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AN EMPIRICAL AND CLASSICAL APPROACH FOR NON-PERTURBATIVE, HIGH VELOCITY, QUANTUM MECHANICS

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While conventional approaches to high velocity quantum mechanics (such as QED) have been very successful when a perturbation approach can be applied, those conventional approaches have been found lacking when applied to other physical phenomena, such as the strong force. For this reason, an alternative approach is desired. By beginning with some simple empirical observations, and making a single assumption concerning the existence of an underlying wave, formulas are derived for a non-perturbative, high velocity, quantum mechanics. It is shown that the new formulas reduce to the conventional formulas in the low velocity limit.

Key Words: Quantum Mechanics, Relativity, Schrödinger equation, Dirac Equation, Klein-Gordon Equation

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Part 1 – Introduction.

Schrödinger's equation[1] is quite useful for calculating the quantum mechanical wave function in low velocity situations. Application of Schrödinger's equation to two body states such as the hydrogen atom yield good results, as the spectral evidence is in excellent agreement with the theory. However, to apply high velocity corrections or to investigate the hyperfine structure caused by the spin-spin magnetic dipole interaction, it is necessary to turn to a perturbation analysis. And to account for the Lamb shift[2], the perturbative approach of QED[3, 4, 5, 6, 7] is required. While QED is spectacularly successful in its calculational ability, the perturbation approach is valid only if the perturbations are small when compared to what is being perturbed. In the case of electrodynamics, the parameterization factor is given by the fine structure constant, α, which is approximately 1/137. However, for stronger forces, such as those found in nuclear matter, the perturbation approach is ineffective. Furthermore, QED involves the handling of infinities via a process called renormalization, a process that is quite distasteful for a physical theory.

The mesons are presently believed to be two body states; yet finding a satisfactory solution for determination of their masses has proven elusive. In the ABC Preon Model [8], leptons are proposed to be two body states; yet lepton masses have not been theoretically calculable. For these reasons, it is of value to find a complete, high velocity, quantum mechanical equation for the central force, two body problem.

Here, a formulation for high velocity quantum mechanics will be developed. The approach will be to appeal to simple empirical observations, and then apply an assumption of an underlying wave in order to reach the result. With the result in hand, it will be shown that the result reduces to familiar forms, such as Schrödinger's equation, in the low velocity limit.

In order to present the derivation in the most concise way, Part 2 will now contain only the minimum needed to arrive at the results. In Part 3 additional supportive remarks will be given.

Part 2 – Derivation of the Equations.

It is empirically observed for both light and material particles that

$$E = \hbar\omega \text{ (the Planck-Einstein relation)} \qquad (1)$$

and

$$\mathbf{p} = \hbar\mathbf{k} \text{ (the de Broglie relation)} \qquad (2)$$

In Eqs. (1) and (2) $\hbar$ is Planck's constant divided by 2π, **p** is the momentum vector, E is the energy, and an underlying wave is assumed where ω is $2\pi f$, **k** is the angular wave vector (**k** has magnitude $2\pi/\lambda$), f is the frequency, and λ is the wavelength. The assumption of the underlying wave has been supported by interference experiments for both light and matter.

It is also empirically observed that the total energy in the presence of certain forces can be expressed as

$$E = [p^2c^2 + m^2c^4]^{1/2} + V \qquad (3)$$

In Eq. (3) m is the rest mass of the particle, p is the magnitude of the momentum, c is the speed of light and V is the potential energy associated with the forces present.

It is convenient to specify the form of our assumed underlying waves in the form

$$\xi = \exp[i(\mathbf{k}\cdot\mathbf{x} - \omega t)] \qquad (4)$$

In Eq. (4) i is the square root of minus one. Taking derivatives of Eq. (4):

$$\partial\xi/\partial x = ik_x\xi \quad , \quad \partial\xi/\partial y = ik_y\xi \quad , \quad \partial\xi/\partial z = ik_z\xi \qquad (5)$$

and

$$\partial\xi/\partial t = -i\omega\xi \qquad (6)$$

Differentiating Eq. (4) a second time produces

$$\partial^2\xi/\partial x^2 = -k_x{}^2\xi, \qquad \partial^2\xi/\partial y^2 = -k_y{}^2\xi, \qquad \partial^2\xi/\partial z^2 = -k_z{}^2\xi,$$

which can be combined to form

$$\nabla^2\xi = -k^2\xi \qquad (7)$$

In Eq. (7) the usual nomenclature for the Laplacian is used, $\nabla^2 = \partial^2/\partial x^2 + \partial^2/\partial y^2 + \partial^2/\partial z^2$. At this point in the development it is useful to manipulate the empirical relationships $E = \hbar\omega$ and $\mathbf{p} = \hbar\mathbf{k}$ (Eq. (1) and Eq. (2), respectively). Taking the dot product of Eq. (2) with itself and rearranging leaves $k^2 = p^2/\hbar^2$ while rearranging Eq. (1) leaves $\omega = E/\hbar$, and substituting these values into equations (6) and (7) leaves $\partial\xi/\partial t = -iE\xi/\hbar$ and $\nabla^2\xi = -p^2\xi/\hbar^2$, respectively, which can be rearranged as:

$$E = i\hbar(\partial\xi/\partial t)/\xi \qquad (8)$$

and

$$p^2 = -\hbar^2\nabla^2\xi/\xi \qquad (9)$$

Substituting Eqs. (8) and (9) into Eq. (3) leaves:

$$i\hbar(\partial\xi/\partial t)/\xi = [-\hbar^2c^2\nabla^2\xi/\xi + m^2c^4]^{1/2} + V \qquad (10)$$

Eq. (10) is the complete high velocity quantum mechanical equation.

(See Part 3, Remarks 1, 2, 6 and 7 for an explanation of why differential relationships derived from Eq. (4) can be used in the derivation of Eq. (10). See Part 3, Remark 3 to understand what is meant by the terminology "high velocity".)

Next we will follow closely the typical development when dealing with stationary states where V = V(**r**,t) = V(**r**). (An excellent presentation of the typical development is given in the textbook by Anderson[9].) For such cases, ξ can be decomposed into temporal and spatial functions:

$$\xi(\mathbf{r},t) = \Psi(\mathbf{r})\Phi(t) \qquad (11)$$

Substituting Eq. (11) into Eq. (10) yields:

$$i\hbar(\partial\Phi/\partial t)/\Phi = [-\hbar^2c^2\nabla^2\Psi/\Psi + m^2c^4]^{1/2} + V \qquad (12)$$

Since the left hand side of Eq. (12) is a function of t alone, while the right hand side is a function of **r** alone, each side can be set to some separation constant which we will call E_n. The resultant equation for the left hand side, $i\hbar(\partial\Phi/\partial t)/\Phi = E_n$ can be solved by inspection, $\Phi(t) = \Phi_0 \exp[-i\omega t]$, where we recall that $E = \hbar\omega$. Note that this is the same solution that is found in the typical, low velocity treatment using Schrödinger's Equation.

Turning to the spatial equation, we now have $E_n = [-\hbar^2c^2\nabla^2\Psi/\Psi + m^2c^4]^{1/2} + V$. This equation can be manipulated by bringing V over to the other side and squaring, leaving $-\hbar^2c^2\nabla^2\Psi/\Psi + m^2c^4 = [E_n - V]^2$, which, after we expand the square, move the mass term to the other side, and multiply through by Ψ leaves:

$$-\hbar^2c^2\nabla^2\Psi = [E_n^2 - 2E_nV + V^2 - m^2c^4]\Psi \qquad (13)$$

Equation (13) is the complete high velocity quantum mechanical equation for stationary state spatial wave functions.

As a particularly useful example of Equation (13), we can investigate the case of the hydrogen atom, and here it is relevant to bring in two more empirical observations. First, it is empirically observed that the potential energy associated with the Coulomb force (the electric potential) is

$$V_e = K_cQ_1Q_2/r \qquad (14)$$

In Eq. (14) Q_1 is the charge on one of the particles, Q_2 is the charge on the other particle, r is the distance between the particles and K_c is the Coulomb constant. Second, it is empirically observed that the potential energy associated with a spin ½ dipole-dipole interaction (the magnetic potential) is

$$V_m = K_m\mu_1\mu_2(1-3\cos^2\theta)/r^3 \qquad (15)$$

In Eq. (15) μ_1 is the dipole moment associated with one particle, μ_2 is the dipole moment associated with the other particle, r is the distance between them, θ is the polar angle, and K_m is a constant. For our purposes, it is desirable to combine some constants:

$$K_1 = K_cQ_1Q_2 \qquad (16)$$

and

$$K_2 = K_m\mu_1\mu_2 \qquad (17)$$

With Eqs. (14) through (17) this leaves the potential as:

$$V = V_e + V_m = K_1/r + K_2(1-3\cos^2\theta)/r^3 \quad (18)$$

Using Eq. (18) for V, and expanding out the Laplacian in spherical coordinates while suppressing the non-contributing variable leaves Eq. (13) as:

$$\hbar^2c^2\nabla^2\Psi = [m^2c^4 + 2E_nV - E_n^2 - V^2]\Psi \Rightarrow$$
$$\partial^2\Psi/\partial r^2 + (2/r)\partial\Psi/\partial r + (1/r^2)\partial^2\Psi/\partial\theta^2 + (\cos\theta/r^2\sin\theta)\partial\Psi/\partial\theta = \quad (19)$$
$$[m^2c^4 + 2E_n\{K_1/r + K_2(1-3\cos^2\theta)/r^3\} - E_n^2$$
$$- \{K_1/r + K_2(1-3\cos^2\theta)/r^3\}^2]\Psi/\hbar^2c^2$$

And now expand the square:

$$\partial^2\Psi/\partial r^2 + (2/r)\partial\Psi/\partial r + (1/r^2)\partial^2\Psi/\partial\theta^2 + (\cos\theta/r^2\sin\theta)\partial\Psi/\partial\theta =$$
$$[m^2c^4 + 2E_n\{K_1/r + K_2(1-3\cos^2\theta)/r^3\} - E_n^2 - K_1^2/r^2 - 2K_2K_1(1-3\cos^2\theta)/r^4 \quad (20)$$
$$- K_2^2(1-3\cos^2\theta)^2/r^6]\Psi/\hbar^2c^2$$

Equation (20) is the exact, high velocity, hyperfine-inclusive form of the quantum mechanical wave function for the Hydrogen atom for s-states. (States of non-zero angular momentum will include additional terms.)

Part 3 – Remarks.

Remark 1 – The Implicit Assumption. Taking derivatives of the plane wave $\xi = \exp[i(\mathbf{k}\cdot\mathbf{x}-\omega t)]$ in the above treatment leads to relationships between derivatives of ξ and the quantities $\mathbf{k}$ and ω. The empirical relationships $E = \hbar\omega$ and $\mathbf{p} = \hbar\mathbf{k}$ are then used in conjunction with those derivative relationships to obtain $p^2 = -\hbar^2\nabla^2\xi/\xi$ and $E = i\hbar(\partial\xi/\partial t)/\xi$. Finally, we use the empirical relationship $E = [p^2c^2 + m^2c^4]^{1/2} + V$, along with simple algebra to arrive at Eq. 10, $i\hbar(\partial\xi/\partial t)/\xi = [-\hbar^2c^2\nabla^2\xi/\xi + m^2c^4]^{1/2} + V$. However, $\xi = \exp[i(\mathbf{k}\cdot\mathbf{x}-\omega t)]$ is only one solution of Eq. 10, and it is not obvious that the relationship between the derivatives of ξ and the quantities p^2 and E will be the same for all solutions of Eq. 10. Nor is it obvious that $E = [p^2c^2 + m^2c^4]^{1/2} + V$ will be valid within and throughout the wavefunction for all solutions of Eq. 10. This brings out the important implicit assumption that has been used in arriving at Eq. 10:

It is implicitly assumed that $p^2 = -\hbar^2\nabla^2\xi/\xi$, $E = i\hbar(\partial\xi/\partial t)/\xi$, and $E = [p^2c^2 + m^2c^4]^{1/2} + V$ are valid relationships within and throughout all wave functions.

$\xi = \exp[i(\mathbf{k}\cdot\mathbf{x}-\omega t)]$ (the free particle solution) is simply that solution of Eq. 10 that allows us to most easily find the relations for p^2 and E in terms of derivatives of ξ based on empirical, macroscopic, observations. The derivation in Part 2 implicitly assumes that the relations found from the analysis of plane waves continue to hold within and throughout all microscopic wave functions, even for the general case where solutions to Eq. 10 may not be plane waves.

Remark 2 – Physical Interpretations. The relationship $E = i\hbar(\partial\xi/\partial t)/\xi$ tells us that $(\partial\xi/\partial t)/\xi$ is proportional to the energy, and the relationship $p^2 = -\hbar^2\nabla^2\xi/\xi$ tells us that $\nabla^2\xi/\xi$ is proportional to the square of the momentum. These facts give us interpretations for what $(\partial\xi/\partial t)/\xi$ and $\nabla^2\xi/\xi$ are, physically, within the wavefunction.

Remark 3 – The Meaning of "High Velocity". It may not be obvious how Eqs. (10) and (13) are "high velocity" equations. Even more confusing might be the concept of "high velocity" in a "stationary state" as mentioned in conjunction with Eq. (13). To understand these concepts, first note that the low velocity description for the energy of a classical particle is $E = p^2/2m + V$. On the other hand, the high velocity description for the energy of a classical particle is Eq. (3), $E = [p^2c^2 + m^2c^4]^{1/2} + V$. The derivation herein uses the high velocity formula for the energy to derive the quantum mechanical expressions, and that is one way that Eq. (10) is the complete high velocity quantum mechanical equation. Another aspect of "high velocity" can be understood through its use in "stationary state" wave functions by appealing to the physical interpretations introduced in remark 2 where it is explained that $(\partial\xi/\partial t)/\xi$ is proportional to the energy and $\nabla^2\xi/\xi$ is proportional to the square of the momentum, *within* the wave function. The internal momentum can involve a high velocity, even though the quantum state itself may not change over long periods of time. (The state can be stationary in that it does not change, but there can still be internal motion within it.) This situation arises in single electron atoms that have highly charged nuclei, where "relativistic corrections" are needed to evaluate the energy due to high velocity effects of the wave function near the nucleus. However, as will be discussed further in remark 8 below, the treatment herein is not relativistic, and so the term "high velocity" is used instead of the term "relativistic".

Remark 4 – Low Velocity Limit of Eq. (10). It is useful to examine Eq. (10) in the low velocity limit. In that limit, the energy associated with the momentum is much less than the rest mass energy, $\hbar^2c^2\nabla^2\xi/\xi << m^2c^4$, and manipulation of the radical in this limit leaves $[-\hbar^2c^2\nabla^2\xi/\xi + m^2c^4]^{1/2} = mc^2[1 - \hbar^2c^2\nabla^2\xi/\xi m^2c^4]^{1/2} = mc^2[1 - \hbar^2c^2\nabla^2\xi/2\xi m^2c^4] = mc^2 - \hbar^2c^2\nabla^2\xi/2\xi mc^2$. Cancelling the c^2 terms and substituting this into Eq. (10) results in $i\hbar(\partial\xi/\partial t)/\xi = mc^2 - \hbar^2\nabla^2\xi/2\xi m + V$. At this point, since a constant in a potential does not affect the physics, we can absorb mc^2 into V, and by also multiplying through by ξ we can find the low velocity limit of Eq. (10) as $i\hbar(\partial\xi/\partial t) = -\hbar^2\nabla^2\xi/2m + V\xi$, which is immediately recognized as Schrödinger's Equation.

Remark 5 – Low Velocity Limit of Eq. (13). It is also of interest to investigate Eq. (13) in the low velocity limit. In this case, we can set $E_n = \varepsilon + mc^2$ in Eq. (13), where ε is an energy that is small in comparison to mc^2. This leaves $-\hbar^2c^2\nabla^2\Psi = [(\varepsilon + mc^2)^2 - 2(\varepsilon + mc^2)V + V^2 - m^2c^4]\Psi = [\varepsilon^2 + 2\varepsilon mc^2 + m^2c^4 - 2\varepsilon V - 2mc^2V + V^2 - m^2c^4]\Psi$. V will also be small in comparison to mc^2 in the low velocity case. Noting that the terms m^2c^4 cancel, and discarding terms that are second order in small quantities, this leaves $-\hbar^2c^2\nabla^2\Psi = [2\varepsilon mc^2 - 2mc^2V]\Psi$, and dividing through by $2mc^2$ leaves $-\hbar^2\nabla^2\Psi/2m = [\varepsilon - V]\Psi$, which is recognized as the typical low velocity quantum mechanical equation for the spatial component of stationary states.

Remark 6 – A Low Velocity Derivation of Schrödinger's Equation. Note that Schrödinger's Equation can be derived quickly if we replace Eq. 3 by the low velocity expression $E = p^2/2m + V$ in the derivation done in Part 2. With our implicit assumptions of $p^2 = -\hbar^2\nabla^2\xi/\xi$ and $E = i\hbar(\partial\xi/\partial t)/\xi$

we get $E = p^2/2m + V = i\hbar(\partial\xi/\partial t)/\xi = -\hbar^2\nabla^2\xi/\xi 2m + V$, and after multiplying the later equation by ξ we obtain $i\hbar(\partial\xi/\partial t) = -\hbar^2\nabla^2\xi/2m + V\xi$, which is Schrödinger's Equation.

Remark 7 – Low Velocity Verification of the Implicit Assumption. The implicit assumption is presented in Remark 1: *It is implicitly assumed that* $p^2 = -\hbar^2\nabla^2\xi/\xi$ *,* $E = i\hbar(\partial\xi/\partial t)/\xi$ *, and* $E = [p^2c^2 + m^2c^4]^{1/2} + V$ *are valid relationships within and throughout all wave functions.* The implicit assumption is seen in Remark 6 to lead to Schrödinger's Equation when the low velocity energy expression is relevant. Hence, it is reasonable to believe that the implicit assumption will also be valid when the high velocity energy expression is relevant. (The doubt about validity of the derivation arises because of the departure from the plane wave condition – not because of the form of the energy equation.)

Remark 8 – Inconsistency with Relativity. The treatment presented here is not covariant, since Eq. (20) describes a wave function spread out over spatial coordinates, but time does not appear in the equation. This lack of covariance is the reason for the use of the term "high velocity" rather than the term "relativistic" throughout this work, since the treatment herein is not relativistic. Relativity[10] is a point-like theory of events in four-space, and the theory presented herein is not consistent with such a foundation. Indeed, it is the constraint of relativity that has stopped others from already developing what is shown here. Instead, Dirac[11] proposed an equation that involves four by four matrices and a four component wave function for a description of electrons and positrons. Klein and Gordon[12,13] and Proca[14,15] developed two other covariant approaches applicable to other classes of particles. Those manifestly covariant approaches necessarily result in more complex treatments than what is described above, and they also involve a departure from the classical approach to physics.

Remark 9 – Consistency with Absolute Theories. While the theory proposed above does violate relativity, this does not imply that it violates any known experimental results. In addition to relativity, the absolute theories of Lorentz[16] and the author[17] are also overwhelmingly consistent with all known experimental results. While not greatly appreciated in the year 2017, there is almost no predictive difference between the theory of Lorentz and that of Einstein. Indeed, the fundamental transformation equations of Einstein's special relativity are called "the Lorentz equations" not "the Einstein equations" because those equations were first proposed by Lorentz, not Einstein. The main difference between Lorentz and Einstein lies in the interpretation of the Lorentz Equations – the equations themselves are identical. Furthermore, the absolute theories also allow for a ready understanding of Aspect, Dalibard, and Roger's tests[18] of Bell's theorem[19], an understanding that relativity cannot easily provide. (See reference 17 for a more thorough discussion of the absolute versus relative theories.) The theory presented here – involving wave functions with a finite spatial spread described by a non-covariant equation – fits well within the absolute frameworks for space and time, even as it does not fit well within relativity.

Remark 10 – A Return to the Classical Approach. The approach taken in this paper is extremely simple: it merely relies on a few empirical observations along with a single assumption of an underlying physical wave. No Hamiltonian nor Lagrangian formulations are necessary; no underlying principles (such as the relativity principle or the principle of least action) are appealed to. Instead, the approach is to return to classical thinking, which involves proposing a simple underlying physical model for nature, working from that physical model to develop the mathematical equations, and then analyzing the results of those equations to ensure that they accurately predict experimental reality. In this return to a classical approach, both the mathematics and the underlying physical model are readily amenable to human understanding.

Remark 11 – Handling of Infinities. Eq. (20) has terms that involve the inverse of r to the fourth and sixth power. Those terms will go rapidly to infinity as r tends toward zero. For that reason, the author suspects that particles have some sort of finite size. (That is, Eq. (20) may only be applicable above some small limiting value, and below that limit, the wave function may be a constant.) One either accepts such an ultimate finite size, or one must deal with some unpleasantness equivalent to renormalization theory to handle the infinites. As a speculation, a small limiting size may be the result of particles being small solid balls. Such small balls may come about because of a preonic[8] constituency of matter or perhaps from something even smaller. Alternatively, the small size limit may result from just how dense charge can become. For instance, it may be that charge density cannot exceed that of an underlying aether[20]. But no matter the source of the finite size, the important point for the present work is that a finite size can eliminate the problems that would otherwise be present for small r. Note also that the absolute theories can easily allow for finite size particles, but that relativity (a point-like theory in four-space) cannot so easily accommodate them.

Remark 12 – Missing Dirac Delta Function in the Magnetic Potential. In contemporary treatments of the spin-spin interaction, use is made of a Dirac delta function for the return flux of the magnetic field. In this work, since it is assumed that the particles have a finite small size, the return flux will be confined within the finite size of the particle and hence the return flux does not play a role in the equations. (The equations are not to be applied within the small size of the particles.)

Remark 13 – Applicability to Stronger Forces. While Eq. (20) is derived for the Hydrogen atom, Eqs. (10) and (13) are more general, as they allow for different potentials that may be useful in other situations. Calculations of lepton and meson masses can now in principle be treated, since the non-perturbative quantum mechanical Eqs. (10) and (13) can be applied to those situations where perturbative approaches are not feasible. Of course, it remains to specify the function V for those cases.

Remark 14 – The Lamb Shift. The standard quantum mechanical treatment of the Hydrogen atom does not completely predict experimental results. Famously, the quantum mechanical treatment falls short as it does not predict the Lamb shift, where a very small difference is found from what is predicted by quantum mechanics. Only when a full QED treatment of radiative corrections is applied can the Lamb shift be predicted. However, as mentioned above, QED involves the process of renormalization which is itself a rather dubious technique. The equations presented herein are a new approach to quantum mechanical predictions and at this point it is not clear to the author whether additional corrections will be needed. The p state wave functions have zero value at the origin while s states have a finite value. If there is a small limiting size for the particles, this difference between p and s states near the origin may lead to a difference in energy levels due to the proposed small hard core, although this is mere speculation at this point.

Remark 15 – Difficulty of Finding Analytic Solutions. The author was unable to find analytic solutions to Eq. (20) despite considerable effort. It may be that numerical methods will be required in order to find solutions to Eq. (20).

Remark 16 – Further Research. Eventually, application of the treatment herein should enable advances in our understanding of forces stronger than that of electromagnetism. However, prior to those studies it would be useful to apply Eq. (20) to the hydrogen atom using numerical techniques. If Eq. (20) is truly representative of nature, both the hyperfine splitting and the high velocity corrections to the Hydrogen energy levels should be predicted, and as mentioned above, the Lamb shift may be predicted as well.

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Introduction. (draft 5-22-2017)

This paper concerns the ABC Preon Model, which is an elementary particle model for what makes up our world. At the time of writing, the established elementary particle is know as the "Standard Model". There is a substantial difference in thought between the ABC Preon Model and the Standard Model, and to better understand the remainder of this work it is helpful to review some important history.

A distinct demarcation in physics occurred in 1905 when classical physics gave way to what is known as modern physics. This demarcation was of course the result of the path breaking work of Einstein's special relativity theory, or SRT. In SRT, Einstein abandonned the classical idea that physics should be based upon a mental picture involving underlying models or concepts. Instead, SRT was the first significant work to build upon positivist philosophy promoted by Ernst Mach. Positivist philosophy asserts that underlying models and concepts are unnecessary, since all we can really be certain of are empirical results. Einstein used this philosophy to derive the Lorentz transformation equations for space, time and electromagnetism based upon an operationalist approach starting with simple postulates. In doing this, Einstein not only revolutionized our thinking about space and time, but he also revolutionized how physics was done. Underlying models and concepts that themselves could not be proven - such as the aether, or primitive concepts of space and time - were abandonned as superfluous. Replacing the underlying models and concepts were simple principles which could then be used as the starting point for the derivation of mathematical formulas. The important issues were only sound principles, logical derivation of the mathematical formulas, and a requirement that those mathematical formulas must predict accurately the empirically observed data.

Work on quantum mechanics embraced the new paradigm of a model-free physics, and the developments of Dirac and others further separated the mathematics from any recognizable underlying model for nature. Whereas the wavefunction of Schroedinger could perhaps be thought of as the square root of the density of a real existing object, the four-spinors and sixteen component (4 by 4) matrices of Dirac defied understanding within such a simple worldview. At the present time the Standard Model is a glorious instantiation of the more primitive vision foreseen by Mach and Einstein, as it involves an equation with over 150 terms and at least 19 free parameters. The Standard Model now stands as a definitive description of nature that is well backed by all presently existing, empirically observed data.

However, the shear complexity of what now stands as the Standard Model should perhaps give us pause. Is there a better way? Could we have gone too far in the direction that Mach and Einstein have directed us? While the positivist idea of the supremacy of empirical observations is a sound philosophical assertion, could it not yet also be true that nature adheres to underlying concepts and modeling along the lines of what the classical physicists believed?

In what follows, an underlying model for elementary particle physics will be described that returns to the classical way of thinking. A model is proposed the envisions real, existing particles - called preons - that will be theorized to be the underlying cause for presently observed experimental results.

One example of the different way of looking at things concerns the Weinberg angle. In the present Standard Model approach, the Z and W boson masses are related through the relation cos(theta_W) = m_w/m_z, where theta_W is the Weinberg angle. The Weinberg angle also plays a role in the Weinberg-Salam theory of the electroweak interaction as it is the angle associated with spontaneous symmetry breaking and it also relates to the coupling strengths associated with the group theoretical underpinning of the weak force.

In the classical worldview of the ABC Preon Model the W and Z are understood to simply be unbound preon pairs with the mass of what is known as a W simply being the sum of the masses of the B and anti-A preon, and the mass of what is known as the Z simply being the sum of the masses of the A and anti-A preon. The Weinberg angle does not play an important part in arriving at the ABC Preon Model. Unlike the substantial mathematical underpinning of the Standard Model, there is no such mathematical underpinning in the ABC Preon Model. Rather than a mathematical underpinning, there is an assumed model for an underlying physical existence. In both cases, there is an agreement with experimental data. However in the presently prevailing view the experimental data arises from a deep principle followed by a mathematical derivation, while in the classical view of the ABC Preon Model the data arises from proposition of a simple classical model.

The ABC Preon Model is presently at a very early stage in its development, as it has been worked on by a single individual for only a few years. This is in contrast to the Standard Model which has seen tens of thousands of person-years put into its development over the past several decades. Presently, the ABC Preon Model does not include any variation (running) of its constants, and it has very limited mathematical underpinnings. The author would certainly welcome the contributions of others to improve upon this situation in the future. Yet despite the lack of mathematical underpinnings, since it is a preon model, the ABC Preon Model does dovetail nicely into the Standard Model, as certain combinations of preons are seen to be the components of the massive leptons, and other combinations of preons are seen to be the components of hadronic matter.

Since the ABC Preon Model is a reversion back to a classical approach to physics it has little connection with present efforts to extend the Standard Model or to attempts at a Grand Unified Theory. But despite the fact that the ABC Preon Model uses what appears to be a more primitive thought process to arrive at its conclusions, it is still shown below that numerous puzzles of nature are solved by the model. The generational problem is readily understood, and a great reduction in the number of elementary consitituents and forces are obtained by the postulate that the ABC Preons actually exist in nature. And perhaps most important is the predictive power of the ABC Preon Model. As seen below, by using only three free parameters - the preon masses - 18 quantitative predictions can be made for the results of high energy physics experiments, six of which have already been seen.