Quantum mechanics and classical physics

Predictions of quantum mechanics have been verified experimentally to a very high degree of accuracy. Thus, the current logic of correspondence principle between classical and quantum mechanics is that all objects obey laws of quantum mechanics, and classical mechanics is just a quantum mechanics of large systems (or a statistical quantum mechanics of a large collection of particles). Laws of classical mechanics thus follow from laws of quantum mechanics at the limit of large systems or large quantum numbers.[10] However, chaotic systems do not have good quantum numbers, and quantum chaos studies the relationship between classical and quantum descriptions in these systems.

The main differences between classical and quantum theories have already been mentioned above in the remarks on the Einstein-Podolsky-Rosen paradox. Essentially the difference boils down to the statement that quantum mechanics is coherent (addition of *amplitudes*), whereas classical theories are incoherent (addition of *intensities*). Thus, such quantities as *coherence lengths* and *coherence times* come into play. For microscopic bodies the extension of the system is certainly much smaller than the coherence length; for macroscopic bodies one expects that it should be the other way round.[11] An exception to this rule can occur at extremely low temperatures, when quantum behavior can manifest itself on more macroscopic scales (see Bose-Einstein condensate).

This is in accordance with the following observations:

Many macroscopic properties of classical systems are direct consequences of quantum behavior of its parts. For example, the stability of bulk matter (which consists of atoms and molecules which would quickly collapse under electric forces alone), the rigidity of solids, and the mechanical, thermal, chemical, optical and magnetic properties of matter are all results of interaction of electric charges under the rules of quantum mechanics.[12]

While the seemingly exotic behavior of matter posited by quantum mechanics and relativity theory become more apparent when dealing with extremely fast-moving or extremely tiny particles, the laws of classical Newtonian physics remain accurate in predicting the behavior of large objects—of the order of the size of large molecules and bigger—at velocities much smaller than the velocity of light.[13]