quantum physics states that electrons can act as a wave or a particle. I thought they meant that the particle would be moving in a sine wave, but they told me that that was not the case. that the particles acted like waves in an ocean or something like that. I do not understand this at all, and I need a basic understanding of quantum physics by next fall. So, can someone please explain the particle or wave thing to me.

Answer:

The results of quantum mechanics make it clear that waves exhibit particle-like properties and particles exhibit wave-like properties, depending on the specific experiment. It allows describing quantum phenomena in terms of classical concepts such as “wave” and “particle”. Quantum objects in some cases can be described as particle or wave, but it is not classical mechanics particle and not classical mechanics wave. De Broglie waves have a specific nature, which has no analogy among the waves studied in classical physics: the square modulus of the amplitude of the de Broglie wavelength at this point is a measure of the probability that a particle is detected at this point.

The de Broglie equations relate the wavelength λ to the momentum p, and frequency f to the total energy E (including its rest energy) of a particle:

$$\lambda = \frac{h}{p}$$

$$f = \frac{E}{h}$$

where h is Planck's constant.

Obviously, massive objects exhibit very small wavelengths, so small in fact that it's rather pointless to think of them in a wave fashion. But for small objects, the wavelength can be observable and significant, as attested to by the double slit experiment with electrons. (The double-slit experiment, sometimes called Young's experiment, is a demonstration that matter and energy can display characteristics of both waves and particles. http://en.wikipedia.org/wiki/Double-slit_experiment)

Albert Einstein, who, in his search for a Unified Field Theory, did not fully accept wave-particle duality, wrote:

This double nature of radiation (and of material corpuscles)...has been interpreted by quantum-mechanics in an ingenious and amazingly successful fashion. This interpretation...appears to me as only a temporary way out...