

C O P Y

UNIVERSITETETS INSTITUT  
FOR  
TEORETISK FYSIK

Blegdamsvej 17  
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Telegrams, Phycicum, Copenhagen

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Prof. John A. Wheeler  
Instituut-Lorentz  
Leiden, Nederland

Dear Prof. Wheeler:

Many thanks for your nice letter. I gave a seminar on Everett's paper on Monday, May 14. Prof. Bohr was kind enough to make a few introductory remarks and open the discussion. Prof. Mercier and Prof. Møller made some comments.

In my opinion, there are some notions of Everett's that seem to lack meaningful content, as, for example, his universal wave function. Moreover, he employs the concept of observer to mean different things at different times--the measuring apparatus, a servo-mechanism for registering experimental results, and its dictionary meaning, that is, common usage. Also, at times, he talks about observers in the sense of a statistical ensemble of classical statistical mechanics, and reminds one of other attempts at a causal, deterministic interpretation of quantum mechanics.

I do not follow him when he claims that, according to his theory, one can view the accepted probabilistic interpretation of quantum theory as representing the subjective appearances of observers. At times he gives one the impression that he believes that, were it not for the interference of physicists (observers) quantum theory would be a continuous, deterministic, and elegant theory. Significantly enough, his second chapter on Probability, Information, and Correlation is the best in his book.

But, to my mind, the basic shortcoming in his method of approach of his erudite, but inconclusive and indefinite paper is his lack of an adequate understanding of the measuring process. Everett does not seem to appreciate the FUNDAMENTALLY irreversible character and the

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FINALITY of a macroscopic measurement. One cannot follow through, nor can one trace the interaction between the apparatus and the atomic system under observation. It is not an "uncontrollable interaction", a phrase often used in the literature. Rather, it is an INDEFINABLE interaction. Such a connotation would be more in accord with the fact of the indivisibility, the wholeness of the quantum phenomenon as embodied in the experimental arrangement.

Interestingly enough, now that molecular causes are being discovered for various serious ailments as well as for basic biological phenomena, a problem similar to the observation problem has arisen in the biological sciences. Let us take a concrete example that has recently been in the news. There has been good evidence accumulating in recent years that schizophrenia is due to some "abnormal" molecular process in the blood. However, to trace the schizophrenic phenomenon from the basic molecular level to the observational level of its psychological symptomatic manifestations is an aspect of the observation problem. It cannot be traced in the detail of a space-time description. Moreover, the space-time coordinates, such as, position and momentum, are not relevant for the description of such phenomena. All this may seem far from physics, but the transition from the microscopic to the macroscopic observational level presents a problem in biology similar to that in physics. In biology, of course, the event is infinitely more complex, but it is likely that a common basic principle is operative in both cases.

Then there is the concept of state in quantum theory. An elementary system does not come with a "ready-made" state. It does not possess a state in the sense of classical physics. Its state (usually the initial state) is prepared. The probability distribution in quantum theory implies more than a mere information content. Rather, the experiment is so designed as to give a meaningful information

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PATTERN. One can no more exclude meaning and understanding from physics than one can substitute servo-mechanisms for physicists. Wave mechanics without probability excludes physicists.

In your letter you ask, "Do we need mathematical models, like those of game theory, that will include the observers, in order to put across to the mathematically minded what is meant by these ideas?" (I take it you mean complementarity and other ideas of quantum theory "as distinct from the mere formalism.") But the mathematical model of game theory has different ideational implications from those of quantum theory.

The role and behavior of the observer in game theory are fundamentally different from those of the observer in quantum theory. The observer in quantum theory prepares the initial state of the system, but this is certainly not a legitimate function of the observer in game theory. For example, the preparation of a deck of cards in a certain initial state in a game of poker would violate the rules of the game, if not the ethics of the observer who has prepared the system. In physics, the meaningful pattern is associated with the probability distribution of the system other than that of the observer, while in game theory it is associated with the behavior of the observer (strategy). There is no objective feature concerning the rules of a game. They are man-made and are completely determined by man.

The unobservables in a theory should have observable consequences. The unobservables and the observables together form the theoretical structure, and they must be logically connected. If Everett's universal wave equation demands a universal observer, an idealized observer, then this becomes a matter of theology. If a complete knowledge of the state of the composite system (apparatus plus atomic subsystems) involves practically an infinite number of observers which cannot communicate with one another, then we are talking metaphysics. One may invoke the image of a large number of mystics in

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different "resonant" states. Heisenberg's recent attempt at a theory of elementary particles is a good example of what I mean. Heisenberg has conceived of a Hilbert Space II in which the rules of quantum theory do not apply. It is in some sense a symbolic receptacle wherein he can deposit the undesirable features of present-day field theory, and there is no logical thread of connectivity between his symbolic limbo and the rest of his theory.

I cannot help believing that, if Everett went further and carried out his mathematical ideas, forgetting his preconceived model of the univers, which guided, channeled, and concluded his mathematical investigation, he would have come across a contradiction in his work. His claim that process I and process II are inconsistent when one treats the apparatus system and the atomic object system under observation as a single composite system and if one allows for more than one observer is, to my mind, not tenable.

The subjective aspect of physics, which some scholars and philosophers have claimed to detect but have not understood, has its origin in the fact that physics must make contact with reality which is, after all, the way the world appears to us, and can be understood by us. Mathematics and the abstract concepts of physics which it inspires are the connecting links between our all-too narrow and little world and infinite pageant that is nature. In the pursuit of truth the concepts of objectivity and subjectivity are no longer antithetical, but takes on a complementarity aspect. Our formalism must be in terms of possible or idealized experiments whose interpretations thereby involves the use of concepts intimately connected with our own sphere of experience which we choose to call reality. The epistemological nature of our experiments and the objective nature of the abstract mathematical formalism TOGETHER form the body and spirit of science.

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I am sorry I have not read Bush's book on "Stochastic Models for Learning." I went to the University library the day after receiving your letter, but they did not have the book in their collection. I intend to read it when I get back to the States.

Finally, I hope that I have not bored you by telling you many things which you know better than I do. Also, I realize that, in places, my remarks may have been too cryptic, and I should have liked to expatiate, but I felt I should keep my comments within the confines of a letter.

My wife joins me in sending our best regards to you and Mrs. Wheeler.

Sincerely,

Alexander W. Stern