the widely differing careers of his five actors and the way they accommodated to or rebelled against the dominance of Cambridge in British science. He shows a fine eye for the telling detail and the choice phrase. For instance, he recites with impish glee the stories of Haldane's unconventional social behavior. Academic dinner parties of that era did not easily accommodate a guest who might throw off some such sentence as "I have never gone in really seriously for bestial sodomy" (p. 83). Haldane was dismissed from Cambridge for "gross immorality" when in his early 30's. His crowning sin was the staging of the sort of adulterous situation then required to obtain a divorce. The university board obligated to consider his offense consisted of six men—the Sex Viri or, as wags had it, the Sex Weary. (Subsequently, and thanks to Haldane, the university had Septem Viri.)

The book has a complex, finely crafted structure of nine chapters in three parts. The first of these parts (117 pages) develops a stage setting by considering in detail the careers and contexts of the chosen heroes before the '30s. The second (126 pages) treats their theory and practice in the '30's. The importance of the Cambridge Scientists' Anti-war Group is stressed, together with the development of "Bernalism." Bernalism was "the deeply held conviction that there was just one international science, and [that] it could only be fully practised and humanely applied in a socialist society" (p. 300). More than that, it was a belief in science as the exemplar of human progress and the pattern for all thought. The theoretical articulation of this belief had obvious appeal and succeeded in "making the left safe for science." The brief third part (65 pages) considers the mixed careers of the actors, and of their ideas, since the '30's.

Though engrossing and often funny, the book Werskey has written is basically a sad one. On the positive side, it shows how the British educational system could work to identify extraordinary talent among the lower classes and escalate the possessors of that talent to the pinnacles of academe, even before World War I. But it also shows how certain social and psychological outsiders (Levy, the Scottish Jew; Bernal, the Irish Catholic; Hogben, the lower-middle-class provincial; Haldane, the temperamental rebel) never felt fully at home within the scientific establishment of their day. More than that, it shows how brilliant scientific minds were—in the end—dupes of those with more subtle and single-minded purposes. J. B. S. Haldane was for many years the leading geneticist in the British Communist party. He found himself forced into an agonized "phased withdrawal" from the party following the Lysenko affair. He eventually retreated to a self-imposed exile in India. Hyman Levy had been a loyal party member for more than a quarter of a century when he belatedly awoke to the reality of the persecution of Russian Jews by the Soviet state. What he never comprehended was his own subsequent expulsion by the party. J. D. Bernal ended his days less noted for his brilliant work in crystallography than for his unflinching defense of Stalinism. Lancelot Hogben became "a recluse, politically isolated, bereft of family and far removed from his old, too often estranged friends" (p. 211).

The common fate seems to have been avoided only by Joseph Needham. It is interesting to speculate why. Unlike the others, Needham from the first insisted on a stance that respected the complexity and the essentially religious nature of life. His Marxism always marched hand in hand with his Anglo-Catholicism. The culture of professional life was in his birthright, and—unlike Haldane—he took easily to, and never really strayed from, the ethos of a Cambridge existence (over a 60-year span he moved from undergraduate through fellow to master of a major college, Gonville and Caius). More than that, he was the only one of the group to abandon his science and to commit himself full time to the study of a facet of those social phenomena about which they all wrote so easily. The complex, tempered humanity of the resultant insights are displayed in his monumental, continuing study *Science and Civilisation in China*.

Werskey's book is sad for additional reasons. The central dogma of the scientific socialists was that a communistic form of society would prove best able to nourish abstract science. This particular triumph over capitalism has not been proven by events. The belief that there can be only one objective, international science (a faith shared by the liberals of the era) has also failed to hold up under scrutiny, or to spark a significant research program in the history and sociology of scientific knowledge. The more provocative, fruitful insights of the last quarter-century have come not from Marxist theorists of science and society but from historians, philosophers, sociologists, and anthropologists who owe nothing to "Bernalism."

Werskey himself has been heavily influenced by the rather different radicalism fashionable in "the other Cambridge" a dozen years ago. His Harvard experience has shaped a determination to find ways forward for the New Left in a critique of the Old. Werskey makes no secret of his desire to tackle "the impact of the thirties generation of socialists on my own" (p. 15). The result is that he sometimes detours into the subtleties of Marxist exegesis. His time would have been better spent exploring the masses of manuscript evidence on which any full and final accounting of his scientific socialists will have to rest. Instead, he relies almost entirely on printed documents and personal reminiscences. Nonetheless, Werskey is a highly capable historian. He has produced an eminently enjoyable book. To read it is to be entertained. To read it is also to be sobered by the difficulties inherent in any passage from scientific knowledge to political wisdom.

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Recollections and Visions

Disturbing the Universe. FREEMAN DYSON. Harper and Row, New York, 1979. x, 284 pp. $12.95.

A book of recollections by a scientist of Dyson's caliber should make good reading, and this one does. He writes skillfully of his youth in England with his composer father and lawyer mother, of his studies of field theory with Bethe at Cornell, of his formulation of quantum electrodynamics while on a bus tour of the United States, and of his career at the Institute for Advanced Study. Physicists will particularly enjoy his vivid sketches of Bethe, Feynman, Oppenheimer, and Teller.

Dyson's wartime work in operations research stimulated a lifelong interest in technology. At the age of only eight, reading Edith Nesbit's *The Magic City*, he became fascinated with machines. In the book a boy builds a toy city out of bric-a-brac. One night the city grows magically to full size. Moving through it, the boy finds an inexorable rule: one can get any new machine one wishes for, but only on the condition that one keeps it and goes on using it for the rest of one's life. Dyson points out that we in fact inhabit such a magic city and that the survival of the human race may depend upon how we handle the overgrown toys produced by modern technology.

In the summer of 1958, Ted Taylor in-

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