Low Temperature Physics

The Helium Liquids. Proceedings of a NATO Advanced Study Institute, St. Andrews, Scotland, July 1974. JONATHAN G. M. ARMITAGE and IAN E. FARQUHAR, Eds. Academic Press, New York, 1975. xii, 512 pp., illus. $41.50.

Liquid ^{4}He becomes superfluid near 2°K. Its spectacular properties have been explored in hundreds of papers. Each time it appears that the subject is nearly exhausted, some new discovery stimulates new interest. In spite of all the activity in the field, there is still no really fundamental theory of ^{4}He standing on the same basis as the Bardeen-Cooper-Schrieffer theory of superconductivity. Five of the lectures in this summer school proceedings treat various aspects of ^{4}He, including a general introduction by G. V. Chester, which discusses both ^{3}He and ^{4}He, and lectures by G. Rickayzen on many-body theory of ^{4}He, by S. Putterman on quantum fluid hydrodynamics, by L. J. Campbell on film flow, and by A. Eggington on various aspects of superfluidity in restricted geometrics.

For many years after the introduction of the Bardeen-Cooper-Schrieffer theory, it was confidently expected that liquid ^{3}He would become a superfluid at a low enough temperature. Finally, superfluid ^{3}He was produced experimentally at Cornell, but at a temperature 1000 times lower than that which produces the transition in ^{4}He. And it is thought that the superfluid state of ^{3}He both is anisotropic and has a hydrodynamics in which spin degrees of freedom will appear. Developments have come so quickly in this field that readers will appreciate this effort to set the history of the subject in order and provide some perspective on the development of theory and experiment. The book includes lectures on ^{3}He by A. Ron, by J. C. Wheatley, and by P. W. Anderson and W. F. Brinkman. Anderson and Brinkman remark that, in spite of the simplicity of the ^{3}He and ^{4}He atoms, the condensed phases of these substances exhibit properties as complex as those of any inorganic system and "perhaps the most challenging intellectually and complex phenomenologically are the recently discovered anisotropic superfluid phases of ^{3}He." The experimental evidence for this statement is carefully summarized in Wheatley's lectures. As in all rapidly moving fields, there have been important developments since the lectures were written, but they stand as examples of fine reporting on a complex new subject.

The final lectures are on dilute solutions of ^{3}He in ^{4}He at low temperatures, by Gordon Baym, and on the Kapitza conductance, by L. J. Challis. These fields are relatively well established, and each of the lectures is a mature account of its subject with extensive references to the literature.

There are many volumes of proceedings of conferences in low temperature physics. I'll shelve this one with my other longtime favorites: the Fermi Summer School of 1961 (*Liquid Helium*, G. Careri, Ed., Academic Press, 1963) and the Sussex Quantum Fluids Conference (*Quantum Fluids*, D. F. Brewer, Ed., North-Holland, 1966). The book is not likely to appeal to beginners, but it should be of great value to anyone working in the field or wishing to learn the status of advanced research. It includes proper references and complete subject and author indexes.

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Plasmodesmata

Intercellular Communication in Plants. Studies on Plasmodesmata. Papers from a meeting, June 1975. B. E. S. GUNNING and A. W. ROBARDS, Eds. Springer-Verlag, New York, 1976. xvi, 390 pp., illus. $29.60.

Multicellular plants generally contain small intercellular channels, 30 to 50 nanometers in width, roughly circular in cross section, and frequently containing a central rod, so that bulk transport must occur through a cylindrical annulus. The entire structure is called a plasmodesma. The channels are thought to be filled with endoplasmic reticulum (desmotubules). Being virtually ubiquitous in multicellular plants, plasmodesmata have long presented obvious questions with regard to function. For example, how structured is a solution moving in a pore of such dimensions, and are the viscosity and wall effects appreciably different from those that occur in large structures? What of surface tension and surface solute concentration? Do plasmodesmata even permit bulk flow?

The intriguing aspect of the book under review is its even-handed approach to these questions. After a brief look at the hydrodynamics of model plasmodesmata, the properties of plasmodesmata in higher plants (frequency, dimensions and the difficulties in determining them, microstructures, and possible functions) are discussed in detail. Plasmodesmata in algae and fungi present a different problem. Not only are there a variety of intercellular connections other than plasmodesmata, but the mechanisms for photosynthate transport have evolved very little as compared with those in higher plants. (In the Pinaceae, where the absence of phloem fibers points to the importance of plasmodesmata for long-range photosynthate transport, intensive study has been initiated only relatively recently.) It is therefore understandable that studies of plasmodesmata in algae and fungi are still primarily descriptive (though there are distinct exceptions, as in the case of *Chara*). Indeed, the primary and secondary formation of plasmodesmata, their frequency, and their structural regulation are still important subjects of research in these phyla.

After the plasmodesmata have been thoroughly described both physically and phylogenetically, the question of transport as a major function is addressed. It has been shown that known rates of longer-distance transport are hydrodynamically possible in pores such as plasmodesmata. Electrical conductivity, fluorescent dye markers, and radioactive tracers are among the means used to assess plasmodesmatal transport. Ion fluxes in *Chara* nodes and root meristems provide vehicles for the study of symplastic movement requiring plasmodesmata. More recently, cytochemical probes of electron microscopic sections provide strong evidence of transport, especially of inorganic ions. It has long been known that viruses with dimensions larger than plasmodesmatal cross sections cannot cross midrib barriers in higher plants and are nevertheless transported to other parts of the plant through the phloem. The question is whether they are loaded onto and unloaded from the phloem through plasmodesmata. If they are, does it follow that the nucleic acid is the only actively transported viral solute?

The book ends on a challenging note; the present state of knowledge is viewed against the background of the past and in the light of unsolved problems. Do plasmodesmata compete with membranal transport processes (active transport, facilitated transport)? Are plasmodesmatal fluxes alone adequate for long-range transport in lower plants, and if so what is the driving force? Can movement in plasmodesmata be bidirectional? What of the plasmodesmatal annuli: how are they made and what is their function?

The text shows its origin in a conference. The chapters are reviews, though often with original data, followed by questions. The reviews, however, are of remarkably high quality, and the questions are pertinent and carefully answered. References are numerous and recent. The text is reproduced photograph-