

tions require some changes in present conversion tables.

Aspects of resistance thermometry are described by eight papers in the second section. These include four papers on thermistors, whose applications and limitations are carefully detailed in the introductory paper to this sub-section. In particular, the difficulties in providing for the non-interchangeability of individual thermistors in designing thermistor bridges are discussed in some detail.

There are nineteen papers in the section on radiation thermometry. Several papers describe two-color radiation pyrometers, and a number of others are concerned with temperature measurements in radiating gases. Thermal properties of materials at high temperatures is the subject of two additional papers in this section.

Section four on dynamic temperature measurements contains seventeen papers, with a majority of them devoted to gas flow applications. Also discussed, however, are surface temperature measurements on solids. The importance of careful installation and interpretation of results is emphasized in this section. Included is a fine paper on the accuracy and response of thermocouples by Green and Hunt.

Automatic methods of temperature measurement and control is the subject of section five. The first paper is an interesting but unnecessary review of the papers presented at the 1939 symposium under this title. The remainder of the papers in the first sub-section discuss control system fundamentals. A second sub-section of seven papers is devoted to automatic measurement methods in radiation pyrometry.

Collected in section six are fourteen papers on miscellaneous methods. These include discussions of the intermittent thermometer, an ablating probe, infrared imaging techniques, and several other special applications. A number of the papers in this section describe techniques recently developed for particular applications but which may have a wider use in the future.

A final section contains seven papers dealing with high temperature sources and thermal imaging techniques. Many of the papers in this

section deal with the operational techniques used with arc-imaging furnaces. Difficulties in calibration and control are discussed in detail.

In a volume of this scope with contributions from so many different individuals, there is inevitably some duplication. Most of this is not objectionable, and in some cases it is even desirable. Nevertheless, while many exotic new methods are described adequately, this reviewer would have appreciated at least one paper on the liquid-in-glass thermometer which is still widely used and misused in science and industry. Taken as a whole, this latest edition of a long useful work contains significant new material, and the almost twelve-hundred references provide an additional valuable guide to current literature for all whose interests and assignments bring them to problems of temperature measurement and control.

An Introduction to Vacuum Technique. By A. H. Turnbull, R. S. Barton, J. C. Riviere. 190 pp. Wiley, New York, 1962. \$7.75

Reviewed by **R. A. Pasternak**, *Stanford Research Institute, Menlo Park, California.*

The uses of vacuum in research and in industry have shown a spectacular growth in recent years, particularly since the initiation of large-scale space programs. The great demand for information on vacuum techniques has resulted in quite a few monographs on this subject.

An Introduction to Vacuum Technique is based on a United Kingdom Atomic Energy Authority report directed to the beginner which has been expanded by adding engineering data. The result does not appear well balanced to this reviewer, particularly in view of the small size of the book.

Two of the seven chapters are devoted to the more theoretical aspects of vacuum. The treatment is elementary and easily understandable. The other chapters are mainly collections of short descriptions of vacuum components, instrumentation, and of engineering instructions. The data presented are quite extensive—the selection naturally is colored by the preferences of the authors; they are useful handbook references to vacuum tech-

niques, but their instructiveness for beginners in the field is somewhat questionable. For example, eighteen pages are devoted to vacuum seals and their design, and a table of O-ring dimension occupies two-and-one-half pages.

The style is simple and precise; the text is very adequate. Finally, both the drawings and the printed text are kind to the eye.

Interstellar Communication. A collection of Reprints and Original Contributions. A. G. W. Cameron, ed. 320 pp. Benjamin, New York, 1963. \$8.50.

Reviewed by **E. J. Öpik**, *Armagh Observatory and University of Maryland.*

Here, 10 original essays and 22 reprints are offered on a subject which, though of enormous philosophical and scientific interest, seemed to "lack respectability" until the publication of G. Cocconi and P. Morrison's pioneering paper in *Nature* (1959) (Paper No. 15 of the collection).

Communications within the solar system are now considered a commonplace matter. For the time being, communication with advanced civilizations on planets of other stars is, of course, a matter of speculation only. Its pursuit is justified as a stimulant, even if success cannot be guaranteed. A first effort has already been made at the Green Bank National Radio Astronomy Observatory (F. D. Drake, Papers 16 and 17).

Estimates are made of the probable number of contemporaneous advanced civilizations in the Galaxy, of their lifetimes, of the probability of receiving a reply before the other partner has vanished or lost interest. Existing knowledge is supplemented by more or less plausible guesswork. However, unnecessary guesses are also made where knowledge is at hand. Thus, Huang (Papers 6-9), Morrison (Paper 26), and Shklovsky (Paper 1) assume that the frequency of stellar planets is proportional to orbital area or volume; faint dwarf stars are therefore thought unlikely to carry many habitable planets. The assumption is contradicted by the statistics of binaries which show a logarithmic distribution of the distances of stellar companions (E. Öpik, *Tartu Observatory Publ.*, Vol. 25, No. 6, 1924). The

logarithmic law has now been rediscovered by Cameron from the distribution of the orbits of satellites in the solar system (Paper 10), and Morrison in a concluding paper (No. 32) allows for this.

Communication with objects outside our solar system by direct space travel, even with relativity dilatation of time and antimatter fuel, is and will remain impossible, as shown in a brilliant essay by E. Purcell (Paper 13), supported by S. von Hoerner (Paper 14). There remains only transmission of information (we have much to learn) by electromagnetic

waves, of which the 21-cm hydrogen line is most promising, with optical lasers also being considered.

Advanced civilizations could be discovered from thermal infrared radiation in the 10-micron region, supposing that they have expanded the life area of their solar system by building a beehive of trillions of orbiting asteroids from the material of some giant planet (F. J. Dyson, Paper 11). The same author (Paper 12) gives an imaginative sketch of the possible utilization of gravitational energy on a cosmic scale, with fundamentals of gravitational waves (not for utiliza-

tion, however). An extensive essay on the biological aspects of the origin and evolution of life is offered by Melvin Calvin (Paper 5).

Care is taken in presenting the terminology and formulae, except perhaps in Paper 1 which is a translation from "*Privoda*" ("the concealment of Jupiter by the sun" stands for "the transit of J. over the sun's disk", and there are other inaccuracies; the mathematics on p. 14 is all wrong, despite the same formulae being given correctly on pp. 161, 162).

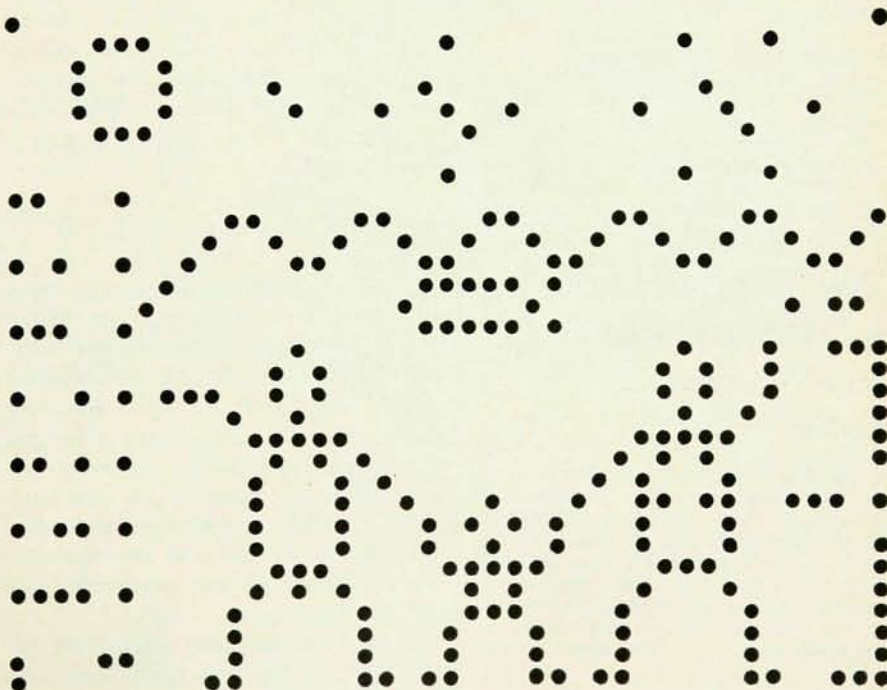
It is difficult to say what is more attractive in the collection—its direct

An imitation message from outer space and its interpretation (from B. M. Oliver's article "Interstellar Communication" in the book of the same name):

"Let us assume that after years of futile listening we receive a peculiar series of pulses and spaces from ϵ Eridani. The message is repeated every 22 hours and 53 minutes, apparently the length of their day. The pulses occur at separations which are integral multiples of a minimum separation. Writing ones for the pulses and filling in the blanks with the appropriate numbers of zeros we get the binary series shown [in the top figure]. It consists of 1271 ones and zeros. 1271 is the product of two primes 31 and 41. This strongly suggests that we arrange the message in a 31×41 array. When we do so, leaving blanks for the zeros and putting down a dot for each pulse we get the nonrandom pattern [of the bottom figure].

"Apparently we are in touch with a race of erect bipeds who reproduce sexually. There is even a suggestion that they might be mammals. The crude circle and column of dots at the left suggests their sun and planetary system. The figure is pointing to the fourth planet, evidently their home. The planets are numbered down the left-hand edge in a binary code which increases in place value from left to right and starts with a decimal (or rather a binary) point to mark the beginning. The wavy line commencing at the third planet indicates that it is covered with water and the fish-like form shows there is marine life there. The bipeds know this, so they must have space travel. The diagrams at the top will be recognized as hydrogen, carbon, and oxygen atoms, so their life is based on carbohydrate chemistry. The binary number six above the raised arm of the right figure suggests six fingers and implies a base-twelve number system. Finally the dimension line at the lower right suggests that the figure is eleven somethings tall. Since the wavelength of 21 cm on which we received the message is the only length we both know, we conclude the beings are 231 cm or seven feet in height."

(Interstellar Communication, p. 302 ff.)

[illegible]

The Theory of Laminar Boundary Layers in Compressible Fluids

By K. STEWARTSON. An up-to-date account of the theoretical position today. Discusses properties of two-dimensional and three-dimensional boundary layers, principles underlying equations, time-dependent problems, and interactions. 27 text figures. \$10.10

The Optical Model of Elastic Scattering

By PETER EDWARD HODGSON. Summarizes existing analyses of scattering of nucleons, deuterons, helium-three nuclei, alpha particles, heavy ions, pions, and kaons. Includes mathematical model formulation, computing techniques, theoretical interrelations, historical review, numerous appendixes. 45 text figures. \$4.80

The Lunar Society of Birmingham *A Social History of Provincial Science and Industry in Eighteenth-Century England*

By ROBERT E. SCHOFIELD. Describes the role of this "almost legendary" scientific society in solving the scientific, technological and sociological problems of its community. Surveys the work of individual members such as Watt, Priestley, Bolton, Wedgwood, and re-emphasizes the interrelations of science and technological change. 12 halftones. \$11.20

Low Temperature Solid State Physics *Some Selected Topics*

By H. M. ROSENBERG. Covers theory, key experiments, modern developments in the field—with emphasis on underlying physical principles. Topics include: specific heats, thermal and electrical conductivities, magnetic and mechanical properties, thermoelectricity, thermal expansion, and the behavior of super and semi-conductors. 450 pages. \$10.10

Oxford University Press
New York

purpose of elucidating the prospects of interstellar communication, or the scope of unusual information on very different topics, not so often found in one volume. Most of the articles are written on a popular level; others are more technical, but their meaning should be accessible to the intelligent reader.

Astrophysical Quantities (2nd ed.). By C. W. Allen. 291 pp. Athlone, London, 1963. Distr. in US by Oxford Univ. Press, New York. \$10.10.

Reviewed by **Martin F. McCarthy, S.J.**, *Vatican Observatory, Castel Gandolfo, Italy.*

To publish a book of precise values for astrophysical quantities at this point in the evolution of modern astronomy demands both courage and competence. The first edition, published in 1955, demonstrated the author's courage in facing the challenges offered by unprecedented advances in astrophysics during the first five decades of the 20th century. It also showed his exceptional competence in searching out the most reliable values from the voluminous literature and in presenting these with fairness, balance, and a fine sense of order. The fact that he is called upon again within eight years to publish a second edition indicates the fast pace of astrophysical research. Professor Allen deserves the thanks of his colleagues.

The aim and form remain the same: to present in numerical and tabular form the essential quantitative information on astrophysics. The increase in size has been limited very prudently to 28 pages. The chapters which present the constants of physics remain approximately the same length as before, while the sections devoted to the earth, planets, and satellites; and to the sun, stars, and stellar systems have been amplified. The sections on stellar populations, open clusters and associations, and sources of radio emission reflect very well the new advances made since the last edition. The author has resisted the temptation to include data on space flights and artificial satellites. Special praise is due for the description and use throughout the book of the new system of galactic coordinates.

Readers should start at the very beginning and examine the author's ex-

cellent introduction in which he acknowledges how very changeable constants can be and stresses the importance of understanding the qualifications required in such a compilation. These include ready availability of data, avoidance of ambiguity, conciseness, generality and completeness, accuracy, and evaluation of errors. The principal danger associated with a book such as the present one is that the readers will accept the published values too uncritically in spite of continued warnings. This danger may perhaps be less for the observational astrophysicist than for the theoretician. As an instance of this consider the following example. Since the completion of this edition in November 1962, the accepted value for the distance from the sun to the center of the galaxy has been revised upwards from 8.2 to 10.0 kiloparsecs and the velocity of rotation in the solar neighborhood changed from 215 to 250 km/sec. No author can be expected to issue weekly supplements to his work. Rather one must expect that with the author's precautions in mind, his readers will employ the valuable data compiled here with care but without a blind and absolute acceptance.

The references are exact, concise, and a clear guide to the literature. A "must" for every library, this excellent book merits a place on the desk of every astronomer.

Matrices and Tensors. By G. G. Hall. Vol. 4 of Topic 1 of The International Encyclopedia Of Physical Chemistry And Chemical Physics, edited by E. A. Guggenheim, J. E. Mayer, and F. C. Tompkins. 106 pp. (Pergamon, Oxford) Macmillan, New York, 1963. \$6.50.

Reviewed by **J. Gillis**, *Weizman Institute of Science, Rehovoth, Israel.*

The development of high-speed computing machines has stimulated a growth of interest in linear algebra, and a large number of books on the subject have appeared in recent years. However, most of these have been addressed to the professional computer specialist or mathematician and are too detailed to be useful to chemists. In the circumstances there was room for a book like the present one which concentrates on a lucid and concise presentation of the topics most likely to occur in physico-chemical research.