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Arlington Towers, T-438
Arlington, Virginia
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Dear Dr. DeWitt:

Professor Wheeler has sent me a copy of your letter concerning my paper, "On the Foundations of Quantum Mechanics." I found your comments quite interesting and well expressed -- so well that I am taking the liberty of sending parts of your letter to others with whom I am corresponding.

I find your analysis correct and penetrating on most essential points, particularly with respect to the parallel between my theory and the theory of Relativity. I must take issue, however, with what you call the major flaw in the theory, the question of the transition from "possible to actual."

First, I must say a few words to clarify my conception of the nature and purpose of physical theories in general. To me, any physical theory is a logical construct (model), consisting of symbols and rules for their manipulation, some of whose elements are associated with elements of the perceived world. If this association is an isomorphism (or at least a homomorphism) we can speak of the theory as correct, or as faithful. The fundamental requirements of any theory are logical consistency and correctness in this sense.

However, there is no reason why there cannot be any number of different theories satisfying these requirements, and further (somewhat arbitrary) criteria such as usefulness, simplicity, comprehensiveness, pictorability, etc., must be resorted to in such cases. There can be no question of which theory is "true" or "real" -- the best that one can do is reject those theories which are not isomorphic to sense experience.

When one is using a theory, one naturally pretends that the constructs of the theory are "real" or "exist." If the theory is highly successful (i.e. correctly predicts the sense

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perceptions of the user of the theory) then the confidence in the theory is built up and its constructs tend to be identified "elements of real physical world." This is, however, a purely psychological matter. No mental constructs (and this goes for everyday, prescientific conceptions about the nature of things, objects, etc., as well as elements of formal theories) should ever be regarded as more "real" than any others. We simply have more confidence in some than others.

A crucial point in deciding on a theory is that one does not accept or reject the theory on the basis of whether the basic world picture it presents is compatible with everyday experience. Rather, one accepts or rejects on the basis of whether or not the experience which is predicted by the theory is in accord with actual experience.

Let me clarify this point. One of the basic criticisms leveled against the Copernican theory was that "the mobility of the earth as a real physical fact is incompatible with the common sense interpretation of nature." In other words, as any fool can plainly see the earth doesn't really move because we don't experience any motion. However, a theory which involves the motion of the earth is not difficult to swallow if it is a complete enough theory that one can also deduce that no motion will be felt by the earth's inhabitants (as was possible with Newtonian physics). Thus, in order to decide whether or not a theory contradicts our experience, it is necessary to see what the theory itself predicts our experience will be.

Now in your letter you say, "the trajectory of the memory configuration of a real physical observer, on the other hand, does not branch. I can testify to this from personal introspection, as can you. I simply do not branch." I can't resist asking: Do you feel the motion of the earth?

In another place: "...Everett's theory contains all possible branches in it at the same time. In the real physical world we must be content with just one branch. Everett's world and the real physical world are therefore not isomorphic." Yet another: "But the real world does not branch, and therein lies the flaw in Everett's scheme."

I must confess that I do not see this "branching process" as the "vast contradiction" that you do. The theory is in full accord with our experience (at least insofar as ordinary quantum mechanics is). It is in full accord just because it is possible to show that no observer would ever be aware of any "branching," which is alien to our experience as you point out.

The whole issue of the "transition from the possible to the actual" is taken care of in a very simple way -- there is no such transition, nor is such a transition necessary for the theory to be in accord with our experience.

From the viewpoint of the theory, all elements of a superposition (all "branches") are "actual," none any more "real" than another. It is completely unnecessary to suppose that after an observation somehow one element of the final superposition is selected to be awarded with a mysterious quality called "reality" and the others condemned to oblivion. We can be more charitable and allow the others to coexist -- they won't cause any trouble anyway because all the separate elements of the superposition ("branches") individually obey the wave equation with complete indifference to the presence or absence ("actuality" or not) of any other elements.

This is only to say that the theory manages to avoid the difficulty of "the transition from possible to actual" -- and I consider this to be not a weakness, but rather a great strength of the theory. The theory is isomorphic with experience when one takes the trouble to see what the theory itself says our experience will be. Little more can be asked of it without exposing a naked philosophic prejudice of one kind or another.

Of course, I do not hold that this theory is the only possible acceptable interpretation of quantum mechanics. I believe that any number of theories can be constructed which will adequately portray our experience, so that selection among them must be largely a matter of taste.

I do believe, however, that at this time the present theory is the simplest adequate interpretation. The hidden variable theories are, to me, more cumbersome and artificial --

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while the Copenhagen interpretation is hopelessly incomplete because of its a priori reliance on classical physics (excluding in principle any deduction of classical physics from quantum theory, or any adequate investigation of the measuring process), as well as a philosophic monstrosity with a "reality" concept for the macroscopic world and denial of the same for the microcosm.

I would like to point out that from my point of view there is no preference for deterministic or indeterministic theories. That my theory is fundamentally deterministic is not due to any deep conviction on my part that determinism holds any sacred position. It is quite conceivable that an adequate stochastic interpretation could be developed (perhaps along the lines of Bopp's theories) where the fundamental processes of nature are pictured as stochastic processes whether or not they are undergoing observation. I only object to mixed systems where the character changes with mystical acts of observation.

With respect to your "minor" criticisms, most of them are explicitly dealt with in the original work from which the article was condensed. I hope, sometime soon, to revise it and make it available, as it contains a much fuller discussion of the various points, as well as a discussion of the present alternative formulations of quantum mechanics. It is just impossible to do full justice to the subject in so brief an article as the one you read.

Sincerely yours,

Hugh Everett, III

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Copies sent to

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