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Motion and Its Principles

MOTION IS GIVEN IN EXPERIENCE

The most striking feature of the sense world is its motion. Everywhere it is present, and our very search for it often involves another of its myriad manifestations. Something new is constantly being born into our universe, while old things pass away. The seasons come and go, and the universe from heaven to earth bears witness to the changes. The soil is hot one day and moist the next. Thunder and lightning are but aspects of the movements of the clouds. Living things are in constant process of being born, growing, aging, and dying. The wind and the waves, the twinkling of the stars and the melting snow of the spring, the river in the valley and the slow erosion of the eternal hills—all reveal the perpetual motion astir in nature, and man sets his clocks, and therefore his life, by the movement of the earth around the sun.

The empiriologist, when he roams behind his measurement to explore its background by non-metrical means, bears similar witness to the reality of motion. Chemically speaking, his universe consists of nearly a half billion different kinds of stuff which he calls substances and which he envisions as in constant kinetic molecular motion. What goes on among the molecules is but a larger sign of a subtler rhythm stirring in nature, that of subatomic particles. In this infinitesimal world, which empiriological physics attempts to predict by theory and command by experiment, matter and energy have now merged into the same thing, and energy is power, work, force, tension, movement. In the last analysis, empiriological physics determines the possibility of

chemical, atomic, and nuclear reactions by an appeal to the energies involved and to the directions in which they tend to flow. Much more than the nineteenth-century emphasis on mass and quantity, twentieth-century empiriological physics presents evidence of nature as basically a dynamic thing, and such concepts as field, waves, entropy, surface tension, and electric forces play a greater role in the empiriological vision than they ever did before.

But empiriological physics only measures matter without studying its motions and mobilities in truly causal fashion. This is the business of philosophical physics and can only be settled by transcending measures to the realities that instruments presuppose. In an age like ours, the first question would not be to define the reality of motion but to establish the fact that motion is a reality. Aristotle faced a similar question from the Humes and Kants of ancient Athens. Yet it is not the office of the philosophy of nature to deal with this question, Aristotle argued, since it can be treated only in that part of metaphysics which defends the value of knowledge. However, Aristotle faced the problem in his *Physics* because of its importance for his study of nature, and the twentieth-century realist in like circumstance is invited to pursue a similar course.

Before embarking on the journey, a distinction might be drawn between change proper (*mutatio*), which is instantaneous, and motion proper (*motus*), which is primarily continuous and successive. But in a wide way, the two can be taken as equivalent, and their technical differences, when they become important, will be mentioned in the pertinent passages. After all, it is more important to point up general truths than to squander space on technical detail.

After a discussion of motion, the next hurdle will be the definition of motion; then will follow a more precise characterization of mobile being or nature and the principles of nature; these principles next will be applied to changes of substance with a defense against other views on substantial change.

MOTION IS NOT DEDUCIBLE

When Aristotle said that motion is known by induction, he was calling attention to its character as given in experience. The fact of motion cannot be proved and moreover needs no proof, if proof is taken to mean syllogistic inference. It is nonsense to try to prove motion since there is nothing more obvious in the sense world from which motion could be deduced.

All philosophers require a starting point. Some begin arbitrarily, using a precooked notion of the subject matter. A realist takes reality rawly as he finds it, without preconception or hypothesis. He begins in experience—the hard, fast, stubborn data which cannot be contradicted with impunity and which will, if contradicted, attack the philosopher who tries to deny them. That is why false philosophies continually come and go. To ignore the obvious is to inhale the lethal germs of skepticism, a state that would not only render science false but make it impossible.

The realist cannot help beginning with the obvious. To deny it means to know absolutely nothing in the end. To attempt to prove the more evident by the less evident is not only invalid as a reasoning process, but the less evident, which is the premise of the proof, can only be known and recognized in terms of the more evident, which is presumably to be established. You cannot prove that you see something by deducing it from the fact that you have never seen anything; for you have already seen something or you would not be asking the question.

The empiriological extremist has the habit of shrugging off the familiar world as an illusion and enshrining his own technical world of atoms, quanta, and tensor fields as the only world that is real. But he has constructed all his concepts by reference to this familiar world; he expresses his thoughts basically in its language; he uses the familiar world in order to read his instruments and to communicate his thoughts. No one can avoid beginning in experience, and if that is so, more attention ought to be paid to it. If the empiriological approach is used to explain away experience,

it is only in terms of an eventual appeal to that experience itself that the explanation is thought to be valid.

Motion does not need proof because of its obvious experiential character. What needs proof is always the obscure and the questionable, the unseen and the unknown. Motion is so apparent that to demonstrate its existence is unnecessary. The proof consists in opening our eyes, feeling the moving keys of a typewriter, taking a ride on a subway. If motion does not force itself upon us, the only recourse in the proof would be to deduce it from the non-moving or the static. But the static is less obvious than the moving, and the senses can detect it only by reference to the moving which is more obvious. Perhaps the senses best confirm the verdict of the intellect on the exteriority of the world by an appeal to the facts of motion. If a thing moves against us or we move against it, and if we thus feel the interaction between its reality and our bodies, we are spontaneously sure that it is real and objective. The static, for example the world of mathematics, is harder to grasp than the moving; it can be taught to beginners only by instances from motion, the physical adding and the physical taking away of apples which a teacher uses as first examples of addition and subtraction.

MOTION IS DEFINED BY ACT AND POTENCY

The definition of motion is more difficult than its discovery. The most effective approach to the problem might be to face squarely the historical dilemma that challenged Aristotle and to rethink the struggle that his definition arbitrates since both warring parties have today risen anew from their tombs. There were two opposing views that urged Aristotle's genius into action. One was the doctrine of the Eleatics, led by Parmenides and Zeno. The other was the view of Heraclitus.

Parmenides and his school declared that motion is impossible, pointing for proof to the principle of non-contradiction. Their argument ran thus: Being is, and non-being is not. Between the two there cannot be a middle term, and since motion would ap-

pear as an intermediate between being and non-being, it turns out to be an illusion. Nothing can come from being, Parmenides went on, since being already is and whatever comes from it would already *be* in it, incapable of becoming because it already is. Nothing can come from non-being either: *ex nihilo nihil fit*. Zeno's arguments will be discussed later since they presuppose an understanding of the problem of the infinite and can best be deferred until after this problem is formally put into the forum. Like Zeno's world, the universe of Parmenides is radically static and monistic.

Heraclitus, on the other hand, denied the reality of being and claimed that all is motion. As in the case of Parmenides, some plausible arguments seem to conspire toward this view. Take the case of time, so subtly emphasized by Bergson, a modern Heraclitus. The past has already been; the future is not yet; and the present passes. The only real thing in this triad is the present, and its reality is flowing constantly by. On such evidence, Heraclitus declared that motion alone is authentic, motion as symbolized by fire which he took to be the basic texture of matter. No man can swim in the same stream twice, he is supposed to have said; Cratylus, his disciple, said that no one can swim there even once. Heraclitus thus proposes a philosophy of radical dynamism and pluralism. It stands in polar contrast to the cosmic picture of Parmenides.

Aristotle was too loyal to experience to allow sophistry to rule on the real and to validate these extreme views. Despite their argument, they are out of touch with the rhythm of daily life which discloses both permanence and change and does not ratify a view of the world as either wholly fluid or wholly fixed. The problem is to find a suitable definition of motion that will agree with this experience which the true science of nature must explain rather than explain away. Such a definition Aristotle formed in terms of the twin concepts of potency and act.

Potency and act are so intimately interlaced that they should be unraveled together. Act, in the broad sense, is synonymous

with existence; to be actually something is not to be an imagined something. Kant pointed out that there is not a cent more in a dollar truly existing than in a dollar conceived by the mind. But the dollar existing is an actual dollar. Our wealth is proportioned to it, to the money we own and not to the riches we imagine.

Potency is the capacity to be actual. It has the meaning of possibility, an aptitude for existence rather than the existing itself, a readiness to be influenced by a cause. Shopping downtown, a person has a real capacity to be at home, and later on in the day, he will be actually there. The water in the Ohio river has an aptitude to be in the rain clouds, and if the evaporating heat of the sun is turned its way, some of it will actually be in the heavens by nightfall. The acorn is potentially an oak tree, and the parts of a car in a Ford storage plant are potentially an automobile. Before a radioactive substance emits an electron, it must have the potentiality for so doing, otherwise the emission would be impossible. Potential energy is energy poised and ready for action, like a lion crouching for a kill.

The difference between potency and act is the gap between a capacity and the fulfillment of that capacity. Both are real things. Both refer to existence. The actual is that which is; the potential is that which can be. To discover their deep meaning has formed the historical career of genuine philosophy, and their importance, appearing in full dress at the level of metaphysics, cannot be printed boldly enough. Because they are so basic, they are elusive and have given rise to numerous blunders of a far-reaching character.

Potency is not a simon-pure logical concept, as Northrop suggests nor, as Santayana puts it, a mere name invented to disguise our ignorance. It is a real thing, though not actualized. If it were not real, it could never be a source of the actual. The match has a real capacity for being struck, or the actual striking could not be real either. The airplane has a real capacity for flying, otherwise it could never leave the ground. If the potentialities of our parents were mere figments of an imaginary world, all of us are

dream stuff. And if the skeptic declines to believe that atoms have a real potentiality for destroying civilization, why does he discuss the problem of atomic energy control?

Before the loam is dug by the farmer, it has a real capacity to be spaded. The solid coral of a Pacific atoll has no such potencies. Oxygen has a genuine aptitude for union with hydrogen, silver does not. The potencies of things, especially in the experimental disciplines, are in a large measure the way in which we identify them and divide them off from one another. They are thus real and objective. Energy, the power to do work, assumes a deeper meaning when it is remembered that power is a potency. Inertia is likewise a way of saying potency; and inertia, passivity, are alone enfranchised in the empiriological world, where potency, far from a purely logical or nominal convenience, is considered in a deep and genuine way to be more real than act.

MOTION IS A MIXTURE OF ACT AND POTENCY

The actual is that which is. The potential is that which has the capacity to be actual. Through the bifocal lens of these two realities, philosophical physics can now recognize motion for what it is. Aristotle says, "The fulfillment of what exists potentially, in so far as it exists potentially, is motion."

Dissecting this definition into its parts provides a conclusive answer to the dilemma of Parmenides versus Heraclitus. Motion belongs to a thing only so far as it is in potency, for whatever already has a perfection does not move to acquire it. Motion essentially involves the production of novelty. Thus iron does not tend to become iron since it is iron already; and a dog does not tend to become a dog but to satisfy its animal urges.

Motion thus entails the fulfillment or the act of the thing that is in potency, but this alone is incomplete as a definition of motion. It must emphatically be added that motion is the act of the potency only as far as the thing moved is still in potency. Why this clause must dominate the definition is clear from another example. Marble has a potency to be a statue, and oxygen has a