2 Human Knowledge as the Foundation of Science

In the introduction to his book *Quantum Theory and Reality* the philosopher of science Mario Bunge (1967, p. 4) said:

> The physicist of the latest generation is operationalist all right, but usually he does not know, and refuses to believe, that the original Copenhagen interpretation – which he thinks he supports – was squarely subjectivist, i.e., nonphysical.

Let there be no doubt about this point. The original form of quantum theory is subjective, in the sense that it is forthrightly about relationships among conscious human experiences, and it expressly recommends to scientists that they resist the temptation to try to understand the reality responsible for the correlations between our experiences that the theory correctly describes. The following brief collection of quotations by the founders gives a conspectus of the Copenhagen philosophy:

> The conception of objective reality of the elementary particles has thus evaporated not into the cloud of some obscure new reality concept but into the transparent clarity of a mathematics that represents no longer the behavior of particles but rather our knowledge of this behavior. (Heisenberg 1958a, p. 100)

> [...] the act of registration of the result in the mind of the observer. The discontinuous change in the probability function [...] takes place with the act of registration, because it is the discontinuous change in our knowledge in the instant of registration that has its image in the discontinuous change of the probability function. (Heisenberg 1958b, p. 55)

> When the old adage "Natura non facit saltus" (Nature makes no jumps) is used as a basis of a criticism of quantum theory, we can reply that certainly our knowledge can change suddenly, and that this fact justifies the use of the term 'quantum jump'. (Heisenberg 1958b, p. 54)

> It was not possible to formulate the laws of quantum mechanics in a fully consistent way without reference to the consciousness. (Wigner 1961b, p. 169)

> In our description of nature the purpose is not to disclose the real essence of phenomena but only to track down as far as possible relations between the multifold aspects of our experience. (Bohr 1934, p. 18)

> Strictly speaking, the mathematical formalism of quantum mechanics merely offers rules of calculation for the deduction of expectations about observations obtained under well-defined classical concepts. (Bohr 1963, p. 60)

> [...] the appropriate physical interpretation of the symbolic quantum mechanical formalism amounts only to prediction of determinate or statistical character, pertaining to individual phenomena appearing under conditions defined by classical physics concepts. (Bohr 1958, p. 64)

The references to 'classical (physics) concepts' is explained by Bohr as follows:

> [...] it is imperative to realize that in every account of physical experience one must describe both experimental conditions and observations by the same means of communication as the one used in classical physics. Bohr (1958, p. 88)

> [...] we must recognize above all that, even when phenomena transcend the scope of classical physical theories, the account of the experimental arrangement and the recording of observations must be given in plain language supplemented by technical physical terminology. (Bohr 1958)

Bohr is saying that scientists do in fact use, and must use, the concepts of classical physics in communicating to their colleagues the specifications on how the experiment is to be set up, and what will constitute a certain type of outcome. He in no way claims or admits that there is an actual objective reality out there that conforms to the precepts of classical physics.

In his book *The Creation of Quantum Mechanics and the Bohr–Pauli Dialogue*, the historian John Hendry (1984) gives a detailed account of the fierce struggles by such eminent thinkers as Hilbert, Jordan, Weyl, von Neumann, Born, Einstein, Sommerfeld, Pauli, Heisenberg, Schroedinger, Dirac, Bohr and others, to come up with a rational