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Dialectical Materialism in Physical Theory

In the 1970s, I was attending a curriculum committee meeting of my department, the physics department of the University of Minnesota. In the midst of the meeting, a staff person came in to ask us if we wished to retain in the new university catalog the description of the subject matter of physics that appeared in the physics department section of the present catalog. This description began with the words: „Physics is an exact science." I asked my colleagues whether any had a theory for an individual field of specialization that he or she would assert was exactly true. Not one did. I then rapidly scribbled the following draft, drawing on Lenin's well-known statement, „Matter is a philosophical category given to man by his sensations . . . "

My draft read: „Physics is a science that studies properties common to all forms of matter, living and nonliving. Through a combination of experimental and theoretical investigation, it seeks to reproduce the properties of the physical world in mathematical form with ever-increasing accuracy and adequacy." This was immediately accepted and subsequently presented for formal adoption at the next meeting of the full faculty of the department, where it was approved unanimously. This definition of physics was put into the new university catalog almost exactly as I had written it.

A few years later, I attended a departmental dinner held to honor department achievements and particularly those of the then-outgoing department chair. Under the influence of a certain quantity of dinner wine, I told the eight colleagues sitting at my table, in a voice loud enough for those at all the other tables to hear, „One of the great achievements of our department during our chair's tenure is that we are the first physics department in the United States to have a Marxist-Leninist statement on the subject matter of physics in a university catalogue." Deep silence immediately fell upon the entire hall. Then a colleague seated opposite me said, „But it sounded so sensible."

My point here is that advances in physical knowledge obviously did not require a conscious acceptance of dialectical materialism by those scientists who contributed or accepted them. Nonetheless, one can find many examples of thinking that we would characterize as dialectical, or materialist – or dialectical materialist – by scientists responsible for major advances in our knowledge of physics.

Let me give one example. Except for his role in the creation of calculus, Marxists generally have not viewed the methodology by which Isaac Newton arrived at his famous three laws of motion as an example of dialectical-materialist thought. Much of his approach, of course, had a mechanistic character. I should like, however, to point out some examples of the dialectical-materialist thinking virtually forced on him as he formulated his basic laws.

A literal translation of Newton's law of inertia, which he designated in his famous *Principia* as Law 1, reads:

Every body remains in a state resting or moving uniformly in a straight line except insofar as forces on it compel it to change its state. (Wolfson and Pasachoff 1987, 73)

Newton's original Latin text contained the phrase *nisi quatenus,* which is equivalent in this context to *except insofar as,* but it is invariably translated as *unless*. I have looked at many texts in French, German, and Russian and found this to be the general practice in those languages too.

Unless carries the meaning of *either the state remains unchanged or it changes*. Instead of such an either/or situation, *except insofar as* gives the law the character of a causality principal, in which the cause of the change is quantitatively and qualitatively relatable to the change in motion. To lay the basis for this, Newton gave scientific precision to the concept of force by invoking two distinct but dialectically related types of force. The first was the *innate force (vis insita)* of matter, which he also called the *inertial force (vis inertiae)*; the second he called the *impressed force*. In his Definition III, Newton takes the first step toward the quantification of force.

The *vis insita* or innate force of matter is a power of resisting, by which every body, as much as in it lies, continues in its present state, whether it be at rest or of moving uniformly forwards in a right line. (Newton 1934, 1:2).

The phrase „as much as in it lies" asserts the existence of a quantitative relationship between the mass and the inertial force, both of which have yet to be quantified. Since actually neither has yet been quantified, this „definition" expresses the idea that the inertial force is the phenomenal manifestation of the mass.

The problem here is that the quantitative existence of the mass persists during inertial motion, and is associated with an inertial force. But the inertial force does not manifest itself in the absence of the impressed force. Newton is essentially resorting to the Aristotelian dialectic of the unity of the potential and the actual – that is, the force persists as a potential force, a potential power to resist a change in motion that appears as an actual force when an attempt is made to impress upon the body a change in motion. This is the significance of the phrase in the definition „the power of resisting." Newton is quite clear that the force becomes active only in response to a change in motion. This can be seen in the continuation of his commentary on Definition III:

But a body only exerts this force when another force, impressed upon it, endeavors to change its condition.

The commentary on this definition includes the following:

This force consists in the action only, and remains no longer in the body when the action is over.

Newton's concept of force and its relation to mass is clearly a highly dialectical one.

A principal weakness in Newton's concepts was his assumption of a priori space and time, including the a priori existence of straight lines, although his first law actually provided the material criteria of straightness – that is, the line traced out by inertial motion.

These a priori concepts of space and time persisted into the nineteenth century. Over the centuries, attempts had been made to prove that Euclid's parallel postulate could be derived as a theorem from his other axioms and postulates. This postulate states that given a line *L* and a point *p* not on *L,* there exists one and only one line passing through *p* parallel to *L,* where two lines are considered to be parallel if they never intersect. In the 1820s, the mathematicians Lobachevsky in Russia and Bolyai in Hungary attempted to prove this was not needed by showing that the assumption of a contradictory postulate would lead to an internal logical contradiction – that is, to theorems that were in contradiction with each other. Lobachevsky and Bolyai independently replaced Euclid's parallel postulate with the following postulate: Given a line *L* and a point *p* not on *L,* there are at least two lines passing through *p* parallel to *L*. Lobachevsky and Bolyai, however, were unable to arrive at any internal contradiction.

Euclidean geometry and the new geometry thereby established were each internally consistent but led to results that contradicted one another. For example, in Euclidean geometry, the sum of the internal angles of a triangle equals 180 degrees. In Lobachevsky-Bolyai geometry the sum is always less than 180 degrees, but the difference be too small to establish experimentally which gave a better description of physical space. In 1850, Riemann created another geometry by postulating that there were no lines passing through point *p* that were parallel to *L*. In his geometry, the sum of the internal angles of a triangle was always greater than 180 degrees. Riemann, however, broke the logical impasse by asserting that only experience will determine which geometry applies to the physical world. While not clearly a materialist concept, this is a step in that direction, lacking only the introduction of matter as the source of the experience. Actually, it was the philosophical idealist Hegel who early in the 1800s put forth a dialectical-materialist approach to space and time by stating that „it is the concept of space itself that creates its existence in matter," and that in relation to space, „matter is the primary reality" (Hegel 1940, 343). In 1915, Einstein, who never considered himself a dialectical materialist, showed how the distribution of matter determined the local geometry.

The ties between physics and philosophy became quite strong in a negative sense with the emergence of logical positivism on the background of the philosophical views of physicist Ernst Mach. This led to the introduction of operational definitions by P. W. Bridgeman in 1927.

Operational definitions spread rapidly to other fields. The concept that intelligence could be defined by the results of an IQ test was used to limit the educational opportunities for children of color in the New York school system.

In the 1970s, on the first page of the leading physics textbook in the United States, one could read: „The definition of a physical quantity has been given when the procedures for measuring that quantity are specified. This is called the *operational* point of view because the definition is, at root, a set of laboratory operations leading to a number with a unit" (Halliday and Resnick 1974, 1). In this spirit, another textbook states that time is defined by defining the way it is measured and rejects the „romantic philosophical question ‚What is time?'" (Zafiratos 1976, 3–4). Marxists point out that fundamental physical properties cannot be defined. Such properties are specialized categories of physics, the meanings of which are elaborated by study of their interrelation. Operational definitions, on the other hand, do not define physical properties, but standardize their measurement units. It was largely under the influence of such Marxist critiques that operational definitions generally ceased to be used to define fundamental physical properties. (Hörz 1990, 44–53)

Another important conceptual shift to which Marxists have contributed is the abandonment of the notion that physics is the study of invariances in nature. With the laws of conservation of energy, momentum, and charge in the nineteenth century and the discovery of a wide variety of additional conservation laws in physics in the twentieth century – conservation of parity, conservation of strangeness, conservation of baryon number, etc. – physics was portrayed as the science of invariances of nature. In his time, Engels pointed out that the law of conservation of energy is a law of transformation of matter. Engels's views, however, were largely ignored. But by the 1980s, in part as a result of Marxist polemics on the subject, physics textbooks began to characterize physics as the science for the study of *changes* in nature. (Hörz 2000, 241–242)

With the collapse of socialism in Europe, the contribution by Marxists to philosophical questions in the natural sciences has greatly weakened. Various shades of irrationalist viewpoints have gained much strength in a wide variety of fields. Dialectical materialists working in the natural sciences need to begin consultations on collaborative efforts to develop further, in our various fields, the scientific worldview.

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