SECTION 12

Atomic Electrons Stable Versus Unstable Orbits

THE ATOMIC ELECTRONS STABLE ORBITS

The fact, observed at the time of Bohr's development of the relationship between atomic line spectra and atomic orbital structure, namely that the orbital lengths of the stable orbits of atomic electrons are an integer multiple of the orbiting electron's matter wave length was largely neglected because the problem of the matter wave frequency then remained unresolved. Furthermore, the Stern Gerlach experiment [see Section 13] had [erroneously] convinced the science community that quantized angular momentum was an inherent part of the nature of atomic particles.

The fact of the stable orbits has long been accepted without a specific reason, a specific operative cause, for those orbits and only those orbits being stable. It is not sufficient to assert that the stable orbits are those in which the orbiting electron' angular momentum is an integer multiple of $h/2\pi$ without supplying any cause or mechanism for that assertion. The matter wave of the orbiting electron now provides an operative reason, as follows.

For the orbit to be stable it must be the same for each pass, pass after pass. If each pass includes exactly an integer number of the orbital electron's matter wave lengths then each pass is the same in that regard. But if, for example, the orbital path length contains only $9/10$ of a matter wave length, $9/10$ of the matter wave period, then the next pass will contain the missing $1/10$ of the matter wave length or wave period plus $8/10$ of the next, and so on. The matter wave being sinusoidal in form, the successive orbital passes will be all different.

It is this behavior which operatively causes the "stable orbits", and only those orbits, to be stable. It has nothing to do with angular momentum nor quantization of angular momentum. For the angular momentum hypothesis there is no underlying reason nor mechanism to produce stability or instability. The quantization of angular momentum concept is merely an invented defined condition, without operative cause, just as were the "stable orbits" it seeks to explain until their being here justified in terms of the operative matter wave behavior

The statement that the orbital electron's angular momentum is quantized, as in the following traditional equation

$$(12\text{-}1)\qquad m\cdot v\cdot R = n\cdot\frac{h}{2\pi}\qquad [n = 1,\ 2,\ \ldots]$$

is merely a mis-arrangement of

$$(12\text{-}2)\qquad 2\pi\cdot R = n\cdot\frac{h}{m\cdot v} = n\cdot\lambda_{mw}\qquad [n = 1,\ 2,\ \ldots]$$

a statement that the orbital path length, $2\pi \cdot R$, must be an integral number of matter wavelengths, $n \cdot \lambda_{mw}$, long. The latter statement has a clear, simple, operational reason for its necessity. The former statement is arbitrary and is justified only because it produces the correct result, even if without an underlying rational reason.

It is this behavior which operatively causes the "stable orbits", and only those orbits, to be stable. It has nothing to do with angular momentum nor quantization of angular momentum.

How Electrons Are Forced Into Stable Orbits

With the vast amount of *Propagated Outward Flow* from myriad *Spherical-Centers-of-Oscillation* orbital electrons are continuously buffeted. How are specific stable orbit paths enforced? To analyze and quantify the deviations in the variable quantities involved, the radius, R, and the electron orbital velocity, v, will be expressed in terms of the orbit number, n, the number of matter wavelengths in the orbital path. That requires obtaining expressions for them that do not include any other variables.

That quantity, n, will here be deemed to be a continuous variable so that the R and v expressed in terms of n can be continuously variable and able to address locations between stable orbits, not merely the discrete amounts at the stable orbits.

The balance of forces for stability in a circular orbit requires

(12-3) $$\text{Centrifugal Force} = \text{Centripetal Force}$$

$$\frac{m \cdot v^2}{R} = \frac{q^2}{4\pi \cdot \varepsilon \cdot R^2}$$

$$R = \frac{q^2}{4\pi \cdot \varepsilon \cdot m \cdot v^2}$$

(12-4) $$\text{Orbit Path Length} = n \cdot \text{Matter Wavelength}$$

$$2\pi \cdot R = n \cdot \frac{h}{m \cdot v}$$

$$2\pi \left[\frac{q^2}{4\pi \cdot \varepsilon \cdot m \cdot v^2} \right] = n \cdot \frac{h}{m \cdot v}$$ [Substitute R]

$$v = \frac{q^2}{2\pi \cdot \varepsilon \cdot n \cdot h}$$ [Solve for v]

$$v \propto \frac{1}{n}$$

(12-5) $$R = \frac{q^2}{4\pi \cdot \varepsilon \cdot m \cdot v^2} \propto \frac{q^2}{4\pi \cdot \varepsilon \cdot m \cdot \left[\frac{1}{n} \right]^2}$$ [Substitute 12-4]

$$R \propto n^2$$

In those terms the variation of the required centripetal force for a circular orbit as n varies is

(12-6) $$F_{Centripetal} = \frac{m \cdot v^2}{R} \propto \frac{\left[1/n \right]^2}{n^2} = \frac{1}{n^4}$$

With constant charge the only variable in the expression for the Coulomb force is R in the denominator and is proportional to n^4. Therefore

(12-7) $F_{Coulomb} \propto {}^1/_{n^4}$

Thus the normal Coulomb force always provides the exact value of $F_{centripetal}$ required for a stable circular orbit.

The numerator of the Coulomb force expression is q^2. The variation from the force it exerts in the stable orbits depends on the ratio of the orbital path length, $2\pi \cdot R$, to the matter wavelength, ${}^h/_{m \cdot v}$. If that ratio is an integer then the behavior is the normal stable orbit Coulomb force.

If that ratio is not an integer then the force is *quasi-stable Coulomb*, as if the effective charge were modified as follows.

(12-8)

$$\text{Coulomb Force Numerator} \propto \frac{\text{Orbit Length}}{\lambda_{mw}}$$

$$\propto \frac{2\pi \cdot \mathbf{R}}{{}^h/_{m\mathbf{v}}} = \frac{2\pi \cdot \mathbf{R} \cdot m \cdot \mathbf{v}}{h}$$

$$\propto n^2 \cdot [{}^1/_n] = n$$

$$\text{Coulomb Force Denominator} \propto \mathbf{R}^2 \propto n^4$$

and the overall *quasi-stable Coulomb* force then varies as

(12-9)

$$F_{Quasi\text{-}Coulomb} = \frac{\text{Numerator}}{\text{Denominator}} \propto \frac{n}{n^4} = {}^1/_{n^3}$$

The ratio of the quasi-Coulomb force to the normal Coulomb force then varies as

(12-10)

$$\frac{F_{Quasi\text{-}Coulomb}}{F_{Normal\ Coulomb}} = \frac{{}^1/_{n^3}}{{}^1/_{n^4}} = n$$

This means that for values of n somewhat larger than that of the next lower stable orbit integer value the actual Coulomb force acting, $F_{Quasi\text{-}Coulomb}$, is too large. For values of n somewhat below the stable orbit integer value the actual Coulomb force acting, $F_{Quasi\text{-}Coulomb}$, is too small.

Those results mean that:

- *Outside or above the stable orbit* integer value of orbit n the excessive values of $F_{Quasi\text{-}Coulomb}$ have the *net effect of moving the electron path inward*. The inward force produces an inward acceleration that is greater than the amount to produce a circular orbit. The excess acceleration produces inward electron velocity. (The inward $F_{Quasi\text{-}Coulomb}$ is greater than the outward "centrifugal force".)

- *Inside or below the stable orbit* integer value of orbit n the insufficient values of $F_{Quasi\text{-}Coulomb}$ have the *net effect of moving the electron path outward*. The inward force produces an inward acceleration that is less than the circular orbit amount. The deficiency produces less than circular motion, a net outward motion effect. (The inward $F_{Quasi\text{-}Coulomb}$ is less than the outward "centrifugal force".)

The overall effect is to force the electrons into stable orbits as Figure 12-1.

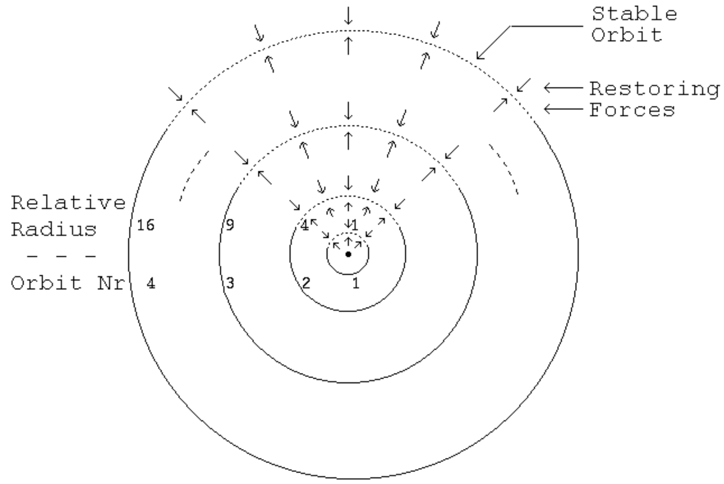

Figure 12-1
The Orbital Electrons Forced Into Integer Matter Wavelength Orbits

The Electrons' Transition Paths Between Stable Orbits

The above Figure 6-3 depicts the status when the orbital electrons are all in their lowest [least energy] orbits. When the outermost of those orbital locations is not occupied and the electron that should be in that position is in an excessively higher orbital location the action of the restoring forces is to direct that electron inward on an orbital transition path to fill the unoccupied position. That happens as follows.

The absence of an electron in the unoccupied position means that the positive electron-attracting field of the atom's positive nucleus is slightly un-offset by the orbital electrons' negative charges. With all of the lowest orbits filled the atom overall presents an electrically neutral status as viewed from outside, but with the outer electron missing that presentation is slightly of inner positive charge as viewed from the excessively higher orbital location electron.

That extra centrally directed attraction curves the pattern of restoring forces of Figure 12-1 to that of Figure 12-2, below.

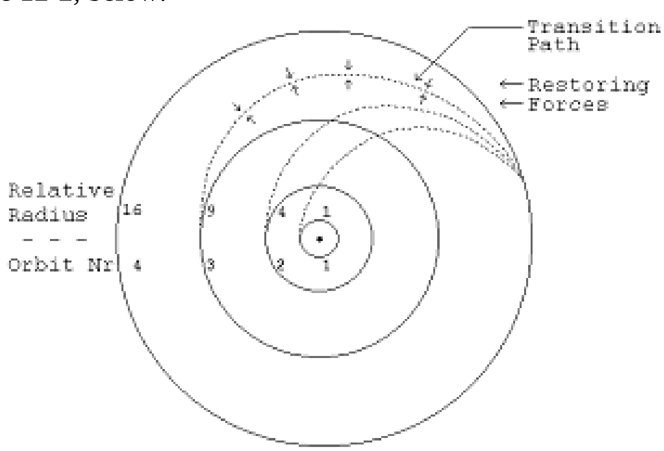

Figure 12-2
The Electrons Orbit Transition Paths

That drives the excessively higher orbital location electron inward to fill the empty location.

Any vacant location in the lowest energy positions of the orbital electron structure is automatically filled from above by this directing of the restoring forces. That is how an outer electron "knows" that there is a space that it can and should move into and that is how it follows the correct path to get there.

From any point in an outer orbit there is one specific path to each of the inner orbits of that outer orbit. Such paths, which involve inward motion of the electron in transition between stable orbits, have at each point in their path the correct inward motion to compensate for the deviation of the value there of $F_{Quasi-Coulomb}$ from what the normal Coulomb force should be at that point.

The electron velocity must vary smoothly from the stable velocity of the initial outer orbit through a period of increase and ending in the stable velocity of the final orbit. To do that without a discontinuity the variation must be in the form of a half cycle cosine. That is attested to by the sinusoidal nature of the *E-M* radiated photon. There can only be one such path that correctly compensates between any particular pair of initial and final orbits.

On either side of such a path the transition path restoring forces act just as for the stable orbits. The restoring forces arise because the stable orbit restoring forces will not allow locations between stable orbits.

Next, the most important, the Stern-Gerlach experiment