

PALMER PHYSICAL LABORATORY
PRINCETON UNIVERSITY
PRINCETON, NEW JERSEY

22 January 1959

Dr. Hugh Everett III
Weapons Systems Evaluation Group
The Pentagon
Washington 25, D. C.

Dear Hugh:

I enclose a letter from Dr. Michael M. May which reached me in December and which I have studied several times. He concludes that the axiom that "distinguishable states of a system have equal a priori probability of being observed" can in some sense be derived from the relative state formulation of quantum theory, with, however, this feature -- happy or unhappy as one wishes to regard it -- that the "equality of probability" depends in the last analysis on the choice of calibration; that is, upon the choice of the measure of the possible readings of the observer apparatus. Obviously there is a question of principle to be cleared up here. I have not been able to clear it up. Can you?

I would be most grateful if you would write Dr. May your own impression of the matter and even more grateful if you would let me have a carbon of your letter. Incidentally, may I ask if you could speak at the theoretical seminar here on Friday afternoon May first or May 8th at 4.30 pm on the subject of your "Relative State Formulation of Quantum Theory"?

I send all good wishes to you Mrs. Everett for the New Year.

Sincerely,



John A. Wheeler

JAW:mbp

Enclosure: Photocopy of letter from May

AW

E. H. PLESSET ASSOCIATES, INC.
6399 WILSHIRE BOULEVARD
LOS ANGELES 48, CALIFORNIA
WEBster 6-5255
NEW PHONE
OLive 3-2890

December 5, 1958

Dr. John A. Wheeler
Palmer Physical Laboratory
Princeton University
Princeton, New Jersey

Dear Dr. Wheeler:

I have recently come to some conclusions which seemed a little surprising to me. They fall within one of your fields of interest, and Harris Mayer, with whom I discussed them, thought that you would not mind commenting on them.

I wished to see whether the usual quantum mechanical assumption that "distinguishable states of a system have equal a priori probability of being observed" can be derived from, or somehow connected with, Everett's (1) relative states formalism. It seems reasonable to look for such a connection since the formalism takes into account the state of the observer explicitly and therefore makes possible definitions of both distinguishability and a priori probability. I took those two definitions to be as follows:

Two states of a system are distinguishable if the probability distribution of the result of at least one measurement on the system over the range of possible results is different (i.e., leads to different observer states) for the two states. A measurement is any interaction with an observer apparatus, and an observer apparatus may be thought of as a system at least two states of which can be put into one-to-one correspondence with states in our memory. Incidentally, since the use of a probability distribution in the definition implies that the measurement is repeatable either on the same system or on identical systems, a question is raised about what mathematical feature of the theory corresponds to a restriction of measurements to repeatable ones. ✓

(1) H. Everett III, Rev. Mod. Phys., 29, 454 (1957).

APP

J. B. PLESSET ASSOCIATES, INC.

Dr. John A. Wheeler

December 5, 1957

The a priori probability of observing the system in a given eigenstate of the quantity measured is the probability of finding the system in that eigenstate, averaged over all possible eigenstates and normalized. The restriction to normalizable ranges of eigenstates does not seem practically important.

Now, by Everett's theory, the states of observed system and of observer apparatus are coupled, so that the probability of finding a system in an eigenstate, averaged over all its possible eigenstates, is also the probability of finding the observer apparatus in the corresponding relative state, averaged over all possible eigenstates of the observed system.

But observer apparatus are so calibrated that they will give equal a priori probability of obtaining any distinguishable result of measurement. The fact that a priori probability here means "averaging over all readings" rather than "averaging over all readings which correspond to possible results of a measurement on a given system" does not matter, I believe, since we simply wish to establish that any possible reading is as likely as any other possible reading in the absence of knowledge about the quantity measured. The difference would matter if the two ranges of a priori probability did not have the same measure. However, they do have the same measure in Everett's theory, since observer and observed system states are coupled in one-to-one fashion, the total state obeying Schrödinger's equation.

Hence, the equal a priori probability axiom, in Everett's theory, seems to be simply a choice of calibration; i.e., a choice of the measure of the possible readings of the observer apparatus.

I have not been able to satisfy myself as to whether the above is complete nonsense, or not, and I would very much appreciate having your opinion.

Sincerely yours,



Michael M. May

MMM:am

ABP