Uncertainty in Position & Momentum

1. If an electron has the properties of both a particle and a wave, what can we determine about its position in the atom?
2. Werner Heisenberg postulated the uncertainty principle, which state that "It is impossible to know the exact position and momentum (mv) of a particle simultaneously".
3. For a particle with constant mass, m the principle is expressed mathematically as:

$$\Delta x \,.\, m\Delta u \geq \frac{h}{4\pi}$$

where Δx = uncertainty in position
Δu = uncertainty in speed.

4. Electrons are very small in size and mass. High-energy photons (short λ, higher ν) would be required to locate the small electron. But such photon (high energy) will collide with the electron causing it to move to other position with a certain velocity. ie. the momentum, p ($= mv$) will

If lower energy photons (long λ, lower ν) were used to avoid affecting the momentum (it will not move to other position), we will find that little information would be obtained about the location of the electron.

Analogy Uncertainty in Position & Momentum : Photography

ANALOGY (Photography) :

- If you take a picture of a high-speed car at a higher shutter speed setting, you get a clear picture **BUT** you cannot tell how fast they are going or whether they are moving.
- If you take the picture of the same high-speed car using a slow shutter speed, you can tell from the blur car image something about the speed but you have less information about the location of the car (blur image).

* So if we want to locate the exact position of an electron, there will high uncertainty in its velocity/momentum.

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