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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