

§5 Prediction Schemes

Rough

So far we have discussed a universe containing observers solely upon the basis of wave mechanics, by assigning state functions to all systems, as well as observers, and considering their interactions. This is the basis of the complete theory. However, questions arise as to the amount of knowledge an observer can obtain about the state of another physical system — i.e. about what predictions can be made by observers. thus it may be, for example, impossible for an observer to obtain the complete state function for some other ~~system~~ observer, without an intervention so drastic as to completely upset the functioning of the second observer. Actually, however, it is not really relevant that an observer should be interested in the state functions themselves, but only in rules which will correlate his experiences.

Thus what one is really interested in is functions of one's memory which serve the purpose of useful prediction. This problem can be formalized by seeking functions of memory sequences $[-t_i, \dots]$ which best predict future elements of the sequence. Thus such questions concerning the knowledge attainable to observers, and any limitations on it can be investigated within the framework of our formal theory. (This irrelevant whether or not one can obtain the wave function for the whole universe, which is considered

as the basic element of our theory. The theory simply provides a logical framework from which deductions can be made, ~~which~~ which can be put into correspondence with our experience. The theory is even capable of describing any limitations upon actual knowledge available to observers. -- it tells us which deductions can be put into such correspondence, namely its predictions about appearances to observers.)

Example of such
deduction
of limitations Uncertainty Principle

Formalize process where Observer first measures position, then momentum. Investigate relation of memory sequences. I.e. show that for no state of system is it possible that memory sequence contain interleaved repeatable position + Momentum measurements.

i.e. general limitations on predictors for non-commuting quantities. . . .

Case II

Finally, we allow a single observer to perform a sequence of different measurements upon the same system. Let him first observe A, so that we get

$$\psi^{S+0} = \sum_i a_i \phi_i \psi^0_{[\alpha_i]}$$

Let him now measure B, so that we get

$$\sum_{ij} a_i b_{ij} n_j \psi^0_{[\alpha_i, \beta_j]}$$

Let him finally re-observe A, for which we get

$$\sum_{ijk} a_i b_{ij} b_{kj}^* \phi_k \psi^0_{[\alpha_i, \beta_j, \alpha_k]}$$

and, just as before

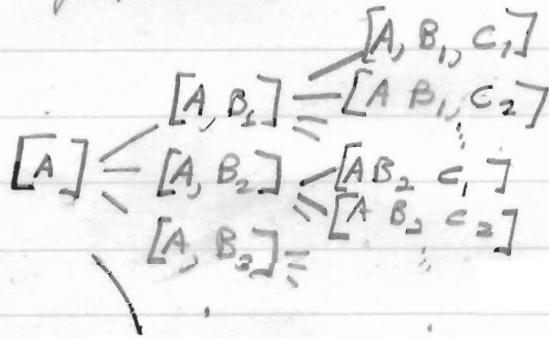
and so forth, for a long sequence

We notice furthermore, that what we have said applies equally well to successive measurements upon systems of different states, as well as measurements of different quantities in the same system. In all cases our ^{final} measure leads to a measure on the individual memory sequence elements which is equivalent to that of the usual probability for the result.

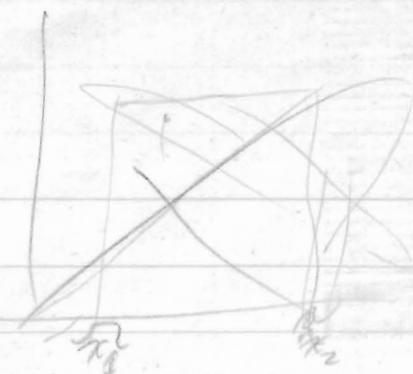
Thus, if we wish, we can regard observation as a process which converts a single observer with memory sequence $[A, B, \dots, C]$ into a number of observers with memory sequences $[A, B, \dots, C, D_i]$

There is no question about which of the final observers corresponds to the initial one, since each of them posse the total memory of the first.
(which amoeba is the original one?)

The successive memory sequences of an observer then do not form a linear array, but a planar graph (tree);



That is, the trajectory of an observer forms not a line but such a tree.



We consider the case of a single observer performing a series of different measurements upon the same system. Let him first measure A, then we get

$$\sum_{a_i} \phi_i \psi^0_{[a_i]}$$

Let him now measure B

$$\phi_j = \sum_i b_{ij} n_j$$

$$\Rightarrow \sum_{ij} a_i b_{ij} n_j \psi^0_{[a_i, \phi_j]}$$

There is now no direct correlation between the memory sequences.

In general, another observer in state ψ^0 can not predict results from any later in his memory of future measurements any better than those given by his relative state function (system), since the future memory states (and their amplitudes) are completely determined by this.

We see that the predictions of an observer have fundamental limitations. These limitations arise, however, not from the fact that there is no unique correspondence from initial to final system states, but because there is no unique final observer state for a given initial state.

As far as the theory is concerned all elements of the superposition exist simultaneously, and there is no question of any particular observer described by an element of the superposition being any more "real" than another. Thus, when an observer, state $\psi_{[x_i]}$ makes observations, so that the result is a superposition

$$\sum \alpha_i \psi_{[x_i]}$$

each observer described by an element of the superposition (described by state $\psi_{[x_i]}$) ~~can~~ be regarded as existing independently of the rest. That is, for all future interactions each such element independently obeys the wave equation, ie proceeds in exactly the ^{only} same manner as if the total state consisted of the single observer $\psi_{[x_i]}$. (rule 2) The presence or absence of the remaining observer states in no way affects the future behavior of the observer described by $\psi_{[x_i]}$, so that it is proper to think of it as an independently existing observer.