vited Dyson to join Project Orion, which was aimed at propelling spaceships with nuclear explosions. Until the project was cancelled in 1965, Dyson and others believed that nuclear explosions were the optimum method of space propulsion; he states that the 15 months he spent working on Orion were the most exciting and in many ways the happiest of his scientific life. In view of his achievements in field theory, that is quite a statement.

Dyson also worked for the Arms Control and Development Agency, even though he saw little hope of reversing the policy of mutual assured destruction that now governs the strategic balance. He argues that we should work for the elimination of all offensive strategic weapons and for reliance upon defensive ones. Disbelieving that world government, even if desirable, will ever come about, he argues that the race will survive only if there is a balance of power among sovereign states based upon defensive weapons. Here he may be overlooking the fact that the cultural diversification he believes is essential could perhaps continue under the umbrella of political integration, as it has in the United States, and as it might do in Europe.

Dyson expresses a deep feeling that human destiny is ultimately beyond the earth, and he has worked toward that goal, not only with Project Orion but in papers exploring how civilizations could prosper in space. For example, he proposed that a civilization could use the entire energy emitted by its parent star by erecting a giant sphere created from planetary materials to capture the star's light. He is unsympathetic to the plans of his Princeton colleague O'Neill to build giant space colonies in earth orbit, preferring instead to theorize about small bands of pioneers homesteading the asteroids.

Dyson identifies two approaches to technology: "gray technology" (factories, physics, plutonium, bureaucracy) and "green technology" (gardens, biology, horse manure, pioneer communities). He believes both are needed if the race is to survive and chides the "small is beautiful" enthusiasts who would scrap much of the gray technology upon which we now depend. His son George, however, a pioneer in the Pacific Northwest, is an advocate of green technology. Dyson describes a visit to him, in the company of his daughter Emily and the writer Ken Brower, on the occasion of George's completion of a six-person kayak. George designed it for exploration of the coastal waters, just as his father worked on Orion to explore the solar system. Gray and green, yes; but the urge to leave humdrum civilization behind motivates both father and son.

In the final chapter Dyson recounts two recurrent dreams. In the first, he roams the universe in a tiny spaceship with George but finally tires of the endless procession of galaxies. In the other, he visits God with his two daughters, only to find a three-month-old baby on a throne. Playing with the baby, Dyson and his daughters find that their questions have been answered.

Like Robert Pirsig (*Zen and the Art of Motorcycle Maintenance*), whom he admires, Dyson responds to the world on different levels. He quotes poets—like Eliot, from whose "The Love Song of J. Alfred Prufrock" he takes the book's title—more than he does physicists. His own personal visions of the world are expressed in this book.

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Dynamical Astronomy

Dynamics of the Solar System. Proceedings of a symposium, Tokyo, May 1978. RAYNOR L. DUNCOMBE, Ed. Reidel, Boston, 1979 (distributor, Kluwer Boston, Hingham, Mass.). xiv, 330 pp., illus. Cloth, $44.50; paper, $38.95. International Astronomical Union Symposium No. 81.

Yusuke Hagihara, sometimes called "the Laplace of the 20th century," was one of the giants of celestial mechanics. His enormous five-volume treatise *Celestial Mechanics*, like the treatise of Laplace, is an encyclopedia whose value will be measured in centuries, not in years, of usage. This volume, the proceedings of an International Astronomical Union symposium held in his honor, is a fitting tribute to a remarkable man.

In recent years, the solar system has once again come to be seen as an interesting place. Abandoning the sterile view of a few years ago in which the solar system was seen as merely a bunch of rocks floating around the sun, we have begun to relearn that we inhabit a region of truly remarkable objects. This rediscovery began with the physical exploration of the moon, and it now extends to the physics and dynamics of a surprising array of bodies. The origin of Chiron, the future of Phobos, tidally induced vulcanism on Io, satellites of Pluto and other minor bodies, the intransigence of the Kirkwood gaps to attempts to explain them, rings around all manner of planets—such issues have injected a spirit of excitement into dynamical astronomy that has not been known for a long time.

Dynamics of the Solar System provides a fairly comprehensive picture of the subject as of early 1978. The average quality of the papers is high, and many papers are valuable and permanent contributions to the literature; a small number would have been omitted or revised by a hard-nosed referee, but this is not a harsh criticism in an age when many refereed journals suffer the same lack of rigor. Specific comments on what I consider to be the highlights of the book follow.

Ever since Poincaré demonstrated that the series expansions of celestial mechanics are not formally convergent, long-term stability has been a near-obsession for dynamicists, and understandably so, since stability is central to two concerns that may together be considered the raison d'être of celestial mechanics: the evolution of dynamical systems with time and the feasibility of representing that evolution mathematically. Szebehely's paper is the most succinct and clear summary of the problems of dynamical stability in the solar system that I have ever encountered. Nacozy describes an interesting attempt to facilitate numerical studies of the stability of real systems by the use of analogous fictitious systems with augmented mass of the "planetary" objects. It is not clear how directly information derived from such fictitious systems is applicable to the real bodies of interest, but this approach is certain to stimulate further studies of numerical stability.

Most of the book is concerned with more specific present-day problems. Yuasa and Hori have developed a new procedure for the construction of planetary orbit theories that may provide formal advantages over previous methods. Chapront and Dvorak present a new method for the determination of the near-resonant terms in such a theory, a particularly vexing problem. Kowal *et al.* suggest on the basis of orbital evidence that Chiron may be related to Phoebe. The case for "recent" creation of the asteroids by the breakup of a large planet is argued by Van Flandern, and the discussion this controversial idea gave rise to is as interesting as the paper. Papers by Delsemme, Everhart, and Weissman detail the problems that still exist concerning the origin and evolution of comets. In addition, there are many papers on more specific topics.

Dynamics of the Solar System is a book that contains much food for thought for the established researcher

and a rich supply of dissertation topics for the beginner. It is not in the nature of symposium proceedings to be profound and long-lasting, but this one is at least important and stimulating. I am happy to have it in my library, and I can recommend it without hesitation.

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Sedimentary Geology

Aspects of Diagenesis. Papers from symposiums, Mar. 1976 and Apr. 1977. PETER A. SCHOLLE and PAUL R. SCHLUGER, Eds. Society of Economic Paleontologists and Mineralogists, Tulsa, Okla., 1979. vi, 444 pp., illus. $19; to members, $15. SEPM Special Publication No. 26.

This volume, which contains the proceedings of two symposiums, offers review papers on some of the geochemical and mineralogical techniques used to estimate temperatures reached at particular points in sediment piles and papers concerned with how porosity and permeability are created and destroyed in these materials. Although the conceptual range of the volume is broad, it is a fair representation of the subfields about which a sedimentary geologist interested in diagenesis would try to keep informed. Because coal, natural gas, and petroleum are diagenetic products, the subject has important practical applications, particularly in locating stratigraphic traps.

The methods of estimating temperature that are discussed in the book make use of parameters that range from stable oxygen isotopic ratios (Eslinger *et al.*), whose interpretation is solidly grounded in physical theory, to the color alteration of the organic matter in conodonts, microfossils of carbonate apatite from organisms of unknown taxonomic affinity (Harris). The reflectance and the extent of graphitization of organic matter fragments (Bostick, Harrison), fission-track density (Naeser), fluid-inclusion properties (Roedder), and the nature of clay and zeolite mineral assemblages (Hoffman and Hower, Ghent) complete the list. Not surprisingly, many of these parameters are sensitive to solution composition as well as to temperature, and metastable phases and compositions form and persist at low temperatures (up to 200° or 250°C). Calibration of the organic parameters draws upon the body of knowledge about coals, which are made up of the same constituents in different proportions. The consistency of fluid-inclusion compositions observed by Roedder in geode minerals, Mississippi-Valley-type orebodies, the sphalerite of bituminous coal seams, and carbonate and quartz cements of detrital limestones and sandstones strongly suggests that hot, strongly saline solutions moved pervasively through sediment piles at some time in their history and thereby contributed to diagenetic alteration.

Papers concerned with the general principles governing generation and destruction of porosity are followed by others that consider particular sediment types and particular localities. The volumetrically dominant arkosic and lithic sandstones of the continental margins have clays and zeolites as their principal cements, requiring modification of the former assumption that quartz- and feldspar-cemented cratonic sandstones are typical (Hayes). The important role played by water from shale dewatering in both petroleum migration and porosity and permeability modification has led to the utilization of increasingly complex mathematical models that seek ultimately to incorporate fluid flow, chemical reactions, sedimentation rate, and thermal regime. These models now routinely test whether present-day pore fluid is in thermodynamic equilibrium with the enclosing mineral assemblage, but the course of mineral-pore-fluid interaction back through time to the initial, frequently organic-rich, sediment must remain speculative. In this volume, Wood and Surdam test a model involving chemical reaction, chemical diffusion, and convective flow.

The book contains some sobering comments about the bounds within which the increasingly difficult search for petroleum must be made. The burial temperature of some continental shelf sediments may never have been high enough to generate hydrocarbons from included organic matter, whereas many of the sedimentary rocks of the eastern United States may have gotten too hot (Bostick). The pores of lithic, arc-derived sandstones in Northeast Pacific basins may be largely filled with mineral cements by the time they are buried deeply enough for hydrocarbon generation to take place, leaving but little volume available for petroleum accumulation (Galloway). In other areas, however, secondary porosity may form at depth by dissolution of both pore-filling cement and detrital particles (Hayes).

The pairing of papers from these two symposiums was fortunate. It would be difficult to assemble the same material from existing textbooks, so the volume should be useful in a variety of advanced courses in sedimentary geology. The papers on maturation of organic solids (Bostick), clay mineralogy (Hoffman and Hower), and sandstone porosity (Hayes) are particularly successful in conveying the subtleties of approach that have evolved for dealing with particular aspects of diagenesis.

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Health Hazards of Asbestos

Asbestos and Disease. IRVING J. SELIKOFF and DOUGLAS H. K. LEE. Academic Press, New York, 1978. xviii, 552 pp., illus. $39.50. Environmental Sciences.

The authors of this welcome book have attempted to put together in one volume a comprehensive review of all aspects of asbestos and its relationship to human health. They have addressed the book to the nonspecialist but have included a bibliography of over 800 references to enable an interested reader to explore the literature further.

The book is well organized for the intended audience. Five major sections cover the distribution of the mineral, nonmalignant effects, malignant effects, pathogenic mechanisms, and prevention and control of asbestos-related disease. The chapters within sections are planned to stand alone to the extent possible, so there is some repetition for those who will read the book from cover to cover.

The discussion of methods of measuring asbestos and their relative merits and limitations is particularly useful in light of the continuing debate about the most desirable field measurement techniques. In addition, the discussion serves as a background to the authors' consideration of the hazardous nature of nonfibrous or small-fibril forms of asbestos. There is also a well-documented chapter summarizing existing knowledge of the environmental distribution of asbestos in air, water, food, drugs, and consumer products.

Particularly welcome is an extension and restatement of Koch's postulates, a set of rules designed to establish the relationship between a particular agent and a particular disease. The original postulates were formulated for infectious disease, largely acute in onset. Selikoff and Lee have extended and modified them for use with chemical agents associated with chronic disease. The proposed postulates are applied in a review of evidence concerning the role of asbestos in causing pleural and parenchymal nonmalignant disease and mesothelial, bron-