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An outline for a quantum golden field theory

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Abstract

Conventional quantum field theory may be advantageously reformulated in terms of a golden mean based number system. The present short paper is devoted to outlining such a quantum golden field theory.

1. Introduction

Mathematics in some views is nothing but a good system of notations [1]. Somewhat analogously, physics is highly affected by a good or lucky choice of physical units. If all this is true and it is to a large extent true, so what about the role played by number system in mathematical physics [1,2]? The answer is really simple as it is definite: if notations and units are important, the number system we are using is crucial. In fact it is almost everything [2,4].

The golden mean and the golden mean based number system upon which QGFT is based is anything but mystical [2,3]. Human beings may be fooled in doing many things the wrong way, but at least because of the infinite time which nature had to perfect itself, it makes far less mistakes than we do. After all infinity is in the Cartesian philosophy an attribute of the omnipotent. Looking at organic forms for instance as well as many mathematical facts, one finds the golden mean because a golden mean based theory is simply the simplest and most perfect. This is visible every where on the macroscopic level. For the micro cosmos on the other hand, and in an even more profound way, the golden mean seems to dominate in every rational mathematical modeling because it is the very principle upon which nature has constructed itself.

The fundamental role of QGFT may be as trivial or as profound as the following example:

In the not so distant past, engineers, particularly architects, used to make hand sketches of their designs and then give them to an army of assistants and draftsmen to make clear workshop and building site drawings out of these inaccurate conceptual sketches which the executing staff can use to actually build the design. Nowadays, there are computer programs which can do the job much faster and far more exactingly. One, more or less, puts the sketch into the left side of the computer only to find the exact drawing coming out automatically from the right side.

The present QGFT could be said to be able to do the same trick. You simply give the results of lengthy, tedious and complex perturbation analysis or a mixture of experimental data put by hand into the theory together with some

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reasonable assumptions and various approximations and presto one is handed back an elegant, concise and frequently exact equation and the corresponding solution [5,10].

Without further ado, we give in the next section some explicit simple examples of how QGFT works [7–14].

2. The high degree of symmetry inherent in the quantum golden field theory (QGFT)

Quantum golden field theory possesses an ultra high degree of symmetry which is manifest in various ways [5,6]. This is particularly clear in the coupling constants as well as the mass spectrum. Let us start by giving various evidences of this symmetry before discussing it in full detail.

2.1. The electromagnetic inverse fine structure constant is $\bar{\alpha}_0 = (20)(1/\phi)^2 = 137.0820393$ where $\phi = \sqrt{5} - 1)/2$ is the golden mean, but at the same time, the expectation number of the particles of a minimally extended standard model is $\bar{\alpha}_0/2 \cong 69$ particles [6–11].

2.2. The inverse coupling constant of a super-symmetric unification of the fundamental forces is $\bar{\alpha}_{gs} = 26 + k = 26.18033989$. However, the instanton number of the manifold constituting the bulk of our E_8E_8 is also $26 + k$. At the same time the Euler characteristic of the very same manifold which is a Fuzzy Kähler K3 manifold is $\chi = 26 + k$ [5,6].

2.3. The symmetry of the quantum golden field theory goes as far as embracing the transfinite version of heterotic superstring theory. Thus the dimensional hierarchy and a great deal more of this theory may be generated using the golden mean scaling exponent ϕ starting from $\bar{\alpha}_0/2$ which is the inverse electromagnetic fine structure constant of a Cooper pair [7]

$$\left(\frac{\bar{\alpha}_0}{2}\right)(\phi) = 42 + 2k \simeq 42$$
$$\left(\frac{\bar{\alpha}_0}{2}\right)(\phi)^2 = 26 + k \simeq 26$$
$$\left(\frac{\bar{\alpha}_0}{2}\right)(\phi)^3 = 16 + k \simeq 16$$
$$\left(\frac{\bar{\alpha}_0}{2}\right)(\phi)^4 = 10 \equiv 10$$
$$\left(\frac{\bar{\alpha}_0}{2}\right)(\phi)^5 = 6 + k \simeq 6$$
$$\left(\frac{\bar{\alpha}_0}{2}\right)(\phi)^6 = 4 - k \simeq 4$$

Now 42 is the integer value of the inverse super-symmetric unification, 26 is the spacetime dimensionality of bosonic string theory. The 16 is the additional extra bosonic dimension of the heterotic theory of *D*. Gross or the Yukawa coupling. The 10 is the exact number of super symmetric string theory or $\bar{\alpha}_3 + \bar{\alpha}_4 = 9 + 1 = 10$ of the exact inverse coupling $\bar{\alpha}_S = 8 + 1 = 9$ and where $\bar{\alpha}_4$ is the inverse coupling of the Planck mass to the Planck Aether [7–10].

Furthermore, we have 6 as the dimension of the compactified sector of super strings spacetime, when modeled by an orbit field or a Calabi-Yau manifold. It is also the number of particles and anti particles when the generation number is 3 for each quark and lepton family [7–14].

2.4. It is highly interesting to note that if we conjecture that 26 is the number of bosons and 42 is the number of fermions in a minimally extended super-symmetric standard model, then the total number would be $26 + 42 = 68$ almost equal to the exact value $\bar{\alpha}_0/2 = 69$. However, we know that the number of fermions discovered so far is 48 and the number of bosons is 12 which together add up to a total of $48 + 12 = 60$. In other words, a minimum of 8 and a maximum of 9 particles should be still found for a minimal consistent standard model. In this case, we have to say why we have 42 fermions and not 48. Our explanation is that at least 6 from the 8 gluons some time transmute to quarks and vice versa. Noting that we have a minimum of 68 particles rather than the 60 discovered so far, then we could say that all the 8 and not only 6 of the gluons could transmute to quarks so that the demarcation between fermions and bosons is rather fuzzy at this point. In fact various golden quantum field analyses indicate that our minimally extended model will have 49 fermions and 19 bosons making a total minimum of $49 + 19 = 68$ elementary particles. The 19 bosons could be our classical $|SU(3)SU(2)U(1)| = 12$ plus a Higgs field with 8 degrees of freedom plus one graviton, so that the total is $12 + 8 + 1 = 19$. This number happens to be exactly equal to $b_2^- = 19$ of $K3$ Kähler which is a fundamental cohomology information as discussed elsewhere [13].

We could go on mentioning virtually dozens more of similar facts indicating the ultra high symmetry of the QGFT, but we will stop at this point and return to our basic question which is why QGFT is that efficient [7–14]?

3. New formulation of old problems using QGFT and the corresponding exact solution

The beta function based first loop renormalization equation may be found in countless textbooks on the subject. One may ask why the beta function does not feature in QGFT. The answer is that it does but very indirectly. To explain the point, let us recall that the beta function [1]

$$B(m,n) = \int_0^1 x^{m-1}(1-x)^{n-1}\,\mathrm{d}x$$

can be defined in terms of a gamma function

$$B(m,n) = \frac{\Gamma(m)\Gamma(n)}{\Gamma(m+n)}$$

On the other hand, a gamma function is a generalization of the factorial function $n!$ to a non-integer n. In this way, the scaling properties of the beta function, which is essential for gauge invariance, is extended to the rational and irrational dimensions. However, such scaling is taken care of automatically in the transfinite spacetime geometry and topology of E-Infinity via the so-called transfinite correction terms. In QGFT we have therefore used the notion of simple and exceptional Lie groups where perturbation and factorial functions are basic tools and extended them to the non-integer and irrational domain. Proceeding that way, one finds some truly fascinating simple connections between $\bar{\alpha}_i$ of the electro weak and $D^{(10)}$ of string theory namely [5,6]

$$D^{(10)} = \sqrt{\sum_{i=1}^{4} \bar{\alpha}_i} = 10$$

where

$$\bar{\alpha}_1 = 60,\ \bar{\alpha}_2 = 30,\ \bar{\alpha}_3 = 9 \text{ and } \bar{\alpha}_4 = 1$$

In addition, one finds the exact theoretical value of $\bar{\alpha}_0$ as

$$\bar{\alpha}_0 = (1/\phi)(\bar{\alpha}_1) + \bar{\alpha}_2 + (\bar{\alpha}_3 + \alpha_4) = (1.1618033989)(60) + 30 + (9+1) = 137 + k_0 = 137.082039325$$

where $k_0 = \phi^5(1-\phi^5)$ and $(1/\phi)$ plays the role of $C^2 = 5/3$ in the classical Q.F.T. [5,6].

From the preceding result it is almost a trivial matter to harmonize the classical renormalization equation and generalize it to encompass both the non-super-symmetric and the super-symmetric cases [5,6]

$$\begin{bmatrix} \bar{\alpha}_{\mathrm{g}} \\ \bar{\alpha}_{\mathrm{gs}} \end{bmatrix} = (\bar{\alpha}_3 + \bar{\alpha}_4) + \rho_{1,2}\left(\ln\frac{M_{\mathrm{u}}}{M_z}\right) = (\bar{\alpha}_3 + \bar{\alpha}_4) + \begin{bmatrix} 1 \\ 1/2 \end{bmatrix}(\bar{\alpha}_0)(\phi^3) = 10 + \begin{bmatrix} 1 \\ 1/2 \end{bmatrix}(32 + 2k) = \begin{bmatrix} 42 + 2k \\ 26 + k \end{bmatrix}$$

where $\bar{\alpha}_{\mathrm{g}}$ and $\bar{\alpha}_{\mathrm{gs}}$ are the inverse non-super-symmetric and super-symmetric unification coupling constant, respectively and $k = \phi^3(1-\phi^3)$.

The result is exact and the reader is strongly advised to follow the standard analysis and perform the detailed calculations to judge and ascertain for himself what a golden mean harmonization could do. Incidentally, renormalization group used by M. Feigenbaum is undoubtedly behind the discovery of the Feigenbaum universalities and was partially a source of inspiration for E-Infinity theory. In fact, we willingly admit that without the development of nonlinear dynamics and deterministic chaos, QGFT could not have been possible.

It is definitely instructive and essential for understanding to mention some details of our harmonization procedure.

As an example let us consider the vital logarithmic term. Setting $M_{\mathrm{u}} = (10)^{16}$ GeV and M_{z} at $M_{\mathrm{z}} = 91$ GeV, we see that [5,6]

$$\ln\left(\frac{(10)^{16}}{91}\right) = 32.33050198$$

Now anyone with little experience with the golden mean system will notice immediately, with a probability bordering on certainty that the correct value must be $32 + 2k = 32.6067977$. The slight difference is surely due to the inaccuracy of the experimental measurement of $M_z = 91$ GeV as well as inaccuracy in our estimation of the unification energy scale $M_u = (10)^{16}$ GeV. Together with the exact theoretical value of the $\bar{\alpha}_i$ electroweak coupling, the harmony becomes perfect and the value

$$\bar{\alpha}_g = 42 + 2k$$

and

$$\bar{\alpha}_{gs} = 26 + k$$

follows elegantly and naturally. For a determination of $\bar{\alpha}_{gs} = 26 + k$ using J. Nash's Euclidean embedding see Appendix.

An important point which should not escape our attention is that $\rho = 1/2$ instead of $\rho = 1$ is the only difference between the super-symmetric and the non-super-symmetric renormalization equation. Thus 1/2 is due to the doubling of the number of particles in the case of adding the super-symmetric partners. Since we are writing in terms of the inverse coupling, we must first divide by 2 rather than multiply by 2. It is then normal that one asks why it is not as simple as it is in the classical theory. The answer is the perturbation. It is not simply a matter of a factor 1/2 when using a perturbation theory involving a special function, such as the Beta function. This is why QGFT is considerably simpler in handling all these aspects.

Let us attempt to validate the above result using physically motivated approximate estimation of $\bar{\alpha}_{gs}$ and $\bar{\alpha}_g$. Pondering the deep meaning of $\bar{\alpha}_{gs}$, we come to the conclusion that it is nothing but the logarithmic scaling of the square root of the coupling between the Planck mass $m_p = (2)^{(127/2)}$ GeV $= (1.3)(10)^{19}$ GeV and the electron mass $m_e \cong 0.511$ Mev. In other words [5,6]

$$\bar{\alpha}_{gs} \simeq \frac{1}{2} \ln \frac{m_p}{m_e} \simeq \frac{1}{2} \ln \left(\frac{2^{63.5}}{0.000511} \right) \simeq \frac{1}{2} (51.59398613) \simeq 25.79699 \simeq 26$$

This is in reasonably good agreement with our exact results.

In the case of the non-super-symmetric coupling, the electron scale remains the same but the Planck mass must be replaced by 'tHooft-Polyakov monopole $M_u \simeq \sim(10)^{16}$ GeV and the factor 1/2 must be replaced by unity.

Consequently one finds [5,6]

$$\bar{\alpha}_g \simeq \ln \frac{M_u}{M_e} \simeq \ln \left(\frac{(10)^{16}}{0.000511} \right) \simeq 44.4205$$

This is not as good an approximation as in the super-symmetric case but it is not that bad either when we consider the simplicity of the analysis and that the exact result is 42.236.

To conclude this section, we give the final result generalizing our renormalization equation to include the electromagnetic inverse fine structure constant $\bar{\alpha}_0$ as well as $\bar{\alpha}_{GUT}$ and $\bar{\alpha}_{ew}$. These are given simply by

$$\begin{bmatrix} \bar{\alpha}_0 \\ \hline \bar{\alpha}_{GUT} \end{bmatrix} = (\bar{\alpha}_2 + \bar{\alpha}_3 + \bar{\alpha}_4) + \begin{bmatrix} 3 \\ 2 \end{bmatrix} \ln \frac{M_u}{M_z} = 40 + \begin{bmatrix} 3 \\ 2 \end{bmatrix} (32 + 2k) = \begin{bmatrix} 137 + k_0 \\ 104 + 4k \end{bmatrix}$$

and

$$\begin{bmatrix} \bar{\alpha}_0 \\ \bar{\alpha}_{ew} \\ \bar{\alpha}_{GUT} \end{bmatrix} = \begin{bmatrix} 4 + \phi^3 \\ 4 \\ 3 + \phi^3 \end{bmatrix} \left(\ln \frac{M_u}{M_z} \right) = \begin{bmatrix} 4 + \phi^3 \\ 4 \\ 3 + \phi^3 \end{bmatrix} (32 + 2k) = \begin{bmatrix} 137 + k_0 \\ 128 + 8k \\ 104 + 4k \end{bmatrix}$$

all in excellent agreement with the experimental and numerical results quoted in the literature [4–14].

4. Connections between QGFT, exceptional Lie symmetry groups and stein spaces

A major feature of QGFT is the intimate connection to the exceptional Lie symmetry groups as well as one and two stein spaces hierarchy. The first hierarchy (see Appendix for details) leads to [15]

$$\bar{\alpha}_0 = \left(\frac{1}{5}\right)\sum_{1}^{12}|E_i| = \left(\frac{1}{5}\right)(685) = 137$$

where $|E_i|$ is the corresponding exceptional Lie group dimension. For instance, $|E_8| = 248$, $|E_7| = 133$ and so on when ignoring the transfinite corrections. The second hierarchy (for details see Appendix) leads to [16]

$$\bar{\alpha}_0 = \frac{1}{5}\left[\sum_{1}^{17}\mathrm{Dim(Stein)}|^{1,2} - 1\right] = \frac{1}{5}(686-1) = \left(\frac{1}{5}\right)(685) = 137$$

At first sight, the whole thing seems almost incredible but it is not. It is most natural for the following reasons: Everything, the entire universe, emerges from vacuum fluctuation. The Vague Attractor of Kolomogorov, i.e. the VAK of this vacuum fluctuation has combined two contradictory properties, namely chaos and order [18]. Thus although it is a sum or super position of infinitely many random sets, it has a deep symmetry. We call this chaotic symmetry average symmetry. The dimension of this average symmetry depends on the resolution of observation. Starting from total unification down to electromagnetism, an important expectation value is $\bar{\alpha}_0$. Remarkably in 4D we find that

$$\bar{\alpha}_0 = \frac{1}{4}(548) = 137$$

where 548 is the total sum of the dimensions of certain exceptional and unification symmetry groups as given in the appendix [15].

In 5D a similar result (see Appendix) is easily found using [15]

$$\bar{\alpha}_0 = \frac{1}{5}(685) = 137$$

It is remarkable that the exact theoretical value $\bar{\alpha}_0 = 137 + k_0 = 137.082039325$ consists of two parts. The prime part 137 and the transfinite part $k_0 = \phi^5(1-\phi^5) = 0.082039325\ldots$ The experimental value of $\bar{\alpha}_0$ is found on the other hand by projection

$$\bar{\alpha}_0(\mathrm{ex}) = (\bar{\alpha}_0 - k_0)/[(\cos(\pi/\bar{\alpha}_0)] = 137.0359852$$

The almost exact agreement with the most accurate experimental result shows that the Beta function is nothing but a substitute albeit a non exact one for the transfiniteness of E-Infinity spacetime. Our method, i.e. golden mean partial reformulation of QGFT automatically takes care of the rescaling which is a logarithmic one in the classical QGFT This logarithmic scaling appears also in a proposal due to E. Teller. Thus our new theory which predicts absolute confinement of quarks [17] does not do that by discovering a different sign of the Beta function.

So far we have not considered explicitly the paramount role of randomness. The role of Monte Carlo simulation in QCD is well known. What is less well known is that the success of the work of Prof. C. Beck of Queens Mary College, London, England in finding the mass spectrum is not due to a dissimilar reason. We all know the supposedly mysterious relation between prime numbers and quantum chaos. It is all based on more or less the same facts illustrated by the three and four points chaos game [18]. The roots of quantum indeterminism lie in deterministic chaos. Consequently, our highly symmetric and at the same time chaotic system is exactly what is required by Q.C.D as the epitome of non-Abelian gauges theories of high energy physics.

5. Conclusion

It is virtually impossible to imagine our modern scientific achievement and the resulting vast technological progress if we would not have had the good sense of replacing the roman number system by our present decimal system based on Arabic numbers and the introduction of a special symbol for the size of the empty set, i.e. the zero. In fact the word number in German, i.e. Zifferen derives almost directly from the word Sifr which means zero in Arabic [1]. A zero is not "nothing". In fact it is something.

Few years ago one of my graduate students, Mr. Mahrus Ahmed [2], originally from Upper Egypt, conveyed to me his belief that the remarkable success of E-Infinity Cantorian spacetime theory in solving exactly many highly complicated problems in high energy physics may be traced back to the fact that the theory unconsciously has introduced a new number system to physics [3–5].

This number system Mr. Mahrus believed it to be what he labeled the golden mean binary. Of course, the author knew about various theorems showing that any number could be expressed rather neatly using certain golden means and Fibonacci sequences [3]. However, the author met Ahmed's proposition with the usual skepticism of a supervisor toward his supercilious students. On reflection and after a long time of deliberation, Mr. Mahrus' explanation seems to me extremely rational and to the point.

In the present work we gave further fundamental examples and yet more economical and elegant formulations of the equations of quantum field theory renormalization group using the new golden mean number system [3] which Mahrus Ahmed [2] must be regarded as the first one to propose explicitly. Developing these ideas was subsequently the beginning of what Scott Olsen has called "golden physics" [4].

Appendix A

The total dimension of $|E_i|$ from $i = 1$ to 12 is given by the sum of the following subgroups made of exceptional Lie symmetry groups, quasi exceptional Lie groups and unification groups:

$$\sum_{n=4}^{n=8} |E_n| = |E_4| + |E_5| + |E_6| + |E_7| + |E_8| = 24 + 45 + 78 + 133 + 248 = 528$$
$$528 + |\overline{SM}| + |H| = 528 + 12 + 8 = 548 = (4)(137)$$
$$548 + |D_4| = 548 + 28 = 576 = (8)(72)$$
$$576 + |F_4| + |G_2| = 576 + 52 + 14 = 642$$
$$642 + |E_{6(2)}| + |SU(2)| = 642 + 40 + 3 = 685 = (5)(137)$$

Thus summing up the dimensions of these 12 Lie Symmetry groups yields $685 \simeq (5)(\bar{\alpha}_0)$.

Alternatively, we could replace $|E_{6(2)}| = 4$ and $SU(2) = 3$ by $|E_{6(6)}|$ and $U(1) = 1$ and find the total value 685.

Similarly, the sum of the dimensions of the seventeen one and two stein spaces may be found as the total sum in the following table:

A_2^R	5
$D_4^{R,4}$	16
$D_4^{R,3}$	15
$D_4^{R,2}$	12
A_3^H	14
$G_{2(2)}$	8
$F_{4(4)}$	28
$E_{6(-26)}$	26
$E_{6(-14)}$	32
$E_{6(2)}$	40
$E_{6(6)}$	42
$E_{7(-25)}$	54
$E_{7(-5)}$	64
$E_{7(7)}$	70
$E_{8(-24)}$	112
$E_{8(8)}$	128
$D_6^{R,2}$	20
Total	686

Next we use Nash's Euclidean embedding formula to find $\bar{\alpha}_{gs} \simeq 26$. Thus from

$$D = \frac{n}{2}(3n + 11)$$

and taking n to be the Hausdorff dimension of the deterministic fractal model of 3D spacetime namely, the Menger sponge

$$n = \ln 20 / \ln 3$$

one finds

$$D = \frac{\ln 20}{2\ln 3}\left(3\frac{\ln 20}{\ln 3} + 11\right) = 26.1510092$$

This result can be made exact by transfinitely continuing Nash's formula to

$$D = \frac{n}{2 + (k/10)}([(3 + \phi^3)n + (11 + 3\phi^3)]$$

Setting $n = 2 + \phi$ one finds

$$D = 26 + k = 26.180330989$$

exactly as should be.

We note that $\bar{\alpha}_{gs}$ could also be determined in an extremely elementary manner using the exact theoretical values of the electroweak $\bar{\alpha}_1 = 60, \bar{\alpha}_2 = 30$ and $\bar{\alpha}_3 + \bar{\alpha}_4 = 10$

$$\bar{\alpha}_{gs} = \sqrt[3]{(60)(30)(10)} = 26.20741394$$

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