our information concerning him is not worse than most of the doxography pertaining to the presocratics. The rationalistic character of Sanchuniathon's views is very striking indeed, as well as the analogy with those of the Milesian Anaximenes. It therefore seems that we may risk going one more step back towards the origin of rationalism in that commercial civilisation which preceded the Ionian one. It would be wrong, however, to suggest that the Ionians just took over Phenician views. The transmission of philosophical and scientific ideas is never a mere imitation. Even though the general trends may remain essentially the same, the details of the picture must be worked out anew under the influence of ever-changing circumstances.

Looking back on the whole evolution we have endeavoured to reconstruct, we see rationalism at a nascent stage among the Phenicians, revived and developed by the presocratic philosophers, and reaching its acme with Demokritos. The opening-up of the Orient enabled the Greeks to rediscover the Phenician origins of their thinking. Phenician books were actively translated and the ideas they contained were one of the sources of inspiration of the utopists. Together with these, the Epicurean school prolonged the rationalistic tradition, and fought a losing fight for it until the very end of the ancient world.

Action at a Distance

ABSTRACT of Paper read by Dr. MARY HESSE at the meeting of the Northern Branch held at Leeds University on 13th March, 1954.

A distinction can be made between two sorts of statement in physical science: *observation statements* which are directly testable by measurement, and those which are not so testable, which may be called *non-observational.* Statements about the way in which action is communicated between bodies are usually non-observational, and if one considers a statement such as "Action is communicated between the fundamental particles of matter by their mutual impacts", one can suggest four possible answers to the question of what is the logical status of this statement in physics:

(i) The realist view that it is a straightforward description of empirical fact.

(ii) The view that it is meaningless because it is non-observational. This is hardly held seriously by anyone, because it would reject as meaningless most of the statements of theoretical physics.

(iii) The formalist view that it can only be given meaning by interpreting it into a mathematical calculus from which observation statements can be deduced.

(iv) The view that it is an analogical description which shows what model from macroscopic experience is being used to describe small-scale phenomena.

To determine the logical status of a scientific statement one must examine the way in which it is used in its scientific context, and in the case of action at a distance, it is necessary to examine the history of the concept.

From the seventeenth century to the advent of modern physics three types of fundamental actions were recognised, each exemplified by models drawn from familiar experience, and each describable by a definite mathematical calculus. The three types are action by impact, action in a continuous medium,

and action at a distance. The progress of physics can be described in terms of attempts to extend the application of each model to new fields, and at the same time to reduce two of the models to the remaining one, depending on the view which was taken at various times of the ultimate nature of matter. In the controversy over Newton's theory of gravitational attraction the realist view of statements about action was assumed on both sides, and this view was maintained until it was made untenable by developments in the nineteenth century. The influence of Faraday and Maxwell in particular then led to a reinterpretation of the terms of the original controversy of action at a distance versus continuous action, so that physicists no longer tried to discuss the actions of the fundamental particles in literal mechanical terms. The field theories of electromagnetism, deriving from mathematical analogies with fluid flow in a continuous medium, came to be regarded as the new type of continuous action theory, even though it became meaningless to speak of mechanical events going on in the intervening medium. At the end of the century all cases of apparent action at a distance, except gravitation, were included in a field theory which assigned a mathematical structure to space and described events going on in space in terms of the flow of mathematically defined quantities such as tubes of force and energy.

Thus even in the nineteenth century concepts like " action ", " contact ", " particle ", ceased to be used literally in their Newtonian sense, but they did not disappear from the literature of physics as the formalist view would suggest; their function was to point to analogies between diverse types of phenomena and to indicate what models taken from familiar experience were being used to describe the unfamiliar. If one pursued the analysis into modern physics one would find still other conceptions of the transmission of action which cannot easily be fitted into any of the categories of action here discussed, and the interesting question becomes, not whether action in modern physics is at a distance or continuous, but what are the various models and types of mathematical description which are found to be appropriate.

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