

## The existence and Meaning of Classical Objects:

(Justification for use of wave function for classical object)

In order to carry out our plan we must find how classical physics is linked with wave mechanics, i.e. in the light of our knowledge about the atomic constitution of matter, any "object" of classical size is composed of an enormous number of constituent particles, hence possessing a wave function in a space of fantastically high dimension. How are we to relate the ordinary behavior of objects in the 3-dim world to the underlying wave mechanics in this space?

Let us consider a relatively simple case. Suppose that in a box of ~~one cubic centimeter~~ we place a proton and an electron independently; so that each is in a state of definite momentum, so that the position amplitude density of each is uniform over the whole box, and they are uncorrelated. After a time we would expect that a hydrogen atom in the ground state would form, with ensuing radiation. We notice, however, that the position amplitude density of each particle is still uniform over the whole box, but they are no longer uncorrelated. In particular the conditional amplitude density for the electron, conditioned by some definite proton position, is that given by the usual Hydrogen atom ground state wave function. What we mean by the statement that "a hydrogen atom has formed in the box" is just that this correlation has taken place. We could then open the box and let the "hydrogen atom" spread even further. In this case the wave function of the centroid is entitled to be called the wave function of the hydrogen atom, since it obeys the wave equation for a particle of the mass of a hydrogen atom,

and since furthermore, the electron-proton relative wave function for a definite centroid position is that usually ascribed to the hydrogen atom. That is, due to the strong electron-proton correlation, the electron will always be found near the proton, no matter how spread out the position amplitude of the centroid is. It is hence in this sense of correlation that the electron and proton are bound together so that we speak of a hydrogen atom.

In a similar manner larger and more complex objects can be built of strong correlations between the constituent particles. A large number of initially independent particles can through their mutual interactions and the emission of radiation build up such strong position correlations that we can say that they have condensed into a solid body. In this case, the position marginal position amplitude for any single particle, or for the centroid, may extend over a very large region, tending to fill the whole universe or time increases sufficiently in the manner of spreading of wave packets, but nevertheless we speak of the existence of a solid object since the specification of the position of any single particle, or of the centroid, leads to a relative wave function for the remainder where all the remaining particles are found distributed closely about the specified one, and forming the object spontaneously. Thus the existence of objects having fairly well defined boundaries and shapes at a classical level is understood as a strong correlation between constituent particles. And one is justified in speaking of (the wavefunction for the object) by which is meant the W.F. for some constituent part e.g. centroid

as a side issue it is interesting to note, in the example of the hydrogen atom formation in a  $^{10^6}$  box, that there was a net increase in information about the electron-proton system corresponding to the correlation information for their position amplitudes of about 55 base e information units. (The marginal position distributions did not change, so the total info change was the correlation change.) One expects this to be compensated by a loss of information about the electromagnetic field corresponding to the presence of a photon of unknown whereabouts which was radiated. Similarly for all bodies. The correlations which produced them should be counterbalanced by a loss of information of the EM field if Liouville's theorem (extended) holds. It is, again if Liouville's theorem holds, always necessary to lose information in some systems in order to gain information or to build up correlations in another. In the cases discussed here the electromagnetic field plays this role.

Machine State

Machine Configuration  $G_{ij}$        $i$  config     $j$ -memory  
 Wave function  $\Psi_A(G_{ij})$

Memory  $M_j$        $M_j \supset M_K \Rightarrow M_j$  includes  $M_K$       ( $M_j$  later than  $M_K$ )  
 that is, if recorded sequence usual memory  
 (subjective time sense)

Definite Machine Configurations       $\Psi_A(G_{ij}) = S_{ij}^m$   
 $G_m$       above  $S_{ij}$

mapping       $(G_{ij}, S_m) \xrightarrow{F} (G_m)$       may depend upon  $M$   
 such that  $M_m \supset M_j$       (same)

Point: The "Turning on" of interaction is really just the result of the machine obeying its wave equation.

Point: The use of machine configurations on a classical level is justified from the discussion about the existence of classical objects as strong correlations among constituent particles, so that Wave function for Classical Config is W.f. of some representative part, perhaps antecedent, etc. Hence it is meaningful to talk about wave function over machine configurations.