9. Summary of Part I.

A radical break in our understanding of the nature of matter was initiated by Schrödinger’s discovery of his famous equation for the hydrogen atom. In this equation, there is no mention of particles or their positions or velocities; instead there is just the enigmatic wave function. The wave function-Schrödinger equation approach has been enormously successful in numerically predicting virtually all physical phenomena. But it is difficult to obtain a satisfactory understanding of how the wave function relates to our perceptions. These difficulties can be put in the form of three ‘mysteries,’ the first of which is

> **How are we to account for the particle-like nature of physical reality when the quantum mechanical equations involve only the wave functions?**

The solutions to subsidiary mysteries such as understanding the uncertainty principle or explaining the results of the Bell-Aspect experiment depend on satisfactorily solving this mystery.

Second, the wave function can contain several different versions of reality. In the half-silvered mirror example, it leads to one version of reality with detector states where the detectors read H=yes, V=no and, at the same time, to another version where the detectors read H=no, V=yes. Or in the Schrödinger’s cat case, it leads to a cat that is simultaneously dead and alive. So the next mystery is:

> **How are we to reconcile the fact that the wave function contains several equally valid versions of reality with the fact that we perceive only one version?**

Finally, when there are several versions of reality simultaneously present in the wave function, we find experimentally that the probability of perceiving a particular version is equal to the square of the coefficient associated with that version. The third mystery, then, is:

> **How are we to explain the coefficient squared probability law? In fact, how are we to explain probability of perception at all in a theory where there is no probability in the mathematics?**

A good deal of the conceptual work in understanding quantum mechanics has been done in Part I. In Part II, we use the implications of these concepts to look for solutions to the mysteries. The main thrust will be to show that the mathematics of quantum mechanics, by itself, can be used to solve the first mystery. The mathematical properties of the wave function are sufficient to explain both the wave-like *and* the particle-*like* properties of matter. Wave-particle duality is therefore only a duality in the properties of the wave function, not in the actual structure of matter.

Along the way, we will show that the mathematics of quantum mechanics, by itself, also solves part of the second mystery; the mathematics implies the observer can never perceive more than one version of reality. But it doesn't say which version we will be aware of.

In Part III, we will show that the mathematics of quantum mechanics, by itself, can *not* account for probability or the probability law. Thus the quantum mechanical mathematics, plus the conceptual position that reality consists of the wave function alone, is not sufficient for explaining all aspects of our perceptions. Something, either mathematical or conceptual, must be added to the bare linear mathematical scheme of reality.

Evaluation:

There is nothing controversial in Part I. We are just laying out the basic ideas of quantum mechanics and explaining the difficulties in understanding how these basics lead to our perceived world.