

ordinarily sanguine, as the author occasionally avows, to expect that knowledge of structure, that is, three-dimensional conformation as distinct from chemical structure and bonding, could make more than a very limited contribution to understanding the operation of biologically interesting materials. The long and intensive x-ray studies of the three-dimensional structure of proteins are an example in point. On the other hand, by 1951 the key genetic material had been chemically identified as deoxyribonucleic acid, and many of the essential features of its structure had been surmised by the organic chemists (see page 53). The letters "DNA" were not just the label of some genetic "stuff," notwithstanding Watson's contempt for "boring chemical facts" and the "chemists who never provided anything incisive about the nucleic acids" (page 31). That the genetic material was a particular nucleic acid appears to be a pretty incisive fact! Moreover there was the strong clue in Erwin Chargaff's observations (1950) of the base-pairing ratios. What then was the significance of the great chase for the "structure," with the dominant recurrence of the helical theme, the heightened suspense of the far-away threat from Pauling (the pioneer of the helix) and the comings and goings between Cambridge and London?

Intuition? Perhaps; but it was hardly foreseen that the helical structure, per se, would be almost irrelevant, except insofar as it—or any other structure—could provide some clues and checks as regards the precise nature of the chemical structure and bonding? The earlier double-stranded models with the central sugar-phosphate backbone and Mg^{++} ion bonding (page 87), whether compatible with the helical structure or not, had no hint of the complimentary base pairing that was to be the outstanding feature of the Watson-Crick model. And the subsequent diversion into tobacco mosaic virus RNA (now known to be a single-stranded molecule!) clearly reveals the obsession with the helix itself (page 114).

The most direct impact of the x-ray studies appears to have come from the work of Wilkins and Rosalind Franklin with the newer B-conformation, which not only left little doubt about the helical structure (page 169), but much more specifically revealed that "... the meridional reflection at

3.4 Å was much stronger than any other reflection. This could only mean that the 3.4 Å-thick purine and pyrimidine bases were stacked up on top of each other in a direction perpendicular to the helical axis" (page 175). Since this juxtaposition of the purine and pyrimidine bases (about which the new B-pattern gave such a strong clue) is at the very heart of the essential feature of the Watson-Crick model, it is surprising to find, in the later letter to Delbrück, the x-ray information was treated rather slightly.

We are given the impression that this "homing-in" on the DNA "structure" was a goal-directed operation from the start. It's the old story of *post hoc ergo propter hoc*. This situation has been for a long time a troublesome matter for biologists: What some have seen in evolution to be a goal-oriented process, most regard as the result of random mutation and selection. But it is surprising to find a leading molecular biologist with such teleological propensities!

Scientific developments apart, there

are other singular features of *The Double Helix*. The description of the cozy atmosphere of English (in contrast to American) science and its implication of different shades of ethical behavior is convenient but hardly convincing. There is also throughout a curious duality—even a contrast—between the deliberate brashness of what is related and the intermittent urbanity of style. There is a candor that is at times difficult to equate with accuracy, and an ambiguity that makes it difficult to know whether an impression is being recalled or created.

A strong breeze certainly blows through these pages, but with it comes whiffs of insalubrity; and as the chase and the narrative race on, there is sometimes left behind the lingering scent of an obscure trail. Perhaps one should read *The Double Helix* as a thriller—which it certainly is—although there is no doubt about whodunit!

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Helium, the stuff of cryogenics

THE PROPERTIES OF LIQUID AND SOLID HELIUM. By John Wilks. 703 pp. Oxford U. Press, London, 1967. \$24.00

by Ralph P. Hudson

Helium, surely the most interesting of all the elements, has not been with us very long—although it is and has been familiar to the great majority of this planet's physical scientists, which is,

perhaps, more significant. Its existence has been known for 100 years, its identification on earth occurred 80 years ago, and its first liquefaction took place in 1908. It is, of course, in its condensed state that helium manifests its unique properties and, with superconducting metals, exhibits quantum behavior on a macroscopic scale. And through its agency all other matter

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may be brought readily into the temperature region of a degree or so above absolute zero, a fact that has led to a vast amount of solid-state and nuclear research, ingenious devices and the prospect of future discoveries of limitless scope between 4 K and absolute zero (as long as we humans conserve our helium resources—a proviso that requires eternal vigilance and that supplies much food for thought in the light of present US consumption, that is, loss, of one billion cubic feet per year).

Two decades ago, as the postwar proliferation of cryogenics laboratories got slowly under way, the specialist library in the subject ran to a mere handful of volumes. Of these, no other matched in size, scope and importance the famous monograph *Helium* of the late W. H. Keesom. For a long time thereafter the growth of the field far outpaced that of the hardback literatures, but in recent years a balance has been largely restored. One has had to wait for a new "Keesom"—until the appearance now of *The Properties of Liquid and Solid Helium* by John Wilks.

The author does not claim supplantation as his actual aim, but rather presents a survey of the properties of liquid and solid helium in light of modern knowledge, with the exercise of judicious selection of articles for detailed discussion, and concentration "principally on basic features that illustrate fundamental principles." The result is the same. With this massive (700 pages) and impressive book Wilks skillfully and essentially exhaustively covers the subject in its modern complexity up to 1965-66. The pace of current developments rules out the possibility of producing another "Keesom" in completeness and durability, but this new volume suffers nothing by comparison in terms of authority and educational value.

Major experimental findings are clearly described and supported most adequately with details of apparatus and techniques, graphs and schematic drawings. Wilks treats theoretical developments mostly in outline, with summaries of the main results obtained, to preserve clarity of exposition for the average reader and manageable bulk for the book. The original papers and major review articles are fully referenced, and one notes that contributions from Russian authors—which are numerous and important—are very thoroughly covered.



SMALL BAR MAGNET floating on its own magnetic field. The frosted lead dish beneath it has been made superconducting by immersion in liquid helium at 4 K; the field lines excluded from the superconducting material levitate the magnet. This photograph was made at the Lewis Research Center of NASA.

Wilks himself is a well known specialist in cryogenics research, particularly active in the study of transport processes in liquid and solid He^4 and liquid He^3 . The concerns of both careful experimentalist and experienced teacher emerge from these pages, and though the style is a trifle laconic the text is still very readable. Some economy of words was, in any case, highly necessary to restrict a thorough (up to 1965) coverage of He^4 and He^3 to some 450 and 150 pages, respectively. (There is also one chapter each on the subjects of dilute solutions of He^3 in liquid helium II and phonons in crystalline solids.) The latter treatment, of the light isotope of helium in liquid and solid forms, covers a field of research in existence but 20 years and hence un-

known to Keesom and pre-World War II researchers. Here some of the most fascinating studies are restricted to the region of very low temperatures, 0.001 to 0.01 K, and thus are still very much the private fief of a very few laboratories, paralleling the situation concerning liquid He^4 in the 1930's.

I believe that students and lecturers will find this volume indispensable and that the author has ample grounds for satisfaction with a splendid contribution to the literature of low-temperature physics.

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The reviewer, a former chief of the cryogenic-physics section, National Bureau of Standards, states that his review is as determinedly objective as his having been a student of the author can allow.

Applications of lasers

LASER SYSTEMS AND APPLICATIONS. By Herbert A. Eliot. 624 pp. Pergamon Press, Oxford, 1967. \$22.50

by David F. Hotz

Over the past eight years a very great investment has been made in the development of lasers. This investment has been so successful that its sponsors suffer from an embarrassment of riches. One realizes the magnitude of return when one remembers that ten years ago a coherent optical source was hopeful speculation and today such sources are available all over

the traditional optical spectrum ranging from the ultraviolet to the far-infrared region. A well known wit in the field has characterized the laser as a solution looking for a problem, a pithy statement that conveys both an appreciation for the potential of the laser and an impatience with the pace of application appropriate to the capabilities of the device. This state of affairs presages a shift of emphasis towards the peripheral apparatus and accessories capable of exploiting the unique properties of this new radiation source. This shift will very likely