

Probability in Wave Mechanics

In present formulations of quantum mechanics there are two essentially different ways in which the state of a system changes, one continuous and causal, and the other discontinuous and probabilistic. Let  $\psi$  be the state of a system with energy operator  $H$ , then the two processes are:

1. The discontinuous change brought about by the measurement of a quantity with eigenstates  $\{\phi_i\}$ , in which case the state  $\psi$  will be changed to the state  $\phi_j$  with probability  $|\langle \psi, \phi_j \rangle|^2$ .
2. The continuous, causal change of the state of the system with time generated by the energy operator:

$$\psi_t = e^{-\frac{iHt}{\hbar}} \psi_0$$

The question arises as to whether these two rules are compatible; in particular what occurs in the event that (2) is applied to the measurement process itself (i.e. to the state of the combined system of original system plus apparatus and observer). In this case nothing like the discontinuity of (1) can occur, and one has to decide whether to abandon (1), and the statistical interpretation of quantum mechanics in favor of the purely causal description (2), or to limit the applicability of (2) to systems within which "measurements" are not taking place. If we were to deny the applicability of (2) to the measurement process, however, we are faced with the difficulty of how to distinguish a measurement process from other natural processes. For what might a group of