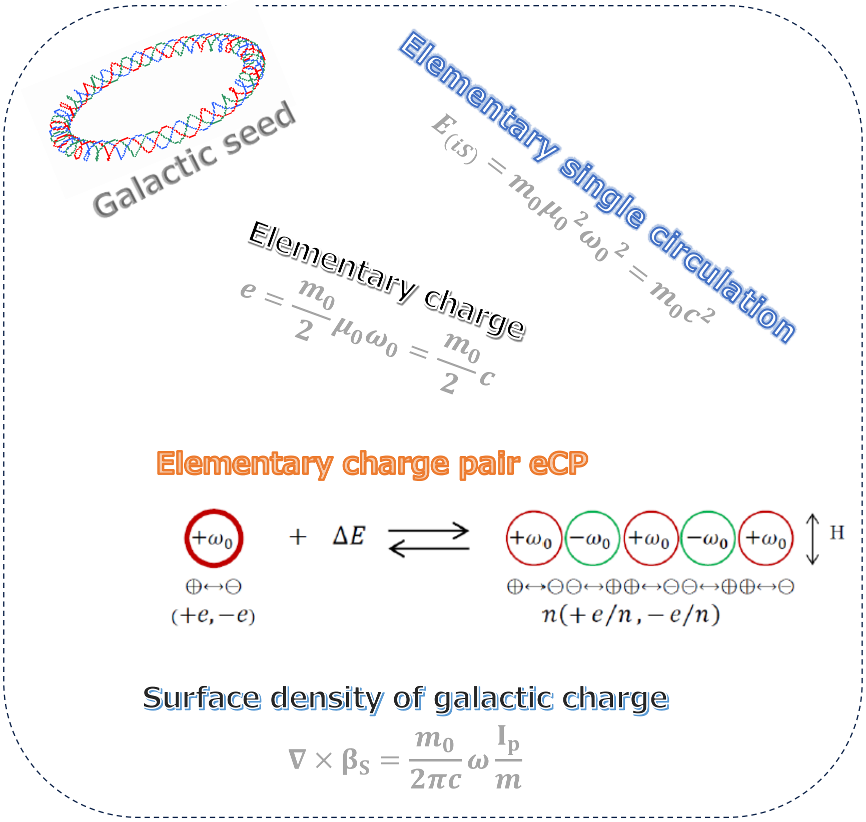
Japanese

Novel Electromagnetism

by the Energy Circulation Theory



Ver. 2024.04

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Introduction: Problems of existing electromagnetism

It is said that the electromagnetism can be finally reduced to Maxwell's equations and is complete without a need of modification. However, is it true? In the existing electromagnetism, the electric charge is an important property; when positive and negative charges are separated, an electric potential difference is created, and the flow of electric charge becomes an electric current. It is this electric charge that I question. Currently, the electric charge is considered to be a fundamental property that charged particles have from the beginning, and the origin of how electric charge appears is ignored and shelved. It is regarded that electron and proton each has a negative or positive elementary electric charge e, and an integral multiple charge of it $q = ne$ is possible in their aggregate. Let us call such a collection of elementary charges as the "**isolated electric charge**". It is said that the following electrostatic force works between isolated electric charges.

$$F = K_e \frac{q_1 q_2}{d^2} \tag{1}$$

It is said that one charge exhibits a radial electric field, and when another charge is placed there, the above force exerts.

$$|\mathbf{E}| = K_e \frac{q}{d^2} \tag{2}$$

✧ **Does an isolated electric charge exist?**

Few people would question this isolated electric charge and the electrostatic force. In textbooks, a diagram of electric fields from multiple isolated charges is shown plausibly. However, is there an example that such an electrostatic force has been observed? You may mention the attraction between an electron and a proton in an atom, which we will discuss later in detail in this book. Let us now here consider other types of isolated charges and their electrostatic forces. In fact, there have been no observed cases at all. Take the case of two batteries. It is said that in a battery, positive charges are gathered at the positive electrode and negative ones are at the negative electrode. If this were true, electrodes of two batteries should have showed an attractive or repulsive force when they are brought close. However, in reality, no matter how close they are, we cannot feel any force. In a capacitor, two large-area electrodes are located with a short distance apart. It is said that negative charges are accumulated on one electrode and positive charges are on the other, but no matter how much electricity is stored, two electrode surfaces do not receive an attractive force. In the case of a spherical charged body, too, even if an opposite charged body is brought close, no clear force is observed even though a discharge between them occurs.

These facts show that there are actually no observed examples of isolated electric charges and their electrostatic forces. The isolated electric charge, electric field, and electrostatic force shown by the equations (1) and (2) need to be fundamentally reconsidered. Furthermore, the electric current is said to be the transmission of electric charge, but if the existence of isolated charges becomes uncertain, the definition of it also needs to be reconsidered. What the electric charge is; it is necessary to elucidate its origin.

✧ Energy circulation theory newly defining the electric charge

I published the energy circulation theory in 2018 with the claim that there is a force working based on the energy movements, that is, momentums, while the gravitational force acts on the energy magnitudes. The theory was able to clearly define what the electric charge is. Furthermore, it has solved the unsolved problems of the standard physics one after another, and has created a completely new system of physics. As for the electromagnetism, the following paper was published in 2023.

“Renewed Concepts for Electric Charge, Electric Current and Magnetic Charge by the Energy Circulation Theory”

https://doi.org/10.1142/S2424942423500081

✧ Contents of this book

This book first explains the energy circulation theory and then the building of a new electromagnetism from scratch based on the contents of the above paper. Specifically, starting from the two promises of the energy circulation theory, we will show the formation of energy circulations, the separation and expansion of the universe, the formation of galaxies, and the generation of the elementary single circulations playing a key role to form particles and exhibit electromagnetic phenomena. Then we will elucidate the real features of electromagnetic phenomena, and newly define the electric charge, magnetic charge, and electric current. Furthermore, we will theoretically formulate the magnetic charge density (magnetic field) that appears around the electric current.

The phenomenon, which is called as the electrification in the existing electromagnetism, is not the accumulation of positive or negative electric charges, but is the accumulation of elementary charge pairs, overall electric charges of which are zero. The interaction of charged bodies is due to the magnetic force rather than the electrostatic force. In this book, let us trace the construction of a completely new system of electromagnetism based on the energy circulation theory.

Chapter 1: Overview of the Energy Circulation Theory

1-1 Energy Circulation Theory

The energy circulation theory is to develop the essences of the universe logically from scratch, while putting aside the existing physics once. 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.

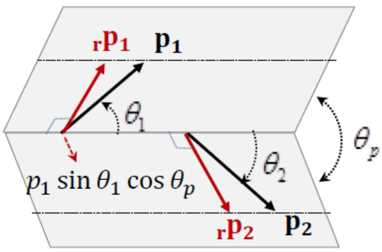
$$E = M_1 {V_1}^2 = M_2 {V_2}^2 = mc^2 \tag{3}$$

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

$$F = K_f \frac{{}_{\mathrm{r}}\mathbf{p}_1 \cdot {}_{\mathrm{r}}\mathbf{p}_2}{d^2} = K_f \frac{p_1 p_2}{d^2} \cos\theta_p \sin\theta_1 \sin\theta_2 \tag{4}$$

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 consider what can be said by assuming them. 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, ${}_{\mathbf{r}}\mathbf{p}$ 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 ${}_{r}p = p\sin\theta$. 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).

1-2 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 ($d\Delta M/d\theta = 0$).

$$M = \int_0^{2\pi} \Delta M d\theta = \Delta M \int_0^{2\pi} d\theta = 2\pi\Delta M \tag{5}$$

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.

$$\psi = [X \quad Y] = [\mu\cos\omega t \quad \mu\sin\omega t] = \mu(\cos\omega t + i\sin\omega t) \tag{6}$$

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 $0 \le \theta \le 2\pi$. 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.

$$E\psi, \qquad M\psi, \qquad p\psi \tag{7}$$

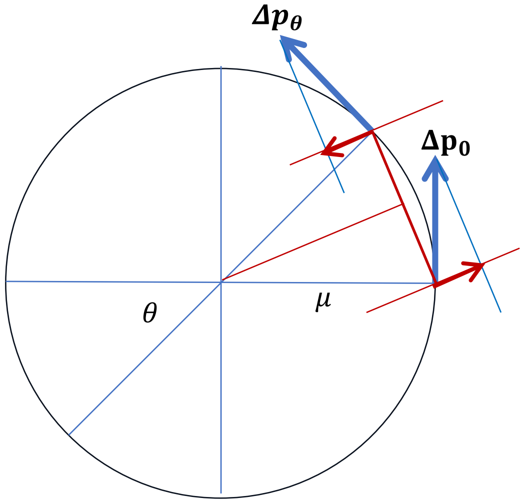
The amount of the total energy can be expressed by the intrinsic energy and its circular velocity as follows.

$$E = M{V_c}^2 = M\mu^2\omega^2 \tag{8}$$

✧ 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



$$d = 2\mu \sin\frac{\theta}{2}$$

$$\Delta_r p_0 = \Delta p_0 \sin\frac{\theta}{2}$$

$$\Delta_r p_\theta = \Delta p_\theta \sin\frac{-\theta}{2}$$

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

$$d = 2\mu \sin\frac{\theta}{2}\ . \tag{9}$$

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

$$\Delta F = K_f \frac{\Delta p_0 \Delta p_\theta}{d^2} \sin\frac{\theta}{2} \sin\frac{-\theta}{2} = -K_f \frac{\Delta p_0 \Delta p_\theta}{4\mu^2} \tag{10}$$

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.

$$cF_\perp = -K_f \frac{\Delta p_0}{4\mu^2} \int_0^{2\pi} \Delta p_\theta \sin\frac{\theta}{2} d\theta = -K_f \frac{\Delta p_0}{4\mu^2} \frac{p}{2\pi} 4 = -K_f \frac{p\Delta p_0}{2\pi\mu^2} \tag{11}$$

If the intra-circulation force is balanced with the centrifugal force, it is a stable energy circulation.

1-3 Novel physics by 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.
https://doi.org/10.1142/S2424942423500081

Concrete explanations on the novel physics based on the ECT are posted on the following website. Please visit to any items you are interested in.

From here on this book, we will explain the cosmic evolution by the ECT, then the formation and structure of the elementary single energy circulation that is the key to generate particles and exhibit electromagnetic phenomena. Then, we will explain the construction of the novel electromagnetism by the ECT, focusing on the paper [7].

1-4 Cosmic evolution by the ECT

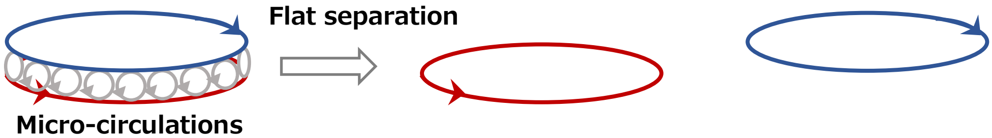
✧ Energy

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 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



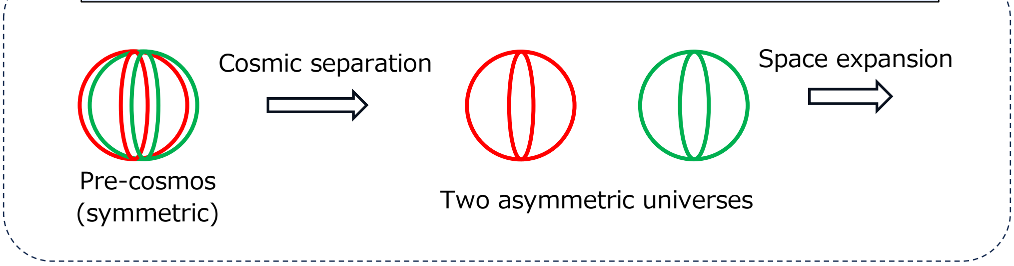
We call such a separation in the flat direction as shown in Fig. 3 as the "**flat separation**". When the width of the energy distribution of the pre-cosmos becomes larger than a threshold in any one-dimensional direction, the original amplitude in it cannot be maintained and it expands. Among the M/2 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.

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

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

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



✧ 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.

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.

$$\mathbf{X} = [\mu \quad \theta_1 \quad \theta_2 \quad \theta_3] = [\mu \quad \omega t \quad \theta_2 \quad \omega t] \tag{13}$$

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

$$\mathbf{X} = \mu \begin{pmatrix} \cos\omega t + i\sin\omega t\cos\theta_2 + j\sin\omega t\sin\theta_2\cos\omega t \\ +k\sin\omega t\sin\theta_2\sin\omega t \end{pmatrix} \tag{14}$$

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.

$$\mathbf{e_0} \equiv \cos\theta_1 + i\sin\theta_1 \tag{15}$$

$$\mathbf{e_1} \equiv \cos(\theta_1 + \pi/2) + i\sin(\theta_1 + \pi/2) = i\mathbf{e_0} \tag{16}$$

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. (14) is expressed by the following formula.

$$\mathbf{X} = \mu\big(\omega t\mathbf{e_1}\cos\theta_2 + \sin\theta_2\,(j\cos\omega t + k\sin\omega t)\big) \tag{17}$$

✧ Space energy in a unit space: 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.

$$E_\mu \psi_\mu = E_\mu \mu_0 \big(\exp(i\omega_0 t) + \exp(-i\omega_0 t)\big) \tag{18}$$

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

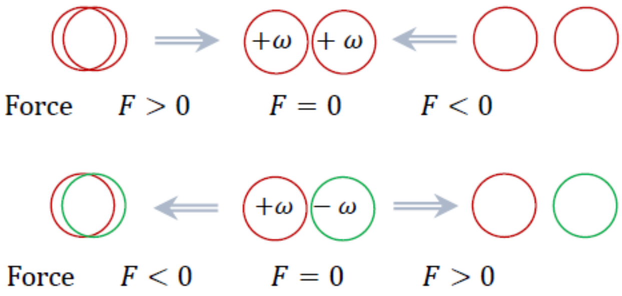
$$E_\mu = m_\mu {v_c}^2 = m_\mu {\mu_0}^2 {\omega_0}^2 = m_\mu c^2 \tag{19}$$

✧ **Particle**

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 circulation of an apparent energy shows the properties of a particle. An energy circulation can be static to the space energy, keeps a constant radius by the fundamental force, and interacts with others to exert an attractive or repulsive force. We can define the "**particle**" as an energy circulation.

There works an interaction between two energy circulations due to the fundamental force. We call the interaction in the same plane as the "**flat interaction**" and that in the vertical direction as the "**orthogonal interaction**". Although omitted here, the equations showing the force and the potential energy for both interactions have been derived using some approximations (Ref. [2][5]). Fig. 5 shows the image of the flat interaction. Two circulations with the same circular direction $+\omega$ shows a repulsive force when they overlap (left in Fig.5) and an attractive force when they are separated with no overlap (right). In the central state, where the two are adjacent, the force is zero, and this state is the most stable. In the case of opposite directions as $+\omega$ and $-\omega$, an attractive force acts at places from the overlapping state on the left to the adjacent state in the center, and they tend to return to the coupled conjugate pair (left). However, once they separate beyond adjacency, a repulsive force acts and they recede. The state, in which two circulations of the same direction overlap (upper left in Fig. 5), comes up immediately after one energy circulation was divided to two. The two circulations make not only a flat separation but also an orthogonal separation.

Fig. 5. Flat interaction of energy circulations (within a plane)



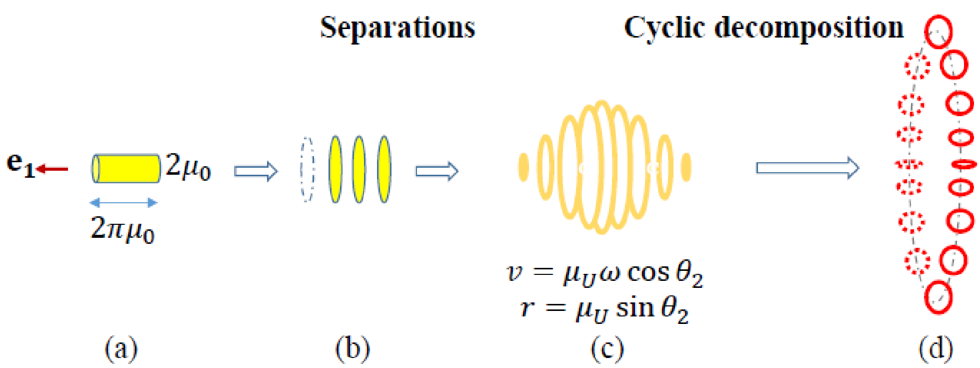
✧ Early development of the universe

The distribution of the apparent energy in the 3D space immediately after the cosmic separation can also be expressed by Eq. (17). θ_2 is a parameter to show a location, and shows continuous values in the range of $0 \leq \theta_2 \leq \pi$.

$$\text{Eq. (17):}\quad \mathbf{X} = \mu\big(\omega t \mathbf{e_1} \cos\theta_2 + \sin\theta_2\,(j\cos\omega t + k\sin\omega t)\big)$$

The apparent energy immediately after the separation can no longer be maintained as a circulation as the space expands, and, as shown in Fig. 6, will make the separations and decompositions of energy circulations.

Fig. 6. Early development of the universe with space expansion



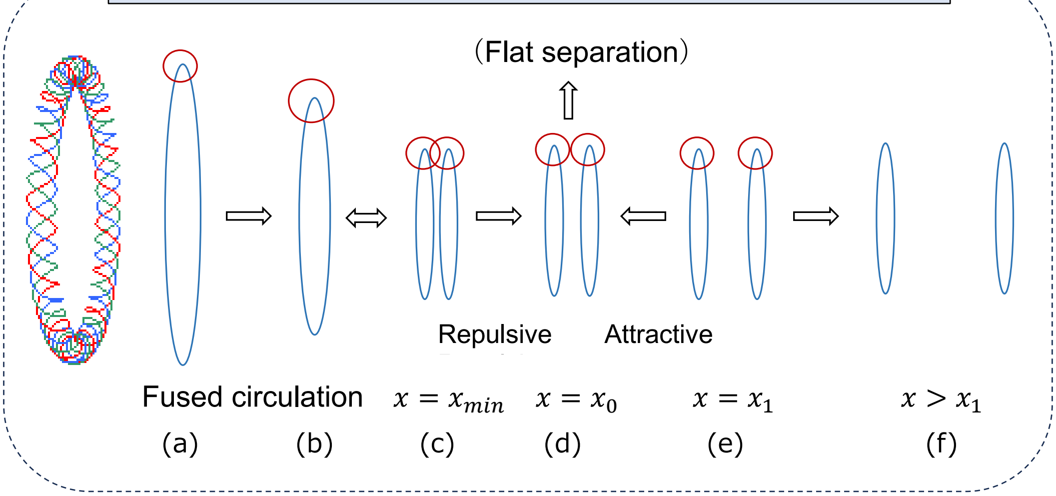
The both ends of the first state (a) are connected as circulating in the 4D space. It divides to multiple discs (b) due to the expansion, and each disc divides into multiple energy circulations (c). The radiuses of these circulations are proportional to $\sin\theta_2$, and the velocities in the $\mathbf{e_1}$ direction are proportional to $\cos\theta_2$. That is, in Fig. 6(c), they are moving leftward ($0 \le \theta_2 \le \pi/2$) and rightward ($\pi/2 \le \theta_2 \le \pi$). Then 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 (d). 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.

✧ Galactic seed separation

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. In recent years, many large-scale motions in the universe have been reported, but the existing standard model cannot explain them at all.

Fig. 7 shows the process of the **galactic seed separation**. The radius of an energy circulation is proportional to its energy amount (Ref. [3]). If a space-space dimensional energy circulation like a galactic seed is expressed in three space-dimensions, it has a donut-like shape. The intrinsic energy is in a **spiral motion** with a **local circulation** and main one. The selected intrinsic energy is different between two-dimensional and three-dimensional representations.

Fig. 7. Galactic seed division and orthogonal separation

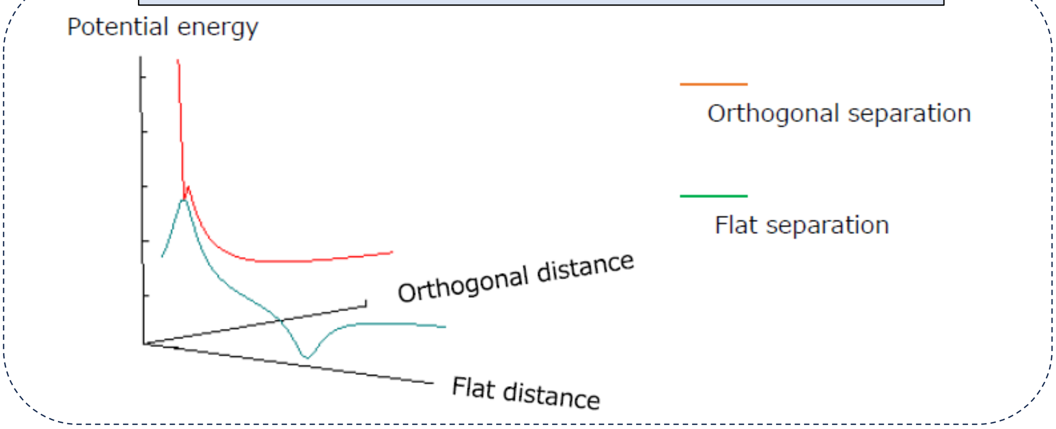


The red circle in Fig. 7 indicates one of local circulations of a galactic seed in the three-dimensional representation. The distribution to the main circulation and the local one is flexible, and varies depending on individual galactic seeds. Provided, there is a quantization condition that the frequency of the local circulation should be an integral multiple that of the main one, and the radius of the main circulation takes discrete values.

As the space expands, a galactic seed is releasing small energy circulations and radiations, and reducing its energy. By this reason, the radius of the main circulation decreases and that of local one increases to a new ratio (Fig. 7 (a)-(b)). As the local radius increases, it is divided into two galactic seeds as shown in Fig. 7 (b)-(c). Another reason to cause a galactic seed division is an extremely fast rate of the space expansion. In the early stages of the space expansion, the main radius increased slightly due to the rapid expansion, resulting in insufficient energy relative to the radius, and the galactic seed was divided as shown in Fig. 7. Such divisions occurred much more frequently in early stages.

The two divided galactic seeds show an interaction between local circulations in a close range. There works a repulsive force between (c) and (d) in Fig.7, and an attractive one between (d) and (e). In the range of (f), the repulsive force between the main circulations becomes dominant, and they recede. Fig. 8 shows the change in the potential energy by the galactic seed separation (the formulas of the force and potential energy between the seeds were reported in Ref. [5]). The potential energy for the vertical displacement shows the trough at the state of Fig. 7(d), where the local circulations are attached. The decrease in the potential energy is converted into the radiation or an increase in the kinetic energy of the linear motion. If the velocity is enough, they will pass the energy crest (Fig. 7(e)) and continue to separate vertically, which is an orthogonal separation, and each one will be an isolated galactic seed. If they lose energy by radiation and the velocity becomes slow, the flat separation will occur from the state shown in Fig. 7(d). In the flat separation, the two galactic seeds show a potential energy trough where they are attached to each other. The two galactic seeds give the "**attached galactic seeds**" or the "**rotating binary galactic seeds**", which keep a constant distance with rotating.

Fig. 8. Potential energy in galactic seed separations



The radiations due to the decrease in potential energy in a galactic seed separation are gamma rays and gravitational waves (space-space dimensional waves), resulting in a **gamma-ray burst**. Details on these processes were reported in Ref. [5].

✧ Formation of galaxies

Once a galactic seed separation is completed, releases of **stellar seeds** from the galactic seed begin. 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. Galaxies exhibit a variety of shapes depending on whether the galactic seed is isolated, attached or rotating binary, as well as the modes of stellar seed releases. Our simulations by the ECT successfully reproduced the many observed shapes of galaxies (Ref. [6]). The current standard physics cannot explain almost any shape at all. A black hole at the center of a galaxy or dark matter in the halo region does not need to be assumed, and does not exist.

1-5 Elementary single energy circulation

✧ Elementary single circulation

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 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. (18), and let m_0 be its intrinsic energy. Its energy distribution and amount are shown as follows.

$$E_{(iS)}\psi_{iS} = E_{(iS)}[X \quad H] = E_{(iS)}\mu_0(\cos\omega_0 t + i\sin\omega_0 t) \tag{20}$$

$$E_{(S)}\psi_S = E_{(S)}[X \quad Y] = E_{(S)}\mu_0(\cos\omega_0 t + j\sin\omega_0 t) \tag{21}$$

$$E_{(iS)} = E_{(S)} = m_0{v_c}^2 = m_0{\mu_0}^2{\omega_0}^2 \tag{22}$$

We call the coupled conjugate pair consisting of two conjugate circulations as the "**double circulation**" shown by iD or D. The circulating velocity of the double circulation is $v_c = \pm\mu_0\omega_0$. What is quantized within a spacia is defined as the "**quantum particle**". A quantum particle has the radius μ_0, and is a composition of single and/or double circulations, and/or their excited form within a spacia.

✧ Variation of the light speed by the space expansion

An elementary single circulation is given by doubling the circulating velocity of one of the two conjugate circulations in a spacia. Therefore, it has the same radius μ_0 and circular frequency ω_0 as those of the spacia. If the frequency of an energy is an integral multiple of ω_0, it becomes a quantized circulation (particle), but if it is smaller than ω_0, it is not quantized and propagates linearly in the space energy. This kind of radiation in hidden-space dimensions is the **light**, the propagation speed of which is the circulating velocity of the spacia.

$$c = v_c = \mu_0\omega_0 \tag{23}$$

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.

$$m_\mu{\mu_0}^2\big(\omega_0(x_0)\big)^2 = \frac{x^3}{{x_0}^3}m_\mu{\mu_0}^2\big(\omega_0(x)\big)^2 \tag{24}$$

If we express the light speed as a function $c(x)$ of the radius, we get the below formula.

$$c(x) = \sqrt{\frac{{x_0}^3}{x^3}} * c(x_0) \tag{25}$$

Since ${x_0}^3/x^3$ is equal to the ratio of the space energy density, this Eq. (25) 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. (22) also decreases as ω_0 decreases (the intrinsic energy m_0 remains constant). However, the following relation of it to the light speed remains unchanged.

$$E_{(iS)} = E_{(S)} = m_0 c^2 \tag{26}$$

✧ Hubble diagram

The **Hubble diagram** of the observed data of supernovae shows a **decrease in the light speed**, not an acceleration of the rate of the space expansion. The space expansion is decelerating by the usual time, and is constant if the cosmic radius is taken as time (Ref. [1]). The details of the Hubble diagram had been already published in the Journal of Physics: Conference Series https://doi.org/10.1088/1742-6596/880/1/012058 in 2017 before the ECT was released. Based on the empirical rule that the propagation speed of waves in general is proportional to the square root of the density of the medium, we proposed there exactly the same equation as Eq. (25) above. There the predicted Hubble diagram based on it showed almost a perfect fit to the observed data of supernovae. This agreement means the correctness of Eqs (23), (24), and (25) for the light speed, which the ECT logically derived.

Dark energy that is expected to accelerate the space expansion by the standard physic does not exist. Provided, the vacuum space of the universe is filled with the space energy.

Chapter 2: Electric phenomena by the ECT

2-1 Definition of electric charge and electric force

✧ Definitions of the electric charge and the magnetic charge

As shown in Eq. (4), 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. (4) 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 $\sin\theta_1$, $\sin\theta_2 = +1$ 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

Next, let us examine the intra-circulation force of iS; the hidden-space single circulation. The force between two local momentums on the circumference was shown by Eq. (10). In order to find the component in the space direction X of the intra-circulation force of iS, we divide the circulation into two halves of the angles α and β as shown below.

$$-\frac{\pi}{2} \leq \alpha \leq \frac{\pi}{2}\,, \qquad \frac{\pi}{2} \leq \beta \leq \frac{3\pi}{2}\,, \qquad \theta \equiv \beta - \alpha \tag{27}$$

The force between $\mathbf{\Delta p_{\alpha}}$ and $\mathbf{\Delta p_{\beta}}$ becomes as below from Eq. (10).

$$\Delta F = K_f \frac{\Delta p_\alpha \Delta p_\beta}{d^2} \sin\frac{\theta}{2} \sin\frac{-\theta}{2} = -K_f \frac{\Delta p_\alpha \Delta p_\beta}{4{\mu_0}^2} \tag{28}$$

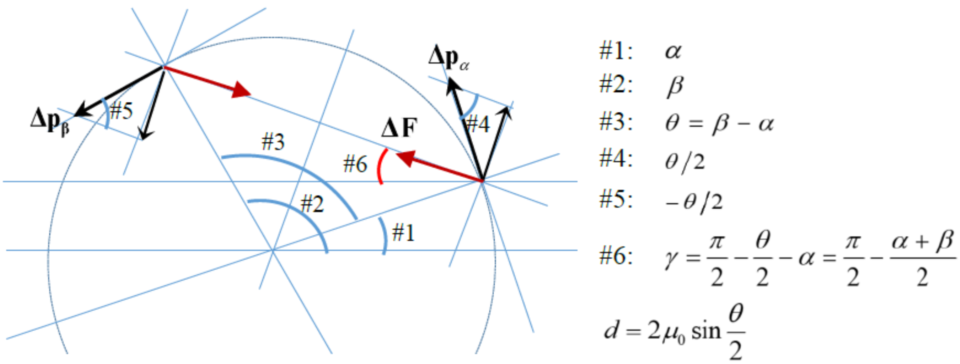
The component in the space direction is

$$\Delta F_x = \Delta F \cos\gamma = \Delta F \sin\frac{\alpha+\beta}{2} = \Delta F \left(\sin\frac{\alpha}{2}\cos\frac{\beta}{2} + \cos\frac{\alpha}{2}\sin\frac{\beta}{2}\right) . \tag{29}$$

γ is the angle #6 in Fig. 9, and given by

$$\gamma = \frac{\pi}{2} - \frac{\theta}{2} - \alpha = \frac{\pi}{2} - \frac{\alpha+\beta}{2} . \tag{30}$$

Fig. 9. Local momentums of an energy circulation and their force



The component in the X direction of the force that $\mathbf{\Delta p_\alpha}$ receives from the entire momentum $\mathbf{p_\pi}$ in the half circle arc $\frac{\pi}{2} \le \beta \le \frac{3\pi}{2}$ gets as follows.

$$p_h \equiv p_\pi = \Delta p_\beta \int_{\pi/2}^{3\pi/2} d\beta = \Delta p_\beta \pi , \qquad \Delta p_\beta = p_h/\pi \tag{31}$$

$$\begin{aligned} F_x(\alpha) &= \int_{\pi/2}^{3\pi/2} \Delta F_x \partial\beta = \int_{\pi/2}^{3\pi/2} \Delta F \left(\sin\frac{\alpha}{2}\cos\frac{\beta}{2} + \cos\frac{\alpha}{2}\sin\frac{\beta}{2}\right) \partial\beta \\ &= -K_f \frac{\Delta p_\alpha}{4{\mu_0}^2} \frac{p_h}{\pi} 2\sqrt{2} \cos\frac{\alpha}{2} \end{aligned} \tag{32}$$

The component in X of the force that the momentum $\mathbf{p_0}$ of the half circle arc $-\frac{\pi}{2} \le \alpha \le \frac{\pi}{2}$ receives from the momentum $\mathbf{p_\pi}$ of the other half-circle arc $\frac{\pi}{2} \le \beta \le \frac{3\pi}{2}$ is given as below.

$$F_x = \int_{-\pi/2}^{\pi/2} F_x\,(\alpha)\partial\alpha = -K_f \frac{2\sqrt{2}}{4\mu_0{}^2}\frac{p_h{}^2}{\pi^2}\int_{-\pi/2}^{\pi/2}\cos\frac{\alpha}{2}\partial\alpha$$
$$= -\frac{8}{\pi^2}K_f\frac{p_h{}^2}{(2\mu_0)^2} \tag{33}$$

This is the intra-circulation force of iS in the space direction.

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

$$K_e \equiv \frac{8}{\pi^2}K_f\,, \qquad e \equiv p_h = \frac{m_0\mu_0\omega_0}{2} = \frac{m_0 c}{2} \tag{34}$$

If we express the intra-circulation force of Eq. (33) by the electric charge, it becomes as follows.

$$F_x = -\frac{8}{\pi^2}K_f\frac{p_h{}^2}{(2\mu_0)^2} = -K_e\frac{e^2}{(2\mu_0)^2} \tag{35}$$

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

The similar force also acts in the hidden dimension H. If we define the "**elementary magnetic charge**" as the half circle momentum $b_e \equiv p_h$, the force is expressed as follows.

$$F_h = -\frac{8}{\pi^2}K_f\frac{b_e{}^2}{(2\mu_0)^2} = -K_e\frac{b_e{}^2}{(2\mu_0)^2} \tag{36}$$

However, we cannot detect a force in the hidden dimension H. Furthermore, no circulation can expand in the H direction. Therefore, there is a no chance to use Eq. (36). In a stationary iS, the magnetic charge in the space direction X is canceled out in the opposite directions and becomes zero.

$$\mathbf{b_x} = (b_e - b_e)\mathbf{e_x} = 0 \tag{37}$$

2-2 Rotation of iS and light radiation

✧ Rotation of iS around the hidden dimension axis H

There are three planes orthogonal to each other in 3D, but are six planes in 4D; XY, YZ, ZX, HX, HY, HZ. When an iS rotates around the hidden dimension axis H, it rotates in space dimensions, but there is no variation in H. Therefore, no energy is lost by the light radiation. By a rotation around the H axis, the circulating velocity in the space dimension of iS can be flexibly divided to each space components.

$$v_x{}^2 = c^2 \implies v_x{}^2 + v_y{}^2 + v_z{}^2 = c^2 \tag{38}$$

✧ Light radiation by rotation of iS around a space axis

If we make an iS rotate around a space dimension axis, it will emit the light because it cannot rotate to a mixed direction of hidden and space dimensions. Let us take a look at the details below. First, consider an iS in X-H.

$$E_{(iS)}[X \quad H] = m_0 {\mu_0}^2 {\omega_0}^2 \, \mu_0 (\cos \omega_0 t + i \sin \omega_0 t) \tag{39}$$

Add an energy ΔE and make iS rotate around a space axis Z by $\omega < \omega_0$.

$$\Delta E = m_0 {\mu_0}^2 \omega^2 \tag{40}$$

In addition to the circulation by Eq. (39), the following circulation shall be tried to be added to the intrinsic energy m_0.

$$[\mathrm{X} \quad \mathrm{H}] = \mu_0 (\cos \omega t + i \sin \omega t)\,, \qquad [\mathrm{X} \quad \mathrm{Y}] = \mu_0 (\cos \omega t + j \sin \omega t) \tag{41}$$

However, in order to be quantized as a particle, its frequency should be an integral multiple of ω_0. Therefore, the additional energy cannot rotate and will move linearly in the space direction X while vibrating. The vibrations in H and Y propagate in two directions; +X and -X, this is the "**light radiation**". The energy of the light radiation to one direction is as follows.

$$E_\gamma = \frac{\Delta E}{2} = \frac{m_0 {\mu_0}^2}{2} \omega^2 \ \ (\text{energy of light})\,. \tag{42}$$

The propagation speed in the X direction is the circulating velocity of the spacia, which is the light speed.

$$v_x = \mu_0 \omega_0 = c \tag{43}$$

✧ **Energy position of radiated light**

The energy of the additional circulation shown by Eqs. (40) and (41) is radiated in the X direction, and does not remain on the circumference of iS. However, this rotation is applied continuously from the outside, and Eq. (40) shows the energy per one second. We can regard that the energy is continuously supplied and light is emitted to two directions; -X at the phase of $\theta = 0$ of the circulation of Eq. (41) and +X at that of $\theta = \pi$.

Since the propagation velocity is Eq. (43), the wavelength is expanded from the circumference of $2\pi\mu_0$ by ω_0/ω times, and given by the below formula, in which $\nu = \omega/2\pi$ is the frequency of the light.

$$\lambda = 2\pi\mu_0 \frac{\omega_0}{\omega} = \frac{\mu_0 \omega_0}{\nu} = \frac{c}{\nu} \tag{44}$$

Here, let us see the energy position of the radiated light from the phase of $\theta = 0$. As shown in Fig. 10, the position of the light in X is given by the following formula.

$$\mathbf{X} = (-\mu_0 \omega_0 t + \mu_0)\mathbf{e_x} \ \ (\approx -\mu_0 \omega_0 t \mathbf{e_x} = -ct\mathbf{e_x}) \tag{45}$$

The second term, μ_0, can be ignored except for immediately after the radiation. The position in H is given as follows.

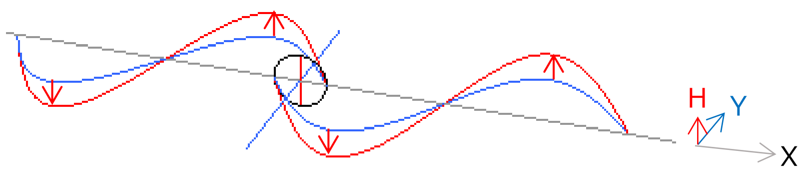
$$\mathbf{H} = \mu_0 \sin \omega t \, \mathbf{e_h} \tag{46}$$

The position in Y is given by the following formula because the rotation velocity of $\mu_0\omega$ propagates to surrounding spacias at the speed of $\mu_0\omega_0$, so that the amplitude becomes larger. (similar to Eq. (44) for wavelength)

$$\mathbf{Y} = \frac{\omega_0}{\omega} \mu_0 \sin \omega t \, \mathbf{e_y} \tag{47}$$

In Fig. 10, we show the energy locations of the radiated lights from $\theta = 0$ and $\theta = \pi$.

Fig.10. Energy locations of radiated lights by rotating is (hidden-space single circulation) around the Z axis



Red; 4D expression Blue: 3D expression $Z = 0$ (not expressed)

✧ Vibrations of electric and magnetic charges of radiated light

The velocities in H and Y are as follows.

$$\mathbf{v_h} = \frac{d\mathbf{H}}{dt} = \omega\mu_0 \cos\omega t\, \mathbf{e_h} \tag{48}$$

$$\mathbf{v_y} = \frac{d\mathbf{Y}}{dt} = \omega_0\mu_0 \cos\omega t\, \mathbf{e_y} \tag{49}$$

The half circle momentum in the case that the energy of Eq. (40) circulates by Eq. (41) is the **electric charge** and the **magnetic charge**. Since the vibration parts other than the amplitude as well as the direction are equal to those of the velocity, the momentums are shown as follows.

$$e_\gamma = b_\gamma = p_h = \frac{m_0\mu_0}{2}\omega \tag{50}$$

$$\mathbf{e_\gamma} = e_\gamma \cos\omega t\, \mathbf{e_h} \tag{51}$$

$$\mathbf{b_\gamma} = b_\gamma \cos\omega t\, \mathbf{e_y} \tag{52}$$

If the electric charge and magnetic charge in Eqs. (51) and (52) are expressed in sine like the location in Y, they are as below.

$$\mathbf{e_\gamma} = \frac{m_0\mu_0}{2}\sin(\omega t + \pi/2)\, \mathbf{e_h}\,, \qquad \mathbf{b_\gamma} = \frac{m_0\mu_0}{2}\sin(\omega t + \pi/2)\, \mathbf{e_y} \tag{53}$$

We can see that the vibrations in electric and magnetic charges are advanced by $\pi/2$ than the energy location in Y.

✧ Representation of light propagation as a plane wave

If we express the propagation to X of electric charge as a plane wave in the X-H plane and that of magnetic charge and that of the position in Y as plane waves in the X-Y plane, they become as follows. k is the wave number (angular wave number) given by $k = \omega/c$.

$$\mathbf{e_Y} = \frac{m_0\mu_0}{2}\omega\cos(kx - \omega t)\,\mathbf{e_h} = \frac{m_0\mu_0}{2}\omega\sin\big(kx - (\omega t + \pi/2)\big)\,\mathbf{e_h} \tag{54}$$

$$\mathbf{b_Y} = \frac{m_0\mu_0}{2}\omega\cos(kx - \omega t)\,\mathbf{e_y} = \frac{m_0\mu_0}{2}\omega\sin\big(kx - (\omega t + \pi/2)\big)\,\mathbf{e_y} \tag{55}$$

$$\mathbf{Y} = \frac{\omega_0}{\omega}\mu_0\sin(kx - \omega t)\,\mathbf{e_y} \tag{56}$$

✧ Bremsstrahlung (braking radiation)

What have been explained above is for the case that an iS is stationary at $(x, y) = (0,0)$. However, in reality, the rotation around the Z axis is given by making an iS (or eCP to be explained later) orbit with a radius $r \neq 0$. If we adopt an X-Y coordinate system that rotates around $y = -r$ with the light radiation direction as the X-axis and the radial direction as the Y-axis, the position of iS is always $(x, y) = (0,0)$, so that the all equations about the light emission, which have been shown above so far, are applied as they are. The light radiation direction X is the tangential direction of each point on the orbit. This type of light radiation is called as the "**bremsstrahlung**" (or braking radiation), and emits continuous light. There is another type of light emission that an energy difference is released as light when an eCP gets shorter (to be explained later in the Section 2-5).

✧ Energy of light quantum and the Planck constant

The energy of light is given by Eq. (42), which shows a value for one second. Here, we define the one cycle of light as the "**light quantum**". The light quantum is same as so called the photon, but is not a particle. The energy of a light quantum (photon) is given by the following formula.

$$E_q \equiv \frac{E_\gamma}{\nu} = \frac{2\pi}{\omega}\frac{m_0{\mu_0}^2}{2}\omega^2 = \pi m_0{\mu_0}^2\omega$$
$$= 2\pi^2 m_0{\mu_0}^2\nu \quad \text{(energy of light quantum)} \tag{57}$$

Here, the **Planck constant** h has been given by m_0 and μ_0.

$$h = 2\pi^2 m_0{\mu_0}^2 \ \text{(Planck constant)} \tag{58}$$

As shown here, the Planck constant is invariant by the space expansion, but is obtained by m_0 and μ_0. Using the Planck constant, the energies of light and light quantum (photon) are shown by the following formulas, which do not change as the space expands.

$$E_\gamma = h\nu^2, \qquad E_q = h\nu \tag{59}$$

m_0 and μ_0 are the most fundamental constants in the ECT, which do not change as the space expands. In addition to these two, ω_0 is an important constant that determines the energy density of the universe and the light speed, but it changes as the space expands as shown by Eq. (24).

Cautions about energy quantum (light quantum) and energy

- **Energy** is an amount conserved over time and is expressed as a value **per unit time (one second)**. (All the speed, momentum, and frequency in the formulas written so far are values per one second. The energy described by them is also an amount per second.)
- The energy quantum including light quantum is defined as the energy per one cycle $E_q \equiv E/\nu$. This is an energy amount per $1/\nu$ second.
- When an energy circulation absorbs one cycle of light quantum $E_q = h\nu$, the added energy remains on its circumference. Therefore, the increase in energy (per second) of it is $\Delta E = h\nu^2$.
- When a light quantum (e.g. gamma ray) is moving linearly, its energy per one second is $E = h\nu^2$, but its position moves a distance of light speed times one second. In this case, the energy passing through one point is $E_q = h\nu$, and the passing time is $1/\nu$ second.
- The energy of continuous light passing at a point per second is $E = h\nu^2$.

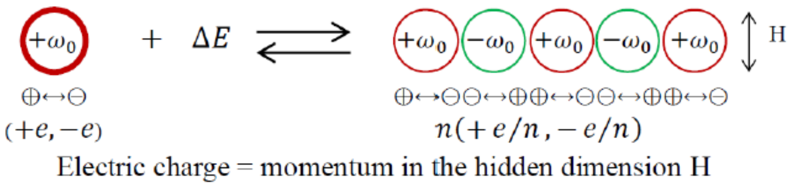
Conclusion: The energy of light is $E = h\nu^2$.

2-3 Connected electric force in an eCP

✧ Elementary charge pair eCP

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. 11. The number n of circulations is limited to an odd number. This prolonged one is called as the "**elementary charge pair** (**eCP**)".

Fig. 11. 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. (35).

$$F_x = K_e \frac{(e/n)(-e/n)}{(2\mu_0)^2} = -K_e \frac{e^2}{(2n\mu_0)^2} = -K_e \frac{e^2}{d^2} \tag{60}$$

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. (60) 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. While it will be explained in the next section, in an electron, a neutrino is attached to the minus end of an eCP, and in a proton, a space-space single circulation is attached to the plus end of an eCP (proton includes also other circulations). I 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. Therefore, one electron cannot interact with plural protons. The elementary electric charge e is the maximum value of the charge, and a cluster charge $q = ne$, which is an integral multiple of e and expected by the existing electromagnetism as gathered electrons or other charged particles, does not exist. An end of an eCP can directly act with that of another eCP, that is, the electrostatic force works. However, in the case of an atom, the electric charge at the ends is so small as $10^{-4}e$, and the effective distance that the force can extend is so short as up to a few times of a spacia. Therefore, we can consider that there exist practically no isolated charges nor the electrostatic force by them. This is the answer to the problems of the existing electromagnetism mentioned in the Introduction.

2-4 Hemi-circulations and structure of hydrogen atom

✧ Hemi-circulation

We divide an eCP into two parts; one for plus electric charges and the other for minus electric charges. Each part is named as the "**hemi-circulation**" and expressed by iH_+ or iH_-.

$$eCP = iH_+ \cdots iH_- \qquad (61)$$

iH_+ and iH_- have an elementary charge of $\pm e$, but both charges are dispersed throughout the eCP.

The space-space single circulation S is unstable on its own, and splits to two, which make an orthogonal separation to opposite directions. The divided one is also called as a **hemi-circulation** and expressed by H. Although the original direction of rotation is the same among the separated two ones, the direction of rotation relative to the direction of travel, that is, the helicity is opposite to each other. These two are the **neutrino** and the **antineutrino**".

$$S \longrightarrow \nu(H) + \overline{\nu}(\overline{H}) \tag{62}$$

As the energy $m_0c^2/2$ of H is not enough to be quantized, it cannot be stationary toward the space energy. The intrinsic energy of H is helically moving with the radius of μ_0, and the distribution of the velocity between the circular component (in X-Y) and the linear one (in z) can be flexibly changed.

$$E_{(H)} = \frac{m_0}{2}c^2 = \frac{m_0}{2}\left(v_{x-y}^2 + v_z^2\right) \tag{63}$$

The circular component corresponds to the rest energy, and this flexibility is the true reason for the phenomenon (**neutrino oscillation**), in which the value of mass of a neutrino is spread out and this distribution changes on the way. The circular component shows a particle nature, but the neutrino is not a quantized particle.

✧ 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. 12(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.

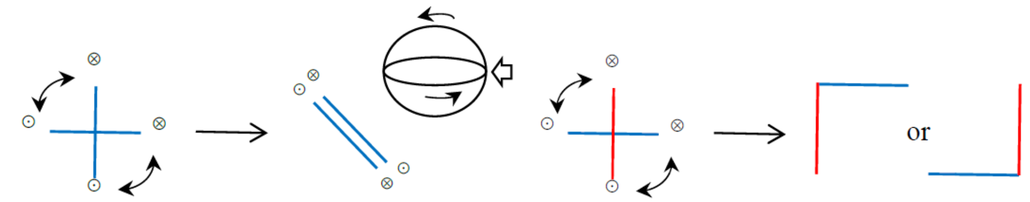
$$S_{x-y} + S_{x-z} \longrightarrow S_{x-yz}\!:\!\overline{S_{x-yz}} = D_{x-yz} \tag{64}$$

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. 12(a)).

$$iS_{h-x} + iS_{h-y} \longrightarrow iD_{h-xy} \tag{65}$$

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. 12, they attract each other and S attaches to an end of iS (Fig. 12(b)). In this way, a hidden-space circulation (single or hemi) and a space-space circulation (single or hemi) attract each other.

Fig. 12. Interaction of single circulations in a spacia



$2S \rightarrow D\left(S:\overline{S}\right)$ or $2iS \rightarrow iD\left(iS,i\overline{S}\right)$

(a) Two space-space circulations, or two hidden-space circulations

(b) One hidden-space and one space-space circulations

✧ Structure (energy circulation composition) of proton, electron and hydrogen atom

The ECT has revealed the composition of energy circulations for most of major particles (leptons, mesons, baryons) (see Ref. [2]). The proton and the electron in an atom are a complex that shares an eCP, and expressed as follows using iH. $D^{\#}$ is an excited form of D, and has twice frequency and four times the energy.

$$\textbf{Proton}: \quad p^{+}\left(D^{\#}, D, \overline{S}, iH_{+}\right) \tag{66}$$

$$\textbf{Electron}: \quad e^{-}\left(H, iH_{-}\right) \tag{67}$$

$$\textbf{Hydrogen atom}: \quad p^{+}\left(D^{\#}, D, \overline{S}, iH_{+}\right) \cdots e^{-}\left(H, iH_{-}\right) \tag{68}$$

While the charges of the proton and the electron are shown in accordance with the existing convention, either of them has zero electric charge as a whole. The electron is what where a neutrino is attached to the minus end of iH_- and the eCP is rotating around the H axis. This rotation includes a rotation in a space-space dimensional plane around the proton. If we let the position of the neutrino be that of the electron, the neutrino attached by iH_- shows the orbiting of the electron. Since this rotation of eCP is around the axis of the hidden dimension H, it does not radiate a light.

2-5 Energy of an elementary charge pair eCP

✧ Energy of an elementary charge pair (polarization energy)

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

$$eCP(x) + \gamma \rightleftarrows eCP(x + \Delta x)\,, \qquad x = 2n\mu_0 \tag{69}$$

The smallest eCP is iS of $n = 1$. If we express the energy of eCP as

$$E_{(n-iS)} = m_0c^2 + \Delta E\,, \tag{70}$$

ΔE is the increase in electric potential energy from iS. Here, as the potential energy at $x = 2\mu_0$ we set the energy of iS.

$$U(2\mu_0) \equiv E_{(iS)} = m_0c^2 \tag{71}$$

$$\Delta E = U(x) - U(2\mu_0) = \int_{2\mu_0}^{x} (-F_x)dx = \int_{2\mu_0}^{x} K_e \frac{e^2}{x^2} dx \tag{72}$$

Then, the electric potential energy of an eCP becomes equal to the total energy of the eCP.

$$U(x) = \Delta E + U(2\mu_0) = K_e e^2 \left(\frac{1}{2\mu_0} - \frac{1}{x}\right) + m_0c^2 \quad (x \geq 2\mu_0) \tag{73}$$

We call this energy of eCP as the "**polarization energy**".

✧ Light absorption/emission of an eCP and ionization of a hydrogen atom

If an eCP is prolonged by addition of energy to $U(x)$, the added energy is expressed as below.

$$\Delta E = U(x+\Delta x) - U(x) = K_e e^2 \left(\frac{1}{x} - \frac{1}{x+\Delta x}\right), \qquad \Delta E_{max} = \frac{K_e e^2}{x} \tag{74}$$

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**.

$$eCP(x) + \Delta E \longrightarrow eCP(x_1) + eCP(x_2) \tag{75}$$

In the case of a hydrogen atom, this eCP division by light absorption shows the ionization to a hydrogen ion and an electron, but here we call them as the “**free proton**” p_f and the “**free electron**” e_f.

$$\begin{aligned} &p^+(D^\#, D, \overline{S}, iH_+) \cdots e^-(H, iH_-) + \Delta E \\ &\longrightarrow p_f(D^\#, D, \overline{S}, eCP) + e_f(H, eCP) \end{aligned} \tag{76}$$

In the free electron, a neutrino is attached to the minus end of the eCP with the plus end free. In the free proton, the minus end of the eCP is free. Overall, either one has a neutral electric charge. It is an option to change the name and notation of ions, but one idea would be to leave them as they are and correct their meaning.

2-6 Definition of electric current and current potential

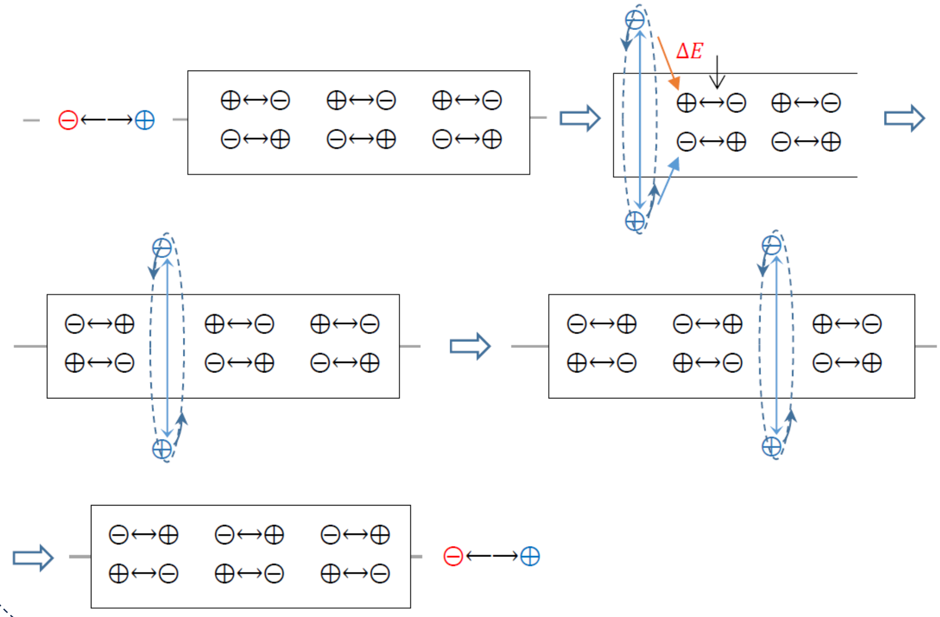
✧ Reconsideration of electric current, voltage, electric potential

In the current electromagnetism, the electric current is defined as the electric charge that passes through a cross section of a conductor in one second. However, as have been explained so far, there are no isolated electric charges. Furthermore, although it is said that the electric charge transmission is achieved by the movement of electrons, the electrons are never moving in such a way. It is necessary to redefine the electric current fundamentally. What is really significant when the electric current is flowing is the power P (watt), which is the energy passing per unit time. Currently, the power is expressed by the product $P(W) = I(A)E(V)$ of the electric current I (ampere) and the electromotive force E (volt), but with the reconsideration of the electric current, the electromotive force also needs to be reconsidered. The electromotive force is generally called as the voltage or source voltage. It is constant when connected in parallel and is a sum when connected in series, so that it has a high utility value. With keeping this convenience, we will define a new concept corresponding to the electromotive force in accordance with a new definition of the electric current. Currently, the unit volt is used for the potential difference as well as for the electromotive force, but these two are different things. We will also define a new concept that corresponds to the potential difference.

✧ True nature of electric current: transmission of polarization energy

The real nature of the electric current is the transmission of the polarization energy (= energy of eCP), which is determined by the length of an eCP. How does the polarization energy transmit in a conductor? By the ECT, we proposed the following model, an image of which is shown in Fig. 13.

Fig. 13. Local unit of a conductor and Model of transmission of polarization energy



Inside the conductor, two eCPs with opposite directions form a conjugate adduct, and those of which line up in series. The polarization moment of the eCP conjugate adduct is zero as those of each ones are set off. A single eCP, which has entered there, rotates in a vertical plane and remains there. While it will be explained in the next section, it shows a rotating magnetic charge. The intrinsic energy (mass) of a hidden-space energy circulation is moving at the light speed c. Its velocity c in the space dimensions can be flexibly divided to respective components of space directions. The prolongation in X of the eCP changes to that in Y, then the local circulations in X-Y rotate in Y-Z resulting in a helical motion (explained later: Fig. 15).

$$V_{main}^2 + V_{local}^2 = c^2 \tag{77}$$

This rotating eCP releases an energy (light) by a decrease in radius, and makes a pair rearrangement with the next eCP conjugate pair, resulting in a new conjugate pair and a single eCP. The new single eCP absorbs the previously released energy and becomes a rotating eCP with an enlarged radius. This process repeats, and the rotating eCP migrates in the conductor. The energy of a single eCP is thus transmitted, this is the phenomenon of the electric current.

✧ Polar potential

Currently, the electrostatic potential, which is also called as the voltage with the unit of volt, is given by the electric potential energy divided by the electric charge. However, such an electric charge does not exist. As a new index to properly indicate the electric potential energy, which is also called as the polarization energy, let us define the polar potential.

We define a series connection of the conjugate eCP pairs of local units as the "**unit line**". The "**polar potential** V_p" shall be the sum of polarization energies of one unit line, and is defined strictly by the following formula. In an uncharged conductor, since polarized eCPs form conjugate pairs and the polarization moments cancel each other out, the polar potential is zero.

Polar potential V_p : sum of polarization energies $U(x_i)$ (shown by Eq. (73) in a unit line

$$V_p \equiv \left| \sum_i U(x_i)\mathbf{e_i} \right| \text{ in a unit line} \tag{78}$$

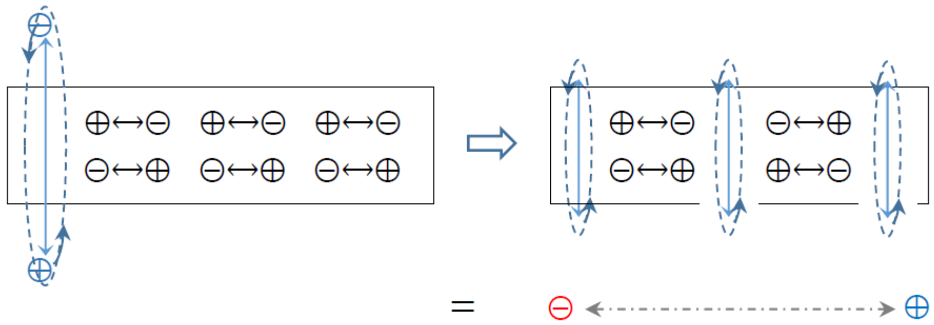
$\mathbf{e_i}$: unit vector of curvilinear coordinates along the conductor, $+1$ or -1

When an eCP is added to a conductor that is not connected to the outside, the energy spreads and disperses throughout the conductor as shown in Fig. 14. The polar potential does not depend on the length of a conductor. Furthermore, when plural unit lines are connected in parallel, the polar potentials of all of them become equal. If a certain unit line temporarily reaches a higher value, the excess energy will be transferred to the other unit lines and all will become equal. A conductor is in a state, in which plural unit lines are connected in parallel. The polarization energy (electric potential energy) of the whole conductor is the product of the polar potential and the number m of unit lines.

$$U = mV_p \tag{79}$$

This shows a similar relation to $U = QV$ in the existing electromagnetism, but m is a dimensionless number and V_p has the dimension of energy.

Fig. 14. Addition of eCP to unconnected conductor



Polarization of eCP spreads throughout the conductor, and the polar potential does not depend on its length.

✧ **Definition of electric current**

Let us define the electric current based on the polarization energy. If we use a unit that makes us imagine the origin of the energy passing per unit time, it is easy to have an image that a polarization energy is passing. Instead of an electric charge, it is conceivable to indicate how many eCPs passes per unit time. However, the polarization energy of an eCP is not constant and varies depending on its length. Therefore, using the energy of iS, which is the smallest eCP, as a unit, the polarization energy divided by the energy U_0 of iS shall be defined as the "**polar charge** C_p".

Polar charge C_p : polarization energy divided by the energy of iS

$$C_p \equiv U/U_0 \ , \qquad U_0 = E_{(iS)} = m_0 c^2 \tag{80}$$

$$\mathbf{C_p} = C_p \boldsymbol{e_p} = +C_p \text{ or} - C_p \tag{81}$$

Polarization has a direction, and that in which the electric charge in an eCP lies from minus to plus is defined as the plus. The polar charge also has a direction whether its polarization is plus or minus.

Then, we define the electric current as follows.

Electric current $\mathbf{I_p}$: polar charge passing per unit time through a cross section

$$\mathbf{I_p} \equiv \mathbf{C_p}/t \tag{82}$$

The electric current has a direction, whether the direction of the energy transmission is that of plus polar charge or that of minus polar charge. The power (watt) is expressed by the electric current as follows.

$$P = U/t = C_p U_0/t = I_p U_0 \tag{83}$$

✧ Current potential

In the current electromagnetism (EM), the power is expressed as the product of the electric current and the electromotive force, $P = IE$, and the electromotive force E is generally called voltage (or source voltage), the unit of which is volt. We have defined the polar potential V_p by Eq. (78). Here we define the "**current potential**", which corresponds to the electromotive force when an electric charge flows in the current EM, as follows.

Current potential V_c : Power per one unit line

$$V_c \equiv P/m = I_p U_0/m \tag{84}$$

The power is the product of the current potential and the number m of unit lines.

$$P = U/t = mV_c \tag{85}$$

2-7 Comparison of major concepts with existing EM

As explained above, we have newly defined the major concepts related to the electric current. Here let us put them in order by comparing with concepts and related formulas of the existing electromagnetism. We show in the order of "related expressions in the existing EM" ⟹ "those in the ECT".

1) Electric charge

Q ⇒ isolated electric charge not exist, $Q = +e - e = 0$ for an eCP

2) Electric potential energy: U (common)

3) Polar charge

None ⇒ $C_p = U/U_0$ (U_0: energy of iS)

4) Electric current

$$I = Q/t \quad \Rightarrow \quad I_p = C_p/t$$

5) Power

$$P = U/t = IE \quad \Rightarrow \quad P = U/t = I_p U_0$$

6) Number of unit lines

None ⇒ m

7) Electromotive force / Current potential

(source voltage) (power of a unit line)

$$E = P/I \quad \Rightarrow \quad V_c = P/m = I_p U_0/m$$

8) Electrostatic potential / Polar potential

(electric potential) (electric potential energy of a unit line)

$$V = U/Q \quad \Rightarrow \quad V_p = U/m$$

Chapter 3: Magnetic phenomena by the ECT

3-1 Rotating magnetic charge around a unit line

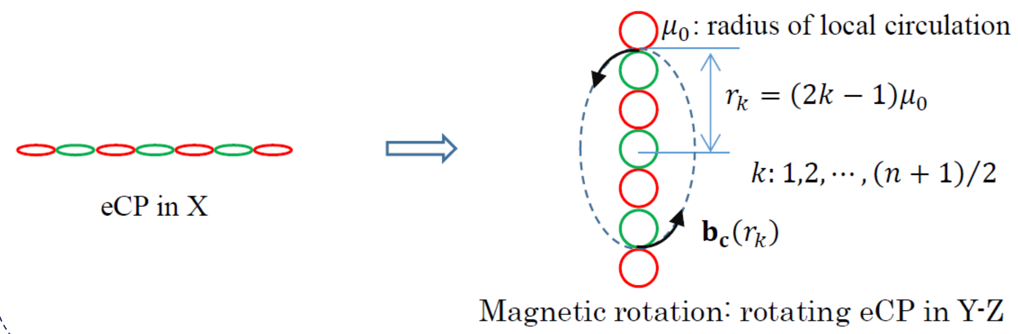
In the current electromagnetism, the magnetic charge is not assumed, but instead it is believed that the magnetic force acts through interaction of magnetic fields. The magnetic field is said to be generated by fluctuations in the electric field. However, there is no isolated charge and no electric field in fact. In the ECT, the magnetic charge is defined as the momentum in the 3D space of a hidden-space energy circulation. In the 3D space, the magnetic charge is a vector charge having a direction, and the fundamental force shown by Eq. (4) acts among them. The force between the two magnetic charges $\mathbf{b_1}$ and $\mathbf{b_2}$ is as below (see Fig. 1 for angular components).

$$F = K_f \frac{b_1 b_2}{d^2} \cos\theta_p \sin\theta_1 \sin\theta_2 \tag{86}$$

✧ Magnetic rotation

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 as shown in Fig. 15. We call this as the "**magnetic rotation**".

Fig. 15. Rotation of eCP in space dimensions around the hidden dimension axis



If we see each one of circulations within the eCP, the motion in space dimensions of the intrinsic energy changed from one-dimensional in X to spiral, in which a local circulation in X-Y is rotating in Y-Z.

$$V_{main}^2 + V_{local}^2 = r^2\omega^2 + {\mu_0}^2{\omega_{xy}}^2 = c^2 \tag{87}$$

r and ω are the radius and the frequency of the main rotation in Y-Z.

As shown in the figure, the magnetic charge is shown collectively for each radius r_k from the center to the tip (strictly speaking, it is continuous). There are two points for one radius; 0 and pi (180 degrees) of phase, but we treat their momentums as one rotating magnetic charge. For the main rotation in Y-Z, the energy distribution is expressed as follows.

$$\psi_k = [Y \quad Z]_k = r_k(\cos\omega t + i\sin\omega t) \tag{88}$$

$$r_k = (2k-1)\mu_0\,, \qquad k: 1,2,\cdots \le (n+1)/2 \tag{89}$$

The energy and rotating magnetic charge at each radius are as below.

Energy amount:

(E: energy of eCP)

$$E_k = \frac{2E}{n} = \frac{2mc^2}{n} \quad \text{for } k < (n+1)/2 \tag{90}$$

$$E_k = \frac{E}{n} = \frac{mc^2}{n} \quad \text{for } k = (n+1)/2 \tag{91}$$

Circulating magnetic charge:

$$\mathbf{b_c}(r_k) = \frac{2m}{n}\mathbf{v_c} = \frac{2m}{n} r_k \omega \mathbf{e_c} \quad \text{for } k < (n+1)/2 \tag{92}$$

$$\mathbf{b_c}(r_k) = \frac{m}{n}\mathbf{v_c} = \frac{m}{n} r_k \omega \mathbf{e_c} \quad \text{for } k = (n+1)/2 \tag{93}$$

$\mathbf{e_c}$: unit vector of an arc on the circumference

3-2 Magnetic charge density around an electric current

✧ Linear density of magnetic charge

During one cycle of magnetic rotation, the magnetic charge goes around the circumference by one circle. Here, we call the magnetic charge per minute line segment on the circumference as the "**linear density of magnetic charge**", which shall be defined as below.

$$\mathbf{b_L}(r_k) \equiv \frac{\mathbf{b_c}(r_k)}{2\pi r_k} \tag{94}$$

Substitute $\mathbf{b_c}(r_k)$ of Eqs (92) (93) to it, we get the linear density as follows.

$$\mathbf{b_L}(r_k) = \frac{m}{\pi n} \omega \mathbf{e_c} \quad \text{for } k < (n+1)/2 \tag{95}$$

$$\mathbf{b_L}(r_k) = \frac{m}{2\pi n} \omega \mathbf{e_c} \quad \text{for } k = (n+1)/2 \tag{96}$$

The radius is canceled out in the formula, and the line density does not depend on the radius. We add the linear densities of all radii, and define the sum as the "**linear density of gross magnetic charge**". There is a question how to deal with the radius of the gross magnetic charge. However, because the radius of magnetic rotation is at the atomic size level, it is not a problem to treat that the gross magnetic charge exists on the surface of the magnetic rotation in actual cases where many unit lines are gathered.

Gross magnetic charge:

Sum of magnetic charges of all radii of $r_1 \sim r_{(n+1)/2}$

Linear density of gross magnetic charge:

$$\boldsymbol{\beta}_{\mathbf{L}} = \frac{n-1}{2}\frac{m}{\pi n}\omega\mathbf{e_c} + \frac{m}{2\pi n}\omega\mathbf{e_c} = \frac{m}{2\pi}\omega\mathbf{e_c} = \frac{E}{2\pi c^2}\omega\mathbf{e_c} \tag{97}$$

✧ Surface density of gross magnetic charge of a unit line

Next, let us examine the magnetic charge associated with an electric current I_p, which flows through a unit line. Consider a minute length Δx in a unit line. The value of an electric current is the amount of energy that passes through a point for one second when the current is flowing continuously. The energy in the region Δx is the power P times the time it takes to pass through the region. Since the electric current transmits almost at the light speed, the energy is given by $Pt = P\,\Delta x/c$ and shown as follows.

$$E(\Delta x) = P\frac{\Delta x}{c} = I_p U_0 \frac{\Delta x}{c} \tag{98}$$

Substitute it to Eq. (97), then we get the linear density of gross magnetic charge in the length Δx of the unit line as below.

$$\boldsymbol{\beta}_{\mathbf{L}}(\Delta x) = \frac{E(\Delta x)}{2\pi c^2}\omega\mathbf{e_c} = \frac{I_p U_0 \Delta x}{2\pi c^3}\omega\mathbf{e_c} \tag{99}$$

What this is divided by Δx shows the magnetic charge density per unit area of the surface, and we named it as the "**surface density of gross magnetic charge**".

Surface density of gross magnetic charge:

$$\boldsymbol{\beta}_{\mathbf{S}} \equiv \frac{\boldsymbol{\beta}_{\mathbf{L}}(\Delta x)}{\Delta x} = \frac{U_0}{2\pi c^3} I_p \omega\mathbf{e_c} = \frac{m_0}{2\pi c} I_p \omega\mathbf{e_c} \tag{100}$$

$$\nabla \times \boldsymbol{\beta}_{\mathbf{S}} = \frac{m_0}{2\pi c}\omega\mathbf{I_p} \tag{101}$$

Eq. (101) is expressing Eq. (100) using the rotation around the electric current instead of $\mathbf{e_c}$, and the both are equal to each other. This shows the surface density of gross magnetic charge when an electric current $\mathbf{I_p}$ flows in a unit line.

✧ Magnetic charge density on the surface of a conductor

In a conductor in fact, a large number of unit lines are connected in parallel. Those unit lines on the surface of a conductor show the surface density of magnetic charge shown above. However, inside of it, since all the unit lines have the rotating magnetic charge of the same magnitude and direction, the rotating charges are set off at the connected parts and become zero. Since the value of an electric current is the sum of those of all unit lines, that of one unit line is the sum divided by the number m of unit lines given by $\mathbf{I_p}/m$. Therefore, the surface density of gross magnetic charge on the surface of a conductor is given as below.

Surface density of gross magnetic charge of a conductor:

$$\nabla \times \boldsymbol{\beta}_\mathbf{S} = \frac{m_0}{2\pi c}\omega\frac{\mathbf{I_p}}{m} \quad (m\text{: number of unit lines}) \tag{102}$$

This equation shows that the magnetic charge density on the surface of a conductor is proportional to the frequency ω of magnetic rotation and the electric current density $\mathbf{I_p}/m$. This corresponds to the Ampere's law expressed by the following equation in the standard electromagnetism.

$$\nabla \times \mathbf{H} = \mathbf{j} \quad (\mathbf{H}\text{: magnetic field}, \mathbf{j}\text{: current density}) \tag{103}$$

The frequency ω of magnetic rotation is determined by the energy distribution ratio between the main rotation and the local circulation, as shown in Eq. (87). It varies depending on the material that makes up the conductor.

✧ Asymmetry of magnetic rotation (Ampere's right-handed screw law)

The direction of a magnetic rotation is right-handed to the plus direction of an electric current. This is called as the Ampere's right-handed screw law, but it was an empirical law unclear why the rotation is only in one direction. In the ECT, the asymmetric energy circulations were generated by the cosmic separation that was explained in the Section 1-4 of this book. The energy circulations changed to smaller and smaller ones by repeating the cyclic decomposition in many rounds. In those processes, the circulating direction relative to the traveling one, that is, the helicity has been inherited. We guess that this is the reason why the magnetic rotation is only in one direction.

✧ **Magnetic charge density and magnetic field**

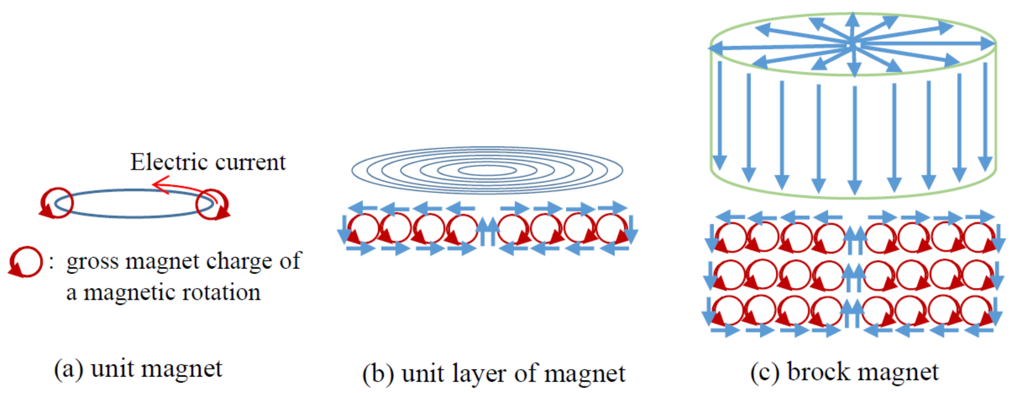
The force between magnetic charges is a direct force, and is not mediated by a transmitter. However, it can be mathematically treated also as that a magnetic field, which is a vector field, is spreading from the magnetic charge. Therefore, Eq. (103) of the existing EM and Eq. (102) of the ECT can be considered to be essentially equivalent. This means that the Ampere' law, which was an empirical rule, has been logically derived from the two premises in the ECT.

3-3 Magnet

✧ **Unit magnet**

Let us now examine the mechanism and structure of a magnet, which is a typical example of presenting the magnetic charge (magnetic field). We consider a circular closed circuit, in which the two ends of a conductor are connected. When unpaired eCPs, that is, polarization energies are present there, an electric current flows in the circuit, and many magnetic rotations come up. As shown in Fig. 10, an eCP gets shorter by releasing an energy (light), makes a rearrangement of pairing with the neighboring eCP pair, and a new single eCP absorbs the energy previously released and becomes a new magnetic rotation. When this energy release and absorption occurs continuously in this way, and almost no energy runs out to the outside, the conductor of a circuit shows a stable surface density of magnetic charge. This shows a magnetism without energy supply from the outside, that is, the paramagnetism. We named this circuit that forms the minimum structure of magnet as the "**unit magnet**". We define the unit magnet as a closed unit line of circuit where an electric current flows. Fig. 16(a) shows its structure. The red circle there shows the gross magnetic charge of a magnetic rotation in the central cross section. In fact, there are located numerous magnetic rotations throughout the circuit.

Fig. 16. Basic components of magnet and surface magnetic charge



✧ Unit layer of magnet

We named an assembly of multiple concentric unit magnets with increasing radiuses in a plane as the "**unit layer of magnet**", which is shown in Fig. 16(b). Adjacent unit magnets exert the magnetic force and attract each other, but the magnetic charges in the adjacent parts are set off to be zero. As a whole, the magnetic charge remains only on the surface of the unit layer of magnet. The direction of the magnetic charge extends radially from the center; outward on one side of the layer and inward on the other side. The red lines in the figure show the individual magnetic rotations, and the blue lines show the directions of magnetic charges.

✧ Brock magnet

If plural unit layers of magnet are connected in series as shown in Fig. 16(c), it forms a "**brock magnet**". The directions of internal electric currents in the constituent unit layers of magnet are the same, and the magnetic charges at the connected surfaces are in opposite directions. A magnetic force acts between the adjacent layers and attract each other, but the magnetic charges on the adjacent surfaces are set off. As a whole of the brock magnet, the internal magnetic charges are set off to be zero, and only on the surface the magnetic charges in the directions of the blue lines in Fig. 16(c) remain. The planes at the two ends show radial magnetic charges; outward at one plane and inward at the other. Between two magnets, two faces with opposite directions of magnetic radiation show an attractive force, and those with the same direction show a repulsive force. The outward surface of magnetic charge is the N pole of a magnet, and the inward surface is the S pole. The cylindrical surface of the magnet shows magnetic charges parallel to the direction connecting the upper and lower plane magnetic charges as shown in Fig. 16(c). In this way, the structure described here perfectly reproduces the properties of magnets that we commonly see.

✧ Requirements for magnet

In order to show a stable magnetism, in a unit magnet, the released energy from a magnetic rotation must be absorbed nearby and passed on to form the next magnetic rotation. If some energy is released outside the circuit, it loses energy through heat generation or light emission. It is presumed that a conductor, which has a structure to once receive and release the emitted energy, such as a pi bond or a metal bond, can minimize the energy radiation to the outside. Furthermore, with the structure of a brock magnet as shown in Fig. 16(c), even if one unit magnet radiates energy to the outside, it will be absorbed by neighboring unit magnets, resulting in a stable paramagnetism as a whole.

As shown in Eq. (102), the magnitude of the surface magnetic charge is proportional to the frequency ω of magnetic rotation. We expect this frequency to depend on the material of the magnet or the conductor.

3-4 Magnetic interactions of charged bodies

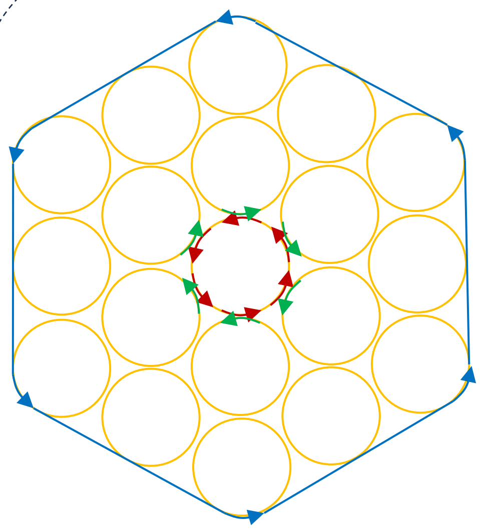
(The contents of this section have not yet been published in a paper, and this book serves as the first explanation.)

What is said to be an electrostatic action between charged bodies in the existing electromagnetism is actually a magnetic action. Let us take a look at the electric charged body.

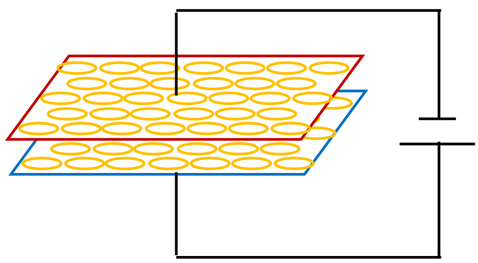
✧ Electrification and charged body

First of all, the "**electrification**" is not a state of excess positive or negative charges, but as explained in the Section 2-6, is the state where the energy of free elementary charge pairs eCPs is accumulated. When eCPs exist in an isolated conductor that is not connected electrically to the outside, the polarization energy is stored in a state where multiple magnetic rotations are distributed over the entire length, as shown in Fig. 14. Let us call such an isolated conductor with free eCPs as the "**charged body**". We defined the polarization energy per unit line as the polar potential V_p (by Eq. (78)). A charged body is made up of multiple unit lines connected in parallel, and the polarization energy of the whole charged body is the polar potential times by the number m of unit lines, $U = mV_p$. As shown in Fig. 17(a), the magnetic charges are set off to be zero inside, where unit lines are adjacent, and remain only on the periphery (blue line in Fig. 17(a)) of a cross section of the charged body (conductor). This magnetic charge density is independent of the value of m and is equal to that of one unit line. In this way, rotating magnetic charges exist only on the side surface of the charged body, and the magnetic charge density under a constant polar potential does not depend on the cross-section area of it or the amount of the stored electricity. Let us call the cross section perpendicular to the unit lines, such as shown in Fig. 17(a), as the "**electrode plane**".

Fig. 17. Cross section of charged body and capacitor



(a) Cross section of charged body (= electrode plane)



(b) Capacitor

The individual circles indicate the magnetic rotation around a unit line. The rotating magnetic charges are set off to zero inside, and remain only on the outer surface.

Fig. 17(b) shows the structure of the capacitor. A capacitor has large electrode surfaces at two ends, and can store a large amount of polarization energy. The whole circuit, including a capacitor, is connected in series, and the polar potential is the sum of those of the parts connected in series.

However, the most of the polarization energy is stored in the electrodes, where a large number of unit lines are connected in parallel. As explained in the previous paragraph, the magnetic charges are set off on the electrode plane, which does not act a magnetic force. This situation is the same for batteries. The battery is a cylindrical charged body, and the electrodes at the two ends have the structure of electrode plane shown by Fig. 17(a), and do not work a magnetic force. A spherical charged body has a curved spherical electrode plane, and the magnetic charges are set off there, too. Between two ones, although a discharge (explained at the end of this section) occurs, no magnetic force acts.

✧ Magnetic force acting on side surfaces of charged body

As described above, the magnetic force does not work on an electrode plane of a charged body. But, since rotating magnetic charges shown in 17(a) by blue line are distributed throughout on its side surface, there magnetic interactions work.

Fig. 18. Interaction of side faces of charged bodies and magnetic action inside a curved charged body

(a) Magnetic interaction of side faces of charged bodies

(b) Magnetic action inside a curved charged body

(a) Between two flat charged bodies, attraction works at their sides. (b) In a curved charged body, distances between rotating magnetic charges are shorter on inside than on outside, and attractive forces on inside are larger.

Fig. 18(a) shows how two flat charged bodies exhibit an attractive force by the rotating magnetic charges on the side surfaces. The attraction between two pieces of cloth due to static electricity is an example of this interaction.

In the case of a curved charged body, the distance between adjacent rotating magnetic charges is shorter on the inside than on the outside as shown in Fig. 18(b). Therefore, the repulsive force by the orthogonal interaction is larger on the inside than on the outside, and the object tries to relieve the bending and become straight. Between distant magnetic charges as well, while the distance is large and the force is weak, the repulsive force by the flat interaction of opposite directional rotations works and tries to recede each other. An example of this is the hair raising due to the static electricity. This force also causes the two ends to spread out when a folded piece of aluminum foil is charged.

✧ Summary of electrification

As we have explained so far, the electrification is the accumulation of a polarization energy by elementary charge pairs eCPs, and the force acting on a charged body is the magnetic force due to the rotating magnetic charges on the side surface. On the other hand, on a cross section of a charged body, the magnetic charges are set off to be zero, and no magnetic force acts there.

✧ Discharge of charged body

At the end, let us explain the discharge of a charged body. The "**discharge**" is the movement of eCPs, which are rotating in a conductor and showing magnetic charges, through the space to another conductor. The eCP can be static in a conductor by rotating. The main rotation in Y-Z in Fig. 15 of an eCP decreases in the radius and becomes the local circulation, which moves linearly in X by conversion of the decreased circulating energy to those for prolongation and linear motion in X. This linearly moving eCP increases the radius of rotation within the nearby conductor and returns to a static magnetic rotation. This is the phenomenon of the discharge. The discharge is the movement of free eCPs with nothing attached to either end, and is by no means the movement of electrons.

Since what is moving by discharge is a free eCP, the direction of local circulation and that of linear motion can flexibly change. On the other hand, an ionized free electron such as an electron beam (see Eq. (76) has a neutrino attached to the minus end of the eCP, and in the absence of magnetism, it goes straight due to the neutrino's inertia (straight momentum). Furthermore, it cannot get static to the space. In the discharge, when the rotating radius of an eCP moving in the air becomes shorter, not all of the difference in rotating energy becomes an increase in linearly moving energy, but a portion is emitted as light. This is the light emission associated with the discharge. The fact, that discharges such as those caused by lightening do not proceed in a straight line but in a zigzag pattern and are associated by luminescence, duly negates the possibility that the discharge is the movement of electrons, and strongly supports that it is the movement of eCPs.

Closing: Discussions

Now up to here, we have seen the completely new electromagnetism based on the energy circulation theory. What impressions did you have? Many people should wonder why it is necessary to consider a new system that abandons the current EM, with which they do not feel any problems, and they will continue to trust the existing EM. However, let us think about it again.

✧ Electric charge, electric field

With respect to the magnetic field in the existing EM, it can be regarded equivalent to the magnetic charge density by the ECT, and has no problem. However, some fatal problems lie in the electric charge and the electric field. The electric charge is thought to be the most important property, but are there any examples where it has been actually observed? As described in the Introduction of this book, the electrostatic force between isolated electric charges has not been observed in fact. They believe in that the electrostatic force should act between the proton and electron in an atom, and brand the electrostatic force as to work between charged particles. Both a hydrogen ion and a free electron have zero of its overall electric charge and are neutral. Most of what is said to be a force between electrically charged particles is actually a magnetic interaction caused by rotating magnetic charges.

✧ Coulomb force (electrostatic force)

The Coulomb's law, which says there acts a force between electric charges, actually holds within only one spacia. Moreover, any electric charge is lined up in pairs, in which plus and minus charges lie alternately with the interval of $2\mu_0$ of the diameter of a spacia. The force acting on the two ends of an elementary charge pair eCP is an intra-circulation force within a local circulation at the end, but it is equal to the virtual force that would act when the elementary charges $+e$ and $-e$ were separated with the length of eCP. In this case, the Coulomb's law virtually holds, but it is limited to the attractive force within an eCP and the virtual charge is limited to the elementary charge $\pm e$. In the ECT, this force is called as the connected electric force, distinguished from the electrostatic force (Coulomb force).

✧ **Maxwell's equations**

If isolated electric charges and their electrostatic forces do not exist practically, the electric field cannot be assumed either. It is said that all electromagnetic phenomena can be reduced to the four Maxwell's equations, but these equations do not hold if the electric field does not exit macroscopically. Existing formulas for laws related to electromagnetism, including Maxwell's equations, were not derived logically but are empirical rules. It is said that the Maxwell's equations exist as truths of nature, and that electromagnetic phenomena are logically derived from them. However, there is no basis for assuming that Maxwell's equations are unconditionally true. If the electrostatic force is not observed, there is no need or basis to assume isolated electric charges.

✧ **Current potential**

When we express the electric current based on energy, there is basically no need to use the electric charge. The power (watt) and the energy (watt hour) are sufficient for the case. However, in order to express the natures of series and parallel connections, an alternative property corresponding to the electromotive force (source voltage) in the existing EM is required to be newly defined. In the ECT, we newly defined the current potential V_c corresponding to the electromotive force. This is the power per unit line, giving the power as $P = mV_c$, in which m is the number of unit lines. An alternative to the voltage is V_c, and that to the electric current is m. V_c is equal in the parallel connection and is summed in the series one.

Furthermore, when the materials are the same, m is proportional to the cross-sectional area of the conductor. Therefore, $P = mV_c$ can be said to be a relational expression of high utility and logic.

✧ **Polar charge**

In the ECT, we defined the polar charge as the polarization energy (sum of energies of eCPs) divided by the energy U_0 of iS by $C_p = U/U_0$, and redefined the electric current by $I_p = C_p/t$. However, the power is $P = I_p U_0$, and differs from the electric current only in the unit of energy. Although it may not be necessary to define the electric current, we introduced the definition of it using the polar charge C_p to express the image that the energy of eCPs (polarization energy) is transmitting.

✧ **Polar potential**

The electric capacity is the energy itself so that there is no need to be changed. The potential difference (electrostatic potential) V cannot be used because it is defined as $V = U/Q$ using the electric charge. In the ECT, as an alternative, the polar potential V_p is defined as the polarization energy of a unit line by $V_p = U/m$. m is a dimensionless number, and V_p has the dimension of energy. V_p shows the same value in parallel, and is the sum in series, so it can replace the potential difference.

✧ **Number of unit lines**

The number m of unit lines is very useful when dealing with the power (electric current) and the amount of electricity. It should be convenient to give a term to m itself or to its product by some coefficient. Please give it a good name.

✧ **Magnetism around electric current**

In the existing EM, the magnetism that comes out around an electric current is given by the Ampere’s law as an empirical rule. No questions are asked as to why it appears. However, the ECT has theoretically shown the generation of magnetism and has formulated it quantitatively. The ECT has also raised a model of basic structures for a magnet to present the magnetism.

✧ Charged body

The electrification is not to have excess of positive or negative charges, but to accumulate the energy of eCPs (polarization energy) in fact. On the cross section of the charged body (electrode plane), magnetic charges are set off and no magnetic force acts, while on the side surface, magnetic interactions act due to rotating magnetic charges that go around it. The ECT clearly showed that the force that acts on a charged body with static electricity by friction or that by conduction is the magnetic force but not the electrostatic force, and that no force works on the electrode plane of it.

✧ Light radiation

The ECT revealed the details of the light radiation. The reason why the rotation of an eCP in an atom or a conductor does not cause a light radiation is because it rotates around the hidden dimension H axis. When an eCP rotates around a space dimension axis, it causes a light radiation, in which the electric charge, the magnetic charge, and the energy position in a vertical space direction transmit linearly with vibrating. This is a radiation of continuous light and called as the bremsstrahlung. In addition, there is a light emission in which an eCP becomes shorter and the difference energy is emitted as light. This is not a continuous light, but a single light emission of one cycle (light quantum).

The propagation speed of light is given as the internal circulating velocity in the spacia, and decreases as the space expands. The observed data of supernovae show the decrease in the light speed but no means of the acceleration of the space expansion.

✧ Conclusion

In this way of we have discussed in this book, it can be said that the ECT achieved overwhelming results also in the electromagnetism. I would kindly like you to compare the existing electromagnetism with that by the ECT, and evaluate them by yourself.

April 2024

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Terms: Link to explanation

- antineutrino
- apparent energy
- asymmetry of magnetic rotation
- attached galactic seeds
- bremsstrahlung
- brock magnet
- charge
- charged body
- connected electric force
- cosmic separation
- coupled conjugate pair
- current potential
- cyclic decomposition
- discharge
- double circulation
- electric charge
- electric current
- electric force
- electrification
- electrode plane
- electron
- elementary charge pair
- elementary electric charge
- elementary magnetic charge
- elementary single circulation
- energy1
- energy2
- energy circulation
- energy circulation theory
- flat interaction
- flat separation
- fundamental force
- galactic seed
- galactic seed separation
- gamma-ray burst
- gross magnetic charge
- hemi-circulation
- hidden dimension
- Hubble diagram
- hydrogen atom
- intra-circulation force
- intrinsic energy
- isolated electric charge
- light quantum
- light radiation
- light speed
- magnetic charge
- magnetic field
- magnetic rotation
- mass
- micro-circulations
- momentum
- neutrino
- neutrino oscillation
- orthogonal interaction
- orthogonal separation
- particle
- Planck constant
- polar charge
- polarization energy
- polar potential
- pre-cosmos
- proton
- quantum particle
- rest dimension
- ring of daughter circulations
- rotating binary galactic seeds
- scalar charge
- space dimensions
- space energy
- space expansion
- spacia
- spiral motion
- stellar seeds
- surface density of gross magnetic charge
- unit layer of magnet
- unit line
- unit magnet
- vector charge