be that it pays to claim as much credit as you can while you can, or, better still, have a bunch of followers who will eagerly do it for you because their prestige is bound up with yours. John worked alone, avoided cliques, found disputes distasteful, and never became identified with an institution or organization. Darwin had his Huxley, Kelvin had his Tait, Clerk Maxwell had both Scots nationalism and the Cavendish Laboratory. Even William Herschel had John. But no one consistently took up the cudgels for John's right to his discoveries. It seems not to have occurred even to an intelligent admirer such as the historian Agnes Clerke that his reputation *could* ever die.

Buttmann's book does not provide an answer for all such questions as these—the amount of John Herschel material still unused is so large that he calls his book a "sketch"—but it provides enough for us to begin to ask questions. He does this in a true biographical form, interweaving John's life with his scientific work in human fashion. The American publishers have provided a most handsome format, with good reproductions of 17 illustrations, notes, bibliography, and a scanty index. Even those who have read the German original will find this edition well worth the moderate increase in price, simply from the pleasure of reading good type on good paper. My main objection is to the picture of a sick, tired old man on the dust jacket and also as frontispiece. Granted, this photograph was one of Julia Cameron's masterpieces; but it was not the old man who made his mark on 19th-century science. It was the vigorous middle-aged man who fascinated his young admirers, men like Faraday, Hamilton, Draper, and Airy.

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Big Instruments

Radiotelescopes. W. N. CHRISTIANSEN and J. A. HÖGBOM. Cambridge University Press, New York, 1969. xii + 232 pp. + plates. $14.50.

This is a small book on a large subject, but it is without question the best in its field. The authors are pioneers in radio telescope design and write with the greatest authority on their subject.

The competition is not very extensive. The first comprehensive work on the subject was Pawsey and Bracewell's *Radio Astronomy* (1955), followed by Steinberg and Lequeux's *Radioastronomie* (1960; translated and revised by Bracewell in 1963) and by Kraus's *Radio Astronomy* (1966). Each of these books updated the earlier ones and each was aimed primarily at the undergraduate engineering or astronomy student. Each was a rather general treatment of its subject with one or two chapters devoted to instrumentation. Bracewell's chapter in the 1962 *Handbuch der Physik* was the first attempt to synthesize the entire subject of radio astronomy instrumentation, a subject evolving rapidly and one which has assumed substantial scientific and economic importance.

Unfortunately radio telescope design is neither engineering research nor astronomical research. Radio telescopes embody well-established scientific and engineering principles; they are unique mainly in their size and cost and in the ingenuity with which the basic principles are applied. Papers on radio telescope design are often unacceptable in both astronomical and engineering journals. This creates a problem, for radio astronomical observations must invariably be interpreted in terms of the characteristics of the telescope. An exception to this rule may be in the area of synthetic-aperture telescopes, in which radio astronomers have made unique contributions. Christiansen and Högbom's effort is welcome indeed as a substantial contribution to a field largely neglected in the book literature.

Despite its small size, the present book is encyclopedic in detail. Some of the technical material is heuristic, some is assumed from the engineering literature, and some is skillfully derived from first principles, depending upon the authors' inclinations and priorities. All in all, the treatment is satisfying to the critical and analytically minded reader. Its level of sophistication is that of the advanced graduate student or experienced antenna engineer.

One subject whose treatment disappointed the reviewer to some degree was the response of the correlation interferometer to the electromagnetic field. This is fundamental to the entire subject of correlation antennas and aperture synthesis. Nowhere in the book or in the references is the subject of coherence mentioned, though rigorous treatment of correlation antennas depends completely on the specification of the spatial and temporal statistical nature of the incident waves. Instead, quasimonochromatic fields are assumed in the derivation of the reception patterns of correlation antennas, and the assumption is then made that broadband, spatially uncorrelated sources can be mapped by using the results of these derivations. This gives correct results for the conditions encountered so far in radio astronomy, but the reader should be aware that these assumptions are not reliable in certain limiting cases and should consult the current periodical literature for the coherence theory of correlation antennas.

In summary, this is an excellent book which should be in the library of every radio astronomer and antenna engineer, and which will be frequently referred to even by experts.

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New Astronomies

High-Energy Astrophysics. TREVOR C. WEEKES. Chapman and Hall, London, 1969 (U.S. distributor, Barnes and Noble, New York). xii + 212 pp. + plates. $9.50.

Although the development is viewed with mixed emotions by traditional astronomers, the past decade has seen the birth of a variety of scientist which one might call the "observational astrophysicist." The respectable status of the theoretical astrophysicist has been assured by the importance of the contributions of such men as Eddington, Chandrasekhar, and Hoyle to the understanding of even the most rudimentary observational data. The new observational astrophysicists specialize in new astronomies—cosmic ray, gamma ray, x-ray, infrared, and neutrino astronomy. This little book by Trevor Weekes tells about some of the things they do. The title *High-Energy Astrophysics* was chosen because of the large energies involved in such astrophysical phenomena as imploding stars and radio galaxies and the generally great quantum energy of the light used in the new astronomies.

After getting off to a bad start the monograph steadily improves. Chapter 1 is too brief to be useful as a summary of "astronomical vocabulary," and

chapter 2 is a rehash of Felton's treatment of magnetic bremsstrahlung and inverse Compton scattering.

Beginning with chapter 3 Weekes discusses a series of essentially separable topics. These are novae, cosmic rays, radio galaxies, quasars, radio source theories, x-ray, gamma ray, and neutrino astronomy, the 3-degree black body radiation, and pulsars. The author does a good job of summarizing the astrophysical importance of each topic. His tabular presentations of properties are uniformly useful. For example, table 3.1 gives the energy released, absolute magnitude, mass ejected, shell velocity, occurrence rate, and associated population type for novae and type I and type II supernovae, and, to skip to the back of the book, table 12.1 lists the important characteristics of nine pulsars including those in the Crab and Vela. Treating such a variety of phenomena in a 200-page book dictates that the discussion of each must be brief and that the emphasis will have to suit the author's fancy. In the reviewer's opinion, the potpourri is well balanced. One might object that almost a quarter of the book is on gamma ray and neutrino astrophysics, where not a single astronomical point source has been observed, but one must be almost certain that gamma rays and neutrinos will be detected and their astrophysical impact will be very great. The upper limits to these fluxes are important in themselves. For example, the present upper limit on solar neutrinos fixes the sun's central temperature at less than 2×10^7 degrees Kelvin, compared with the probable value of 1.6×10^7 degrees, and our uncertainty in the neutrino intensities is large enough to allow the universe to be closed because of the neutrino energy density. Astrophysicists have certain superstitions which are usually not explicitly written down. The author is not afraid to state some of these. For example, he says on page 109 that "the only possible means of detecting an object which has collapsed [to the Schwarzschild radius] is through the influence of the gravitational and electric fields" and does not even mention the possibility that if a massive object can trap light perhaps it can also trap its gravitation.

At the end of the book the author lists about a dozen references for each chapter. These are well chosen, but not independent. Shklovsky's *Cosmic Radio Waves* makes it four times.

Weekes's readable book makes a good case for the new astronomies he discusses. It will find its way to many bookshelves because, as a colleague of mine remarked as he thumbed through it, "he talks about most of the right topics."

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The Classification of Matter

The Periodic System of Chemical Elements. A History of the First Hundred Years. J. W. VAN SPRONSEN. Elsevier, New York, 1969. xviii + 370 pp., illus. $18.

A book with this title, appearing during the anniversary year of Mendeleev's enunciation of the periodic law of the chemical elements, is suspected of being simply another celebration of that famed event. In fact, this book is much more. Its publication in itself is an event of considerable importance. Although E. G. Mazurs helped to bring readers up to date with his 1957 compilation *Types of Graphic Representation of the Periodic System of Chemical Elements*, we have not had a full-length historical treatment of the periodic system in English since F. P. Venable's classic *The Development of the Periodic Law* of 1896.

Van Spronsen brings to his task impressive historical knowledge, chemical ability, and philosophic insight. The different forms of the periodic table are excellently presented, and one's only regret is that a stylist was not employed by the publisher to smooth out some of the infelicities in the text, particularly in the early chapters. Van Spronsen not only covers the last hundred years but also devotes the book's first hundred pages to the origins of the periodic classification, the concepts underlying it, and the precursors from Döbereiner on. He comes to the novel and convincing conclusion that there were six independent discoverers, Beguyer de Chancourtois, Newlands, Odling, Hinrichs, Lothar Meyer, and Mendeleev, in chronological order, all publishing within ten years after the Karlsruhe Congress. That Congress brought agreement on atomic weights and made possible comparison between elements of different families. The contributions were not, of course, of equal value, and Mendeleev stands out as the man with the greatest realization of the power of the system. Both Mendeleev and Meyer came to the discovery through their need to find a useful basis for their textbooks. It is sobering to note that de Chancourtois, the first person to develop a chemical periodic system, was a geologist.

The book contains surprises for almost any reader. In addition to the ingenious two- and three-dimensional tabulations including spirals, pretzels, and even one in the form of a slide rule, we learn that five of the six discoverers left spaces for yet-to-be-discovered elements; that five of the six placed tellurium before iodine in spite of their atomic weights; that Bohr in 1922 predicted an actinide series paralleling the rare earths; that Stoney and Sedgwick made room for the noble gases before their discovery; that attempts were made to explain the nonreactivity of argon by suggesting it was actually the nitrogen analogue of ozone, N_3.

Van Spronsen devotes major sections to element prediction, deviations from the atomic weight sequence, the noble gases, transition metals, rare earths, actinides, and controversies regarding priority. He also has a chapter on limits of the system, but the currency of his treatment is indicated by the fact that the book was not able to report on the U.S.-Russian arguments regarding element 104 or on the predicted "island of stability" among elements heavier than those now known. These developed just as the book was being published.

The author emphasizes the great importance of the discovery of valence, but this reviewer would like to have seen a greater emphasis on its Pythagorean character. Not only was valence discontinuous and integral, but it increased one unit at a time from element to element in groups I through VII, or else went up to four and down again. It was this fact, no doubt, that gave confidence to the discoverers that the system was almost complete. The only family discovered after 1870 had a valence of zero. Following the mathematicians of old, few chemists thought of zero as a number.

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