is first illustrated by considering reversible processes in an ideal gas, and frequent use is made of S-T diagrams so that the reader comes off with a good feel for them. The second law and the internal energy $U(S,V)$ are then applied to discussions of enthalpy, free energies, the Clausius-Clapeyron equation, and the Joule-Thomson effect.

The second part of the book is on the statistical interpretation of entropy, that is, as $S = k \ln W$. This section starts with discussion of particles in discrete energy states, microscopic distributions, and the Boltzmann distribution. As examples, the temperature dependences of occupation numbers, energy, and specific heat of a simple system are carefully developed. One of the strong points of the book is that many worked illustrative examples of this kind are provided throughout, and Dugdale also constantly points up the connections among the statistical mechanical and thermodynamic quantities. This development is applied to solids, including a calculation of the specific heat of an Einstein solid, to classical gases, including a derivation of the Sackur-Tetrode equation and the equation of state, and finally, to properties of Bose-Einstein and Fermi-Dirac gases.

The third part of the book is a unique discussion of the third law and of entropy at low temperatures. It includes much lore which the author acquired as a student of Sir Francis Simon. There are instructive discussions of equilibrium thermodynamic properties and the role of entropy as absolute zero is approached. As examples, He^4 and the lambda point are discussed in terms of the entropy of a Bose gas, and the unusual melting curve of He^3 is explained in terms of the nuclear spin entropy. The roles of entropy and S-T diagrams in production of low temperatures are discussed in connection with cooling by evaporation, the cascade processes for cooling, the Linde process, the Simon expansion liquefier, and adiabatic demagnetization.

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Carcinogenic Agents

Carcinogenesis: A Broad Critique. Papers presented at the 20th Annual Symposium on Fundamental Cancer Research, Houston, Texas, 1966. Published for the University of Texas M. D. Anderson Hospital and Tumor Institute by Williams and Wilkins, Baltimore, 1967. xvi + 774 pp., illus. $16.

The organizers of the symposium which is reported in this volume successfully steered the middle course between attempting to cover the whole of the field of carcinogenesis superficially and applying such intense specialization as to limit the general appeal of the book. The result is a well-balanced and thought-provoking survey of some of the more important aspects of the subject. The emphasis is on the *agents* which bring about cancer in man or in experimental animals and how these agents interact one with another, or with the host, in the induction of tumors. Discussion of the epidemiology of human cancer and of the detailed biochemical mechanisms which are involved in carcinogenesis at the molecular level is limited.

One of the most important problems in the study of carcinogenesis is the relevance of experiments in animals to the human disease. The difficulties are clearly brought out by the articles on viruses, which occupy about half of the book. The ability to induce tumors by the inoculation of cell-free extracts of tissues or of the viral particles themselves into animals of defined genetic constitution has led to rapid progress in the experimental situation. In the human these direct techniques are not available, and despite the sophistication of modern immunological and electron microscopical techniques progress has been slow. Rabotti and, to a lesser extent, Huebner attempt to define a set of principles akin to Koch's postulates, which may be applicable to viral oncogenesis in man and animals; nevertheless, the most that Shubik in the concluding paper of the conference is prepared to admit is that "there is little evidence that any cancer in man is of viral origin. That this will eventually be contradicted, again I do not doubt."

The understanding of the development of mammary cancer in the mouse has not advanced conceptually to any significant extent in the 30 years since Bittner suggested that three factors—an inducing agent, a hormonal factor, and genetic constitution—were necessary. Nevertheless, considerable progress has been made in the detailed analysis of the system. Nandi presents evidence for two forms of the Bittner (mammary tumor) virus. The first is present in the milk and mammary tissues and has a relatively low degree of strain specificity, whereas the second, strain-specific, form is carried on the red blood cells and is not visible as a B particle under the electron microscope. There is another, qualitatively different, virus, which is able to induce mammary gland nodules. These nodules do not of themselves normally progress to cancer. Liebelt and Liebelt report a massive experiment in which various combinations of inducing agents, hormones, and different strains of mouse are compared. Their evidence supports previous work and strongly suggests that the chemical inducing agent, 3-methylcholanthrene, does not activate latent mammary tumor viruses in low-cancer strains of mice. In all of the excellent work on murine mammary tumors it is disappointing to discover no hint of how the information may be related to the disease in women.

Some chemical carcinogens appear to interact directly with the tissues, while others require metabolic activation. It is a pleasure to read the succinct account of the 20 or more years' work by the Millers on the mode of action of the aromatic amines and azo compounds. Their clear elucidation of some of the problems which remain is most valuable. The study of the nitrosamines by Magee and his co-workers has to a considerable extent complemented that on the aromatic amines because it has been concerned not so much with metabolic activation as with the combination of the carcinogens with the biologically important macromolecules. It is now necessary to design experiments to show the biochemical and biological significance of these carcinogen-macromolecule interactions.

The discovery of the aflatoxins has focused attention on the possible carcinogenic activity of other mold products. The relationships between chemical structure and carcinogenic activity which are emerging will be of considerable value in attempting to protect the human population against potential carcinogens, but the amount of reliance that can be placed on experiments which result in one or two local sarcomas following the injection of the test substance into six or fewer rats is open to question. The discovery during the past decade that the mold products as well as the nitrosamines are carcinogenic suggests that other equally potent

groups of carcinogens are waiting to be discovered and should give fresh impetus to the study of the variety of chemical carcinogens.

Most cancer research workers will wish to have access to this volume, for it contains up-to-date accounts of many important aspects of carcinogenesis, of which only a few have been mentioned in this review. It is well produced and free from errors.

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Geology of the Solar System

Mantles of the Earth and Terrestrial Planets. A NATO Advanced Study Institute, Newcastle upon Tyne, England, March–April 1966. S. K. RUNCORN, Ed. Interscience (Wiley), New York, 1967. xii + 584 pp., illus. $25.

This is an unusually good interdisciplinary book which contains the 50 papers (unfortunately a few of them only in abstract form) presented at a conference held two years ago at the University of Newcastle upon Tyne. The many fields discussed are progressing so rapidly today that one reads the book with a sense of history in the making, and occasionally with excitement.

Perhaps the best way to review the book is to summarize some of the conclusions of several authors whose papers seem of unusual interest. In the first of the nine sections the authors have concentrated on the early history of the solar system. Cooling rates of the parent bodies of the meteorites range from about 1° to 40°C every 10^6 years, indicating diameters of 60 to 200 kilometers for the slower-cooling objects and perhaps 30 to 60 kilometers for the faster.

The authors conclude that meteorites did result from the breaking up of several bodies of asteroidal size. Wilkins appears to have resolved a disturbing problem when he found that Phobos does not show the previously suggested acceleration which has led to so many weird interpretations. Bullen's paper on internal density distribution in the terrestrial planets is concise and valuable.

The section Physical Evidence for Non-Hydrostatic Conditions in the Planets is very important. Neither the earth nor the moon is in hydrostatic equilibrium. Anderle's paper, in particular, discusses the reduction of observations of satellites by worldwide networks of Baker-Nunn cameras and Doppler tracking stations, and he offers a geoid height map which demands interpretation. Runcorn and Gray, using new data from the Aeronautical Chart and Information Center, have confirmed earlier demonstrations that the moon does possess a bulge aligned with the earth. Runcorn's interpretation is that the moon possesses a convection pattern of the second degree.

In the last few years improved radar observations of the planets have been made, and one section covers this fascinating subject. Mercury has been shown to rotate in about 58.65 days and Venus to rotate in a retrograde fashion in about 247 ± 5 days. A very important detailed paper, "Theory of the axial rotations of Mercury and Venus," is presented by Bellomo, Colombo, and Shapiro.

Years ago H. N. Russell commented that the moon might be an optical illusion because no one could determine how it was formed. Section 6 contains six papers concerned with the problem of lunar origin. In general, the theories presented are not compatible, but they nevertheless are important because of the limiting conditions they give to the solution of this important problem.

Sections 8 and 9 are in many ways the heart of this volume. In them are papers which seem clearly to indicate that the continents have moved over the surface of the earth throughout geologic time and that the cause of such motions is convection in the mantle. Evidence has now been accumulated which points so strongly in this direction that most, though not all, scientists in these fields have accepted the basic model of a convecting mantle. Details of the model and the history of continental drift are still hotly debated, as the papers of Hospers and Creer show. Girdler's discussion of the world rift system and Coode's spherical harmonic analysis of major tectonic features tie in well with the convecting model.

It is clear from the papers in this volume that this is a very young field of study, and one in a period of flux. The importance of a conference such as this one is that it brings together in one place the accumulated knowledge of a field of investigation. The proceedings volume is a status report from which the specialist and nonspecialist may profit.

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Arctic Explorations

The Greenland Ice Cap. BØRGE FRISTRUP. Translated from the Danish edition (1963) by David Stoner. University of Washington Press, Seattle, 1967. 312 pp., illus. $20.

This is an informative, readable, and splendidly illustrated book on the world's second-largest and best-known ice sheet; it should do much to bring some of the mysteries and delights of Greenland to the notice of the layman. The English book is a slightly expanded version of that which appeared in Danish in 1963, and it incorporates some more recent material. After an introductory section which includes a description of Greenland and the character of its ice sheet, Fristrup devotes the greater part of the book to the history of exploration and research. There are chapters on five major periods of discovery, followed by about a hundred pages on expeditions and investigations since 1940. Considerable space is devoted to American research on the ice sheet, much of it prompted by strategic interests. The work of the International Glaciological Expedition is also described in some detail. The last part of the book is devoted to a systematic survey of the glaciology of the ice sheet, with chapters on its climate, thickness, age, and regimen. There is a comprehensive index, an adequate bibliography, and a useful chronological list of expeditions and major scientific discoveries on the ice sheet.

The text is always interesting and easy to follow, and Fristrup does not deviate from his topic for a moment. There are, however, several irritating pieces of repetition (some of them on the same page), and there is an occasional lack of balance in the treatment of individual expeditions in the first part of the book. The quality of the photographs cannot compare with those in Ernst Hofer's *Arctic Riviera,* but many of them (especially those in color) are very beautiful. They give an exciting insight into life and landscape on the Greenland ice sheet. The photographs are, however, too profuse; several of them would have been better omitted. For example, it is a pity that the fine color prints on pages 111 and 233 should have almost identical black-and-white equivalents on pages 226 and 290, respectively. Throughout the book there is an almost complete lack of coordination between text and illustrative material. This is most marked in the case of maps and diagrams. These are informative and well drawn, but their