

Why Zero Angular Momentum in the First Bohr Orbit ?

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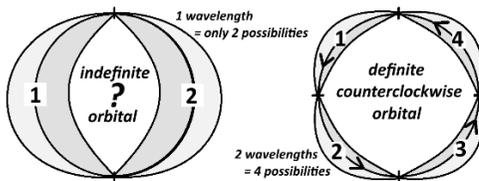
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Abstract

In classical mechanics, the first Bohr orbit has angular momentum $1(\hbar)$ but '0' angular momentum in quantum mechanics. The geometric/logical reason for this is that a single DeBroglie wavelength (amplitude) when squared has only two possible places for an electron to be. The number of places must be more than two to determine angular momentum.

This philosophically troubling feature of angular momentum: '1' in classical mechanics ... '0' in quantum mechanics ... is resolved by understanding that one cannot fundamentally describe rotation without at least three classical or quantum reference points. Thus, for a body to be in an orbit, we say that it is at position 1 then 2 then 3 then 4 ... then repeat the sequence 1,2,3,4,1,2,3,4 ... signifying rotation. The repeating sequence is directionally definite with respect to rotation, i.e. looking down from above we follow an object as it passes points marked 1, 2, 3 and 4 and say ... "*The object is going counterclockwise*" ... as opposed to clockwise. The two directions are "*distinguishable*" (both classically and quantum mechanically).

But if we say that an orbit can be described as 1,2,1,2,1,2,1,2,1,2,1,2 ... then from above the orbital plane, we can no longer state the direction of travel of an object (in QM) with respect to clockwise or counterclockwise because we can interpret the appearance of the object in 1 then 2 as going either way. This is the quandary of quantum mechanics. These two possibilities logically cancel leaving angular momentum as a sum which must be ... equal to 'zero'.



In the first Bohr orbit ... how does an electron in 1 get to 2? Does it go clockwise or counterclockwise? We cannot say, in principle. So, the two possibilities cancel leaving zero angular momentum in quantum mechanics.

However, if two (or more) wavelengths are present, the clockwise/counterclockwise dilemma is logically/philosophically resolved. This is reminiscent of the boson/fermion problem wherein quantum mechanics presents two equivalent choices, and we are left to logically parse definitions and instantiation in physics.

Conclusion

In quantum mechanics, the statistical properties of matter prevail. In classical mechanics the particle's direction is definite and is theorized to be its "*locus of probability*". This is the classical path that any particle takes, around which the statistics of quantum mechanics are centered. That is, at quantum mechanical levels, the classical path is an 'abstract path' that serves as a guide to quantum probabilities. If this were not so, the laws of physics (especially at the quantum level) would be subject to random walk phenomena ... potentially creating violations of linear and angular momentum conservation.

References

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