ISSN 2692-4374

TheGMS
The Gazette of Medical Sciences

INOVACUS

Microvita | Research article

open access

The Hydrogen Atom as an Integrative Eigenstate of the Bifurcating Quantum Field

Frank van den Bovenkamp*

Independent researcher and Entrepreneur, TGM Research, TrigunaMedia, Netherlands.

Address for correspondence:
Frank van den Bovenkamp, Independent researcher, TGM Research, TrigunaMedia, Netherlands. Website: www.frankvandenbovenkamp.com; www.trigunamedia.com. Email: frank@trigunamedia.com

Submitted: 02 August 2020

Approved: 14 August 2020

Published: 16 August 2020

How to cite this article: Bovenkamp F. V. D. The Hydrogen Atom as an Integrative Eigenstate of the Bifurcating Quantum Field, G Med Sci. 2020; 1(4): 022-035. https://www.doi.org/10.46766/thegms.microvita.20080202

ABSTRACT

Over the course of the past century, quantum mechanics has become extremely successful in describing the atoms and elementary particles that make up the world that we know. Strange enough, the current model of quantum mechanics doesn't allow things that are real, to be described in terms of things that are real. A theory that describes things as they really are is more likely to be true and successful. Therefore, while it is hard to say that quantum mechanics is wrong, our interpretation of it is rather unsatisfactory. The present paper proposes an interpretation of quantum mechanics whereby the matter wave and its eigenstates are formed through an underlying, bifurcative self-interaction of the quantum field. Subsequently it will be shown that based on the latter the proton-to-electron mass ratio can accurately be calculated.

Key Words: bifurcative self-interaction, proton-to-electron mass ratio, hydrogen eigenstates, spin-orbital coupling, potential well, matter wave, Goldstone boson, Higgs mechanism, principle of least action, microvita

Introduction

In his 1925 paper "On the Theory of Quanta" [1], Louis de Broglie proposed an elegant and plausible model of stable electron shells, based on his groundbreaking intuition that if a light wave could also be a particle, an electron could just as well be a wave. The latter became known as the matter wave, a super-luminal phase wave consisting of n (principal- or orbital quantum number) wavelengths and an orbital radius of n^2R_0. In the same paper, Louis de Broglie also made the following remark, which went relatively unnoticed but provides an important lead for the present work: *"Nevertheless, action is a very abstract notion, and as a consequence of much reflection on light quanta and the photoelectric effect, we have returned to statements on energy as fundamental, and ceased to question why action plays a large role in so many issues"*. This will be referred to as the energy-centric bias of Quantum Mechanics. Moreover, *"Up to his final work [1982], he [Louis de Broglie] appeared to be the physicist who most sought that dimension of action which Max Planck, at the beginning of the 20th century, had shown to be the only universal unity..."* [2].

The action of the matter wave follows straightforwardly from de Broglie's relation:

$$p = \frac{h}{\lambda} \qquad \text{(eq. 1)}$$

In other words, the action *h* is expressed as the momentum over the length of one period of the matter wave and equals the Planck Constant [3]. For subsequent eigenstates comprising n wavelengths, the action equals an integer times the Planck Constant, *nh*. This correctly represents the Bohr-Sommerfeld stability theorem [4]:

$$m_0 \omega R^2 = n\frac{h}{2\pi} \qquad \text{(eq. 2)}$$

The existence of the matter wave was experimentally confirmed by Davisson and Germer in 1927, which promptly earned de Broglie the Nobel price [5]. Yet its real nature became a matter of dispute, an early hint at an interpretation issue, and has remained so to this day. Shortly after de Broglie's paper, in 1926, Erwin Schrödinger devised an actual wave equation for the orbiting electron, based on the Hamiltonian [6]. In this case the action is evaluated in terms of energy conservation in the wave function. Whereas de Broglie still assumed the existence of a physical particle which simultaneously could be interpreted as a wave, with Schrödinger's solution the idea of a real particle, and de facto that of quantum realism was abandoned. It is argued that especially because of the latter, the energy-centric bias pointed out by de Broglie remained unnoticed, and that in this partial environment the emergence of the probability interpretation was inevitable. Despite relentless opposition, notably from the lead investigator of said light quanta and the photoelectric effect, Albert Einstein, the latter became the status quo, and became known as the Copenhagen Interpretation [7]. Louis de Broglie himself eventually subscribed to the doctrine, so we can assume that there is no quantum realism, because obviously there is no pressing mathematical or physical reason to look for it.

Inspired by de Broglie's timely reflection on the importance of the action principle in physics, a different approach is proposed, whereby the action is given a more decisive role in quantum mechanics than is currently the case. The type of effort (not the solution) is analogous to John von Neumann's search for a mathematically rigorous formulation of Quantum Mechanics, and later Quantum Field Theory with a separable Hilbert space as crucial framework [8]. Careful comparison of the de Broglie vs. Schrödinger approaches reveals that while the concept of the matter wave is clearly incomplete (as it only explains the principal quantum number, that is, the electron shell or energy level), it appears more realistic. After all, the matter wave was proven to be directly measurable, so one cannot say but that the matter wave, although its true nature remains elusive, is a real physical phenomenon. This cannot be said of Schrödinger's wave function. In terms of Gerard 't Hooft's remarks during a brief interview [9], from which the present abstract was adapted, the wave function describes something that is real in terms of things that are not real. Therefore, while the wave function appears to be a more complete solution with regard to the eigenstate problem (describing all possible Hydrogen orbital shapes), it is not likely to be a more correct one. Further it is seen that the action appears naturally more prevalent in the de Broglie relation than in the Hamiltonian equation. While this is merely a hint, it supports the idea that the cause of interpretation issues lies for a decisive part in the unheeded energy-centric bias of Quantum Mechanics. The aim of the present work is to introduce an approach to Hydrogen stability with a decisively more central role for the dimension of action.

Method: A bifurcative approach to self-interaction

While the proposed solution involves for the most part Quantum Field Theory (QFT), some Quantum Mechanics will be discussed first. When it comes to a more realistic solution of the eigenstate problem, the de Broglie relation is obviously the reference of choice. The matter wave formula is somewhat revised to reflect the proposed QFT solution more directly. The de Broglie relation for a (relativistic) moving electron, with the momentum decomposed into its constituents and the explicit time and space parts on one side is:

$$\frac{h}{2m_e} = \frac{1}{2} f x \lambda \qquad \text{(eq. 3)}$$

with m_e being the electron's mass and x being some displacement. The left term is known as the *quantum of circulation*. The right term is associated with a scalar force field obeying an inverse-square law. Quantum mechanically, decomposing the momentum appears rather trivial, not to say unnecessarily complicating. However, as will become evident, it exposes the momentum as being an over-generalization which obscures potential underlying properties of the field, pulling the concept of the matter wave into the energy-centric bias. Not surprisingly, while somewhat losing out on simplicity and elegance, the "de-generalized" de Broglie relation is more in harmony with the quantum field's bifurcative self-interaction presented here.

In the Standard Model of particles and interactions, in order for particles to be massive, the symmetry must be broken, which is achieved by adding a self-interaction term to the free field in the form of a quartic interaction [10]. This forms the basis of the Higgs mechanism. Having distinguished a quantum of circulation and a space-time component in the revised de Broglie relation, it is proposed that the matter wave constitutes a resonance that is initiated and stabilized by the field's self-interaction, plus a free field implied by the self-interaction's potential and kinetic energies in time and space. A Hydrogen stability principle is thus introduced which is complementary, and arguably to some extend precursory to the free field, and does not require a quartic or similar term.

In order to model the Hydrogen atom on the basis of an eligible, underlying stability principle, the self-interactions' integrability with regard to eigenstates and a field potential needs to be ascertained. A distinct possibility was found in the fact that the self-interaction has a bifurcative sub-structure, which might serve as a primordial matrix of known quantum mechanical properties. This leads to the following, general formulation of a discrete bifurcative self-interaction:

$$\phi(x,t) = \prod_{n=1}^{D} e^{i(\rho^{(n-1)}x - \omega t)}$$

,and (eq. 4)

$$\hat{f}(\xi) = \int_{-\infty}^{+\infty} \phi(x,t) e^{2\pi i x \xi}\, dx$$

(eq. 5)

where:

- $\phi(x,t)$ denotes a discrete, spin-zero, self- (i.e. non-linearly) interacting phase wave packet (plane waves), consisting of D waves, with D denoting the bifurcation depth, also referred to as the bifurcative wave function
- $\rho^{(n-1)}$ is the base ρ scaling of the bifurcation
- $\hat{f}(\xi)$ is the Fourier transform of $\phi(x,t)$ for any real term ξ.

The term *"bifurcation"* (litt.: *two-forking*) in physics and mathematics typically refers to a sudden, qualitative or topological change in a non-linear system[11]. In terms of a self-interaction it means that non-linearly interacting parent waves, as per eq. (4) create child waves. Furthermore, motivated by the ubiquity of fractality in the natural world, it is conjectured that the quantum field's self-interaction could likewise be fractal, and that macroscopic structure in nature might actually reflect a fractal quantum level. Especially the widespread fractal attractor Golden Ratio (closely related to the Fibonacci numbers) turns out to elicit a number of unique and potentially significant features in the bifurcating quantum field:

$$\rho = \varphi \quad \text{(eq. 6)}$$

where φ is the Golden Ratio (1.618…). Note the use of the lower case φ to distinguish from the field ϕ. If the bifurcation base approaches Golden Ratio, a phase wave pair with zero wave number (k'=0) and infinite wavelength (λ=∞) is generated. In the rudimentary case of a bifurcation depth D = 3:

$$\hat{f}(0) = 1 \quad \text{(eq. 7)}$$

which is easily verified following from (4) and (6), as:

$$\varphi^0 + \varphi^1 - \varphi^2 = 0 \text{ and } -\varphi^0 - \varphi^1 + \varphi^2 = 0 \qquad \text{(eq. 8)}$$

Secondly, during the bifurcation all the wave numbers double. Evaluating the positive Fourier terms as well as the k'=0 infinite phase wave:

$\varphi^0 + \varphi^1 + \varphi^2 =$	2	φ^2
$-\varphi^0 + \varphi^1 + \varphi^2 =$	2	φ^1
$\varphi^0 - \varphi^1 + \varphi^2 =$	2	φ^0
$-\varphi^0 - \varphi^1 + \varphi^2 =$	2	0 (infinite wave length)

(table 1)

The Fourier spectrum in this case forms a Rabbit Sequence, which is a fractal (12). The latter is more explicitly demonstrated with a greater bifurcation depth:

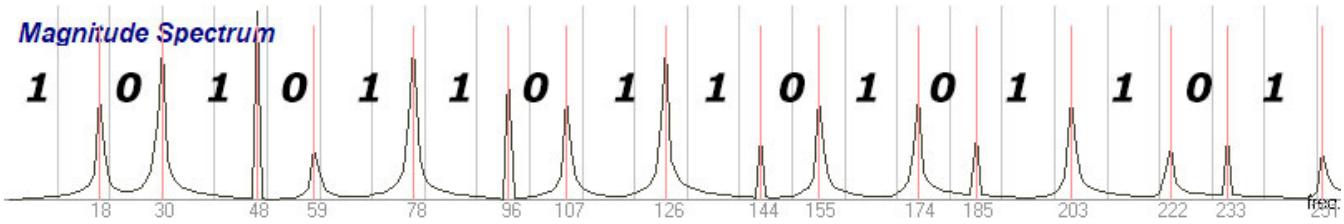

Fig. 1 - Rabbit series, here as an actual spectrum analysis (FFT) of a D=6, ρ=φ (i.e. synchronized) bifurcation. Generated with "Fractal Synth" software by the author.

The rudimentary bifurcative self-interaction, with a bifurcation depth D=3, is visualized as follows:

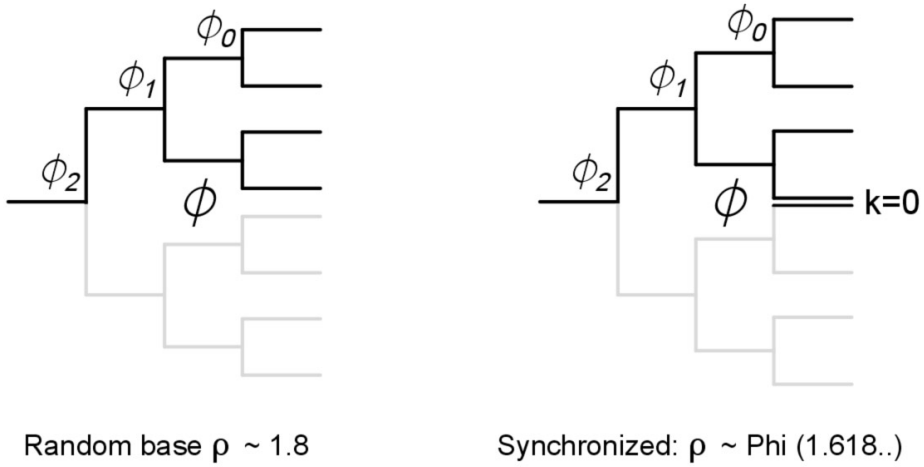

Fig. 2 - Basic bifurcation scheme of D=3 bifurcation, with different scaling factors.

In this basic figure, the wave number k' and phase ω are not distinguished, however from equations (4) and (5) it follows that the space-like and time-like terms both equally bifurcate (although the phase cycle spectrum is not fractal). It is noticed that the bifurcation and the Fourier transform are essentially one and the same. The negative Fourier terms will not be considered (except in the mass factorization). Obviously, it is a unitary transformation [13]. This shows that indeed the self-interaction is integrable. A rudimentary evaluation is now shown, relating the phase cycle bifurcation with known quantum-mechanical properties, which will then be worked out in more detail:

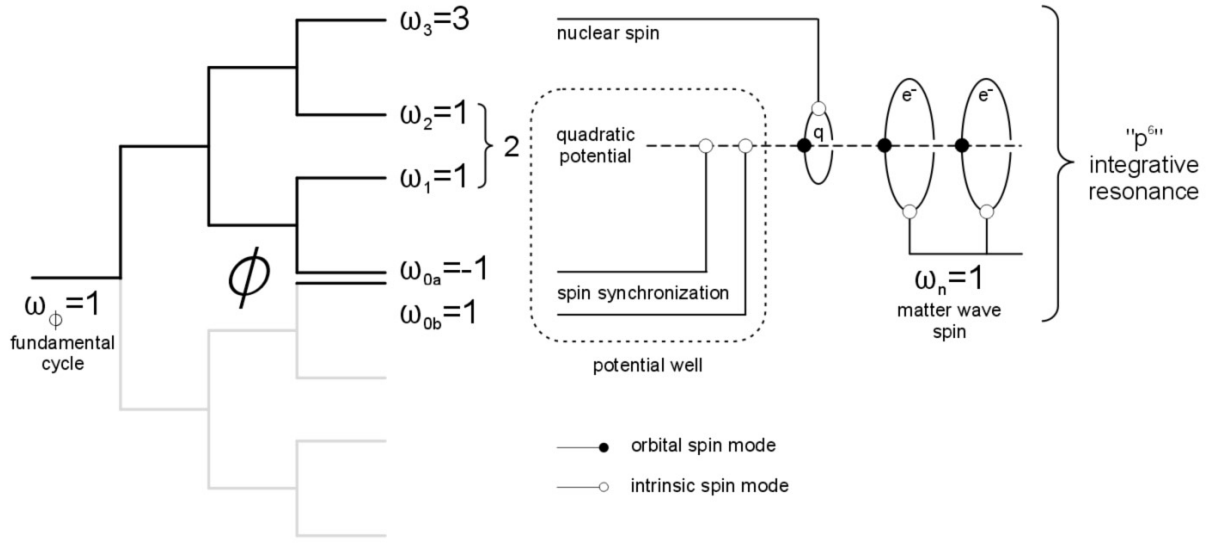

Fig. 3 - Rudimentary evaluation, showing a potential well and spin-orbital states evolving from an apprx. base φ phase cycle bifurcation. The figure highlights that, unlike electron spin, nuclear spin is generated by the bifurcating quantum field directly.

The transition of the quantum field's bifurcative self-interaction into an actual volumetric Hydrogen model involves evaluating resonant, confined and deconfined states as isomorphisms of the bifurcation, representing resp. the matter wave, the nucleus and the free field. The highly theoretical bifurcation itself has one independent space-like and one independent time-like dimension, in other words there are 2 independent degrees of freedom (2DF) only. This is consistent with the topological conjecture that *"At this moment there is no existence and uniqueness theorem for smooth 4-manifolds"* [14]. The concept of 2DF physics was explored by Ghaboussi [15], based on the notion that the idea of infinite 3D space resp. (3+1)D spacetime evolved historically from habitually assuming a reference frame at absolute rest, which however is physically unproven and logically and mathematically contradictory. Brzychczy and Poznanski [16] argue that, to be useful from a neuroscientific point of view, (3+1)D*"must be shown to be the structure of the teleological process"*. With regard to the Hydrogen model, its volumetric expansion could be seen as a finite topological transform in the spirit of the latter, and not as acompliance to an imaginary, typically infinite (3+1)D cinematographic canvas. Starting from the preliminary example, first a quadratic potential is evolved from the bifurcating fundamental phase cycle:

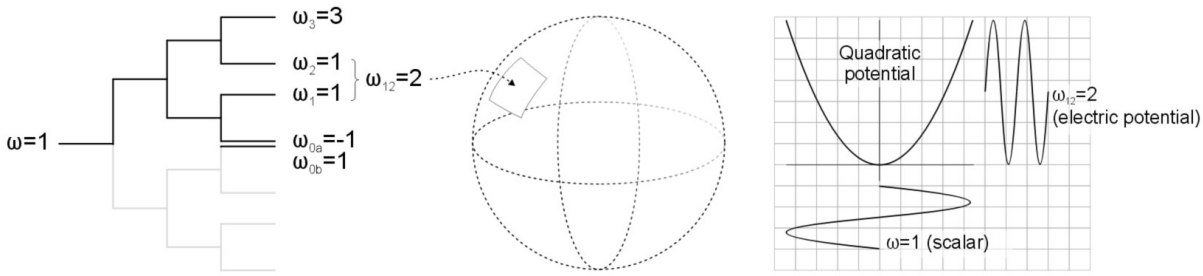

Fig. 4 - Spherical multiplication of the ω_1 and ω_2 terms, constituting a quadratic potential.

The ordinate component of the quadratic potential is physically constituted and modulated by the nuclear and eigenstate spins as described hereafter. The fixed ω_1 and ω_2 are facilitated by the bifurcation's corresponding Fourier terms. Their functional multiplication, doubling the rate, in shorthand $\omega_1 \times \omega_2$, results from the field's square law expansion. In the synchronized case ($\rho = \varphi$), the wave number bifurcation as shown in table 1 shows to be isomorphic with a volumetric expansion:

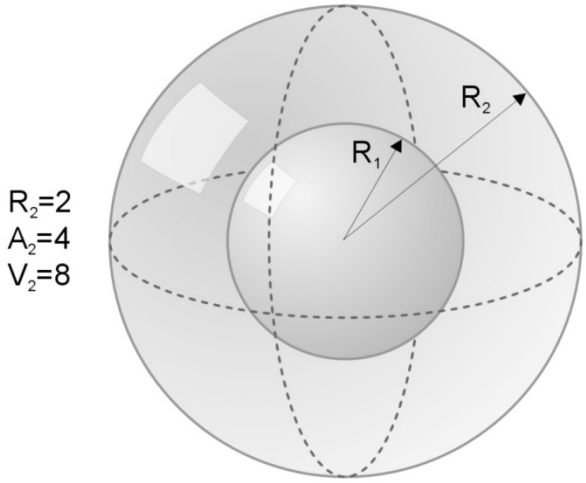

Fig. 5 - Volumetric expansion as an isomorphism of base φ bifurcation.

That is, the self-interaction's 3 source wave numbers according to eq. (4) are each doubled as shown in table 1, so that their bifurcation product is represented by an eight-fold increasing volume. At this point it should be noted that time and space, resp. their known topological structure are considered not fundamental, rather constitute an isomorphic transformation of the bifurcation, representing a local detection mode. Either way, the volumetric expansion at this point is still non-local and therefore does not imply a real physical volume. The quadratic potential and volumetric expansion together form a dynamic potential well. Referring to the revised de Broglie relation (eq. 3), the potential well constitutes the free field aspect of a single, integrative resonance endowed with a congenital self-interaction. The approach is analogous to Goldstone's argument [17] of spontaneous symmetry breaking: *the ground state is not unique*, which is evidenced through the formation of a real vacuum. But instead of a (3+1)D, zero frequency, finite wave number and a static vacuum expectation value (Goldstone), synchronized bifurcative self-interaction generates a 2DF (2 degrees of freedom), zero wave number (k'=0), finite frequency ($\equiv\omega_\varphi$) dynamic potential. In the case of synchronized bifurcation, the k'=0 terms, which are in fact very similar to the fundamental cycle ω_φ, are resonantly and orbitally-coupled with the intrinsic up- and down spins (also see fig. 3) but strictly speaking áre not the latter. In other words, in the present model electron intrinsic spin cannot be seen entirely independent of the Hydrogen (resp. experimental) context. The entity consisting of the spin-orbital coupling and the potential well is represented by a dual spinor:

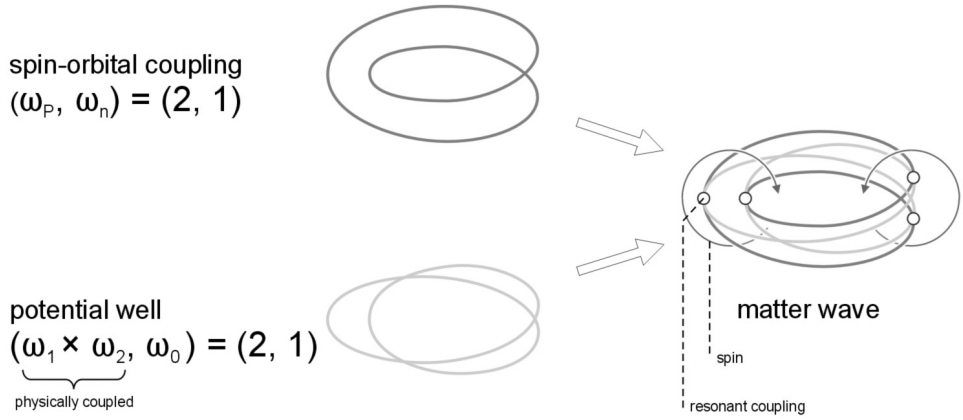

Fig. 6 - The relativistic matter wave as a resonant dual spinor. Note that the two torus-knots at the left are identical, only show reciprocate phases.

Note that the spin-orbital coupled rate (1) ω_n component is not a generic bifurcation term, but the spin effect associated with a discrete orbit resp. Hydrogen energy level. The dual spinor is obviously reminiscent of the Dirac bi-spinor [18]. The latter represents a relativistic wave function consisting of 4 complex components and *incorporates spin*. In other words, spin is an intrinsic requirement of the relativistic theory of the electron. The bifurcative spinor likewise consists of 4 complex components, but unlike the Dirac bi-spinor does not imply 4 but only 2 independent dimensions resp. degrees of freedom, which are resonantly coupled. The fact that intrinsic and orbital spin form one inseparable whole is however demonstrated in the Dirac equation by the fact that only the total angular momentum is conserved. Unlike in the case of the matter wave, where the bifurcation, by means of the potential well, facilitates two opposite terms for two electron intrinsic spins, there is no such obvious clue for 3 quarks. The rate (3) ω_3 bifurcated phase cycle is hypothesized to constitute nuclear spin, but does not by itself imply 3 distinct, intrinsic spins. It is awell-known fact that the case with quarks is different, in that one can have either one or two electrons in a particular orbit, but there is always one inseparable triplet of quarks. To satisfy Pauli exclusion, one quark must be of a different flavor. Therefore, the bifurcative model tentatively presumes a single bifurcation term to facilitate an integral nuclear (2, 3) spin-orbital mode, which is then effectively distributed over the prospective quarks and, presumably, gluons[19]. The nuclear cycle can thus be represented as follows:

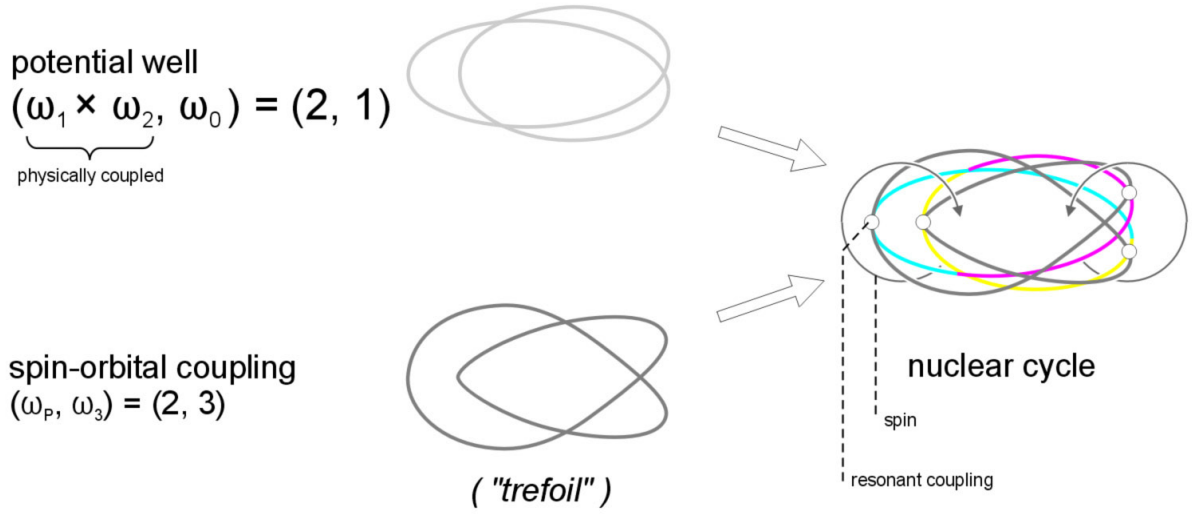

Fig. 7 - The nucleus as a resonant dual spinor. In knot-theory, the trefoil knot is the simplest non-trivial knot.

Obviously, the 3 inseparable quarks do not constitute a sequential phenomenon such as the matter wave. While the resonance is physical in character, it also has a highly non-trivial dual ($\sqrt{3}$ x $\sqrt{3}$) bifurcative base, which will presently not be further evaluated. With regard to the torus knot notation convention, (X, Y) represents X rotations *around* the center, and Y rotations *through* the center. An (X, Y) spin-orbital coupling means an orbital rate X vs. a spin rate Y, in other words, the order of notation is opposite to the naming. While reminding that the ω_n component is the electron spin effect associated with a distinct orbit, the leading physical principle is that spins cross-couple the quadratic potential to one single, shared orbital mode (indicated by the resonance nodes in fig's. 6 ánd 7). See also the expanded diagram of fig. (9) further below. This constitutes one single, integrative or central resonance, which however does not in the absolute sense imply a change in or of the bifurcating field, or in Goldstone's wordings, the ground state is not unique. The equilibrium can be viewed as solving:

$$(X_N, 3) \leftrightarrow (2, Y_P) \leftrightarrow (X_M, 1) \qquad \text{(eq. 9)}$$

where X_N is the nuclear orbital cycle, Y_P is the ordinate (!) of the quadratic potential viewed as torus knot and X_M is the matter wave's orbital cycle. In the simultaneous state described below, the equilibrium is instantiated for each of the prospective eigenstates. Obviously $X_N = X_M = 2$. Y_P accounts for the spin resonant coupling. The evaluation of the latter presumes physical self-interaction of the quadratic potential, producing the bifurcation terms $(2+Y_P)$ and $(2-Y_P)$, which must equal the resp. spin rates (3) and (1), so that $Y_P=1$. This rate of the quadratic potential, equaling the rate of the ω_φ scalar fundamental not only preserves the equilibrium of the integrative resonance, but is also considered to synchronize the bifurcation, i.e. pitching ρ to Golden Ratio. Hence in the diagram of fig.9, the arrow points towards the k'=0 terms. The quadratic potential's physical self-interaction is not trivial, as it confirms the volumetric nature of the latter, which was shown before from a geometric viewpoint, with respect to the wave number bifurcation, and this time in terms of the phase cycle. As obviously the (2, 1) spin-orbital coupling is the one forming eigenstates, and not the

(2, 3) coupling, the latter is the confining case and could alternatively be viewed as a singular, action-centric or purely bifurcative eigenstate of the integrative resonance. The volumetric expansion is at the same time realized as the simultaneous addition of 2^3 volumetric intervals, each representing the unit of action. Physically this is not a self-interaction, but geometrically it can be viewed as a base 2 bifurcation into resp. radius (2^1), spherical surface (2^2) and volume (2^3). The sum of n unit action intervals constitutes a sequential Hydrogen eigenstate as per the Bohr-Sommerfeld orbital stability theorem (eq.2), comprising n periods of the matter wave, with action *nh*. It is hypothesized that this is the underlying reason that there are 8 stable eigenstates, and not the defaulting field strength per sé.

Results

Hydrogen orbital stability based on bifurcative self-interaction can thus alternately be modeled from a simultaneous and from a sequential, that is, eigenstate, point of view:

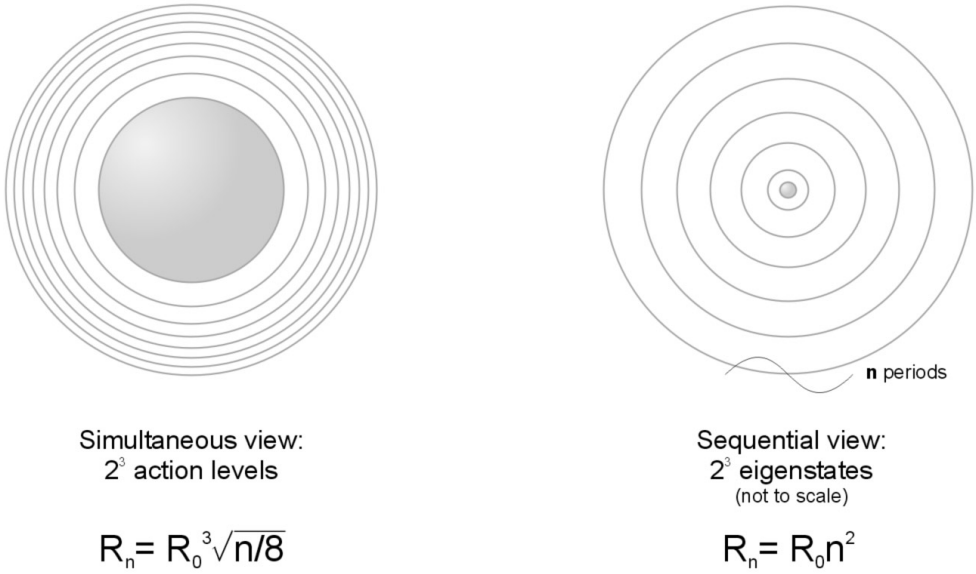

Fig. 8 - Simultaneous and sequential or eigenstate views of the bifurcative Hydrogen model.

The simultaneous or initial state in summary comprises a prototype s^2 orbital, p^6 subshell and 8 shells, together constituting the initial form of the sequential, interactive eigenstate model. The "s^2p^6 prototype" will be further detailed in the mass factorization. The eigenstate model obviously represents the Hydrogen atom in the common de Broglie picture, while incorporating a functional self-interaction. This means that in order to fix the proper mass for the eigenstates, no quartic term was added. Thus the stability criterion is realized through a real, albeit fully concealed phenomenon. It barely needs explanation that without synchronization, that is, fractal bifurcation, the model would instantaneously disintegrate. So far, the somewhat rudimentary bifurcation diagram was used. Considering a) that the self-interaction involves a space-like and time-like term, and b) that the volumetric expansion has been shown to be bifurcative in nature as well, the diagram can be expanded as follows:

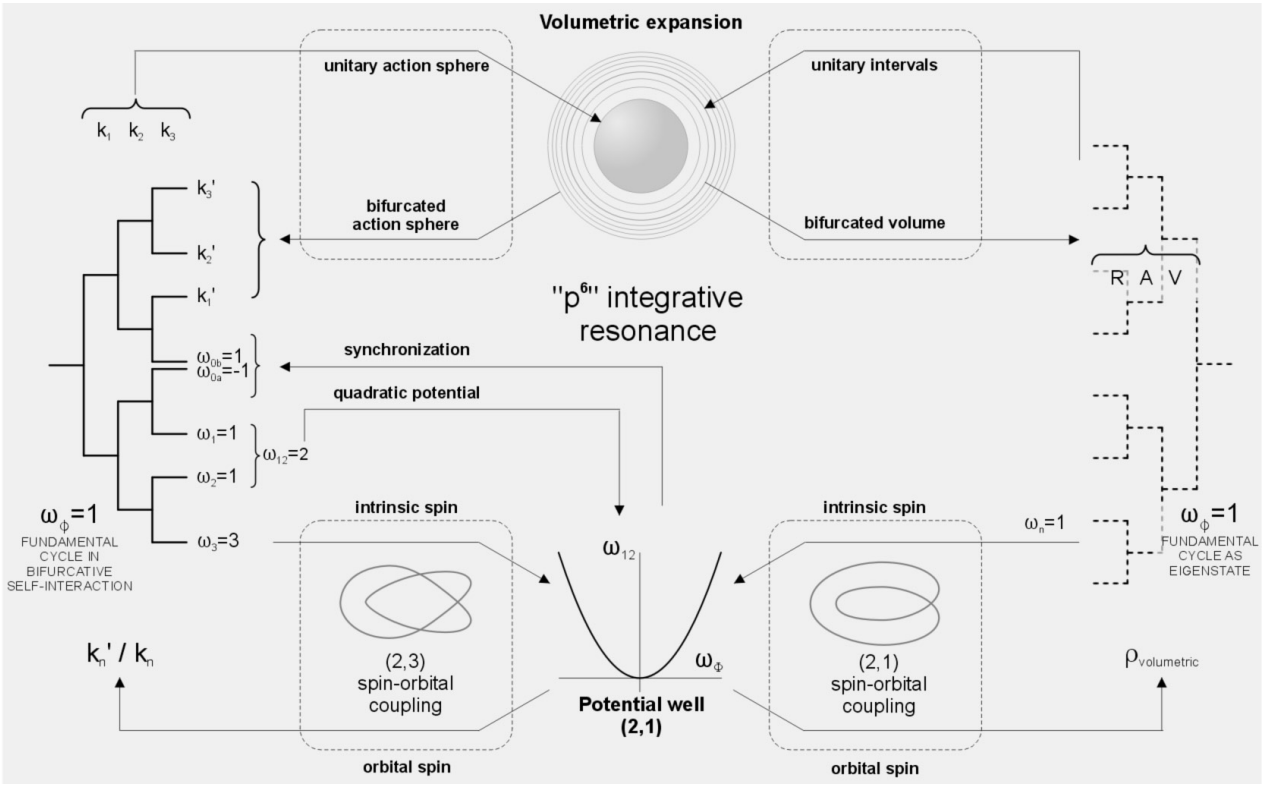

Fig. 9 - Overview of the bifurcative Hydrogen model. Note the cross correlation of the unitary vs. bifurcated modes in the volumetric expansion, as well as the intrinsic vs. orbital spins in the dynamic potential well. The k' and ω terms are arbitrarily positioned as "positives" resp. "negatives" only for graphical clarity.

The eigenstate appears $2^3 = 8$ times but does not constitute an actual self-interaction. Therefore representing it as a bifurcation is not justified and only the fundamental cycle ω_ϕ is emphasized. Considering that the resp. spin-orbital modes constitute the operative principle, whereas the wave number and volumetric bifurcations could be viewed as normative controls or purely geometric attractors, the proposed model can meaningfully be mapped to the Aristotelian Four Causes [20], forming an integrative Hydrogen stability causal framework:

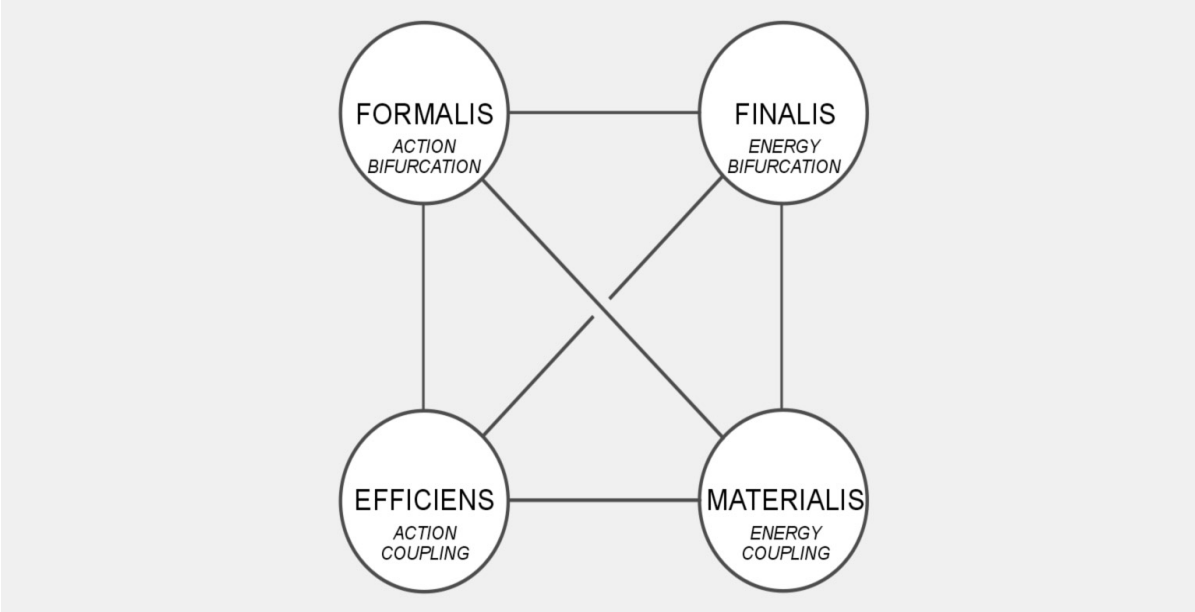

Fig. 10 - The bifurcative Hydrogen model and the Four Causes.

The energy- resp. action couplings constitute the operative principles of the energy- resp. action geometric attractors. The geometric- and operative principles can also be viewed as being cross-related through the potential well. This, as well as the other relations will become more apparent in the functional diagram of fig. 12. The function of the bifurcative model is to establish a discrete, integrative, stable physical resonance within the abstract of the self-interacting quantum field. Arguing that mass generation is a signature effect of the bifurcative self-interaction, analogous to, but different from the standard Higgs mechanism, the mass can be factorized as follows:

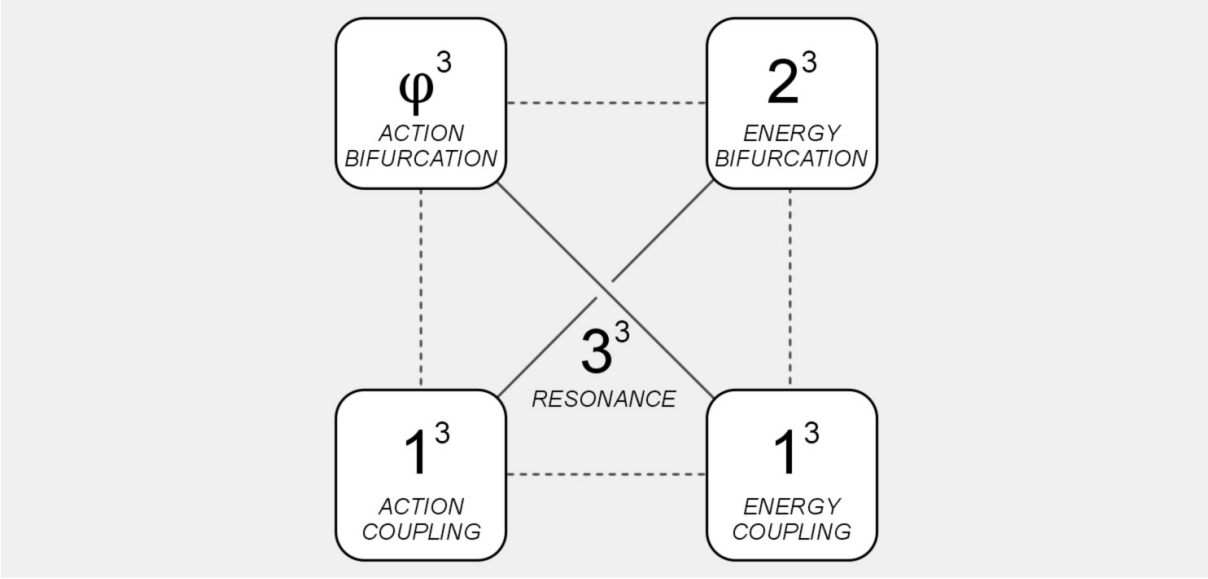

Fig. 11 - The bifurcative Hydrogen's mass factorization.

That is, the bifurcative mass model consists of a primary generative factor φ^3 (fractal bifurcative self-interaction), a main counting or multiplication factor 2^3 (the eigenstates), and the intermediate resonant state 3^3, which not surprisingly comprises a mixed generative and multiplicative factor. The latter constitutes the resonance's volumetric completion, referenced by the completed p^6-subshell's (x, y, z) orientations, and represented by the multiplier 3. The 3 generative terms each represent the rate (3) bifurcative equilibrium of the simultaneous state, instantiated for the nuclear plus the up-and down spin matter waves (ref. fig. 2 and eq. 9). The latter are referenced by a completed s^2 orbital. The spin-orbital couplings are neither generative nor multiplicative and therefore don't contribute to the mass. As follows from the (revised) de Broglie relation (eq. 3), the mass is proportional to the action, and therefore the relative mass can be measured by units of action:

$$M = \varphi^3 \times 2^3 \times 3(3+3+3) = (6\varphi)^3 \approx 914.99 \text{ units} \qquad \text{(eq. 10)}$$

The resonant mass factor can as well be written as a dual bifurcation:

$$3\,(3+3+3) = (\sqrt{3}\sqrt{3})^3 \qquad \text{(eq. 11)}$$

The dual $\sqrt{3}$ based resonant bifurcation is key to the electroweak interaction, which will presently not be detailed. In order to calculate the proton-to-electron mass ratio based on the integral bifurcative mass, there are a few considerations. Firstly, as the mass factors assume full spectrum bifurcation (i.e. including the negative terms), and in the synchronized case the k'=0 term represents 1 unit, but 2 electrons, that is, one electron pair or one complete s^2-orbital, the mass of the electron is proportional to ½ unit. Secondly, the integral bifurcative mass concerns the complete Hydrogen atom in the simultaneous state, that is, including 8 potential eigenstates. In the sequential state, the mass of one particular, actualized eigenstate does not come at the cost of the simultaneous mass. Therefore, in the eigenstate picture, the mass of the nucleus, that is, the proton equals . The correct bifurcative proton-to-electron mass ratio is:

$$\mu = \frac{M}{1/2} \approx 1829.98 \qquad \text{(eq. 12)}$$

If the base 2 volumetric bifurcation is substituted with the electron spin g-factor, accounting for additional, subtle coupling effects, the calculated proton-to-electron mass ratio becomes:

$$\mu = \frac{(2.002319 \times 3 \times \phi)^3}{1/2} \approx 1836.35434 \qquad \text{(eq. 13)}$$

Comparing with the experimental value of 1836.15267 [21] gives an accuracy of around 0.011%. A perfect match may however be trivial, as the fundamental bifurcation is most likely not exactly Golden Ratio anyway, rather assumes a value on the edge of equilibrium. The latter is hypothesized to relate to the fine structure. The proton-to-electron mass ratio thus captures and validates the complexity of the bifurcative self-interaction or -wave function in a single quantum mechanical number. A generalized functional diagram of the bifurcative Hydrogen model is given:

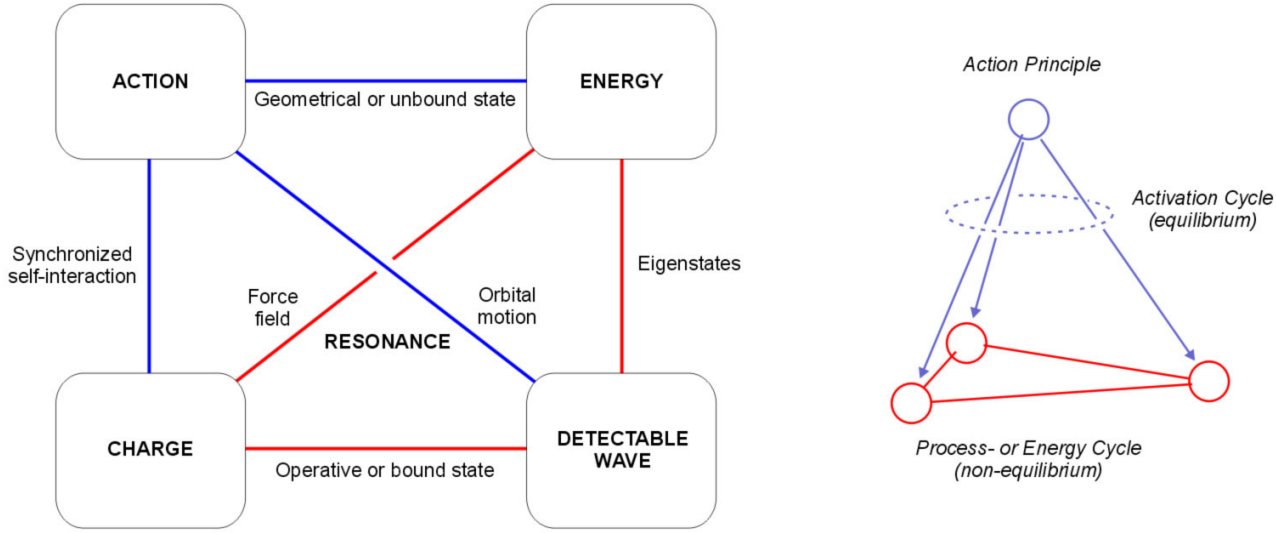

Fig. 12 – Functional diagram of the bifurcative Hydrogen model.

Here, the process- or energy cycle is essentially standard quantum mechanics. The action, and its direct relation to energy and to the detectible wave (and to some extend to a medium of detectable waves) are also known. What's obviously new is the synchronized self-interaction, and following from that, the fact that charge is proposed to have a fractal sub-structure, which normally goes undetected. The same is represented by a tetrahedral model. The process- or energy cycle is associated with the force field term in the revised de Broglie relation (eq. 3). It is thermodynamic in nature and therefore unstable (entropic). The integral equilibrium, associated with the quantum of circulation, is preserved through the "positive" (fractal), "negative" (undulatory) and "neutral" (standard, linear) interactions, together constituting the Action Principle's activation cycle. This summarizes the proposed action-centric Hydrogen stability principle based on the quantum field's bifurcative self-interaction. Lastly, the Hydrogen model based on bifurcative self-interaction is related to the quantum numbers:

Name	Symbol	Value examples	Bifurcative relation
Principal quantum number; shell	**n**	n = 1, 2, 3, …	Base 2 volumetric bifurcation.
Azimuthal quantum number (angular momentum); subshell	$\boldsymbol{\ell}$	for n = 3: ℓ = 0, 1, 2 (s, p, d)	Same as standard; specifically the volumetric completion of the resonance, indicated by the p^6 subshell.
Magnetic quantum number (projection of angular momentum); energy shift of subshell	$\mathbf{m}_\ell$	for ℓ = 2: m_ℓ = −2, −1, 0, 1, 2	Hypothesized energy shifts due to variations in the synchronization (φ ± dρ).
Spin quantum number	$\mathbf{m}_s$	for an electron: s = 12 m_s = −12, +12	k' = 0 terms of the base ϕ bifurcative self-interaction; spin synchronization per the s^2 orbital.

Table 2 - Bifurcative self-interaction vs. quantum numbers

Discussion

In the present work, which is intended as an introduction to a theory of bifurcative self-interaction, the quantum mechanical aspects are not being discussed in as much depth and detail as one may expect in a physics paper. At the same time, the theory by its very purpose and nature is centered on the Action Principle and on the Planck Constant, and therefore in every practical sense approaches the heart of quantum physics. It seems therefore appropriate to discuss the present theory in the light of a fundamental role of the Action Principle in Quantum Mechanics, as was expressed by Louis de Broglie in his 1924 paper and cited early on.

De Broglie was not quite alone in his concerns. Other authors have gone through great length to rekindle interest in, and verily rehabilitate the Action Principle as a fundamental invariant in nature. In 1986, support came from an unexpected angle in the form of microvita theory from the Indian philosopher Shrii P.R. Sarkar (1921-1990). In an auspicious series of 42 lectures, Sarkar expounded his theory which he referred to as *"a new line of thinking"*, unrelated to some of the leading concepts of his own elaborate philosophical treatise (22). Sarkar consequently introduced a number of (relatively) new terms, including the Action Principle and the Knowing Principle (the Sanskrit terms are *"KritaPurusa"* and *"JinaPurusa"* resp.). Specifically, Sarkar identified the smallest instance of the Action Principle, which he termed *"microvitum"*. At the same time, he startlingly designated the Knowing Principle as being (identical to) Energy. The latter is not that surprising, if we recall Noether's theorem, stating (in short), that *every symmetry of a physical system has a corresponding conservation law*. Symmetry in this context implies gauge symmetry, which could indeed be thought of as a "knowing principle", whereas energy obviously represents the conserved quantity, its smallest quantum being the photon. The smallest instance in Quantum Physics is the Planck Constant. This suggests that "microvitum" is simply another term for the Planck constant, however with considerable caution. Firstly, Sarkar proposed various types (positive, negative, neutral), categories (detectability levels) and classes (functionalities) of microvita. Secondly, the scope and implications of microvita theory are vastly more comprehensive than is the case with the Planck constant, as it is proposed to define life at a fundamental level. It is at this point that we require a potentially equally extensive interpretation of Quantum Mechanics. An incentive and prospective groundwork for the latter has been proposed through the present theory of bifurcative self-interaction. The obvious and well considered connection between Quantum Mechanics and Microvita Theory can impossibly be covered, or even barely be summarized in the present paper. P.R. Sarkar's own overview, in the form of the *"Four Chambers of Creation"* proofs very helpful by way of introduction. It includes the aforementioned Action and Knowing Principles, both having a "Subjective" and "Objective" aspect, together constituting the *"Four Chambers of the Universe"*. The obvious conformity with the Aristotelian Four Causes barely needs elucidation. There is no doubt that there lies a vast research potential in the field of microvita, theoretically as well as practically, which was empathically emphasized and carefully outlined by Sarkar [23].

A still more contemporary advocate of the Action Principle is physicist and writer Jennifer Coopersmith [24]. In a private correspondence, Coopersmith affirmed: *"Yes, you may describe my book 'The Lazy Universe' as a passionate plea to rehabilitate the Principle of Least Action"*. In the introduction she quotes: *"If one could grasp the whole Universe from one viewpoint, it would appear, if it is permitted to say this, as a unique fact and a great truth"*, from Jean le Rond d'Alembert, an 18th. century French philosopher. The book's recommendations refer to the Action Principle as *"... one of the most*

fascinating and fundamental principles which theoretical physics has uncovered".

In summary and somewhat philosophically, this sets the stage for an interpretation of Quantum Mechanics *"based on things that are real"*, of which the proposed Hydrogen orbital stability theory is arguably its first and most fundamental application. With this background, the concept of bifurcative self-interaction is somewhat further evaluated. Firstly, the latter has been introduced as an alternate interpretation of quantum mechanics resp. QFT, rather than a whole new theory. The underlying idea of bifurcation is that on a fundamental level, geometry and quantum field self-interaction are interchangeable. This allows the existence of an entirely abstract, yet realistic underlying quantum state, which has no reality in the absolute sense but is superior to and inferred by its effects. In the Standard Model theorem, that is, the Higgs mechanism's self-interaction, the bifurcation is presumably present just as well, but is indistinct. It can be likened to hitting all the piano keys at once, versus playing harmonies. In both cases sound is produced (mass), but only in the latter case there is also musical structure (eigenstates). That's why distinct bifurcative self-interaction is called "synchronized", pertaining to the notes (self-excitation angular rates) that contribute to harmonic structure. Somewhat poetically, bifurcative self-interaction is the "musical key" to Hydrogen formation, taking the external form of an integrative, volumetric resonance. The term*"bifurcation"* was used by Sarkar in microvita theory: *"That is why during the bifurcation, the unitary strength remains the same"* [22]. This is highly indicative of the Fourier transform resp. integration of a non-linear interaction, which, as shown, is both bifurcative and unitary. Now the question may arise: *what causes or actualizes the bifurcation?* The answer is: there is no cause - the non-bifurcated and bifurcated states are simply two sides of the same paper. Alternatively, one could say that the quantum field and its imminent bifurcative action are one and the same entity or principle. The difference with the so called *"collapse of the wave equation"* in Quantum Mechanics is that the latter is seen as an isolated phenomenon, whereas bifurcative self-interaction is considered the characteristic bearing of the quantum field itself. It was shown that the set of 2^3=8 eigenstates can be viewed as a base-2 bifurcation. This not entirely trivial. Firstly, the subsequent bifurcation levels with values of resp. 2^1, 2^2, 2^3 correctly represent the geometric ratio's of the volumetric expansion, that is resp. the radius, spherical surface and volume. Secondly, it shows that the base-2 bifurcative eigenstate set encodes the volumetric expansion not only incrementally but also geometrically, all on its own. As a consequence of this apparent self-sufficiency in the realm of measurement, there is no pressing incentive to look for a realistic, underlying phenomenon, geometric or other. This situation is of course very reminiscent of, and perhaps also a bit of a quietus for the energy-centric bias of Quantum Mechanics (pointed out by de Broglie), which is argued to have led to interpretation issues. By the same token, the base-2 bifurcation is dissatisfactory, while despite its geometric consistency, it fails to hint at an underlying reality. The main reason why synchronized bifurcation can be considered action-centric (rather than energy-centric), is that the "k'=0" Fourier terms represent dual phase waves having infinite wavelength. The latter is proposed to introduce the intrinsic (up and down) spin pair, which is quite literally the pivotal factor in particle creation. Infinite wavelength also means that there is no effective energy displacement resp. dispersion (rather, total dispersion). Not surprisingly, the physical unit of spin is pure action, that is, h/2. As shown, the intrinsic spin is subsequently designated to the eigenstates resp. the nucleus, while the integral, resonant bifurcative action generates the mass of the latter. For the sake of argument, a volumetric aspect of intrinsic spin could also be theorized, de facto corresponding to the n=8^{th} eigenstate. This captures how through synchronized bifurcation, pure action, in the form of intrinsic spin, is introduced as the pivotal factor in volumetric Hydrogen formation and stability. It epitomizes synchronized bifurcation as the formalization of action. Lastly, it was mentioned that, although both designate the unit of Action or Action Principle, the scope and implications of P.R. Sarkar's microvita are vastly more comprehensive than currently that of the Planck constant in Quantum Physics. Research related to developing a mathematical model of consciousness has hinted at the usefulness of the bifurcative wave function in biological evolution. Sarkar himself also hinted in that direction: *"Microvita [are] of different characters, either of positive or negative nature, collectively maintaining the balance of the actional universe creating initial forms of carbon atoms that help macro- and micro-propensities in having their pure physical auxiliary media with mass and wants"*. Arguably, exactly such an *"initial form of carbon atom"* is presently presented, in the form of the simultaneous Hydrogen model (i.e. with unitary "eigenstates"). *"Carbon"* here should probably be taken somewhat metaphorically, indicating atoms that contribute to life. The development of *"physical auxiliary media"* most likely refers to biological organs of any kind. It is proposed that the (A) objective or propensitive chamber corresponding to the fractal bifurcative process, is associated with biogenesis as well as with sensual perceptions (fundamentally, of pain and pleasure). The (A) subjective chamber fulfills the cognitive aspect. For example, an algae perceives a wavelength of 580 nm (= (B) objective) and feels something specific (pleasant, unpleasant). Only a human, who's retina produces the same feeling, consciously distinguishes the color yellow. A chimpanzee does not know about colors, but can recognize a banana by its color. Thus, with the gradual development of more advanced organs (incl. glandular and nervous systems), more and more potentialities of consciousness are individually expressed. In P. R. Sarkar's words, through *the emanation of positive, neutral and negative microvita*, the (B) subjective chamber or fractal bifurcative attractor consistently and benevolently guides the current of evolution beneath the untamed waves of life.

Conclusion

An energy-centric bias in Quantum Mechanicsis identified, which calls for a more decisive role for the Action Principle as a key ingredient for quantum realism. The advancement of the dimension of action is realized through a unitary, bifurcative self-interaction of the quantum (resp. scalar) field, in agreement with Goldstone's argument that the ground state is not unique, while rendering a quartic self-interaction obsolete. It is demonstrated that the bifurcative self-interaction or -wave function is synchronized through Golden Ratio, allowing the formation of spin-orbital as well as volumetric isomorphisms which at first constitute an initial or simultaneous form of the Hydrogen atom. Out of the latter, the common, sequential, interactive eigenstate model is formed. The action is shown to preserve equilibrium not only through neutral or linear, but also through fractal and undulatory modes. Further evidence of synchronized bifurcative self-interaction is provided through the prediction of the proton-to-electron mass ratio, which can currently not be calculated in Quantum Mechanics.

Acknowledgements

The author thanks Prof. Dhanjoo Ghista for his support with the publishing. The author also thanks Prof. Roman Poznanski for stimulating discussions in the adjacent field of mathematically modeling consciousness, and Dr. Farhad Ghaboussi for his explanation and feedback on the subject of 2DF physics.

References

1. Broglie, Louis de. Recherches sur la Théorie des Quanta. Ann. Phys. 10e serie, t.III; 1925. Translation "On the Theory of Quanta" by A. F. Kracklauer; 2004.
2. "Louis de Broglie". Wikipedia, July 2020. Retrieved July 2020.
3. Planck, Max. Ueber das Gesetz der Energieverteilung im Normalspectrum. Ann. Phys., 309 (3): 553–63; 1901. English translation: "On the Law of Distribution of Energy in the Normal Spectrum".
4. Bohr, Niels. On the Constitution of Atoms and Molecules". Philosophical Magazine; 1913.
5. Davisson, C. J., Germer, L. H. Reflection of Electrons by a Crystal of Nickel. Proceedings of the National Academy of Sciences of the United States of America, 14 (4): 317–322; 1928.
6. Schrödinger, E. An Undulatory Theory of the Mechanics of Atoms and Molecules. The Physical Review; 1926.
7. Einstein, Bohr and the war over quantum theory. Nature books and arts, 2018. Retrieved from https://www.nature.com/articles/d41586-018-03793-2, July 2020.
8. Neumann, John von. Mathematical Foundations of Quantum Mechanics. Princeton University Press, Princeton, New Jersey 08540.; 1955.
9. Hooft, 't, Gerard. The Flaws of Quantum Mechanics. Interview; 2019. Retrieved July 2020 from, https://www.youtube.com/watch?v=r0tMVN_9-x4&t=1s.
10. "Quartic interaction". Wikipedia, April 2020. Retrieved July 2020.
11. Blanchard, P., Devaney, R. L., Hall, G. R. Differential Equations. Thompson, London. pp. 96–111. ISBN 978-0-495-01265-8; 2009.
12. Gould, H. W., Kim, J. B., Hoggatt, V. E. Jr. Sequences Associated with t-ary Coding of Fibonacci's Rabbits. Fib. Quart. 15, 311-318; 1977.
13. Plancherel, Michel, Mittag-Leffler. Contribution à l'étude de la représentation d'une fonction arbitraire par les intégrales définies. Rendiconti del Circolo Matematico di Palermo, 30 (1): 289–335.; 1910.
14. Kosinski, A. A. Differential manifolds (p. 164). Academic Press, Inc., San Diego; 1993.
15. Ghaboussi, F. Dimensional Structure of Space-Time. ArXiv: arXiv:gr-qc/0309046v1; 2003.
16. Brzychczy, S., Poznanski, R. R. Mathematical Neuroscience. Academic Press, Amsterdam; 2015.
17. Goldstone, J. Field Theories with Superconductor Solutions. Nuovo Cimento. 19 (1): 154–164; 1961.
18. Dirac, P. A. M. The Quantum Theory of the Electron. Proceedings of the Royal Society A: Mathematical, Physical and Engineering Sciences. 117 (778): 610–624; 1928.
19. Proton Spin Mystery Gains a New Clue. Scientific American; 2014. Retrieved July 2020 from https://www.scientificamerican.com/article/proton-spin-mystery-gains-a-new-clue1/.
20. Aristotle on Causality. Stanford; 2006. Retrieved July 2020, from https://plato.stanford.edu/entries/aristotle-causality/.
21. NIST Reference; 2018. Retrieved July, 2020 from https://physics.nist.gov/cgi-bin/cuu/Value?mpsme.
22. Sarkar, P.R. Microvita in a Nutshell. Collected discourses. Discourse "Microvita and Cosmology"; 1989. Ananda Marga Publications, Calcutta.
23. Sarkar, P.R. Microvita in a Nutshell. Collected discourses. Discourse Some Guidelines for Commencing Microvita Research – Sections A-D; 1989. Ananda Marga Publications, Calcutta.
24. Coopersmith. The Lazy Universe. Oxford University Press, New York; 2017.