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THE PROBLEM OF MOTION

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Among those who accept and defend the historic position of Protestantism, interest has recently increased in the philosophy of science. This interest does not arise merely or even mainly from the implications of biological evolution, but rather in part springs from a broader concern with philosophy as a whole and in part from the presence and activity of the scientists among us. The importance of formulating a philosophy of science, whether by Christian thinkers or by secular thinkers, needs no emphasis. What is needed, is, rather, a warning of the difficulties and dangers that attend the attempt. One of these dangers is seen in the frequent neglect of a most basic problem. And the aim of this paper is to bring to the fore the general problem of motion.

The main proposition, the justice of which this paper hopes to support, is that no philosophy of science can be acceptable unless it satisfactorily disposes of the problem of motion.

Although the ancients gave serious thought to this matter, recent philosophy has unfortunately made little progress in explaining motion and modern science has made none at all. On this subject the scientists seem satisfied with a famous statement of Sir Isaac Newton. Near the beginning of his *Principia*, in the Scholium after Definition VIII, he says, “I do not define time, space, place, and motion, as being well known to all.” Now, Sir Isaac Newton was a scientific genius of first order, and therefore he is entitled to make a blunder of first order without diminishing his fame. Such a blunder was this assertion, for time, space, and motion are by no means well known to anybody. Recent physics has to some extent seen the need of examining the meaning of time and space; but if any uneasiness about motion has been felt, it is at least safe to say that no explanation has been achieved. The situation today remains about the same as antiquity left it. That situation was a stalemate. The Eleatic arguments against the possibility of motion still oppose the Aristotelian explanation of motion. Since the latter is not too convincing, the Eleatic arguments are dismissed as poor jokes that scientists ought not to bother with. To forget is to solve.

The original joke was Zeno’s paradox of Achilles and the tortoise. In that notable race, when Achilles had once allowed his competitor a head start, it slowly dawned on him that he could never overtake the tortoise. Two thousand years have passed since Zeno first told this story, and still no refutation of it commands universal assent. The replies are superficial. One calculates how far Achilles could run in ten or thirty minutes and places him far ahead of the tortoise. Another balances the infinite divisibility of space against the infinite divisibility of time. Aristotle (Physics VIII) addressing himself to the simpler form of the paradox, that of a single body exhausting an infinite series of points as it moved toward a fixed terminus, argued that the moving body does not actually pass through an infinite series of points. Zeno, says Aristotle, treats one point, the midpoint, as two. He takes it as both the end and the beginning of a motion. But this can be so only if the moving body stops at this point and then begins again. If the body is in continuous motion, none of these mid-points is “actualized.” The points and the divisions are only potential and do not actually exist. Therefore although it is impossible to pass through or exhaust an infinite number of actual points, there is no difficulty in passing through an infinite number of potential points.

There is another attempt to answer Zeno. One may protest since an infinite series does not have a last term, Zeno cannot require the moving body to reach the last term before it starts to move. He cannot erect as a barrier to motion a factor that admittedly does not exist. And yet, did Zeno say that it was necessary to reach the last term? Will not his paradox remain if he simply asserts that motion can not begin so long as there are more terms in the series. And this is long enough.

Well, perhaps a slightly different expedient will allow the body to move. Let us grant that in any finite space an infinite number of points actually exist. Let us also grant that to move from here to there a body must pass through *all* of these points. But let us deny that the body must pass through *each* of these points. That is, we claim, Zeno confused a *collective* all with a *distributive* each. He supposed, mistakenly, that whatever is true of one must be true of the other. Yet there are many examples where the collective all has qualities quite different from the distributive each. Each nail in this keg is easy to pick up; but it is difficult to pick up all of them. Similarly what is true in every case is not necessarily true in general. Aristotle argues that although a theorem be proved for each of the three types of triangle, it has not on that account been proved a triangle generally. Or, finally, each element of a compound may be poisonous (NaCl), but the whole may be good to eat. Zeno therefore was mistaken because he insisted that a moving body must pass every point, when as a matter of fact it need only pass all of them.

Perhaps this last solution is not so suspicious as the previous ones were. But even so, it would only remove an Elaetic objection to motion: it would not furnish a theory, a definition, an explanation of motion. And this last is what is needed. Professional, practicing scientists like Newton may no doubt be excused if they refuse to tell us what motion is; but a philosophy of science cannot decide to bury a problem simply because it has remained so long unsolved. And if motion is basic to all science, one wonders how any natural phenomenon can be explained before this. We cannot, then, dodge the question, What is motion?

In the *Physics*, Book III, Aristotle begins a determined attack on the problem of motion. He spares no effort to arrive at a solution. And effort is required, for the explanation of motion must make use of the concepts of continuity, infinity, place, time, and perhaps void. This is a constant trouble with philosophic subjects. One hardly begins a topic before one discovers that another matter calls for prior attention. We are always being pushed back or forward, until it seems impossible to solve any one problem without solving all. Omniscience is the prerequisite, and omniscience is hard to come by. But Aristotle makes a brave beginning. The Pre-Socratics had failed to unravel the enigma of motion, chiefly because they did not know what motion is. Their halting hints were faulty as definitions. Within this section (*Physics* III, 1) Aristotle formulates the definition of motion three times. First, he says that motion is the actualization – literally, he says the actuality – of the potential *qua* potential. This cryptic phrase is then explained. When that which is buildable, insofar as it is buildable, is actual, it is being built; and this is the motion or change called building. Note that the completed house is not buildable; it is built, and the motion is completed. Nor is the actuality of brick and wood motion: insofar as the materials as such are concerned, the motion has not yet begun. This motion therefore is the actualization of the buildable *qua* buildable.

Aristotle must insist on the importance of the *insofar as*, the *qua*, the *as such*. Bronze is potentially a statue; but the actuality of bronze *qua* bronze is neither a statue nor motion. To be bronze and to be movable do not mean the same thing. Or, again, to be potentially healthy is not the same as to be potentially sick; for, if it were, to be actually healthy would be to be actually sick. Of course the same person may be sick or well; but the potentialities are different. Motion thus is the actualization of the potential *qua* potential.

The second time Aristotle formulates the definition he says, “Motion is the actuality of a potential being when it operates in actuality not insofar as it is itself, but insofar as it is movable.” The third formulation, a few lines below, is essentially a repetition of the first. Now, the second of these three formulations is clearly untenable: it is obviously circular. To define motion as the actuality of the moveable is to use the concept of motion in its own definition. How could one know what *moveable* means, i.e., able to move, unless one first understood motion? This circularity is present also in the example given under the first formulation. What *buildable* means cannot be known until the motions of building are understood. Either then Aristotle has made a circular blunder, or the first and third formulations must somehow escape this criticism. It is not at all certain that the second formulation is a mere slip of the pen which is excusable in the light of the other two. In *Physics* VIII, 1 (251 a 8), a passage presumably referring to *Physics* III 1, Aristotle again defines motion as the actuality of the moveable *qua* moveable. Similarly, a few pages later (257 b 8) he says "Motion is the incomplete actuality of the moveable." It would seem therefore that the taint of circularity is more than merely superficial.

However, Aristotle should be given every opportunity to rebut this charge before a final judgment is entered. Since he furnished two other formulations, these also should be examined. And it must be admitted, they contain at least no apparent circularity. Motion is the actualization of the potential *qua* potential. It is requisite, however, to state what is meant by the term potentia.l In fact, two requirements must be met. First, the term potential must be defined without using the idea of motion, or else the circularity will reappear; and, second, the idea of potentiality must be set forth clearly and unambiguously, or else all physics will remain vague and confused. The clarification of the concept of potentiality is found more in the *Metaphysics* than in these discussions on motion. In Book Delta he says, "Potentiality is a source of motion and change which is in another thing than the thing moved, or in the same thing qua other . . . Potentiality then means the source of change or motion . . ." It would seem, however, that this is not altogether satisfactory. In the *Physics* Aristotle defined motion in terms of potentiality, and now in the *Metaphysics* he is defining potentiality in terms of motion. Circularity therefore has not been avoided, and we still do not know what motion is.

There is, however, another passage. In Book Theta of the *Metaphysics* (1048 a 30-b 6) Aristotle defines actuality. "Actuality means the existence of an object, but not in the manner we call potentiality. We say, for instance, that a statue of Hermes is potentially in the block of wood . . . because it can be cut out of it. We call a man a scholar even when he is not studying, if he is actually capable of studying . . . We must not seek a definition of everything, but be content to grasp an analogy: that as he who is building is to him who can build, and as he who sees is to him who, though not blind, has his eyes shut . . . so actuality is defined by one member of these antitheses and potentiality by the other." Even in this more extended passage it is a question whether circularity has been avoided. Cutting the statue out of wood, studying, and seeing are motions; and thus potentiality and actuality are explained on the basis of motion. Motion, then, cannot properly be defined in terms of potentiality.

But, says Aristotle, this is not a definition. Potentiality cannot be defined. It must be grasped by analogy. As he who is asleep is to him who is awake, so potentiality is to actuality. Now, the man who is asleep is horizontal and the man who is awake is vertical. Is this what Aristotle means? Of course not. But it is hard to tell what he means, for there are many comparisons that can be made between men asleep and men awake. The former dream, the latter do not. How can one select which point of comparison is intended? It would seem therefore that even if Aristotle has avoided the apparent circularity, he has not given us a clear and unambiguous concept of potentiality.

This argument may now seem to have become all too intricate; but the conclusion should be disturbing enough to jolt one out of any tendency to doze. The conclusion is not that Aristotle got himself into a jam: such would be merely a piece of historical information. Nor is the conclusion simply the meaninglessness of the concept of potentiality and the uselessness of analogical definitions. Such is of course a valuable warning to any ambitious philosophers who are unknowingly starting up a blind alley. But there is the much more disturbing conclusion that the problem of motion remains unsolved. And in the recesses of our oblivion there still lurks the skeleton of Zeno's Achilles. Perhaps motion is just nonsense.

Newton, as has been said, failed to extricate science from the difficulty because he assumed that the meaning of motion was known to all. On this assumption he proceeded to discuss particular forms of motions. The futility of this procedure is clear enough to philosophers, but perhaps scientists wonder why ancient puzzles should be allowed to hinder modern science. For the reason something, as brief as possible, should be said about two important Newtonian laws; the law of inertia and the law of gravitation. The first of these asserts that a moving body continues indefinitely in a straight line unless subjected to an impressed force; and the second is an attempt to explain the curvilinear motion of the planets.

Now, the best known of all Newton's pronouncements is the one that reveals his failure to explain planetary motion. The law of gravitation expresses with mathematical accuracy the forces necessary to change the rectilinear or inertial motion of a planet into an elliptical path. But when one asks the question, what impresses these forces? Newton replies, *Hypotheses non fingo*. Cajori, Newton's recent editor, has collected some of Newton's letters (*Principia*, Appendix, not 6, pp. 632-635) in which he clearly expresses the limitations of his mathematical law. Gravity, newton declares, is not a property of bodies; if it were, one body would act on another at a distance, and this is manifestly absurd; indeed, "We are ignorant of the essential properties of matter." Mathematics only measures the quantity of the force; it says nothing about what impresses the force. Newton himself thought it possible that God impresses this force; but this theological opinion is obviously not a part of experimental science. Therefore science has failed to show what forces the planets out of a rectilinear path.

Now, finally, what is the value of the law of inertia? This law states that a moving body continues in a straight path unless compelled to change by an impressed force. The difficulty with this law is well known. To determine a straight line a fixed point is needed. If a hawk in search of a meal flies always toward another bird, and the other bird is darting hither and yon, the hawk obviously does not fly in a straight line. And if a rocket could be fired so as always to be pointing to the moon, it would not describe a rectilinear path. The determination of a rectilinear path requires a fixed objected in absolute space. But there are no fixed objects. The "fixed" stars are not fixed. Hence the law of inertia has no application. It is completely impossible to discover a body moving in a straight line.

Since this paper is but one section of a larger argument, later conclusions are not here sufficiently prepared for; yet it seems that one subsidiary but important point may be made. The problem of motion, particularly the general problem, but also even some special problems remain unsolved. Space, time, and motion are not "well known to all." In this situation a philosophy of science that pretends to justify scientific knowledge of nature is left without any knowledge to justify. Can anything be known about nature if no one knows what space, time, and motion are? Can it even be known that science is supposed to talk about nature?

Wittgenstein, whose unwise assertions approximately equal Newton's wise ones, is surely allowed one very wise remark to match Newton's blunder; "Whereof one cannot speak, thereof one must be silent."