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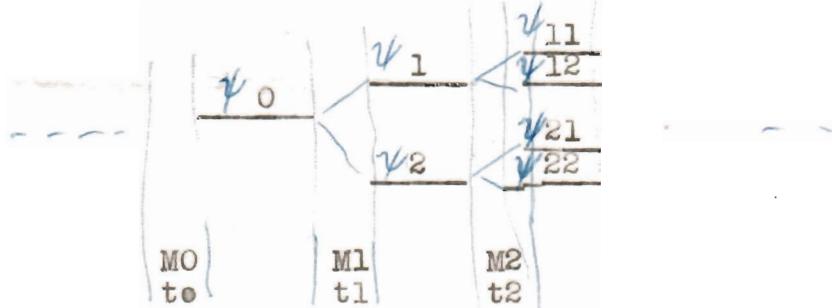
November 24, 1957

Prefessor J.A. Wheeler  
Physics Department  
Princeton University  
Princeton, N.J.

Dear Prof. Wheeler:

After reading Hugh Everett's recent paper on Relative State Formulation of Quantum Theory, I found that I could more readily follow your assessment of it. Hence, I am addressing the following question to you, though you may prefer to pass it on to Everett.

To state the question, I will try to summarize the essential point in still a different fashion. According to the usual description a measurement is associated with a projection operator in Hilbert space, and hence implies a loss of information. This loss may be postponed by the device of following all possible outcomes of all observations. This may be schematized by a branching diagram, where the measurement enforces a change to a basis (complete!) corresponding to the measurement.



Given that a set of measurements of specified properties  $M_0, M_1, M_2, \dots$  occurred at times  $t_0, t_1, t_2, \dots$  Quantum Theory allows the calculation of  $\psi_0(t_i)$  and the expansion  $\psi_0(t_i) = \sum a_i \psi_i(t_i)$   
 $a_1 \psi_1(t_i) + a_2 \psi_2(t_i) + \dots$   
etc.

Then  $|a_{ijk\dots}|^2$  labels a particular branch of this diagram, up to the  $m$ th measurement, and can be consistently associated as the conditional probability of observing the branch, under the conditions given. So far this is just a restatement, to indicate that I fail to see any difference between it and the customary points of view, other than deferring the loss of information to as late a stage as possible, which is all to the good in terms of clarity. There is a real question which now can be quickly stated:

How do we know if a measurement  $M_i$  was made at time  $t_i$ ? Since the calculation gives a different probability, in general, according to whether or not it was made, comparison of calculation and experiment has made us believe that we can make measurements when we choose. In the final analysis, this is an undefined concept; by fiat we say "I made such and such a measurement". My question is:

Hugh - I wrote him an off hand answer. Could you send him mine?  
Regards - John

"2"

How do we know that, despite us, spontaneous measurements were not made?.... that we are impotent in preventing certain measurements from occurring.

This is distinct from considering some additional interaction within the system, or a vacuum fluctuation, since these are coherent, whereas the effect mentioned would be a true, incoherent noise, and hence might correspond to a basic irreversibility. The rate of occurrence might correspond to a fundamental time interval. It might, simply amount to a general neutrino interaction term; the reaction in order of magnitude grounds is thus to dismiss such effects as of no consequence; - or that the neutrino interaction is within the system, inasmuch as neutrino absorption has now been observed.

As a matter of principle, is this to be excluded? If not, such a mechanism might be involved in getting rid of infinities, if coherence could be destroyed essentially only in these cases.

Very sincerely yours,

*Elmer Eisner*

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