names of people to whom their respondents refer.

Perhaps Edge and Mulkay felt constrained to set down so impersonal a narrative because most of their subjects are still alive. Perhaps they could not obtain access to information unless they promised their sources anonymity. Yet their book is so uncompromisingly impersonal as to suggest that they simply saw no point in addressing themselves to the human details because they interpreted social history or sociology to require focusing only on the general. Edge and Mulkay call for incorporating the technical dimension in the social study of science. It seems necessary to insist that the human dimension deserves an equal place. The human dimension is certainly compatible with social and intellectual analysis of a general type, and it is an essential part of the story. One hopes that attempts to explore the historical sociology of science will avoid robbing the subject of life.

Astronomy Transformed itself is not lifeless. It takes an important step in the direction of integrating the social with the cognitive development of a remarkable scientific field. While taking as their central subject the evolution of that field in Britain, Edge and Mulkay set their study in the context of its growth elsewhere in the world. Assessment of the relative significance of the British work—and it was without doubt considerable—after the early years will have to await studies of radio astronomy in other countries. Whatever such studies may purport to show, all will have to meet the scholarly standard established by Edge and Mulkay, which is a very high standard indeed.

DANIEL J. KEVLES
Division of the Humanities and Social Sciences, California Institute of Technology, Pasadena

Chronicle of a Career

In at the Beginnings. A Physicist's Life. PHILIP M. MORSE. MIT Press, Cambridge, Mass., 1977. xxii, 376 pp., illus. $15.

Philip McCord Morse became seriously interested in physics as an undergraduate at the Case School of Applied Science in his native Cleveland in 1924 and has written his autobiography 53 years later, after a distinguished and varied career centered about his position as professor of physics at M.I.T., where he has been since 1931. He places himself in the second rank of physicists, having been close to many important developments but not having made any big discovery on his own. He was better than many who call themselves physicists today, and the reviewer can vouch for his excellence as a teacher.

His chronicle includes graduate study from 1926 to 1929 at Princeton, during the most exciting period that physics has known in this century, teaching at Ann Arbor and Princeton, postdoctoral study at Munich and Cambridge, participation in the founding of M.I.T.'s outstanding program in the physical sciences, work in antisubmarine warfare and underwater acoustics that contributed to the defeat of the Nazis, a role in the early development of computing at M.I.T., and a major role in the development of operations research.

Morse was coauthor, with E. U. Condon, of the first good book on quantum mechanics. His book *Vibration and Sound* and his two-volume work with Herman Feshbach entitled *Methods of Theoretical Physics* are standard sources in physics. His book with George Kimball on *Methods of Operations Research* is basic to that subject. He has also written on queuing theory and thermal physics.

The changes that have taken place in physics and its relation to the world during the half century reported on are implicit but somewhat dimly seen, owing to the purely factual nature of the account. There is a glimpse of the coherence, spirit, and smallness of the world of physics in the 1920's, in that by 1930 Morse knew K. T. Compton, H. N. Russell, Einstein, von Neumann, Robertson, Davisson, Germer, Wigner, Condon, Sommerfeld, Bragg, Pauling, Heisenberg, Bloch, Teller, Dirac, Kramers, Fermi, Oppenheimer, and Lorentz. Of people entering physics at that time, he says, "They had to be highly interested in physics. There was no fortune or fame to be won; achievement in research or teaching had to be its own reward." Further on, he contrasts that with the spirit of the 1960's, when physicists required fame, wealth, and power, when the "publish or perish" syndrome forced narrow specialization, and when one had to spend much time drawing up proposals for grants and contracts, knowing full well that if you can describe it in advance it is not research.

The most interesting part of the book describes Morse's activities and those of various of his colleagues during the Second World War. The work in underwater sound, for sweeping acoustic mines and decoying acoustic torpedoes, was a natural outgrowth of his interest in acoustics. More important was the antisubmarine warfare work, in which new ideas had to be developed (ideas that led to the discipline now called operations research), in which personal and psychological considerations were as important as statistical facts, and which contributed substantially to the defeat of the Nazis. It is a fascinating account. He contrasts that period, too, with later ones. He says it is almost impossible now, "after the militaristic imbecilities of Vietnam" (he might have added, and the vicious lawlessness of the CIA and presidential mendacity) to explain to younger colleagues why it was overwhelmingly important to win the Second World War.

On the larger question of the role of physics and related science in the world, one has to read between the lines, because of Morse's aversion to stating opinions that cannot be easily substantiated. Physicists were no more religious in the '20's than today, but they could believe in "the progress of mankind onward and upward forever," to quote the creed of one of the churches of that period. The world's space and resources seemed limitless then, and everyone believed that science would eradicate disease, poverty, hunger, and inequities. Fifty years later those ills are still not eradicated, and many new ills previously unthought of are upon us. The work of Jay Forrester and the Club of Rome, both referred to in Morse's book, suggests that "forever" may now be quite short and "progress" may have been reversed already. Whether science is good or evil (or just irrelevant for the world as a whole) will be debated indefinitely, especially by nonscientists, but surely physicists ought to give some thought to those questions. Morse's contribution in this regard concerns operations research, for which he had great hopes in the period immediately following the war. He "hoped that the scientific study of the cooperative actions of men and machines, begun in wartime, might be applied to more humane activities." He writes of the "more socially useful applications of operations research," "man's welfare," "long-range planning."

The last chapter discusses sociological problems in a slightly rambling but serious way. Morse states his conviction that there is no conflict between world planning and science (as though the idea had already occurred to him that there might be). It seems to the reviewer that he combines, on the one hand, a slight sense of disappointment that, although operations research has helped solve problems of libraries, police and fire departments, traffic control, NATO, rail-

roads, blood banks, and agriculture, most of the world's big problems are still untouched with, on the other, a hope that operations research, or methods like it, may someday help with the bigger problems.

R. D. RICHTMYER
Department of Physics and Astrophysics, University of Colorado, Boulder

Stellar Atmospheres

Abundance Effects in Classification. Proceedings of a symposium, Lausanne-Dorigny, Switzerland, July 1975. B. HAUCK and P. C. KEENAN, Eds. Published for the International Astronomical Union by Reidel, Boston, 1976. xxviii, 264 pp., illus. Cloth. $31.50; paper, $22.50. IAU Symposium No. 72.

Physics of Ap-Stars. Proceedings of a colloquium, Vienna, Sept. 1975. WERNER W. WEISS, HELMUT JENKNER, and H. JOHN WOOD, Eds. Universitätssternwarte Wien mit Figl-Observatorium für Astrophysik, Vienna, 1976. xvi, 754 pp., illus. Paper, $26. IAU Colloquium No. 32.

Be and Shell Stars. Papers from a symposium, Bass River, Mass., Sept. 1975. ARNE SLETTEBAK, Ed. Published for the International Astronomical Union by Reidel, Boston, 1976. xvi, 466 pp., illus. Cloth, $56.50; paper. $43. IAU Symposium No. 70.

Sometimes it happens in science that too much information can obscure fundamental relationships and processes. One may wonder if Kepler would have decided that the orbits of the planets were ellipses if the observations of Mars by Tycho Brahe had been accurate to 5 arc seconds instead of 8 arc minutes. The latter accuracy was sufficient to determine the elliptical nature of the orbit, the former would have shown the perturbations of the other planets. In a similar way, stellar classification using low-dispersion spectra (100 Å/mm) is sufficient to divide about 80 percent of the bright stars into a unique, two-dimensional array with axes that correspond to surface temperature and to surface pressure or gravity. In addition to these two parameters, however, the atmosphere of a star is characterized by its chemical composition. Between 1930 and 1940 some groups of stars were found in which the abundance of certain metals relative to hydrogen is anomalous, and this knowledge led to the realization that surface composition varies from star to star and that differences in abundance affect classification indices. The effects of such differences on classification were the subject of IAU Symposium No. 72, *Abundance Effects in Classification*, which was dedicated to W. W. Morgan, whose careful work dominates the field of spectral classification. It is possible, at classification dispersion, to distinguish between stars with "normal" and those with "peculiar" chemical composition. Previous discussions of classification systems have demonstrated the increasing importance of abundance effects. Symposium No. 72 provides those interested in stellar abundances with a survey of the subject as it stands now and with an indication of the directions that future lines of research are likely to take. In addition to the submitted papers, the invited reviews by both theoretical and observational experts comprehensively cover our present understanding of the subject. Particularly noteworthy is a catalog of atmospheric parameters and Fe/H determinations that will be useful not only to those astronomers interested in the problems associated with abundance but also to those who from time to time need a catalog of the chemical compositions of stellar atmospheres. The proceedings end with a short discussion by Morgan of spectral classification, including what might best be described as some advice to a young person for future work in the field.

The other two volumes under review also deal with stellar atmospheres. IAU Colloquium No. 32, *Physics of Ap-Stars*, concerns A and B peculiar (Ap, Bp) stars, those stars that have surface temperatures ranging from about 7000°K to 20,000°K and that exhibit abnormally high atmospheric abundances of certain elements, such as the rare earths. Many of these stars have very strong magnetic fields organized on a global scale. Their field strengths range from several hundred gauss to several tens of thousands of gauss. At classification dispersion, these stars have been divided into various categories, such as silicon or mercury-manganese stars, but at higher dispersion the abundance peculiarities increase and their division into a few simple classes is not possible. While ordinary stars in this temperature range typically exhibit rapid rotation, all the Ap and Bp stars are slow rotators; in fact, one such star is thought to take over 70 years to complete a single rotation. The abundance anomalies of these stars are concentrated near their magnetic poles, which are not usually aligned with their rotation axes and which produce spectrum changes as the star rotates.

L. Mestel reviews the magnetic field models that have been proposed to explain the abundance anomalies of Ap stars. The principal issue such models address is whether the field is the remnant of a primordial field "frozen" into the stellar plasma or is continuously being created by dynamo activity. F. A. Catalano reviews the origins of the abundance anomalies: Are they produced by diffusional separation, by nuclear activity on the surface of the star, by selective trapping of interstellar gas by the star's magnetic field, or by one of several other processes?

Among the numerous observational papers are a review of the ultraviolet properties of Ap stars by D. S. Leckrone, a review of the atmospheric parameters of Ap stars by M. Hack, a description of an investigation of element identifications in peculiar stars by C. R. Cowley, a review of the mercury-manganese stars by S. C. Wolff and R. J. Wolff, and a delightful paper discussing the metallic line stars by D. J. Stickland. The colloquium volume concludes with open discussions of several of the controversial theories and major problems in the study of these stars: those associated with the origin of their magnetic fields and their peculiar chemical composition, with the mercury-manganese and related stars, and with line blanketing and the transfer of radiation through the stellar atmosphere. It is clear that although we have a large amount of observational information concerning these stars, we still have no self-consistent theoretical model that explains all the observed data.

I would like to compliment the editors on the inexpensive way they have chosen to publish the proceedings; the paperback binding and photo-offset printing enable the book to be distributed without excessive expense.

IAU Symposium No. 70, *Be and Shell Stars*, treats another class of hot, peculiar stars. The spectra of these stars are characterized by emission lines and broad absorption features. Otto Struve in 1931 connected the broad absorption lines of these stars with their rapid rotation and concluded that it was likely that the emission lines were produced by a disk thrown off from the equator of the rapidly rotating, hot star.

As with the Ap stars, there is at present no consistent theory explaining all the properties of the Be stars. There are theoretical and observational difficulties with Struve's model. Competing models, such as one offered by S. Kříž and P. Harmanec that postulates that many or all Be stars are mass exchange binaries, require additional theoretical and observational justification before they can be accepted.

Symposium No. 70 has the flavor of a meeting of a working group. The review