Eds. Wiley-Interscience, New York, 1987. xvi, 331 pp., illus. $59.95. Society of General Physiologists Series, vol. 41. Based on a symposium, 1985.

The study of electrically excitable membranes is much wider and deeper than it was 15 years ago, when ion pumps and ion channels had yet to be directly observed as macromolecules. The membrane physiologists are still busy providing fundamental information about the functions of ion pumps and channels, now with enhanced, high-resolution techniques (such as single-channel recording and rapid quench-flow methods). But now the proteins responsible for these functions are falling, one by one, to the assaults of membrane biochemists and molecular biologists. The adenosine triphosphate–powered pumps for Ca^{2+} and for Na^{+} and K^{+} have been purified, reconstituted, and cloned, as have several of the physiologically important ion channels. So now, while looking closely at the ion-moving functions of these membrane proteins, we can begin to base our dreams about their molecular structures on real, experimental results.

In this volume, B. Hille and D. M. Fambrough (who weigh in as heavies on ion channels and ion pumps, respectively) bring together practitioners of this newly broadened field of excitable membranes by collecting 17 contributions from a symposium held in September 1985. Chapters focus on five key transport proteins: the Ca^{2+}-adenosine triphosphatase of sarcoplasmic reticulum, its plasma membrane cousin the Na^{+}, K^{+}-adenosine triphosphatase, the acetylcholine receptor, and the Na^{+} and Ca^{2+} channels. These five proteins are all crucially involved in making excitable membranes