Some Notes on Quantum Mechanics

Einstein's laws still did not give good results for very small particles. Einstein and Maxwell's theories were useless at defining what goes on inside atoms, or explaining phenomena such as the Compton effect and the photo electric effect, where electromagnetic radiation causes a current of electrons.

In 1801, the British physicist Thomas Young appeared to prove light was a wave from the results of his "Double Slit Experiment", which showed that multiple light sources produce interference patterns; yet in 1839, it was first shown that light waves falling on metal caused the emission of electrons, which suggests that light has particle properties.

Maxwell made the point that although the things we call photons and electrons appear to us to behave sometimes like particles and sometimes like waves, we should not make the mistake of thinking that they are either[1].

The original theory of quantum mechanics was formulated in 1925 and was found to better describe the behavior of small particles than Newton's Laws. It provided explanations for a wide range of phenomena, including spectral lines, the Compton effect and the photo-electric effect.

Albert Einstein, although disavowing the evolved theory of Quantum Mechanics, nevertheless paved it's way by a Nobel Prize winning paper he wrote in 1905, which described how light has both wave and particle properties.

From the Uncertainty Principle, QM showed that the Universe was indeterminate. For this reason, Einstein rejected it saying "God does not play dice with the Universe"

QM showed that there was no such thing as a pure particle or pure wave; the smaller it is, the more it exhibits the characteristics of both particle and wave.

Max Plank produced a formula in an "act of desperation" which allowed matter to absorb radiant energy only in discreet amounts, or quanta. Einstein completed the coup in 1905 by asserting that radiation itself comes in discreet packets, now called "photons". [2]

Niels Bohr's explanation was that an electron radiates only when it jumps from one orbit (energy level) to another and that the orbits have to have the proper difference in energy to account for any emission of photon light.

- Plank's constant
  specifies the amount of discreetness. if PC=0, nature is continuous

experimentally it is not 0, so although nature is largely continuous, it is also a bit discrete

- Matrix Quantum Mechanics
  proposed by Werner Heisenberg, who won the 1932 Nobel Prize in Physics
  for creation of "Quantum Mechanics"
  Heisenberg also postulated the "Uncertainty Principle:
  "The more precisely the POSITION is determined, the less precisely the MOMENTUM is known"

- Wave Quantum Mechanics
  proposed by Irwin Schrodinger

- Max Born:
  Electrons are "particles" but behavior is described by probability
  in Schrodinger's wave equation.
  Quantum theory determines the shape and movement of probability waves

- Transformation QM was proposed by Paul Dirac
  Dirac showed that wave and matrix QM amounted to the same thing
  Focusing on electrons, Dirac found a math description of an electron's wave
  using quantum theory, is consistent with Einstein's Relativity Theory.
  The math allows a "+" and "-" solution, which predicts the existence
  of anti-electrons; ie antimatter.

- Copenhagen Interpretation of Quantum Mechanics
  main original proponent: Niels Bohr
  There is no deep reality beneath the phenomena of appearances
  rejects objectivity and determinism
  accepts probability (uncertainty) and dependence on the observer

- Bell's Theorem
  Shows that reality is "non-local"
  This means that causes in one location in the universe may have an instantaneous effect anywhere else in the universe
  Experimentally validated by Alain Aspect

- The Transactional Interpretation of Quantum Mechanics
  John G. Cramer, Department of Physics, University of Washington, Seattle WA
  "The basic element of TI is the transaction describing a quantum event as an exchange of advanced and retarded waves
  as implied by the work of Wheeler, Feynman, Dirac and others."
  Allows "real" interpretation of waves, therefore objective
  explicitly non-local yet relativistic ally invariant and fully causal
  Provides insight into QM state vector
  Leads to a justification of Heisenberg's Uncertainty Principle.
  http://www.npl.washington.edu/ti

- DeBroglio Wavelength
  If light, so clearly a wave has particle characteristics,
  then an electron, which is clearly a particle, must have wave characteristics
  the wavelength associated with electros is called the DeBroglio wavelength,
  after Louis DeBroglio. Validity of the de Broglie hypothesis has been confirmed for macromolecules, as well as molecules, atoms, and subatomic particles. [3]

[1] *The Man Who Changed Everything: The Life of James Clerk Maxwell* Basil Mahon] p. 182.

[2] *The Man Who Changed Everything: The Life of James Clerk Maxwell* p. 182.

[3] http://en.wikipedia.org/wiki/De_Broglie_hypothesis; http://www.colorado.edu/physics/2000/quantumzone/debroglie.html;