The Problem of the inter-relationships of several Observers

The statistical interpretation of the formalism of Quantum mechanics rests upon a separation of system and observer. While the system remains unobserved, its state changes deterministically according to a time dependent wave equation. While the statistical interpretation insists that an interaction (measurement) between the system and observer will lead to probabilistic (unpredictable) results which are perceived by the observer.

The difficulty arises in the event that an observer, O_1, is incorporated into a system $S = S' + O_1$, which is in turn the object of interest of another observer, O_2. According to the formalism, when the second observer is not interacting with the system (including O_1), then the system state develops deterministically in time — even though all the while O_1 may be making observations on a subsystem S' within S.

The question then arises — to what extent is the formalism (wave function of $S' + O_1$) for O_2 an adequate and complete description of physical reality?

As an example, suppose that I am in a laboratory out in space making a series of quantum mechanical measurements upon some system (say first the z component of spin of an electron, then x component, then again z, etc.) and that I am recording the results in a notebook. Furthermore, I imagine that before I began the series of experiments there was an observer, O, outside

of the room (and not interacting) who was in possession of the entire wave function of the room, including the electron, the spin measuring apparatus, and myself, and who furthermore has the computational ability to solve for this wave function at any later time.

Now suppose that O is interested in the contents of my notebooks – in particular he asks himself the question what will he find if he opens the door to my room and looks at it (which could be construed as a position measurement of the marks) at a future time t. He then calculates the wave function for t and finds a bewildering number of possibilities – i.e. the wave function (as will be shown later) contains equal amplitudes for all of the possible sequences which might have been written down. Being an orthodox quantum mechanist O concludes that the probabilities are equal that he will discover any of the possible sequences; and furthermore that prior to his intervention there, in fact, did not exist any definite sequence i.e. that he rejects the idea that there is "in reality" a definite physical result (definite sequence recorded in notebooks) and that his wave function is simply an incomplete description of physical reality – but believes that a definite result was brought about only at the time of his intervention, and that prior to that

his wave function was a complete description of the physical situation. He then rushes up, opens the door, bursts into the room and looks at the notebooks. Abruptly he turns to me and in a patronizing manner informs me that until this moment I had no objective physical existence, and that it was only through his courtesy that the latent possibilities of my existence were ~~brought~~ developed to reality. This startling revelation is quite disconcerting — the fact that I owe my objective existence to this patronizing gentleman — until it occurs to me to deflate him by pointing out that there is nothing for him to be so happy about since probably this whole interview and himself included have no reality yet, and depend upon the effects of the action of some third observer sometime in the future. Having thus spoken I turn my back upon my bewildered intruder and continue gleefully my experiments, hoping that my work will not be in vain, and not be changed by later observers.

Was it really meaningless (Bohr) or indeterminate (Reichenbach) or undeveloped potentiality (Early Bohm) to talk about the objective existence of a definite but unknown physical situation in the room before the intervention? This would deny any reality to our present existence making it dependent upon the actions of future observers

~~Do~~ So there are incompleteness in the formalism, such as the existence of hidden Variables ?, which would satisfactorily resolve the difficulty since O would then regard his probabilities simply as measures of his ignorance of the true situation.

We shall see that there is another alternative, in which all of the possibilities seen by O have equal reality, and in which the intervention does not ~~do~~ change this reality at all, but instead affects O ! (which serves him right anyhow.) Furthermore this new interpretation requires nothing new, but follows from pure wave mechanics without any statistical interpretation. The statistical interpretation then follows from the theory as a subjective phenomenon.

Briefly, all the phenomena (effects) of measurement are simply transformed from system to observer.