book reviews

De Broglie's philosophy

Louis de Broglie: Sa conception du monde physique, By A. George, et al. Pp. xxviii+387. (Gauthier — Villars: Paris, 1973.)

LOUIS DE BROGLIE'S 80th birthday (August 15, 1972) came close enough to the 50th anniversary of his three famous notes to *Comptes Rendus* (September–October 1923) and the publication of his doctoral thesis (November 25, 1924) to warrant a double celebration. This collection of articles by his close colleagues, old and young, describes both his long career as a teacher and leader of research and the contributions that he and his pupils have made to "the past and the future of wave mechanics". Handsomely produced, elegantly phrased, and well integrated despite more than twenty different authors, it will prove a valuable source for biographers and for historians of science.

The accuracy of the personal picture cannot be easily estimated in a work of this kind, whose whole emphasis is naturally on the positive and virtuous—the guide, philosopher and friend, the lucid and eloquent teacher, the imaginative scientific intellect, still enthusiastic in old age, still able to state, more clearly than his pupils, the essential stages in his own scientific development and his own analysis of current problems. No man is perfect; but we do well to admire these qualities of greatness.

But the scientific work, being in the public domain, must be appraised more judiciously. Its standing depends not on the fact that it was done by M. de Broglie, but that it conforms to reality and is accepted by other competent scientific experts. This is the harsh law of science which defers not to prince, professor or poet.

Of the thesis of 1924 there can only be the highest praise. The very idea of 'matter waves' is the most revolutionary innovation in the philosophy of nature since the ancient Greeks. This significant step in modern physics was no mere stumble into the unknown, but a tremendous leap, gracefully poised on the classical principles of Fermat and Maupertuis but vaulting beyond Einstein's conjecture on the particulate nature of radiation. The first half of this book deals with the theoretical background of this brilliant paper, and on some of its modern

consequences, in electron microscopy, and so on.

So profound, indeed, was the revolution of thought that the revolutionary has spent the rest of his life trying to resist the further, yet more radical, statistical interpretation of the wave function. The papers in the second half of this volume record the considerable efforts of de Broglie and his school to reconcile waves with particles in a more deterministic scheme. Since this work is largely ignored by other theoretical physicists, one must ask why it has not found wide acceptance.

Nobody who has seriously grappled with (let alone had to teach!) the modern paradigm of quantum theory can feel completely satisfied with its present form. The essential localisation of the particle event is not intuitively consistent with the equally certain evidence of interference between extended wave fields. The fantastically precise discreteness of the rest mass and charge of an electron is a fact of nature that is difficult to swallow philosophically. The operator formalism of Heisenberg and Dirac seems to answer all the practical questions but leaves hollow the interior reality. The extraordinary paradox of a physical quantity that seems to depend upon the state of mind of the physicist is not to be shrugged off without comment.

There is, of course, a vast literature on these problems, to which the de Broglie school make almost no reference. Their theme is the ultimate 'reality' (potentially unequivocal observability?) of wave fields, of which the particles are singularities and by which they are guided. In his work of the 1930s, de Broglie concentrated on a theory of photons, which were assigned a very small rest mass to make them localisable. In the 1950s, he developed the 'double solution' for the particle singularity and its guiding wave, explaining the statistical phenomena of particle physics as manifestations of a hidden thermodynamic ensemble. Are these models of submicroscopic physics convincing, or worthy of further sustained effort?

Despite many elegant results, the physical systems to which they are applied are very simple (for example a few nearly free electrons) and no new phenomena are predicted for experimental verification. Indeed, it is taken

for granted (although with rather meagre proof) that the whole scheme must be capable of reproducing the results obtained by conventional methods for almost all atomic, nuclear and high energy systems. The de Broglie model is scarcely falsifiable, since it is presented as an alternative 'explanation' of quantum physics at the deepest level, incorporating automatically all existing theoretical achievements such as quantum electrodynamics, many body theory, and broken symmetry schemes.

The necessity for such an explanatory scheme thus rests on metaphysical rather than on physical considerations. The practical physicist may continue to solve all his problems by the conventional operator formalism, and need not learn the more complicated mathematical techniques of non-linear field theory. Until experiment, or some astonishing theoretical coup, demonstrates the practical superiority of the de Broglie interpretation, we can safely ignore it.

Does that explain, or justify, the neglect of this work by almost all orthodox physicists? It would be more honest to say that despite all the mathematical effort that has been lavished on it, the whole project rests upon too narrow a foundation of hypothesis and technique. The natural phenomena are richer (for example neutrinos, muons, pions, strong and weak forces) and our mathematical resources more diverse (finite and continuous groups, topology, tensor calculus and so on) than this book seems to imagine. For aesthetic reasons, and in modest deference to the unknown knowledge of future men, we do well to doubt that physics is conceivable only in the manner inherited from Newton, Laplace and Einstein. I would rather live uncomfortably with the paradoxes of quantum physics, hoping that some day they will be resolved, than accept, for the sake of peace of mind, a well meant but essentially backward looking scheme which promises more than it has yet achieved.

JOHN ZIMAN

Fine structure of algae

The Fine Structure of Algal Cells. By John D. Dodge. Pp. xii+261. (Academic: London and New York, 1973.) £6.

THIS book is well produced and many of the illustrations will doubtless be