MAIMONIDES, SPINOZA, AND THE FIELD CONCEPT IN PHYSICS

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I. There has been a great deal of discussion in recent years on the structure of scientific revolutions.[1] There are philosophers and historians of science who contend, with Kuhn, that during most of our history, fundamental changes in ideas occur only over relatively short periods of time. The new ideas that come with each scientific revolution are then upheld during the longer stage of conservatism that follows, called "normal science," until the next revolution occurs. It is further contended that the ideas upheld in such periods of conservatism are independent of the ideas that had prevailed in all preceding periods of "normal science."[2]

It is my thesis that the actual truths sought by the philosopher and the scientist about the real world emerge in the form of abstract, invariant relations that are independent of the domain of understanding to which they may be applied, whether in the arts, the sciences, the philosophy of religion, or any other intellectual discipline, and that these relations are invariant with respect to the different periods of history during which they may be expressed. In the language of theoretical physics, I am contending that *the principle of relativity*—the assertion that the laws of nature are independent of the frame of reference in which they may be expressed—applies equally to the relations that govern the evolution of human understanding, i.e., the history of ideas, as it does to the natural phenomena of the inanimate world of stars, planets, and elementary particles.

To support this thesis, I shall discuss in this paper some of the ideas expressed in the philosophy and theology of two leading scholars, from widely separated periods—Moses Maimonides (1135–1204) and Baruch Spinoza (1632–77). I shall attempt to relate some of their ideas to modern notions of the field concept in theoretical physics, as developed by Faraday and Einstein in the contemporary period of history. In this analysis, I should like to point out the similarity between Faraday's field concept, as an example of Aristotle's theory of matter in terms of continuous distributions of potentialities and actualities *of motion,* and Maimonides' logical exposition of the interaction between corporeal entities and an incorporeal entity. I then compare Maimonides' philosophical view with the generalization from Faraday's field concept to Einstein's field concept. The latter development in twentieth-century physics is in terms of viewing the universe as a closed system, without actual parts, not characterized by Aristotelean potentialities and actualities, but rather by a fully predetermined existential entity. I then indicate the similarity of the latter approach to Spinoza's view of the universe.

[1]T.S. Kuhn, *The Structure of Scientific Revolutions* (Chicago, 1970); I. Lakatos and A. Musgrave, eds., *Criticism and the Growth of Knowledge* (New York, 1970).

[2]P. Feyerabend, in Lakatos and Musgrave, *ibid.*

II. One of Maimonides' chief philosophical discussions[3] addresses itself to the question concerning the quality of incorporeality of God. In this discourse it was necessary for him to justify philosophically the meaningfulness of the assertion that an incorporeal entity, that is, an entity not directly detectable with our five senses, or related in any way to ordinary matter, can have influence on the physical actions of corporeal entities, i.e., ordinary matter, be it animate or inanimate. Aside from its theological implications, the philosophical aspect of this problem is not unlike the mind-body problem to which Descartes, Spinoza, and other philosophers addressed themselves several centuries later. A difference, of course, was that Maimonides' interpretation of God was in terms of an incorporeal entity external to and independent of the individuality of a body, while Descartes' and Spinoza's incorporeal entity (mind or soul) is identified with each individual body.

To accomplish his task, Maimonides was led to the notion of an abstract continuum in describing the influence exerted on corporeal entities. Such a view, in contrast with the "action-at-a-distance" description of the forces exerted on matter, was not fully exploited in science until the period in the nineteenth century when Faraday developed the field concept interpreted as a *field of influence,* and its later generalization in the twentieth century, with Einstein's philosophy of a unified field.[4]

To demonstrate Maimonides' view of the *field of influence* concept, consider the following:

. . . it has become clear that the actions of bodies upon one another, in respect to their forms, necessitates the preparation of the various kinds of matter with a view to the reception of the act of that which is not a body, these acts being the forms. Considering that the effects produced by the separate intellect are clear and manifest in that which exists—being everything that is produced anew, but does not result solely from the mixture of elements itself—it is necessarily known that this agent does not act either through immediate contact or at some particular distance, for it is not a body. Hence the action of the separate intellect is always designated as an overflow, being likened to a source of water that overflows in all directions and does not have one particular direction from which it draws while giving its bounty to others. For it springs forth from all directions and constantly irrigates all the directions nearby and afar. Similarly the intellect in question may not be reached by a force coming from a certain direction and from a certain distance; nor does the force of that intellect reach that which is other than itself from one particular direction, at one particular distance, or at one particular time rather than another. For its action is constant as long as something has been prepared so that it is receptive of the permanently existing action, which has been interpreted as an overflow.[5]

Further on in his discussion, Maimonides explains:[6]

It also is said with regard to the forces of the spheres that they overflow

[3]M. Maimonides, *The Guide of the Perplexed,* trans. S. Pines (Chicago, 1963).

[4]I have discussed the notion of "field of influence" in more detail in "A New Approach to the Theory of Fundamental Processes," *Brit. Jour. Phil. Sci.,* **15** (1964) 213, and in my book, *The Field Concept in Contemporary Science* (Springfield, Ill., 1973), where I refer to this as an "elementary interaction field."

[5]Maimonides, *op. cit.,* 279. [6]*Ibid.,* 280.

toward that which exists. Thus the overflow of a sphere is spoken of though its actions proceed from a body.

With this passage Maimonides conceptualizes the notion that is analogous to the field theoretic idea that a field of force associated with matter ("overflow") *propagates toward* the matter that is to be acted upon ("that which exists"). In theories of matter, this is an idea that contrasts with the notion of spontaneous "action-at-a-distance," of the classical views—replacing it with the idea that the forces that influence corporeal bodies are propagating disturbances within a field of force (like a ripple propagating on the surface of a pond), *toward* the matter that is to be influenced (as a cork on the surface of a pond may be bobbed up and down by the ripple when it arrives at the cork's location). His use of the word "toward," then, signifies that the actual influence on the matter propagates, rather than acts spontaneously, at a distance. Such a conception is entirely in accord with Faraday's and Einstein's view of the field representation of the actions exerted on matter, and in contrast with the atomistic views in ancient Greece and in Newton.

In the nineteenth century, to explain the forces of electricity and magnetism, Faraday was led to the conception that what is fundamental in the nature of matter is its continuous field of potential force. That is, rather than Newton's "action-at-a-distance" concept of force, Faraday proposed that the basic representation of matter (rather than one of its derivative properties) should be its abstract field of potential force, mapped continuously in space and time. The idea, then, is that if one should introduce a bit of matter—the "test body"—at a particular place and time, this body should then move in accordance with the amplitude of the field of potential force where it would be. In Aristotle's terms, such behavior of the test body would be the actuality arising from the potentiality of the field. Thus, Faraday substituted the concept of a (corporeal) discrete atom and the notion that it acts on other atoms spontaneously, at a distance, with the concept of the incorporeal field of continuous potential influence, as a basic representation of matter.

Maimonides' analogue, in which he describes the influence of an incorporeal entity on matter in terms of a continuous "overflow" seems to me to be close to Faraday's field concept. The role of the "test body" appears in the last sentence of the quotation above: "For its action is constant as long as something has been prepared so that it is receptive of the permanently existing action, which has been interpreted as an overflow."

Next we come to the role of space and time in field theory. In the view of the atomists of antiquity, as well as in Newtonian physics, it was believed that space and time are separate, objective entities, independent of matter. That is to say, to describe the effects of the forces exerted by matter on matter, one describes the motions that are caused by such actions. The motions, in turn, are then related to the locations of the moving matter, defined within a fixed grid of points, i.e. in the background of the continuum of spatial and temporal coordinates. This would be like locating the position of a man climbing on a ladder by the rung he has reached, treating the man and the ladder as separate entities.

A revolutionary step was taken in physics in this century when Einstein reinterpreted the space and time coordinate system as a continuum of parameters whose only logical role is to provide a language to be used in facilitating a representation of the laws of nature. The logic of this language—the relations between the points of space-time, as defined in terms of the axioms of a geometry—was then taken to relate to physical manifestations of the material system described. The general notion that space and time are entities not separable from matter was held by philosophers as far back as antiquity. Plato's view of the world was a notable example. But Einstein was the first in theoretical physics to fully exploit this view, and further, to explicitly identify the geometry of space and time with the physical properties of matter.

The idea that "time," in particular, is not independent of matter, but rather relates in a fundamental way to the matter whose duration is considered, was also expressed by Maimonides in his argument (against Aristotle) for *creation ex nihilo*. According to him,[7]

> . . . time is a created and generated thing as are the other accidents and the substances serving as substrata to these accidents. Hence God's bringing the world into existence does not have a temporal beginning, for time is one of the created things.

Maimonides' "time," however, represents the existential feature of matter that is its physical duration. Herein lies a major difference with Einstein's use of the temporal concept. In general relativity theory, time is an abstract parameter that is used in a mathematical language to express physical laws. The basic language elements of these laws are the continuous field variables. The field variables, in turn, are mappings in space and time that indirectly relate to the actual predictions of the physical properties of matter, such as its physical duration. Thus, the logic prescribing the relations between the points of time (and space) in Einstein's theory—the geometry—is not more than a representation of the physical manifestations of matter.

Maimonides' "time," on the other hand, is not unlike Aristotle's. It is a measure of the motion of matter, which, according to this view, is the underlying theoretical basis for the nature of matter and the physical universe.[8] Of course, a major difference in the views of these scholars is Maimonides' belief that time was created with matter from nothing, at "the beginning," as contrasted with Aristotle's belief that motions being eternal, time must be infinite in extent, with no beginning. Maimonides argues in his treatise that neither his view nor that of Aristotle, on this question, is logically verifiable, but rather must be accepted axiomatically, according to one's beliefs.

To continue the analysis of similar concepts in Maimonides' philosophy and that of contemporary field theory, it is salient that according to the former, the fundamental nature of the physical world must be based on the fundamental nature of relation, rather than of "thing." In expressing this view, Maimonides said:[9]

> In the case of everything produced in time, which is generated after not having existed—even in those cases in which the matter of the thing was already existent and in the course of the production of the thing had merely put off one and

[7] *Ibid.*, 282.
[8] *The Basic Works of Aristotle*, ed. R. McKeon (New York, 1941).
[9] Maimonides, *op. cit.*, 294.

put on another form—the nature of that particular thing after it has been produced in time, has attained its final state, and achieved stability, is different from its nature when it is being generated and is beginning to pass from potentiality to actuality.

I interpret Maimonides' comments here to mean that the fundamental features of a physical system stem primarily from the mutual interactions of its components, rather than from the independent properties of its constituent parts. For the entire character of the system changes after "the moment of their production" in a way that loses sight of its properties as the qualities of a sum of parts.

To illustrate this idea further, compare it with the properties of a fictitious universe, consisting of a double star—two mutually interacting, equally massive stars. Suppose that at first the stars may be considered to be in static equilibrium, exerting the gravitational force on each other whose magnitude depends only on their mutual separation. Suppose now that they start to move relative to each other. As soon as one of these stars, say S_1, changes its position relative to the second star, S_2, its corresponding change in gravitational potential at the site of S_2 will cause S_2 to alter its motion in a corresponding way. But this change in the motion of S_2 (relative to S_1) and its relative change in position, thereby affects its gravitational potential at the site of S_1, thereby changing S_1's original motion. Thus it appears that S_1 is moving in such a way as to affect its own motion—through the intermediary of the second star, S_2. Similarly, S_2 affects its own motion, through the intermediary of S_1. It then becomes impossible to separate S_1 and S_2 and their motions into independent cause-effect relations. One rather loses sight of S_1 and S_2 as independent parts, leaving the single closed system, S_1-S_2, as the fundamental existent to be described and explained. It was Maimonides point that the physical attributes of a system, such as S_1-S_2, are not the sum of attributes of the individual parts, such as S_1 and S_2, and that these, in fact, lose meaning as independent parts.

The preceding argument, favoring the idea that "the whole is not the sum of parts," still leaves a question as to whether or not Maimonides is truly referring to the system as closed. While his philosophy does seem to me to incorporate the notion of the continuous field of force, I do not believe that it yet reaches the stage in which the underlying field of influence to which he refers relates to a closed system. The reason is clear. It is Maimonides' theological interpretation of God as a transcendent entity that is independent of corporeal entities, or of any of the qualities of corporeality, yet exerting influence on corporeal entities. This is to be contrasted with Spinoza's immanent interpretation of God, as the substantive universe, *en totalité,* but not transcending it.[10] Nonetheless, the analysis here does not address itself to these theological questions. It concerns only the philosophical content of Maimonides' and Spinoza's comments.

In regard to Maimonides' philosophical arguments on the nature of the interaction between incorporeal entities and ordinary matter, this seems to me to come close to Faraday's interpretation of the field of force as continuously

[10]B. Spinoza, *Ethics* (New York, 1960).

distributed potentiality (or, as others have called it, "power"[11]), representing the effect that matter can exert on matter (a "test body") should the latter be located at any of the continuous points of space—to be acted upon (the actuality), causing its motion. A field of influence, in this sense, is a superposition of continuous fields of potential force—though a vectorial sum in Faraday's case (directed) and a scalar sum in Maimonides case (undirected). This is a linear sum of fields representing the total influence on any bit of matter within a physical system. It is essential in both Maimonides' and Faraday's views that the "test body" can have no effect on the field of force that is influencing it.

III. But in physics, why shouldn't the "test body" be included in the system that is to be represented by a total field? How can one accept the dualism of both the continuous field concept—to describe a part of the actual physical system called "influencer"—and the atomistic concept—to describe the rest of the system—the "test body" called "influenced?" This division seems to me to be logically dichotomous. If one should assert that the actions exerted mutually by matter on matter are generally reciprocal, but that, by definition, the "test body" acts on the remainder of the closed system in a sufficiently small way to be neglected, one must then specify precisely how small this must be. This is not a trivial point as it bears on the entire conceptual and mathematical structure of a theory of matter. For if the total field, including the manifestations of a "test body," is first treated exactly, *as a closed system,* then its formal mathematical representation would necessarily be in terms of nonlinear field equations. To predict the motion of a "test body," one must first solve for the field solutions corresponding to the entire closed system, and then take the asymptotic limit in which the system *appears to* manifest itself as a part very weakly coupled to the rest of the closed system, treating this part as a "test body." It is important to note, however, that no matter how closely one may approach the limit where there would appear to be an actual uncoupling of the test body from the rest, the actual limit cannot be reached, in principle. The closed system is not composed of separable parts!

This is a conceptual view of the oneness of the universe in accordance with Spinoza's philosophy.[11] Such an existential approach is also taken in Einstein's unified field theory. This is a view which asserts the elementarity of relation, not as a set of secondary restraints on relata, but rather as a *basic order* that is primary to an understanding of the real, substantive universe. It is an order in terms of fundamental relations, in the sense of logically necessary connections, where no manifestation of the universe, be it man or elementary particle, is unconnected from the rest of the single closed system. In this view, what appear as relata in atomistic philosophies play the secondary role of being derivative features, following from the underlying abstract relations that are the laws of nature.

From my reading of Maimonides, his philosophical view of the existing physical universe, aside from the mode of its interaction with God, is analogous to the way in which Faraday views the coupling of the (corporeal) "test

[11] R. Harré, *The Principles of Scientific Thinking* (Chicago, 1970), chs. 10, 11.

body" to the (incorporeal) field of potential force, that represents the other matter that is doing the influencing. The role of the "angels" in Scripture, according to Maimonides' interpretation, as messengers to convey a force *to* corporeal matter, in accordance with God's will,[12] is similar to the role of the propagating field of force, at a finite speed, toward the matter that is to be influenced, in accord with the way in which the existence of this other matter makes itself felt in terms of a continuous field of potential action.

It seems clear then, that the conceptual change evoked in proceeding from Faraday's field concept of the substantive universe, as an open system of material things, manifested as Aristotelean potentialities and actualities, to Einstein's unified field concept of the substantive universe, manifested as an existentially closed system, corresponds with the evolution of ideas from Maimonides' philosophical view of the physical universe to Spinoza's view, each extending beyond the conceptual bases of the respective field theories of Faraday and Einstein, so as to incorporate man.

IV. To sum up, the correspondence of Maimonides' ideas, in the twelfth century, to those of Faraday in the nineteenth century, and the evolution of these ideas to the correspondence of Spinoza's approach, in the seventeenth century, with those of Einstein, in the contemporary period, strengthens the view that indeed there are fundamental ideas about the real world that persist throughout the history of mankind. It is then incumbent on the scientist and philosopher to sift out those ideas that are indeed invariant to transformations between the frames of reference of the different intellectual disciplines, in the different periods of history, in order to gain clues as to succeeding steps toward further understanding of the world.

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[12]Maimonides, *op. cit.*, 262.

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