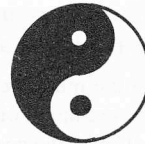
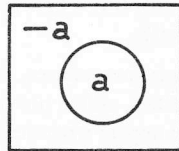


HOW DID NIELS BOHR UNDERSTAND COMPLEMENTARITY?

Archie J. Bahm

This question has become important in the context of Western science and technology invading the ages-long Chinese culture accepting a conception of complementarity permeating habitual ways of thinking. At stake are two contradictory conceptions of complementarity.



Western science normally presupposes a mathematics and logic based on clear distinctions between classes, for example, which, when they have no members in common, are regarded as "contradictory". For example, when a , any class, and $-a$, all other classes, together constitute the universe (all classes), they are regarded as both contradictory (in having no members in common) and complementary (in together constituting the universe completely). Each of the two, a and $-a$, is the complement of the other, so their relationship is called "complementary". "Complementarity" is here conceived in terms of contradiction.

Ancient Chinese conceptions of tao, existence, according to Lao Tzu, presupposes the omnipresence of opposition.

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The principle of opposition is inherent in Nature. The tendency toward opposition is ever-present. Opposition is the source of all growth. Yang, the principle of initiation, persists, and yin, the principle of completion, continues also. Why do such opposing principles persist? Because they inhere in Nature, rather than stand by themselves¹.

And

by acting together complement each other².

How do yin and yang complement each other? Together they constitute tao, not only completely, and thus complementarily, but also by constantly sharing such completeness both by being continually present in tao (signified by the fact that a diameter revolving about the circle always covers some of both) and by a dot of each embedded in the other (to symbolize mutual immanence of each in the other). So conceived, the complementarity of yang and yin excludes any sharp distinctions of the kind conceived as contradiction.

The Chinese conception intends to be realistic in attributing the complementarity of yang and yin to tao as actual existence. Niels Bohr's conception results from the embarrassing evidence that, although the particle and wave conceptions are contradictory, both are needed to account for the conflicting evidences resulting from experiments. So, without committing himself about the actual nature of light, he formulates his theory in terms of descriptions of contradictory evidences both of which seem needed to account for experimental results.

It is only by the mutual exclusion of any two experimental procedures, permitting the unambiguous definition of complementary physical quantities, which provides room for new physical laws, the coexistence of which might at first appear irreconcilable with the basic principles of science. It is just this entirely new situation as regards the description of physical phenomena that the notion of complementarity aims at characterizing³.

The notion of complementarity points to the logical conditions for description and comprehension of experience in atomic physics⁴.

All we can demand in a new field of experience is the removal of any apparent contradiction. However great the contrasts exhibited by atomic phenomena under different experimental conditions, such phenomena must be termed complementary in the sense that each is well defined and that together they exhaust all definable knowledge about the objects concerned⁵.

¹ A.J. Bahm, *Tao Teh King by Lao Tzu*, New York: Frederick Ungar Publishing House, 1958, p. 15.

² *Ibid.*, p. 43.

³ Niels Bohr, *Atomic Physics and Human Knowledge*, New York: John Wiley, 1958, p. 61.

⁴ *Ibid.*, p. 91.

⁵ *Ibid.*, p. 90.

The notion of complementarity simply characterizes answers we can receive by such inquiry whenever the interaction between the measuring instruments and the objects form an integral part of the phenomena⁶.

Evidences gained by different experimental arrangements cannot be comprehended on accustomed lines, and the necessity of taking into account the conditions under which experience is obtained calls directly for the complementary mode of description⁷.

If Bohr's conception of complementarity is limited to regarding two contradictory conceptions as both necessary for a complete account of the nature of light, his conception of complementarity is defined in terms of contradiction. If the Chinese conception of complementarity excludes the concept of contradiction, then the Chinese conception and Bohr's conception are contradictory.

If some Chinese believe that Bohr, who adopted the term "complementarity" to describe contradictory results from experiments regarding the nature of light, thereby adopted their traditional concept of complementarity as symbolized in the yin-yang symbol, then their belief seems unwarranted.

Department of Philosophy
University of New Mexico (Albuquerque)

⁶ *Ibid.*, p. 4.

⁷ *Ibid.*, p. 2