The Electric Charge and Magnetization Distribution of the Nucleon: Evidence of a Subatomic Turing Wave Pattern

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Abstract

Subquantum kinetics, a physics methodology that applies general systems theoretic concepts to the field of microphysics has gained the status of being a viable unified field theory. Earlier publications of this theory had proposed that a subatomic particle should consist of an electrostatic field that has the form of a radial Turing wave pattern whose form is maintained through the ongoing activity of a nonlinear reaction-diffusion medium that fills all space. This subatomic Turing wave prediction now finds confirmation in recent nucleon scattering form factor data which show that the nucleon core has a Gaussian charge density distribution with a peripheral periodicity whose wavelength approximates the particle's Compton wavelength and which declines in amplitude with increasing radial distance. The subquantum kinetics explanation for the origin of charge correctly anticipates the observation that the proton's charge density wave pattern is positively biased while the neutron's is not. The phenomenon of beta decay is interpreted as the onset of a secondary bifurcation leading from the uncharged neutron solution to the charged proton solution. The Turing wave dissipative structure prediction is able to account in a unitary fashion for nuclear binding, particle diffraction, and electron orbital quantization. The wave packet model is shown to be fundamentally flawed implying that quantum mechanics does not realistically represent the microphysical world. This new conception points to the possible existence of orbital energy states below the Balmer ground state whose transitions may be tapped as a new source of energy.

Keywords: self-organizing systems, Turing patterns, electromagnetic form factors, particle diffraction and scattering, field theory, quantum mechanics, subquantum kinetics

1. Introduction

Subquantum kinetics is a unified field theory whose description of microphysical phenomena has a general systems theoretic foundation (LaViolette 1985a, 1985b, 1985c, 1994, 2003). It conceives subatomic particles to be Turing wave patterns that self-organize within a subquantum medium that functions as an open reaction-diffusion system. In so doing, subquantum kinetics presents a substantially different paradigm from that of standard physics which views particles as *closed* systems. Whether these be subatomic particles bound together by force fields, or quarks bound together by gluons, physics has traditionally conceived nature at its most basic level to be composed of immutable structures. Unlike living systems which require a continuous flux of energy and matter with their environment to sustain their forms, conventional physics has viewed particles as self-sufficient entities, that require no interaction with their environment in order to continue their existence.

This closed system paradigm has elevated the First and Second Laws of Thermodynamics from laboratory rules to rigidly enforced universal laws of nature. The imposition of the First Law, the law of energy conservation, accords well with a universe that behaves as a closed system for in a closed system energy can be neither created nor destroyed, only converted from

one form into another. Similarly, the Second Law enforces the idea of a closed system universe whose entropy can only increase over time, never decrease. These rules, of course, are conveniently put aside to accommodate the creation of the universe which otherwise should never have been able to come into being.

Physics, though, is ripe for a conceptual revolution. String theory, the unified field theory that for some time has been in fashion, has made no testable predictions in the 30 years of its existence. Moreover its higher dimensional mathematics are so abstract as to be inaccessible to most theoretical physicists, string theorists included. As a result, many physicists have become disappointed with string theory and believe it is time for a change (Smolin, 2006; Woit, 2006). By comparison, subquantum kinetics has made a number of testable predictions and twelve of these were subsequently verified (LaViolette 1986, 1992, 1996, 2003, 2005); see Table 1.

The present paper focuses on the first prediction presented in table 1, namely that the electric field in the core of a nucleon does not have an aperiodic cusp shape, as classical nuclear theory had envisioned it, but rather is configured as a radially periodic stationary wave pattern which may be termed a *Turing wave*. Not only does this Turing wave model solve long-standing problems in modeling the phenomenon of particle diffraction, it also provides a new understanding of hydrogen atom orbital energy levels, giving credence to emerging technologies that purport to be tapping a source of clean energy from electron transitions to energy levels below the Balmer ground state.

2. The Subquantum Kinetics Approach

Let us summarize the subquantum kinetics approach and examine how it predicts the existence of these unique wave patterns in the core of the nucleon. Subquantum kinetics was inspired from work done on chemical wave phenomena such as that observed in the Belousov-Zhabotinskii reaction (Zaikin and Zhabotinskii 1970, Winfree 1974) as well as modeling work done on open chemical reaction systems such as the Brusselator studied by several investigators (Lefever 1968, Glansdorff and Prigogine 1971, and Prigogine, Nicolis, and Babloyantz 1972, Nicolis and Prigogine 1977); see figures 1 and 2. Under the right conditions, the concentrations of the variable reactants of these reaction systems spontaneously self-organize into stationary reaction-diffusion wave patterns called *Turing patterns*, so named in recognition of Alan Turing who in 1952 was the first to point out their importance for biological morphogenesis. Alternatively, they have been referred to as *dissipative structures* because the initial growth and subsequent maintenance of these patterns is due to the activity of the underlying energy-dissipating reaction processes.

The Brusselator is defined by the following four kinetic equations:

$$\begin{aligned} A &\xrightarrow{k_1} X, && a) \\ B + X &\xrightarrow{k_2} Y + Z, && b) \\ 2X + Y &\xrightarrow{k_3} 3X, && c) \\ X &\xrightarrow{k_4} \Omega. && d) \end{aligned} \qquad (1)$$

The capital letters specify the concentrations of the various reaction species, and the k_i denote the kinetic constants for each reaction. Each reaction produces its products on the right at a rate equal to the product of the reactant concentrations on the left times its kinetic constant. Reaction species X and Y are allowed to vary in space and time, while A, B, Z and Ω are held constant. This system defines two global reaction pathways which cross-couple to produce an X-Y

Table 1

Twelve Apriori Predictions of Subquantum Kinetics that were Subsequently Verified

1)	The prediction (discussed in this paper) that the electric field in the core of a nucleon should be configured as a radially periodic Turing wave pattern of progressively declining amplitude, and that a charged nucleon should have a Turing wave pattern whose core electric potential is biased relative to the background electric potential.
2)	The prediction that higher energy photons should travel slightly faster than lower energy photons, in other words, that the velocity of photons traveling over astronomical distances should be seen to increase inversely with their wavelength.
3)	The prediction that the universe is cosmologically stationary and that photons passing through intergalactic regions of space should progressively decrease their energy, that is, that photons should continually undergo a tired-light redshift effect.
4)	The prediction that photons travelling within galaxies should progressively increase their energy, that is, blueshift their wavelengths, and consequently that the luminosity of planets and red dwarf stars should be due to energy being spontaneously generated in their interiors.
5)	The prediction that the luminosity of brown dwarf stars should be due to the photon blueshifting effect described in (4).
6)	The anticipation of the Pioneer effect; the prediction that a spacecraft maser signal transponded through interplanetary space should be observed to blueshift its wavelength at a rate of about one part in 10^{18} per second.
7)	The prediction that blue supergiant stars rather than red giant stars should be the precursors of supernova explosions.
8)	The prediction that galactic core emissions should come from uncollapsed matter-creating stellar masses (Mother stars), rather than from matter-accreting black holes.
9)	The prediction that stars in the vicinity of the Galactic center should be massive blue supergiant stars as opposed to low mass red dwarf stars.
10)	The prediction that galaxies should progressively grow in size with the passage of time proceeding from compact types such as dwarf ellipticals and compact spirals to mature spirals and giant ellipticals.
11)	The prediction that a monopolar electron discharge should produce a longitudinal electric potential wave accompanied by a matter repelling gravity potential component.
12)	The prediction that the speed of the superluminal gravity wave component of a monopolar electron discharge should depend on the potential gradient of the discharge.

reaction loop; see figure 2-a. One of the cross-coupling reactions, (1-c), is autocatalytic and prone to produce a nonlinear increase of X, which is kept in check by its complementary coupling reaction (1-b). Computer simulations of this system have shown that when the reaction system is supercritical, an initially homogeneous distribution of X and Y can self-organize into a wave pattern of well-defined wavelength in which X and Y vary reciprocally with respect to one another. The concentration pattern produced by the computer simulation of the Brusselator in a

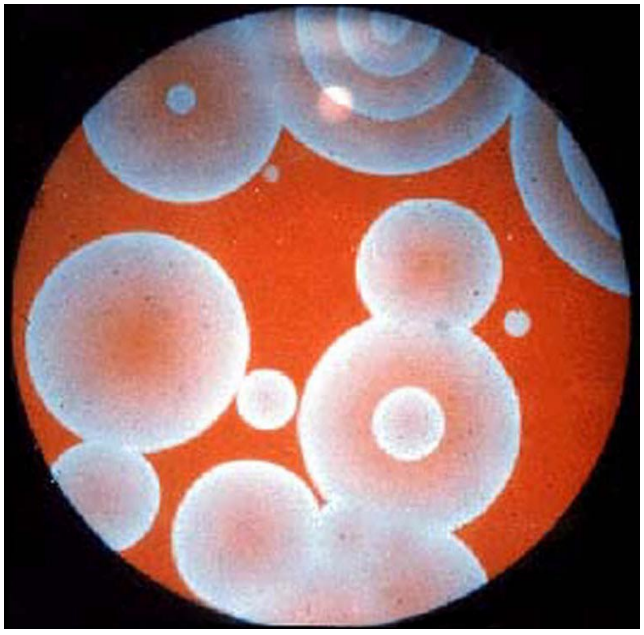

Figure 1. Chemical waves formed by the Belousov-Zhabotinskii reaction (photo courtesy of A. Winfree).

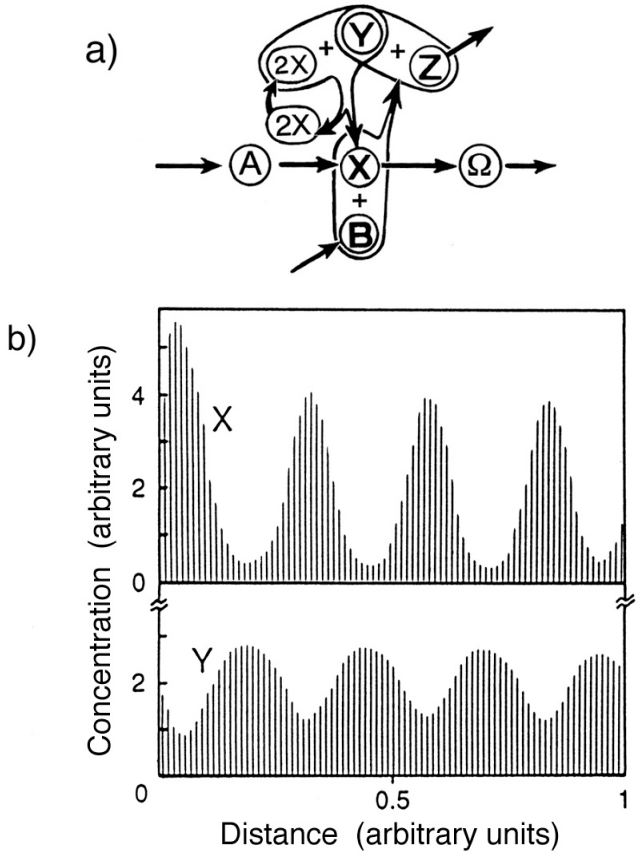

Figure 2. a) The Brusselator reaction system. b) One-dimensional computer simulation of the concentrations of the Brusselator's X and Y variables (after R. Lefever 1968).

one-dimensional reaction volume is shown in figure 2-b. In a three-dimensional volume we would expect that a supercritical Brusselator reaction-diffusion system would give rise to a periodic structure having a Gaussian central core surrounded by a pattern of concentric spherical shells of declining amplitude.

Subquantum kinetics postulates that similar reaction-diffusion processes take place among subquantum units termed etherons which exist in various types, A, B, X, and so on, and which together form a space filling ether (or aether) medium. It postulates that these etherons diffuse through space and react with one another in a manner specified by the following set of reactions:

$$\begin{aligned} A &\xrightarrow{k_1} G, && a) \\ G &\xrightarrow{k_2} X, && b) \\ B + X &\xrightarrow{k_3} Y + Z, && c) \\ 2X + Y &\xrightarrow{k_4} 3X, && d) \\ X &\xrightarrow{k_5} \Omega. && e) \end{aligned} \qquad (2)$$

These five equations form a nonlinear reaction system called Model G which is mapped out in figure 3. It is similar to reaction system (1) with the exception that step (1-a) is here replaced by steps (2-a) and (2-b) which introduce a third intermediary variable G. We may write the following set of partial differential equations to depict how all three reaction intermediates G, X and Y vary as a function of space and time in three dimensions:

$$\left.\begin{aligned} \frac{\partial G(x, y, z, t)}{\partial t} &= k_1 A - k_2 G + D_g \nabla^2 G \\ \frac{\partial X(x, y, z, t)}{\partial t} &= k_2 G + k_4 X^2 Y - k_3 B X - k_5 X + D_x \nabla^2 X \\ \frac{\partial Y(x, y, z, t)}{\partial t} &= k_3 B X - k_4 X^2 Y + D_y \nabla^2 Y \end{aligned}\right\}, \qquad (3)$$

where the D_g, D_x and D_y values represent the diffusion coefficients of the respective variables.

Etherons in this reaction system play a morphogenetic role similar to Turing's *morphogens*. Variations in the concentrations of the three reaction intermediates form observable electric and gravitational potential fields which, in turn, form material particles and energy waves. Subquantum kinetics identifies G concentration with gravitational potential, lower G concentrations being correlated with more negative gravity potentials, a G etheron concentration

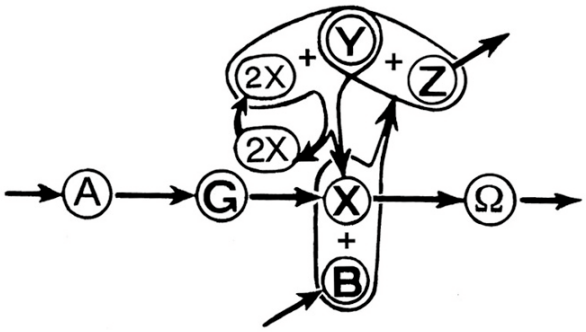

Figure 3. The Model G ether reaction system investigated by subquantum kinetics.

well corresponding to a matter attracting gravity potential field. The X and Y concentrations, which are mutually interrelated in reciprocal fashion, are together identified with electric potential fields, a positive electric potential being correlated with a higher Y and lower X concentration, and a negative electric potential being correlated with a lower Y and higher X concentration. Relative motion of an electric potential field, of an X-Y concentration gradient, generates a magnetic (or electrodynamic) force (LaViolette 1994, 2003). As Feynman, Leighton, and Sands (1964) have shown, in standard physics magnetic force can be mathematically expressed solely in terms of the effect that a moving electric potential field produces on a charged particle obviating the need for magnetic potential field terms. Also relative motion of a gravity potential field, of a G concentration gradient, generates a gravitodynamic force, the gravitational equivalent of a magnetic force.

The subquantum kinetics ether functions as an open system, etherons transforming irreversibly through a series of "upstream" states, including states A and B, eventually occupying states G, X, and Y, and subsequently transforming into the D and Ω states and from there through a sequence of "downstream" states. This irreversible sequential transformation is conceived as defining a vectorial dimension line termed the transformation dimension. Our observable physical universe would be entirely encompassed by the G, X, and Y ether states, which would reside at a nexus along this transformation dimension, the continual etheron transformation process serving as the Prime Mover of our universe. According to subquantum kinetics, the arrow of time, as physically observed in all temporal events, may be attributed to the continuation of this subquantum transformative process. Since etherons both enter and leave the etheron states that compose physical forms, the observable universe is open to the throughput of etherons. Consequently, the universe's state of order is able to spontaneously increase provided that its ether reaction system (Model G) operates close to or above a critical threshold. Thus spontaneous matter/energy creation is allowed in subquantum kinetics.

Since etherons react and transform in a stochastic fashion, changing their individual etheron states through a Markov process, the etheron concentrations characterizing any given etheron state will vary stochastically above and below their steady-state value, the magnitudes of the fluctuations conforming to a Poisson distribution. It is known that such fluctuations are present in the chemical species of reaction-diffusion systems such as the B-Z reaction and the theoretical Brusselator system and such would be true as well in the Model G reactive ether. Hence subquantum kinetics predicts that stochastic electric and gravity potential fluctuations should spontaneously arise throughout all of space, in regions both where field gradients are present and where they are absent. This stochastic ether concept is similar to the conventional idea of a zero-point energy (or dark energy) background, with the exception that these fluctuations for the most part are not large enough to nucleate the creation of material particles, fluctuations of such a large magnitude being extremely rare. As described above, the zero-point energy background arises as a direct result of the ether's regenerative flux and hence is conceived to be an indication of the ether's open system character. At the same time, these emerging zero-point energy fluctuations constitute the ether's incipient ability to create order, each fluctuation being a potential seed for nucleating physical order.

We may assume that a large fraction of the zero-point fluctuations are of sufficient magnitude to qualify them as the causal basis for quantum indeterminacy. Bohm and Vigier (1954) have shown that random fluctuations in the motions of a subquantum fluid are able to generate a field probability density $|\psi|^2$ that provides an adequate causal interpretation of quantum theory. Similar reasoning could be applied to subquantum kinetics, except for fluctuations that arise as random concentration pulses (energy potential fluctuations) rather than as random mechanical

impulses.

When the kinetic constants and diffusion coefficients of the ether reactions are properly specified to render the system in the supercritical mode, the system is able to undergo a Turing bifurcation. That is, a sufficiently large spontaneously arising zero-point electric potential fluctuation (i.e., a critical fluctuation in the concentration of X or Y etherons), with further growth would cause the initially uniform electric potential background field to break its symmetry and nucleate a periodic structure. That is, it would cause the X and Y etheron concentrations to spontaneously depart from their initial uniform distributions to form a steady-state wave pattern. In subquantum kinetics this pattern would form the central field structure of a subatomic particle. The particle's electric field would consist of a Gaussian central core, of either a high-Y/low-X polarity or low-Y/high-X polarity, surrounded by a pattern of concentric spherical shells where X and Y alternate between high and low extrema of progressively declining amplitude. Being a reaction-diffusion wave pattern, we may appropriately name this the particle's *Turing wave*.

Figure 4 depicts how the electric potential Turing wave might look in radial cross section inside a proton (left) and antiproton (right).* This diagram is taken from the 1994 book publication of the theory (LaViolette 1994 Fig. 8), a similar diagram earlier having appeared in the original 1985 paper on subquantum kinetics published in the *International Journal of General Systems* "Special Issue on Systems Thinking in Physics" (LaViolette 1985b Fig. 4). No ad hoc assumptions need be introduced to produce such dissipative structures; they follow naturally from the interplay of the reactions specified above in system (2). Subquantum kinetics predicts that the electric fields of all subatomic particles, including nucleons, electrons, and their antiparticles, should consist of such radial Turing wave patterns.

Furthermore subquantum kinetics has proposed that this Turing wave should have a wavelength equal to the particle's Compton wavelength. The Compton wavelength of a particle, λ_0, is related to its rest mass energy E_o, or to its rest mass m_o, by the formula:

$$\lambda_0 = h\,c/E_o = h/m_o c, \qquad (4)$$

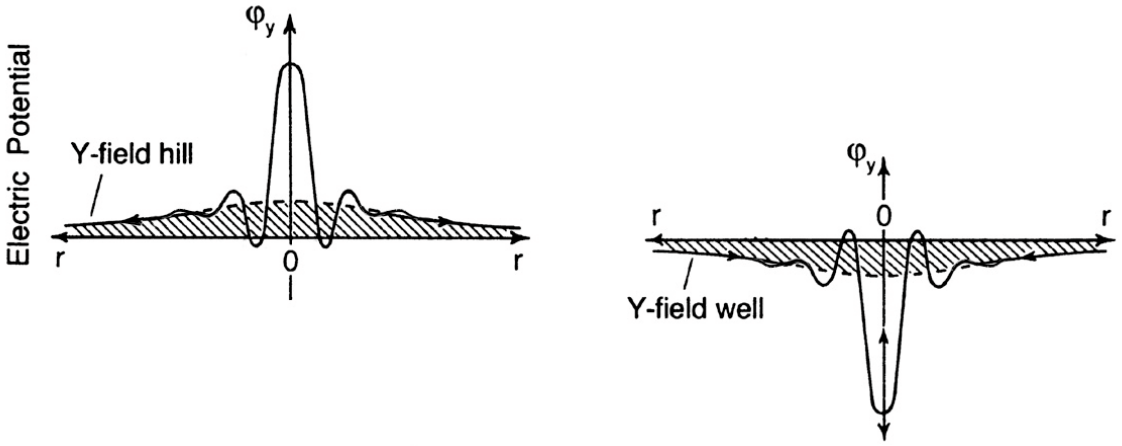

Figure 4. Radial electrostatic potential profiles for a charged subatomic particle, positive matter state (left) and negative antimatter state (right). The characteristic wavelength would equal the particle's Compton wavelength.

* This diagram was not generated from a computer simulation of Model G; it is a reasonable depiction based on computer simulations and mathematical analyses that other researchers have performed on the Brusselator.

where h is Planck's constant and c is the velocity of light. The Compton wavelength for the nucleon calculates to be 1.32 fermis ($\lambda_0 = 1.32 \times 10^{-13}$ cm). To generate a physically realistic representation of the subatomic particle, the parameters of Model G (kinetic constants, diffusion coefficients, and reaction concentrations) must be so chosen that this result is obtained.

The Compton wavelength is twice the wavelength of a hypothetical precursor gamma ray photon capable of generating the particle. That is, in the course of pair production, a gamma photon energy of approximately $2hc/\lambda_0$ would transform into a particle and antiparticle each having an energy hc/λ_0. In this way, the transition from the energy wave state to the matter state becomes essentially a change of wave propagation geometry, the initially linear wave propagation mode of the precursor photon changing into a *radial* wave propagation mode as the electric potential field of the newly created particle expands radially outward from the particle's core. Collision with a heavy nucleus provides the needed boundary condition to absorb the photon's forward momentum and effect the resulting change of wave geometry with energy being conserved.

Subquantum kinetics identifies positive charge density with an excess production rate of Y per unit volume coupled with an excess consumption rate of X per unit volume. A negative charge density would involve an excess consumption rate of Y and excess production rate of X per unit volume. These production rate balances produce corresponding electric field potentials, either a positive potential (high Y/low X) or a negative potential (low Y/high X). These terms, positive and negative charge density, may be used to describe the X and Y concentration minima and maxima that form a nucleon's electric potential Turing wave pattern. For example, the positive electric potential (high-Y/low-X concentration) at the center of the Turing wave of a neutron or proton would be produced by a local excess Y production rate per unit volume correlated with an excess X consumption rate per unit volume, which subquantum kinetics identifies with positive charge density. Similarly, the negative potential well prevailing in the spherical shell that immediately surrounds this positive core would be produced by a local excess consumption rate of Y and excess production rate of X which constitute a negative charge density.

The appearance of these charge densities necessitates the simultaneous appearance of the particle's inertial rest mass. The shorter the wavelength of the Turing wave, and greater its amplitude (greater its etheron concentration wave amplitude), the greater will be the inertial mass of the associated particle (LaViolette 1985b). Since acceleration requires a structural shift and recreation of the particle's Turing-wave dissipative space structure, the particle's resistance to acceleration, its inertia, should be proportional to the magnitude of its Turing-wave charge densities; that is, proportional to the amount of negentropy that must be restructured (LaViolette 2003).

The proton's electric potential pattern is positively biased relative to the ambient potential, as indicated by the hatched region shown in figure 4. Correspondingly, the electric potential of the antiproton's Turing wave is negatively biased. Subquantum kinetics identifies this biasing with the origin of the particle's long-range electric field and predicts that such biasing should be absent in the neutron's electric potential Turing wave pattern. The unbiased electric potential profile for the neutron is portrayed in Figure 5 which shows two neutrons in a hypothetical state of nuclear bonding (LaViolette 1985b Fig. 10, 1994 Fig. 15). It should be kept in mind that the charge densities that generate the proton's Turing wave pattern, and that are associated with its inertial mass, are distinct from and additional to the charge density that centrally biases its Turing pattern and produces the proton's long-range electric field. The former periodic densities emerge as a result of the particle's primary bifurcation from the homogeneous steady-state solution, while the latter aperiodic bias emerges as a result of its secondary bifurcation from an existing

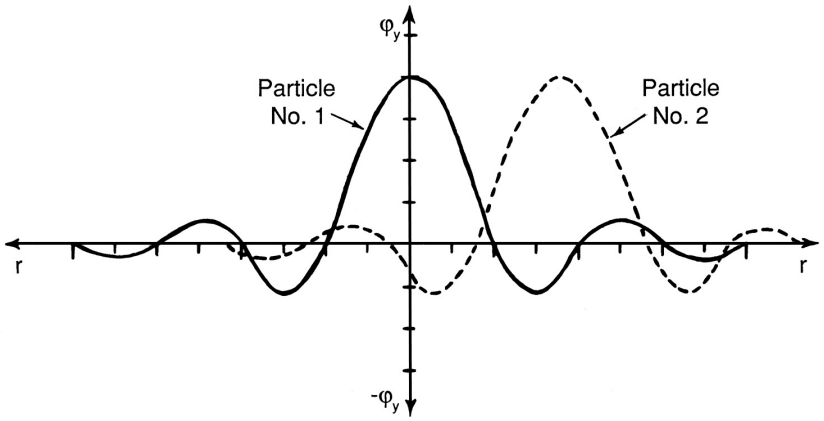

Figure 5. Illustration of the electric field profile of a neutron (Particle No. 1). In close proximity, two such nucleon electric fields could interlock to form a nuclear bond, producing an unstable di-neutron nucleus, in the case of neutron-neutron binding, or a stable deuteron nucleus in the case of proton-neutron binding.

steady state Turing solution. The origin of charge as a secondary bifurcation is described further in section 5.

The subatomic particle, then, may be conceived to be an organized entity, or system, whose form is created through the active interplay of a plurality of particulate structures existing at a lower hierarchic level. Whereas quark theory postulates that a nucleon is composed of just three quarks, subquantum kinetics proposes that a nucleon should be composed of a myriad of constituent etherons, e.g. over 10^{25} per cubic fermi. Moreover whereas quark theory proposes that quarks exist only within the nucleon, subquantum kinetics presumes that these are far more ubiquitous, filling all of space and forming the substrate for all fields.

In open chemical reaction systems like the Brusselator, entropy can spontaneously decrease without constituting a violation of the Second Law of Thermodynamics. For example, according to the Prigogine equation, $dS = d_iS + d_eS$, where dS is the total change of entropy in the system, d_iS is the entropy change due to irreversible processes (i.e., reactions) occurring within the system and d_eS is the entropy transport across the system boundaries to the environment. Thus if the entropy decrease due to irreversible processes is greater than the system processes that increase the entropy of the system's environment, $|-d_iS| > d_eS$, it is possible for the system's entropy to decrease. By analogy, the same would be true of a physical universe that is conceived to function as an open, reaction-diffusion system. Although, methods of defining entropy change at the subquantum, etheric level would need to be revised since measurable quantities such as heat, energy, and temperature would exist only at the quantum (supersystem) level, not at the etheric (subsystem) level. At the etheric level, concepts such as ether reaction affinity, action, change, or flux might be applicable, but it is unclear how these would correspond to physically measurable quantities such as potential energy or temperature.

Subquantum kinetics is incompatible with the idea of a big bang since a zero-point energy fluctuation large enough to create all the matter and energy in the universe in a single event would be a virtual impossibility. Rather, subquantum kinetics proposes the more likely scenario in which subatomic particles (e.g., neutrons) spontaneously materialize throughout supercritical

regions of space through a process of continuous creation (LaViolette 1985, 2003).* Also to be conservative in our assumptions, we must assume that the ether is cosmologically stationary and that galaxies, excepting their peculiar motions, are at rest relative to their local ether frame. The cosmological redshift effect, which big bang theorists cite as evidence for cosmological expansion, has been shown to make a better fit to cosmological data if it is interpreted as a tired-light energy loss effect (LaViolette 1985, 1986, 1995, 2003). This tired-light phenomenon has been shown to emerge naturally from the Model G ether which predicts that photons propagating through subcritical intergalactic space should continuously lose energy. Thus unlike the big bang theory, which predicts that the entropy of the physical universe as a whole should be progressively increasing, subquantum kinetics predicts that the entropy of the physical universe should be progressively decreasing as matter is continuously created.

For the same reason that the entropy of the universe is permitted to decrease through a process of continual matter and energy creation, so too subquantum kinetics allows violations of the First Law of Thermodynamics as well. But the photon redshifting or blueshifting rates that subquantum kinetics models for subcritical and supercritical regions of space are so small as to be undetectable in the laboratory, more than ten orders of magnitude smaller than what can reasonably be measured in an Earth-based laboratory. Nevertheless subquantum kinetics had correctly predicted the approximate rate of photon blueshifting that one should observe in maser signals transponded through interplanetary space; see prediction 6 of Table 1 (LaViolette 1985), because this prediction was subsequently verified by analyzing the blueshift in signals returning from the Pioneer 10 spacecraft (Anderson 2002, LaViolette 2005).

The notion of an ether or of an absolute reference frame in space necessarily conflicts with the postulate of special relativity that all frames should be relative and that the velocity of light should be a constant for all frames. However, experiments by Sagnac (1913), Graneau (1983), Silvertooth (1987, 1989), Pappas and Vaughan (1990), Lafforgue (1991), and Cornille (1998), to name just a few, have established that the idea of relative frames is untenable and should be replaced with the notion of an absolute ether frame. Furthermore the recent finding that the velocity of light is frequency dependent, not only confirms one of the predictions of subquantum kinetics (Prediction 2 of Table 1), it also refutes the relativistic notion that the velocity of light is an absolute constant. Supporting evidence that higher frequency photons travel slightly faster than lower frequency photons was found by studying the arrival times of gamma rays emitted by flares in the core of Markarian 501, a galaxy that lies about 460 million light-years away. Gamma rays in the energy range of 0.25 to 0.6 Tev were found to arrive 4 minutes after their higher frequency counterparts whose energy was an order of magnitude higher in the range 1.2 to 10 Tev (Albert, et al., 2007). Even so, subquantum kinetics does not negate the existence of "special relativistic effects" such as velocity dependent clock retardation and rod contraction. These emerge as expected results of its reaction-diffusion ether model (LaViolette 1985b, 1994, 2003, 2004).

3. Early Models of the Nucleon's Core Field

According to standard field theory, the electric and gravitational field of a subatomic particle arises from a point source at the particle's center, the field potential ideally rising to an infinite value as this center is approached. Even in the modern era of physics and astrophysics, the assumption that a gravitational field singularity exists at the center of a particle is a fundamental

* In earlier writings it had been suggested that these primordially nucleating particles would be protons. It is more likely, however, that they are neutrons that decay to protons and electrons through the process of beta decay.

prerequisite to allow the formation of a black hole singularity. Einstein (1950), however, was against the idea of point field sources, believing that the idea of a continuous field continuum coexisting with mass or charge points led to a fundamental inconsistency of physical field theory as a whole. He envisioned particles as "bunched fields," regions in which the field density was particularly high. Thus Einstein's model is consistent with the predictions of subquantum kinetics.

Physicists have sought to probe the interior of the nucleon by means of particle scattering experiments to determine how its central electric and magnetic fields vary with radial distance. Measurements of the resulting particle scattering angles and the transferred momenta Q yield a function expressed in terms of the square of the momenta, $F(Q^2)$, which is called the electric form factor and which equals the Fourier transform of the charge distribution of the target nucleon. Thus it is possible to take electric form factor data and perform a reverse Fourier transform to estimate the distribution of electric charge within the probed nucleon. Recent model fits to the form factor data indicate that the nucleon's charge density is spatially distributed, rather than point-like, and that it reaches a finite value at the particle's center, rather than rising to infinity. Thus they show that early notions of the electric charge being point-like and having a potential that rises to infinity at the nucleon's center is essentially a fiction and that the bunched field particle model is more correct. The idea of a singularity-like charge could be retained if one were willing to theorize that the charge stochastically danced around in such a fashion that allowed its average, or probability density, to form the observed distributed charge density pattern. But, as is seen below, the new measurements require that this dance be so complex as to undermine the credibility of the singularity model.

Initially, particle scattering experiments analyzed momentum transfers at relatively low particle momenta, for example, in the range of $Q^2 < 1\ (E/c)^2$, where energy, E, is measured in billions of electron volts. Thus this low range implies that the scattered particles have energies of less than 300 million electron volts. At these energies, relativistic Lorentz contraction effects of the scattered particle along the direction of particle momentum transfer may be neglected without posing a problem. Consequently, early model fits were able to make reasonably good fits to electric form factor data by predicting a simple exponential decline of charge density ρ with increasing radius r, $\rho \sim e^{-\alpha r}$, where α is a model constant. Examples include Galster's model published in 1971, Platchkov's (1990) representation of the 1980 Paris potential model, and Schmieden's (1999) fit to the Mainz Microtron data. All predicted that charge density should form a sharp central cusp, rising to a finite central value; see figure 6 (Kelly 2002).

As early as 1938, Gregory Breit (1938) had proposed that the charge distribution of a nucleon rounds off at its center somewhat like a Gaussian curve. Licht and Pagnamenta came to a similar conclusion in 1970. They noted that by taking relativistic effects into consideration, this central cusp would become smoothed into a Gaussian shape, although they did not explicitly graph this spatial variation. They noted that such a charge distribution would be consistent with expectation if the nucleon was theorized to consist of a cluster of quarks trapped in a potential well (Licht and Pagnamenta 1970).

Subquantum kinetics, which began its development in 1973, predicted a very different electric field distribution within the neutron and proton. It predicted that a particle's electric field should be Gaussian shaped at the particle's core, as in Breit's model, but in addition, that this field should be periodic, that further out from the core it should form a spherically symmetric shell pattern having a wavelength equal to the particle's Compton wavelength. The subquantum kinetics prediction about the subatomic particle's core field was advanced at a time when fits to nucleon form factor data were instead modeling the nucleon's electric field as having an aperiodic

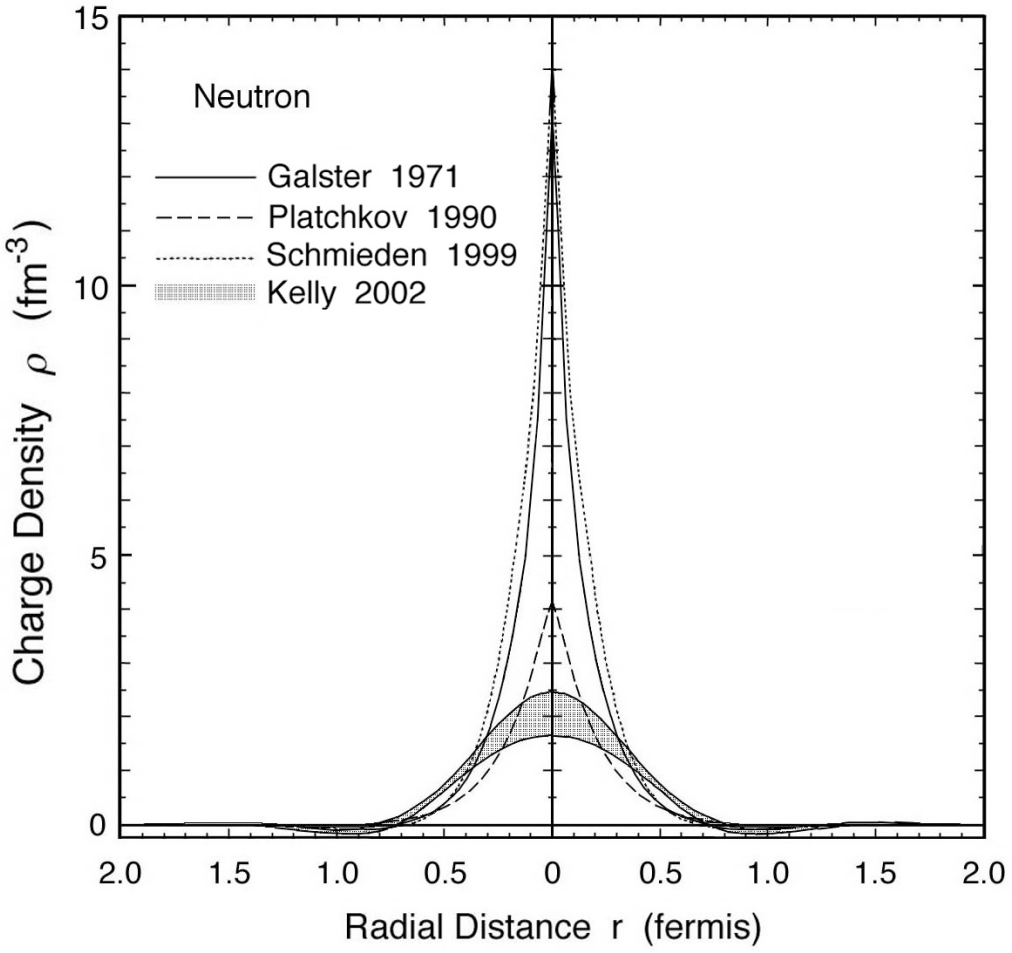

Figure 6. The relativistic neutron charge density model of J. Kelly made to fit Jefferson Lab data (shaded profile) compared to three nonrelativistic exponential model fits to earlier data sets (after Kelly 2002, Fig. 12).

cusp shape. Although Licht and Pagnamenta had earlier proposed that a nucleon with a Gaussian central charge distribution would make a good fit to form factor data, their quark cluster model, like the Gaussian chiral quark soliton model later published by Christov et al. in 1995 did not anticipate that the nucleon's charge or magnetization distribution should have a surrounding periodic component.*

It should be emphasized that these quark models were developed in an attempt to explain the results of nucleon scattering data, whereas subquantum kinetics was devised from a systems theoretic standpoint, namely with the belief that some version of the open reaction-diffusion system model useful in describing the emergence of chemical wave patterns should provide a useful description for the emergence and formation of a subatomic particle.

* While the model of Christov et al. did predict a reasonably good fit to proton form factor data available at the time, it made a poor fit to form factor data then available for the neutron.

4. Confirmation of the Subquantum Kinetics Nucleon Model

As particle scattering experiments began studying collisions at higher particle collision momenta ($Q^2 > 1$), it became necessary to use polarized particle beams and increasingly important to take account of relativistic effects. These more recent experiments made it possible to more accurately assess the spatial variation of the nucleon's charge and magnetization density, and to distinguish amongst the various competing models. Kelly (2002), for example, used a method developed by Mitra and Kumari to perform a relativistic inversion of Sachs form factor data from recent scattering experiments that employed the recoil-polarization technique (Jones 2000, Gayou 2001, Gayou 2002). His model fits to scattering data cast doubt on the cusp models and instead pointed to a Gaussian charge density distribution modulated with a radial stationary wave pattern, hence confirming the subquantum kinetics Turing wave model. His charge density profile for the neutron is compared in figure 6 to the nonrelativistic cusp models of Galster, Platchkov, and Schmieden. Kelly found that his relativistic model made a better fit to data than the nonrelativistic models of Platchkov and Schmieden, although Galster's model fortuitously also made a good fit to the data.

Kelly obtained a good data fit by representing the radial variation of charge and magnetization density with a Laguerre-Gaussian expansion and obtained similar results with a Fourier-Bessel expansion. His charge density profiles for the proton and neutron are shown in figures 7-a and 8-a. With his relativistic Laguerre-Gaussian expansion fit to electric and magnetic form factor data, Kelly (2002) showed that the charge and magnetization distributions for the nucleon are best characterized by a peripheral periodicity. The periodic character of Kelly's model fit is more apparent when surface charge density ($r^2\rho$) is plotted as a function of radial distance; see figures 7-b and 8-b. The surface charge density plot integrates the amount of charge contained within an incremental spherical shell located a distance r from the particle's center and has the effect of enhancing the magnitude of the charge density ordinate values at large radii along with their associated periodicities.

Kelly pointed out that unless this surrounding periodicity is included, his nucleon charge and magnetization density models will not make as good a fit to form factor data. In other words, Kelly is saying that for a model to make a good fit to the most recent form factor data derived by probing nucleons with high energy electron beams, such models must include this peripheral periodic component, or what we here term the Turing wave. Based on his findings we may conclude that the subquantum kinetics model offers a more detailed and accurate representation of the nucleon field than the aperiodic predictions of the quark models of Licht and Pagnamenta and Christov et al. All of the main features of the subquantum kinetics model are verified in Kelly's model, the Gaussian shaped central charge distribution, the surrounding periodicity, and the central bias characterizing the proton's positively charged field pattern. This peripheral periodic feature was not anticipated by earlier quark models.

As in the subquantum kinetics model, Kelly's charge density model predicts that the proton and neutron should both have a positive core potential. Compare figures 7 and 8 to figures 4 and 5. In addition, Kelly's model, like subquantum kinetics, depicts the proton's electric potential wave pattern as being positively biased compared to that of the neutron, with the bias increasing as the center of the particle is approached. Furthermore, as in the subquantum kinetics model, Kelly's model shows the amplitude of the proton's peripheral periodicity declining with increasing radial distance.

Kelly models the nucleon's periodicity to have a wavelength of ~0.7 fermis for the proton and ~0.9 fermis for the neutron. Expressed in terms of the Compton wavelength, $\lambda_{0,}$, this models the

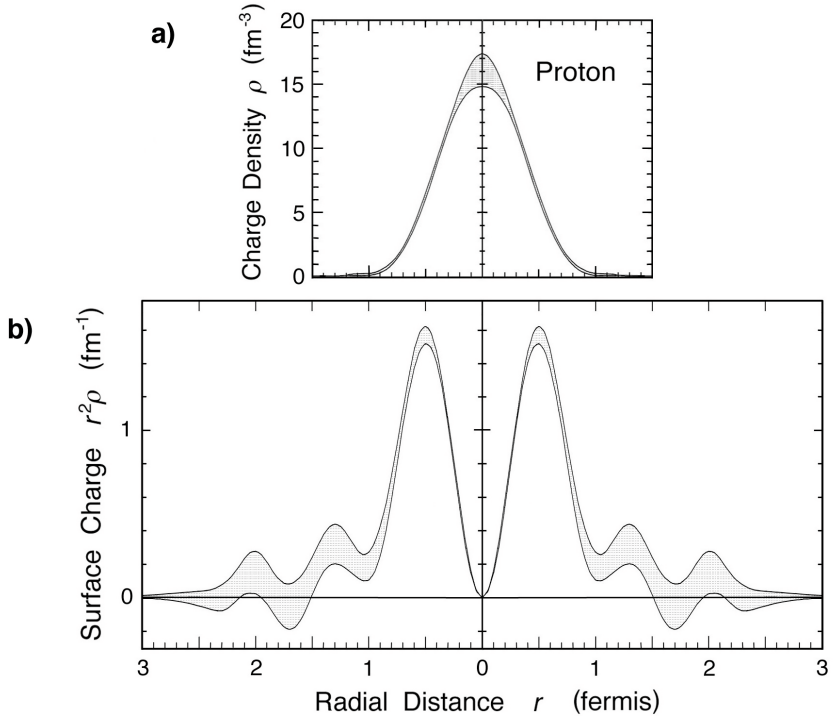

Figure 7. a) Charge density profile for the proton predicted by Kelly's preferred Laguerre-Gaussian expansion models and b) the corresponding surface charge density profile (after Kelly 2002, Fig. 5 – 7, 18).

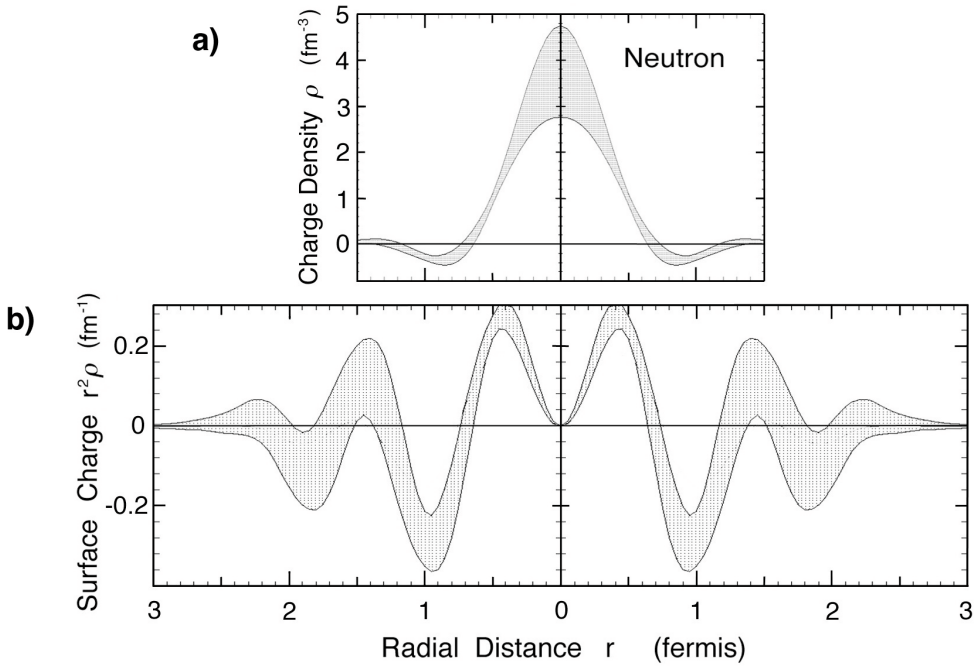

Figure 8. a) Charge density profile for the neutron predicted by Kelly's preferred Laguerre-Gaussian expansion models and b) the corresponding surface charge density profile (after Kelly 2002, Fig. 5 – 7, 18).

proton as having a periodicity of ~0.5 λ_0 and the neutron as having a periodicity of ~0.7 λ_0. This is smaller than the 1.0 λ_0 Turing pattern wavelength predicted in the subquantum kinetics model. However, the form factor data that Kelly used to fit his models was obtained by bombarding nucleons with relativistic electrons having Lorentz factors approximating the nucleon rest mass energy. So at the moment of collision the nucleon's potential energy would momentarily double causing the form factor data to predict a particle wavelength about half as long as would be expected on the basis of the nucleon's rest mass. So Kelly's nucleon models do not portray the particle's inherent wavelength, but one that arises as a result of the act of measurement. Doubling Kelly's model wavelengths to correct for this collision energy effect yields values close to the Compton wavelength values predicted by subquantum kinetics.

Kelly's findings that a periodic spatial pattern makes a good fit to nucleon charge form factor data may be itself taken as evidence that the electric field pattern of a nucleon is generated from reaction and diffusion processes continually taking place among constituents of a space-filling subquantum medium. Hence Kelly's findings provide strong support for the subquantum kinetics reaction-diffusion system approach. Unlike the linear wave packets of quantum mechanics, the subatomic dissipative structures modeled by subquantum kinetics do not spread out over time. Just as fast as X and Y etherons diffuse out from their respective shells, the nonlinear reactions (3) rebuild the structure's form keeping entropy at bay. Thus subquantum kinetics provides a simple solution to a problem that has plagued wave mechanics since its inception.

Accounting for Kelly's findings in terms of the quark model instead proves to be quite problematic. To represent the nucleon's wave-like electric charge distribution, one would have to postulate a corresponding wave-like patterning in the probability distribution of up and down quarks. Thus in the proton, two up quarks with an electric charge of +2/3 would be theorized to occupy predominantly the Gaussian core region, and one down quark with a charge of -1/3 to occupy predominantly the surrounding negative well, thus giving a net charge of +1. But proceeding outward, it becomes difficult to account for the surrounding succession of hills and wells. One now has to postulate that the three quarks dance about in such a manner that the two up quarks spend their times predominantly in the vicinity of these successive hills and the down quark spends its time predominantly in the vicinity of these successive wells. But it is difficult to imagine what would cause quarks to move about in such a fashion to generate the observed spherically symmetric wave patterns. Quarks themselves, or the "gluons" theorized to bind them together, have no script to tell them they should behave in this manner. With the subquantum kinetics approach, on the other hand, such subatomic particle periodicities emerge as a natural consequence of the behavior of the subquantum reaction-diffusion processes that are postulated to take place throughout all space, reaction processes that were proposed decades before there was observational evidence of a subatomic Turing wave. The quark model not only failed to anticipate the wave-like character of the nucleon's charge and magnetization distribution, but to survive and accommodate Kelly's findings it must make a posteriori ad hoc assumptions dictating that quarks behave kinetically in a very strange manner.

5. The Creation of Charge

Subquantum kinetics differs from the quark theory in several respects, one being the manner in which it handles the origin of mass, charge and spin. Quark theory does not attempt to explain how inertial mass, electric charge or spin arise. It merely assumes them to be physical attributes present in quarks in fractional form and which in triplicate summation appear as corresponding properties detectable in the nucleon. By comparison, etheron reactants of subquantum kinetics

have no mass, charge, or spin. Subquantum kinetics proposes that such properties are present only at the quantum level, mass and spin emerging at the time the subatomic particle is created, and charge emerging as a secondary bifurcation of the primary Turing bifurcation as described below.

The practice of ascribing charge to quarks has met with some objection in that fractional charge units (±1/3 or ±2/3) characterizing an unbound quark have never been experimentally observed. Also the assumption that quarks have spin has been refuted on experimental grounds. For example, quark theory predicts that protons whose quark spins are magnetically aligned should interact 25% more frequently than those whose quark spins are unaligned. But particle scattering experiments find an interaction ratio that is 20 fold greater, the spin-aligned protons being found to interact five times more frequently (Jaffe 1995). A spin magnetization that is a property of the particle as a whole and not present in any hypothesized subquantum constituents would be more consistent with these experimental results. Since subquantum kinetics requires that spin should emerge as a property of the particle as a whole, its concept of spin is more in line with observation than that of the quark theory.

According to subquantum kinetics, the property of spin should emerge as a direct consequence of the existence of the particle's Turing wave. Hence like inertial mass, it should appear at the time the particle is formed through a Turing bifurcation. Following the emergence of the Turing wave, radial etheron fluxes would extend between the particle's core (e.g., high-Y/low-X) and its adjacent spherical shell (e.g., low-Y/high-X). That is, X would continually flow into the core and Y would continually flow out of the core because of the core's X production rate deficit and Y production rate surplus. Judging from a similar phenomenon occurring in macroscopic systems, the inward flows would develop into a free vortex which could stimulate a rotational wave pattern to propagate circumferentially. These would appear as rotating modulations of the X-Y concentration pattern, or rotating electric fields, which would give rise to magnetic effects that may be identified with particle spin (LaViolette 1985b, 1994, 2003). Since the particle's Turing wave is periodic, its spin magnetization would also be expected to be periodic which is in agreement with Kelly's findings.

This charge creation process may be better understood with the help of the bifurcation diagram shown in figure 9. The horizontal axis plots the bifurcation parameter, β, which represents the ether reaction system's degree of criticality, higher values of β indicating that the system is operating increasingly far from equilibrium. Suppose that the system operates such that its bifurcation parameter β surpasses critical thresholds β_c and β', the first of these thresholds being the Turing bifurcation. The φ_y ordinate in figure 9 charts electric potential which in etheric terms is represented as the concentration magnitude of the Y etheron component relative to the ambient Y concentration. Let us also assume that space is initially in its field-free vacuum state where the X and Y reactants are initially uniformly distributed in space at their ambient levels; i.e., $\varphi_y = 0$. Since the bifurcation parameter lies above, β_c, the uniform state will be unstable so that an emerging zero-point energy fluctuation (X-Y fluctuation) will tend to grow in size and spontaneously break the prevailing symmetry. Past this Turing bifurcation, the reaction system moves to a new steady state in which the X and Y reactants are inhomogeneously distributed as a spherically symmetric reaction-diffusion wave pattern. The Y concentration would be at a maximum and the X concentration at a minimum at the particle's center, the X-Y concentration values, reciprocally alternating and declining in amplitude with increasing radial distance. This solution, represented by the positive polarity upper branch in figure 9, is identified with the neutrally charged neutron (n°). The neutron's Turing wave would have a maximally positive electric potential at its center which would become negative at increasing radial distance and then

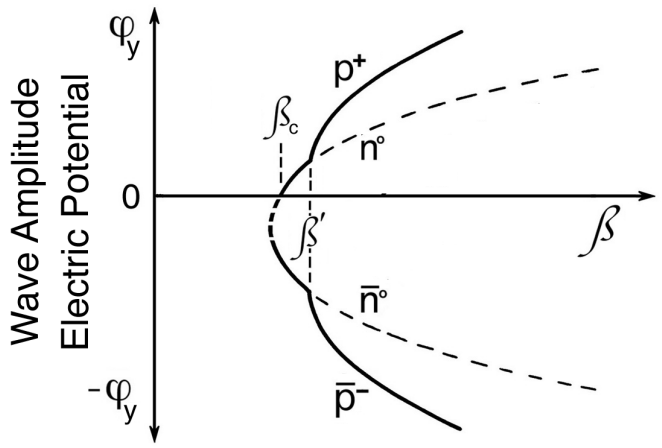

Figure 9. A hypothetical bifurcation diagram for nuclear particles. Beyond the primary bifurcation threshold β_c a fluctuation emerging from the uniform steady state leads to the creation of a subatomic particle, and beyond the secondary bifurcation threshold β' leads to the emergence of its electrostatic charge.

positive still further out, alternating with a characteristic wavelength of λ_o. This wave pattern would not be biased relative to the background potential, but would appear externally to have a zero charge. Kelly's charge density model for the neutron confirms this unbiased field configuration.

At this intermediary stage, where the reaction system has just passed the Turing bifurcation threshold, β_c, the particle's field pattern will be unbiased; no charge will be present. But, as the amplitude of the core wave pattern grows and eventually surpasses the secondary threshold β', the primary branch neutron solution becomes unstable, as indicated by the dashed portion of the line. This is consistent with the observation that the neutron, as a free particle, is unstable and decays with a half-life of about 15 minutes. When the neutron at some point spontaneously decays, the solution jumps to the left in the bifurcation diagram, to adopt a new stable state, the electrically charged proton state (p^+). Since the proton has a rest mass slightly lower than that of the neutron, this neutron-to-proton transformation will result in the additional emission of an electron and an electron antineutrino whose summed energy will equal the rest mass energy difference. This transition from the primary bifurcation, or neutron state, to the secondary bifurcation, or proton state, is commonly termed *beta decay*.*

It is significant that model fits that Kelly has made to electric form factor data show that the peak core charge density for the proton is about four times that of the neutron; compare figures 7-a and 8-a. This is consistent with the bifurcation analysis shown in figure 9 which shows that, with the emergence of the positively charged proton state, the φ_y core electric field amplitude ultimately increases above that characteristic of the neutron solution.

Mathematical analysis of the Brusselator, which is applicable also to Model G, indicates that at this secondary bifurcation the Turing wave pattern becomes biased relative to the ambient zero

* The proposal that the proton solution emerges as a secondary bifurcation of the neutron primary branch, as depicted in figure 9, is new. In the original 1985 paper and in subsequent publications, the proton had instead been theorized to emerge from a primary branch different from that for the neutron, but lying close to the neutron's branch. The formulation presented here is felt to offer a better representation and leads naturally to an explanation for beta decay.

potential state. In other words, in transforming into the newly adopted proton state, the neutron's electric potential Turing wave pattern becomes positively biased. In this new state, the proton's mean Y concentration will be increased and mean X concentration decreased from its pre bifurcation value, the Y bias being indicated in figure 4 by the hatched region. To use the terminology employed in mathematical treatments of the Brusselator reaction system (Auchmuty 1975), we may say that X and Y are "nonconserved" in the transition to the biased periodic steady state. However, since the neutron emits an electron in this process, we see that charge is ultimately conserved when all components involved in the transition are taken into account, that is the sum of all charges remains zero. If we were instead describing antineutron decay ($\bar{n}^{\circ} \longrightarrow \bar{p}^{-}$), the lower branch in figure 9, the negative polarity Turing wave pattern of the antineutron would become negatively biased to yield the negatively charged antiproton state.

The proton's electric field bias arises because, Y is being produced in its core, at an excess rate and X is being consumed there at an excess rate. Subquantum kinetics identifies these excess production and consumption rates with the particle's electric charge, for they are ultimately responsible for the central biasing of the particle's electric field pattern. As mentioned these excess productions and consumptions occur when the particle's field amplitude surpasses threshold β'. Thus in the subquantum kinetics methodology, there is no need to introduce additional ad hoc assumptions to secure the existence of charge. Charge emerges as a direct consequence of the behavior of equation system 2. It appears as a secondary bifurcation of the primary bifurcation that brings the neutrally charged precursor particle into existence. The proton's positively biased electric potential field consists of an upward biased positive Y core potential and a downward biased negative X core potential and, as described in earlier publications (LaViolette 1985b, 1994, 2003), the magnitudes of these biasings would decline inversely with increasing radial distance to form a long-range 1/r electric potential field. Hence subquantum kinetics produces a field result that conforms to the laws of classical electrostatics.

Subquantum kinetics qualifies as a unified field theory. First, its subatomic particles produce long-range fields that conform not only to the classical laws of electrostatics, but to the classical laws of gravitation as well (LaViolette 1985b, 1994, 2003). Furthermore it explicitly describes what subatomic particle charge and gravitational mass are, how they arise, and how they produce their fields. This is something that the quark theory does not attempt to do. Also magnetic and gravitodynamic forces follow as corollaries of moving charges or masses. Second, subquantum kinetics provides a reasonable model for spin magnetization. Third, it accounts for beta decay. Beta decay is often connected with what is called the "weak force," although, in subquantum kinetics there is no need to speak of a "force" being involved since the transition is simply a jump from one steady-state solution to another. Fourth, subquantum kinetics also accounts for the strong force since the Turing patterns of two nucleons, e.g., a proton and neutron, would interlock with one another when in close proximity, the proton's positive core becoming trapped in the negative potential well surrounding the neutron's core and the neutron's positive core becoming trapped in the potential well surrounding the proton's positive core; see Figure 3. Thus nuclear binding is attributed to the operation of very strong attractive and repulsive *electrostatic* forces which come into play when nucleons are in close proximity to one another.

In discussing the charge distribution found for the neutron, theorists in the past have suggested that the neutron has a positively charged core surrounded by a negatively charged shell and that these neutralize one another to yield a net zero charge for the neutron. But this explanation misses the point. Regardless of whether one deals with a proton or neutron, in either case, the nucleon's electric potential distribution is periodic — a positive core potential hill being surrounded by a negative potential well, which in turn is surrounded by a positive potential hill,

and so on. The reason that the proton projects a long-range positive electric field and the neutron does not is that the proton's Turing pattern is biased positively, whereas the neutron's remains unbiased, its potential wells exactly canceling its potential hills.

Subquantum kinetics predicts that the peak-to-peak magnitude of a particle's Turing wave should decline with increasing radial distance r and that the nuclear force should drop off in proportion to this wave amplitude decline. Kelly's neutron charge density model supports this prediction in that it depicts the amplitude of the Turing pattern declining with radial distance. In the context of subquantum kinetics, where nuclear force is due to the interlocking of Turing wave patterns, we would expect nuclear force to follow a power law decline similar to that of the particle's Turing wave pattern. Based on the surface charge density profiles shown in figures 7b and 8b, we may conclude that Kelly models an approximately inverse fourth power decline at the center of the Turing pattern. Standard nuclear theories, on the other hand, model a steeper decline for the nuclear force, $F_n \propto 1/r^7$. In performing form factor model fits to nucleon scattering data, it would be interesting to use a wave function with a $1/r^{-7}$ decline to investigate the goodness of fit. To account for particle diffraction, it is necessary to presume that this initial steep decline transitions further out to a more gradual decline approximating the $1/r^2$ decline of the electric field. This subject is examined further in the next section.

Although we can never hope to measure the shape of the particle's gravity field by means of particle scattering data, experimental evidence that points to the existence of electrogravitic coupling would lead us to conclude that the particle's gravity field, like its electric field, is also Gaussian in shape at the particle's center and hence does not form a central singularity. This is consistent with subquantum kinetics which predicts that there should be a close coupling between charge and gravity (between X-Y concentration polarity and G concentration polarity). If the particle's gravity field is Gaussian, then we may rule out the possibility that black hole singularities might form. Einstein would undoubtedly agree.

6. Particle Diffraction and the Wave-Particle Dualism

The existence of the particle's Turing wave eliminates the need to speak in terms of a "wave-particle dualism." The subatomic particle simultaneously has both particle and wave characteristics, its nuclear electric field having both a well-defined core and a surrounding periodicity. This λ_0 core wave by itself is able to account for the phenomenon of particle diffraction (LaViolette 1985b, 1994, 2003).* The Turing wave forming a nucleon or an electron would diffract from a diffraction grating in a manner identical to deBroglie's postulated phase wave. In other words, the particle's advancing Turing wave pattern would establish an electric potential interference pattern at the surface of the diffraction grating that would be identical to that produced by de Broglie's hypothesized phase wave. For example, suppose that a subatomic particle with its extended Turing wave periodicity approaches the diffraction grating at velocity v. In the particle rest frame the Turing wave will have a wavelength equal the particle's Compton wavelength, λ_0, whereas in the grating's rest frame it will appear to have a slightly shorter wavelength $\lambda'_0 = \lambda_0(1 - ß^2)^{½}$ due to the Lorentz length contraction effect, where $ß = v/c$. As the approaching Turing wave field continuously impinges on the diffraction grating with a velocity v relative to the grating rest frame, it excites electric potential oscillations at the grating's surface at a frequency, f_e:

* The discovery that the Turing pattern adequately accounts for the phenomenon of particle diffraction was made after this dissipative structure representation of subatomic matter had already been completed, hence indicating the predictive potential of this approach.

$$f_e = v/\lambda'_0 = v/\lambda_0(1 - ß^2)^{½}, \quad (5)$$

The faster the particle travels toward the grating, the higher will be the excited frequency. These oscillations will occur coherently at each of the grating's grooves, and will radiate out longitudinal electric potential waves traveling at the velocity of light. These together will create an electric potential wave interference pattern in the direction of the approaching particle. Since the radiated waves travel away from the grating at the speed of light, their wavelength, λ_v, will be longer than the particle's intrinsic Compton wavelength, their wavelength, λ_v, being given as:

$$\lambda_v = c/f_e = \frac{c}{v}\lambda_0(1 - ß^2)^{½}. \quad (6)$$

These radiated waves are termed "velocity waves" because of their dependence on the particle's velocity relative to the grating rest frame, their wavelength varying inversely with respect to the particle velocity (LaViolette 1985b, 1994, 2003). When equation (4) is used to eliminate the Compton wavelength, λ_0, from equation (6), the velocity wave wavelength becomes expressed as:

$$\lambda_v = h/mv. \quad (7)$$

The wavelength of the velocity waves creating the electric potential interference pattern turns out to be numerically equal to the deBroglie wavelength, λ_p, which is similarly related to particle mass m and velocity v (or to momentum p = mv) as:

$$\lambda_p = h/mv = h/p. \quad (8)$$

The electric potential gradients that make up the grating velocity-wave interference pattern exert forces on the electric potentials that make up the dissipative structure of the approaching particle/Turing wave, thereby perturbing the particle's trajectory, scattering it toward regions of constructive interference. These scattering forces, which are electrostatic in nature, would operate just as readily on charge densities making up a neutral particle, such as a neutron, as on those making up charged particles, such as protons and electrons. Put another way, particle diffraction is a phenomenon in which a subatomic particle interacts with the interference pattern induced by its own periodic electric potential field. Since the velocity wave interference pattern requires some time to be established and must already be in place to influence the particle's trajectory as the particle nears the grating, we may conclude that the Turing pattern periodicity extends a considerable distance outwards from the particle's core, perhaps on the order of tens of millions of Compton wavelengths. In the case of the electron, this would amount to a distance of several tens of microns.

This Turing-wave/velocity-wave explanation of particle diffraction, predicted by subquantum kinetics, is indirectly validated by the electric form factor data discussed above, which reveals the existence of the nucleon's Turing wave pattern, at least in the vicinity of the nucleon's core. As we shall see below, the Turing wave description of the wave properties of matter avoids the shortcomings of the quantum mechanical wave packet model which developed from deBroglie's phase-wave model.

De Broglie's particle diffraction model conceived the subatomic particle, in the classical sense, to be a localized bit of matter undergoing a periodic vibration. He suggested that this vibration generated a phase-wave of wavelength $\lambda_p = h/mv$, which he represented as a continuous plane monochromatic wave, having a constant amplitude and no spatial localization, that traveled linearly at superluminal velocity in the same direction as the particle. Hence he did not take the phase-wave as a description of the particle itself. Neither could it constitute a reasonable description of a real electromagnetic wave since its velocity *w* computed to be greater than the

speed of light, i.e., $w = E/p = c^2/v$, where $E = mc^2$ is the particle's total energy and $p = mv$ is its momentum. Hence according to deBroglie, the phase wave's velocity would be greater than c by the factor c/v. Although De Broglie (1962) associated this imaginary wave with the particle, he did not assign to it any real physical significance; he merely meant it as a metaphor.

However, this changed when Erwin Schroedinger reinterpreted deBroglie's phase wave, viewing it not as a metaphor, but as a concrete reality. Inspired by de Broglie's thesis, Schröedinger in 1926 conceived his famous wave equation which was to become the foundation of modern quantum mechanics. He had the idea of representing a moving particle as a propagating wave packet made up of several linear monochromatic wave functions, $\Psi_{(x,t)}$, traveling in the same direction as the particle at a superluminal speed. They were chosen to have wavelengths that differed from one another by a small amount, $d\lambda$, about an average value equal to the de Broglie wavelength $\lambda_p = \hbar/p$; hence they were essentially conceived as a group of deBroglie phase-waves. Also the waves were assumed to have frequencies that differed from one another by a small amount, $d\nu$, about an average value equal to the Compton frequency $f_0 = E/\hbar$. Hence like deBroglie's phase waves, Schroedinger's wave packet waves were conceived to have a superluminal velocity: $w = \lambda_p f_0 = E/p = c^2/v$. In linear superposition the wave amplitudes amplitudes would constructively interfere at the center of the wave group where their phases would coincide, and destructively interfere further out where the wave amplitudes would desynchronize and mutually cancel out due to their differing frequencies and phases. As a result, these superimposed waves were conceived to produce a localized wave packet having a non-zero amplitude over a finite region of space; see figure 10.

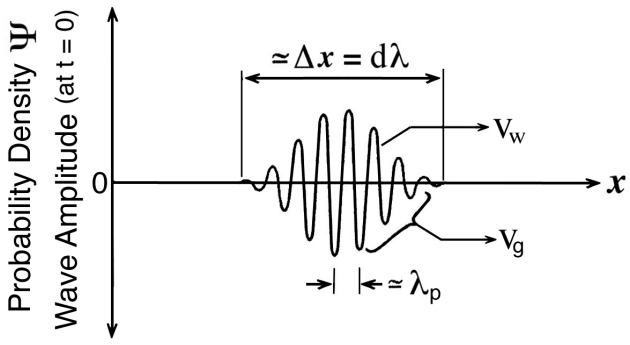

Figure 10. A wave packet representation of a material particle.

The breadth of the wave packet, Δx, was determined by a suitably choosing the wavelength range $d\lambda$ of the wave group (i.e., $\Delta x = d\lambda$). The velocity of the wave group $v_g = d\nu \cdot d\lambda$ then became identical with the particle velocity v (since $d\nu \cdot d\lambda = dE/dp = v$). The ranges, $d\nu$ and $d\lambda$, were was justified as representing the uncertainty in knowing the frequency and wavelength of the group's waves at any given instant.

But in proposing this representation, Schröedinger abandoned de Broglie's idea of a virtual "associated" phase-wave and instead considered the wave packet waves as having physical significance in the classical sense, the particle being conceived to be synonymous with this traveling wave packet. Later, Born, Bohr, and Heisenberg adopted Schröedinger's model for their own probabilistic interpretation. They proceeded to construct a wave-particle dualism in which the wave packet, or more precisely the function Ψ^2, was viewed merely as a description of the probability of finding the point-like particle in a particular region of space. Whereas de Broglie initially intended his phase-wave as an imaginary manifestation of a concrete particle singularity,

his insight became lost in the shuffle. The emphasis now became reversed. The Copenhagen school of thought, as it came to be known, gave credence only to the wave packet. The breadth of the packet Δx was identified with the observational uncertainty in locating the particle's position, given that the particle's momentum was subjectively evaluated to an accuracy Δp. The reality of the point-like particle itself was downplayed since the particle could not be accurately resolved in terms of position and momentum.

Thus, in the space of a few years de Broglie's associated phase-wave had become reified into a "concrete picture of reality." This presents an excellent example of what Whitehead has referred to as the fallacy of misplaced concreteness. At a very early stage in its development, Shroedinger's wave mechanics had become sidetracked by the probabilist school and to this day has failed to extract itself from the Procrustean bed it helped to create.

However, this quantum mechanical reformulation of de Broglie's theory had several problems. As in de Broglie's phase-wave, the individual waves forming the packet calculated to have a velocity greater than the speed of light, thereby contradicting a basic tenet of special relativity that an electromagnetic wave's velocity should always equal the speed of light, c. Furthermore, the Schröedinger's wave packet was prone to spatial dissipation. In the words of de Broglie (1960, p. 25, 1962, p. 121):

> At the end of a sufficiently long period of time, the wave-group can no longer be considered as moving without deformation, and, eventually, it spreads out further and further into space with a diminution proportionate to its amplitude. In the usual (linear) theory of wave propagation, wave trains spread into space with a consequent drop of amplitude. Linear analysis shows that this process is associated with the fact that linear theory considers wave trains as superpositions of plane monochromatic waves. These plane waves are propagated through space independently, whence they are progressively thrown out of phase and consequently dissipated.

A third difficulty lay in the fact that the extended hill-like character of the wave train provided an inadequate description of the physical shape of the particle which according to classical theory should be discrete and well localized. A fourth problem lay in the description of the particle at low or zero velocity. Since the dimensions of the wave packet, $\Delta x = d\lambda$, must necessarily be greater than the wave packet wavelength, λ_p, and since the value of λ_p in turn depends inversely on the particle's momentum, see equation (8), then as v goes to 0, λ_p must approach infinity. As a result, the location of the particle becomes completely indeterminate.

Moreover since the size of the wave packet and its de Broglie wavelength depended entirely on the relative velocity of the observer, hence on the particular frame of reference chosen for observation, the wave packet representation of a particle became highly subjective. This leads to a fifth problem, which frames a serious paradox. Consider several observers each having an equal opportunity for observing a remote wave packet (particle) and each bearing a diffraction grating capable of scattering the wave packet (particle). Also suppose that each observer resides in a different frame of reference such that the wave packet moves at a different velocity relative to each. Depending on which observer ultimately ends up being the one to observe the particle, the particle in advance would be characterized by different particle momenta and hence by different wave packet wavelengths. In that case, which wave packet are we to say actually represents the particle? Or conversely, how does the particle know in advance which wave packet it must be formed as? In the case of Schröedinger's wave mechanical model if a particle were simultaneously observed from many reference frames, there should exist a multiplicity of mutually contradictory wave packets simultaneously defining the particle's position (Lande, 1971). In an effort to avoid this problem, quantum theory has gravitated toward a monist view in which it regards the particle

as having no independent existence, its physical state being imminent until the moment of measurement wherein its properties suddenly become defined in a real sense, the so called "collapse of the wave function."* However, Dewdney et al. (1985) report the results of experiments showing that the position of the particle is defined in a real sense prior to its deBroglie scattering event. They conclude that this experimentally disproves the Copenhagen interpretation and its wave-packet-collapse concept and favors a causal deterministic model such as that proposed by deBroglie which theorizes that a subatomic particle and its wave aspect coexist simultaneously.

These results also support the subquantum kinetics Turing wave model which proposes that the subatomic particle's Turing wave is uniquely defined by its wavelength λ_0 *independent of any act of measurement*. By being uniquely characterized in this fashion, the particle is freed from being defined by any future act of observation. The positivist paradigm, which has maintained an active enclave in physics, may now come to an end. If a "tree" in the microphysics forest "falls", and no one is there to observe it, the "tree" nonetheless does "fall". The Copenhagen wave function has now collapsed, but for good. We can say now with some certainty that the Turing wave model of subquantum kinetics effectively replaces the indeterminate quantum mechanics paradigm, being now armed with particle scattering evidence which shows that the subatomic particle's Turing wave does in fact exist.

This is not to say that there is not an indeterminate aspect to the Turing wave model. By its nature, the underlying ether reactions are stochastic and the ether concentrations that form the observable energy potential fields are in a continual state of fluctuation forming a zero-point energy background. Subquantum kinetics proposes that these background fluctuations are crucial since, under prevailing supercritical conditions, a critical fluctuation can lead to the creation of a subatomic particle. This would occur through the morphogenetic process that Prigogine, et al. (1972) term order-through-fluctuation.

The Turing wave model also avoids the localization problem that plagues Schröedinger's wave packet. Whether in motion, or at rest relative to an observer, the particle's core would have a fixed size, its diameter equaling the particle's Compton wavelength. The particle's center would be defined by the central Gaussian maximum of its Turing electric potential wave pattern. Moreover the troublesome concept of an entropically dispersing wave packet, may now be dispensed with and replaced by the idea of the particle's Turing wave, or etheric concentration pattern, continually maintaining its structural coherence as a result of the nonlinear reaction-diffusion processes continually taking place in the underlying ether and continuously regenerating the particle's form (LaViolette 1985b).

It is interesting that de Broglie became dissatisfied with the indeterminate quantum mechanical description and in later years proposed a revision of his earlier ideas. Like subquantum kinetics, he proposed the idea of a *nonlinear*, nondispersing core region as uniquely defining the position of the particle which he conceived of as a "bunched field singularity", u_0, having a radius approximating the particle's Compton wavelength. But, unlike subquantum kinetics, he did not elucidate what these nonlinear processes might be. Furthermore he theorized that the core field potential was oscillating in clock-like fashion, having a characteristic frequency ν equal to the Compton frequency and giving the *subjective appearance* to an outside observer of being a translating wave of wavelength λ_p which he called the ψ-wave. The character of the ψ-wave entirely depended on the observer's frame of reference and state of knowledge and had for him no

* Those interested in a general overview of the concept of the wave function collapse and its various conundrums are referred to the site: http://en.wikipedia.org/wiki/Wavefunction_collapse.

physical significance except for its phase. He further theorized that a linear "v-wave" immediately surrounded and was somehow "fused" to the particle's nonlinear core and shared its characteristic frequency of oscillation. Further he proposed that this v wave was somehow guided or piloted by the ψ-wave so that the phases of the v-wave and ψ-wave always matched with one another. Mediated by the v-wave, the ψ-wave would guide the particle's core, steering it towards regions of constructive interference in the ψ-wave interference pattern.

Although de Broglie's model had the particle core, u_0, of Compton wavelength dimensions, surrounded by a periodicity, the v-wave, unlike the steady-state Turing wave of subquantum kinetics, this v-wave was theorized to have a far larger wavelength approximating that of the ψ-wave, a wavelength that could change from one moment to the next depending on which remote observer would choose to ultimately diffract the particle. Thus de Broglie's rather complex and contrived formulation was substantially different from that of subquantum kinetics, and suffered from many of the same externally determined multiple-reference-frame difficulties that plagued Schroedinger's wave packet. Moreover, like the wave packet, de Broglie's linear v-wave was prone to entropic dispersion.

7. Hydrogen Atom Orbital Quantization

Earlier publications also noted that the Turing wave formulation anticipates the atom's quantized orbital electron states (LaViolette 1985b, 1994). That is, when an electron is in orbit about a proton, its Turing wave will generate an orbital velocity wave in the proton's reference frame having a wavelength $\lambda_v = h/mv$, where m is the electron's mass and v is its orbital velocity. For this orbital oscillation to become self-reinforcing, this velocity wave wavelength must fit a whole number of times within the circumference, $2\pi r$, of the electron's orbit, leading to the equivalence, $2\pi r = nh/mv$, where n = 1, 2, 3,... is the principal quantum number. Without a need for additional assumptions, this directly yields Bohr's orbital quantization formula:

$$mvr = nh/2\pi. \tag{9}$$

Alternatively, this circling may be thought of as an electric potential oscillation that occurs at every point in the electron's orbit. If we suppose, as before, that the velocity wave travels at the velocity of light, the frequency, *f*, it excites in the atom's rest frame will be given as, $f = c/\lambda_v = mvc/h$. Applying the restriction specified by equation (9), to eliminate mv/h, this becomes:

$$f = cn/2\pi r. \tag{10}$$

When this equality holds, the velocity wave's phase will properly match with that of previous orbital excursions so as to reinforce this oscillation.

To specify more exactly what orbital radii are allowed, we must take account of the requirement that the outward centrifugal force due to the electron's orbital motion must exactly balance the centripetal force of electrostatic attraction. This equality yields the following velocity-radius relation: $v = (ke^2/mr)^{1/2}$, where k is the electrostatic constant, e is the electron's charge, m is the electron's mass, and r is its orbital radius. For the Bohr ground state, n = 1, v calculates to have the nonrelativistic value of 0.73% c. Using this relation to eliminate v in relation (9), we get the following allowable orbital radii for the electron:

$$r = n^2h^2/4\pi^2ke^2m. \tag{11}$$

In the case of the Bohr ground state (n = 1), the electron's orbit will have a radius of a_o = 0.5292 Å, the so called *Bohr radius*, and its orbital circumference will equal 3.325 Å. This circumference is such that a single velocity wave wavelength λ_v makes an exact fit to the orbit. In the n = 2 orbit, the electron's velocity will be half as much and its velocity wave wavelength will

be twice as long. But since r increases according to n^2, the n = 2 orbital circumference will be four times as large, allowing two λ_v waves to fit within the orbital circumference a whole number of times. Three velocity wave wavelengths will fit within the n = 3 orbital circumference, and so on. Electron transitions between these orbital energy states may be treated by means of catastrophe theory wherein each orbit is viewed as a stable attractor domain to which the system gravitates unless sufficiently perturbed. For example, through the reception or emission of the proper amount of energy the electron is able to transition to a new orbital attractor domain.

The Compton wavelength of the electron's Turing wave is far smaller than the orbital circumference. For the n = 1 Bohr ground state orbit 137.06 electron Compton wavelengths are able to fit around the orbital circumference. Coincidentally, this comes very close to the fine structure constant which is estimated to equal 137.036. So we see that with the Turing wave model, the compactness of the electron relative to its orbit allows a rather classical description of the electron. Its orbital motion may be understood relatively concretely in terms of a charge orbiting a proton of opposite charge, viewed in some respects like a planet orbiting a central star.

Such was not possible for Schrödinger's wave packet model. Figuring that the wave packet would be approximately ten fold larger than its de Broglie phase wave, i.e., $\sim 10\lambda_p$, its size would be so large as to envelope the entire atom, the electron wave packet for the n = 1 orbit being roughly 63 Bohr radii in size. So a classical description was not possible. Indeed, in discussing the application of his wave mechanics to the Bohr orbits, Schrödinger (1926, p. 1056) acknowledged that his electron wave packet will "spread out in all directions far over the range of the orbit". This led him to state (p. 1055):

> "...ordinary mechanics will be no longer applicable to such an orbit than geometrical optics is to the diffraction of light by a disk of diameter equal to the wavelength. ...the conception of orbits of material points seems to be inapplicable to orbits of atomic dimensions."

Schrödinger is correct in saying that we cannot treat such a situation naively in terms of ordinary mechanics, for ordinary mechanics would not anticipate the electron's restriction to certain quantized orbital radii. Nevertheless his stated need of dispensing altogether with ordinary mechanics is now seen to be unnecessary. Following the Turing wave conception, we find that the electron core structure is over 8000 times smaller than Schrödinger had supposed. Hence the classical picture of an orbiting charge is still feasible. It is merely the inherent periodic character of this charge that requires it be treated specially at atomic dimensions.

We have seen in equation (9) above that due to the electron's production of velocity waves, its atomic orbit angular momentum, mvr, is restricted to discrete whole number multiples, $nh/2\pi$, where n adopts quantum values of 1, 2, 3,... But, what about quantum states n = 1/2, 1/3, 1/4. Might fractions of the Bohr orbit angular momentum be allowed as well? If so, this would correspond to Bohr orbital radii $r = n^2 a_o$, leading to orbital radii of $a_o/4$, $a_o/9$, $a_o/16$. Mills et al. (2000) and Eccles (2000, 2005) have suggested that such sub ground energy states do exist and that transitions to them are triggered through collisional excitations with nearby catalytic ions. Mills uses the term "hydrino" state to characterize these more tightly bound orbital states in the hydrogen atom. Catalysts for triggering such transitions in hydrogen atoms include elements such as potassium, rubidium, and strontium which are capable of collisionally absorbing 27.2 ev energy quanta from the hydrogen atom to produce an electronic transition in the catalyst atom which would reradiate this energy in the form of heat or ultraviolet photons.

In one experiment, using a potential of only 2 volts, Mills et al. (2000) were able to generate an ultraviolet emitting plasma in a hydrogen gas containing strontium as a catalyst. Without the catalyst, they had to increase their threshold voltage to 250 volts and supply 4000 times more power to generate the same amount of light output. Also Eccles (2005) reports the emission of

308 Å (40.3 ev) ultraviolet photons coming from rubidium catalyst electrolytes, a wavelength that approximates the 40.8 ev transition between the n =1 and n = 1/2 sub ground state. Both Mills and Eccles have developed technologies for releasing latent energy present in the hydrogen atom through this collisional excitation process. Conrads et al. (2003) and Eccles (2000, 2005) both suggest that this process could offer a new exploitable source of energy. In fact, some companies state that they will soon have water heaters on the market that will power themselves using Eccles' patented process.

Quantum mechanics and Schrödinger's wave mechanics both preclude the existence of such sub ground orbital states, for they characterize the electron by its motion-dependent phase-wave, λ_p, the equivalent of the subquantum kinetics velocity wave. Since the phase-wave is unable to fit into an orbit smaller than the n = 1 Bohr ground state, quantum mechanics views any lower energy states as being forbidden. However, the Turing wave model is not similarly restricted. The electron, which in this case is characterized by the much smaller Compton wavelength, can easily fit orbital circumferences smaller than the Bohr ground state. A fit to the n = 1/2 state is possible if the electron's velocity wave circulates at c/2, and a fit to the n = 1/3 state is possible if the velocity wave circulates even slower at c/3. Since these stimulated orbital velocity waves would circulate at sub light speeds, their energy states would not be accessible via normal photon emission and absorption processes. But, one might suppose that transitions to them could be triggered through collisional excitations as research has experimentally demonstrated. Thus in seeking an explanation for the energy source that will be powering water heaters that will soon be entering public households, the answer will not be forthcoming from quantum mechanics, but from subquantum kinetics.

It should be noted that no more than eleven such subground orbits should be allowable on the basis of this model. That is, orbits having a circumference smaller than the electron's Compton wavelength, the wavelength of the electron's Turing wave, would be prohibited. The smallest allowable orbit, the n = 1/11 orbit, would have a circumference equal to 2.75×10^{-12} meters whereas the Turing wave that would characterize the core electric field of the circulating electron would have a wavelength slightly smaller, equal to 2.43×10^{-12} meters. Hence there is a limit as to how much energy might potentially be extracted from electron transitions to such subground orbits.

8. Conclusion

The subquantum kinetics dissipative structure model has successfully anticipated an astounding array of details about the distribution of charge and spin in the core of a subatomic particle, two decades before these features became known through the results of high-energy particle scattering experiments; see Table 2 for a summary. While the comparisons made here between the Model G Turing wave predictions for the nucleon and Kelly's charge distribution models are qualitative, it is difficult to escape the conclusion that the Turing wave model offers an excellent interpretation of the particle scattering results. Certainly, it offers a more accurate description of the nucleon than the quark model. This experimental confirmation, together with, to date, eleven other confirmations of the theory's a priori predictions, gives reason to believe that quantum physics may greatly benefit from efforts to apply general systems concepts to the microphysical domain.

As a next step, a more quantitative comparison should be made to form factor data. The Brusselator-like Model G reaction-diffusion system should be simulated in three dimensions in the marginally critical supercritical state to produce electric potential dissipative structures having wavelengths equal to the nucleon Compton wavelength. The simulation for the proton

Table 2

Subquantum Kinetics Particle Field Predictions Versus Observation

Characteristic	Subquantum Kinetics Prediction	Best Model Fit to Observational Data
Gaussian core	Yes	Yes
Spherical symmetry	Yes	Yes
Surrounding electric field periodicity, amplitude declines with distance	Yes, the Turing wave	Yes
Wavelength equals the Compton wavelength	Yes	Somewhat less, due to probe particle effect
Positive electric field bias for the proton	Yes	Yes
Positive potential for the neutron core	Yes	Yes

should be such that the resulting structure resides past its secondary bifurcation where the potential biased charged state emerges. The resulting simulated Turing wave profiles should then be compared against form factor data. Based on the analysis presented here, it is expected that the electric potential field simulated for the nucleon should fit form factor data at least as well as Kelly's Laguerre-Gaussian expansion.

The confirmation of the Turing wave periodicity is particularly significant since this intrinsic wave can account for the phenomena of particle diffraction, electron orbital quantization, and nuclear binding, as subquantum kinetics had earlier proposed (LaViolette 1985b, 1994, 2003). Furthermore we may now reasonably assume that the core electric field potential of all subatomic particles is similarly characterized by a Compton wavelength Turing wave, not just nucleons, but leptons and all baryons as well.

It has been shown above that, by effectively describing the phenomenon of particle diffraction in a paradox-free manner, the Turing wave formulation offers a superior model to the trouble-ridden wave packet formulation. Considering that recent particle scattering evidence compels us to regard the Turing wave as a reality, we may accordingly regard the wave packet alternative as a fiction that ultimately should be dispensed with. The Schrödinger equation, which has become the fundamental equation of physics for describing non-relativistic quantum mechanical behavior, plays a role for microscopic particles analogous to Newton's second law in classical mechanics for macroscopic particles. Yet in view of the current insecure footing of the wave packet concept, which is fundamental to the theory, quantum mechanics should no longer be considered to offer a realistic description of subatomic particle structure but rather be viewed as merely a heuristic model of subatomic particle interaction. The subquantum kinetics approach, which provides the basis for a viable replacement, ultimately leads physics back towards a more concrete, deterministic view of the microphysical world.

Furthermore the Turing wave model has been shown to provide a more classical view of an electron's orbit in the hydrogen atom and allows for the possible existence of quantized subground orbital energy states. Technologies being developed to excite electron transitions to such sub ground states and thereby release the electron's store of orbital potential energy could provide a revolutionary approach to clean energy production.

Finally, subquantum kinetics is able to explain the process of beta decay as being a secondary bifurcation of the unstable primary branch solution forming the neutron. At this bifurcation, the neutron abruptly transitions to the stable, charged nucleon state, to form the proton with the additional creation of electron and anti-neutrino by-products. Thus subquantum kinetics is able to account for the so called weak force, although subquantum kinetics views it as being due to a transition of an unstable to a stable nonlinear solution, rather than as being due to any kind of force. Since subquantum kinetics also accounts for the strong force, the electric field, the gravity field, and spin, it forms the basis for a true unified field theory.

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