Answer on Question # 84367, Physics / Quantum Mechanics

Question 1. *1. why can't we see matter as a particle and a wave?*
2. use a similar example to explain the wave particle duality?

Solution.
1. To answer this, we need to consider the mathematics of the matter-wave (or De Broglie wave) and one of the most important and ubiquitous elements of quantum physics: Planck's constant h. The parameters of the matter-wave are given by the relationship: $\lambda = h/p$, where p is the magnitude of the particle's momentum. Let's compare this to the De Broglie wavelength of the average human being running for a bus, running straight into a lamp-post. Let's take the average global body mass of $62\,kg$ and let's say our running speed is $3\,m/s$ when we hit the post. Which gives us:

$$\lambda = \frac{6.63 \cdot 10^{-34}\,Js}{62\,kg \cdot 3\,m/s} = 3.56 \cdot 10^{-36}\,m.$$

As we can see the De Broglie wavelength for a macroscopic object is incredibly small. The tiny value of Planck's constant is the reason we don't see particle-wave duality in the macroscopic world.

2. Now for an electron with a mass of $10^{-30}\,kg$ travelling at roughly six million meters per second, the De Broglie wavelength is:

$$\lambda_e = \frac{6.63 \cdot 10^{-34}\,Js}{10^{-30}\,kg \cdot 6 \cdot 10^{6}\,m/s} = 1.105 \cdot 10^{-10}\,m.$$

Diffraction only occurs when the size of the wavelength of the travelling wave or particle is comparable in size to the gap through which it passes or the object around which it's diffracting. λ_e is roughly about a tenth of a nanometre.

Bonus:
For example, light is not a wave and it's not a particle. Light is a quantum field, or at least that's our current best description of it.
Quantum fields can behave in ways that appear to be wave like, and they can also behave in ways that appear to be particle like, and this the origin of the claim that light is both a wave and a particle. It's more accurate to say that light can behave like both a wave and a particle.
Anyhow, as far as I know quantum fields can't behave like a wave and like a particle at the same time. Generally speaking they behave like waves when propagating and like particles when exchanging energy. So we can't have a wave of particles or a particle of waves. It's one or the other.
Incidentally, this applies to all particles and not just light. □