distinct until heritable differences have been definitely demonstrated.

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PHILOSOPHY OF PHYSICS

PROFESSOR HOUSTON'S recent article[1] on the philosophy of physics discusses the significance of quantum mechanics for the philosophical problem of the existence of the external world. I believe that physical theory is neutral toward this problem, and in the following I restate a theory[2] of the relation between perception and the physical world, which provides an adequate basis for science but does not commit one to a specific philosophy.

The primary factor in science is perception. Perceptions are found to be correlated. A perception which belongs to a correlated set of actual and possible perceptions is interpreted to be a perception of some physical body. A theory of physical bodies may now be expressed by two principles. The first principle is that a physical body is a center of reference of correlated perceptions. That physical bodies exist is confirmed by the discovery of functional relations between perceptions. The second principle is that the structure of perceptions indicates the structure of bodies. Its precise version in physics is that the coincidence of perceptions for all observers signifies the space-time coincidence of the events perceived. For mathematical exactness an event must be thought of as a space-time point.

The neutrality of the preceding formulation may be exhibited by giving two philosophical interpretations, dualistic realism and phenomenalism. In traditional dualism a physical body is absolutely independent of experience; it produces perceptions by acting on the observer. The structure of bodies is indicated in perceptions because the structure of an effect corresponds to that of the cause. In dualism the physical world is the object of a constructive hypothesis. The phenomenalistic interpretation is that a physical body is a conceptual parameter which serves to correlate perceptions; thus the physical world is the object of a constructive definition. Perception exhibits the structure of physical bodies in virtue of the mode of construction of the latter.

The issue between dualism and phenomenalism is not affected by the quantum mechanical theory of measurement. In this theory measuring instruments, such as a screen with a slit, are macrophysical bodies which are experienced in perception by classical methods. The properties of microphysical entities are determined from their effects upon the measuring instruments. In these determinations principles, such as those of conservation of momentum and energy, are employed to infer the properties of a microphysical entity. Now, the functional relations expressed by physical principles are to be viewed as constituents of physical reality. Hence the microphysical entity has the same kind of physical reality as the measuring instruments. If the latter are conceptual constructs to which possible perceptions are referred, so are the microphysical entities which interact with them. If the measuring instruments are independent realities in the dualistic sense, so are electrons and photons. The choice between these philosophical interpretations falls outside of physics. Indeed, some positivists hold that since the issue can not be decided by experience it is meaningless.

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[1] SCIENCE, n. s., 85: 413, 1937.
[2] *Nature*, 136: 433, 1935.

FURTHER DISCUSSION ON SUBMERGED CANYONS

IN the April 3, 1936, issue of SCIENCE, MacClintock and the writer advanced a hypothesis that the submerged canyons off the coasts of all continents might be the result of a change in ellipticity of sea-level. F. P. Shepard[1] criticized this hypothesis, claiming to show that it was untenable because a zero line of no change of sea-level should exist at 35° N. and 35° S. latitude. Therefore the hypothesis could not explain valleys at higher altitudes than 35°.

Shepard's reasoning contains a fallacy. Two ellipses of the same area would intersect at 35°, but the two sea-level surfaces such as we suggested would not do so. The reason for this is that there is not enough water between 35° N. and 35° S. latitude to fill the volume up to the new spheroid above 35°; therefore the new sea-level surface would be parallel to the new spheroid but considerably below it. Thus the zero line of no change of sea level might lie at 55° or 60°, as we postulated.

The writer also wishes to take exception to Shepard's statement concerning the accuracy of soundings taken by the S 48. The writer was on the S 48 when these soundings were taken, and believes the accuracy was quite sufficient for the conclusions drawn.

The writer is not at all convinced that the change in ellipticity of sea-level hypothesis is the correct explanation for the origin of the submerged valleys, but he does still consider it a *working hypothesis,* even though it may be an "outrageous" one. If a solution is to be arrived at for this complex problem, all possible hypotheses must be kept in mind and the critical data bearing on all of them collected.

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[1] SCIENCE, June 26, 1936.