THEOLOGY AND PHYSICS FORTY YEARS LATER

by Ian G. Barbour

Abstract. Almost forty years later I look back on a 1966 article on theology and physics by Sanford Brown and my response published with it. I reflect on his hope that theological seminaries would give attention to the methods used in scientific inquiry. I compare our comments with subsequent thought on three issues: (1) the role of models in science and religion; (2) the relation of wholes to parts in physics and other sciences and the debate over reductionism and emergence; and (3) the implications of quantum physics for theology, including the possibility of divine action at the quantum level.

Keywords: Sanford Brown; divine action; emergence; indeterminacy; levels; models; quantum theory; reductionism; wholes and parts.

The inaugural issue of *Zygon* included an article on theology and physics by Sanford Brown (1966) and my response (Barbour 1966a). No one could have foreseen the immense influence the new journal would have in subsequent years on almost every aspect of the science-religion dialogue, including the comparison of methodologies and the discussion of theological implications of virtually every scientific discipline. Brown's article opened by expressing the hope that an understanding of the methods of science would have a significant role in theological education. Forty years later that hope has been only partially realized. In colleges and universities there has indeed been a substantial growth in courses on science and religion, especially in the 1990s with encouragement from the course program of the Center for Theology and the Natural Sciences (CTNS) in Berkeley, funded by the Templeton Foundation. But comparable courses in theological seminaries have not grown as rapidly.

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Brown was a physicist and Associate Dean at M.I.T. Scientists have been active in the dialogue since then, notably through the Chicago Center for Religion and Science (now the Zygon Center) and at the Star Island (New Hampshire) summer conferences of the Institute for Religion in an Age of Science, in which Brown had participated. Scientists have also been active in CTNS programs. Recently the CTNS "Science and the Spiritual Quest" program enlisted prominent scientists from all the major world religions in small workshops and public presentations around the world. In it the dialogue was expanded beyond Christianity and naturalistic humanism to the traditions of Judaism, Islam, Buddhism, and Hinduism. The encouragement of inquiry that is both interdisciplinary and interfaith is the distinctive challenge for the future.

Three topics were central in Brown's article and my response.

1. The Role of Models. Brown defended the use of conceptual models in both scientific and religious thought. He said that it is sometimes necessary to use complementary models, such as wave and particle models of light, even though they cannot be integrated in a single model. In my response I suggested that in *naive realism* scientific models are viewed as literal representations of reality, whereas in *instrumentalism* models are taken to be useful fictions that help us make predictions about observable phenomena. I advocated *critical realism* as an intermediate position: "One has to use models, but one has to recognize their limitations; one has to realize they are partial and limited, that each one selects certain aspects of the world and emphasizes those, that none of them corresponds exactly in any simple way to reality" (Barbour 1966a, 30). I suggested that personal models of ultimate reality are more prominent in the religions of the West, and impersonal models are more prevalent in Eastern religions, but both are found in all the world's religious traditions. I concluded, "The logic of models in both science and religion, and their relation to experience, needs to be explored more fully if we want to make any kind of comparison between them" (1966a, 30).

I had already begun such an exploration in *Issues in Science and Religion,* published the same year that *Zygon* was launched (Barbour 1966b), and I carried it further in *Myths, Models and Paradigms* (Barbour 1974) and in my Gifford lectures (Barbour 1990, 41–51). During the intervening years a number of authors compared scientific and religious models, including Sallie McFague (1982) and Arthur Peacocke (1984). Critical realism in both disciplines was endorsed by Peacocke and by John Polkinghorne (1991). However, Nancey Murphy (1996) has accepted some of the critiques of critical realism found in postmodernism. A helpful summary of this ongoing debate is given by Kees van Kooten Niekerk (2003).

2. Wholes and Parts. Brown said that physics uses distinctive concepts applicable to systems as a whole as well as concepts applicable to their component parts. For example, without knowing the details of the behav-

ior of individual particles one can treat them statistically as an ensemble whose overall behavior can be predicted. My response gave additional examples from physics. In quantum theory the wave function of an atom refers to the atom as a whole, and individual electrons at the same energy level cannot be identified, as expressed in the Pauli Exclusion Principle. Solid state physics studies the energy states of a crystal as a whole. I also emphasized that systems can be organized at a variety of levels as one moves from physics to chemistry, biology, and then psychology. I wrote, "Man is indeed composed of nothing but atoms; yet in man there occur patterns of activity and types of event which do not occur in separate atoms. So we must also use distinctive concepts and theories which refer to higher levels of organization in integrated systems. . . . The point is that one can use a variety of types of explanatory model at different levels (Barbour 1966a, 28).

In the years since then there has been an ongoing discussion of reduction and emergence. *Epistemological reductionism* is the belief that theories applicable to higher levels can (at least in principle) be derived from theories referring to lower levels. *Ontological reductionism* is the belief that events at higher levels are determined by the behavior of lower-level components. *Emergence* denies both of these claims and argues that novel patterns of activity appeared in evolutionary history; they also appear at a variety of levels today, notably in the development of an embryo and the life of an organism (Barbour 1990, 230–35). Emergence has been a central theme in the writing of Peacocke (1993, 62; 2001, 108–14) and Philip Clayton (2004), both of whom emphasize the importance of causal influences from whole to part (or from higher to lower levels, sometimes referred to as top-down causality). Additional examples of emergence can be found in the extensive literature on nonlinear thermodynamics, complexity theory, and chaos theory, in all of which there appear in nonliving systems patterns of order different from those of their component parts and not describable by lower-level theories and concepts (Gregersen 2003). In 1966 both Brown and I commented on holism in physics; today the relation of wholes to parts is of interest to authors writing about a wide range of scientific disciplines.

3. Quantum Physics. From quantum physics Brown drew examples of more general methodological principles. In my response to his defense of the need to use complementary models of the quantum world I pointed to another feature of quantum theory: "There is a breakdown of any separation between the observer and the observed, between subject and object. The observer disturbs the system. You cannot deal with the atom-as-it-is-in-itself, apart from the experiment" (Barbour 1996a, 29). I should perhaps have distinguished two interpretations of the role of the observer in quantum measurements: (1) an experimental limitation (the observer as *physical experimenter* disturbs the system) and (2) a conceptual limitation

(the observer as *cognitive subject* is necessary for an observation to occur). Along with most physicists I have supported the first interpretation, noting that quantum events occurred long before human beings were around, and that quantum events today can be recorded by a camera and not seen by a human observer until several years later. But others such as John Wheeler have held that consciousness is necessary for observation in the collapse of a quantum wave function, and Roger Penrose holds that quantum phenomena in neurons play an important role in consciousness (see Barbour 1990, 96–108).

Neither Brown nor I mentioned the possibility of God's action at the quantum level, but it has been extensively discussed since then. Quantum theory allows us to predict only the probability that a particular event will occur within a range of possible events (the Heisenberg Uncertainty Principle). Three interpretations of this uncertainty have been offered. A few physicists continue to hold Einstein's view that all events are precisely determined and in the future we will have a better theory from which exact predictions can be made (ontological determinism). The majority of physicists hold Bohr's view that because of experimental or conceptual limitations we will never be able to know accurately what is happening in nature itself (inescapable epistemological limitations). Still others hold Heisenberg's view that between observations there are multiple potentialities in nature itself (ontological indeterminism). In either of the last two interpretations, God might control or influence the outcome of individual quantum events without altering their probability distributions or violating scientific laws. No input of energy would be needed, since alternative outcomes all have exactly the same energy, and God's influence would not be scientifically detectable. No supernatural intervention is required to alter what would otherwise have occurred, since what would have occurred is unknowable or indeterminate. The possibility of divine action in the quantum world has been discussed in a series of volumes sponsored by CTNS and the Vatican Observatory edited by Robert Russell and collaborators (most recently in Russell et al. 2001).

Quantum theory will undoubtedly be a topic of interest to theologians in the future, along with issues arising in cosmology concerning the beginning of the universe, life on other planets, and the end of life on our planet. Perhaps Brown's hope will yet be realized that many people will become well enough informed about both science and religion to discuss such questions intelligently.

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