Part III. Probability. Problems with interpretations.

For our considerations here, the goal of physics is to find a mathematical/conceptual description of nature that matches our perceptions. In Part II, we found that basic linear, unitary quantum mechanics led to almost all the desired results—perception of only one outcome, agreement among observers, perception of a single film grain exposed from a spread-out wave function, and an explanation of the photoelectric and Compton effects. This leaves only two things left to explain; probability and the probability law, and why we perceive a *particular* version of reality.

To have probability, it seems necessary to have a definite outcome for each 'toss of the dice.' But, as we argue in Ch. 18, basic quantum mechanics doesn't provide that; *every* outcome occurs on every run of the experiment. It would therefore appear necessary to add some mechanism—mathematical, conceptual, or physical—that singles out just one version of reality for perception. Different proposed mechanisms define different interpretations.

The mechanism most widely subscribed to, **collapse**, is discussed in Ch. 19. In this approach, a random time evolution, outside basic quantum mechanics, is added to the mathematics so that, after a short time, the wave function 'collapses' to just one version of reality. It is presumed to collapse to version *i* of reality in a random way, with the randomness adjusted so that it exactly reproduces the $|a(i)|^2$ probability law. There are, however, a number of problems with this conjectured solution to the probability problem, and these are pointed out in the collapse chapter. One of the primary ones is that experimental results so far give no hint of collapse.

The other major interpretation, discussed in Ch. 20, is **hidden variables**. The mechanism here is to suppose that underlying quantum mechanics there is a classical-like, objective reality, with only one version of reality at each instant. The hidden variables, which may include the position of a 'particle,' describe this reality, and they determine which quantum mechanical version of reality we perceive. But as with collapse, there is no evidence for hidden variables, and there are also substantial problems with this possibility.

A few of the more minor interpretations—those subscribed to by fewer physicists—are given in Ch. 21.

To reiterate, the sole purpose of an interpretation is to explain how probability is to be integrated with the highly successful basic linear, unitary quantum mechanics. There is no evidence that collapse or any other current interpretation constitutes the correct explanation.