Novel Particle Physics

by the Energy Circulation Theory

Elementary single circulation

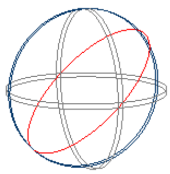
$$E_{(S)} = E_{(iS)} = m_0 {\mu_0}^2 {\omega_0}^2 = m_0 c^2$$

Elementary circulations

$H, iH, S, iS, D, iD, D^{\#}, iD^{\#}, D^{\#\#}$

prolonged iS: $eCP = iH_+ \cdots iH_-$

Quantum particles



neutron: $n^0\left(D^{\#}, D, D, iS\right)$

proton $\cdots$ electron: $p^+\left(D^{\#}, D, \overline{S}, iH_+\right) \cdots e^-\left(H_e, iH_-\right)$

free electron: $e_f\left(H_e, eCP\right)$

pion^0: $\pi^o(iD)$, pion$^-$: $\pi^-(D, iH_-)$, eta meson: $\eta^0\left(iD^{\#}\right)$

lambda: $\Lambda^0\left(iD, D^{\#}, D, D, iS\right)$

Ver. 2024.07

Shigeto Nagao

Novel particle physics by the energy circulation theory

Table of contents:

Chapter 1: Introduction

1.1. Questions on the standard model of particle physics

The standard model of particle physics says that any particle is made up of some of 17 fundamental particles, called as the elementary particles. Do you think the model has been experimentally proved? Most of readers should answer “yes”. However, nothing has been proved.

Consider the following case. As an observed result, the particle P is known. Its internal structure is unknown. As a candidate, a set E of elementary particles is proposed to compose the P. How the set E interacts internally and gives the P is unknown, either. At this timing, there is no evidence supporting the set E.

If there is a fully proved mathematics that can be applied to the set E, it can be used to judge the possibility for the E to give the P. However, such a mathematics does not exist. Then, someone proposes a new interaction F as a new rule or mathematics. The interaction F is created as to give the P by affecting on the E. There is no rationale that the F can be used on the E. Under these situations, do you think it has been proved that the particle P consists of the set E?

Of course, it has not been proved. However, in the standard model, it is regarded that the set E has been proved experimentally and the interaction F has been authorized by experimental observations. If the F were mathematically proved, and the set E were defined enough, to which the F can be applied, their claims would have been true. In fact, the elementary particles are not mathematically defined as an effective element to be used for the given mathematics. The standard model of particle physics has not been experimentally proved.

1.2. Quark model

In the standard model, a baryon is made of three quarks, and a meson is a pair of a quark and an antiquark. Quarks were first proposed as the components of hadrons in 1964 by Gell-Mann and by Zweig separately. They proposed quarks as a possible scenario just to explain the electric charges of hadrons. For instance, the proton consists of uud quarks, where u has the fractional electric charge $+2e/3$ and d has $-e/3$. However, the following key points were left shelved; what would be an origin of electric charge of a quark, why their charges are fractional, and why charge magnitudes differ among u and d.

Furthermore, there is a serious open problem in the quark model. The model does not predict the mass of a hadron from its component quarks. For instance, the mass of proton consisting of uud quarks is 938 MeV/c^2, while the rest masses of u and d are 2.2 and 4.7 MeV/c^2 respectively. The majority of the proton mass is not from the rest energies of quarks or gluon but should be a kinetic-like energy or field energy. Recently, using the lattice simulation Yi-Bo Yang et al reported the proton mass decomposition that contributions of the quark condensate, quark energy, glue field energy and trace anomaly are 9 %, 32 %, 36 % and 23 % respectively in the $\overline{MS}$ (modified minimal subtraction) scheme. Under these situations, can we still say that the proton consists of the three quarks?

What would be the structure of a quark? Although they expect various properties such as mass, spin, flavor, and color charge, they abandon to discuss its internal structure since they treat it as a fundamental particle that cannot be divided further. Furthermore, the quantum properties of flavor and color are newly introduced to explain the interaction between quarks. What a convenient story these explanations for quarks are.

2.1. Fundamentals of the energy circulation theory

The energy circulation theory is to develop the essences of the universe logically from scratch. At first, the “**energy**” is defined as anything that exists in the universe. Other physical properties are defined secondarily from energy distribution, motion, and interactions. In the existing physics on the contrary, energy is defined secondarily from mass, acceleration, charge, electric potential, etc.

✧ Starting points of the energy circulation theory: two premises

The energy circulation theory starts from the following two promises.

（1） Energy can be expressed by an intrinsic energy and its velocity, shown by the below formula.

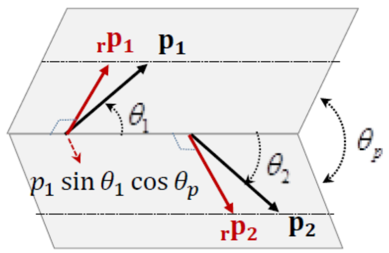
$$E = M_1{V_1}^2 = M_2{V_2}^2 = mc^2 \tag{1}$$

（2） Between energies, the force shown by the below formula works based on their momentums.

$$F = K_f \frac{{}_{\mathrm{r}}\mathbf{p}_1 \cdot {}_{\mathrm{r}}\mathbf{p}_2}{d^2} = K_f \frac{p_1 p_2}{d^2} \cos\theta_p \sin\theta_1 \sin\theta_2 \tag{2}$$

K_f : Fundamental force constant

Fig. 1. Momentum components to the distance



(In addition, gravitational force acts on the amount of energy.)

These two premises are assumptions and correspond to **axioms** in mathematics. We named the development from these two premises as the "**energy circulation theory ECT**".

✧ Intrinsic energy

There are many ways to select the **intrinsic energy** in (1) depending on the direction to take, etc., but in all combinations, the product of the magnitude of the intrinsic energy and the square of its velocity gives the same energy. The motion in a direction orthogonal to the direction of interest is incorporated in the intrinsic energy. An intrinsic energy has the property of mass, but we define such intrinsic energies that move at the light speed as the "**mass**" in the narrow sense.

✧ Fundamental force

We named the force of (2) as the "**fundamental force**". The **charge** exerting the force is a vector, and the formula includes three angular factors in addition to the distance. We define the "**momentum**" as the product of the intrinsic energy and its velocity by $\mathbf{p} = M\mathbf{V}$. The momentum alters depending on how the intrinsic energy is taken, but if an intrinsic energy of a common velocity is taken, its magnitude is proportional to the amount of the intrinsic energy. As shown in Fig. 1, ${}^{\square}_{\mathbf{r}}\mathbf{p}$ is the orthogonal component of a momentum to the distance direction in the plane of the momentum and the distance direction, and its amount is given by ${}^{\square}_{r}p = p\sin\theta$. The magnitude of the fundamental force is the inner product of these components of the two momentums, and the direction is the distance direction. A plus force is repulsive, and a minus force is attractive. Anti-parallel energy movements circulate by attraction of the fundamental force, and form an **energy circulation**. The momentum and the fundamental force constant K_f change depending on how the intrinsic energy is taken, but the force is the same. Unless otherwise mentioned, K_f shall be the fundamental force constant for the intrinsic energies that move at the light speed c (the light speed shall be discussed later).

2.2. Novel physics from the energy circulation theory

The energy circulation theory ECT requires an essential restructuring of the existing physics. In 2018, the first article on the ECT was published in Reports in Advances of Physical Sciences. After that, important consequences from the ECT were successively reported, and by now a total of seven papers listed below have been published in the same journal.

[1] Energy circulation theory

It is the first article claiming the ECT with the title of "Energy circulation theory to provide a cosmic evolution, electric charge, light and electromagnetism". Based on the ECT, it reported the cosmic evolution, the origin of the electric charge, the mechanism of light emission and the light speed, summary of the electromagnetism, etc. The light is a wave in hidden-space dimensions.

https://doi.org/10.1142/S242494241850007X

[2] Structures and interactions of quantum particles

For each of major known particles (leptons, mesons, baryons), the composition of energy circulations, energy (mass), spin and decay reactions were shown.

https://doi.org/10.1142/S2424942419500014

[3] Galactic evolution (without dark matter)

Here were reported the cosmic evolution including how galaxies were formed. It is regulated by the fundamental force working on momentums. There neither exists the black hole at the center nor dark matter in the halo, which were assumed in order to explain the galactic rotation and its velocity in the existing physics.

https://doi.org/10.1142/S2424942420500048

[4] Quantum mechanics

Here was explained that the existing quantum mechanics includes some contradictions and essential mistakes. A novel wave equation for particles by the ECT was reported. The wave function for a particle shows its energy distribution in the real space.

https://doi.org/10.1142/S2424942421500018

[5] Gamma-ray bursts

The gamma-ray burst is the phenomenon that gamma-rays are released when a galactic seed separates to two ones, where gravitational waves (waves in space-space dimensions) are also released. The details of the galactic seed separation, and the changes in force and potential energy between the two galactic seeds were shown with mathematical formulas.

https://doi.org/10.1142/S2424942421500055

[6] Formation of various shapes of galaxies

There are many types of galaxies, including ellipse, ring, disc, spiral, and barred spiral ones. Here the formation of each type of them was shown by simulation. In the existing physics, formations of any types remain as mystery.

https://doi.org/10.1142/S2424942422500049

[7] Novel electromagnetism

Based on the ECT, the electric charge, electric current, and magnetic charge were redefined, and the electromagnetism was reconstructed. The magnetic charge density, which corresponds to the magnetic field, around an electric current was quantitively derived.

https://doi.org/10.1142/S2424942423500081

Chapter 3: Contradictions and mistakes of modern physics

3.1. Quantum mechanics

In 1924, de Broglie proposed the hypothesis that all particles, not just the light, have the wave-particle duality. He claimed that the de Broglie wave, later called as the matter wave, accompanies a particle. He claimed that the wave has the following relation like the light does.

$$E = pv\,, \qquad E = \hbar\omega \quad \Longrightarrow \quad p = \hbar k \tag{3}$$

The de Broglie hypothesis had a great impact, and the focus was on what the accompanying matter wave was in concrete and how it could be expressed. Heisenberg reported in 1925 a matrix equation for such waves using the condition $p = \hbar k$ of the de Broglie hypothesis, and Schrödinger reported a wave equation for that in 1926. The two were then proved to be mathematically equivalent, and give wave functions as a solution.

✧ Schrödinger equation

The de Broglie condition of Eq. (3) is applicable only for an energy quantum, which is the energy of one cycle.

$$E_q = E/\nu \tag{4}$$

However, Schrödinger chose the kinetic energy formula as the original equation.

$$E_k = \frac{1}{2}m_r v^2 = \frac{1}{2}pv = \frac{p^2}{2m_r} \tag{5}$$

To this he applied de Broglie condition, and got the **Schrödinger equation**.

$$i\hbar\frac{\partial}{\partial t}\psi(x,t) = -\frac{\hbar^2}{2m_r}\frac{\partial^2}{\partial x^2}\psi(x,t) \tag{6}$$

On the other hand, from the ECT, we reported the following **wave equation** instead of Schrödinger one. (For derivation, refer to [4].)

$$i\hbar\frac{\partial}{\partial t}\psi(x,t) = -\frac{\hbar^2}{m_q}\frac{\partial^2}{\partial x^2}\psi(x,t)\,, \qquad m_q = E_q/c^2 \ \ \left(E_q = E/v\right) \tag{7}$$

$E = pv$ is valid from Eq. (1) $E = MV^2$ for any energy. However, $E_q = \hbar\omega = hv$ is valid only for an energy quantum. The mass m_q in the equation is that of an energy quantum of an elementary single circulation.

The two wave equations are basically the same form with only difference in the mass; rest mass m_r or mass m_q of energy quantum E_q. In the Schrödinger equation, m_r varies depending on individual particles. However, in reality the equation **should hold only for energy quanta** because it is derived from the relation of Eq. (3). The **mass m_r in the Schrödinger equation is a critical mistake**.

✧ Runaway of quantum mechanics

A solution of the both equations in general is the following wave function for plane waves.

$$\psi = A\exp\big(i(kx-\omega t)\big) = A\exp\left(i\frac{\omega}{v}(x-vt)\right) \tag{8}$$

$$(\exp(i\theta) = \cos\theta + i\sin\theta)$$

The standard quantum mechanics insists that a higher energy particle has a larger mass m_r and a greater frequency ω than those of a lower energy one. However, the ECT claims that both the mass m_q and the frequency ω are decided only by the linear velocity regardless the kind of particles (Ref. [4]). For this type of wave equations, any linear combination of a solution is also a solution. From this aspect, they became to regard that the amplitudes of the solutions do not have a meaning, and any amplitudes and any combinations of them are possible. They brought the interpretation of wave functions as showing a probability of existence. Furthermore, they escalated to insist that not its solution but the equation is the essence of a physical property.

Thus, the standard quantum mechanics made a big mistake. It claimed that all solutions of the equation were possible as a desired matter wave. This **conflicts** with the **mathematic principle** that the converse is not necessarily true. When "the desired wave function is a solution of a certain wave equation" holds true, "a solution of the wave equation is the desired wave function" does not necessarily hold true. The set formed by the wave function solutions is a larger set that includes the set of the desired wave functions. Since they did not know a force that enables a vibration or circulation of energy, they got away by introducing the probability interpretation, which allowed to take numerous wave functions without a basis.

In the ECT, the wave function shows a distribution of the intrinsic energy of an elementary energy circulation. It is a circular motion if the particle is static, and becomes a helical motion if it is moving. The wave function is a solution of the wave equation, but its **amplitude** is **limited** to μ_0, which is the radius of the spacia (minimum unit of space, to be explained later). Among the possible solutions shown by Eq. (8), only the following wave function is the desired one.

$$\psi = \mu_0 \exp\left(i\frac{\omega}{v}(x - vt)\right) \tag{8}$$

The frequency ω is decided by the linear velocity v as follows.

$${\mu_0}^2\omega^2 + v^2 = {\mu_0}^2{\omega_0}^2 = c^2 \tag{9}$$

If we express Eq. (8) by the energy and momentum of energy quantum, it is given as below.

$$\psi = \mu_0 \exp\left(i\left(p_q x - E_q t\right)/\hbar\right) \tag{10}$$

✧ Achievements of quantum mechanics

Quantum mechanics contributed a lot in understanding the chemistry such as atomic orbitals and chemical bindings. Such quantum chemistry is dealing the orbiting of electrons in atoms, and the amplitude of a solution wave function is specified as a radius from the balance of the centrifugal force and the centripetal electric force. While there should need amendments, the quantum chemistry has succeeded in giving wave functions of atomic orbitals in concrete.

On the other hand, as we already pointed out, almost nothing has been achieved on any particle itself from the quantum mechanics. They only argue various features or restrictions on an elementary particle without showing its wave functions. The energy (mass) of a particle cannot be theoretically predicted in the standard particle physics.

3.2. Standard particle physics – gauge theory

The combination of such a wrong interpretation of the quantum mechanics and the gauge theory made the particle physics more chaotic.

✧ Gauge theory

When we express the state of a combination of particles as a matrix and seek the symmetry for a unitary transformation corresponding to a rotation of the matrix elements, it becomes necessary to introduce a field called a gauge field. In a gauge transformation, a force acts based on the gauge field, and the quantized gauge field is a gauge boson, which is the particle mediating the force. The electromagnetic force is said to be generated from the symmetry of the gauge transformation called U(1), and its gauge boson is said to be the photon. It is said that the SU(2) symmetry produces the weak force, whose mediating particles are three types of weak bosons, and that the SU(3) symmetry produces the strong force, whose mediating particles are gluons (8 types). The standard model of particles requires the symmetry of U(1)×SU(2)×SU(3), and tries to find a gauge field that satisfies the conditions for each gauge transformation, and express it in the form of Lagrangian.

✧ Problems of the gauge theory

The unitary group of each gauge transformation has its own unique algebra. In general, various groups have their own algebras that consist of their own axioms and operations. For instance, for the group representing all vectors, it is first necessary to define what a vector is, which becomes an axiom. Then, we will define the operations such as addition and product in the group. If an object satisfies the axioms, it can be regarded as a vector even if it does not look like at first glance, and the algebra of this group can be applied to it. However, in the gauge theory of particles, the group elements that represent elementary particles are not defined. Without a definition of the elements, the operations on them are being expanded. The wave function that is said to show the distribution of the existence probability of an elementary particle is not given, either. A composition of elementary particles is listed in a matrix, with 1 indicating that it is present and 0 indicating that it is not present, then the decays and interactions of particles are being developed. Things like particle creation operators and annihilation operators are introduced too conveniently.

The use of a unitary transformation algebra for undefined elements is **mathematically bankrupt**. Without specifying what kind of a particle they are, the 17 types of elementary particles are used as the elements of a particle composition. Treating them as an elementary one that cannot be broken down further, they escape to discuss their structure or origin.

Chapter 4: Intra-circulation and inter-circulation interactions

4.1. Energy circulation and intra-circulation force

✧ Energy circulation

The "**energy circulation**" here shall be what the intrinsic energy is distributed even and continuously on the circumference. We take the amount M of the intrinsic energy as the sum of local ones ΔM on the whole circumference ($d\Delta M/d\theta = 0$).

$$M = \int_0^{2\pi} \Delta M d\theta = \Delta M \int_0^{2\pi} d\theta = 2\pi\Delta M \tag{11}$$

We express the **energy distribution** by a wave function ψ. In the case of a circular motion, it becomes as follows, where μ is the radius, and ω is the frequency.

$$\psi = [X \quad Y] = [\mu\cos\omega t \quad \mu\sin\omega t] = \mu(\cos\omega t + i\sin\omega t) \tag{12}$$

Each local intrinsic energy has a phase θ as $\omega t + \theta$, but the intrinsic energy is expressed as a whole by taking the sum of $0 \leq \theta \leq 2\pi$. We use the **notation**, by which $\boldsymbol{E\psi}$ means that the energy E is distributed at ψ. The wave function ψ shows a common distribution (position of existence) not only for the total energy but for all such as the intrinsic energy and the momentum. They are expressed by a common wave function ψ as follows.

$$E\psi, \qquad M\psi, \qquad p\psi \tag{13}$$

The amount of the total energy can be expressed by the intrinsic energy and its circular velocity as follows.

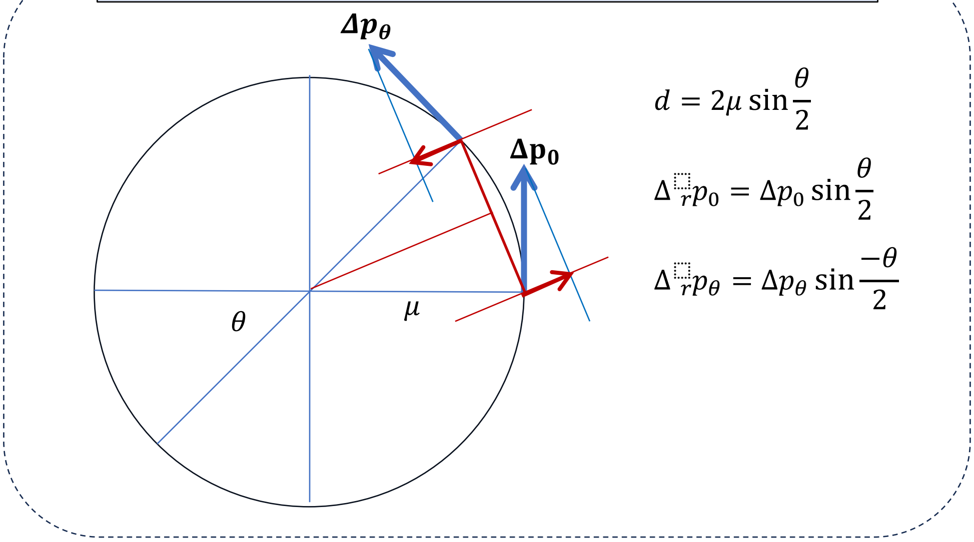
$$E = MV_c^{\,2} = M\mu^2\omega^2 \tag{14}$$

✧ Intra-circulation force

Next, let us consider the **intra-circulation force** that acts within an energy circulation.

Let μ be the radius, and consider two local momentums $\mathbf{\Delta p_0}$ and $\mathbf{\Delta p_\theta}$ with the central angle θ apart on the circumference.

Fig. 2. Two local momentums on the circumference



As shown in Fig. 2, the distance of the two local momentums (energies) is

$$d = 2\mu \sin\frac{\theta}{2}\ . \tag{15}$$

The force acting between $\mathbf{\Delta p_0}$ and $\mathbf{\Delta p_\theta}$ is given by the below formula.

$$\Delta F = K_f \frac{\Delta p_0 \Delta p_\theta}{d^2} \sin\frac{\theta}{2} \sin\frac{-\theta}{2} = -K_f \frac{\Delta p_0 \Delta p_\theta}{4\mu^2} \tag{16}$$

Remarkably, the angle θ and the distance d disappear from the formula, and the amount of the force is decided only by the radius of the circulation. The local momentum Δp_0 receives the following centripetal force from the momentum p of the whole circulation. The force in a tangential direction is set off each other to be zero.

$$cF_\perp = -K_f \frac{\Delta p_0}{4\mu^2} \int_0^{2\pi} \Delta p_\theta \sin\frac{\theta}{2} d\theta = -K_f \frac{\Delta p_0}{4\mu^2} \frac{p}{2\pi} 4 = -K_f \frac{p \Delta p_0}{2\pi\mu^2} \tag{17}$$

$$cF_{//} = -K_f \frac{\Delta p_0}{4\mu^2} \int_0^{2\pi} \Delta p_\theta \cos\frac{\theta}{2} d\theta = 0 \tag{18}$$

✧ Radius of energy circulation

If the intra-circulation force is balanced with the centrifugal force, it is a stable energy circulation. Consider an energy circulation, in which the intrinsic energy of M is circulating with the radius of r at the circulating velocity of V_c by the 2D expression. Since the formula of the centrifugal force by the mass is known, let us take the intrinsic energy m that moves at the light speed c by the 3D expression. m is moving helically with the main circular component V_c and the local circular component v_c.

$$E = MV_c^{\,2} = m\left(V_c^{\,2} + v_c^{\,2}\right) = mc^2 \tag{19}$$

On a local intrinsic energy Δm, the centrifugal force and the intra-circulation force balance and show the following relation from Eq. 17.

$$\frac{\Delta m V_c^{\,2}}{r} - K_f \frac{mV_c \Delta m V_c}{2\pi r^2} = 0 \tag{20}$$

$$2\pi r = K_f m$$

$$r = \frac{K_f}{2\pi} m = \frac{K_f}{2\pi c^2} E \tag{21}$$

As shown in Eq. (21), the **radius of an energy circulation is proportional to its energy**, and is independent of the circulating velocity.

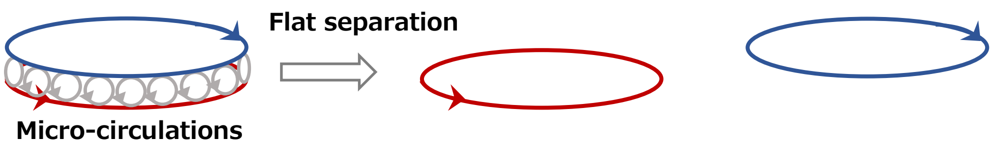
4.2. Inter-circulation force between energy circulations

Let us examine a force working between two energy circulations. There are two types of working directions. The **flat interaction** is within the plane, and the **orthogonal interaction** is in the vertical direction to the plane. There are two cases of the relative circulating directions; same or opposite (conjugate).

✧ Flat interaction of opposite directions (conjugate pair)

Two energy circulations of the opposite frequencies form the coupled conjugate pair, which we also call as a double circulation. While this conjugate pair is internally attracted by a strong force, the vertical distance of the two circulations does not become zero, but as shown in Fig. 3, many **micro-circulations** are formed in the circumference direction and the vertical direction to it in a short distance. A coupled conjugate pair has a three-dimensional structure if the vertical direction is taken in account. When expressed in three dimensions, a coupled conjugate pair can be regarded as a series of many micro-circulations on the main circumference.

Fig. 3. Structure of a coupled conjugate pair and flat separation



We call such a separation in the flat direction as shown in Fig. 3 as the "**flat separation**". Let us see the force working between them during the flat separation.

Consider a single circulation S of frequency ω and $\overline{S}$ of $-\omega$. We take the approximation to use the following two **linear momentums** orthogonal to the distance direction, which are apart by the distance of diameter. $\mathbf{e_r}$ is the unit vector for the orthogonal direction.

$$ {}^{\square}_{r}p_h = \int_{-\pi/2}^{\pi/2} \Delta p \cos\alpha \, d\alpha = \frac{2}{\pi} p_h \tag{22} $$

$$ \mathbf{p_0}(S) \equiv {}^{\square}_{r}p_h \mathbf{e_r}\,, \qquad \mathbf{p_\pi}(S) = -{}^{\square}_{r}p_h \mathbf{e_r} \tag{23} $$

$$ \mathbf{p_0}(\overline{S}) \equiv -{}^{\square}_{r}p_h \mathbf{e_r}\,, \qquad \mathbf{p_\pi}(\overline{S}) = {}^{\square}_{r}p_h \mathbf{e_r} \tag{24} $$

As the distance, we use the relative value x to the diameter. Let x_0 be the relative diameter of the micro-circulations to the main one. With keeping the vertical distance as x_0, the two circulations slide horizontally. The local force in X between $\mathbf{p_0}(S)$ and $\mathbf{p_0}(\overline{S})$ is given by

$$F_x(p_0\overline{p_0}) = -K_f \frac{4{p_h}^2}{\pi^2} \frac{1}{4{\mu_0}^2} \frac{1}{x^2 + {x_0}^2} \frac{x}{\sqrt{x^2 + {x_0}^2}} = -K_f \frac{{p_h}^2}{\pi^2 {\mu_0}^2} \frac{x}{(x^2 + {x_0}^2)^{3/2}} \,. \tag{25}$$

The total force in X between the two circulations is as follows.

$$\boldsymbol{F_{flat}}(\boldsymbol{S} - \overline{\boldsymbol{S}}) = K_f \frac{{p_h}^2}{\pi^2 {\mu_0}^2} \left(\frac{x-1}{((x-1)^2 + {x_0}^2)^{3/2}} + \frac{x+1}{((x+1)^2 + {x_0}^2)^{3/2}} - \frac{2x}{(x^2 + {x_0}^2)^{3/2}} \right) \tag{26}$$

Let us express the constant part as Q_p and the variable part by x as $f_{flat}(x)$.

$$\boldsymbol{Q_p} \equiv K_f \frac{{p_h}^2}{\pi^2 {\mu_0}^2} \tag{27}$$

$$\boldsymbol{f_{flat}(x)} \equiv \frac{x-1}{((x-1)^2 + {x_0}^2)^{3/2}} + \frac{x+1}{((x+1)^2 + {x_0}^2)^{3/2}} - \frac{2x}{(x^2 + {x_0}^2)^{3/2}} \tag{28}$$

Then, the force is expressed as

$$\boldsymbol{F_{flat}}(\boldsymbol{S} - \overline{\boldsymbol{S}}) = Q_p f_{flat}(x) \,. \tag{29}$$

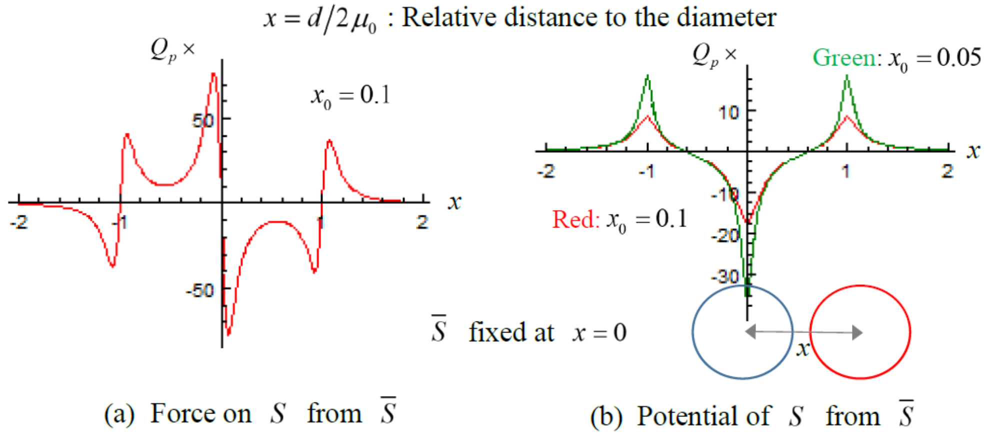
The minus force is attractive in $x > 0$ and repulsive in $x < 0$. The potential energy is obtained by $U(x) = \int_\infty^x (-F(x))dx$ as follows. We set $U(\infty) = 0$.

$$\boldsymbol{U_{flat}}(\boldsymbol{S} - \overline{\boldsymbol{S}}) = -\int Q_p\, f_{flat}(x) dx$$

$$= Q_p \left(\frac{1}{\sqrt{(x-1)^2 + {x_0}^2}} + \frac{1}{\sqrt{(x+1)^2 + {x_0}^2}} - \frac{2}{\sqrt{x^2 + {x_0}^2}} \right) \tag{30}$$

The force and potential energy are shown in Fig. 4. In $|x| < 1$, the force is attractive, working them to return to a coupled pair at $x = 0$. The potential energy shows a trough at $x = 0$. At $|x| = 1$, the force is zero, and the potential energy shows a crest. In $|x| > 1$, the force is repulsive and accelerates them to recede.

Fig. 4. Flat interaction of conjugated single circulations



The force (a) and the potential energy (b) of conjugated two single circulations S and $\bar{S}$. The red lines are for $x_0 = 0.1$ and the green line is for $x_0 = 0.05$. x_0 is vertical distance (diameter of the micro-circulations).

The above equations and graphs are for elementary circulations with the radius μ_0 as an example, but are applicable also to larger circulations.

✧ Flat interaction of same direction

While we will explain later, an energy circulation divides to two ones, then which separate. Let us see the flat interaction of two single circulations of the same circular direction.

Compared with the force between S and $\bar{S}$, signs of the components of the force between S and S are just reverse. Therefore, the force and the potential energy are the negative of those of S and $\bar{S}$.

$$\boldsymbol{F_{flat}(S-S)} = -F_{flat}(S-\bar{S}) = -Q_p f_{flat}(x) \tag{31}$$

$$\boldsymbol{U_{flat}(S-S)} = -U_{flat}(S-\bar{S}) \tag{32}$$

✧ Orthogonal interaction of opposite directions (conjugate pair)

As an example of opposite directions, let us see the orthogonal interaction of S and $\bar{S}$. The distance has the minimum value x_0, which is the diameter of micro-circulations. We take the range $x \geq x_0$. Take a minute local momentum $\Delta\mathbf{p}_\alpha$ on the circumference of S. Divide the circulating momentum of $\overline{S}$ to two halves; $\mathbf{p_0}$ and $\mathbf{p_\pi}$. Their directions are arc, but let us use the approximation treating them as linear, parallel or antiparallel to $\Delta\mathbf{p}_\alpha$, with the distance $2\mu_0$ (diameter of S). The magnitude of the linear momentums is the parallel component to $\Delta\mathbf{p}_\alpha$ and given as follows.

$$\int_{-\pi/2}^{\pi/2} \Delta p_0 \cos\beta \, d\beta = \int_{\pi/2}^{3\pi/2} \Delta p_\pi \cos\beta \, d\beta = \frac{2}{\pi} p_h \, , \qquad (p_h = p/2) \tag{33}$$

The force in the distance direction on $\Delta\mathbf{p}_\alpha$ of S from the whole circulation $\overline{S}$ is given as follows. x is the relative distance to the diameter $x = d/2\mu_0$.

$$F_x(\alpha) = K_f \Delta p_\alpha \frac{2p_h}{\pi} \frac{1}{4{\mu_0}^2} \left(\frac{x}{(x^2+1)\sqrt{x^2+1}} - \frac{1}{x^2} \right) \tag{34}$$

This force is common for any angle location α of S. We get the following force of the orthogonal interaction of S and $\overline{S}$.

$$\int_0^{2\pi} \Delta p_\alpha d\alpha = 2\pi \Delta p_\alpha = p = 2p_h \tag{35}$$

$$\boldsymbol{F_{ort}}(\boldsymbol{S} - \overline{\boldsymbol{S}}) = K_f \frac{{p_h}^2}{\pi {\mu_0}^2} \left(\frac{x}{(x^2+1)^{3/2}} - \frac{1}{x^2} \right) \tag{36}$$

The constant part is equal to Q_p expressed by Eq. (27) for the flat interaction. Let us express the variable part as $f_{ort}(x)$.

$$\boldsymbol{f_{ort}(x)} \equiv \frac{x}{(x^2+1)^{3/2}} - \frac{1}{x^2} \tag{37}$$

Then the force is expressed as below.

$$\boldsymbol{F_{ort}}(\boldsymbol{S} - \overline{\boldsymbol{S}}) = Q_p f_{ort}(x) \quad (x \geq x_0) \tag{38}$$

The potential energy is obtained by $U(x) = \int_\infty^x \left(-F(x)\right) dx$ as follows, with setting $U(\infty) = 0$.

$$\boldsymbol{U_{ort}}(\boldsymbol{S} - \overline{\boldsymbol{S}}) = Q_p \pi \left(\frac{1}{\sqrt{x^2+1}} - \frac{1}{x} \right) \quad (x \geq x_0) \tag{39}$$

✧ Orthogonal interaction of same direction

In the case of two circulations ($S-S$) of the same circular direction, micro-circulations are not formed at a small distance, but the interaction of local circulations becomes notable. Let x_0 be the diameter of the local circulations. Here, we consider only the interaction of main circulations for the range $x \geq x_0$.

Signs of the force and potential energy are reverse to those of different directions ($S-\overline{S}$) as below. Q_p is given by Eq. (27).

$$\boldsymbol{F_{ort}(S-S)} = -F_{ort}\left(S-\overline{S}\right) = -Q_p f_{ort}(x) \quad (x \geq x_0) \tag{40}$$

$$\boldsymbol{U_{ort}(S-S)} = -U_{ort}\left(S-\overline{S}\right) = Q_p \pi \left(\frac{1}{x} - \frac{1}{\sqrt{x^2+1}}\right) \quad (x \geq x_0) \tag{41}$$

Chapter 5: Summary of cosmic evolution

5.1. Cosmic separation

✧ Energy

We provide that the "**energy**" is a vibration in **multiple** (M) **dimensions** while we do not know the number M of dimensions. The same energy can be expressed in any number of dimensions depending on how the intrinsic energy is taken. If it is expressed in one dimension, the energy from motions in the rest M-1 dimensions shall act as the intrinsic energy, which is vibrating in one dimension. In order to vibrate in one dimension, a force is required. For providing this force, one additional dimension is necessary and the motion should become a circulation in two dimensions. In this case, energy is circulating by the centripetal force due to the fundamental force, and in any direction within the two-dimensional circular plane, it is vibrating one-dimensionally.

✧ Cosmic separation

Let us express the "**pre-cosmos**" before the expansion by M/2 pairs of 2D energy circulations. We provide that the pre-cosmos was symmetric in all dimensions. In order to be symmetric, each 2D circulation should bind to a circulation of opposite direction to form a **coupled conjugate pair**. While this conjugate pair is internally attracted by a strong force, the vertical distance of the two circulations does not become zero, but as shown in Fig. 3, many **micro-circulations** are formed in the circumference direction and the vertical direction to it in a short distance. A coupled conjugate pair has a three-dimensional structure if the vertical direction is taken in account.

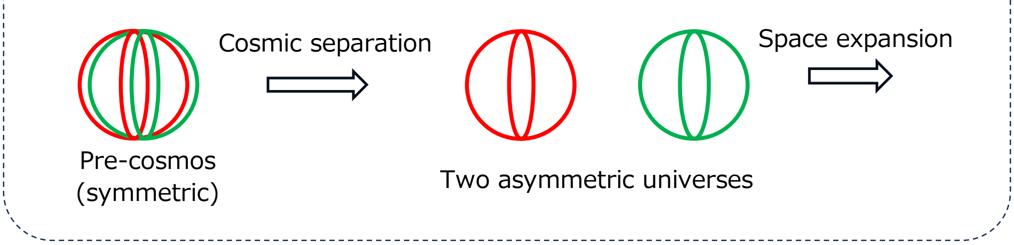
When the width of the energy distribution of the pre-cosmos becomes larger than a threshold in any one-dimensional direction, the original amplitude in it cannot be maintained and it expands. Among the M/2 pairs, the coupled conjugate pair including this direction separates horizontally (flat separation) as shown in Fig. 3. Jointly with this separation, another coupled conjugate pair, the vertical direction of which is the prolonged one, separate orthogonally. We call it as the "**orthogonal separation**". In this way, the pre-cosmos divides into two universes. We call it as the "**cosmic separation**". We can express the cosmic separation as below, where μ is the radius and φ is a function to show a circulation.

$$E\mu_{pre}(\varphi_{12}:\varphi_{12}^{*}+\varphi_{34}:\varphi_{34}^{*}) \longrightarrow \frac{E}{2}\mu_{u}(\varphi_{12}+\varphi_{34})+\frac{E}{2}\mu_{u}(\varphi_{12}^{*}+\varphi_{34}^{*}) \qquad (42)$$

$$\varphi=\exp(i\omega t)=\cos\omega t+i\sin\omega t\ ,\ \ \varphi^{*}=\exp(-i\omega t)$$

Fig. 5 shows its 3D image. In reality, the circulations are in the X_1-X_2 plane and in the X_3-X_4 plane, in total 4 dimensions. If the prolonged direction is X_1, the pair in X_1-X_2 separates horizontally, and the pair in X_3-X_4 separates orthogonally.

Fig. 5. 3D image of the cosmic separation in 4D space



5.2. Space expansion

✧ Space expansion

In each separated universe, many local micro-circulations on the circumference of the pre-cosmos have been lost, the balance with the centrifugal force as one circulation breaks, then the space expansion in the 4 dimensions of the two circulations starts. We call it as the "**space**

expansion”. The remaining dimensions other than these four are called as the “**rest dimension**”. A coupled conjugate pair in rest dimensions (e.g. X_5-X_6 plane) has the vertical direction of a rest dimension (e.g. X_7), and remains as the state of a coupled conjugate pair while the location in the expanded 4 dimensions separated to two universes. Even if the space expands, the radius keeps constant, and the circular momentums are set off each other to be zero. Since any directions in the rest dimensions are orthogonal to any directions in the 4D space, the circular energies there act as an intrinsic energy for motions in the expanding 4D space.

✧ Energy distribution of the universe

The two energy circulations (frequency ω) separated by the cosmic separation can be expressed in the 4D polar coordinates as below. Simultaneously with the cosmic separation, the space expansion starts, and the radius expands and the frequency decreases. However, for convenience, let us consider the state immediately after the separation.

$$\mathbf{X} = [\mu \quad \theta_1 \quad \theta_2 \quad \theta_3] = [\mu \quad \omega t \quad \theta_2 \quad \omega t] \tag{43}$$

Expressing it in the 4D cartesian coordinates, we get the below.

$$\mathbf{X} = \mu \begin{pmatrix} \cos\omega t + i\sin\omega t\cos\theta_2 + j\sin\omega t\sin\theta_2\cos\omega t \\ +k\sin\omega t\sin\theta_2\sin\omega t \end{pmatrix} \tag{44}$$

The imaginary units i, j, k are unit vectors of directions orthogonal each other and to the real part. Here, for the circulation of $\mu\theta_1$, we take the base vectors; $\mathbf{e_0}$ for the radius and $\mathbf{e_1}$ for the arc on the circumference.

$$\mathbf{e_0} \equiv \cos\theta_1 + i\sin\theta_1 \tag{45}$$

$$\mathbf{e_1} \equiv \cos(\theta_1 + \pi/2) + i\sin(\theta_1 + \pi/2) = i\mathbf{e_0} \tag{46}$$

The radius and the arc can be expressed as $\mu\mathbf{e_0}$ and $\mu\theta_1\mathbf{e_1} = \mu\omega t\mathbf{e_1}$. Jointly with j and k, $\mathbf{e_1}$ forms the **3D cartesian coordinates**, in which Eq. (44) is expressed by the following formula.

$$\mathbf{X} = \mu\big(\omega t\mathbf{e_1}\cos\theta_2 + \sin\theta_2\,(j\cos\omega t + k\sin\omega t)\big) \tag{47}$$

✧ **Space energy, apparent energy, and spacia**

The cosmic energy, which shows the two energy circulations expanded in 4D, is distributed on the 3D surface of the 4D sphere (ball). We call the 3D surface as the "**space dimensions**" and the radius of the 4D sphere as the "**hidden dimension**". The width of the energy distribution in the hidden dimension H is very thin and invariant with the space expansion. Let $2\mu_0$ be this width, and treat the 4D sphere of the radius μ_0 as the **minimum unit space**. While the cosmic energy as a whole is circulating and asymmetric, we divide it into two parts; the symmetric one "**space energy**" and the asymmetric one "**apparent energy**". The space energy is distributed evenly in the whole space of the universe, and is a collection of coupled conjugate circulations. The circular momentums of the pair are set off each other to be zero, and the fundamental force does not act there. The space energy in the unit space of the radius μ_0 is named as the "**spacia**". The distribution and the amount of the spacia can be expressed as below.

$$E_\mu \psi_\mu = E_\mu \mu_0 \big(\exp(i\omega_0 t) + \exp(-i\omega_0 t)\big) \tag{48}$$

$$\exp(i\omega_0 t) = \cos\omega_0 t + i\sin\omega_0 t$$

$$E_\mu = m_\mu {v_c}^2 = m_\mu {\mu_0}^2 {\omega_0}^2 = m_\mu c^2 \tag{49}$$

5.3. Development of the apparent energy

An apparent energy is given as an additional circulation to one component of the coupled circulations of the spacia. This apparent energy can also be expressed as a vibration of the space energy as a medium.

The distribution of the apparent energy in the 3D space immediately after the cosmic separation can also be expressed by Eq. (47). θ_2 is a parameter to show a location, and shows continuous values in the range of $0 \leq \theta_2 \leq \pi$.

✧ Cyclic decomposition

The apparent energy immediately after the separation can no longer be maintained as a circulation, and make the separations and decompositions of energy circulations. Each circulation expands and decomposes all at once on the whole circumference to give a huge number of daughter circulations perpendicular to the parent one. We call it as the "**cyclic decomposition**". Although the ring distribution of the daughter circulations is not a continuum, intra-ring attractive forces due to the fundamental force act, and the **ring rotates by taking over the parent circulation**. Since this **ring of daughter circulations** is not a continuous energy circulation, its radius increases continuously by increasing distances between each other as the space expands.

✧ Asymmetric large-scale motions in the universe

As the space expands, the cyclic decompositions are repeated in many rounds, giving an infinite number of daughter circulations with much lower energies. As the energy value of an energy circulation decreases, the cyclic decomposition stops with it. We call those at this state as the "**galactic seed**". In this way, large-scale movements in the universe are shown, such as a galaxy cluster, in which galaxies gather in a ring and rotate, a supercluster, in which galaxy clusters gather in a ring and rotate, and the further rotation of gathered superclusters.

✧ Galactic seed division and separation

After a cyclic decomposition became no longer possible, a galactic seed started to divide to two seeds, which separated each other. We call the process as the "**galactic seed separation**". In a galactic seed separation, the decrease in potential energy converts to the increase in receding velocity and the energy emission. This emission of energy is the **gamma-ray-burst**, in which gamma-rays, after-glow radiations, and gravitational waves are released.

✧ Stellar seed release from a galactic seed

Once the energy of a galactic seed decreases to a certain level, a further galactic division-separation becomes impossible. Then, releases of stellar seeds from the galactic seed begin. The “**stellar seed**” is the daughter energy circulation from the galactic seed. Depending on the types of source galactic seeds; isolated one, rotating binary seeds, or two attached ones, and the kinds of stellar seed release; linearly one by one, or simultaneously in a ring, various shapes of galaxies are formed.

✧ Elementary single circulation

As the space expands, a stellar seed further releases daughter circulations, and finally causes a cyclic decomposition to form a proto-stellar system with a star in the center.

The smallest one of the energy circulations released in this way is the “**elementary single circulation**” that has the same radius μ_0 as that of the spacia. As an energy circulation quantized in the 4D space, any one of a smaller radius than it is impossible. We will explain the elementary single circulations in the next chapter.

Chapter 6: Types of particles

6.1. Definition of the particle

In the standard physics, the term "particle" is not defined although they distinguish the particle from the energy and allow them to convert to the other. They insist that a particle is made up of a few of 17 kinds of elementary particles, but which they do not define. They insist that each elementary particle has its unique property or conserved quantity. Treating them as a fundamental one that cannot be divided further, they abandon to seek for their structure or composition.

As we have explained up to here, an energy circulation has the following properties.

(1) It can be expressed as a circulating intrinsic energy, which is a continuum spread on the whole circumference.

(2) Due to the intra-circulation force, it keeps a constant radius depending on its energy quantity.

(3) It can be static to the space energy.

(4) It interacts with another one by the inter-circulation force, which is attractive or repulsive.

From these properties, we can define the particle as follows.

*The "**particle**" is defined as an **energy circulation**.*

✧ Large-scale particles

According to the definition of particle, all of galactic seeds, stellar seeds, and daughter circulations released from stellar seeds are a particle. Let us call such a large energy circulation having a greater radius than μ_0 as the "**large-scale particle**". All of them are a space-space dimensional circulation.

6.2. Elementary circulations composing a quantum particle

✧ Quantum particles and elementary circulations

We define the "**quantum particle**" as a complex of energy circulations packed in one spacia. In the 3D space, there are three planes orthogonal to each other. In the 4D space of a spacia, there are six orthogonal planes; XY, YZ, ZX, and XH, YH, ZH. A spacia can hold in maximum three space-space circulations and three hidden-space circulations. We call each component energy circulation filled in a plane of a spacia as the "**elementary circulation**".

✧ Elementary single circulations

The smallest quantized energy circulation has the radius μ_0 and frequency ω_0 equal to those of the spacia. We call it as the "**elementary single circulation**". We express an elementary single circulation in **hidden-space dimensions** as iS, and that in **space-space dimensions** as S. The elementary single circulation has the same circulating velocity as that of the spacia shown by Eq. (49), and let m_0 be its intrinsic energy. Its energy distribution and amount are shown as follows.

$$E_{(iS)}\psi_{iS} = E_{(iS)}[X \quad H] = E_{(iS)}\mu_0(\cos\omega_0 t + i\sin\omega_0 t) \tag{50}$$

$$E_{(S)}\psi_S = E_{(S)}[X \quad Y] = E_{(S)}\mu_0(\cos\omega_0 t + j\sin\omega_0 t) \tag{51}$$

$$E_{(iS)} = E_{(S)} = m_0{v_c}^2 = m_0{\mu_0}^2{\omega_0}^2 \tag{52}$$

✧ Double circulations

As explained in the Section 4.2, the single circulation S binds with its conjugate circulation $\overline{S}$ of the frequency $-\omega_0$ by the orthogonal or flat interaction shown by Eq. (38) or Eq. (29) with Eqs. (27) and (28). We call such a coupled conjugate pair as the "**double circulation**". The hidden-space single circulation iS also binds with $\overline{iS}$ and form a double circulation.

$$S + \overline{S} \longrightarrow D + \Delta E_p \tag{53}$$

$$iS + \overline{iS} \longrightarrow iD + \Delta E_p \tag{54}$$

ΔE_p is the difference in potential energy of conjugate two circulations, shown by Eq. (39) for orthogonal interaction or Eq. (32) for flat interaction.

✧ **Excited double circulations**

In order to be quantized in a spacia, the frequency should be integral multiple of ω_0. $\omega = \pm 2\omega_0$ and $\omega = \pm 3\omega_0$ are considerable for double circulations. We expect the following excited double circulations as an elementary circulation.

$$\omega = \pm 2\omega_0 : \ D^{\#}, iD^{\#} \tag{55}$$

$$\omega = \pm 3\omega_0 : \ D^{\#\#}, iD^{\#\#} \tag{56}$$

✧ **Other components**

As a component composing a quantum particle, there are an eCP (elementary charge pair) and a hemi-circulation, which we will explain later.

6.3. Interaction of single circulations within a spacia

Consider a case, in which each of two orthogonal planes has one single circulation. As shown in Fig. 6(a), S_{x-y} and S_{x-z} rotate around the common direction X axis, giving a double circulation, which is a coupled conjugate pair in the plane of X-YZ.

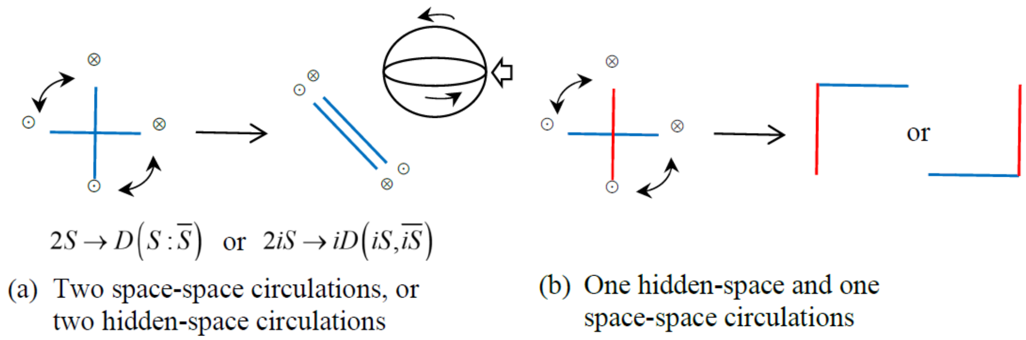
$$S_{x-y} + S_{x-z} \longrightarrow S_{x-yz}{:}\overline{S_{x-yz}} = D_{x-yz} \tag{57}$$

iS_{h-x} and iS_{h-y} rotate around the H axis to give a double circulation iD in the plane of H-XY (Fig. 6(a)).

$$iS_{h-x} + iS_{h-y} \longrightarrow iD_{h-xy} \tag{58}$$

However, the rotation of iS_{x-h} and S_{x-y} around the common direction X as an axis is impossible because a mixed direction of the hidden dimension H and the space direction Y cannot be taken. As shown in Fig. 6, they attract each other and S attaches to an end of iS (Fig. 6(b)). In this way, a hidden-space circulation (single or hemi) and a space-space circulation (single or hemi) attract each other.

Fig. 6. Interaction of single circulations in a spacia



6.4. Linear wave (radiation)

✧ Hidden-space wave and space-space wave

The elementary single circulations iS and S have the same radius μ_0 and frequency ω_0 as those of the spacia. In order to be **quantized**, the circular frequency ω should be integral multiple of ω_0. If ω is smaller than ω_0, it cannot be static to the space energy, and propagates linearly. Let us call it as **radiation** or simply as **wave**, distinguished from the particle. A hidden-space dimensional wave is the "**light**" (used as a term for any frequencies). In a space-space dimensional radiation, a fluctuation in space-space dimensions is propagating in a space direction, that is, an intrinsic energy is helically moving in the 3D space. The space-space wave of the smallest radius is the **neutrino**, which is generated by the division of S as a pair with **antineutrino**.

$$S \longrightarrow \nu(H) + \overline{\nu}(\overline{H}) \tag{59}$$

We call them as a “**hemi-circulation**” in space-space dimensions, and express it by the symbol H. A space-space wave of larger radius and energy is so called the **gravitational wave**, many of which were released in a galactic seed separation.

✧ Light speed

The propagation speed of light is equal to the **circulating velocity of the spacia**.

$$\textbf{Light speed}: \; c = v_c = \mu_0 \omega_0 \tag{60}$$

As the space expands, the number of spacias increases, but at this time, the radius μ_0 of the spacia remains unchanged, and the frequency ω_0 decreases. The light speed c also decreases as ω_0 decreases. When the cosmic radius becomes x from x_0, the number of spacias increases to the cube of x/x_0. The intrinsic energy m_μ of the spacia is invariant, and the total energy does not change, either. When ω_0 is expressed as a function of the cosmic radius x, we have the following relation.

$$m_\mu {\mu_0}^2 \big(\omega_0(x_0)\big)^2 = \frac{x^3}{{x_0}^3} m_\mu {\mu_0}^2 \big(\omega_0(x)\big)^2 \tag{61}$$

Let us express the light speed as a function $c(x)$ of the radius.

$$c(x) = \sqrt{\frac{{x_0}^3}{x^3}} * c(x_0) \tag{62}$$

Since ${x_0}^3/x^3$ is equal to the ratio of the space energy density, this Eq. (62) indicates that the light speed is proportional to the square root of the medium density. As the space expands, the **energy** of the **elementary single circulation** shown by Eq. (52) also decreases as ω_0 decreases (the intrinsic energy m_0 remains constant). However, its following **relation to the light speed** remains **unchanged**.

$$E_{(iS)} = E_{(S)} = m_0 c^2 \tag{63}$$

7.1. Definition of electric charge and electric force

✧ Definitions of the electric charge and the magnetic charge

As shown in Eq. (2), the charge of the fundamental force is a momentum, which is a vector having a direction. The direction in the hidden dimension H is orthogonal to any directions in the three space dimensions. Therefore, the angular factors in Eq. (2) disappear for the force in a space direction between two momentums in H. Since H is one dimension, a momentum there and the distance direction are on one plane. If we take $\cos\theta_p = 1$, θ_1 and θ_2 are $+\pi/2$ or $-\pi/2$, and $\sin\theta_1$, $\sin\theta_2 = +1 \text{ or } -1$. Therefore, the charge for this force is a scalar, and take a plus or minus value. In the ECT, the momentum in the hidden dimension H of a hidden-space dimensional circulation is defined as the "**electric charge**". The electric charge takes a plus or minus value depending on the direction of momentum in H. In addition, the momentum in the space dimensions of a hidden-space circulation is defined as the "**magnetic charge**". In the 3D space, the electric charge is a **scalar charge** but the magnetic charge is a **vector charge**.

✧ Electric force

The intra-circulation force of iS in the space direction between the two halves of the circle is given as below.

$$F_x = -\frac{8}{\pi^2} K_f \frac{{p_h}^2}{(2\mu_0)^2} \tag{64}$$

For derivation, please refer to [7] or the pdf book

"Novel electromagnetism by ECT".

http://www3.plala.or.jp/MiTiempo/NovelEM-E.pdf

Here, we define the half circle momentum p_h as the "**elementary electric charge**" e and the constant K_e as follows.

$$K_e \equiv \frac{8}{\pi^2} K_f \,, \qquad e \equiv p_h = \frac{m_0 \mu_0 \omega_0}{2} = \frac{m_0 c}{2} \tag{65}$$

Express the intra-circulation force of Eq. (64) by the electric charge.

$$F_x = -\frac{8}{\pi^2} K_f \frac{{p_h}^2}{(2\mu_0)^2} = -K_e \frac{e^2}{(2\mu_0)^2} \tag{66}$$

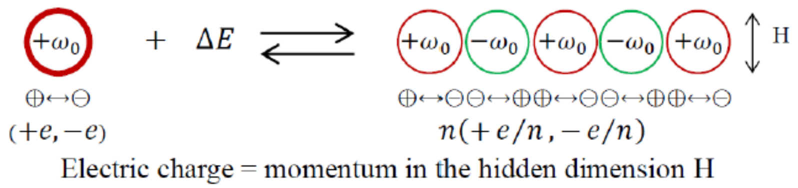
This is the "**electric force**" that acts in the **space direction** between the electric charges in an iS.

7.2. Elementary charge pair eCP

✧ Elementary charge pair

When an iS absorbs a light (light quantum) and energy is added, it prolongs in the space dimension to plural (n) circulations over n spacias as shown in Fig. 7. The number n of circulations is limited to an odd number. This prolonged one is called as the "**elementary charge pair** (**eCP**)".

Fig. 7. Prolongation of hidden-space single circulation iS



✧ Connected electric force

By the addition of energy, the potential energy in the space direction is increased, but the sum of the momentums in the hidden dimension, that is, that of electric charges does not change. The space directional force in each circulation is given as follows from Eq. (66).

$$F_x = K_e \frac{(e/n)(-e/n)}{(2\mu_0)^2} = -K_e \frac{e^2}{(2n\mu_0)^2} = -K_e \frac{e^2}{d^2} \tag{67}$$

At each adjacent part of two circulations, the outward and inward intra-circulation forces set off each other to be zero. The force of Eq. (67) remains only at the two ends of an elementary charge pair. This is equal to the virtual force if it is assumed that elementary charges $+e$ and $-e$ would be separated by the distance $d = n \times 2\mu_0$ (length of eCP). This is the true feature of the electric force acting between an electron and a proton. The electric charges $+e$ and $-e$ are dispersed between the proton and electron, and each of the elementary charge is the sum of the charges. In an atom, the electron-proton pair includes an eCP. A neutrino is attached to the minus end of the eCP, which is an electron. A space-space single circulation $\overline{S}$ is attached to the plus end of the eCP, which is a proton (proton includes also other circulations). We named this force within an eCP as the "**connected electric force**". Thus, the force between a proton and an electron is a connected electric force, not an electrostatic force between isolated electric charges.

✧ Prolongation of eCP

The length of an eCP changes by absorption or emission of light (light quantum).

$$eCP(x) + \gamma \rightleftarrows eCP(x + \Delta x)\,, \qquad x = 2n\mu_0 \tag{68}$$

The energy addition is made by absorbing one cycle of light (light quantum), but the added energy will remain within the eCP. Therefore, the increase in energy (per one second) is $\Delta E = h\nu^2$. Conversely, when an eCP becomes shorter, the difference energy is released as light. In this case, the light emission is that of a light quantum of one cycle, and is not a continuous light.

The added energy ΔE has a maximum. If an eCP absorbs a light of higher energy than the maximum (**higher frequency**), it will **divide to two**.

$$\Delta E = U(x + \Delta x) - U(x) = K_e \frac{e^2}{(2\mu_0)^2}\left(\frac{1}{x} - \frac{1}{x + \Delta x}\right), \qquad \Delta E_{max} = \frac{K_e e^2}{4{\mu_0}^2 x} \tag{69}$$

$$eCP(x) + \Delta E \longrightarrow eCP(x_1) + eCP(x_2) \tag{70}$$

✧ **Magnetic charge by rotation of eCP**

The magnetic charge of a static eCP is zero since those of opposite directions are set off. An eCP can rotate around the hidden dimension axis, and its velocity components in each space direction can flexibly change. By rotating around the H axis, a free eCP with nothing added to either end is rotating in the space dimensions around its center. It shows the “**rotating magnetic charge**”, which is the core feature of the magnetism. (For details, please refer to [2] or the Novel electromagnetism by ECT.)

Chapter 8: Hemi-circulations

8.1. Hemi-circulation in space-space dimensions

As explained in the Section 6.4, the free single circulation S is unstable alone, and divides to two hemi-circulations; H and $\overline{H}$, which are neutrino and antineutrino. The intrinsic energy of a space-space hemi-circulation is $m_0/2$, which is insufficient to be quantized. It moves helically as shown below.

$$m_0{\mu_0}^2{\omega_0}^2 = \frac{m_0}{2}({\mu_0}^2\omega^2 + v^2) + \frac{m_0}{2}({\mu_0}^2\omega^2 + (-v)^2) \tag{71}$$

$$E_{(H)} = \frac{m_0}{2}({\mu_0}^2\omega^2 + v^2) = \frac{m_0}{2}{C_r}^2 + \frac{m_0}{2}v^2 \equiv E_c + E_L \tag{72}$$

If v is in X, the circular velocity C_r is in Y-Z. The total velocity in the 3D space remains as $c = \mu_0\omega_0$.

$${C_r}^2 + v^2 = {v_{yz}}^2 + {v_x}^2 = c^2 \tag{73}$$

We define the circular component of energy as the "**circular energy E_c**" and the linear component as the "**linear energy E_L**". The circular energy shows a particle-like property, but it cannot be static in the space energy. The ratio of C_r and v can be rather flexible, but the linear velocity v is close to the light speed c. Even if ω in C_r increases several times, the change in the linear velocity is almost zero and we can treat as $v \approx c$.

Just immediately after the division of S, a strong repulsive force by orthogonal interaction like Eq. (40) acts between the two halves, while the force constant is $Q_p/4$. This force is what is called as the "**weak force**" in the standard physics. The circular direction is common for the two, but the relative directions toward the moving direction are the opposite to each other. We call one as neutrino and the other as antineutrino.

By receiving the repulsive force, the receding speed is accelerated and the potential energy decreases. The sum of change in kinetic energy and that in potential energy is set off to be zero.

$$E_p \equiv \int_{\infty}^{x} \big(-F(x)\big)\, dx\,, \qquad E_k = -\Delta E_p \tag{74}$$

The energy of neutrino can be expressed as below.

$$E_{(H)} = \frac{m_0}{2} c^2 + E_k + \Delta E_p = \frac{m_0}{2} c^2 \tag{75}$$

The rest energy E_r is defined as the total energy minus the kinetic energy.

$$E_r \equiv E - E_k \tag{76}$$

For more details on the rest energy and kinetic energy, please visit to http://www3.plala.or.jp/MiTiempo/NovelDynamics.pdf for "Novel dynamics by ECT". The energy of neutrino by Eq. (72) can be expressed as follows using the rest energy and kinetic energy.

$$E_{(H)} = \left(\frac{m_0}{2} c^2 + \Delta E_p\right) + E_k = E_r + E_k \tag{77}$$

The change in potential energy is incorporated in the rest energy.

Thus, there are two ways to express the energy of neutrino; the **circular** and **linear** energies shown by Eq. (72) and the **rest** and **kinetic** energies shown by (77). Hereafter, we will use the circular energy as a particle-like property instead of the rest energy.

8.2. Hemi-circulation in hidden-space dimensions

As explained in the Section 7.2, the plus and minus electric charges are lined up alternately in an eCP. Let us express the minus electric charge parts collectively as iH_- and the plus charge parts collectively as iH_+. We call them also as a **hemi-circulation** in hidden-space dimensions, while the two are not divided. The electric charge of either iH disperses to the whole length of an eCP. We express the eCP as below using the hemi-circulations.

$$eCP = iH_+ \cdots iH_- \tag{78}$$

✧ **Structure of electron**

The electron in an atom is the adduct of a neutrino and iH_-. The neutrino is attached to the minus end of the eCP, and $\overline{S}$ of the proton is attached to the plus end of the same eCP. A proton–electron pair in atom has the following structure.

$$\textbf{proton} \cdots \textbf{electron}\text{: } p^+\left(D^\#, D, \overline{S}, iH_+\right) \cdots e^-(H_e, iH_-) \tag{79}$$

H_e is the e-neutrino. Depending on the adduct partner, the ratio of circular and linear velocities varies. The e-neutrino has a smaller circular energy than those of other types μ-neutrino and τ-neutrino while their total energies are the same.

As explained and shown by Eqs. (69) and (70), the eCP has the maximum energy, and it divides to two ones when absorbs a light quantum of higher energy than the maximum. If it happens in an atom, it results in so called the ionization. The released electron, which we call as the "**free electron**", is the adduct of the neutrino and an eCP. The proton becomes the "**free proton**". Their structures are shown below.

$$\begin{aligned} &p^+\left(D^\#, D, \overline{S}, iH_+\right) \cdots e^-(H_e, iH_-) + \Delta E \\ &\longrightarrow p_f\left(D^\#, D, \overline{S}, eCP\right) + e_f(H_e, eCP) \end{aligned} \tag{80}$$

Either the free electron or the free proton is electrically neutral in total.

9.1. Beta decay of neutron

✧ Neutron

The neutron has the following composition of energy circulations.

$$\textbf{neutron}:\ n^0\left(D^\#, D, D, iS\right) \tag{81}$$

The neutron is electrically neutral in total but has the polarization of e^+ and e^- by iS. The iS rotates around the hidden dimension axis, and shows a rotating magnetic charge (magnetism). As for the energy and spin, we will explain in the next chapter.

✧ Excitation of neutron

iS is the shortest eCP. By absorbing energy (light), it prolongs as shown by Eqs. (68) and (69).

The flat separation of S and $\overline{S}$ of D is shown by Eq. (29) with Eqs. (27) (28) for the force and by Eq. (30) for the potential energy, and their graphs are in Fig. 4. In $|x| < 1$, the force between S and $\overline{S}$ is attractive, but once got $|x| > 1$, it becomes repulsive. The two pieces of D once absorbs energy and cross the energy crest at $|x| = 1$, the they accelerate to recede away.

After the flat separation of D, $\overline{S}$ remains in the nucleus and attaches to the plus end of eCP, and S attaches to the minus end of eCP. The decrease in potential energy of the flat separation from $x = 1$ to $x = \infty$, that is, the potential energy at $x = 1$ of Eq. (30) is given as below, where $x_0 \equiv 0.1$.

$$U_{flat}(1) = Q_p\left(\frac{1}{\sqrt{0+0.1^2}} + \frac{1}{\sqrt{2^2+0.1^2}} - \frac{2}{\sqrt{1+0.1^2}}\right) \approx 8.5Q_p \tag{82}$$

If the separated S and $\overline{S}$ are free without binding to others, the decrease in potential energy converts to the increase in kinetic energy. However, in this case, they attach to the plus end and the minus end of eCP, respectively.

Next, let us see the potential energy of eCP by prolongation of iS. The connected electric force is given by Eq. (67). Let us rewrite it by Q_p and x. At $x = 0$ without prolongation, the distance of the two ends of iS is $2\mu_0$. The distance of the two ends of eCP is $d = 2\mu_0(x+1)$. From Eqs. (67) and (65), the electric force is expressed as follows.

$$F_e = -K_e \frac{e^2}{d^2} = -\frac{8}{\pi^2} K_f \frac{{p_h}^2}{4{\mu_0}^2(x+1)^2} \tag{83}$$

Q_p is given by Eq. (27) as

$$Q_p = K_f \frac{{p_h}^2}{\pi^2 {\mu_0}^2}.$$

The force by Eq. (83) is expressed by Q_p as below.

$$F_e(x) = -2Q_p \frac{1}{(x+1)^2} \tag{84}$$

The potential energy of the electric force is defined as below.

$$U_e(x) \equiv \int_{\infty}^{x} \left(-F_e(x)\right) dx = -2Q_p \left[\frac{1}{x+1}\right]_{\infty}^{x} = -2Q_p \frac{1}{x+1} \tag{85}$$

At $x = 0$, that is, in the case of iS, the potential energy is

$$U_e(0) = -2Q_p\,. \tag{86}$$

✧ First step of the beta decay of neutron

The sum of the potential energy of Eq. (82) and that of Eq. (86) is greater than zero.

$$U_{flat}(1) + U_e(0) \approx 6.5Q_p > 0 \tag{87}$$

This means that the released energy by the decrease in potential energy from $x = 1$ to $x = \infty$ by the $S - \overline{S}$ separation is much greater than the necessary energy to increase the potential energy of eCP from $x = 0$ to $x = \infty$. This fact results in the division of eCP to two eCPs if once the distance of $S - \overline{S}$ gets $x \geq 1$. After the separation, $\overline{S}$ in the nucleus attaches to the plus end of one eCP, and S attaches to the minus end of the other eCP. This is the first step of the beta decay of neutron.

$$n^0\left(D^\#, D, D, iS\right) + \Delta E \longrightarrow \left(D^\#, D, \overline{S}, iS\right) + S \longrightarrow p_f\left(D^\#, D, \overline{S}, eCP\right) + a(S, eCP) \quad (88)$$

$p_f\left(D^\#, D, \overline{S}, eCP\right)$ is the **free proton**, which is the ionized proton in the standard physics. $a(S, eCP)$ is an interim particle and named as the "**anon**" with the symbol a.

✧ Second step of the beta decay of neutron

As shown by Eq. (59), S divides to neutrino and antineutrino, which separate by the orthogonal interaction (weak force in the standard physics). The second step of the beta decay is this division and separation. The neutrino ν attaches to the minus end of the eCP, and forms a **free electron** e_f. The **antineutrino** $\overline{\nu}$ moves alone to the opposite direction. The energies and velocities of the neutrinos are shown by Eqs. (71) (72) and (73).

$$a(S, eCP) \longrightarrow e_f(H, eCP) + \overline{\nu}\left(\overline{H}\right) \quad (89)$$

✧ Overall process of the beta decay of neutron

The two steps of Eqs. (88) and (89) give the following overall process of the beta decay of neutron.

$$n^0\left(D^\#, D, D, iS\right) \longrightarrow p_f\left(D^\#, D, \overline{S}, eCP\right) + e_f(H, eCP) + \overline{\nu}\left(\overline{H}\right) \quad (90)$$

The p_f and e_f from the same neutron do not bind since they continue to recede. However, the p_f captures another e_f from another neutron, and the e_f binds to another p_f, resulting in forming the hydrogen atom.

$$p_f\left(D^\#, D, \overline{S}, eCP\right) + e_f(H, eCP) \longrightarrow p^+\left(D^\#, D, \overline{S}, iH_+\right) \cdots e^-(H, iH_-) \quad (91)$$

Thus, the neutron is not stable on its own, and pursues the beta decay with a half-life of about 15 minutes.

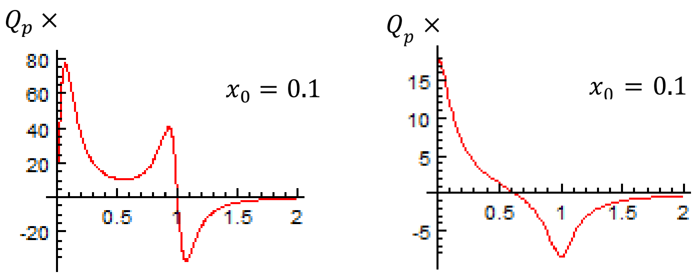
9.2. Nuclear forces between nucleons

✧ Basic nuclear force between $\overline{S}$ and $\overline{S}$

The neutron has a double circulation $D = S{:}\overline{S}$, and the proton has a single circulation $\overline{S}$. Between proton and proton, and proton and neutron, there is a common interaction, which is the flat interaction of $\overline{S} - \overline{S}$. Its force and potential energies are given by Eqs. (31) and (32) with Eqs. (27) (28) and (30). Their graphs are shown in Fig. 8.

Fig. 8. Flat interaction of $\overline{S}$ and $\overline{S}$ in nucleus

$x = d/2\mu_0$: Relative distance to the diameter



(a) Force (b) Potential energy

The force (a) and the potential energy (b) of flat interaction between $\overline{S}$ and $\overline{S}$. x_0 is vertical distance (diameter of the local circulations) set as 0.1.

If x gets a little smaller than 1, a strong repulsive force works. In $x > 1$, a strong attractive force acts. This interaction makes the two $\overline{S}$ attached to each other.

✧ Flat interaction of S with two attached $\overline{S} \cdot \overline{S}$

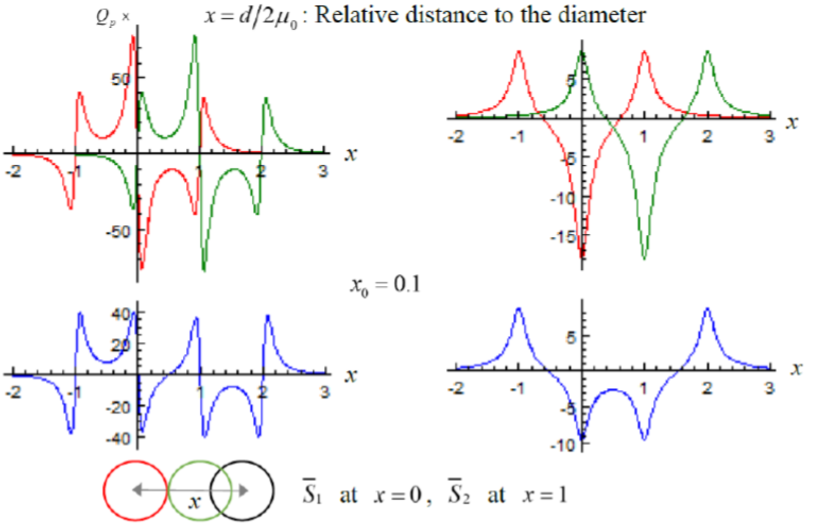
Consider the adduct of a proton and a neutron. In the nucleus, if S of the neutron in D separates, it is captured by $\overline{S}$ of the proton. Thus, the two nucleons can exchange S. Let us examine the following process.

$$S + \overline{S} \cdot \overline{S} \leftarrow D(S{:}\overline{S}) \cdot \overline{S} \leftrightarrow \overline{S} \cdot D(\overline{S}{:}S) \rightarrow \overline{S} \cdot \overline{S} + S \tag{92}$$

Let $x = 0$ be the position of one $\overline{S}$ and $x = 1$ be that of the other $\overline{S}$. The force and potential energies are given by Eqs. (29) and (30) with (27) and (28) for the flat interaction with $\overline{S}$ at $x = 0$. Those for $\overline{S}$ at $x = 1$ can be obtained by substituting $x + 1$ to x. We show the graphs of force and potential energy of this interaction in Fig. 9.

Fig. 9. Flat interaction of S with two attached $\overline{S} \cdot \overline{S}$

$$S + \overline{S} \cdot \overline{S} \leftarrow D(S\!:\!\overline{S}) \cdot \overline{S} \leftrightarrow \overline{S} \cdot D(\overline{S}\!:\!S) \rightarrow \overline{S} \cdot \overline{S} + S$$



(a) Respective forces on S (black) from $\overline{S}_1$ (red), $\overline{S}_2$ (green), sum (blue)

(b) Respective potentials of S from $\overline{S}_1$ (red), $\overline{S}_2$ (green), sum (blue)

The red lines are for the interaction of S with $\overline{S}$ at $x = 0$. The green lines are for that with $\overline{S}$ at $x = 1$. The blue lines are the sums and show the force and potential energy of S with the whole of $\overline{S} \cdot \overline{S}$. As we see there, the S shows the energy troughs at $x = 0$ and $x = 1$, and the energy crests at $x = -1$ and $x = 2$. Thus, even if D of a neutron separates, S is captured by the other $\overline{S}$ and forms another D. The neutron is extremely stable in a nucleus.

Chapter 10: Energy and spin of elementary circulations

10.1. Energy of elementary circulations

✧ Single circulations

The energy of S and iS is given as $E_{(S)} = E_{(iS)} = m_0 {\mu_0}^2 {\omega_0}^2 = m_0 c^2$. We do not know yet the value of m_0. Let us **assume** that both the single circulations have the energy of 100 MeV.

$$E_{(S)} = E_{(iS)} = m_0 c^2 \coloneqq 100\ \text{MeV} \tag{93}$$

✧ Hemi-circulation H

The total energy of the hemi-circulation H is a half of $E_{(S)}$. The value is the same for all types of neutrino.

$$E_{(H)} = E_{(S)}/2 = 50\ \text{MeV} \tag{94}$$

H is not a quantized particle, and is moving at a velocity close to c. As a particle-like property, we show the circular energy E_c. H attaches to eCP, where other circulations join in some case. The **circular energy** depends on the energy of the complex. We **assume** the circular energies of H_e (e-neutrino) and $\overline{H_e}$ (e-antineutrino) as follows.

$$E_{c(H_e)} \coloneqq 0.4\ \text{MeV}\,, \qquad E_{c(\overline{H_e})} :\approx 0\ \text{MeV} \tag{95}$$

While we will show the structures of muon and tau later, we **assume** the circular energies of μ-neutrino and τ-neutrino as below.

$$E_{c(H_\mu)} \coloneqq 5\ \text{MeV}\,, \qquad E_{c(\overline{H_\mu})} :\approx 0\ \text{MeV} \tag{96}$$

$$E_{c(H_\tau)} \coloneqq 40\ \text{MeV}\,, \qquad E_{c(\overline{H_\tau})} :\approx 0\ \text{MeV} \tag{97}$$

✧ eCP and iH

The energy of an eCP depends on its length as explained in the Section 7.2. Take x as the length (not relative one to $2\mu_0$). ΔE_p is the increase in electric potential energy from iS.

$$\Delta E_p = U_e(x) - U_e(2\mu_0) = \int_{2\mu_0}^{x} \left(-F_e(x)\right) dx = \int_{2\mu_0}^{x} K_e \frac{e^2}{x^2} dx \tag{98}$$

Here, we set the energy of iS as the potential energy at $x = 2\mu_0$.

$$U_e(2\mu_0) \equiv E_{(iS)} = m_0 c^2 \tag{99}$$

Then, we **define** the **potential energy** of the **electric force** as follows.

$$U_e(x) \equiv \int_{2\mu_0}^{x} \left(-F_e(x)\right) dx + m_0 c^2 \quad (x \geq 2\mu_0) \tag{100}$$

It is a big contrast to the potential energy in general for other forces such as inter-circulation forces and gravitational force shown as below, where the value of infinity distance is set as zero, $U(\infty) \equiv 0$.

$$U(x) \equiv \int_{\infty}^{x} \left(-F(x)\right) dx \tag{101}$$

The electric potential energy of an eCP is given as follows and is equal to the total energy.

$$U_e(x) = K_e e^2 \left(\frac{1}{2\mu_0} - \frac{1}{x}\right) + m_0 c^2 = E_{(eCP)}(x) \quad (x \geq 2\mu_0) \tag{102}$$

We do not know yet the value of K_e or K_f. In the case of an atomic eCP, the value of x is about $10^4 \times 2\mu_0$. Let the energy of atomic eCP be expressed as $E_{(eCP)}$, which we **assume** as 276 MeV (for hydrogen atom).

$$E_{(eCP)} \coloneqq 276 \text{ MeV} \tag{103}$$

The energy of iH is a half of $E_{(eCP)}$. We take the location of an atomic electron as the place where the neutrino exists. The energy of the end part of iH_- in one spacia is about 10^{-4} of $E_{(iH_-)}$. We **conveniently set** the circular energy $E_{c(iH_-)}$ to the motion of electron as 0.1 MeV.

$$E_{(iH_-)} = E_{(eCP)}/2 = 138 \text{ MeV}, \qquad E_{c(iH_-)} \coloneqq 0.1 \text{ MeV} \tag{104}$$

On the other hand, the circular energy of iH_+ for the static proton is equal to the total energy.

$$E_{(iH_+)} = 138 \text{ MeV}, \qquad E_{c(iH_+)} = 138 \text{ MeV} \tag{105}$$

✧ Double circulations

The double circulation D is the coupled conjugate pair of S and $\overline{S}$.

$$E_{(S)} + E_{(\overline{S})} = E_{(D)} + \Delta E \tag{106}$$

ΔE is equal to the difference ΔE_p in potential energy of the separated S and $\overline{S}$ from $x = x_0$ to $x = \infty$. From the definition of potential energy, $\Delta E = -E_p(x_0)$. $E_p(x_0)$ is the potential energy at $x = x_0$. The energy of D is given as follows.

$$E_{(D)} = 2m_0c^2 - \Delta E = 2m_0c^2 + E_p(x_0) \tag{107}$$

The potential energy from the orthogonal interaction is given by Eq. (39). Let us call this potential energy at $x = x_0$ as the **potential energy of D**.

$$U_{ort}(S - \overline{S})(x = x_0) = Q_p\pi\left(\frac{1}{\sqrt{{x_0}^2 + 1}} - \frac{1}{x_0}\right) \equiv U_{(D)} < 0 \tag{108}$$

$U_{(D)}$ is equal to $E_p(x_0)$. The energy of D is expressed as follows.

$$E_{(D)} = 2m_0c^2 + U_{(D)} \tag{109}$$

We do not know yet either the value of Q_p or that of x_0. The value of $U_{(D)}$ is determined but not yet known. We **assume** the potential energy $U_{(D)}$ and the total energy $E_{(D)}$ of D as follows.

$$U_{(D)} \coloneqq -0.6m_0c^2\,, \qquad E_{(D)} \coloneqq 140\ \mathrm{MeV} \tag{110}$$

As for the hidden-space double circulation iD, we expect a little different value of $U_{(iD)}$ from that of $U_{(D)}$. We **assume** the potential and total energies of iD as follows.

$$U_{(iD)} \coloneqq -0.65m_0c^2\,, \qquad E_{(iD)} \coloneqq 135\ \mathrm{MeV} \tag{111}$$

✧ Excited double circulations

As a quantized energy circulation, we expect some excited forms of double circulations, the frequency of which is double or triple of ω_0. $D^\#$ and $iD^\#$ have the frequency $\omega = 2\omega_0$, and their energies are 4 times that of D or iD since the energy is given by $m{\mu_0}^2\omega^2$.

$$E_{(D^{\#})} = 4 \times 140 \text{ MeV} = 560 \text{ MeV} \tag{112}$$

$$E_{(iD^{\#})} = 4 \times 135 \text{ MeV} = 540 \text{ MeV} \tag{113}$$

We further expect $D^{\#\#}$, whose frequency is $\omega = 3\omega_0$. We **assume** its energy a little smaller than $9 \times E_{(D)}$ as below.

$$E_{(D^{\#\#})} = 9 \times 140 - 10 \text{ MeV} = 1250 \text{ MeV} \tag{114}$$

✧ **Note on assumption of energies of elemental circulations**

The most of energies of elementary circulations mentioned above are an assumption by anyhow, while they include various considerations. You should have a question why such values are assumed. If we assume those values, we can get the best fit of expected values to the observed ones of various quantum particles. We will explain the composition of energy circulations on individual quantum particles in the next chapter.

10.2. Spin of particles

✧ **Spin of single circulations**

The spin of a particle can be regarded as a **qualitative** parameter of its angular momentum in **space dimensions**. The elementary single circulation S has the following angular momentum.

$$\mathbf{L}_{(\mathbf{S})} = \mathbf{L}_{(\mathbf{iS})} = m_0 \mu_0 \boldsymbol{\omega}_\mathbf{0} \times \boldsymbol{\mu}_\mathbf{0} \tag{115}$$

It has a direction depending on the circular direction of $\boldsymbol{\omega}_\mathbf{0}$; $+\omega_0$ of S or $-\omega_0$ of $\overline{S}$. We **define** the spin J of the **single circulations** as $J = 1/2$. Taking the direction, the third component of spin is $J_3 = +1/2$ or $J_3 = -1/2$ for $+\omega_0$ or $-\omega_0$.

In the case of the single circulation iS, the angular momentum shown by Eq. (115) is in hidden-space dimensions. The helicity, which is the circular direction to the linear direction, has been inherited in many rounds of cyclic decompositions from the cosmic separation. The helicity of iS in our universe is asymmetry and expressed by iS having the frequency ω_0. Here is an important aspect that iS can flexibly rotate around the hidden dimensional axis H. It results in a helical motion of the intrinsic energy m_0 in space dimensions. This helicity in space dimensions inherited that of iS in 4D space. In the case of a static iS, the circular frequency in space dimensions is ω_0, and its circular momentum is expressed by Eq. (115). We define the spin of iS as $J = 1/2$ similar to S. The third component of the majority is $J_3 = +1/2$ of iS. As shown in Fig. 6, two iS in one spacia form iD consisting of iS and $\overline{iS}$. $\overline{iS}$ has $J_3 = -1/2$.

The elementary charge pair eCP is a prolonged iS. Like the case of iS, an eCP can flexibly rotate in space dimensions, and its helicity is limited to the right screw one. We assign $J = 1/2$ for eCP, which shows only $J_3 = +1/2$.

✧ Spin of double circulations

We can define the spin of any particle of composite circulations as

$$J \equiv \left|\sum J_3\right| . \tag{116}$$

In the case of any double circulations, their spin becomes zero as $J = 1/2 - 1/2 = 0$.

In a nucleon like neutron, iS of $+\omega_0$ couples with $\bar{S}$ of $-\omega_0$ when D separates to S and $\bar{S}$. $\bar{S}$ remains in the nucleon, and S gets out then divides. This **hetero coupled pair** is not but like a double circulation, and the circular momentum is cancelled out as below.

$$J_3(iS{:}\bar{S}) \approx 1/2 - 1/2 = 0 \tag{117}$$

✧ Spin of hemi-circulations

The circular momentum of the hemi-circulation H is extremely smaller than that of a single circulation. We assign $J = 1/2$ for H, but $J = 0$ if associated with S. Similarly, we assign $J = 1/2$ for iH_+, but $J = 0$ if associated with $\overline{S}$. For an atomic electron, we can consider only the spin of the neutrino, and assign $J = 0$ for iH_-.

✧ **Summary of spins of elementary circulations**

S: $J = 1/2$

iS: $J = 1/2$

eCP: $J = 1/2$

H: $J = 1/2$ but $J = 0$ if associated with S

H_-: $J = 0$

H_+: $J = 1/2$ but $J = 0$ if associated with $\overline{S}$

$D, iD, D^{\#}, iD^{\#}, D^{\#\#}$: $J = 0$

Composite particle: $J \equiv |\sum J_3|$

$(iS{:}\overline{S})$: $J = 0$ (hetero coupled pair)

Chapter 11: Compositions of major particles

11.1. Listed items of properties of particles

In this chapter, we will show the list of major particles including various properties. Let me explain the items of properties.

Name: New particles, which we named, are shown by "name". The existing ones are shown by "name". We do not show **anti-particles**, in which **all** single circulations are opposite to those of particles.

Symbol: We assigned new ones for new particles.

Composition: As mentioned in the Section 6.2, there are three space-space dimensional planes and there hidden-space dimensional planes in one spacia. In one particle, in maximum three space-space and three hidden-space elementary circulations can occupy. Anti-circulations are shown by $\overline{Cir}$ such as $\overline{iH_+}$, whose electric charge is $-e$ in total.

Electric charge: + and – show $+e$ and $-e$, respectively. ⇔ means that the total charge is zero but electrically polarized.

Spin: The qualitative spin, which was explained in the Section 10.2, is shown. We use $J \equiv |\sum J_3|$ shown by Eq. (116) and $J_3(iS{:}\overline{S}) \approx 0$ shown by Eq. (117)

Total energy: It is the sum of energies of component elementary circulations. Shown in MeV.

Circular energy: Sum of values of components. It is not equal to but corresponds to the rest energy.

Reported mass: Reported values are shown in MeV/c^2.

Decay reactions: Reported reactions are shown with component of energy circulations. This is a very important factor to guess the composition of energy circulations along with the energies.

11.2. Compositions of quantum particles

✧ Elementary circulations (single and double circulations)

We assumed the energy of an individual elementary energy circulation as explained in the Section 10.1. Double circulations are of the class of meson.

Table 1

Name	Symbol + (Composition)	Electric charge	Spin (J)	Total energy E(MeV)	Circular energy E_c(MeV)	Reported mass (MeV/c^2)
<Single circulation>						
"unino"	$u(S)$	0	1/2	100	100	
"photino"	$Ph(iS)$	⇔	1/2	100	100	
"eCP"	$eCP(iH_+ \cdots iH_-)$	⇔	1/2	100-280		
<Double circulation (meson)>						
"duon"	$d(D)$	0	0	140	140	
"duon$^\#$"	$d^\#(D^\#)$	0	0	560	560	
"duon$^{\#\#}$"	$d^{\#\#}(D^{\#\#})$	0	0	1250	1250	
pion^0	$\pi^0(iD)$	0	0	135	135	(135)
		$\pi^0(iD) \longrightarrow 2\gamma$				
eta meson	$\eta^0(iD^\#)$	0	0	540	540	(549)
		$\eta^0(iD^\#) \longrightarrow 2\gamma$				
		$\eta^0(iD^\#) \longrightarrow 3\pi^0(iD)$				
		$\eta^0(iD^\#) \longrightarrow \pi^-(D, iH_-) + \pi^0(iD) + \pi^+\left(D, \overline{iH_-}\right)$				

✧ Hemi-circulations

We classify the hemi-circulations as a lepton as shown in the below table. We also call some complexes with other circulations as the complex lepton.

Table 2

Name	Symbol + (Composition)	Electric charge	Spin (J)	Total energy E(MeV)	Circular energy E_c(MeV)	Reported mass (MeV/c^2)
<Hemi-circulation>						
1) Neutrino (lepton)						
e-neutrino	$\nu_e(H_e)$	0	1/2(0)	50	0.4	
anti-ν_e	$\overline{\nu_e}(\overline{H_e})$	0	1/2	50	≈ 0	(≈ 0)
μ-neutrino	$\nu_\mu(H_\mu)$	0	1/2(0)	50	5	
anti-ν_μ	$\overline{\nu_\mu}(\overline{H_\mu})$	0	1/2	50	≈ 0	(≈ 0)
τ-neutrino	$\nu_\tau(H_\tau)$	0	1/2(0)	50	40	
anti-ν_τ	$\overline{\nu_\tau}(\overline{H_\tau})$	0	1/2	50	≈ 0	(≈ 0)
2) Electric charge						
"protino"	(iH_+)	+	1/2(0)	138	138	
"electrino"	(iH_-)	-	0	138	0.1	
<Complex lepton>						
electron	$e^-(H_e, iH_-)$	-	1/2	188	0.5	(0.5)
muon	$\mu^-(S, H_\mu, iH_-)$	-	1/2	288	105.1	(106)
	$\mu^-(S, H_\mu, iH_-) \longrightarrow e^-(H_e, iH_-) + \overline{\nu_e}(\overline{H_e}) + \nu_\mu(H_\mu)$					
tau	$\tau^-(2iD^\#, D^\#, S, H_\tau, iH_-)$	-	1/2	1928	1780.1	(1777)
	$\tau^-(2iD^\#, D^\#, S, H_\tau, iH_-) \longrightarrow e^-(H_e, iH_-) + \overline{\nu_e}(\overline{H_e}) + \nu_\tau(H_\tau)$					
	$\tau^-(2iD^\#, D^\#, S, H_\tau, iH_-) \longrightarrow \mu^-(S, H_\mu, iH_-) + \overline{\nu_\mu}(\overline{H_\mu}) + \nu_\tau(H_\tau)$					
	$\tau^-(2iD^\#, D^\#, S, H_\tau, iH_-) \longrightarrow \pi^-(D, iH_-) + \pi^0(iD) + \nu_\tau(H_\tau)$					

✧ **Mesons (non-lepton, non-baryon)**

Not only double circulations, let us classify the particles, which are not a lepton or a baryon, also as a meson.

Table 3

Name	Symbol + (Composition)	Electric charge	Spin (J)	Total energy E(MeV)	Circular energy E_c(MeV)	Reported mass (MeV/c^2)
<Meson>						
"anon"	$a(S,eCP)$	⇔	1	200-380		
pion$^-$	$\pi^-(D,iH_-)$	-	0	278	140.1	(140)
	$\pi^-(D,iH_-) \longrightarrow \mu^-(S,H_\mu,iH_-)+\overline{\nu_\mu}(\overline{H_\mu})$					
kaon^0	$K^0(2D,\overline{S},iS)$	⇔	0	480	480	(498)
	$K^0(2D,\overline{S},iS) \longrightarrow \pi^-(D,iH_-)+\pi^+(D,\overline{iH_-}) \quad (K_S{}^0)$					
	$\overline{K^0}(2D,S,\overline{iS}) \longrightarrow \pi^-(D,iH_-)+e^+(\overline{H_e},\overline{iH_-})+\nu_e(H_e) \quad (K_L{}^0)$					
kaon$^+$	$K^+(iD,D,\overline{S},iS,\overline{iH_-})$	+	0	613	475.1	(494)
	$K^+(iD,D,\overline{S},iS,\overline{iH_-}) \longrightarrow \mu^+(\overline{S},\overline{H_\mu},\overline{iH_-})+\overline{\nu_e}(\overline{H_e})+\nu_\mu(H_\mu)$					
	$K^+(iD,D,\overline{S},iS,\overline{iH_-}) \longrightarrow \pi^+(D,\overline{iH_-})+\pi^0(iD)$					
kaon$^-$	$K^-(iD,D,\overline{S},iS,iH_-)$	-	0	613	475.1	(494)
	K^- is not the antiparticle of K^+.					
D meson^0	$D^0(D^{\#\#},2iD,D,\overline{S},iS)$	⇔	0	1860	1860	(1865)
	$D^0(D^{\#\#},2iD,D,\overline{S},iS) \longrightarrow K^-(iD,D,\overline{S},iS,iH_-)+\pi^+(D,\overline{iH_-})+\pi^0(iD)$					
D meson$^+$	$D^+(D^{\#\#},iD,D,\overline{S},iS,iH_+)$	+	0	1863	1863	(1870)
	$D^+(D^{\#\#},iD,D,\overline{S},iS,iH_+) \longrightarrow K^0(2D,\overline{S},iS)+\pi^+(D,\overline{iH_-})+\pi^0(iD)$					
D meson$^-$	$D^-(D^{\#\#},iD,D,\overline{S},iS,\overline{iH_+})$	-	0	1863	1863	(1870)
	K^- is not the antiparticle of K^+.					

✧ Baryons

The “baryon” is generally defined as a particle that decays finally to a stable nucleon (proton or neutron). As we see below, any baryon has the excited double circulation $D^{\#}$ and either iS, iH_+ or $\overline{iH_+}$.

Table 4

Name	Symbol + (Composition)	Electric charge	Spin (J)	Total energy E(MeV)	Circular energy E_c(MeV)	Reported mass (MeV/c^2)
<Baryon>						
proton	$p^+(D^{\#}, D, \bar{S}, iH_+)$	+	1/2	938	938	(938)
neutron	$n^0(D^{\#}, 2D, iS)$	⇔	1/2	940	940	(940)
	$n^0(D^{\#}, 2D, iS) \longrightarrow p_f(D^{\#}, D, \bar{S}, eCP) + e_f(H_e, eCP) + \overline{\nu_e}(\overline{H_e})$					
	$p_f(D^{\#}, D, \bar{S}, eCP) + e_f(H_e, eCP) \longrightarrow p^+(D^{\#}, D, \bar{S}, iH_+) \cdots e^-(H_e, iH_-)$					
lambda	$\Lambda^0(iD, D^{\#}, 2D, iS)$	⇔	1/2	1075	1075	(1116)
	$\Lambda^0(iD, D^{\#}, 2D, iS) \longrightarrow p^+(D^{\#}, D, \bar{S}, iH_+) + \pi^-(D, iH_-)$					
	$\Lambda^0(iD, D^{\#}, 2D, iS) \longrightarrow n^0(D^{\#}, 2D, iS) + \pi^0(iD)$					
sigma^0	$\Sigma^0(2iD,\ D^{\#}, 2D, iS)$	⇔	1/2	1210	1210	(1192)
	$\Sigma^0(2iD,\ D^{\#}, 2D, iS) \longrightarrow \Lambda^0(iD, D^{\#}, 2D, iS) + \gamma$					
sigma$^+$	$\Sigma^+(2iD,\ D^{\#}, D, \bar{S}, iH_+)$	+	1/2	1208	1208	(1180)
	$\Sigma^+(2iD,\ D^{\#}, D, \bar{S}, iH_+) \longrightarrow p^+(D^{\#}, D, \bar{S}, iH_+) + \pi^0(iD)$					
	$\Sigma^+(2iD,\ D^{\#}, D, \bar{S}, iH_+) \longrightarrow n^0(D^{\#}, 2D, iS) + \pi^+(D, \overline{iH_-})$					
sigma$^-$	$\Sigma^-(2iD,\ D^{\#}, D, \bar{S}, \overline{iH_+})$	-	1/2	1208	1208	(1197)
	$\Sigma^-(2iD,\ D^{\#}, D, \bar{S}, \overline{iH_+}) \longrightarrow n^0(D^{\#}, 2D, iS) + \pi^-(D, iH_-)$					
xi^0	$\Xi^0(iD^{\#},\ D^{\#}, D, iS)$	⇔	1/2	1340	1340	(1315)
	$\Xi^0(iD^{\#},\ D^{\#}, D, iS) \longrightarrow \Lambda^0(iD, D^{\#}, 2D, iS) + \pi^0(iD)$					
xi^{--}	$\Xi^-(iD^{\#},\ D^{\#}, \bar{S}, \overline{iH_+})$	-	1/2	1338	1338	(1321)
	$\Xi^-(iD^{\#},\ D^{\#}, \bar{S}, \overline{iH_+}) \longrightarrow \Lambda^0(iD, D^{\#}, 2D, iS) + \pi^-(D, iH_-)$					
omega	$\Omega^-(iD^{\#}, D^{\#}, iD, 2D, \overline{iH_+})$	-	1/2	1653	1653	(1672)
	$\Omega^-(iD^{\#}, D^{\#}, iD, 2D, \overline{iH_+}) \longrightarrow \Lambda^0(iD, D^{\#}, 2D, iS) + K^-(iD, D, \bar{S}, iS, iH_-)$					
	$\Omega^-(iD^{\#}, D^{\#}, iD, 2D, \overline{iH_+}) \longrightarrow \Xi^0(iD^{\#},\ D^{\#}, D, iS) + \pi^+(D, \overline{iH_-})$					

Conclusion

As shown in the Chapter 11, the novel scheme of particles by the ECT successfully predicted the energy values for individual particles. It is a big contrast to that the standard model cannot at all. Reported decay reactions also supported the novel scheme, in which any quantum particle consists of elementary energy circulations. Can you still support the standard model of quarks?

As explained in the Chapter 3, the two main bases of the standard particle physics; the conventional quantum mechanics and the gauge theory, contain critical contradictions and mistakes from a mathematical point of view. Why did they persist the standard model even they ignored a mathematical bankrupt? It should be because they **did not know** the **force** working on momentums. The situation is similar to the case of the geocentric theory vs. the heliocentric one. Before the gravitational force was discovered, various possibilities to explain the complex movements of planets should have been thought to have a chance. If some factor or force to cause such motions of planets under the geocentric vision was proposed, it might have been accepted. However, it would be denied after the gravitational force was discovered. Now, the new force working on momentums, which they did not know, has been discovered.

Anti-parallel movements of energy make an energy circulation by the fundamental force working on momentums. As the space expands, cyclic decompositions occurred in many rounds, and gave a tremendous number of smaller energy circulations. The particle is defined as an energy circulation. It can keep a constant radius and be static to the space energy. It receives an inter-circulation force with others; attractive or repulsive.

The smallest quantized energy circulation is the elementary single circulation; S in space-space or iS in hidden-space dimensions. It has the same radius μ_0 as that of the spacia in a 4D unit space. Two single circulations in one spacia form a coupled pair of conjugate circulations called as a double circulation. Excited forms of double circulations of twice or three times frequency are possible. These circulations can function as an elementary circulation. In one spacia, three space-space and three hidden-space elementary circulations in maximum can occupy, and form a quantum particle. We can express the structure of a quantum particle by the composition of elementary circulations. Its energy is the sum of those of component circulations.

The electric charge is defined as the momentum in the hidden dimension of hidden-space energy circulations. The single circulation iS has the elementary electric charges $+e$ and $-e$. By absorbing a light, it prolongs to plural circulations, in which plus and minus charges line up alternately, but the total charges are kept as $+e$ and $-e$. We call such a prolonged one as the elementary charge pair eCP. An eCP has an electric polarization but its total charge is zero. The minus charge part of an eCP is defined as the hemi-circulation iH_- and the plus part as iH_+.

The final outcomes on particles from the ECT are summarized in the Tables 1 to 4 in the Chapter 11. I would highly appreciate if you will kindly correct the composition of circulations for any particle.

Shigeto Nagao

First version: posted on July 2024. This version: shown on the cover page

Posted in Books on the ECT

http://www3.plala.or.jp/MiTiempo/books.html

The following books are also available from the above URL.

Novel electromagnetisms by the ECT

Novel cosmology by the ECT

Novel dynamics by the ECT