cloth. In science, on the other hand, the measurement is primary, and there may or may not be a "thing" which is measured. What thing lies behind the altitude of the First Point of Aries? The spectroscopist measures λ, and afterwards chooses whether to call it the length of a wave or the reciprocal of the momentum of a particle: he does not first observe the wave or particle and then measure one of its properties. It follows that a true fundamental account of measurement must not presuppose a metaphysical something of which the measurement ascertains the magnitude.

Mr. Ellis's account is based on the presupposition that every measurement is the measurement of a "quantity" possessed by a "thing". He has then to define "quantity", and his "final position" is that it depends on "the existence of a set of linear ordering relationships"; he leaves it to others to decide which quantities are entitled to be given names. On this definition probability, for example, is a quantity, and it is discussed at length. It is scarcely too much to say that all the problems dealt with are created by the unnecessary introduction of quantities, and the acuteness of the analysis does not compensate for its superfluity.

Nor are quantities merely superfluous; their introduction as entities prior to their measurement (there is, of course, no reason to forgo the convenience of using such terms as wave-length for descriptive purposes) is a fundamental error, for it misrepresents empirical discoveries as logical necessities. Thus, the agreement between measurements of distance by laying rods end to end and by triangulation follows inevitably on the "quantity" assumption, for they are measurements of the same thing. When there is reason to think that it breaks down over long distances, all we can do is to try to discover which method is "right". But if we regard both as valid but different measurements the results of which are approximately equal, their disagreement over long distances reveals an important fact about the universe. Whether it is best described as the curvature of space or the non-rectilinear propagation of light or what not can then be discussed, but in any case it is a discovery about the universe which the presupposition of quantities would have made impossible.

HERBERT DINGLE

HIGH-ENERGY NUCLEAR PHYSICS

High Energy Nuclear Reactions

By A. B. Clegg. (Oxford Library of the Physical Sciences.) Pp. vi+130. (Oxford: Clarendon Press; London: Oxford University Press, 1965.) 18*s*. net.

NUCLEAR reactions induced by low-energy nucleons are usually complicated processes, but at higher energies in the region above 100 MeV and for light target nuclei a great simplification is possible in certain types of reactions. This book is especially concerned with reactions induced by protons and neutrons in the energy region between 100 and 400 MeV, in which a simple change is made in the target nucleus. In this case it is possible to understand the reaction mechanisms in some detail and in some instances also to obtain information about the structure of the nuclei involved.

In the first chapter it is pointed out that at these energies the incident nucleon frequently interacts with only one nucleon at a time, and in subsequent chapters the reactions considered are those in which only one collision with a nucleon changes the state of the nucleus. In the next chapter the reasons why this type of reaction is likely to occur are discussed and the matrix elements involved are related to the nucleon–nucleon scattering amplitudes. Distortion effects on the incident and outgoing waves are next considered and the quasi-classical approximation introduced. The third chapter is concerned with the experimental features of the investigation of high-energy nuclear reactions and contains a brief discussion of the measurement of particle energies, the measurement of γ-ray energies from the decay of excited states and polarization phenomena in nuclear reactions.

Chapter 4 discusses the elastic scattering of nucleons by nuclei. Here the treatment in some places is brief and not complete because several other books have recently been published on the theoretical analysis of elastic scattering data using the optical model. Dr. Clegg instead concentrates on the relationship to the nucleon–nucleon scattering amplitudes, and an extensive comparison is made between the theoretical calculations and the available experimental data. The contributions from spin-flip and isotopic spin-flip processes are considered in some detail.

Chapter 5, which is by far the longest in the book, is concerned with inelastic scattering. Using the plane-wave approximation the contribution from spin flip effects are considered together with the information which can be obtained from the angular distribution of γ rays from the excited nucleus. Distorted wave calculations are then introduced and the effects due to a spin-dependent distorting potential are found to be small. These calculations are then compared with the experimental measurements of the polarization and angular distributions and where possible related to the nucleon–nucleon scattering amplitudes. Other excitation mechanisms which might contribute to inelastic scattering reactions and how they can be related to single nucleon excitation are then considered.

Nucleon knockout reactions in which the incident nucleon collides with a nucleon in the nucleus with the result that both nucleons leave the otherwise undisturbed nucleus are dealt with in the next chapter. After a brief discussion of (p,d) reactions, $(p,2p)$ reactions are considered in great detail, especially the interpretation of the results in terms of the shell model. In the final chapter reactions in which a cluster of nucleons are ejected from the target together with a nucleon are discussed. Although a comparison with experimental results is difficult because of the lack of data there is an extensive discussion of the relationship between the cluster model and the shell model and it is shown that in many cases the predictions of these two models are very similar.

This book can be strongly recommended. The reactions are considered from a theoretical point of view, but the results are extensively compared with the experimental data. The underlying physics of the nuclear model or nuclear reaction is kept continually in mind and the calculations made using simple models so that the physical principles are not obscured by mathematical or computational complexities. The book is likely to be of considerable interest to the nuclear physicist studying nuclear reactions at lower energies and to the physicist working with nucleons in the 100 to 400 MeV energy region. It is particularly valuable at a time when there is considerable interest in the use of high-energy particles to study nuclear structure.

C. J. BATTY

ERDTMAN'S PALYNOLOGY

Pollen and Spore Morphology/Plant Taxonomy—Gymnospermae, Bryophyta (Text)

By G. Erdtman. (An Introduction to Palynology, III.) Pp. 191+24 plates. (Stockholm: Almqvist and Wiksell, 1965.) 88 Sw. kr.

Pollen and Spore Morphology/Plant Taxonomy is the most recent volume of Prof. Erdtman's impressive series of contributions to the studies of spores and pollen of living plants. The rather disconcerting companionship of Bryophytes and Gymnosperms in the one volume is a reminder that palynology is still suffering the pains of over-rapid growth. The series (*An Introduction to Palynology*)