RELATING THE PHYSICS AND RELIGION OF DAVID BOHM

by Kevin J. Sharpe

Abstract. David Bohm's thinking has become widely publicized since the 1982 performance of a form of the Einstein-Podolsky-Rosen (EPR) experiment. Bohm's *holomovement* theory, in particular, tries to explain the nonlocality that the experiment supports. Moreover, his theories are close to his metaphysical and religious thinking. Fritjof Capra's writings try something similar: supporting a theory (the bootstrap theory) because it is close to his religious beliefs. Both Bohm and Capra appear to use their religious ideas in their physics. Religion, their source for physical hypotheses, provides the motivation to develop and uphold them.

Keywords: David Bohm; holomovement; religion and science; Fritjof Capra; nonlocality; physics.

David Bohm started his career in physics as a brilliant exponent of the accepted point of view, but in the early 1950s he changed. Since then, his theories have been controversial; indeed, most physicists do not accept them. Bohm nevertheless wrestles with basic questions raised by contemporary quantum physics. However, he does not escape physics and flee into a world of his own. He asks questions of the accepted physics and, using physics' techniques, tries to solve them. One of his principal drives is to clarify an idea he finds at the heart of quantum physics—connectedness. His theory is that everything connects with everything else.

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Bohm has a strong philosophical and religious sense. Physics also engrosses him. Indeed, his religion appears to influence his physics, as well as the other way around. In this paper, as I explore a little of his physics and his religion, I will look at some of their connections. The nonlocality illustrated by the EPR experiment will be my focus.

NONLOCALITY

For Bohm, one of the significant and novel features of quantum theory appears in the EPR paradox. (Its name comes from the first letter of the names of its authors, Albert Einstein, Boris Podolsky, and Nathan Rosen, who published an article on it in 1935 [Einstein, Podolsky and Rosen 1935].) Bohm helped to develop it further in 1951 (Bohm 1951, 611–23). In this thought experiment, certain events appear connected but do not physically interact with each other, and they are some distance apart.

A simplified version of the EPR experiment is as follows. A particle that enters the experimental device has the properties that it is not spinning initially and can be split in half, with each half heading in opposite directions. One half is spinning in one direction and the other half is spinning in the opposite direction. The total spin must be zero, by the conservation of spin at the point at which the parent splits. The parent particle had zero spin, and equal but opposite spins cancel each other out. When the two halves are some distance apart, one half has its spin changed. The question is: What happens to the spin of the other half? It too would change, instantaneously, so the conservation of spin holds. But how could it do this? It is a blatant contradiction of physics as Einstein understood it.

One way to approach this question is to ask about the connection between the two half-particles. What tells the "second half" that its sibling has changed its spin? Normal connections do not travel faster than light. The EPR experiment, however, requires a connection that travels faster than light. This conflicts with Einstein's relativity theory, in which nothing can travel at such speeds.

Einstein's intention in pointing to this problem was to bring out a difficulty with quantum theory. The instantaneous connection between particles, suggested by quantum physics, is a base for the EPR experiment. However, the experiment contradicts the idea that connections cannot travel faster than the speed of light. Thus it disproves, to Einstein at least, the validity of quantum physics.

Unlike Einstein, Bohm and his colleagues do not interpret the result of the EPR experiment as illustrating a problem in quantum physics. They see it as representing an essential, new feature in quantum phenomena. Moreover, they do not think it contradicts relativity; they have another way of explaining it (Bohm and Hiley 1980).

The EPR experiment is an example of a nonlocal effect. This means that something affects something else that is not within its immediate area. Neither is there a normal causal connection between the two; for instance, there are no physical forces connecting them. Nonlocality contrasts with the commonsense principle of local causes or locality, which says: Take two places, some distance apart, at the same moment of time. What happens in one has nothing to do with what happens in the other (Stapp 1977, 314). The opposite idea, nonlocality, is sensational. Because physics violates common sense once again, public interest arouses from its slumber.

The EPR paper is Einstein's most famous statement of his dislike of the nonlocality in Niels Bohr's quantum theory. Einstein wrote that physics should be "free from spooky actions from a distance [that is, nonlocality]" (Bohm and Hiley 1980, 51). Locality was necessary in his relativity theory, and he took it as being an "absolutely inevitable requirement for any reasonable physical theory" (Bohm and Hiley 1980, 51).

For many years the EPR experiment existed only in the imagination of physicists; John Bell, however, was a primary force in changing that. In a paper published in 1964 he distinguished precisely and mathematically the experimental results of the two types of theories (Bell 1964). One is classical and assumes locality; it takes the properties of a system to be independent of those that are some distance from it. The other type of theory supports the nonlocal connection (at least at the quantum level) of systems that are quite separate. Bell's theorem produces a mathematical inequality. If quantum theory has the locality of classical physics, then there is a limit on the number of pairs of particles with a certain property. Experiments can detect this number. To exceed this limit and thus to break Bell's inequality will mean that quantum theory does not have a simple, classical locality. Einstein would then be wrong.

Experimental evidence for nonlocality existed, to some extent, in 1957 (Bohm and Aharonov 1957). However, the unambiguous execution of an EPR experiment had to wait until the 1980s. A team headed by Alain Aspect performed the decisive experiment, which most physicists now accept (Aspect, Dalibard, and Roger 1982). It violated Bell's inequality considerably, and thus it confirmed quantum connections over distances up to twenty-six, and perhaps up to thirty, meters. It contradicted theories that assume locality. (Researchers plan more experimental work on this question.)

Bohm and Basil Hiley leave us with a warning: we may want to accept nonlocality. We may even want to see it in all situations. Thus we may think of everything as connected to everything else, regardless of their separations in time and space. The evidence, however, does not support this. The connection between objects at the quantum level may only apply in certain circumstances. An example is "over relatively short distances for simple systems" (Bohm and Hiley 1976, 178). The connection can also appear in complex systems and over somewhat longer distances, when the temperature is near absolute zero. Thus, breaking systems into independent subsystems, as required by classical physics, is often quite acceptable. Bohm and Hiley believe "nonlocality will only reveal itself in very subtle ways." They want to explore "the precise conditions under which such effects appear" (Bohm and Hiley 1976, 178).

INTERPRETING AND RESOLVING NONLOCALITY

The results of Aspect's EPR experiment uphold quantum physics and its nonlocality. However, they challenge our usual understandings, for example, of space, time, and matter. "As physicists we have learned to live with this [experiment], but we have never really come to terms with it." So conclude F. Frescura and Hiley (Frescura and Hiley 1980, 8). John Clauser and Abner Shimony think similarly: "Either one must . . . abandon the realistic philosophy of most working scientists, or dramatically revise our concept of space-time" (Clauser and Shimony 1978, 1881). Speculation, therefore, runs wild—there are many conflicting approaches and interpretations. Must we have nonlocality, or can we rewrite physics to keep locality? If we do have to have nonlocality, how are we to understand why it is there? What causes nonlocality?

Approaches that accept nonlocality differ from common sense; nonlocality itself differs from common sense. Some approaches even conflict with acceptable physics. T.M. Helliwell and D.A. Konkowski ask about influences traveling faster than the speed of light (Helliwell and Konkowski 1983, 1000). Could there be a relativity-disobedient faster-than-light "elaborate signalling mechanism" between the two particles in the experiment? (Gribbin 1984, 228–29). Or do the particles somehow know what is going on with each other? This seems an "unattractive proposition" to Hiley (Hiley 1977, 413). Jack Sarfatti suggests a faster-than-light transfer of information without signals. Or perhaps nonlocality connects the two particles immediately and intimately (Zukav 1979, 310–14). Shimony, who offers a property called *passion*, allows the instantaneous matching of the behaviors of two particles far apart, without their interacting via any forces known to classical physics. There is some form of communication that does not involve information-passing as we know it. Jean-Pierre Vigier replies: "Passion without interaction isn't satisfying" ("Passion at a Distance . . ." 1986, 12).

Some approaches differ from those above. For example, Itamar Pitowsky claims the EPR experiments only point to a problem with the theory of probability in quantum physics. Changes to this theory allow him to sidestep Bell's theorem (Pitowsky 1982). He is also controversial (Ballentine 1987, 790).

An unconventional way of presenting quantum theory makes use of hidden variables. Quantum theory principally deals with the quantum or subatomic level—the level of the world where electrons and other objects smaller than the atom exist. These make up atoms. Lower down the scale, hidden variables help make the objects of the subatomic level. They are some of the building blocks of such particles as electrons, and the behavior of the hidden variables determines the behavior of particles at the quantum level. It is like understanding the behavior of a nest of ants as the net outcome of the behavior of each ant in the nest. This way of explaining quantum-level phenomena, however, creates a problem. It contradicts the usual approach to quantum physics, whose uncertainty principle says there is no way to determine the behavior of subatomic particles. There is only a chance that an electron, for instance, has a particular position and velocity. We cannot make two definite statements about the electron. If we know that it is in such and such a place, we cannot know the velocity at which it is traveling. It is not possible, according to the usual understanding of quantum physics, to be precise about two such properties at once. However, a theory of hidden variables says that, in principle, it is possible to be precise about them. If we know the behavior of the hidden variables of the system, we can predict with certainty—within experimental error—the behavior of the electron. To fly in the face of the accepted approach in this manner creates major opposition to hidden-variable theories.

Einstein made use of hidden variables in his EPR paper. He showed that the nonlocality of accepted quantum physics leads to faster-than-light communication; but this is unacceptable. He then rebuilt quantum theory, using hidden variables, and suggested that his new theory resolves the EPR problem. Since the hidden variables would underlie the existence and behaviors of both particles in the experiment, they could determine the simultaneous spin changes. It is like pushing one button to cause two effects.

However, the hidden variables of Einstein are *local* hidden variables. Although he hoped they would help remove the so-called strange nonlocality he saw in quantum physics, he was wrong. The Aspect experiment rules out their existence. Physics must therefore abandon his alternative base for quantum theory. Thus we need to come to terms with the nonlocality of quantum physics. The problem is how to explain it.

Bohm has built several bases for approaching quantum physics that differ from the usual. One uses nonlocal hidden variables, and agrees with the EPR experiments. Bohm can explain how nonlocality occurs, and thereby help us come to terms with it (Bohm and Hiley 1984, 260–62).[1] For him there is no faster-than-light signaling or an instantaneous awareness; rather, he suggests, there is something including or underlying simultaneous but distant events. This underlying something means that the events are not distinct (Bohm and Aharonov 1957, 1072). There is a type of connection between events at the quantum level even if they happen simultaneously.

Several physicists follow Bohm. Richard Mattuck lists reasons why nonlocal hidden-variables theories have merit: "First, such models can yield agreement with quantum physics. Second, they can solve the quantum measurement problem [a puzzle raised by the usual quantum physics]. Third, history shows us that it is risky to reject theories on the grounds that they defy 'common-sense'. Fourth, these models may reflect a [basic], inescapable nonlocality in nature itself" (Mattuck 1981, 331).

THE HOLOMOVEMENT THEORY OF BOHM

Hidden-variables theories are one of the ways Bohm tries to understand and explain such quantum phenomena as nonlocality. Another is to develop his holomovement or "implicate order" ideas. These theories, which center on the notion of unbroken wholeness, deny the dominant picture of the world as made up of separate and independent parts.[2]

One of the ideas by which Bohm and Hiley describe unbroken wholeness is that of a system. Classical physics studies each part of the universe as separate, and brings the parts together to explain the whole. Bohm and Hiley, however, take the relationships between the parts and the qualities of a part as dependent on the whole. They do this even if, for practical purposes, they treat the part as separate. Thus they do not see the world as made up of independent elementary parts arranged into systems. Rather, each part connects with every other part at the quantum level. The whole universe is the basic reality. The system of the whole comes first; the separate parts are only temporary approximations (Bohm and Hiley 1975, 101–6).

Bohm and Hiley divide reality into supersystem, system, and subsystem. They do not, of course, assume (as does classical physics) that subsystems explain their larger system, or that a subsystem is independent of its larger system. Subsystems are usually dependent on the systems that include them. Subsystems and their larger systems form a chain that extends to the whole universe.

The emphasis on dependency is what Bohm calls *wholeness of form*. It means that a complete description is never possible. Every system is in a supersystem. A theory that claims it is complete has closed itself off from the unknown whole into which everything merges.

The idea of a system is only a beginning of Bohm's trying to develop the notion of unbroken wholeness. And it is easier to understand than his others. Another revolves around the holomovement, which is basic to reality. "*What is* the holomovement?" (Bohm 1980, 178).

There are two essential properties of the holomovement. The holomovement's model for reality comes from the properties of a holographic image of an object, which forms on a photographic plate by capturing a certain pattern of light. This pattern is the interaction or interference pattern of two portions of a beam of laser light. One beam reflects off an object; the other reflects off a mirror. Lighting the photographic plate with a laser will produce an image of the object that has three dimensions. In addition, the plate has the property that an image of the whole object forms by lighting any portion of the plate. When a piece of the plate is lighted, the image will have less detail than when the whole plate is lighted. The smaller the portion of the plate lit up, the less the detail. The point is still the same, however. Any portion of the holographic plate (the hologram) contains information on the whole object (Bohm 1973, 144–45).

The major point about the hologram, according to Bohm, is not the photographic plate; rather, it is that movement is constant (Bohm 1978b, 91). Light waves from the laser continually interfere with those reflected off the object, and the interference pattern is a moving web of the light waves interacting with each other in a limited region of space. The holographic plate captures the moving pattern. The first aspect of the holomovement pertains to the *movement* part of the word. Rather than taking something essentially static and rigid as the basis for their new order, Bohm and his colleagues propose to make activity basic (Hiley 1980, 94).

Psychological and neurological research shows that the idea of an unchanging object is learned in early childhood. However, Bohm suggests there is a more primitive level of perception than that of objects. Movement, or change, or breaks in regular arrangements are basic. From the confusing mass of movements that we sense, our minds make stable simplifications. From these, in turn, we build the objects we see as relatively fixed or slowly moving (Bohm, Hiley, and Stuart 1970, 175). Bohm thinks that our commonsense descriptions of objects as unchanging are devices we learn to think of as primary. Classical physics mirrors this commonsense approach.

Grammar also mirrors this object metaphysics that our culture conditions us to accept. For instance, the noun, the indicator of an object, has a primary grammatical role; however verbs, which call attention to action, have a secondary status. Bohm wants us to stop taking objects as primitive. He wants to give the basic role to the verb and to think of nouns as creations from verbs. Thus Bohm's new approach to language emphasizes movement and activity (Bohm 1980, chap. 2).

The second element of the holomovement is undivided or unbroken wholeness. The word *holomovement* uses the prefix *holo*, from the Greek word meaning "whole," which refers to the unbroken and undivided movement that Bohm takes as basic (Hiley 1980, 78). The wholeness parts of the holomovement idea draw on the hologram. The photographic plate of the hologram records the interference pattern of light in its region of space. Within this pattern, and therefore in the plate, is the whole lit-up object. The whole object becomes part of the light in each region of space.

Bohm builds the hologram into an idea of undivided wholeness. He suggests that each region of space and time contains the total order of the universe, including the past, the present, and the future (Bohm 1980, 177). Bohm thinks of everything as folded into everything. He uses the idea of the *implicate order*. (The word *implicate* comes from the verb *to implicate*, meaning "to fold together.") Reality as implicate means, for Bohm, that any portion of it involves every other portion. Each portion of reality contains information on every other portion. One could say that each region of space and time contains the structure of the universe within it. The whole is in some sense contained in any region (Bohm 1973, 146–47).

The holomovement is an example of the implicate order. Bohm defines the holomovement as that which carries an implicate order. The movement of the holomovement in each region carries information on every other part of reality. This is analogous to the hologram. The movement of light in each segment of space carries information on the whole lit-up object.

Bohm and his colleagues rebuild quantum theory from their informal language centered on the holomovement. They claim that the holographic image is a better explanation for the reality that quantum theory describes than the usual approach. The latter, they claim, relies in part on classical metaphysics (Bohm 1978a, 37–38). In particular, holomovement physics explains nonlocality. In the holomovement, the basic connections between elements are neither local nor nonlocal. They are, rather, alocal, or neutral concerning locality. The nonlocal connections of the EPR experiment can be thought of as coming from the more basic alocal connections of the holomovement (Hiley 1980, 93).

THE METAPHYSICS AND RELIGION OF BOHM

The physics community will determine whether Bohm's theories stand or fall as physics: his hidden variables, holomovement, and other theories. People who are not physicists cannot pass judgment. At the moment, most physicists do not accept Bohm's theories, but only time and experiments will tell. The only experimental test of his ideas disconfirmed the second of his hidden-variables theories (Papaliolios 1967). The strength of Bohm's physical theories is that they overcome perplexities in the usual approach (see, for example, Bohm and Hiley 1984)..

Bohm's theories should not be applied out of context. Some writers use his physical theories to support their metaphysics, as if the weight of physics were behind Bohm (see Bohm and Hiley 1976). On the other hand, his theories are also metaphysics, and the holomovement theory is an example. Its evaluation as a metaphysics does not entirely depend on its success or failure as physics. Some theologians think it may be useful as a base for their discipline (e.g., see Peters 1985).

Bohm and his theories have a religious and philosophical background, which of course does not come out of a vacuum. He grew up in a Jewish household, and Eastern mysticism has influenced him since childhood. Jiddu Krishnamurti, the Indian philosopher in whom Bohm became interested in 1959, has played a special role in his life and thought. Bohm has always had a sense of the wholeness of nature and a drive to break free from conventional ideas, many of which he finds distorting and inappropriate. "[I]t is far more dangerous," he writes, "to adhere to illusion than to face . . . the actual fact." What is the point of life, he asks, if one lives in an invented world? There is none if there is no relationship to people, the world, or anything (Briggs and Peat 1987, 70; and Temple 1982, 361–63).

Bohm's metaphysical beliefs underlie, as well as inspire, his physics. What follows in the rest of this section, regarding Bohm's metaphysical base, also introduces some beliefs that have helped shape his physics. The beliefs are also religious in the sense that they resemble ideas from some religions.

That reality has *endless depth* is one of the core ideas in Bohm's metaphysics; that is, what we know of reality does not exhaust it. Although our scientific knowledge may grasp its significance to a marked extent, its properties and qualities will always be beyond us. We cannot imagine or intuit how far reality lies beyond our knowledge. Every object and process, Bohm writes, has infinitely many sides to it. At any time, the laws and the ideas used by science only partly express the objects or processes supposedly covered (Bohm 1976, 3). If reality did not have stability, Bohm suggests, there could not even be the approximate representations presented by scientific theories. For the predictions of a theory to be right at least some of the time reality must have stability.

Since nature is always beyond human knowledge, Bohm says that a theory is only a limited insight. It is like a light shining on some aspects of reality, penetrating—to an extent—into the open and unknown. Thus one ought to expect a continuing development of quite different insights. Further, there can be no steady approach toward fixed knowledge. Bohm interprets the history of science as matching his idea of the unending creation of new forms of insight. Each form is in harmony with the real world only to a certain extent. The unclear features of a theory need investigation only for amplification; they may not *have* a resolution but point, instead, towards new forms of insight (Bohm 1976, 3).

That the parts of reality *relate* to each other is another core idea. Again, Bohm emphasizes the wholeness of reality. Every segment selected from it connects with any other segment, and isolating pieces from reality may oversimplify them and distort their true character.

Bohm frequently raises the question of relation or its opposite, fragmentation. In an article titled "Fragmentation in Science and Society," he writes that science and technology have flaws, with damaging results for society, because they reflect an important problem in society itself: fragmentation. No human act, no element of life or the environment, no human activity is an island, any more than an individual is an island. However, people deal with fragments as separate objects; they do not think how the fragments act with each other within wholes. Bohm opposes fragmentation to wholeness, with the dynamic character of the latter moving in cycles, as he asks us to think in wholes (Bohm 1970, 159).

Connections between objects and events are often emphasized in Bohm's physics. Whereas a thorough mechanist emphasizes an objectivity of uninvolved and distant physicists, Bohm opposes this notion to a person-involving subjectivity attained by emphasizing relations. He thinks that the mechanist outlook is inadequate. Further, it is dangerous, for it can become an authoritarian faith. He believes, instead, in openness between the two approaches and a close relationship between the subjective and objective. Neither can stand in its totality; they are two views of one reality (Bohm 1974).

The third core idea is *movement*. The whole and any piece of reality are constantly in process, in movement, in activity. "Rocks, trees, people, electrons, atoms, planets, galaxies, are . . . the centers or foci of vast processes, extending ultimately over the whole universe" (Bohm 1969, 42). Again, each piece of reality is constantly changing, and each center or focus of change refers to some aspect of the total or overall process of the universe.

There are connections between the three metaphysical ideas mentioned above. For instance, the latter two support the first by suggesting two ways in which reality has depth: (1) its seemingly isolated segments relate with each other and (2) they are always moving.

Two further ideas have their roots in the three core ideas. The first is that the movement of reality is *creative*; reality is always transforming itself. "There are no basic objects, entities, or substances, but . . . all that [we can observe] comes into existence . . . remains relatively stable for some time, and then passes out of existence" (Bohm 1969, 43). Each piece of reality continuously forms, re-forms, transforms, and ceases to be.

The second idea (the fifth in all) is that reality divides into *levels*. The levels, in turn, are enmeshed in systems of hierarchies. This is one way to represent the qualitative infinity of nature, its endless depth (Bohm 1969, 51–58).

The world contains infinitely many levels. A set of laws, based perhaps on probabilities, direct causes, or both, characterizes each level. The validity of a set of laws need not apply beyond its level, where quite different processes may appear. To describe the latter requires a new set of laws (Feyerabend 1960, 328–30).

Reality, Bohm says, has endless depth, divides into levels, and its parts relate to each other. The whole and every piece of it is constantly creative and in process. Besides these beliefs, Bohm specifies others, including the following. Consciousness is material, with its origin in the holomovement. Fragmentation and chaos infect consciousness and the world. And there is something beyond the world and the holomovement (Bohm and Weber 1978).

CAPRA AND THE BOOTSTRAP THEORY

Fritjof Capra stirred interest in the comparison between physics and such metaphysical or religious ideas as wholeness with his book *The Tao of Physics* ([1975] 1977). His subtitle explains his work: an "exploration of the parallels between modern physics and Eastern mysticism." An article in this issue of *Zygon* by Robert Clifton and Marilyn Regehr that explains and critiques Capra's thinking (1990, 73–104)[3] interprets Capra as tying his religious beliefs to physical theories. Their chief problem with his approach is its danger: physical theories may change or have various interpretations. Fickleness therefore applies to any religious beliefs wed to such physics.

I find Clifton and Regehr's criticism underdeveloped. They do not say *why* it is dangerous or unhealthy to have religious beliefs that can change and be open to various interpretations. What is wrong with questioning a theology because science has replaced its base? Why should we want a theology that is permanent? It is healthy, on the contrary, to question a theology as society and its ideas change, because each theology builds from a metaphysics that can go out of vogue. A theology also assumes a social order that we might question, as liberation theology does admirably. Further, Clifton and Regehr point to a physical theory having several interpretations, but this is true for all fields—and theology transgresses more than most. One has to live with this problem and justify the interpretation one eventually takes.

Clifton and Regehr propose an alternative to tying religious ideas to physical theory while retaining some relationship between physics and theology. Their solution to what they call the *positive conformity problem* (1990, 95) asks two questions: Why can we present the interaction between us and the world in rigorous mathematical terms? and Why can we be so successful in using mathematics to predict what might happen? This capacity allows us to control the world. They base their solution not only on the belief that God created human beings, but that God intentionally gave us those qualities with which we describe and predict our interactions with the physical world.

I believe there are nonreligious answers to the positive conformity problem, which Clifton and Regehr have not considered. In fact, the very evolution and development of human belief systems produce a solution. A function of a belief system is to increase the believing group's chances of survival, and control of the environment is essential to human survival. *All* belief systems must enable control of the environment, to some extent or other, for the believing group to survive. Further, the better a belief system is at controlling the world, the more likely it is to survive, flourish and dominate. Western science appears better at doing this than other belief systems (Sharpe 1984, 48–49, 105).

Another approach compares the physical matter of our brains and the physical matter of the universe outside of our brains, and finds they are the same. Moreover, the brain and nonbrain stuff obey the same laws. Thus our theories, as products of our brains, may reflect the laws that control our brains and the world.

Clifton and Regehr promote their interesting solution in the following ways. First, it reassures those who hold a theistic faith: their faith is reasonable and they do not have to seek its confirmation from science. Second, it sidesteps science's changing nature and various interpretations. Third, it satisfies the theist by not separating science and theism into two, unrelated realms (1990, 99).

My solutions, however, undermine the reassurance granted by Clifton and Regehr. Nevertheless, for many people, my suggestions may be more reasonable than appealing to the theistic competitor. We have not secured a place for God, who does not fill this gap. Nor does Clifton and Regehr's proposal escape the changing nature of science and its different interpretations, because a time may come when changes in science explain the positive conformity question (perhaps my proposals may lead to such explanations). Also, we have to deal with the many interpretations of the new scientific theory. Finally, rather than avoiding the segregation of theism and science, their proposal may promote it. When faced with such natural explanations as I have proposed, theists may want to dig their heels more deeply into their beliefs.

In short, I find Clifton and Regehr's criticism and alternative to Capra's work unconvincing. They do not show an error in tying religious beliefs to scientific theories. Neither does their approach work; theology cannot be immune to changes in science while still in dialogue with it. Their theological answer may have scientific competition that may be more adequate. I am skeptical about conducting that dialogue while saying one side cannot change the other.

Most critics of Capra, including Clifton and Regehr, overlook an aspect of his work. More than pointing out the parallels, and more than seeking validation of his religious beliefs from physics (as Clifton and Regehr believe), Capra may be employing Eastern mysticism for help in solving certain puzzles in quantum theory. Indeed, one of Capra's parallels between physics and Eastern mysticism is the bootstrap theory, in which he moves beyond the similarities, seeking, instead, an influence of mysticism on physics.

Capra suggests the bootstrap theory not only as a physical theory but also as a vision, a metaphysic, of the universe. "Bootstrappers" believe the universe is a dynamic web of related events, with no basic parts or properties, be they laws, equations, or principles. Any property of a part of the universe follows from the properties of all the other parts. The harmony of all the relationships between the parts determines the structure of the web. Moreover, they believe that the structure of the universe at the subatomic level follows from a few general ideas that they think are important. They explain the universe's properties by its properties ("each particle helps to generate other particles which in turn generate it"). In so doing, they have the universe pulling itself up by its own bootstraps (Capra 1977, 276, 291–92; Dull 1978, 389).

Perhaps Capra puts forward the bootstrap idea because it is close to the way he sees Eastern mysticism, which is, after all, of considerable meaning and importance to him. I say this because Capra's way of presenting the theory suggests that physics accepts it. The theory, however, is now out of vogue and faces many difficulties (Dull 1978, 388–89). The quark competitor, which says there is a most elementary particle that explains other particles, appears to be more acceptable. Even Capra admits to considerable problems in setting up and confirming the bootstrap theory (Capra 1977, 290).

Although Capra appears to prefer the bootstrap theory for physics because it is similar to the ideas of Eastern mysticism, this does not mean it has no use or truth as a theory for physics. I mean that part of the drive for suggesting and upholding it lies in Capra's belief that it is true. Capra has been most energetic in trying to show that it is more adequate and truthful than its competitors, and some of his energy comes from his religious or mystical experience. In this way, Capra's religion is influencing his science. He supports and develops a physical theory because it is more or less the same as his religious belief.[4]

Capra says he is not proposing a synthesis of science and mysticism, and in some places he is even quite clear about their separation. One does not contain the other, he believes; physics and mysticism complement each other. Each provides a type of understanding, a mode of knowing, that the other cannot (Capra 1977, 297). I do not agree with him. Moreover, he misleads us. Capra's proposing and use of the bootstrap theory contradicts the separation he sometimes affirms.

John Schumacher and Robert Anderson, in their "Defense of Mystical Science," want to reconcile science and mysticism, to they hope for "a new and fuller science", and they point to considerable interest in some possible similarities between central ideas of contemporary physics and those of Eastern mysticism (1979, 73). As Schumacher and Anderson suggest, there is even interest in developing a new science, based on what some consider to be truths uncovered by Eastern mysticism. Capra's physics and religion are examples of this attitude.

There is a movement from science to religion, because religion is using scientific ideas in a variety of ways. Clifton and Regehr's example is Capra, who, they suggest, is trying to support his religious beliefs with physics. (One could also construct a scientifically informed metaphysics, or make religious ideas conform to science.)

I also see a movement from religion to science, as Schumacher and Anderson intimate. In some ways, they want to base science on religious insights, as Capra is trying to do by introducing and upholding the bootstrap theory.[5]

Early in this century the mysticism of various schools influenced several physicists, such as Arthur Stanley Eddington, a Quaker and Christian mystic who believed in a close connection between spiritual and scientific inquiry. For him, knowledge gained in one field influenced knowledge gained in the other (Douglas 1956, 136).

In the same way, Bohm's religious ideas appear to shape his physics. By his rebuilding of physics, he may be trying to use religion in physics, making the latter spiritual or mystical (Restivo 1983, 117, 121, 124).

There are several reasons why I think Bohm is using religion in physics. First, he is trying to create not only a physics but an entire worldview beyond physics. Second, as I suggest, Bohm's own religious interests motivate him. The third reason centers on his efforts to rebuild physics—what he accepts and what he rejects. There is no convincing reason, from physics, for making the choices he makes (Bohm 1971, 369-79, and Sharpe 1983, 48). Bohm's motivation may come from another religious source.

The point is that Bohm's idea of undivided wholeness has its roots in religion or mysticism, and it may or may not be useful in physics. Bohm proposes it as a physical hypothesis, subject to testing by physics. Another contribution of religion is to create in a believer such as Bohm the dedication, enthusiasm, and tenacity to strive to have his ideas accepted as a physical theory, despite all opposition and difficulties.

The physics of Bohm and Capra show that religion can try to add to the knowledge of the "hardest" science, namely physics. Many religions, including Christianity, have much to say about the nature and direction of the physical world, and they should not be afraid to bring these ideas, in appropriate forms, to the sciences. As hypotheses, they are, of course, subject to the strictures of factual support.

NOTES

1. The reference also outlines Bohm's quantum potential theory. This is his most recent approach, closely related to his original hidden-variables theory. Between proposing these two theories, he championed another hidden-variables theory with Jeffrey Bub (Bohm and Bub 1966).
2. Although hidden-variables theories are physics, they also have a metaphysical base. Presentations of the holomovement/implicate order theories usually represent them as a philosophy or metaphysics. However, they have a physics counterpart. Bohm and his colleagues have modeled them mathematically (e.g., Bohm 1973), even though they now appear to have abandoned this approach.
3. They omitted mentioning an important work on Capra, namely Restivo's (1983).
4. Clifton and Regehr tell us that taking "theistic conceptions as *physical* hypotheses is simply misguided" (1990, 95), but they do not say why this is so.
5. Elsewhere I suggest a ladder model as a way of thinking about this science = religion integration (Sharpe 1984, 86–91).

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