lishments. Rather, I would argue that the best laboratories are those that are able to maintain a sense of urgent mission. A new laboratory generally has a sense of urgent mission. It becomes old only when its mission has become rusty and when its management has too little imagination or energy to redeploy and revitalize its mission. A laboratory might be old chronologically and its division leaders may be in their late 50's; yet if the laboratory is fired by a new and exciting mission, it is young in Sir Edwin's sense.

The question of missions is strongly involved in the relation between a research establishment and the governmental or industrial agency that supports it: and in every one of the essays attention is devoted to the relation between the laboratory and its supporting agency. In one respect, the point at issue finally is "Who runs the laboratory—the laboratory management or the staff of the agency that supports the laboratory?" I suspect that every one of the British research directors would answer unequivocally, the laboratory management, of course. American research directors, especially those involved in contract research for the government, would surely be less positive. For with the elaboration and strengthening of Washington staffs, the inevitable tension between laboratory management and headquarters staff as to how things should be done tends to become a dominant issue. Since the project office in Washington finally controls the funding of a project, what the laboratory director can do is always constrained by the project officer's power to provide funds or not to provide funds. The laboratory management must steer a somewhat precarious course that is influenced in substantial degree by the headquarters staff, with their ultimate fiscal power. Who finally prevails depends upon such intangibles as the management's prestige and competence, its skill in maneuvering, and the confidence the laboratory and its management enjoy at the highest levels of the agency for which the laboratory works.

To balance the inevitable growth of the scientific agency staffs American laboratories often establish intermediate hierarchies that serve as counterweights to the headquarters staff. This layer of administrators frees the working scientist of the necessity for sparring directly with the funding agency, and it gives the highest level of laboratory management the time and energy to occupy itself with the "main concerns of management"—establishing the laboratory's sense of mission, maintaining its scientific tone and excellence, and counteracting the inherent centrifugal forces that thwart the achievement of the mission. Actually I suspect that the British situation is not so very much simpler than is the American (though the UK has the advantage of being smaller, and the American contractor system accentuates the separation between laboratory management and headquarters staff). And from the one essay dealing with a defense establishment, RAE, I gathered that the relations between headquarters staff and laboratory staff must involve a good deal of the give-and-take that we Americans have come to take for granted.

Though the book is largely devoted to research performed outside the university, many of the authors speak of the connection between their institutions and the universities. The matter has acquired an urgency in recent years as the universities and the laboratories find that they are competing for the same funds. Adams, in describing the relation between CERN, the national laboratories, and the universities, urges a strong flow between these institutions, but urges that each must retain its identity and strength: "if . . . national and international laboratories took over the teaching functions of the universities, or if one of the three types of institutions is starved of resources, then the whole pyramid will crumble." By contrast, Sir Gordon Sutherland of NPL comments, "There is a great unused teaching potential in the National Physical Laboratory. . . . The NPL might even become the nucleus of a postgraduate technological university with associated research institutes." I suppose I find these two views curiously reversed: an institution such as CERN devoted to basic research could much more readily tolerate the university, discipline-oriented, and individualistic organization than could a mission-oriented institution such as NPL. Or does Sir Gordon visualize only the more basic parts of the National Physical Laboratory as forming the nucleus of his new technological university?

The essays in *The Organization of Research Establishments* are rewarding reading, especially to a research administrator who learns from these essays that his problems are not unique. They would perhaps have been more useful if the Research Directors had let their hair down more. But this is asking too much: there is a kind of etiquette that forbids a research director from admitting publicly that anything is going badly, or that his agency is behaving unreasonably.

Yet some of the essays, notably the ones by Fisk, Adams, Vick, and Lewis, I found to have an openness and sparkle that reflect well not only upon the research director who wrote the piece, but also upon the institution that he directs. Surely CERN must have prospered under a man who, in speaking of language difficulties, writes "The language problem resolved itself quite simply. It was soon discovered that an inability to express oneself forcibly in another language lowered the tensions normally experienced in a research laboratory. In any case, the real difficulty lies not in understanding what somebody else is saying, but in forgiving him for saying it, and this has little to do with language difference." The author of this gem is J. B. Adams, who now heads the fusion laboratory at Culham. Does anyone want to make book on how the British will do in the thermonuclear sweepstakes?

Philosophy and physics

CONCEPTIONS DE LA PHYSIQUE CONTEMPORAINE. Les interprétations de la mécanique quantique et de la mesure. By Bernard d'Espagnat. 154 pp. Hermann, Paris, 1965. 24F.

by R. B. Lindsay

It is generally taken for granted that in order to pursue successfully the

trade of a physicist, that is, to participate actively in the program of describing, creating and understanding human experience, it is unnecessary to hold any particular professional philosophical view. Thus to be successful the physicist need not believe in the existence of a "real" world as the basis of experience, nor is he forced on the other hand to subscribe to the notion that, because many abstract theories have worked remarkably well, our experience is really only a figment of our imagination. So one might be tempted to conclude that philosophy has nothing to do with physics. Actually this ignores the persistent desire to provide an interpretation of modern physical theories which is not content with their role as mere tools for predicting experience but insists that the concepts of these theories shall be related somehow to the great ideas of space, time, number, probability, causality and the like which have long served the human mind in its search for meaning in human experience. The greatest physicists of our time have felt this desire, and the writings of men like Planck, Einstein, Bohr, De Broglie, Schrödinger and Heisenberg reflect their attempts to satisfy it.

The author of the book under review, the well-known professor of theoretical physics at the University of Paris, has felt himself impelled to study once more the meaning to be attributed to the concepts of the quantum theory. The result is a volume which, though perhaps unduly verbose, is worthy of considerable attention.

After an introduction justifying his concern over the whole problem and a very brief resumé of the fundamental principles of quantum mechanics, the author proceeds to divide his book into two main parts, devoted respectively to what he calls the realistic interpretation on the one hand and the positivistic or empiricist on the other. By the realistic point of view he means the assumption that on the microscopic level, systems can exist and have well-defined properties wholly independent of any observer or measuring instrument. On this view the "knowledge" of the observer has nothing to do with the existence of the system and its behavior. The author then endeavors to show how quantum mechanics can be interpreted in terms of the realistic hypothesis. There is a fair amount of detailed analysis presented in the Dirac notation. This includes an analysis of the Einstein, Podolsky and Rosen paradox and the problem of measurement. The difficulties are found to be great and the conclusions are negative. The next step is to investigate macroscopic systems under what the author calls the unirealistic hypothesis, which he expresses in the form that everything that exists in the world is purely physical in nature and obeys the principles of quantum mechanics. This view also is found to be untenable.

The second part of the book is devoted to an exposition of what the author calls the positivistic or empiricist point of view. To him the positivist or empiricist in physics (and he treats the terms as essentially synonymous) is one who believes that the only legitimate aims of the science are to provide an accurate and economical description of actual observations and to construct a formalism which permits the prediction of new observations on the basis of those already made. Probably few physicists would quarrel with this. Indeed, if by "constructing a formalism" means to invent a theory with full play allowed to the human imagination, this statement just made would fit practically all theoretical physicists and indeed a great many who do not think of themselves as at all positivists or empiricists in what they believe to be the professional philosophical meaning. Terminology can be deceptive. The interested person should read Professor d'Espagnat's book to see how ingeniously he develops his critique. In this part of the volume there is an interesting discussion of the views of Niels Bohr and other adherents of the Copenhagen school as well as the objections raised by Einstein, Wigner and others.

The book concludes with a mélange of observations on the relevance of ancient Greek philosophy for modern physics, including numerous references to Plato and Pythagoras. The author sums up by expressing his belief that the great contribution of modern physics to science is its defiance of dogmatism and its insistence on the freedom to invent new ideas to meet new experience.

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R. Bruce Lindsay, who is dean of the graduate school at Brown University, has been interested in relations between physics and philosophy for many years.

Compositions of diamond-like substances

THE CHEMISTRY OF DIAMOND-LIKE SEMICONDUCTORS. By N. A. Goryunova. J. C. Anderson, ed. 244 pp. MIT Press, Cambridge, Mass., 1965. $10.00.

by Lars C. Luther

The author of this monograph is a member of the Leningrad Physico-Technical Institute. She and her coworkers have published numerous articles since 1950 reporting on experimental work in the semiconductor field with special emphasis on multicomponent solid solutions. The present text, whose original Russian version appeared in Leningrad in 1963, is based in part on lectures given in the Chemistry Department of Leningrad University in 1958-1961.

The book is divided into three chapters. An introduction dealing with theoretical aspects is followed by a small encyclopedia with a large bias. In the encyclopedic articles on each of the Group IV elements and the III-V compounds, a considerable amount of detail is summarized (physical appearance and constants, methods of preparation, etches, etc.) However, arriving at the II-VI and I-VII compounds, the discussion becomes very cursory. Throughout these articles the author's interest is reflected in a prominence of phase diagrams. A review article on solid solutions between III-V, II-VI and I-VII compounds completes the middle section. The final chapter contains an interesting qualitative discussion of the variation of properties within groups and periods.

In the theoretical introduction some of the author's original work is presented. Most important is her discus-