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Hypothetical Dark Matter Explains the Origin of Subatomic Universe: FEP-Theory

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Abstract

Although the standard model provides a suitable pattern based on observable experimental data, it cannot explain dark matter, gravitation, the structural nature of the fundamental particles, and charges. In this paper, a new theory about the nature of charges, particles and proposed structures for atoms were presented. This theory explains how an ideal quantum fluid (IQF) including hypothetical dark matter or fundamental elementary particles (FEPs) can produce the building blocks of matter. This theory describes quadruple blocks with two types of independent charges that can create different characteristics for these building blocks. Quadruple blocks have similarities and differences with the fundamental particles in standard model. This theory also explains the possible mechanism of creation the next generation of particles such as protons and neutrons.

Keywords

Theory, Statistical Thermodynamics, Ideal Quantum Fluid, Fundamental Elementary Particles

1. Introduction

The Standard Model (SM) of particle physics is known as the most advanced and promising theory which successfully describes the interactions of elementary particles with three fundamental forces (weak, strong, and electromagnetic), however, excludes the gravitation force [1]. Actually, while the three fundamental forces have been well-described in the SM, three phenomena of gravity, dark matter, and the sudden appearance of "virtual particles", and also their relations still remain unresolved [2] [3]. In quantum electrodynamics (QED), the most rigorously tested quantum field theory of the SM, all phenomena regarding the interaction of charged particles are precisely predicted using exchanging photons [4] [5].

The "virtual particles" have been introduced by the QED as the quantum vacuum fluctuations [6] to describe interactions between fundamental particles. Despite the common use of virtual particles in quantum mechanics, the concept that particles can arise from vacuum electromagnetic fluctuation is not well understood [2]. Therefore, unanswered questions, such as whether it is possible for particles to appear from emptiness, are raised. This does not mean that virtual particles are not real, but that they are created by a perturbation in the quantum vacuum [7].

Several theories have been introduced and developed to solve the raised problems. Some theories, such as String Theory or Grand Unifying Theory, tried to unify the fundamental forces beyond the SM. Some other theories tried to introduced hypothetical substructures for elementary particles, including "anyon" [8]-[10], "I-particle" [2], etc., to create a better understanding of the obscure points of quantum physics. This article aimed to introduce new elementary particles which are placed in a quantum fluid (QF), and a perturbation in the QF can create the new particles and charges.

On the other hand, the issue of the dark matter and its gravitational effects is still the focus of scientists' research [3]. Although the dark matter is practically accepted, it has yet to be found experimentally. The dark matter, its gravitational effects, the relation of gravity to the SM, and aforementioned obscure points of quantum physics are the motivation for a theoretical investigation in this paper. Here, the relationship of SM with the nature of charge and matter, and its gravitational properties will be discussed elsewhere. This theory aimed to introduce new elementary particles, as a hypothetical dark matter, which are placed in a QF, and a perturbation in the QF can create the new particles and charges.

2. Fundamental Elementary Particles (FEP)-Theory

2.1. Theory Assumptions

Simple and understandable minimum assumptions are considered to provide a theoretical framework and to justify the formation of fundamental particles and charges. No additional dimensions, fields, various or unknown particles, energy levels, and charges are assumed in this theory. The only assumption of this theory is the existence of Fundamental Elementary Particles (FEPs) with the same energy ε, without any force or field between them. The FEPs play the role of free particles in an ideal quantum fluid (IQF), where FEPs move freely in the IQF.

2.2. Collective Behavior of FEPs

As assumed, there is no force or field between FEPs, so we are looking for particles and charges among the statistical behavior of FEPs in IQF. The possibility of the emergence of new particles and charges from the random and accidental behavior of the FEPs in IQF can be imagined. Such behavior can be classified as the properties of an "independent package" that related to the "collection of particles" and not found in individual particles. In other words, the collective behavior of FEPs, resulting from their distribution, can be the origin of new characteristics that did not exist in the FEPs, and this characteristic and collective behavior can be introduced as a new nature in the world of particles. For example, in a fluid, fluidity is not an independent property, existing in individual particles, but is related to the "collective behavior of particles".

Due to the collective behavior of particles, stationary states or new hypothetical particles (NHPs) can be created during a perturbation process. The principles of statistical thermodynamics can be used to explain the dynamic behavior, states, and new properties of NHPs. These new states (or NHPs), which are described in accordance with mathematical formulas, will bring physical interpretations with new properties. Finally, these properties should be consistent with the empirical and tangible evidence.

2.3. New Hypothetical Particles (NHPs)

2.3.1. Formation and Physical Borders

As assumed, FEPs only have a certain amount of energy (ε) and are unstructured. In out-of-equilibrium systems, the concept of local regularity relates to collective behavior such a typical stationary non-equilibrium state. So, when the system receives a perturbation such as energy, matter or volume, the transport of FEP (or energy) and entropy production between two states are different from zero, while the "resultant transport of matter" is zero. This transformation, as an intermediate state, characterized by an extremum principle such as minimum entropy production. A stationary non-equilibrium state arises when the concentrations of the intermediate components no longer vary with time. So, the correlation between NHPs should be accorded to the "Equilibrium Laws". In other words, the exchange of FEPs can occur independently among the generation of NHPs, but still, this exchange cannot be out of the "Equilibrium Laws". Therefore the system in the "Equilibrium Laws" impose zero change of particle/energy density gradient at the NHPs boundaries. So, in this dynamic equilibrium system, after perturbation, closed cells of FEPs (or NHPs), that are topologically independent, can be imagined (Figure 1). More explanations are presented in the supplementary.

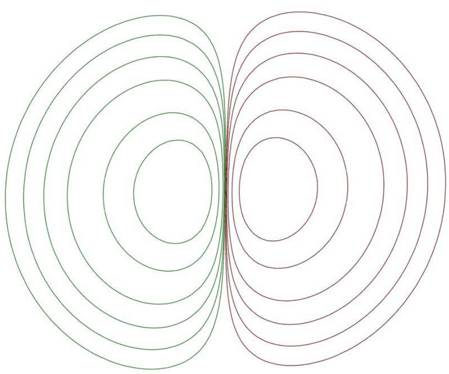

Figure 1. The formation of independent closed cells of FEPs (NHPs).

Since no inherent force is defined in this theory, the stability of these cells (NHPs) without external factors requires scientific reasoning. Therefore, one of the following two situations should be accepted: First: to accept the existence of an external factor, in keeping these cells stable, which requires the introduction of new assumptions. Second: according to the basic assumptions, a mechanism for the emergence of new forces should be presented. The emergence of a new subset of NHPs along with new forces can be described by two independent mechanisms that will provide relatively identical results.

2.3.2. Different States in NHPs

1) Standing wave mechanism:

In these closed cells with stationary non-equilibrium state (NHPs), the stability origin of "non-equilibrium state" is the number of available states of the cells, which is defined by the collective behavior of FEPs. Since each FEP is assigned only a certain amount of energy ε, the change in the number of particles (N) will be the direct change in the energy value of the system.

Therefore, for a number of the FEPs, the microcanonical statistical set of Ω (N, V, E), the partition function can be defined by two variables of N and V, or E and V, in Ω (N/E, V). It should be noted that in equilibrium systems, the steady state, which describes the average quantities, can be characterized with the help of the partition function, but the reality of the outside world is that most of the systems are out of equilibrium. Therefore, physically stable systems or steady states are as a non-equilibrium systems or fluctuations around the equilibrium point.

Changing the parameters N (number of FEPs) or V (primary cell volume), as a kind of shock, can be considered as examples for out-of-equilibrium systems. In these non-equilibrium states, if the cells are shocked by any of the variables of the partition function, a cell, as an environment, can pass the shock as a traveling wave or it can keep it as a standing wave. If two waves with the same amplitude and wavelength move in opposite directions and superimpose each other in an environment, it looks like a wave that has stopped at that place. Therefore, a standing wave can be described in the context of the thermodynamic partition function.

If two waves $W_1(N,t)$ and $W_2(N,t)$, move in two opposite directions, the equation of the first wave is $w_1 = A\sin(kN+\omega t)$ and the second wave is $w_2 = A\sin(kN-\omega t)$, where A and k are constant and N, ω and t are the number of FEPs, angular frequency and time, respectively. If these waves interfere with each other, the resulting wave (**Figure 2**) will be formed as follows:

$$W_t(N,t) = 2A\sin kN\cos\omega t \tag{1}$$

It is a standing wave dependent on the number of particles N that oscillates in its location.

With similar calculations for the variable of V in the partition function Ω (N, V, E), the super positioned function is $w'_t(V,t) = 2A'\sin k'V\cos\omega' t$, where A', k' are constant and V, ω' and t are the volume of NHP, angular frequency and time, respectively. Therefore, due to the two variables N and V, two types of extremum can be imagined in the standing wave function.

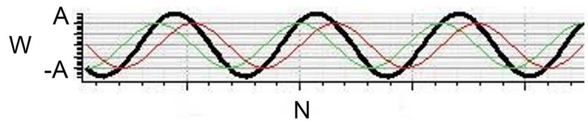

Figure 2. Interfering of two waves with opposite direction. The red wave moves in the negative direction and the blue wave moves in the positive direction. The black wave is a superposition of two waves and it stays in its location and oscillates.

$$W(N,V,t) = w(N,t)w'(V,t) = 2AA'\sin kN\cos\omega t\sin k'V\cos\omega' t \tag{2}$$

One of the characteristics of a standing wave is that it spends most of its time around extremum points. Therefore, for a specific wavelength in the primary traveling wave, four different modes can be imagined for the standing wave. On average, these standing waves will have the highest probability of their presence around extremum points.

State 1: (N_{max} and V_{max}), $\left[\frac{\partial W(N,V,t)}{\partial N}\right]_{V,t} = 0$, $\left[\frac{\partial W(N,V,t)}{\partial V}\right]_{N,t} = 0$, $\left[\frac{\partial^2 W(N,V,t)}{\partial N^2}\right]_{V,t} < 0$, $\left[\frac{\partial^2 W(N,V,t)}{\partial V^2}\right]_{N,t} < 0$

State 2: (N_{min} and V_{min}), $\left[\frac{\partial W(N,V,t)}{\partial N}\right]_{V,t} = 0$, $\left[\frac{\partial W(N,V,t)}{\partial V}\right]_{N,t} = 0$, $\left[\frac{\partial^2 W(N,V,t)}{\partial N^2}\right]_{V,t} > 0$, $\left[\frac{\partial^2 W(N,V,t)}{\partial V^2}\right]_{N,t} > 0$

State 3: (N_{min} and V_{max}), $\left[\frac{\partial W(N,V,t)}{\partial N}\right]_{V,t} = 0$, $\left[\frac{\partial W(N,V,t)}{\partial V}\right]_{N,t} = 0$, $\left[\frac{\partial^2 W(N,V,t)}{\partial N^2}\right]_{V,t} > 0$, $\left[\frac{\partial^2 W(N,V,t)}{\partial V^2}\right]_{N,t} < 0$

State 4: (N_{max} and V_{min}), $\left[\frac{\partial W(N,V,t)}{\partial N}\right]_{V,t} = 0$, $\left[\frac{\partial W(N,V,t)}{\partial V}\right]_{N,t} = 0$, $\left[\frac{\partial^2 W(N,V,t)}{\partial N^2}\right]_{V,t} < 0$, $\left[\frac{\partial^2 W(N,V,t)}{\partial V^2}\right]_{N,t} > 0$

In aforementioned states, attributed of two different waves in systems, two particular characteristics can be introduced. This feature causes that, for example, the first and third states cannot neutralize each other, because it is possible to neutralize the V_{max} in the third state and the V_{min} in the first state, along with the overlapping of the two N_{max} in these states. There is such a reason for the second and fourth states, first and fourth states, and finally between the second and third states. With this possibility, if an intermediate state is located between two states that can neutralize each other (such as the first and second or third and fourth states), two opposing states can be maintained and a cycle of interactions with intermediate states can be imagined. This result can have many effects in justifying the formation of new hypothetical particles (NHPs) with different natures.

Therefore, by joining two types of vibration in the primary system, four new natures in closed cells can be reached, which can remain stable next to each other. For example, we can mention the four new generation particles which are the result of a cycle of interactions between the four mentioned states (**Figure 3**).

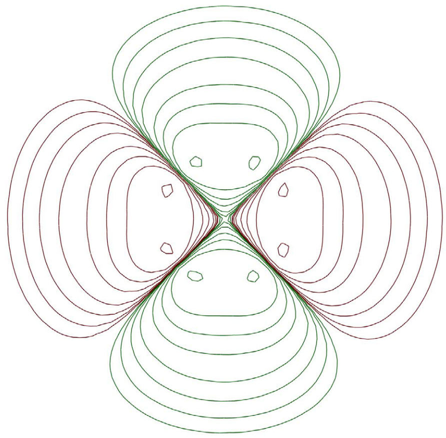

Figure 3. Schematics of four new hypothetical particles (NHPs).

2) Stationary state mechanism

In non-equilibrium thermodynamics, stationary states choose the path with the minimum entropy production (Equation (3)).

$$\frac{\partial \Delta S}{\partial t} = 0 \tag{3}$$

This does not mean the entropy change equal to zero, but rather choosing the path that has the smallest entropy difference from the equilibrium state. In Equation (3), ΔS does not mean the entropy change, but rather the entropy difference between the non-equilibrium state and the equilibrium state. Equation (3) can be rewritten with the help of statistical thermodynamic Equations. The relation of entropy and microcanonical partition function Ω (*N*, *V*, *E*) is defined as Equation (4) [11]:

$$S_{\text{Equilibrium}} = K \ln \Omega_{\text{Equilibrium}} \left(N, V, E \right) \tag{4}$$

where K is Boltzmann constant, and $\Omega_{\text{Equilibrium}} \left(N, V, E \right)$ is the microcanonical partition function at equilibrium state with a specific and constant value. Therefore, the ΔS can be rewritten as follows:

$$\Delta S = S_{\text{Non Equilibrium}} - S_{\text{Equilibrium}} \tag{5}$$

Therefore,

$$\frac{\partial \Delta S}{\partial t} = \frac{\partial \left[K \ln \frac{\Omega_{\text{Non Equilibrium}} \left(N, V, E \right)}{\Omega_{\text{Equilibrium}} \left(N, V, E \right)} \right]}{\partial t} = 0 \tag{6}$$

which means $\Omega_{\text{Non Equilibrium}} \left(N, V, E \right)$ derivative respect to time is equal to zero. As mentioned, for FEPs, there is a linear relationship between N and E, and the derivative of the partition function can only be done with respect to two variables, N and V.

$$\mathrm{d}\ln\Omega = \left[\frac{\partial \ln\Omega}{\partial N}\right]_V \mathrm{d}N + \left[\frac{\partial \ln\Omega}{\partial V}\right]_N \mathrm{d}V = 0\,. \tag{7}$$

Four different states can be considered for Equation (7) to be zero:

State 1: $\left[\frac{\partial \ln\Omega}{\partial T}\right]_{N,V} = 0\,,\ \left[\frac{\partial \ln\Omega}{\partial V}\right]_{N,T} = 0\,,\ \left[\frac{\partial^2 \ln\Omega}{\partial T^2}\right]_{N,V} < 0\,,\ \left[\frac{\partial^2 \ln\Omega}{\partial V^2}\right]_{N,T} < 0$

State 2: $\left[\frac{\partial \ln\Omega}{\partial T}\right]_{N,V} = 0\,,\ \left[\frac{\partial \ln\Omega}{\partial V}\right]_{N,T} = 0\,,\ \left[\frac{\partial^2 \ln\Omega}{\partial T^2}\right]_{N,V} > 0\,,\ \left[\frac{\partial^2 \ln\Omega}{\partial V^2}\right]_{N,T} > 0$

State 3: $\left[\frac{\partial \ln\Omega}{\partial T}\right]_{N,V} = 0\,,\ \left[\frac{\partial \ln\Omega}{\partial V}\right]_{N,T} = 0\,,\ \left[\frac{\partial^2 \ln\Omega}{\partial T^2}\right]_{N,V} > 0\,,\ \left[\frac{\partial^2 \ln\Omega}{\partial V^2}\right]_{N,T} < 0$

State 4: $\left[\frac{\partial \ln\Omega}{\partial T}\right]_{N,V} = 0\,,\ \left[\frac{\partial \ln\Omega}{\partial V}\right]_{N,T} = 0\,,\ \left[\frac{\partial^2 \ln\Omega}{\partial T^2}\right]_{N,V} < 0\,,\ \left[\frac{\partial^2 \ln\Omega}{\partial V^2}\right]_{N,T} > 0$

This means that there are four steady states for minimum entropy production. According to the Prigogine's law, the states 1 and 2, and the states 3 and 4, can be neutralized; because the positive deviation of each state from the equilibrium is neutralized by the negative deviation of the other state from the equilibrium. But as explained in the "standing wave" mechanism section, states 1 and 3, states 1 and 4, states 2 and 4, and also states 2 and 3 cannot neutralize each other. This feature can guarantee the stability of these stationary states in a longer period of time.

2.3.3. Charges and Interactions

The "Equilibrium Law" guarantees the possibility of describing the new nature of FEPs in three-dimensional space (NHPs). Based on the mechanisms of "standing wave" and "stationary state", it is shown that one state in equilibrium can split in four stationary states (nearest states to equilibrium with minimum entropy production). This process is another expression of "generation of particles and charges from FEPs" as fundamental blocks of the nature. The various versions of structures built from aforementioned blocks are the subject of the question: it is possible to reach models for the matter structures in the nature?

The described blocks, which are the same quadruple states in the mechanisms of "standing wave" and "stationary state" can be introduced as the new generation of particles relative to the FEPs. These natures do not exist in basic assumptions and can be expressed by mathematical descriptions. From a physical point of view, the statistical behavior of the FEPs in IQF can create new blocks (NHPs), so that each newly created block has its own new features. Also, tendencies between the blocks, which are due to the departure from the uilibrium state, can be interpreted under the title of "Charge". In interpreting the nature of the charges, several points should be mentioned**:**

First point: Since the partition function of FEPs had two variables of the particle number (or energy) and volume, so the origin of two forces in each new block can be considered as the tendency to reach the equilibrium point of "energy/particle" and "energy/particle density". The variable *N* can be the origin of the gradient in the energy distribution and the variable *V* can be the origin of the gradient in the energy density.

Second point: In each block, the amount of energy (depending on the number of particles *N*) and the particle/energy distribution in space (depending on the variable *V*) are independent of each other and have different characteristics. So, the forces dependent on the number of particles (*N*) are independent of space and dimension and consequently acts as a short-range force and within the physical boundary of the particles, while the forces related on the particles density (*V*) are space- and dimension-dependent and consequently have a longer range and act beyond the physical boundary of the particles as a long-range force, which can be related to nuclear and electromagnetic forces, respectively.

Third point: Among the quadruple states (the blocks), states of N_{min} and V_{min}; and, N_{max} and V_{max} are unstable with respect to both characteristics, and two states of N_{min} and V_{max}; and N_{max} and V_{min} (saddle points) have more stability than the first two mentioned states.

Fourth point: Each block independently and simultaneously experiences two different types of out-of-equilibrium state (two types of charges). This means that each block carries two independent charges and thus experiences two independent interactions. Therefore, such blocks have two poles, but they are not dipoles. So, these quadruple blocks can interfere in various and complex interactions. Also, they can depict the matter structures such as baryons and various atoms. Here, the possibility of such descriptions is briefly examined and in the near future, the different stable nuclides will be discussed more in detail.

2.4. Next Generation of Particles

As introduced earlier, there are four blocks according to **Table 1**, which can be placed together in such a way that the maximum and minimum states of the same type interact together; the minimum/maximum states of the same type or states of different types cannot be placed together. So different particles can born as the possible ways in arrangement of these blocks. As stated before, these blocks have an inherent polarization, but they are not bipolar because the poles are not of the same type. The inherent polarization of each block affects how the blocks fit together. Placing blocks together can create closed or open structures. These new arrangements of blocks will somehow create stable particles of the next generation.

Table 1. Numbering of the four primary blocks.

Block No. 1	Block No. 2	Block No. 3	Block No. 4
V_{min} N_{min}	V_{min} N_{max}	V_{max} N_{max}	V_{max} N_{min}

Different arrangements of blocks can be imagined together. Examples of the arrangement of these blocks are shown in Figure 4. According to Table 1, for example, placing two blocks next to each other can lead to the formation of new open structures named 12, 13, 14, 23, 24, and 34, in which structures 13 and 24 neutralize each other and are not probably stable. Also, new open structures consisting of three blocks named 123, 234, 341 and 412 are possible and the structures such as 111, 112, 113, 114, 121, etc. are not possible. Regarding the closed structure consisting of four blocks (Figure 4(a), Figure 4(b)), structure (a) is not possible due to the placement of blocks 13 and 24 next to each other, and structure b is possible.

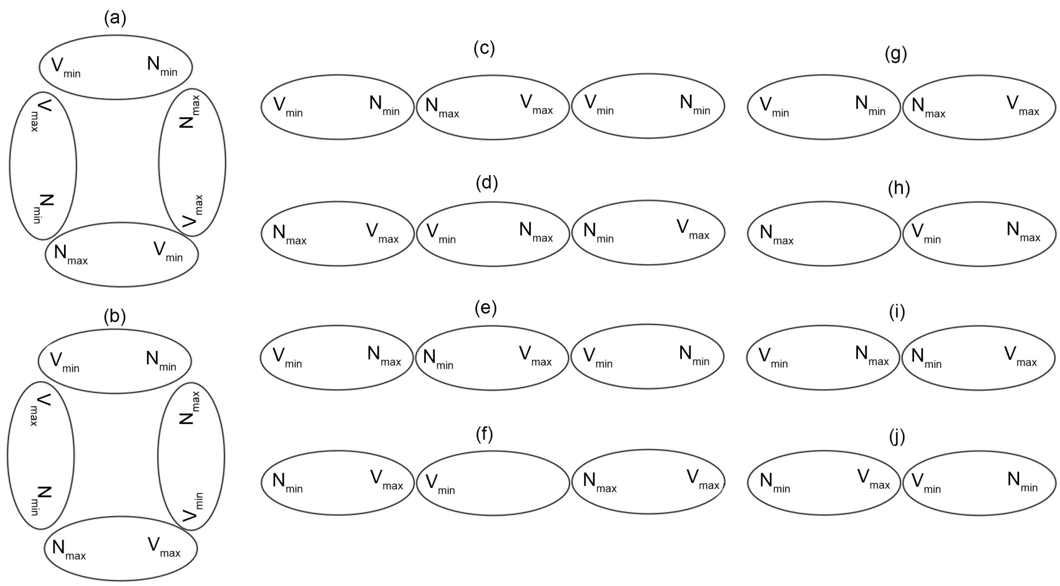

Figure 4. Examples of the possibility of arranging blocks together.

But this question arise that what is the relation between these structures with electron, proton and neutron. According to some empirical evidence, some assumption can be made about neutrons: electron-positron oscillation has been investigated and some relatively simple experimental test for verifying such behavior has been presented. So simple experimental facts strengthen the idea of "electron exists in at least two charge states", negative and positive, or in neutral as a third state [12]-[15]. Also, the question of "Is neutrino its own antiparticle?" is remaining unanswered [16]. On the other hands, in β decay, a neutron is transformed into a proton, electron and electron antineutrino. Therefore, is it reasonable to assume that the neutron is composed of a proton and an electron or it is assumed to be composed of fundamental particles of quarks, electron, and electron neutrino. This issue is kept as an open question and further investigation referred to future articles.

3. Discussion

This theory describes how the NHPs (closed cells) can be formed from FEPs in IQF and split in quadruple blocks from the primary equilibrium state. While each block is unstable and inevitably moves towards equilibrium, the result of out-of-equilibrium for these four blocks is the tendency to pack together, as a chain of interactions looking for each other, and each block can place next to other blocks. These blocks are the most probable states of the NHPs under shock and due to the two new types of charges that have appeared in the NHPs, they also provide the capacity to create new and more developed structures. The origin of these independent charges with different characteristics is the deviation from equilibrium with respect to two variables of N and V. These two types of charges, long and short range, play a kind of mediating role in the interactions between themselves in the quadruple blocks.

This theory also explains how from the origin of FEPs with the characteristics of no structure, no action, no charge, etc., it is possible to reach particles (NHPs) with structure, action and independent double charges that can form newer structures (next generation of particles). The equality of the number of described blocks with the number of fundamental particles in standard model as well as the similarity of two different types of described charges that cause different actions with the electromagnetic and strong nuclear forces in quarks and leptons, gives hope that providing a fundamental and mathematical method along with a physical interpretation is possible to establish the charge and behavior of the particles. Therefore, with this new point of view, the principle of existence of charge, the number of particles and the action mode of the fundamental particles in the standard model, which are obtained based on experimental observations, become provable and analytical propositions. Moreover, the "standing wave" mechanism provides a suitable idea for the equivalence of energy and matter in converting two photons into a particle, in which a standing wave is equivalent to a particle, and can be created from two traveling waves (photons). It is also conversely possible, a particle, as a standing wave, converts to two traveling waves or two photons if it is destroyed. Therefore, based on this definition, the blocks can be considered a type of standing waves consisting of FEPs.

Based on the four blocks proposed in this theory and the way these blocks are placed next to each other, it is possible to describe next generation particles such as protons and neutrons. However, the numbers assigned to the blocks are completely random and can change, it seems, probably, that one of these blocks is the fundamental particle of the electron and the other three are related to the up and down quarks and electron neutrino.

4. Conclusion

In this article, the principles of statistical thermodynamics were used to present a new theory about the nature of charges and particles. This theory explains how FEPs in IQF can produce the quadruple blocks (similar to first generation in SM) with two types of independent charges that can create different characteristics for the building blocks of matter. Quadruple blocks have similarities and differences with the “fundamental particles” in SM. However, in a deeper look, one can reach a comprehensive concept that leads to fundamental improvement in the field of particle physics. This theory has suggestions about the charge of particles, the structure of fundamental particles and the structure of next generation particles such as proton and neutron.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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