Atomic Structure Fundamentals

The Fundamentals of Atomic Theory and Quantum Mechanics

CHAPTER V

QUANTUM ATOMS AND SYSTEM 3

Abstract:
The Bohr model of the atom is fully reviewed, since it provided the foundation for developing the quantum mechanical approach to atomic structure. The most fundamental contributions to atomic and quantum theory are shown to be fully consistent with System 3. The primary interval of time is derived from the first orbit of the hydrogen atom, the number of intervals per orbit being the cube of the principal quantum number. The derivation of Louis de Broglie's wave equation is reviewed. Particle waves are clearly associated with relative jumps in position due to relative space frame skipping. The neutron is a regenerative mode of a secondary System 3. This applies to the fusion of the higher elements that contract internal space-time in stellar centers to compensate for contractions in the integrated fabric of external space-time due to relative space-frame skipping associated with the angular motions of stars. The perceptual transposition of the electron interface associated with the neutron accounts for the strong force and the weak force consistent with nuclear models. Inconsistencies in the Bohr semi-classical model are reconciled with the quantum mechanical model to provide transparent insight into the structural dynamics of the atom. A tertiary application of System 3 is linked to chemical synthesis and the evolution of planetary systems. The reflux of old stellar populations back through the galactic center regenerates the periodic primary projection of hydrogen radially outward to provide feedstock for new generations of stars. Galaxies are cells eternally regenerating their stellar populations. Alternate explanations for the red shift of distant galaxies and the background radiation are reviewed in Chapter VI on cosmology.

Early Work on Atomic Theory:

Atomic hydrogen has been the focal point of investigation in seeking out the mysteries of atomic structure, for obvious reasons.[1] It is the simplest element, each atom consisting only of a proton, an electron,

and photon, intimately linked as a coherent whole. The structure of hydrogen has become an open secret because its telltale spectral fingerprints are everywhere in evidence throughout the heavens. When heated, a gas emits light at certain wavelengths that show up as lines in its spectrum, and hydrogen is the main constituent of stars. It constitutes the bulk of the mass of the entire universe and is the stepping stone to the higher elements. Investigators into the mystery of the atom have focused on this prime candidate and the clues it offers toward understanding secrets of the cosmic order. It has been an admirable piece of detective work.

Following the pioneering work of Anders Jöns Ångström in the mid nineteenth century, Sir William Huggins identified ten spectral lines as being emissions of hydrogen in the spectra of stars. Johann Jacob Balmer followed up in 1885, showing that he could account for these lines by applying a simple empirical formula. Then the Swedish investigator Johannes Rydberg discovered in 1889 that the line spectra of many elements could be fitted by a single empirical formula.[2] For hydrogen the formula can be simplified to

$$\frac{1}{\lambda} = R\left[\frac{1}{m^2} - \frac{1}{n^2}\right]$$ where λ is the wavelength of the spectral line, R is the Rydberg constant, and m and n are integers.

The Bohr Model of the Atom:

In 1912, Neils Bohr was working in the laboratory of Earnest Rutherford, who had shown that an atom consists of a small dense positively charged nucleus surrounded by the required number of negatively charged electrons to make up a neutral system. In undertaking to explain the spectra of hydrogen atoms using this model, Bohr hypothesized that within the atom some well established laws of physics do not apply, otherwise an electron orbiting a nucleus would radiate away all of its energy. This deserves some emphasis. *Bohr hypothesized that some well established laws of physics do not apply within the atom.*

This remarkable statement makes a clear distinction between the internal space of the atom and the external space between atoms where the well established laws of physics do apply. He suggested that the electron could exist in a stationary orbital state without dissipating energy, and that light is emitted or absorbed only when it suddenly jumps from one stationary orbital state to another *without traversing the distance between orbits*. The frequency of the light is determined by the difference in energy between the two orbits, divided by Planck's constant *h*. This is in accord with the Planck-Einstein relation $E=hf$, where f

represents the frequency and E the difference in energy between electron orbits.

It was thus obvious that the expression $(1/m^2 - 1/n^2)$ in Rydberg's equation is proportional to the difference in energy between two orbital states m and n of the atom. Accordingly Bohr defined the value of the Rydberg constant in terms of electronic mass m, electronic charge e, and Planck's constant h.

$$R = \frac{2\pi^2 me^4}{h^2} \qquad \text{V-1)}$$

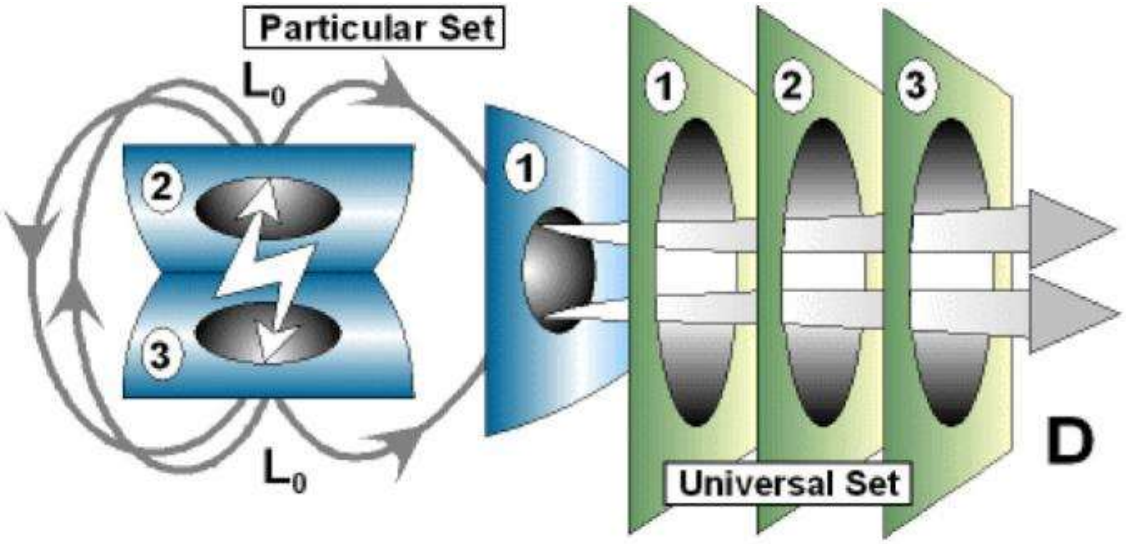
The interesting point in reviewing this is that Neils Bohr, in formulating his theory of the atom, had to make a number of postulates that are consistent with System 3. In doing so he had no compelling intuition about the System other than facing the necessity of reconciling the observed phenomena with a coherent theory of the atom. He followed no logical process of reasoning consistent with a prior basis of understanding. He set conventional wisdom aside together with the consensus of opinion. Like Max Planck before him, and Louis de Broglie after him, he took a flying leap of faith, a quantum leap, you might say.[3] Bohr was trying to marry the Planck-Einstein relation $E=hf$ to Rutherford's orbital atomic model and they didn't seem very compatible. He nevertheless advanced the following propositions:

The Centripetal Force Postulate of the Bohr Atom:

He postulated that the centripetal force that holds the electron in orbit is equal to the angular momentum of the electron. The centripetal force that attracts the electron to the proton nucleus is the Coulomb force. It is directly proportional to the product of their electric charges (e^2 in the case of hydrogen) and inversely proportional to the square of their distance apart (r^2). This relationship, being similar to the gravitational force, was shown to follow directly from System 3 and historic coordinates in the last chapter.

There are important points from previous chapters to emphasize however. The charges on the electron and proton are equal and opposite because they are locked in an intimate one to one relationship *within one particular set.*[4] They are equal in magnitude because the universal countercurrent identities R_1 and R_2 between the electron center C2 and proton C3 of the space frame in Figures III-2 and III-3 are *mutually balanced.* They have opposite charge because they have opposite subjective to objective orientations.

See Gravity, Quantum Relativity & System 3



Space frames below alternate with quantum frames above. Relative motion is a series of particle jumps between space frames, creating linear time.

Since light can travel only a fixed distance in each space frame, its speed is universal. It defines space by connecting up separate particles of atomic matter.

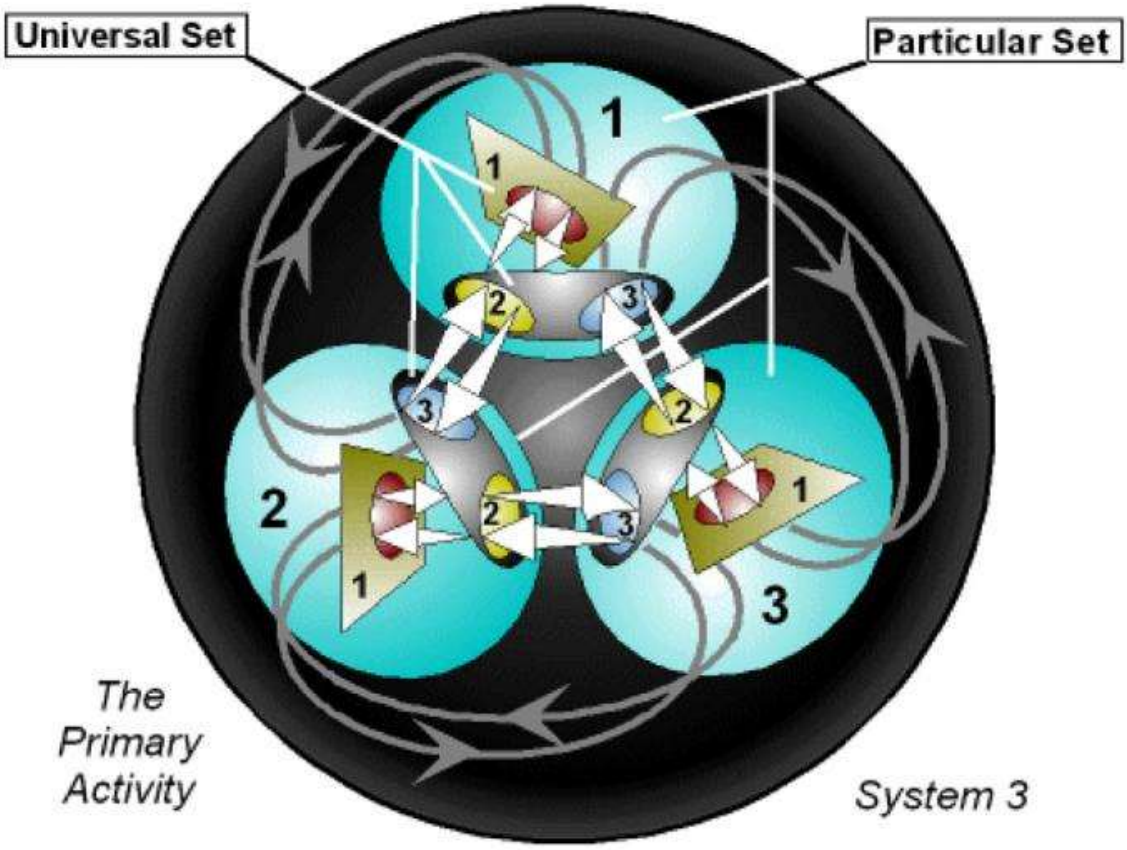


Figure 19

NOTE: ***R1*** and ***R2*** are represented by the white arrows in the bottom half of the System 3 diagram below called a Space Frame in the projection of a cosmic movie. For more detail see Figures 4 and 5 in the article **System 3**.

These mutual relationships are separate in the space frame and united in the quantum frame in the same primary interval of time. *There is no electromagnetic field extended externally through space*, as when the atom is ionized and the electron is separated from the proton by a distance greater than light can span in a single space-frame. There is no relative motion between electron and proton in the inner space of the atom in each space-frame. There is therefore no radiation associated with the electron's orbit to dissipate its energy and cause it to fall into the nucleus. These are not separate bodies in the same sense as a comet going around the sun.

The inner space of the atom is a closed system in this respect. Electromagnetic activity is *confined* within the neutral atom. It determines the fundamental identities of photon, electron and proton by their mutually intimate structural relationship. Nevertheless this internal relationship must be reconciled with the realities of external space. Bohr thus equated the centripetal force holding the electron in orbit with the Coulomb force, assuming a circular orbit, as follows:

$$\frac{mv^2}{r} = \frac{e^2}{4\pi\varepsilon_0 r^2} \qquad \text{V-2)}$$

where m is the mass of the electron, v its velocity, r its distance from the nucleus, and ε_0 is called the permitivity of free space, a constant necessary for dimensional consistency.

Equation V-2 may be rewritten as follows:

$$v^2 = \frac{e^2}{4\pi\varepsilon_0 mr} \qquad \text{V-3)}$$

The Angular Momentum Postulate of the Bohr Atom:

Bohr also placed a quantum condition on the orbital angular momentum, *although there was no apparent justification for doing so. He required that only certain* stable "non-radiating" orbits for the electron are possible, and that the angular momentum must be an integral multiple of h/2π as follows:

$$mvr_n = \frac{nh}{2\pi} \qquad \text{V-4)}$$

where n is a whole number (1, 2, 3, ... etc.) that identifies the orbit. It is known as the *principal quantum number*.

Solving equation V-4 for v and squaring both sides gives

$$v^2 = \frac{n^2 h^2}{4\pi^2 m^2 r_n^2} \qquad \text{V-5)}$$

where r_n represents the radius of the n^{th} orbit with principal quantum number n. Equation V-5 can be substituted in equation V-3 to give

$$r_n = \frac{\varepsilon_0 h^2}{\pi m e^2} n^2 = n^2 a_0 \qquad \text{V-6)}$$

thus $$r_1 = a_0 = \frac{\varepsilon_0 h^2}{\pi m e^2} = 5.29 \times 10^{-11} \, meters \qquad \text{V-7)}$$

where a_0 is called the *Bohr radius*. It is the radius of the first stationary circular orbit, where n=1.

No wonder Bohr created a stir. In equation V-4 he introduced that troublesome group of symbols again, $h/2\pi$, as if h was the circumference of a universal cycle of time and the amplitude, meaning the radius of the circle analogous to the cycle of time, was related to angular momentum. Why should that be so?

Let's take another look at System 3. A primary interval of time is defined as the duration of a single space-frame expressed in classical units of time, and within a single space-frame only electromagnetic activity takes place. Particles only move in quantum jumps between space-frames, so momentum is quantized accordingly. Each jump is directly associated with the cycle of action designated by h. The electron jumps move around the circumference of the spherical energy shell as specified by the closed photon interface a fixed distance from the proton. The linear radius r is incommensurable with the circumference because of the irrational nature of π, but the electron's relative motion is discontinuous from space-frame to space-frame. That is *why π is irrational*. Each jump around the circumference is made through the agency of the orthogonal Void.

There was no justification for the assumed equivalence between the angular momentum of the electron with $nh/2\pi$ expressed by equation V-4 until Louis de Broglie later pointed out the *wave resonance* between the electron and its orbital path, according to equation V-8 where λ represents the *de Broglie wave length* of the electron. (We will come to de Broglie's derivation of his wave equation and its relationship to System 3 shortly.)

This view is consistent with System 3 because the relative jumps in position of the electron around each orbit must be a constant whole

number multiple of h/2π. This expression for wave length represents each jump. There can be no such a thing as part of a jump. The de Broglie waves are not a continuous wave motion through a space-time continuum. The whole atom is discontinuous and the electron makes equal jumps around the orbit relative to the proton in the absence of any change in the photon energy level that determines its orbit. This requires a whole number of quantum jumps around an orbit as expressed in equation V-8. This specifies the essential condition of resonance.

$$2\pi r_n = n\lambda_n \qquad \text{V-8)}$$

In the first orbit n=1 so according to equation V-8 the electron wave length is equal to the circumference of the first orbit. This means that the electron does not move at all between quantum jumps. It jumps to the same relative position in each successive space-frame. This means that the electron has zero angular momentum in the first orbit. On the other hand, from a classical mechanics standpoint, the electron's orbital velocity may be calculated from equation V-4 and this velocity then corresponds to one revolution in one primary interval of time as also indicated by System 3. Nevertheless, the orbital quantum number, *l*, that concerns angular momentum in the quantum formulation of Shrödinger's wave equation is taken to be zero when n=1. This interpretation is essential to explaining the spectral lines and line splitting in magnetic fields.[5]

The Shrödinger wave mechanical treatment gives more values for the orbital quantum number than the semi-classical (SC) Bohr model where electrons move in de Broglie waves around circular orbits. These additional values concern the orientation of the angular momentum in orbits greater than n=1. In the first orbit the angular momentum is zero so it has no relative orientation. In a magnetic field that orients the atom in external space the angular momentum in higher orbits can assume only specific orientations that are designated by the *magnetic quantum number* m_l. This splits the energy level of each orbit into additional energy levels according to the strength of the magnetic field, and consequently accounts for *spectral line splitting* known as the *Zeeman Effect*. Additional fine splitting is associated with two discrete complementary *magnetic spin* orientations of the electron designated as *the spin quantum number* m_s. The SC theory has no counterpart for these two magnetic quantum numbers in magnetic fields. Without the magnetic field the orientation of the atom and electron is not specific with respect to experiment.

It also becomes apparent that *historic integration* is the reason why Shrödinger's wave equation tells us that the probability density of finding the electron in a given position is determined by the *square* of the wave function, $|\Psi|^2$, not by the wave function itself. The accepted explanation is that mass is a form of energy and since the wave function, Ψ, represents the wave field of the particle of mass *m*, the product $\Psi\Psi^*$ may be thought of as including an equivalent energy density, known as the complex conjugate, Ψ^*, associated with the mass. This is clearly in accord with System 3. The equivalent energy density to the particulate mode is the conjugate quantum mode. Together they define a primary interval of time expressed by their historically integrated product $\Psi\Psi^*$.[6]

The Quantum Jump Postulate of the Bohr Atom:

As stated before, Bohr had also postulated that the emission or absorption of light that gives rise to spectral lines occurs when the electron makes a sudden quantum jump from one stable orbit to another. He insisted that the jump is sudden and that the frequency of the energy emitted or absorbed is given by the Planck-Einstein formula

$$\Delta E = hf \qquad \text{V-9)}$$

where ΔE is the energy difference between orbits. The total energy of an orbiting electron is the sum of its kinetic energy, and its potential energy. The kinetic energy is

$$\text{KE} = \frac{1}{2}mv^2 = \frac{e^2}{8\pi\varepsilon_0 r_n} \qquad \text{V-10)}$$

The potential energy in the Coulomb field of the proton nucleus is

$$\text{PE} = -eV(r_n) = -\frac{e^2}{4\pi\varepsilon_0 r_n} \qquad \text{V-11)}$$

The potential energy is negative because it requires energy input to raise the electron to each higher orbit. The proton and electron are in a mutually bound state. The total energy in orbit *n* is

$$\text{KE} + \text{PE} = -\frac{e^2}{8\pi\varepsilon_0 r_n} = -\frac{me^4}{8\varepsilon_0^2 h^2 n^2} = -\frac{E_0}{n^2} \qquad \text{V-12)}$$

Bohr's theory was extended by Sommerfeld, Dirac, Pauli, and others, who added quantum numbers to explain spectral lines and their

fine structure more accurately, then the Schrödinger wave equation, incorporating all factors into the wave function, became accepted as a standard procedure. This sums up the theory of the atom as it developed from ideas first advanced by Neils Bohr, while showing that the most basic assumptions in evolving the quantum perspective of the atom were generally consistent with System 3.

Other Considerations:

Initially, however, Bohr used a more circuitous route in arriving at his theory, involving what he called the *principle of correspondence*.[7] This principle requires that the dynamics of the atom or other system, according to quantum theory, must agree with the classical description of the system for very large quantum numbers. One problem with this is that the quantum and classical descriptions of the atom do not converge to correspond within five percent until the principal quantum number n is greater than 30. The radius of the thirtieth orbit is nine hundred times greater than the radius of the first orbit and atoms this large are not encountered.

There are other points that merit reflection. For example, if we restrict our observations locally to one isolated atom of elemental hydrogen and insist that universal influences have no bearing, then we deprive ourselves of any stable reference in space or time. If there is no operating field that is spatially contextual to each and every atom, then there is no way to distinguish between the orbiting motion of an electron and the spin of the nucleus.

How then can one equate a centripetal force to the Coulomb force as in equation V-2? How can one assign the angular momentum equivalent to $nh/2\pi$ as in equation V-4, or compute the kinetic energy as in equation V-10, if there is no universal referent to implicitly determine on behalf of the atom the relative orbital motion or spin? Experimental physicists find it necessary to employ a magnetic field as a context.

In System 3 one universal set coheres with all particular sets at once. A referent is implicitly given because each particular set is synchronously related to all particular sets, however spatially isolated they may appear to be locally. There is a relationship between the internal space of the atom and external space associated with a preponderance of synchronicity in the universe as a whole. This is distinct from the perspective of experimental physics under contrived circumstances in a laboratory concerned with local influences. Nevertheless the latter perspective takes place within the context of the primary projection of space and time consistent with System 3.

Experimental results should be interpreted within this overriding context not vice-versa.

The Primary Interval of Time:

The primary interval of time is directly related to the fact that the orbital angular momentum in the first orbit of hydrogen is zero, since one orbit is equivalent to one quantum jump in position, whether in the SC model or QM model.

The primary interval of time T_p is thus given by

$$T_p = \frac{2\pi r_1}{v_1} = 1.519 \times 10^{-16} \text{ seconds} \qquad \text{V-13)}$$

where v_1 is the velocity of the electron in the first orbit, determined by solving equation V-4.

If the internal space of the atom is to be consistent with external space the primary interval of time must allow all parts of the largest atom to be fully in communication with itself. We know for example that Rutherford propelled alpha particles through the inner space of atoms. This requires that the primary interval must be sufficiently long to allow light to circumscribe the largest orbital shell of hydrogen as if an atom of this size constituted a maximum event horizon that is fully coherent. This does not mean that the spherical photon energy shells of an atom are scribed in external space. They are spontaneously formed along with electron and proton and they ***define*** three dimensional space. There must nevertheless be a mutually consistent relationship between internal spherical space and external linear space, albeit irrational. This requires that the T_p primary interval is equivalent to the time it requires light to circumscribe an orbit of maximum radius n, such that

$$T_p = \frac{2\pi r_1}{v_1} = \frac{2\pi r_1 n^2}{c} \qquad \text{V-14)}$$

where c is the speed of light. It follows that

$$n = \sqrt{\frac{c}{v_1}} = \sqrt{\frac{2.99792 \times 10^8}{2.1884 \times 10^6}} = 11.7 \approx 12 \qquad \text{V-15)}$$

This indicates that the twelfth orbit of atomic hydrogen approximately defines the maximum dimensions of a fully coherent excited atom,[8] although higher rapidly transient energy levels may allow

electrons to produce weak spectral lines. Higher orbits become exponentially closer together toward the ionization limit.

By equation V-4 electrons in the twelfth orbit move with a velocity of 1.8228×10^5 m/s, thus taking $T_n = 2.6258 \times 10^{-13}$ seconds to go around once, or $1728=n^3$ primary intervals of time. In general, electrons in orbit n require N_p primary intervals of time to circumscribe their orbit where N_p may be called the *principal orbital rate*. Thus

$$N_p = \frac{T_n}{T_p} = \frac{(2\pi r_1)^2 n^4 m}{nh} \times \frac{h}{(2\pi r_1)^2 m} = n^3 \qquad \text{V-16)}$$

There are other factors to consider in heavier elements due to contractions in space- time related to fusion processes that will be introduced below.

The Bohr model of the atom accounted for the main spectral lines of atomic hydrogen and some spectral lines of other elements. The theory evolved into a full wave-mechanical treatment formalized by the Schrödinger wave equation, incorporating the treatment of fine structure and attempts to cope with the complex structure of higher elements.

De Broglie's Wave Equation:

Conjugate identities between space and quantum frames and their historic integration have been unwittingly employed in the derivation of some of our most fundamental formulae of physics. This can be demonstrated if we carefully examine Louis de Broglie's method in arriving at his wave equation of matter. His thoughts are clearly presented in a tribute to him on the fiftieth anniversary of the discovery of the wave nature of the electron[9] as follows:

...I was led to define an internal rest frequency f_0 of the particle, connected with the energy m_0c^2 of the rest mass by the relation

$$h f_0 = m_0 c^2 \qquad \text{V-17)}$$

De Broglie substituted the rest energy of a particle for electromagnetic energy E in Planck's law, $E=hf$. This specifies what is already intimated in Planck's law, that the rest frequency of a particle is a measure of the recurrence of space frames in System 3 as this primary activity relates to electromagnetic frequency. This is the same for all particles in the same inertial system.

This led me to think of the particle as being like a little clock in motion. I was then greatly smitten with the fact that the transformation formula of a wave according to Lorentz is

$$f = \frac{f_0}{\sqrt{1-\frac{v^2}{c^2}}} \qquad \text{V-18)}$$

and the transformation formula for the frequency of a clock, translating the famous "retardation" of clocks in motion is

$$f = f_0\sqrt{1-\frac{v^2}{c^2}} \qquad \text{V-19)}$$

Two perspectives are introduced by the two transformation formulae, one from the outside (eq. V-18), and one from the inside (eq. V-19), corresponding to space and quantum frames respectively, the latter being the conjugate reciprocal of the former. A significant point here is that a primary interval of time is defined by one recurrence from a timeless quantum frame to a particle space frame. Together they define the primary interval of time. The quantum frame is orthogonal to the space frame in the same way that external space is orthogonal to the internal space of the atom.

Intrigued by this difference I asked myself how a particle similar to a little clock should be displaced in its wave in such a manner as to remain incorporated in the wave, that is to say, in such a manner that its internal phase remains constantly equal to that of the wave.

This question is about how the oscillations of a moving particle between space and quantum frames remain synchronous with respect to an external observer and stationary frame of reference.

Applying this picture, albeit a little too schematically, to the simple case of a plane monochromatic wave being propagated along the x-axis I was led to write for the variation $d\phi$ of the phase of this wave

$$d\phi = 2\pi\left(f dt - \frac{dx}{\lambda}\right) = 2\pi\left(\frac{f_0}{\sqrt{1-v^2/c^2}}dt - \frac{dx}{\lambda}\right) = \frac{2\pi}{h}\left(\frac{m_0c^2}{\sqrt{1-v^2/c^2}}dt - h\frac{dx}{\lambda}\right) \qquad \text{V-20)}$$

The motion of the particle relative to a stationary observer, implied by the coordinate system, tends to open synchronous gaps in particle space frames because light can not fully bridge quantum jumps in position from frame to frame. Since light defines external space with respect to each atom, this introduces synchronous distortions between particle and observer. By applying the transformation formula for a wave (eq. V-18), the relative frequency of the particle is increased to effectively close the gaps. This indicates a *relative* omission of space frames in the inertial system of the *observer*. Some of the observer's space frames are lost in the synchronous gaps of the particle.

This can be seen by examining the terms of equation V-20 closely. The fdt term gives the phase of waves for both particle and observer if the particle is at rest. The difference in phase due to the particle's motion is given by dx/λ. The only wavelength λ that can be ascribed to the moving particle is each quantum jump in position as perceived by a stationary observer, but dx relates to a displacement along the stationary coordinate system. The ratio dx/λ is therefore a measure of the relative skipping of space frames between particle and observer. This is compensated for by applying the transformation formula to the fdt term.

De Broglie continues:

...and for the variation in the interval of time dt of the internal phase of the particle being displaced along the x-axis with speed v

$$d\phi_i = 2\pi f_0 \sqrt{1 - v^2/c^2}\, dt = \frac{2\pi}{h} m_0 c^2 \sqrt{1 - v^2/c^2}\, dt \qquad \text{V-21)}$$

Since the internal phase of the particle includes the relative frequency of particle quantum frames, there can be no observations of relative motion. The dx/λ term is thus given no quantum counterpart. This requires that the particle quantum frames associated with the observer's skipped space frames must accumulate in the Void.

It is the reciprocal transformation formula, equation V-19, that reconciles internal phase relations accordingly. When this frequency is translated into the rest mass equivalent of quantized energy, by substitution from Equation V-17, the result indicates a relative skipping of particle quantum frames with respect to the observer. This requires the quantum sequences of the particle to accumulate in the *Void (the sensorium)*, relative to the observer, since particular sets are timeless in the quantum mode. The skipping of the observer's space frames is thus

complemented by a relative accumulation of quantized energy associated with the particle. This is apparent as an increase in its relativistic mass.

De Broglie next performs a second order historic integration, since the Lorentz transformations derive from a first order historic integration as demonstrated in Chapter IV. He equates the external space frame side that is associated with the external motion of the particle with the internal space and conjugate quantum frame side. The latter compensates for relative external space-time motion with relative accumulated quantum frames:

...on combining $d\phi = d\phi_i$ *with* $dx = vdt$

$$\frac{m_0 c^2}{\sqrt{1 - v^2/c^2}} - m_0 c^2 \sqrt{1 - v^2/c^2} = \frac{m_0 v^2}{\sqrt{1 - v^2/c^2}} = \frac{hv}{\lambda} \qquad \text{V-22)}$$

is obtained, whence for the momentum p of the particle

$$p = \frac{m_0 v}{\sqrt{1 - v^2/c^2}} = \frac{h}{\lambda} \qquad \text{V-23)}$$

Thus two fundamental relations of Wave Mechanics have been found, $E = hf$, $p = h/\lambda$ *associating with them the image of a localized corpuscle which is displaced in the wave along one of it's rays yet remaining constantly in phase with it. This was the concrete image I had when I had the first idea of Wave Mechanics. Perhaps I didn't explain this sufficiently thoroughly in my thesis, but I emphasize that it was this which guided me.*

By combining equations V-20 and V-21external space frames and reciprocal space and conjugate quantum are equated relative to stationary coordinates that reflect synchronous relations between observer and particle. This corresponds to historic integration on historic coordinates as outlined in Chapter IV. Skipped space frames of the observer due to particle motion equate to timelessly accumulated quantum frames of the particle.

The derivatives of time, *dt*, thus cancel out. The expressions of rest energy $m_0 c^2$ likewise vanish. In the final form, the equation states that the kinetic momentum of a particle is equal to the quantum of action,

h, divided by the distance it is displaced λ in a primary interval of time, with respect to the observer.

This wavelength represents each electron quantum jump. Since there must be a whole number of jumps around each atomic orbit this accounts for Bohr's Angular Momentum Postulate. It applies equally well to relative motions of neutral atoms.

A strange implication of de Broglie's wave equation is that the complementary skipping of observer space frames and accumulation of particle quantum frames is completely independent of the relative rest mass of the observer. A human individual is the equivalent of the universe as dominated by cyclic patterns of momentum that are hierarchically ordered from galactic to stellar to planetary levels.

This confirms the view that there is a universally synchronous and timeless present that relates independently to each atom of particulate mass.[10] This requires that there must be a preponderance of synchronicity in the universe as a whole. It also confirms the view that relativistic phenomena are dependent on the perspective of the *observer.* This latter is not just an arbitrary affair where the vantage point of observation can be hypothetically switched to that of a moving particle. This relativistic assumption cannot correctly be employed to deduce a spacetime continuum that ignores hierarchies implicit in the cosmic order. Atoms don't have eyes to scan the heavens as humans do.

This human capacity implicitly incorporates billions of years of stellar and biospheric evolution within the galaxy, implicating tier upon tier of historic integration associated with dynamic cycles within cycles cascading from galactic to stellar to planetary levels. On a cosmic level the creative process subsumes and integrates a hierarchy of quantized memories spanning space and time in the Void. Patterns of celestial dynamics relate to the preponderant patterns of history together with the need for these patterns to be reconciled with the synchronous projection of the material content of the universe at large. Like Einstein, Planck, and Schrödinger, Louis de Broglie was not happy with the direction that quantum mechanics took.

The Neutron:

Remember that the universal set is open and thus unconstrained by spatial limitations while tunneling through the particular centers, linking them up in pairs in the space frame. In the neutron this linking up is in clockwise direction because of the perceptual transposition of the *Universal Electron Center UC2.* Figure V-1 compares with Figure III-3, except that the universal electron center UC2 is perceptually transposed.

The proton Form interface UC3 is now subjective to the electronic Routine UC2 which now relates internally to the photon energy shell UC1 that defines the coherent Idea of the neutron. See Figure V-1.

While introducing the neutron in Chapter III it was pointed out that the Idea associated with the Form UC3 of the proton can feed back from within the Routine electron interface UC2 to an objective identity with the photon Idea interface UC1.

The analogy of a painting was used. The Form of the completed painting feeds back to a passive observer to evoke the Idea implicit in the painting's Form. Likewise the photon energy shell of the primary hydrogen atom collapses to a passive identity with the proton Form within the universal electronic interface. This defines its Form within the subsuming context of a whole atom. The quantized photo-electric Form of the proton becomes spatially specified in the neutron space-frame. The neutron can be said to simulate the Idea of the proton in the same way that Form of the painting can simulate the Idea implicit within it via electronic feed back. The Idea implicit in the Form is *re-generated.*

The Neutron as a Regenerative Mode of System 3:

It will be said that the neutron is the *regenerative mode* of an atom essential to nucleosynthesis. The fused atom is the alternate *expressive mode* of System 3. The nuclear binding focus of the two modes mutually alternate in a reciprocal manner, within the subsuming context of the primary projection of hydrogen such that nucleons are bound in pairs. This is indicated by empirical evidence as well as by the System. The strong force is limited to the spatial dimensions of a nucleon and falls off sharply at greater distance. This requires a large contraction in space as defined by a neutron over that defined by the photon energy shell of a neutral atom. This large contraction in space takes place within the subsuming context of an atom.

The neutron is an essential nuclear component of the higher elements. It internally simulates the spatial integration of a primary atom as a nucleon. Since it integrates the spatial distinction between photon, proton and electron as one particle it provides an inner reference for the nuclear fusion of spatially separate primary atoms, even though internal particle distinctions collapse in a neutron. The neutron can also play a regenerative role in the primary projection of hydrogen. About .02 % of normal hydrogen is deuterium. Tritium is extremely rare and radioactive.

In a primary hydrogen atom the universal photon interface is subjective to the electron interface that relates objectively to the universal proton interface as illustrated in Figure III-3.

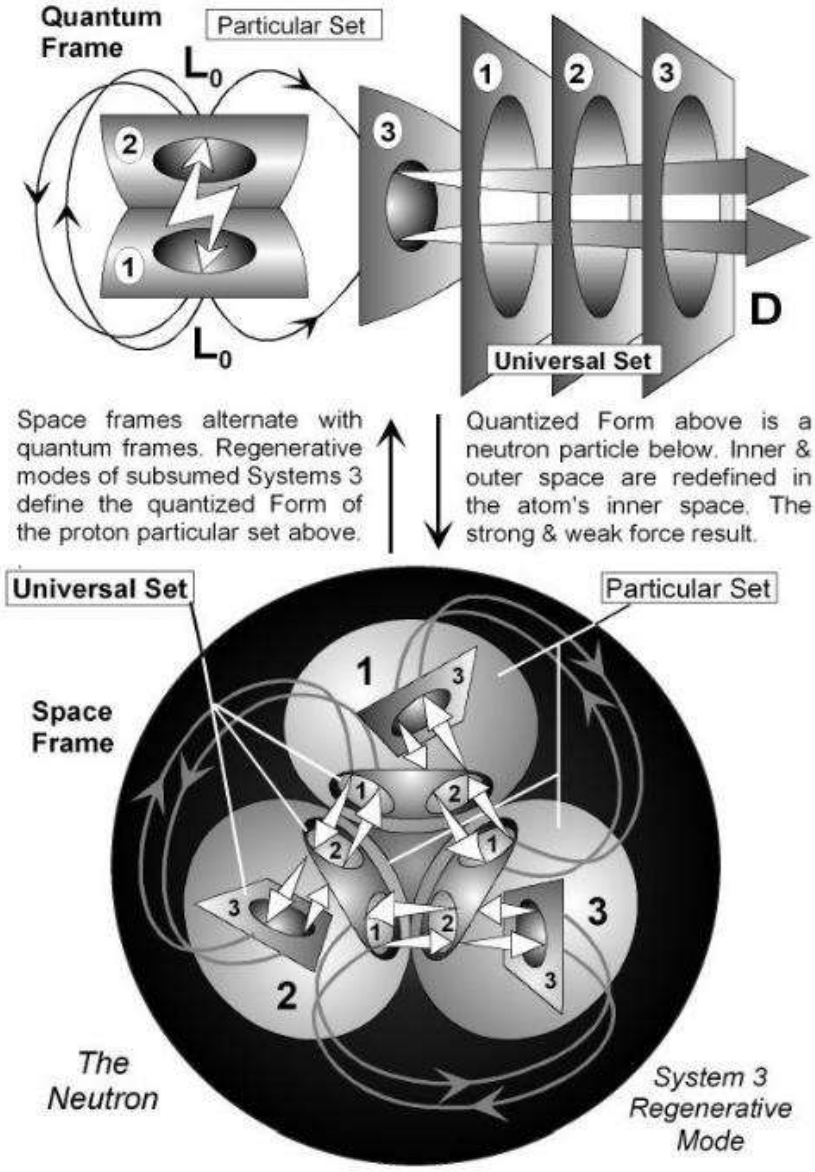


Figure V-1

In the neutron the situation is reversed with respect to the electron as illustrated in Figure V-1. The universal electron interface thus acts as a Janus-faced pivot between the expressive and regenerative

NOTE: This is the same as ***Figure III -3*** referred to in the text.

modes of System 3. The universal electron interface has perceptually transposed giving the neutron two down quarks and one up quark. One up quark in a proton has changed to a down quark in the neutron.

The subjective to objective imbalance in the universal set, that is responsible for the charge between electron and proton in Figure III-3, is internalized in Figure V-1 since the electron UC2 faces in a transposed direction back to the photon UC1. The imbalance in the neutron focuses on the Form of the proton as it relates to the photon energy in the bound state of the neutron. It does not focus on the energy imbalance between electron and proton as it does in an atom. This draws the three particular centers together into a tightly bound state as a single particle.

The universal Form interface of the proton feeds back through the Routine electronic interface to an identity with the universal photon Idea of a whole particle in the space frame of Figure V-1. In the quantum frame the particular electron and photon interfaces are coalesced together as one to define the quantization of Form associated with each particular proton. The coalesced electron and photon interfaces *are* the quantization of proton Form in the quantum mode. This photo-electronic quantum equivalent of the proton is the conjugate equivalent of the neutron in the space-frame.

This is a reciprocal perspective to that of the expressive mode where electron, proton, and photon are mutually distinct as a neutral atom although intimately linked. The universal electron interface UC2 acts as axis between these subjective and objective orientations. The regenerative mode of System 3 is thus a secondary elaboration of the subjective orientation of System 2. As such it indicates that a secondary System 3 is superimposed upon the primary projection of space and time as specified by the primary activity of System 3 that projects primary hydrogen atoms.

This secondary System 3 is locally subsumed by the primary System 3 according to local circumstances imposed by the primary projection of hydrogen and celestial dynamics that contract space-time, such as in the centers of stars. The secondary System 3 is essential to the fusion of the heavier elements from primary hydrogen.

The higher Systems likewise have both expressive and regenerative modes that are essential to their operation. This is a very important feature of all the higher Systems. There are also involutionary modes to Systems 3 and higher that work in opposition to the evolutionary modes described here.[11] In System 3 the involutionary mode accounts for anti-matter.

A Common Source of the Strong Force and Weak Force:

The binding energy within the neutron is identified with the weak force associated with decay processes in quantum theory. It is believed to be one of four fundamental forces that spontaneously emerged for unknown reasons from the Big Bang. System 3 indicates it is associated with the perceptual transposition of the universal electron interface UC2. The universal *routine* interface of a neutral atom turns inward to the universal *idea* of unity within the atom, thus bringing the three particular centers together into a common *form*. It is a process that happens in the centers of stars as heavier elements are fused from primary hydrogen. For each heavier atom fused there is a complementary fusion of primary hydrogen into neutrons, thus balancing the subjective and objective orientations.

While the weak force is identified with the perceptual transposition of the universal electron interface UC2 within the neutron, the strong force is identified with the same transposition in the immediate external vicinity of the neutron. This is analogous to the way the inner spherical space of the primary hydrogen atom is defined by the photon energy shell while external linear space is defined in relation to it by the linear transmission of light in a single space frame. Internal versus external space are mutually defined by their mutual relationship.

Within the neutron, however, the spherical space of the atom is contracted nearly 16 orders of magnitude (8.62×10^{15} times). As with the primary atom, the external space of the neutron in each space-frame is defined relative to its internal space. This specifies the reach of its influence as a binding force. It can only bind to nucleons that are immediately adjacent but it does so strongly because of the large contraction of spatial dimension relative to the inner space of a primary hydrogen atom. The external space defined by a neutron within the subsumed inner space of the atom relates to nucleon particles of comparable size.

Defining Cosmic Form, Space and Time:

The neutron specifies particulate Form in space, as opposed to photon energy levels that define relative spatial dimensions in the primary atom. Both specifications are essential for the coherent generation of space as a universally consistent phenomenon. The inner versus outer imbalance across the electronic interface UC2 binds the neutron together. It defines the nature of coherent particulate Form in each space frame, consistent with the photon energy that specifies

coherent dimension in a primary atom. Otherwise there is no universally standard reference for form, space or time.

The fusion of particular sets up the ladder of the elements cannot violate the integrity of any one particular set even though they are spatially integrated as independent atoms. Each particle's Form must have a unique identity within the atom, consistent with the rift in wholeness. Otherwise it can not be identified as a separate thing, just as electrons and protons can not be identified as separate things within a neutron. Two or more particles cannot define the same space and remain separate. This is essential to *Pauli's exclusion principle* and the orderly dispersion of electrons in the periodic table, each with specific quantum number combinations of four basic kinds: principal (n), orbital (l), magnetic (m_l) and spin (m_s).

Nuclear Models:

The perceptual transposition of the universal center 2 in the regenerative mode of System 3 is generally consistent with important features of the potential well model, the liquid drop model and the shell model concepts that are employed to explain the coherence of nucleons in the nucleus. The expressive and regenerative modes of the secondary System 3 offer a more coherent structural insight to nuclear theories.[12 13]

In summary it can be said from the above assessment that the so-called *strong force*, credited with binding a nucleus together, is associated with the regenerative mode and the perceptual transposition of center 2 of the universal set, as is the weak force. The strong and weak forces are external and internal expressions of the same regenerative mode of a secondary System 3 defined by the neutron and its interactions within the nucleus. The neutron essentially redefines external space in the subsumed environment of a composite nucleus and it is this subsumed definition of space itself that accounts for the strength of the strong force. This also indicates that the strong force is charge independent.

The subsumed space of the neutron that is essential to fusion processes complements and offsets the contractions or curvatures in the integrated fabric of space-time on a cosmic scale as projected by the primary System 3. As mentioned in previous chapters the relative angular motions of galactic and stellar systems involve space-frame skipping at their centers with respect to their peripheries. Neutrons provide a high degree of compensation by the high degree of spatial contraction they provide.

Recent research at the Thomas Jefferson National Accelerator Facility (TJNAF) shows that: *"protons and neutrons in a nucleus can form strongly correlated nucleon pairs. Scattering experiments, where a proton is knocked-out of the nucleus with high momentum transfer and high missing momentum, show that in ^{12}C the neutron-proton pairs are nearly twenty times as prevalent as proton-proton pairs and, by inference, neutron-neutron pairs. This difference between the types of pairs is due to the nature of the strong force and has implications for understanding cold dense nuclear systems such as neutron stars."*[14]

Protons and neutrons in the nucleus form a brief pairing with another nucleon, a phenomenon known as a short-range correlation. Previous experiments have shown that roughly one-fifth of nucleons at any one time are in short-range correlations in atoms of this size. This suggests alternate pairing within the nucleus synchronous with alternate expressive and regenerative modes of the secondary System 3. The relationships between nucleons demonstrate a degree of fluidity even though they appear to be tightly packed cheek by jowl in the nucleus.

Problems Implicit in the Semi-Classical Bohr Model:

It's worth returning again to equation V-6. This formula is written to apply to higher elements in the periodic table by placing the atomic number Z in the denominator so that

$$r_n = \frac{\varepsilon_0 h^2}{Z\pi me^2} n^2 \, meters \qquad \text{V-24)}$$

This equation adds the complication that when n=1 in elements higher than hydrogen, take helium for example where Z=2, then r_1 is only one half the size as in hydrogen. On the face of it this seems to require the two electrons in the first orbit to circumnavigate the nucleus more than once in the primary interval of time.

Moreover the two equations V-3 and V-4 no longer agree on how fast the electrons are moving. Equation V-3 says they are moving $\sqrt{Z} = \sqrt{2}$ times faster than in the first hydrogen orbit, whereas equation V-4 says they are moving Z= twice as fast. In heavier atoms the problem escalates proportional to the square root of the atomic number. On the face of it the semi-classical Bohr model runs into insurmountable difficulties in explaining the higher elements, while solutions to Shrödinger's equation become prohibitively complex.

This warrants some careful reflection from the standpoint of System3.

$$v^2 = \frac{e^2}{4\pi\varepsilon_0 m r_n} \qquad \text{V-3)}$$

Equation V-3 derives from equating the centripetal force to the Coulomb force. It results in a square relationship indicating that it historically integrates a succession of space frames and conjugate quantum frames. Velocity is a measure of equal relative quantum jumps over a succession of primary intervals of time. It is quantized and thus has a conjugate quantum counterpart that is its reciprocal. Given that these are equivalent when velocity is constant defines a square relationship in the integrated fabric of space-time on historic coordinates (See Chapter IV for historic integration on historic coordinates).

The square of velocity thus indicates its historic integration over any extended interval of time. The Coulomb force is a static force in each space frame that derives from the coalesced unity of electron and proton in the conjugate quantum frame, while the centripetal force required to keep the electron in orbit can only be known over a succession of space frames that reveal its velocity. An historic integration of this kind is thus essential if Bohr's premise of the centripetal force being equal to the Coulomb force is valid.

$$mvr_n = \frac{nh}{2\pi} \qquad \text{V-4)}$$

Equation V-4 equates the electron's angular momentum to an integral multiple of $h/2\pi$. It defines the electron's momentum as each quantum jump in position depending on what orbit it is in. Momentum is quantized accordingly. Equation V4 is a definition of momentum as it relates to each equal quantum jump in position in each orbit. It does not implicate historic integration because it applies to each primary interval of time equally and independently.

This means that Equation V3 historically integrates Equation V4. Since the angular orbital momentum of the electron in the first orbit of the primary hydrogen atom is zero it is reasonable to conclude that the electron recurs in each space frame in the same relative location.

Reconciliation of the SC Model:

If we think in terms of classical ideas of continuous motion in continuous space and time there is no resolution to the apparent discrepancy between the two equations in the case of the helium atom. However System 3 requires that we must revise how we think about space and time at the atomic level as well as at the cosmic level. There is

no such a thing as continuous motion. There are only synchronous quantum jumps in relative position. This is true in both the internal and external space of the atom. It is true on every scale of magnitude.

The radius of the first orbit in the Helium atom is contracted by half because the mutual Coulomb force is between two electrons and two protons, not one. The radius is contracted by half because the Coulomb force is doubled. Within the atom we cannot consider the motions of the two electrons separately because they are synchronously projected together in static positions that only change with respect to one another between space frames defined by the primary projection of hydrogen atoms. The fusion of helium takes place within this overriding context and the helium atom as a whole must be synchronous with primary hydrogen.

The secondary System 3 that fuses helium together has an expressive and regenerative mode that alternately relate to the objective and subjective orientations within the subsuming context of the primary System 3. The objective orientation relates to the fused atom as an integral whole. The subjective orientation, the regenerative mode, relates to the strong force binding of the neutron with other nucleons.

Since there are two neutrons and protons there are two ways that this can work in a helium nucleus. The regenerative mode of the secondary System 3 can alternately bind nucleons employing one neutron or the other while the expressive mode remains synchronous with alternate projections of the whole atom along with the physical universe as a whole. This would mean that nuclear binding in the helium atom would lapse briefly in alternate space frames. It would also mean that the secondary projection of the integrated atom as a whole would be skipped in alternate space frames. There is no evidence to indicate this.

This requires that there are two alternate secondary Systems 3 such that they reciprocate, one expressive mode occurring synchronously with the regenerative mode of the other and vice versa. In both alternate space frames only half of the neutrons would be actively binding nucleons in any primary interval of time, since the regenerative mode relates to one neutron. Two reciprocating Systems 3 also provide a means by which mirror symmetries are preserved, accounting for parity. In Helium 3 with only one neutron both secondary Systems 3 relate to the same neutron and still reciprocate in a similar manner.

Correlating Inner and Outer Space-Time:

A universally valid structural basis to the cosmic order requires that there must be a correlation between events in the inner space of the

This is reasonably consistent with the TJNAF research. It showed that about twenty percent of the protons or neutrons in carbon 12 with atomic number 6 were paired at any one time. With six secondary Systems 3, only half have regenerative modes at any one time. This means about 3 pairings with respect to 12 nucleons at any one time, or about 25% with respect to neutrons. This suggests a test for the secondary Systems 3 in other elements.

Three Applications of System 3:

A third or tertiary System 3 applies to the chemical binding of the elements. The coherent *idea* of the molecule is dependent upon the atomic sharing of outer orbital electronic *routines* to produce molecular *forms*. This tertiary activity also has a particular quantized mode of ordered energies in which the *routine* and *form* are coalesced within the *idea* of unity as *elements of technique related to valence*. They are recalled to particulate form in a succession of space frames that define molecular combinations. The tertiary System 3 is thus synchronously related to the primary and secondary System 3.

According to System 3 the physical universe is constituted entirely of particulate matter with associated conjugate energy patterns that are integrated via the Void. However, the three related expressions of System 3 don't begin to explore or explain the myriad forms that we see around us. The most common forms of everyday experience clothe themselves in particulate matter, from the solid earth that we stand on to the legions of living forms that it supports. The life forms that we see around us, the grass, the trees, the birds, are all synchronously dependent upon unit building blocks of another order—the eukaryotic cells that work together in harmony to manufacture their organic bulk.

These eukaryotic cells can be seen as elaborate expressions of System 3, giving *forms* to *ideas* through *routines*, as always. The ideas are encoded in the nucleus of the cell, the routines are enacted in the cytoplasm, and the forms are delineated by membrane processes that house the cell and its organelles. But the form of the cell is not itself a physical entity in the same sense that the atoms that constitute it are. The cell is a living chemical factory that physically assembles its own walls and partitions and equipment to conform to the spatial shapes and functions inherent in the form of its own independent design according to its needs. The cell is thus synchronously organized to clothe itself in matter. It has a subsuming relationship to molecular synthesis that requires it to act as an organizing energy pattern.

atom with respect to the external space between atoms on a cosmic scale that is more credible than the supposed existence of probability waves. In other words there must be some coherent consistency between quantum events on a microscopic scale and events on a macroscopic scale. Bohr's initial postulates together with de Broglie's waves were remarkably successful for the hydrogen atom and served as a foundation for the birth of quantum mechanics. In view of this there should be some explanation for the velocity discrepancies of the electrons in the first orbit of helium and in the orbits of heavier elements.

If we consider the reciprocating actions of both secondary Systems 3 each electron relates to *both an expressive and a regenerative mode in each synchronous space frame because of the reciprocal action.* This amounts to a doubling in the projection of internal space and time with respect to the primary projection of space-time as it relates to the whole helium atom in external space-time. This normalizes the velocity of each electron as determined by quantum jumps such that it appears to orbit the nucleus once, not twice, in each primary interval of time, consistent with equation V-4, where there is no historic integration involved.

Equating the Coulomb force to the centripetal force does involve historic integration, however. The Coulomb force is a static force in each space frame because electron and proton are coalesced together as one in the conjugate quantum frame of the same primary interval of time. This is just enough to counterbalance the inertial momentum of the electron as it jumps from space-frame to space-frame around the orbit. If the internal space and time are contracted by half as for equation V-4, they are for equation V-3 as well. This neatly compensates for the halving of the radius due to the addition of the atomic number in the denominator of equation V-24.

In the lithium atom, Z=3, three secondary Systems 3 come into play that likewise compensate for apparent discrepancies between equations V-3 and V-4. In beryllium, Z=4, four secondary Systems 3 come into play and so on, consistent with the atomic number Z.

The numbers of neutrons increase over the number of protons as the atomic number increases. This is generally recognized as required by the nature of nucleon packing. Neutrons do the bulk of nucleon pairing with protons that holds the nucleus together. They must be adjacent to them to pair, so more are needed to accommodate the needed regenerative modes. This requires that the regenerative modes can relate to different neutrons in different space-frames. Neutrons are sufficiently stable to accommodate this until atomic numbers reach 83. Larger atoms undergo radioactive decay associated with the weak force.

Nor do complex multi-celled creatures like dogs and cats integrate their hoard of interdependent living processes by accident. It is the *routines* inherent in organs that direct the cells to manufacture the physical body in a coherent *form* consistent with the *idea* implicitly associated with the *host creature*. The host is an *archetypal energy pattern* that specifies the nature of the *idea as a coherent living creature*.

Concluding Remarks:

One can begin to see that the System works tier upon tier to synchronously integrate history, spanning space and time to create the miracle of existence. There are patterns to the pattern. For example System 3 integrates levels in three steps. The primary activity generates hydrogen, then the elements are integrated by a secondary activity, and chemical compounds by a third. In the biological arena the triad is the cell, the organ and the host. System 4 elaborates on the pattern,[15] more specifically delineating how the various processes of the cell, the organ and the host are meaningfully integrated.

Evolving by this perpetual reflux and regeneration of experience up through the levels of sentient awareness that enhance the integration of history we have come to be standing on this planet Earth. A good number of us look around with some sense of amazement that we are here at all, trying to figure out how it happened and wondering what it is all about.

For some of us a simplistic explanation is good enough. It is all just a physical accident without meaning or purpose, and values are an arbitrary human creation, without any transcending basis in reality. But under careful inspection, the evidence for this purely physical paradigm begins to tear rather drastically at the seams. And if truth as a value is itself an arbitrary human creation then our theories about the origin and nature of the universe can have no transcending basis in reality either. The best of our theories must be no more than aberrations of the human mind and a meaningless exercise in futility at that.

No serious student of science really believes that, and yet mainstream science perversely pursues this course. No one can deny the factual knowledge that science has accumulated. It is the currently popular interpretation of the factual evidence that is highly suspect and severely limiting. Pursued to the extreme it leaves us morally bankrupt. That was the nagging concern of men like Einstein, Planck, Schrödinger and de Broglie who were disturbed by the direction that quantum mechanics took.

What has been lacking is a paradigm that can liberate us from a blind belief in a purely physical universe of chance without resorting to an equally blind belief in miracle. We need a pragmatic new paradigm that can make holistic sense of the huge fund of empirical knowledge that traditional approaches to the sciences have accumulated. We need a holistic methodology that can complement traditional approaches and make meaningful sense of the phenomenal world. It can not be a contrived belief system. It must be a System that can facilitate direct intuitive insight into the structural dynamics of the creative process. It must have the potential to expand the horizons of science accordingly.

REFERENCES AND NOTES:

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[1] The atomic theory proposed by Leucippus and Democritus in the fifth century BC was not accepted by Aristotle and was forgotten about for two thousand years. The theory was not resurrected until Robert Boyle proposed a corpuscular theory to explain the behavior of gases in the seventeenth century. John Dalton made the modern atomic theory explicit in his work published in 1808, setting out the idea of the elements combining to form molecules, as confirmed experimentally in his Law of Multiple Proportions.

[2] Rydberg's equation can be written more precisely in the following form:

$$\frac{1}{\lambda} = R\left[\frac{1}{(m+b)^2} - \frac{1}{(n+c)^2}\right] \qquad \text{i)}$$

where λ is the wavelength of a spectral line, m and n are integers, and R, b and c are constants. R is called the Rydberg constant and is the same for all spectral lines of the elements, whereas b and c depend upon what series of lines is being measured. For the hydrogen atom the equation has a simpler form, since b and c are equal to zero:

$$\frac{1}{\lambda} = R\left[\frac{1}{m^2} - \frac{1}{n^2}\right] \qquad \text{ii)}$$

If the nucleus is assumed to be infinitely massive for the sake of simplicity, the value of R is given in equation iii) below.

$$R = \frac{2\pi^2 me^4}{h^2} \qquad \text{iii)}$$

To correct for a finite nuclear mass M of a real atom, one must use the reduced mass of the electron and nucleus, given by (mM/m+M), yielding a smaller constant. See Theodor W. Hänsch, Arthur L. Schawlow and George W. Series, The Spectrum of Atomic Hydrogen, *The Laureats' Anthology Vol.II,* Scientific American, 1991, republished from *Scientific American*, March, 1979.

3 Max Planck expresses this succinctly in *Where is Science Going*, Norton, NY, 1932: "... Anyone who has been seriously engaged in scientific work of any kind realizes that over the entrance to the gates of the temple of science are written the words: *Ye must have faith.* It is a quality which the scientists cannot dispense with. "... The pure rationalist has no place here."

4 The fact that the relationship of photon, electron and proton *within* a single atom of hydrogen is delineated by the universal set working through a *single particular set* of System 3, places some internal aspects of the atom outside the established laws of physics, as Bohr assumed. The laws of physics are generally formulated to account for phenomena externally *between* particular sets. Quantum mechanics thus runs into difficulties in reconciling events between particular centers within the atom with external events between different particular sets. At the other extreme, on a cosmic scale, the established laws of physics are in trouble again.

5 The orbital quantum number, l, determines the angular momentum, L, of the atom. The Shrödinger equation gives a different solution than the Bohr SC theory. It is one less than the principal quantum number such that

$$L = \frac{h}{2\pi}\sqrt{l(l+1)} \qquad l = 0,1,2,3\ldots,n-1 \qquad \text{iv)}$$

The third quantum number, m_l describes the orientation of the angular momentum and is called the magnetic quantum number.

6 A similar situation arises in electrodynamics where the energy density of an electromagnetic field is proportional to the square of the electric field, not the field itself.

7 Bohr, N., On the Constitution of Atoms and Molecules, *Phil. Mag.*, **26**,1; 476; 857 (1913).

8 The discrepancy between 11.7 and 12 may be covered by various factors including elliptical effects of the orbit, collective band widths of spectral lines, Doppler effects, and other factors. The spectral lines become infinitely close together as they converge toward the ionization limit close to the 12th orbit.

9 W. C. Price, S. S. Chissick, T. Ravensdale, Eds., *Wave Mechanics; The First Fifty Years*, London, Butterworths, 1974.

10 Synchronicity does not imply that simultaneous events can be identified using transported clocks that are dependent upon signals transmitted through space and time to an observer. Neither can simultaneous discrepancies as

measured by clocks be used to conclude that there is no universal synchronicity to the projection of physical events. Synchronicity is an essential condition of the discontinuous projection of space and time if spatial forms are to exhibit any degree of coherence at all.

[11] There is more on this in Appendix 1 of Fisherman's Guide.

[12] The expressive and regenerative modes become more explicit in System 4. System 4 has nine terms which are suggested by homologues of System 3, although they are not the same.

[13] Prominent physicists have commented frequently that they don't understand quantum mechanics, especially those involved in its development. Richard Feynman went so far as to say that no one understands it. The System thus offers some transparency to a subject that is difficult to fathom at best.

[14] **Published online** *Probing Cold Dense Nuclear Matter*, **Science Express, May 28, 2008.**

[15] The particle accelerators of high energy physics have produced an array of short lived particles or resonances, some of which fall into patterns very suggestive of the nine terms of System 4, for example the meson nonet. This does not mean that the patterns associated with these fleeting particles represent a more fundamental level of cosmic organization in the generation of matter. System 4 is an elaboration of the primary activity delineated by System 3. It is not more fundamental but rather a higher System. This directly suggests that the patterns are fleeting harmonics of the higher Systems due to the reflux and dispersion of the large energies attending these collisions. This means they are without fundamental significance in an assumed origin to the universe. They are not fundamental to the architecture of matter.