Available online at www.sciencedirect.com
ScienceDirect
Chaos, Solitons and Fractals 31 (2007) 782–786
CHAOS SOLITONS & FRACTALS
www.elsevier.com/locate/chaos

E-Infinity theory and the Higgs field

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Accepted 26 April 2006

Abstract

E-Infinity theory predicts nine more elementary particles to be discovered in a standard model including the Higgs bosons. In addition a Higgs field is supposed to endow the particles with mass. This field must interact with the three nongravitational forces, i.e., the electromagnetic force, the weak force, and the strong force, therefore we could have four spin zero massive Higgs particles, namely two neutral ($H_W^{(0)}$ and $H_S^{(0)}$) and two charged (H^+ and H^-), all a part from the spin 2 massless graviton. Considering the possibility of fractional charge, we might have four additional quasi-particles ($H^{+1/3}$, $H^{-1/3}$, $H^{+2/3}$ and $H^{-2/3}$) similar to what we have in quantum fractional Hall effect. This makes nine possible particles all together without including any supermetric partners.

1. A brief introduction to El-Naschie's *E*-infinity theory

We start by explaining what we consider to be possibly an epoch-making theory, namely the infinite dimensional Cantorian spacetime *E*-infinity proposal [3–32]. First let us make a careful inspection of Einstein's field equation

$$R_{ij} - \frac{1}{2} g_{ij} R = -K T_{ij} \quad (1)$$

where R_{ij} is the Ricci tensor, T_{ij} the energy–momentum tensor, K a coupling constant and g_{ij} the metric tensor.

On the right hand side of Eq. (1) we have the mass tensor. According to Einstein's famous formula $E = mc^2$, matter and energy are by virtue of the special relative equivalent. However, energy on a fundamental level obeys Planck's quantum, so at quantum scale, the right hand side of Eq. (1) becomes quantized discrete, while the left hand side of the equation is still continuous. Thus at quantum scale, Einstein's spacetime must become discrete in the sense of quantum mechanics, resembling a stormy ocean due to quantum fluctuation or the equation would be extremely limited.

The problem in Einstein's field equation can be eliminated using El-Naschie's *E*-infinity theory [3], which regards discontinuities of space and time in a transfinite way. Introducing a new Cantorian spacetime, El-Naschie admitted formally an infinite dimensional "real" spacetime, which is hierarchical in a strict mathematical way.

Let us consider first the classical triadic Cantor set in *n*-dimensional space, and write down the following Hausdorff capacity dimensions using the bijection formula $d_c^{(n)} = (1/d_c^{(0)})^{n-1}$ in the case of orderly Cantor set. That way we find:

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0960-0779/$ - see front matter
doi:10.1016/j.chaos.2006.04.041

$$d_c^{(0)} = \ln 2/\ln 3 = 0.6309297536$$
$$d_c^{(1)} = 1$$
$$d_c^{(2)} = \ln 3/\ln 2 = 1.584962501$$
$$d_c^{(3)} = 2.512106129$$
$$d_c^{(4)} = 3.981594012$$
$$d_c^{(5)} = 6.3106770202$$
$$d_c^{(6)} = 10.00218672 \simeq 10$$
$$d_c^{(7)} = 15.85309687$$
$$\vdots$$

Note that for $n = 6$ we have $d_c^{(6)} \simeq D^{(10)} = 10$ the dimension of the conventional super string theory while $D^{(6)} = 6$ is the dimension of the compactified sector.

It is also obvious that at low resolution or equivalently at low energy, we have $d_c^{(n)} \approx n$ only when $n = 4$. That indicates that Cantorian spacetime mimics the appearance of our four dimensional spacetime manifold. We also have $d_c^{(n)} \gg n$ when $n > 4$. It is only when $n = 4$ that we have a quasi ergodic behaviour for which $d_c^{(4)} = 3.981 \approx 4$. We can say that for $n < 4$ our "world" set is stable; while $n > 4$ the set is totally unstable, in fact, chaotic and makes the transition from classical mechanics to turbulence and special forms of statistical mechanics which we call quantum mechanics. Thus spacetime is inherently Cantorian structure at the small scale, or equivalently at high energy resolution. We note that in the case of random Cantor set $d_c^{(0)} = \phi = (\sqrt{5} - 1)/2$ we find $d_c^{(4)} = 4 + \phi^3 = 4.236067977$.

We note further that the expectation value of the Hausdorff dimension is given by the same expression as Connes noncommunicative geometry [31,32].

$$[M : N] = \frac{1}{\lambda} + \frac{1}{1 - \lambda}$$

where the index $[M{:}N]$ of N in M can be expressed as $[M{:}N] = \dim_N(L^2(M))$ and $\lambda = \mathrm{TrM(e)}$. Setting $\lambda = d_c^{(0)} = \phi = (\sqrt{5} - 1)/2$ we find the familiar E-infinity dimension to be

$$\sim \langle n \rangle|_\phi = [M : N]_\phi = \frac{1}{\lambda(1 - \lambda)} = \langle d_c \rangle = \frac{1}{d_c^{(0)}(1 - d_c^{(0)})} = \frac{1}{\phi(1 - \phi)} = 4 + \phi^3 = 4.236\cdots \approx 4$$

Thus Einstein's four-dimensional spacetime may be considered to be only an approximation valid only for the large structure of spacetime.

The spacetime dimension formula may be represented schematically as follows:

$$\textit{Dimension} = 3 \quad + \quad 1 \quad + \quad \phi^3 = 4.236\cdots$$

Newton *F=ma (time is only a flying parameter)*

Einstein $E = mc^2$ *(space and time are assumed to be abstractly continuous)*

El-Naschie $\sim\langle n \rangle = 4 + \phi^3$ *(Space-time becomes transfinitly Cantorian)*

2. El-Naschie mass formulation for elemental particles

Using E-infinity theory, El-Naschie suggested a scaling procedure based on the hyperbolic Klein modular curve projection of $\varepsilon^{(\infty)}$ which can accurately estimate the mass of an elementary particle. The quintessence of the procedure is incapsulated in the following formula [4,6–9,11,34]

$$m_k = \lambda_k m_0 \tag{2}$$

where m_0 is a reference mass, which could be taken to be the mass of electron, m_k is the mass of a certain particle whether elementary or composite, λ_k is the scaling parameter.

In El-Naschie's spacetime, the scaling parameter λ_k depends upon its hierarchical structure, therefore it must be a function of the Golden mean [3] exactly as the dimensional function of Connes' noncommutative geometry [1] as well as von Neuman continuous geometry [35]:

$$\lambda_k = \lambda_k(\phi) \tag{3}$$

To illustrate the remarkable accuracy of El-Naschie's predictions, we can write down the mass of the mesons $m_{\pi^\pm}$ and m_{π^0} as scaling of the mass of the electron [3]

$$m_{\pi^\pm} = \lambda_{\pi^\pm} m_e = (2\bar{\alpha}_0 - 1)m_e = 139.58 \text{ MeV}$$
$$m_{\pi^0} = \lambda_{\pi^0} m_e = (2\bar{\alpha}_0 - 10)m_e = 134.987 \text{ MeV}$$

which are in excellent agreement with the experimental evidence, and thus may be regarded as an indirect verification of *E*-infinity theory. Hereby $\bar{\alpha}_0$ is the El-Naschie's inverse electromagnetic fine structure constant which is determined from the expectation value of *E*-infinity spacetime Hausdorff dimension:

$$\bar{\alpha}_0 = 20\,\text{DimSO}(4+\phi^3) = 20(4+\phi^3)(4+\phi^3-1)/2 = 137.082039325$$

where the dimension of SO(n) is given by DimSO(n) = $n(n-1)/2$.

Note that SO(32) = 496 is used in Heterotic string theory and that SO(10) is used for Grand unification.

Subsequently the number of particles is found using *E*-infinity theory to be [20]

$$N = \bar{\alpha}_0/2 \approx 69$$

This result remind us of a similar one due to Dyson [2].

Since we know that we have already 60 experimentally confirmed particles, then there are still nine particles missing [20,28,29].

At the point of unification of all fundamental forces implied by SO(32) and $E_8 \otimes E_8$ Heterotic string theory (i.e., at the scale of quantum gravity) and in view of *E*-infinity theory, the electromagnetic force, the weak force, the strong force as well as gravity are all equivalent and indistinguishable forces [1–5].

The gravitation force can thus be expressed as follows:

$$F_m = G\frac{m_1 m_2}{R^2} \tag{4}$$

The electrostatic force for two charged particles reads

$$F_q = k\frac{q_1 q_2}{R^2} \tag{5}$$

According to the unification theory for all fundamental forces, we have therefore

$$q = \lambda_q m \tag{6}$$

or

$$m = \lambda_m q \tag{7}$$

where λ_q and λ_m are scaling parameters. This is similar to the discovery of Montonen and Olive [33] that electrons, monopoles and doyens obey a relation connecting the particle mass to its change by

$$M^2 \geqslant c^2(q_e^2 + q_m^2)^{1/2} \tag{8}$$

where q_e and q_m are the electrical and magnetic charges respectively, and c is a constant.

Eq. (6) or (7) indicates that electric charge means matter.

Now we postulate a particle with mass M, or with charge Q. Around this particle a force filed is induced, which can be expressed as

$$E = \lambda_F M \tag{9}$$

or

$$E = \lambda_Q Q \tag{10}$$

where E is the force field, λ_Q and λ_m are scaling parameters.

Thus the force acting on the two particles or two charges is given by

$$F = \lambda_F Mm \tag{11}$$

This is a generalized force expression to include all gravitational and nongravitational forces.

3. Higgs force fields

It is conceivable that there might be four interacting Higgs-like fields which generate mass. These are: the electromagnetic Higgs field, the weak Higgs field, the strong Higgs field as well as gravitational field represented indirectly by the original Higgs field. Accordingly we should have at least five particles: three neutral Higgs particles $H_{\mathrm{W}}^{(0)}$, $H_{\mathrm{S}}^{(0)}$ and $H_{\mathrm{G}}^{(0)}$, where the subscriptions denote Higgs in weak field, strong field and gravitation field respectively, and two charged Higgs particles H^{+} and H^{-}. Considering fractional charge, we might have $H^{+1/3}$, $H^{-1/3}$, $H^{+2/3}$, $H^{-2/3}$, so that all in all we have nine particles, which are yet to be discovered.

In the electromagnetic Higgs field, the mass of neutrinos (e—neutrino, μ—neutrino and τ–neutrino) must be approximately zero: $m_{\text{neutrinos}} = \lambda_{\mathrm{m}} q_{\text{neutrinos}} = 0$. Similarly in gravitational field, the mass of photon is zero. However participant in the strong Higgs field must have much heavier mass and the same might happen in a mini Black Hole.

4. Discussion

(1) If we regard the Higgs field, we see that it has eight degrees of freedom. They could be all or some of them particles. At present we think five may be particles of the Higgs type and the other three do not appear directly as any kinds of particles.
(2) The Higgs field is a substitute for gravity, but is not gravity.
(3) The standard model, strictly speaking, neglects gravity.
(4) Only when calculating the number of particles using a string-like theory, then gravity is implicitly included. For instance we know that the super Yang-Mills spectrum is found from a multicative operation to be $(\mathrm{Dim} E_8 \otimes E_8)(8) = (496)(8) = 3968$ particle-like states. This must include a graviton because it is related to Heterotic super string theory and $E_8 \otimes E_8$. Therefore in the sub Yang-Mills theory we use the opposite division operation which is equivalent to the standard model leading to $(\mathrm{Dim} E_8 \otimes E_8)/8 = 62$. This may be interpreted as the 60 experimentally found particles plus 1 Higgs plus 1 Graviton. However there are other possible scenarios predicting 66 and a maximum of 69 particles. These and various other possibilities are discussed in [7,23–26].
(5) Electric charge means matter, and the electromagnetic force, the weak force, the strong force as well as gravity are all equivalent and indistinguishable forces within a theory of total unification of all fundamental forces such as E-infinity theory.

5. Conclusions

El-Naschie–Tanaka mass formula, Eq. (2), implies the unification of all fundamental forces. The prediction of Eq. (2) agrees excellently with experiments, which amounts to a strong evidence of the physical reality of E-infinity theory. Based on this theory the maximum number of elementary particles in a minimally extended standard model is 69 which may include eight Higgs particles. However the most likely scenario is that we will find either only one or five Higgs particles corresponding to a total of 62 particles or 66 particles respectively where we have included one graviton.

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