

# Temporal Calculus: Time Scaling Space

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**Abstract:** Presented here is the case for what has been termed Temporal Calculus, a new calculus central to a time-algorithm that is able to calculate a direct reference of time to 3-d space and thereby present the case for a mathematics that exists between time and space. The creative drive for this proposed Temporal Calculus is to present a solution to the asymptotic freedom of the most basic/elementary particles compared to the vacuum of space, and therefore to directly address the “Yang-Mills existence and mass gap” problem, in providing a solution. Although the equations of Yang-Mills remain unsolved at energy scales relevant for describing atomic nuclei, Temporal Calculus can show how the elementary particles themselves give rise to the physics of nuclei and nuclear constituents, thus providing a solution to a key problem in theoretical particle physics.

**Keywords:** calculus; temporal; asymptotic freedom; mass gap; Yang-Mills; Bose-Einstein Condensate; Higgs mechanism; neutrino

## 1. Introduction

Temporal Calculus is the summarised body of work [1] (as paper 25 of its 24 preceding papers, see <http://orcid.org/0000-0003-3869-7694>) detailing a time-algorithm that calculates a direct reference of time to 3-d space, presenting the case for a mathematics that exists *between* time and space. Why is this important? Most of the key problems in contemporary physics theory are central to defining particle

behaviour as close as possible to the backdrop of time and space, the stage all phenomena is set upon, to enable a most exact account of particle behaviour as possible. For how indeed can a particle be understood properly without understanding its backdrop, namely time and space? For instance, the proposed mass gap by the Yang-Mills equations [2] is central to measuring the lowest mass particle *compared* to the vacuum of space. So too the Bose Einstein Condensate (BEC) [3] seeks to measure the lowest quantum state of a particle as close to the vacuum of space as possible by reducing the temperature/energy of a particle to near zero, such of course (BEC) being a different concept to the Yang-Mills equations and associated proposal of the mass gap, given the mass gap is well below quantum dimensions, hence the problem itself of the Yang-Mills equations and associated mass gap proposal for the lightest particle, namely, not being inclusive of the massless particle (photon) in the context of known symmetry-breaking protocols in play. Nonetheless, all the key steps in leading-edge physics theory and research are knocking on the door of space and, although as understated as it is, time.

Perhaps the greater of the two key frontlines of research (the Yang-Mills mass gap proposal, and the BEC) is the Yang-Mills existence and mass gap problem, the acknowledgement of this problem echoed by the Clay Institute for Mathematics in their Millennium Prize problem for the “Yang-Mills Existence and Mass Gap” problem [4], as follows:

***Yang–Mills Existence and Mass Gap.*** *Prove that for any compact simple gauge group  $G$ , a non-trivial quantum Yang–Mills theory exists on  $R^4$  and has a mass gap  $\Delta > 0$ . Existence includes establishing axiomatic properties at least as strong as those cited in [45, 35].*

This problem is central to a set of equations (Yang-Mills) [2] that seemingly defy the evidence for what should exist as a particle phenomenon below the scale of the photon. Indeed, in the absence of the Yang-Mills equations to solve this problem alone while also needing to account for the quantum state of the atomic particles, is to suggest that a new calculus is required, which in itself as a solution represents a number of problematic key issues:

- Is there a flaw in the current process of the application of mathematics to the examination of particle phenomena?
- What is the exact determination of that that flaw, namely how does one address that flaw?
- What is the solution is to that flaw while keeping all previous relevant equations associated to know phenomena upheld?

As is widely understood in theoretical physics, the examination of particle phenomena using mathematics requires a number of different (calculi) approaches, each with a number of different algorithms of choice. To suggest a key algorithm that is involved in the mass gap problem requires amending (to solve the mass gap problem) suggests that an entire chain of algorithms themselves may need amending, and therefore that a new calculus in its *entirety*, quite possibly, would be needed to solve the Yang-Mills existence and mass-gap problem. Indeed, proving a *quantum* Yang-Mills “existence” is in acknowledgement of all its preceding steps of logic of formulation and intention of design as an algorithm,

and to therefore improve upon that algorithm is to first acknowledge the Yang-Mills equations while suggesting that a greater approach to the mass gap problem is required, in accounting for non-trivial quantum calculi.

In approaching such a task, this paper shall examine the current mathematical calculus (and associated algorithms) and scales used by physics for time and space, and how they *generally* feature in the current “Yang-Mills existence and mass gap” problem, and whether the fault lies with how those equations (Yang-Mills) [2] are being defined and applied, and how they must be improved upon to account for QED while still using the same backdrop of particle phenomena being analysed. To achieve such, the structure of this paper by section is as follows:

1. Introduction
2. “The Yang-Mills existence and mass gap” problem
3. The mathematics of time and space: what is assumed?
4. Time and space: what is assumed?
5. Providing a solution to the “Yang-Mills existence and mass gap” problem
6. How complete is Temporal Calculus?
7. Conclusion

As shall be demonstrated, the flaw in theoretical physics leading to the “Yang-Mills existence and mass gap” problem is one of how mathematics is applied to physics, and not just that, yet why physics allowed itself to have mathematics applied to it in such a fashion, namely in the fashion it has in leading to the inherent limitations of the Yang-Mills equations (in addressing the mass gap issue and required juxtaposition with quantum phenomena).

## 2. “The Yang-Mills existence and mass gap” problem

2.1 The importance of the “Yang-Mills existence and mass gap” problem should not be underestimated, for it underpins precisely where physics has been unable to venture beyond in its analysis of the lightest particle known compared to the vacuum of space. The solution to the “Yang Mills existence and mass gap” problem lies in solving the very problem it encounters at the mass gap, namely the inherent asymptotic freedom of the particles being measured in regard to the vacuum of space, and how that can be related to quantum physics (QED).

2.2 The key issue with the Yang-Mills approach is its use of the Calculus of Infinitesimals (complete and partial) in that despite the exactness of the Calculus of Infinitesimals (and associated partial differentials), those equations are unable to accommodate for the indeterminacy and associated asymptotic freedom (symmetry-breaking) feature of the most elementary of particles, which therefore creates only a *hypothesis* for *the lowest energy state* of a particle if indeed a particle

cannot be properly defined owing to its inherent asymmetrical (symmetry-breaking, or *asymptotic freedom*) and thus indeterministic characteristic.

- 2.3 Upon this problem (2.2) is that owing to quantum restrictions, a photon technically cannot exist on the proposed most fundamental elementary particle level (sub-quantum), yet only a *mass* can, that which is described as *the non-existence of massless particles in observations of the strong interactions*. The problem here is that quantum mechanics prescribes a certain level for quantum functionality, yet calculations suggest together with experimental observations that there exists something more fundamental at play, as elementary particles, which themselves therefore need an abridged calculus and associated algorithms from the standard quantum mechanical formulae, to account for the known quantum relationship with the idea of symmetry-breaking [5], hence the discrepancy with Yang-Mills equations [2].
- 2.4 As the current Standard Model of particle physics must therefore propose, there are particle *forces* (as these elementary particles) and there are force “carriers” (for these elementary particles/forces), on this elementary particle level, and such forces and force carriers need to explain the 4 basic forces themselves, the *strong* (neutron/proton and associated substructures), *gravity*, *electromagnetic*, and *weak* (the *weak electromagnetic* and *weak* bundled together as *electroweak*).
- 2.5 Understandably, the labelling for each elementary particle force and force carrier needs to be specific and demonstrable, yet the mathematics employed to describe all of such fails, as specified, to accommodate for the inherent symmetry-breaking (*asymptotic freedom*) and therefore indeterminacy of the most elementary particles/forces, hence the request for a solution to the equations currently used on the most fundamental level of particle/force analysis in the elementary particle world, to the Yang-Mills equations, while addressing and upholding quantum accountability on the atomic level.
- 2.6 In short, either quantum theory has to accommodate itself with short-range forces and massive particles, with bridging algorithms describing mathematical properties extending to the “mass gap” and associated “*asymptotic freedom*” of elementary particles, all as a way to explain the non-existence of massless particles (the non-existence of the photon on this sub-atomic level, as it must be) in observations of the strong interactions, or the Yang-Mills equations must accommodate for quantum electrodynamics (QED). The question either way, if not another way, is how.
- 2.7 Hence, the Clay Institute proposes that a rigorous new approach to the “quantum Yang-Mills theory” is required as one that can capture all the essential equations and constants thereof central to quantum theory and its progenitor theories; evidently, the Millennium Problem [3] *seeks to confirm a rigorous mathematics demonstrating the existence of the “mass gap”, namely the non-existence of massless particles in Yang-Mills theory*, which is what this paper proposes to provide, yet more to the point, how that can be explained in the context of quantum

electrodynamics (QED). To reach that algorithm/equation, it is necessary to address how mathematics is currently applied to the concepts of space and time, that general backdrop of all particle behaviour.

- 2.8 The solution presented here in this paper to the Yang-Mills existence and mass gap problem is not necessarily just a new calculus per se, yet also an explanation as to *why* the Yang-Mills equations *exist* in proposing the *mass gap* via the non-existence of the massless particle (photon).
- 2.9 Of course demonstrating that another calculus is required to achieve theorising and equating the mass gap (obviously in proving the mass gap) would represent a calculus that spans through what the equations preceding the Yang-Mills equations have accomplished, which understandably would be a large body of work,
- 2.10 That body of work is presented in a preceding paper, paper 25, "*Temporal Calculus: Solving the "Yang-Mills existence and mass gap" problem*" [1] where all the equations leading to, *and inclusive of*, the Yang-Mills equations are replaced with a new calculus describing the same phenomena ([1]: p20-22, p29-32, p45, p51). Yet the real proof is establishing how that new calculus can exist in alliance with what currently exists of the Yang-Mills equations, while explaining the non-existence of the massless particle (photon) on such a level in the context of known symmetry-breaking protocols for particle manifestation (as per the known Higgs mechanism [5]).
- 2.11 The paper here presents that case and therefore a proposal for the complete solution to the "Yang-Mills existence and mass gap" problem is presented here as such.
- 2.12 Therefore, according to the condition of providing a solution to the "Yang-Mills existence and mass gap" problem, the Yang-Mills equations are not being disputed, yet another route (as per via an algorithm directly related to time-space) is being taken *to demonstrate* the existence of the Yang-Mills equations, its aetiology, and hence its proposal for the mass gap, and why it falls short in defining the exact value for  $\Delta > 0$ , while also failing to take proper accountability for the quantum nature of the atomic particles, rectified nonetheless with a proposed over-arching calculus.

### 3. The Mathematics of time and space: what is assumed?

- 3.1 A number in its most basic sense is a unit, "1"; whole numbers beyond "1" are sets of a unit, "1" ("2" is a set of 2 "1" units, "3" a set of 3 "1" units, and so on).
- 3.2 Mathematics as a concept of numbers is in its most elementary sense is a proposed relationship between numbers (as units or sets of units) equating to an overall set of proposed numbers based

on the nature of association defined for those numbers and sets of numbers being related to each other in a certain nominated way.

- 3.3 For instance, mathematics is essentially the utility of the idea of numbers, usually whole numbers, that bear relation to one another via certain operators such as addition, subtraction, multiplication, division, and so on, such as  $1 + 2 = 3$ ; in other words, if numbers are sets of “1”, how those sets relate as defined by their relationship can equate to an overall set as the equator result.
- 3.4 Mathematics becomes more complex in defining how numbers can relate with each other by defining *new more complex terms* for numbers (real, unreal, rational, irrational, positive, negative, and so on), and new ideas of relations of numbers (for instance, square root, differentials, and so on).
- 3.5 In short, mathematics has developed a vast calculus using a variety of algorithms that represent how numbers in the mathematical set of defined numeracy relate with each other.
- 3.6 The historical stage when mathematics was applied to physics is interesting to note during this process of mathematical discipline formulation:
  - 3.6.1 Circa 1600’s to the 1900’s (from Isaac Newton to just prior Albert Einstein’s relativity theory), space was not a vacuum yet rather an aether filled with particles.
  - 3.6.2 The emphasis then became upon physics to explain particles in this aether as related to gross phenomena, from Newton all the way until aether was disproved by the Michelson-Morley experiment (circa 1880-81, 1887).
  - 3.6.3 Mathematics was thus applied not to space or time, yet to *particle behaviour*, namely as per Isaac Newton’s momentum and inertia in acknowledgement of aether; *time* was considered to be what a clock measured, all the way to Einstein if not still to today, as a linear invariant dimension (with the idea of light subject to Einstein’s relativity conditions of proposed time-dilations) symbolic of the inherent “entropy” in play of the reality of particle behaviour with other particles in the vacuum of space.
- 3.7 Mathematics was thus, as it still is, applied to *particle phenomena*; only after the Michelson-Morley experiment was space considered as a vacuum. Yet, despite such, mathematics was still applied to the study of particle behaviour, and not to the possible definition itself of space as a vacuum in relation to time (as a feature inherent with space).
- 3.8 Applying mathematics to *particle* physics nonetheless seemed the natural thing to do, to use the mathematical toolset of terms and associations (numbers and sets) to describe what is happening with *physical phenomena* as particles in space, initially taking the form of the Cartesian coordinate system of spatial coordinates in 3-d space to more complex manifolds and topologies of spatial

representation, real and unreal (3.6.1-3.6.3), primarily with the use of the Calculus of Infinitesimals (complete and partial differentials) as a way of exacting particle phenomena to a “0” point determination.

3.9 Naturally, such a process has taken the understanding of particle phenomena to its absolute level, as per the Yang-Mills equations and associated proposal of the mass gap where  $\Delta > 0$  [2] is *proposed* and a quantum-related equation accounting for known symmetry-breaking protocols of particle manifestation *sought for* with that proposal to accommodate for asymptotic freedom of particles [5].

#### 4. Time and space: what is assumed?

4.1 Two key variables utilised for the mathematical modelling of particle phenomena by physics are as follows, as per Sir Isaac Newton’s Principia Mathematica [6]:

4.1.1 Inertia: *The vis insita, or innate force of matter, is a power of resisting by which every body, as much as in it lies, endeavours to preserve its present state, whether it be of rest or of moving uniformly forward in a straight line.*

4.1.2 Force  $F = ma$  (and momentum  $p = mv$ )

4.2 Despite the assumption of 1-d time as an invariant in a supposed virtual 3-d spatial “0” (vacuum) manifold, the two key assumed indicators for time are as follows:

4.2.2 the unidirectionality of time from time-before to time-after via time-now (and associated entropy with time) as time’s arrow.

4.2.3 the speed of light in a vacuum as a constant based on the vacuum being a uniform “0” (only having incurred time-dilations in relativistic conditions according to Einstein’s Special Relativity).

4.3 In the application of mathematics as a deterministic tool to the calculation of particles in motion, physics (with mathematics) nonetheless fails to account for the symmetry-breaking (asymptotic freedom) of/as elementary particle formation (and associated indeterminacy), elementary particle formation presumably from the vacuum, yet according to current physics theory, requiring a quantum model to account for [5].

4.4 What has subsequently needed to be asked by this process is that if mathematics is indeed deterministic, then how can mathematics explain the indeterministic nature of the symmetry-breaking of particles and associated particle-particle interaction based on such an intrinsic indeterministic nature of particles on the quantum level when evidence suggests a vastly sub-

quantum phenomena at play with the elementary particles [2] with associated symmetry-breaking protocols of manifestation of their own (presumably)?

- 4.5 All of such leads to the mass gap problem and associated Yang-Mills equations [2] requiring the use of proposing particle-based energy scales of a non-massless (non-quantum) variety (3.1-3.9), still nonetheless requiring a quantum-application to account for the process of particle symmetry-breaking (asymptotic freedom) [5].
- 4.6 In short, the examination of particles using the Newtonian inspired idea of momentum and inertia would appear to be a secondary mechanism attempting to explain the primary nature of space and time and how particles would otherwise be better explained as being intrinsically related to space and time (asymptotic freedom) as accounted for presumably by the elementary particle phenomenon and not it would seem by QED.
- 4.7 If mathematics therefore could be directly applied to space and time *primarily*, then such *should* solve the asymptotic freedom of particles without interfering with the existence of the Yang-Mills equations, merely solving the mass gap issue by addressing the primary issue of time and space as related with the broken-symmetry manifestation of particles, while of course needing to explain the quantum state of known quantum-related particle phenomena (QED).

## 5.0 Providing a solution the “Yang-Mills existence and mass gap” problem

- 5.1 To solve the “Yang-Mills existence and mass gap” problem in addressing a non-quantum symmetry-breaking principle central to particle phenomena manifesting from the vacuum of space (and seemingly a massless super particle known as space), a new calculus must be proposed that focusses directly upon the vacuum of space and associated inclusion of time, to directly prove the mass gap and its value, yet also how this is related to the quantum state of atomic-based particles (QED).
- 5.2 As proposed, the new calculus is central to identifying the relationship between time and space on a theoretic level in accordance with the ability of human logic to rationalise time and space ([1]: p12-13).
- 5.3 “*Temporal calculus: Solving the “Yang-Mills existence and mass gap” problem*” [1] presented the general overview of the Temporal Calculus formulated in its preceding 24 papers as this new calculus; given the required vastness of that algorithm in needing to cover all the same phenomena contemporary physics has covered through its inertia/momentum route, paper 25 [1] was chosen to summarise that rigorous calculus and associated equations ([1]: p20-22, p29-32, p45, p51).

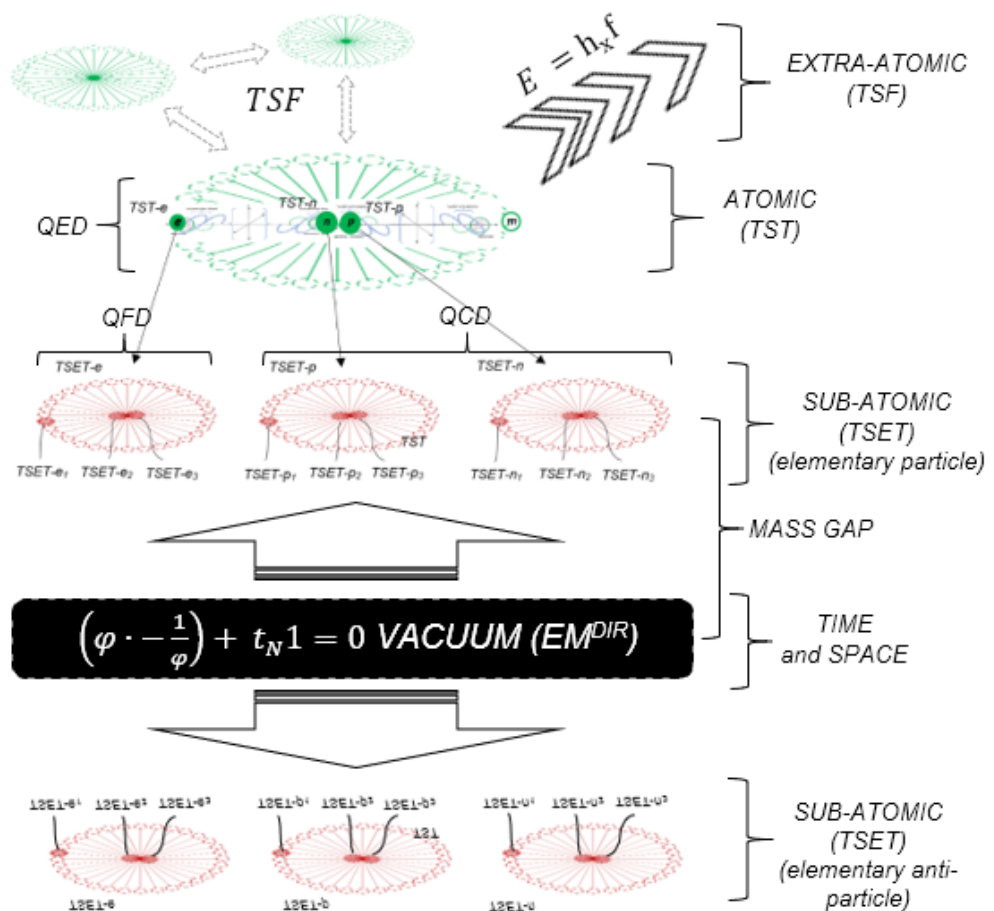


- 5.4 The following key features were presented in “*Temporal calculus: Solving the “Yang-Mills existence and mass gap” problem*” [1]:
- 5.4.1 The basic algorithm for time with space ([1]: p19-20, p33-35).
  - 5.4.2 How that is inclusive of symmetry-breaking ([1]: p33-35).
  - 5.4.3 Proof of the relevance of the Temporal Calculus to the Higgs mechanism (in the currently understood context of symmetry-breaking) in deriving the Higgs mass ([1]: p45, eq9).
  - 5.4.4 How the Higgs mechanism is related to elementary particle manifestation in the context of the Temporal Calculus ([1]: p46, fig14).
  - 5.4.5 Proof of that calculus in deriving all of what the equations leading to the Yang-Mills equations have proven regarding physical data ([1]: p20-22, p29-32, p45, p51).
  - 5.4.6 Proof for the basic atomic masses ([1]: p45, p49-51) using Temporal Calculus.
  - 5.4.7 A derivation for the mass gap value ([1]: p51, eq10).
  - 5.4.8 Confirmation that current estimates propose the same value to be true ([1]: p49) [7].
- 5.5 As much as the discipline of mathematics allows itself the freedom of defining new terms for new number sets/groupings as new names for new algorithms, so too Temporal Calculus has exercised that same freedom in developing the time-algorithm as applied to space, the focus being using an alternative route, an alternative calculus, to demonstrate the existence of the Yang-Mills equations and associated postulate of the mass gap, which the temporal calculus correctly identified with its own theorised elementary particle set and associated characteristics to contemporary descriptions as per in the correct descriptive habitat of what is known of the elementary particles, and what the mass gap value would be.
- 5.6 The following new terms used to describe the association between time and space are as follows, as presented in paper 25 ([1]: p26, p38-41):
- 5.6.1 TSU: Time-space uncertainty ([1]: p26)
  - 5.6.2 TSC: Time-space context ([1]: p26)
  - 5.6.3 TSG: Time-space groove ([1]: p26)
  - 5.6.4 TSS: Time-space spin ([1]: p26)
  - 5.6.5 TSF: Time-space field ([1]: p26)
  - 5.6.6 TST: Time-space template ([1]: p26)
  - 5.6.7 TSW: Time-space wave ([1]: p26)
  - 5.6.8 TSP: Time-space pulse ([1]: p26)
  - 5.6.9 TSEC: Time-space elementary context ([1]: p38)
  - 5.6.10 TSET: Time-space elementary template ([1]: p40)
- 5.7 These 10 time-space features represent how “three” time-space levels come into play:

- 5.7.1 The atomic template level (time-space template, TST) as the basic atomic level *confining* the basic subatomic particles (proton, neutron, and electron) ([1]: p24, fig4).
- 5.7.2 The sub-atomic template level (time-space elementary template, TSET) as the level that *confines* the family of elementary particles (including antiparticles), prescribing the strong and weak nuclear forces ([1]: p40-48, fig8-15).
- 5.7.3 The extra-atomic level (time-space field, TSF) representing how atoms interact with one another as per electromagnetism and gravity in the time-space-field (TSF), EM interactions (and thus atomic compound formulation and destruction) and gravity-based mass attraction ([1]: p24, fig4).

5.8 Figure 1 as an amalgamation of figures 4 and 15 from paper 25 ([1]: p24, fig4; p40, fig8; p48, fig15) represents the idea of these three levels (TST, TSET, TSF):

Figure 1



5.9 By such a process (figure 1), Temporal Calculus has identified the particle nature of the elementary particles ([1]: p40-49), and their association to the four fundamental field forces (strong, electroweak, gravity, and EM) ([1]: p43, fig 12), and associated intrinsic relationship to the basic atomic particles (electron, proton, and neutron) ([1]: p49-51).

5.10 The derivation of the mass gap was achieved in the following extract from paper 25 ([1]: p51):

5.10.1 *To address the TSET- $e_1$  mass value therefore, to note clearly here is that the idea of “ $e$ ” is being considered as a “fundamental property”, and that  $e_c = \frac{e}{c} =$  fundamental property 2. In therefore using that same line of logic in having successfully derived the proton (and neutron) mass from charge on the TST level, and now applying the same logic to the TSET level, two things need to be factored:*

(i) *The “12” factor, as presented.*

(ii) *The fact that a new charge level is being encountered as a new electron analogue (as TSET- $e_1$ ), and this would therefore invoke a new “ $c$ ” factorial according to fundamental property 2.*

(iii)  $m = \frac{e}{c^2}$  ([2]: p16, eq15) still holds as  $m = \frac{e}{c} \cdot \frac{1}{c} = \frac{e_c}{c}$

*Therefore, the equation for the mass of TSET- $e_1$ , the value of the mass gap  $m_{MG}$ , would be as follows:*

$$m_{MG} = \frac{e_c}{c} \cdot \frac{1}{12} \cdot \frac{1}{c} = 1.5 \cdot 10^{-37} kg \quad (10)$$

5.11 The need for this TSEC/TSET level (the entropic>enthalpic “12” factor) was determined in the following extract from paper 25 ([1]: p40):

5.11.1 *The  $12\phi^2$  level is the issue to consider needing accounting for. This level was considered to be enthalpic in line with the proposed subatomic functionality as presented in paper 2 figure 16 ([2]: p16, fig16) and here in this paper as figure 2. The CMBR ([14]: p25, eq12-13) has been calculated by the time-algorithm, together with the vacuum constants ([23]: p30, eq5, eq7), demonstrated to be a process of the atom’s energy dynamic. To explain this as simply as possible, the elementary level by design is enthalpic compared to the vacuum, namely needing to absorb more energy to grow and give structure to their greater dimensional aspects as a time-space template (TST) on this new elementary level (TSET). Accordingly, above the TSET enthalpic level is the TST entropic atomic level, and such are in a steady state relationship relative to the entire TSU context. According to the time-algorithm, certain equations are required in that process that not only decide the gauge of the atom itself (fine structure constant), those dimensional metrics, yet also how that atomic manifold relates itself with surrounding atomic manifolds in a field of time-points in space. The 12-factor is a calculation based on a feature of time-algorithm that needs to be accounted for as per page 5 figure 4 ([5]: p10, fig4), and the proposal is that*

*this 12-factor is accounted for **on** the TSET level (elementary particle), yet not only this level, yet that it determines how energy propagates through space as a “maximum” factor of a quantum approaching an TSET level, as was presented in paper 13 [13], “Space, and the Redshift Effect”. It shall be demonstrated in a section ahead (3.5.2.5) that this 12-factor is able to properly account for the mass gap.*

5.12 It has been demonstrated in sections 3.1-3.5 that mathematics represents sets of numbers relating to each other in a certain way, the basis with physics being that of an application to time and space. Given the Temporal Calculus here is a general singular calculus utilising the time-algorithm, going above and beyond QED, QFD, QCD, and the Yang-Mills equations, reaching the same required equations and associated data solutions as per figure 1, then those processes (QED, QFD, QCD, and Yang-Mills equations) can be considered as sets of Temporal Calculus.

5.13 By such a process as specified in 5.8, 5.10, and 5.11.1, Temporal Calculus has determined how the *non-existence* of massless particles (the photon) is mandatory for the elementary particles on this TSET scale level, accounting nonetheless for the asymptotic freedom of the elementary particles (symmetry-breaking) as per the inclusion of that principle in the time-algorithm itself, while still accommodating for the phenomenology of the Higgs mechanism [5] in deriving the Higgs mass ([1]: p45, eq9), all in the one calculus, thereby providing a solution to the “Yang-Mills existence and mass gap” problem in relaying a non-trivial *quantum (inclusive of quantum phenomena)* Yang-Mills theory as per the condition specified:

5.13.1 **Yang–Mills Existence and Mass Gap.** Prove that for any compact simple gauge group  $G$ , a non-trivial quantum Yang–Mills theory exists on  $\mathbb{R}^4$  and has a mass gap  $\Delta > 0$ . Existence includes establishing axiomatic properties at least as strong as those cited in [45, 35].

5.14 As per figure 1, the *inclusivity* of quantum phenomena (TST: QED) to the mass gap phenomena (TSET: QFD, QCD) of the lightest elementary particle is upheld via the set of equations embodied by Temporal Calculus.

## 6.0 How *complete* is Temporal Calculus?

6.1 Automation is a human design mechanism based on defined limitations of outcomes as per the inherent limitation of the programming-steps humanly designed in that automated process, a concept intrinsic to mathematics and how the relationship between numbers (sets of units) is being defined.

- 6.2 Computers demonstrate how a process of mathematics can be used in a physical way with the idea of electrical gates and associated electrical display mechanisms:
- 6.2.1 Computers essentially represent a process of electrical gates representing a certain outcome as based on the human physically designed input command for those electrical gates (sets of operations as *programs*), a response that represents a certain electrified gated response.
  - 6.2.2 Computers began with such an initial first program, and still depend on human-entered physical command inputs; computers used today are based on minute after minute, second after second, deliberate programming, one step of programming gates upon another, via inputted physical commands representative of those gates and desired electronic outcomes.
  - 6.2.3 Technically therefore a computer can only provide data as an answer based on already pre-programmed/inputted physical commands, data provided as an answer that can also take the form of basic mathematical solutions to equations in the form of electrical displays understood to human perception by the design of such electrically gated displays.
  - 6.2.4 Computers cannot understand or formulate anything they are not designed to understand or formulate as a solution, and thus cannot understand or formulate anything that the programmer has not already accommodated for in that human's physical design of the computer's electronic gates/pathways; thus, computers are merely a reflection of what is already *understood* and *expected* of the human programmer, whether a basic task or a solution to a complicated mathematical algorithm that has its own constraints of mathematical definition as an equation seeking solving.
  - 6.2.5 Computers therefore cannot calculate what is *not already understood of physical phenomena*, as the data of that physical phenomena needs to be inputted as a physical command in order to program the computer for it to register that data, which makes the human perception ability of reality above and beyond any process or stage of computer technology.
  - 6.2.6 Computers therefore, like mathematics, are essentially deterministic, or rather, have a set operation to fulfil according to a certain defined and thus programmed parameter of capability.
- 6.3 The question of the completeness of Temporal Calculus is asking the same question of any calculus, namely is it felled by its own deterministic nature in trying to explain something of an indeterministic nature, namely particles with asymptotic freedom?
- 6.4 Temporal Calculus has integrated into its algorithm symmetry-breaking, as presented in paper 25 ([1]: p33-35); in its application to space (as an automation) the time-algorithm is designed to perform a certain task of *perfecting*  $\pi$  ([1]: p22) as much as the Calculus of Infinitesimals seeks

to perfect a spatial location to a zero point or thereabouts (depending on how that algorithm is defined).

- 6.5 In that perfecting process, the description of particles and their characteristics in regard to the time-algorithm (phi-quantum wave-function) become manifest, all central to the concept of time seeking time-point relativity in an infinite “0” expanse of 3-d space, calculated from the time-algorithm itself, namely 3-d space ([1]: p22).
- 6.6 Despite the time-algorithm (as the phi-quantum wave-function seeking  $\pi$ , as per the TSET level) being a quantum process, owing to the need to uphold the entropic>enthalpic condition (5.11), the TSEC/TSET level was required, necessitating the elementary particles on that TSET level and thence the proposal for the mass gap, the mass gap being the difference between the lightest particle and the vacuum of space as a value of  $\Delta = 1.5 \cdot 10^{-37} kg$  (5.10.1).
- 6.7 As a complete description of physical reality, Temporal Calculus abides with what is allowed by the human perception ability ([1]: p12-13) and what can be locally proven to exist, not what is conjectured to exist through computer-enhanced and thus biased mathematical modelling operating under the constraints of the expectations of its programmers.
- 6.8 As such, Temporal Calculus is not in violation of either local or unbiased cosmological data, despite the fact that the process of cosmology theory has become entirely mathematical as a theoretic device in the absence of physics being able to make local assessments of the phenomena taking place (given the vast distances involved and the human inability to travel to that region being modelled).
- 6.9 As much as with particle physics in there being no way of precisely defining the status of a particle using differential (including partial) mathematical models and associated bespoke algorithms, there is no way ultimately of proving a cosmological model by that same process; what cosmology has caught itself in is mathematics trying to explain what the theory of the stars and astral phenomena *should* be according to the programmers of the computers used to capture that data (and thus according to what is sought for in the programming of that computer data analysis of the light from the stars), simply because it is not yet possible to prove physically what is happening locally in the stars, not yet, as compared to what physics can more readily examine and prove locally.
- 6.10 Temporal calculus, in deriving all the required equations of standard locally proven physical phenomena ([1]: p20-22, p29-32, p45), using the alternative (temporal) pathway to the inertia and momentum characteristics of an object in motion, in rather focussing on the relationship between time and space alone as an a-priori, while then deriving the mass gap value ([25]: p51, eq10) and associated particle characteristics (QCD, QFD) of that level ([25]: p48, fig15) is not in error of what is considered as complete, as much as what is complete *is presented as completely as*

*possible (with all required references of proof)* as a solution to a proposed problem, the problem of the day being the “Yang-Mills existence and mass gap” problem.

## 7. Conclusion

The particle Aether threw mathematics a curveball, creating a mathematically based particle understanding for physics which later via the Michelson-Morley experiment proved to be baseless. If physics executed a fundamental miscalculation, it is *by not* redefining time and space with mathematics at the time the particle aether was dismissed, a then-required re-examination of the mathematical principles for time and space (3.6).

By creating the required terms and associations related to the dimensional mechanics of time and space and then comparing that mathematical outcome of such dimensional mechanics to known phenomena, known phenomena that can be proven to perform as a certain data measurement according to certain specified equations central to that data measurement, Temporal Calculus has become a greater mathematical set to the classical system of inertial/momentum analysis of particles, given the same phenomena is being described and properly accounted for (data based) arriving at the same equations (as per 5.4.5), thus providing a solution to the asymptotic freedom of elementary particles and what the lightest mass would be as compared to the vacuum of space (mass gap), without corrupting the classical pathways of inertial/momentum analysis. Although the equations of Yang-Mills remain unsolved at energy scales relevant for describing atomic nuclei, Temporal Calculus has shown how the elementary particles themselves give rise to the physics of nuclei and nuclear constituents, as per the calculation of the mass of the electron, proton, and neutron, together with the charge of the electron and proton (as per 5.4.6), all in the context of a time-algorithm, thus providing a solution to a key problem in theoretical particle physics while delivering a mass gap value (5.10.1) confirmed through observed data [7], of course the greater importance to this solution being the relation between EM And G and associated greater efficiencies of mechanical energy utility ([1]: p55-56).

### Conflicts of Interest

The author declares no conflicts of interest; this has been an entirely self-funded independent project.

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