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Unified Interpretation of the Gravitational, Electric, Magnetic, and Electromagnetic Forces

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Small total chirality in the gravitational terms originates from the cancellation of the large right- and left-handed helicity elements. Therefore, the external potential energy for gravity can be very small but finite values, and the distortion of the spacetime axes can occur. That is, gravitational field can originate from the fluctuation of the electromagnetic fields because of the slight polarization of the electric charges and spin magnetic moments at the infinite small points (or very small finite sizes). This effect is very similar to the van der Waals forces or intermolecular forces in chemistry even though this effect is much smaller than them because of its very small size. The most of extremely large energy generated at the time of the Big Bang has been stored in the particle as a large potential rest energy, and only small part of it is now used as very small gravitational energy.

Keywords: Cancellation of the Helicity; Massive Charge; Small Fluctuation of the Electromagnetic Fields; Large Rest Energy.

1. Introduction

The effect of vibronic interactions and electron–phonon interactions [1–7] in molecules and crystals is an important topic of discussion in modern chemistry and physics. The vibronic and electron–phonon interactions play an essential role in various research fields such as the decision of molecular structures, Jahn–Teller effects, Peierls distortions, spectroscopy, electrical conductivity, and superconductivity. We have investigated the electron–phonon interactions in various charged molecular crystals for more than ten years [1–8]. In particular, in 2002, we predicted the occurrence of superconductivity as a consequence of vibronic interactions in the negatively charged picene, phenanthrene, and coronene [8]. Recently, it was reported that these trianionic molecular crystals exhibit superconductivity [9].

Related to the research of superconductivity as described above, in the recent research [10,11], we explained the mechanism of the Ampère's law (experimental rule discovered in 1820) and the Faraday's law (experimental rule discovered in 1831) in normal metallic and superconducting states [12], on the basis of the theory suggested in our previous researches [1–7]. Furthermore, we discussed how the left-handed helicity magnetic field can be induced when the negatively charged particles such as electrons move [13]. That is, we discussed the relationships between the electric and magnetic fields [13]. Furthermore, by comparing the electric charge with the spin magnetic moment and mass, we suggested the origin of the electric charge in a particle. Furthermore, we discussed the relationships between the magnetic forces, gravity, electric forces, and electromagnetic forces.

In this research, we will discuss the origin of the gravity, by comparing the gravity with the electric and magnetic forces. Furthermore, we will show the reason why the gravity is much smaller than the electric and magnetic forces.

2. Theoretical Background

2.1 Relationships between the Spin Magnetic Moment and Mass at Space Axis

According to the special relativity and Minkowski's research, the medium for an electron is time as well as space. In this article, the charges of the gravity (massive charge (mass)), of the electric force (electric charge), of the magnetic forces (spin magnetic moment), and of the electromagnetic force are denoted as q_{g}, q_{e}, q_{m}, and q_{em}, respectively. Furthermore, the gauge bosons of the gravity (graviton), of the electric force (electric photon), of the magnetic forces (magnetic photon), and of the electromagnetic force (electromagnetic photon) are denoted as γ_{g}, γ_{e}, γ_{m}, and γ_{em}, respectively.

Let us consider a particle such as an electron in three-dimensional space axis (Fig. 1 (a), (b)). We can consider that the spin electronic state for an electron with massive charge q_{g} and momentum $\boldsymbol{k}$ can be composed from the right-handed chirality $\left|\boldsymbol{R}\uparrow\left(q_{\mathrm{g}},\boldsymbol{k}\right)\right\rangle$ or left-handed chirality $\left|\boldsymbol{L}\downarrow\left(q_{\mathrm{g}},\boldsymbol{k}\right)\right\rangle$ elements, defined as,

$$\left|\boldsymbol{R}\uparrow\left(q_{\mathrm{g}},\boldsymbol{k}\right)\right\rangle = c_{\boldsymbol{R}_R}\left(q_{\mathrm{g}}\right)\left|\boldsymbol{R}_R(+\boldsymbol{k})\right\rangle + c_{\boldsymbol{R}_L}\left(q_{\mathrm{g}}\right)\left|\boldsymbol{R}_L(-\boldsymbol{k})\right\rangle, \quad (1)$$

$$\left|L\downarrow\left(q_{\rm g},\boldsymbol{k}\right)\right\rangle = c_{\boldsymbol{L}_L}\left(q_{\rm g}\right)\left|\boldsymbol{L}_L(+\boldsymbol{k})\right\rangle + c_{\boldsymbol{L}_R}\left(q_{\rm g}\right)\left|\boldsymbol{L}_R(-\boldsymbol{k})\right\rangle, \tag{2}$$

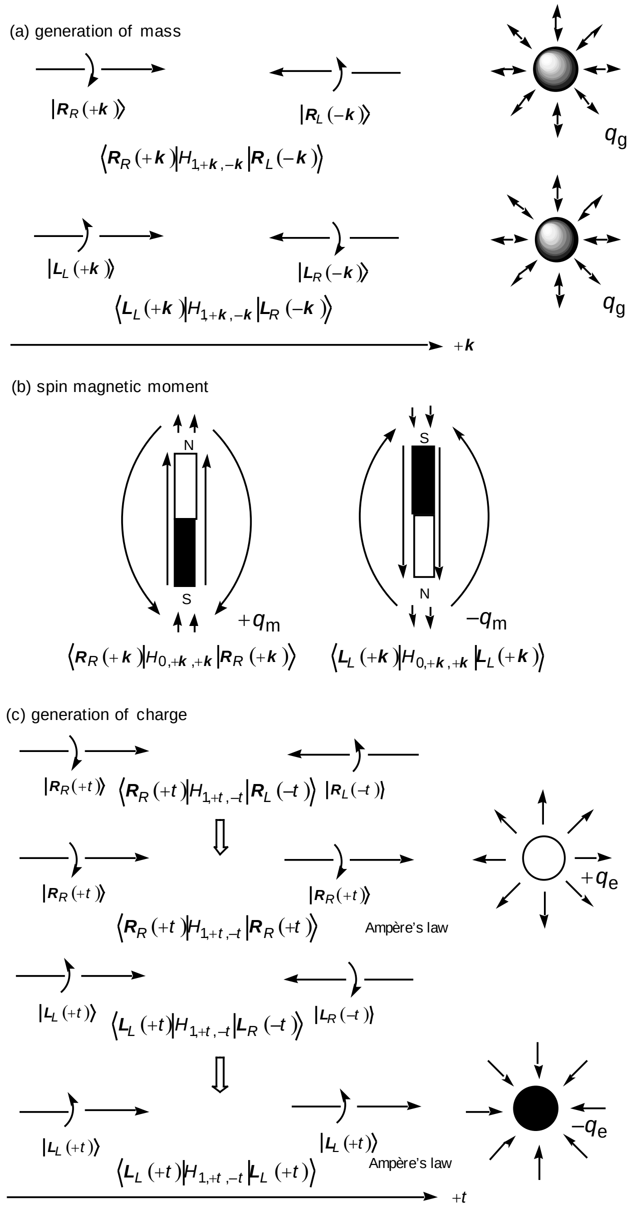

Fig. 1. Mass, spin magnetic moment, and electric charge.

where the $|\boldsymbol{R}_R(+\boldsymbol{k})\rangle$ and $|\boldsymbol{R}_L(-\boldsymbol{k})\rangle$ denote the right- and left-handed helicity elements in the right-handed chirality $\left|R\uparrow\left(q_{\rm g}\right)\right\rangle$ state, respectively, and the $|\boldsymbol{L}_L(+\boldsymbol{k})\rangle$ and $|\boldsymbol{L}_R(-\boldsymbol{k})\rangle$ denote the left- and right-handed helicity elements in the left-handed chirality $\left|L\downarrow\left(q_{\rm g},\boldsymbol{k}\right)\right\rangle$ state, respectively, at the space axis. By considering the normalizations of the $\left|R\uparrow\left(q_{\rm g},\boldsymbol{k}\right)\right\rangle$ and $\left|L\downarrow\left(q_{\rm g},\boldsymbol{k}\right)\right\rangle$ states, the relationships between the coefficients ($0\le c_{\boldsymbol{R}_R}\left(q_{\rm g}\right)c_{\boldsymbol{R}_L}\left(q_{\rm g}\right)c_{\boldsymbol{L}_L}\left(q_{\rm g}\right)c_{\boldsymbol{L}_R}\left(q_{\rm g}\right)\le 1$) can be expressed as

$$\left\langle R\uparrow\left(q_{\rm g},\boldsymbol{k}\right)\middle|R\uparrow\left(q_{\rm g},\boldsymbol{k}\right)\right\rangle = c_{\boldsymbol{R}_R}^2\left(q_{\rm g}\right)+c_{\boldsymbol{R}_L}^2\left(q_{\rm g}\right)=1, \tag{3}$$

$$\left\langle L\downarrow\left(q_{\rm g},\boldsymbol{k}\right)\middle|L\downarrow\left(q_{\rm g},\boldsymbol{k}\right)\right\rangle = c_{\boldsymbol{L}_L}^2\left(q_{\rm g}\right)+c_{\boldsymbol{L}_R}^2\left(q_{\rm g}\right)=1. \tag{4}$$

Let us next consider the Hamiltonian $H_{\boldsymbol{k}}$ for an electron at the space axis, as expressed as,

$$H_{\boldsymbol{k}} = H_{0,+\boldsymbol{k},+\boldsymbol{k}} + H_{1,+\boldsymbol{k},-\boldsymbol{k}}. \tag{5}$$

The energy for the right-handed chirality $\left|R\uparrow\left(q_{\rm g},\boldsymbol{k}\right)\right\rangle$ state can be estimated as

$$\begin{aligned}&\left\langle R\uparrow\left(q_{\rm g},\boldsymbol{k}\right)\right|H_{\boldsymbol{k}}\left|R\uparrow\left(q_{\rm g},\boldsymbol{k}\right)\right\rangle\\ &=\left(2c_{\boldsymbol{R}_R}^2\left(q_{\rm g}\right)-1\right)\varepsilon_{q_{\rm m\infty},\boldsymbol{R}}+2c_{\boldsymbol{R}_R}\left(q_{\rm g}\right)\sqrt{1-c_{\boldsymbol{R}_R}^2\left(q_{\rm g}\right)}\,\varepsilon_{q_{\rm g\infty},\boldsymbol{R}}\\ &=\varepsilon_{q_{\rm m},\boldsymbol{R}}\left(q_{\rm g}\right)+\varepsilon_{q_{\rm g},\boldsymbol{R}}\left(q_{\rm g}\right)\end{aligned} \tag{6}$$

where $\varepsilon_{q_{\rm m\infty},\boldsymbol{R}}\left(q_{\rm g}\right)$ denotes the spin magnetic energies for the right- $|\boldsymbol{R}_R(+\boldsymbol{k})\rangle$ handed helicity element in the right-handed chirality $\left|R\uparrow\left(q_{\rm g},\boldsymbol{k}\right)\right\rangle$, and can be defined as

$$\varepsilon_{q_{\rm m\infty},\boldsymbol{R}}\left(q_{\rm g}\right)=\left\langle \boldsymbol{R}_R(+\boldsymbol{k})\right|H_{0,+\boldsymbol{k},+\boldsymbol{k}}\left|\boldsymbol{R}_R(+\boldsymbol{k})\right\rangle, \tag{7}$$

and the $\varepsilon_{q_{\rm g\infty},\boldsymbol{R}}$ denotes the mass energy originating from the interaction between the right- $|\boldsymbol{R}_R(+\boldsymbol{k})\rangle$ and left- $|\boldsymbol{R}_L(-\boldsymbol{k})\rangle$ handed helicity elements, which depends on the kind of particle, and related to the Higgs vacuum expectation value and Yukawa coupling constant,

$$\varepsilon_{q_{\rm g\infty},\boldsymbol{R}}=\left\langle \boldsymbol{R}_R(+\boldsymbol{k})\right|H_{1,+\boldsymbol{k},-\boldsymbol{k}}\left|\boldsymbol{R}_L(-\boldsymbol{k})\right\rangle, \tag{8}$$

and the $\varepsilon_{q_{\rm g},\boldsymbol{R}}\left(q_{\rm g}\right)$ denotes the generated mass energy for the right-handed chirality $\left|R\uparrow\left(q_{\rm g},\boldsymbol{k}\right)\right\rangle$ state,

$$\varepsilon_{q_{\rm g},\boldsymbol{R}}\left(q_{\rm g}\right)=2c_{\boldsymbol{R}_R}\left(q_{\rm g}\right)\sqrt{1-c_{\boldsymbol{R}_R}^2\left(q_{\rm g}\right)}\,\varepsilon_{q_{\rm g\infty},\boldsymbol{R}}, \tag{9}$$

and furthermore, $\varepsilon_{q_{\rm m},\boldsymbol{R}}\left(q_{\rm g}\right)$ denotes the spin magnetic energy for the right-handed chirality state with mass $q_{\rm g}$,

$$\varepsilon_{q_{\mathrm{m}},\boldsymbol{R}}\left(q_{\mathrm{g}}\right)=\left(2c_{\boldsymbol{R}_R}^2\left(q_{\mathrm{g}}\right)-1\right)\varepsilon_{q_{\mathrm{m}\infty},\boldsymbol{R}}. \tag{10}$$

Similar discussions can be made in the energy for the left-handed chirality $\left|\boldsymbol{L}\downarrow\left(q_{\mathrm{g}},\boldsymbol{k}\right)\right\rangle$ states,

$$\left\langle\boldsymbol{L}\downarrow\left(q_{\mathrm{g}}\right)\right|H_{\boldsymbol{k}}\left|\boldsymbol{L}\downarrow\left(q_{\mathrm{g}}\right)\right\rangle$$
$$=\left(2c_{\boldsymbol{L}_L}^2\left(q_{\mathrm{g}}\right)-1\right)\varepsilon_{q_{\mathrm{m}\infty},\boldsymbol{L}}+2c_{\boldsymbol{L}_L}\left(q_{\mathrm{g}}\right)\sqrt{1-c_{\boldsymbol{L}_L}^2\left(q_{\mathrm{g}}\right)}\varepsilon_{q_{\mathrm{g}\infty},\boldsymbol{L}}$$
$$=\varepsilon_{q_{\mathrm{m}},\boldsymbol{L}}\left(q_{\mathrm{g}}\right)+\varepsilon_{q_{\mathrm{g}},\boldsymbol{L}}\left(q_{\mathrm{g}}\right) \tag{11}$$

$$\varepsilon_{q_{\mathrm{m}\infty},\boldsymbol{L}}\left(q_{\mathrm{g}}\right)=\left\langle\boldsymbol{L}_L(+\boldsymbol{k})\right|H_{0,+\boldsymbol{k},+\boldsymbol{k}}\left|\boldsymbol{L}_L(+\boldsymbol{k})\right\rangle, \tag{12}$$

$$\varepsilon_{q_{\mathrm{g}\infty},\boldsymbol{L}}=\left\langle\boldsymbol{L}_L(+\boldsymbol{k})\right|H_{1,+\boldsymbol{k},-\boldsymbol{k}}\left|\boldsymbol{L}_R(-\boldsymbol{k})\right\rangle, \tag{13}$$

$$\varepsilon_{q_{\mathrm{g}},\boldsymbol{L}}\left(q_{\mathrm{g}}\right)=2c_{\boldsymbol{L}_L}\left(q_{\mathrm{g}}\right)\sqrt{1-c_{\boldsymbol{L}_L}^2\left(q_{\mathrm{g}}\right)}\varepsilon_{q_{\mathrm{g}\infty},\boldsymbol{L}}, \tag{14}$$

$$\varepsilon_{q_{\mathrm{m}},\boldsymbol{L}}\left(q_{\mathrm{g}}\right)=\left(2c_{\boldsymbol{L}_L}^2\left(q_{\mathrm{g}}\right)-1\right)\varepsilon_{q_{\mathrm{m}\infty},\boldsymbol{L}}. \tag{15}$$

2.2 Relationships between the Spin Magnetic Moment and Electric Charge at Time Axis

Let us consider an electron in time axis, as shown in Fig. 1 (c). We can consider that the spin electronic state for an electron with electric charge q_{e} can be composed from the right-handed chirality $\left|\boldsymbol{R}\uparrow\left(q_{\mathrm{e}},+t\right)\right\rangle$ or left-handed chirality $\left|\boldsymbol{L}\downarrow\left(q_{\mathrm{e}},+t\right)\right\rangle$ elements, defined as,

$$\left|\boldsymbol{R}\uparrow\left(q_{\mathrm{e}},+t\right)\right\rangle=c_{\boldsymbol{R}_R}\left(q_{\mathrm{e}}\right)\left|\boldsymbol{R}_R(+t)\right\rangle+c_{\boldsymbol{R}_L}\left(q_{\mathrm{e}}\right)\left|\boldsymbol{R}_L(-t)\right\rangle, \tag{16}$$

$$\left|\boldsymbol{L}\downarrow\left(q_{\mathrm{e}},+t\right)\right\rangle=c_{\boldsymbol{L}_L}\left(q_{\mathrm{e}}\right)\left|\boldsymbol{L}_L(+t)\right\rangle+c_{\boldsymbol{L}_R}\left(q_{\mathrm{e}}\right)\left|\boldsymbol{L}_R(-t)\right\rangle, \tag{17}$$

where the $\left|\boldsymbol{R}_R(+t)\right\rangle$ and $\left|\boldsymbol{R}_L(-t)\right\rangle$ denote the right- and left-handed helicity elements in the right-handed chirality $\left|\boldsymbol{R}\uparrow\left(q_{\mathrm{e}},+t\right)\right\rangle$ state, respectively, and the $\left|\boldsymbol{L}_L(+t)\right\rangle$ and $\left|\boldsymbol{L}_R(-t)\right\rangle$ denote the left- and right-handed helicity elements in the left-handed chirality $\left|\boldsymbol{L}\downarrow\left(q_{\mathrm{e}},+t\right)\right\rangle$ state, respectively. By considering the normalization of the $\left|\boldsymbol{R}\uparrow\left(q_{\mathrm{e}},+t\right)\right\rangle$ and $\left|\boldsymbol{L}\downarrow\left(q_{\mathrm{e}},+t\right)\right\rangle$ states, the relationships between the coefficients ($0\le c_{\boldsymbol{R}_R}\left(q_{\mathrm{e}}\right),c_{\boldsymbol{R}_L}\left(q_{\mathrm{e}}\right),c_{\boldsymbol{L}_L}\left(q_{\mathrm{e}}\right),c_{\boldsymbol{L}_R}\left(q_{\mathrm{e}}\right)\le 1$) can be expressed as

$$\left\langle\boldsymbol{R}\uparrow\left(q_{\mathrm{e}},+t\right)\middle|\boldsymbol{R}\uparrow\left(q_{\mathrm{e}},+t\right)\right\rangle=c_{\boldsymbol{R}_R}^2\left(q_{\mathrm{e}}\right)+c_{\boldsymbol{R}_L}^2\left(q_{\mathrm{e}}\right)=1, \tag{18}$$

$$\left\langle\boldsymbol{L}\downarrow\left(q_{\mathrm{e}},+t\right)\middle|\boldsymbol{L}\downarrow\left(q_{\mathrm{e}},+t\right)\right\rangle=c_{\boldsymbol{L}_L}^2\left(q_{\mathrm{e}}\right)+c_{\boldsymbol{L}_R}^2\left(q_{\mathrm{e}}\right)=1. \tag{19}$$

Let us next consider the Hamiltonian H_t for an electron at the time axis, as expressed as,

$$H_t=H_{0,+t,+t}+H_{1,+t,-t}. \tag{20}$$

The energy for the right-handed chirality $\left|\boldsymbol{R}\uparrow\left(q_{\mathrm{e}},+t\right)\right\rangle$ states can be estimated as

$$\left\langle\boldsymbol{R}\uparrow\left(q_{\mathrm{e}},+t\right)\right|H_t\left|\boldsymbol{R}\uparrow\left(q_{\mathrm{e}},+t\right)\right\rangle$$
$$=\left(2c_{\boldsymbol{R}_R}^2\left(q_{\mathrm{e}}\right)-1\right)\varepsilon_{q_{\mathrm{m}\infty},\boldsymbol{R}}+2c_{\boldsymbol{R}_R}\left(q_{\mathrm{e}}\right)\sqrt{1-c_{\boldsymbol{R}_R}^2\left(q_{\mathrm{e}}\right)}\varepsilon_{q_{\mathrm{e}\infty},\boldsymbol{R}}$$
$$=\varepsilon_{q_{\mathrm{m}},\boldsymbol{R}}\left(q_{\mathrm{e}}\right)+\varepsilon_{q_{\mathrm{e}},\boldsymbol{R}}\left(q_{\mathrm{e}}\right), \tag{21}$$

where $\varepsilon_{q_{\mathrm{m}\infty},\boldsymbol{R}}$ denotes the energies for the right- $\left|\boldsymbol{R}_R(+t)\right\rangle$ handed helicity elements in the right-handed chirality $\left|\boldsymbol{R}\uparrow\left(q_{\mathrm{e}},+t\right)\right\rangle$, and can be defined as

$$\varepsilon_{q_{\mathrm{m}\infty},\boldsymbol{R}}=\left\langle\boldsymbol{R}_R(+t)\right|H_{0,+t,+t}\left|\boldsymbol{R}_R(+t)\right\rangle, \tag{22}$$

and the $\varepsilon_{q_{\mathrm{e}\infty},\boldsymbol{R}}$ denotes the electric charge energy originating from the interaction between the right- $\left|\boldsymbol{R}_R(+t)\right\rangle$ and left- $\left|\boldsymbol{R}_L(-t)\right\rangle$ handed helicity elements at the time axis, which depends on the kind of particle,

$$\varepsilon_{q_{\mathrm{e}\infty},\boldsymbol{R}}=\left\langle\boldsymbol{R}_R(+t)\right|H_{1,+t,-t}\left|\boldsymbol{R}_L(-t)\right\rangle$$
$$=\left\langle\boldsymbol{R}_R(+t)\right|H_{1,+t,-t}\left|\boldsymbol{R}_R(+t)\right\rangle, \tag{23}$$

and furthermore, $\varepsilon_{q_{\mathrm{m}},\boldsymbol{R}}\left(q_{\mathrm{e}}\right)$ denotes the spin magnetic energy for the right-handed chirality state with charge q_{e},

$$\varepsilon_{q_{\mathrm{m}},\boldsymbol{R}}\left(q_{\mathrm{e}}\right)=\left(2c_{\boldsymbol{R}_R}^2\left(q_{\mathrm{e}}\right)-1\right)\varepsilon_{q_{\mathrm{m}\infty},\boldsymbol{R}}, \tag{24}$$

and the $\varepsilon_{q_{\mathrm{e}},\boldsymbol{R}}\left(q_{\mathrm{e}}\right)$ denotes the electric energy for the right-handed chirality state with charge q_{e},

$$\varepsilon_{q_{\mathrm{e}},\boldsymbol{R}}\left(q_{\mathrm{e}}\right)=2c_{\boldsymbol{R}_R}\left(q_{\mathrm{e}}\right)\sqrt{1-c_{\boldsymbol{R}_R}^2\left(q_{\mathrm{e}}\right)}\varepsilon_{q_{\mathrm{e}\infty},\boldsymbol{R}}. \tag{25}$$

Similar discussions can be made in the energy for the left-handed chirality $\left|\boldsymbol{L}\downarrow\left(q_{\mathrm{e}},+t\right)\right\rangle$ states,

$$\left\langle \boldsymbol{L}\downarrow(q_{\mathrm{e}},+t)\right| H_t \left| \boldsymbol{L}\downarrow(q_{\mathrm{e}},+t)\right\rangle = \left(2c^2_{\boldsymbol{L}_L}(q_{\mathrm{e}})-1\right)\varepsilon_{q_{\mathrm{m}\infty},\boldsymbol{L}} + 2c_{\boldsymbol{L}_L}(q_{\mathrm{e}})\sqrt{1-c^2_{\boldsymbol{L}_L}(q_{\mathrm{e}})}\,\varepsilon_{q_{\mathrm{e}\infty},\boldsymbol{L}} = \varepsilon_{q_{\mathrm{m}},\boldsymbol{L}}(q_{\mathrm{e}}) + \varepsilon_{q_{\mathrm{e}},\boldsymbol{L}}(q_{\mathrm{e}}), \qquad (26)$$

$$\varepsilon_{q_{\mathrm{m}\infty},\boldsymbol{L}} = \left\langle \boldsymbol{L}_L(+t)\right| H_{0,+t,+t} \left| \boldsymbol{L}_L(+t)\right\rangle, \qquad (27)$$

$$\varepsilon_{q_{\mathrm{e}\infty},\boldsymbol{L}} = \left\langle \boldsymbol{L}_L(+t)\right| H_{1,+t,-t} \left| \boldsymbol{L}_R(-t)\right\rangle = \left\langle \boldsymbol{L}_L(+t)\right| H_{1,+t,-t} \left| \boldsymbol{L}_L(+t)\right\rangle, \qquad (28)$$

$$\varepsilon_{q_{\mathrm{m}},\boldsymbol{L}}(q_{\mathrm{e}}) = \left(2c^2_{\boldsymbol{L}_L}(q_{\mathrm{e}})-1\right)\varepsilon_{q_{\mathrm{m}\infty},\boldsymbol{L}}, \qquad (29)$$

$$\varepsilon_{q_{\mathrm{e}},\boldsymbol{L}}(q_{\mathrm{e}}) = 2c_{\boldsymbol{L}_L}(q_{\mathrm{e}})\sqrt{1-c^2_{\boldsymbol{L}_L}(q_{\mathrm{e}})}\,\varepsilon_{q_{\mathrm{e}\infty},\boldsymbol{L}}. \qquad (30)$$

3. Relationships between the Spin Magnetic Charge, Massive Charge, and Electric Charge

3.1 Spin Magnetic Moment

The energies for the spin magnetic moment for the $\left|\boldsymbol{R}\uparrow(q_{\mathrm{g}},\boldsymbol{k})\right\rangle$ state can be expressed as Eqs. (7) and (10). At the time of the Big Bang, the $\varepsilon_{q_{\mathrm{m}},\boldsymbol{R}}(q_{\mathrm{g}})$ and $\varepsilon_{q_{\mathrm{m}},\boldsymbol{L}}(q_{\mathrm{g}})$ values were the maximum, as shown in Fig. 2. That is, there is mixture between right- $\left|\boldsymbol{R}_R(+\boldsymbol{k})\right\rangle$ and left- $\left|\boldsymbol{R}_L(-\boldsymbol{k})\right\rangle$ handed helicity elements, and thus the spin magnetic moment was the largest at the Big Bang. In other words, the mass and intrinsic electric charge were not generated at that time. However, since temperatures immediately decrease after Big Bang, because of any origin (i.e., Higgs boson, broken symmetry of chirality etc.), the mixture between the right- $\left|\boldsymbol{R}_R(+\boldsymbol{k})\right\rangle$ and left- $\left|\boldsymbol{R}_L(-\boldsymbol{k})\right\rangle$ handed helicity elements has begun to occur. The mixture between the right- $\left|\boldsymbol{R}_R(+\boldsymbol{k})\right\rangle$ and left- $\left|\boldsymbol{R}_L(-\boldsymbol{k})\right\rangle$ handed helicity elements increases with an increase in time (with a decrease in the $c_{\boldsymbol{R}_R}(q_{\mathrm{g}})$ value). Similar discussions can be made in the $\left|\boldsymbol{L}\downarrow(q_{\mathrm{g}},\boldsymbol{k})\right\rangle$ state.

We can see from Fig. 1 that the $\varepsilon_{q_{\mathrm{m}},\boldsymbol{R}}(q_{\mathrm{g}})$ and $\varepsilon_{q_{\mathrm{m}},\boldsymbol{L}}(q_{\mathrm{g}})$ values are not equivalent in the space axis. The total chirality and momentum in the $\left\langle \boldsymbol{R}_R(+\boldsymbol{k})\right| H_{0,+\boldsymbol{k},+\boldsymbol{k}} \left|\boldsymbol{R}_R(+\boldsymbol{k})\right\rangle$ and $\left\langle \boldsymbol{L}_L(+\boldsymbol{k})\right| H_{0,+\boldsymbol{k},+\boldsymbol{k}} \left|\boldsymbol{L}_L(+\boldsymbol{k})\right\rangle$ terms in the both $\left|\boldsymbol{R}\uparrow(q_{\mathrm{g}},\boldsymbol{k})\right\rangle$ and $\left|\boldsymbol{L}\downarrow(q_{\mathrm{g}},\boldsymbol{k})\right\rangle$ states are not zero. This is the reason why the number of elements for magnetic spin moments is two, and thus there are attractive and repulsive forces between two magnetic moments.

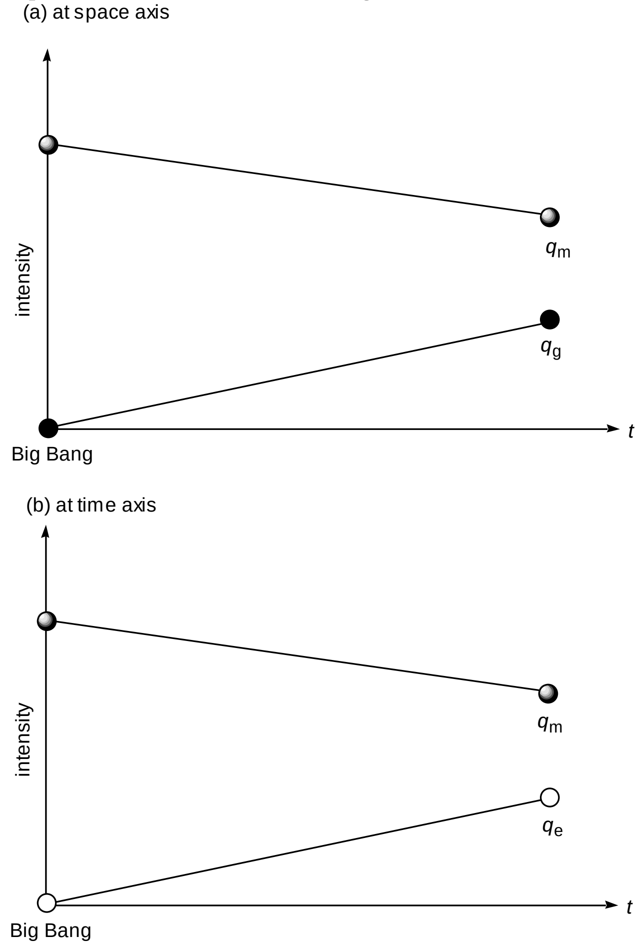

Fig. 2. (a) Intensity of the spin magnetic moment (shaded circles) and mass (closed circles) versus time. (b) Intensity of the spin magnetic moment (shaded circles) and electric charge (opened circles) versus time.

The spin magnetic energy is proportional to the $\left\langle \boldsymbol{R}_R(+\boldsymbol{k})\right| H_{0,+\boldsymbol{k},+\boldsymbol{k}} \left|\boldsymbol{R}_R(+\boldsymbol{k})\right\rangle$ and $\left\langle \boldsymbol{L}_L(+\boldsymbol{k})\right| H_{0,+\boldsymbol{k},+\boldsymbol{k}} \left|\boldsymbol{L}_L(+\boldsymbol{k})\right\rangle$ values (Fig. 1 (b)),

$$\varepsilon_{q_{\mathrm{m}},\boldsymbol{R}}(q_{\mathrm{g}}) = k_{q_{\mathrm{m}},\boldsymbol{R}}\left\langle \boldsymbol{R}_R(+\boldsymbol{k})\right| H_{0,+\boldsymbol{k},+\boldsymbol{k}} \left|\boldsymbol{R}_R(+\boldsymbol{k})\right\rangle, \qquad (31)$$

$$\varepsilon_{q_{\mathrm{m}},\boldsymbol{L}}(q_{\mathrm{g}}) = k_{q_{\mathrm{m}},\boldsymbol{L}}\left\langle \boldsymbol{L}_L(+\boldsymbol{k})\right| H_{0,+\boldsymbol{k},+\boldsymbol{k}} \left|\boldsymbol{L}_L(+\boldsymbol{k})\right\rangle. \qquad (32)$$

The $k_{q_{\mathrm{m}},\boldsymbol{R}}$ and $k_{q_{\mathrm{m}},\boldsymbol{L}}$ values are different between the kinds of particles. This is the reason why we cannot theoretically predict the intensity of the spin magnetic moment for each particle. In summary, because of the $\left\langle \boldsymbol{R}_R(+\boldsymbol{k})\right| H_{0,+\boldsymbol{k},+\boldsymbol{k}} \left|\boldsymbol{R}_R(+\boldsymbol{k})\right\rangle$ and

$\langle \boldsymbol{L}_L(+\boldsymbol{k})|H_{0,+\boldsymbol{k},+\boldsymbol{k}}|\boldsymbol{L}_L(+\boldsymbol{k})\rangle$ terms, originating from the finite right- and left-handed helicity elements, respectively, the magnetic field goes from the infinitesimal source point to the infinitesimal inlet point at finite space axis. This is the reason why the path of the magnetic field is like loop-type, as shown in Fig. 1 (b).

3.2 Mass

The mass energy $\varepsilon_{q_g,\boldsymbol{R}}(q_g)$ for the right-handed chirality $|\boldsymbol{R}\uparrow(q_g,\boldsymbol{k})\rangle$ element can be defined as Eqs. (8) and (9). At the time of the Big Bang, the $\varepsilon_{q_g,\boldsymbol{R}}(q_g)$ value was the minimum ($c_{\boldsymbol{R}_R}(q_g)=1$), as shown in Fig. 2 (a). That is, there was no mixture between the right- $|\boldsymbol{R}_R(+\boldsymbol{k})\rangle$ and left- $|\boldsymbol{R}_L(-\boldsymbol{k})\rangle$ handed helicity elements, and thus the mass energy was zero at the Big Bang. In other words, the mass was not generated at that time. However, after that, temperature significantly decreases, and thus because of any origin (i.e., Higgs boson, broken symmetry of chirality etc.), the mixture between the right- $|\boldsymbol{R}_R(+\boldsymbol{k})\rangle$ and left-handed helicity elements has begun to occur. The mixture between the right- $|\boldsymbol{R}_R(+\boldsymbol{k})\rangle$ and left- $|\boldsymbol{R}_L(-\boldsymbol{k})\rangle$ handed helicity elements increases with an increase in time (with a decrease in the $c_{\boldsymbol{R}_R}(q_g)$ value). Similar discussions can be made in the $|\boldsymbol{L}\downarrow(q_g,\boldsymbol{k})\rangle$ state.

The mass energy is proportional to the $\langle \boldsymbol{R}_R(+\boldsymbol{k})|H_{1,+\boldsymbol{k},-\boldsymbol{k}}|\boldsymbol{R}_L(-\boldsymbol{k})\rangle$ and $\langle \boldsymbol{L}_L(+\boldsymbol{k})|H_{1,+\boldsymbol{k},-\boldsymbol{k}}|\boldsymbol{L}_R(-\boldsymbol{k})\rangle$ values (Fig. 1 (a)),

$$\begin{aligned}\varepsilon_{q_g,\boldsymbol{R}}(q_g) &= \varepsilon_{q_g,\boldsymbol{L}}(q_g) \\ &= k_{q_g}\langle \boldsymbol{R}_R(+\boldsymbol{k})|H_{1,+\boldsymbol{k},-\boldsymbol{k}}|\boldsymbol{R}_L(-\boldsymbol{k})\rangle \\ &= k_{q_g}\langle \boldsymbol{L}_L(+\boldsymbol{k})|H_{1,+\boldsymbol{k},-\boldsymbol{k}}|\boldsymbol{L}_R(-\boldsymbol{k})\rangle. \qquad (33)\end{aligned}$$

The k_{q_g} values are different between the kinds of particles. This is the reason why we do not theoretically predict the mass for each particle.

We can see from Fig. 1 that the $\varepsilon_{q_g,\boldsymbol{R}}(q_g)$ and $\varepsilon_{q_g,\boldsymbol{L}}(q_g)$ values are equivalent in the space axis. The total chirality and momentum in the $\langle \boldsymbol{R}_R(+\boldsymbol{k})|H_{1,+\boldsymbol{k},-\boldsymbol{k}}|\boldsymbol{R}_L(-\boldsymbol{k})\rangle$ and $\langle \boldsymbol{L}_L(+\boldsymbol{k})|H_{1,+\boldsymbol{k},-\boldsymbol{k}}|\boldsymbol{L}_R(-\boldsymbol{k})\rangle$ terms in the both $|\boldsymbol{R}\uparrow(q_g,\boldsymbol{k})\rangle$ and $|\boldsymbol{L}\downarrow(q_g,\boldsymbol{k})\rangle$ states are zero. We can consider that the mass is generated by the mixture of the right- $|\boldsymbol{R}_R(+\boldsymbol{k})\rangle$ and left- $|\boldsymbol{R}_L(-\boldsymbol{k})\rangle$ handed helicity elements at the space axis. In the real world we live, the reversible process ($-\boldsymbol{k}$) can be possible in the space axis while the reversible process ($-t$) cannot be possible in the time axis (irreversible). This is the reason why the number of elements for mass is only one, and thus there is only attractive force between two masses, as discussed in detail later.

In summary, because of the $\langle \boldsymbol{R}_R(+\boldsymbol{k})|H_{1,+\boldsymbol{k},-\boldsymbol{k}}|\boldsymbol{R}_L(-\boldsymbol{k})\rangle$ and $\langle \boldsymbol{L}_L(+\boldsymbol{k})|H_{1,+\boldsymbol{k},-\boldsymbol{k}}|\boldsymbol{L}_R(-\boldsymbol{k})\rangle$ terms, originating from the cancellation of the right- and left-handed helicity elements at space axis, the gravitational fields only spring out from the infinitesimal source point to any direction in space axis.

On the other hand, the total chirality and momentum in the $\langle \boldsymbol{R}_R(+\boldsymbol{k})|H_{1,+\boldsymbol{k},-\boldsymbol{k}}|\boldsymbol{R}_L(-\boldsymbol{k})\rangle$ and $\langle \boldsymbol{L}_L(+\boldsymbol{k})|H_{1,+\boldsymbol{k},-\boldsymbol{k}}|\boldsymbol{L}_R(-\boldsymbol{k})\rangle$ states are zero not because of the intrinsic zero value but because of the cancellation of the large right- and left-handed helicity elements, which are the origin of the spin magnetic moment and the electric charge. Therefore, there is a possibility that the external potential energy ($\varepsilon_{q_g,\text{internal},\boldsymbol{R}}(q_g)$ and $\varepsilon_{q_g,\text{internal},\boldsymbol{L}}(q_g)$) for the $\langle \boldsymbol{R}_R(+\boldsymbol{k})|H_{1,+\boldsymbol{k},-\boldsymbol{k}}|\boldsymbol{R}_L(-\boldsymbol{k})\rangle$ and $\langle \boldsymbol{L}_L(+\boldsymbol{k})|H_{1,+\boldsymbol{k},-\boldsymbol{k}}|\boldsymbol{L}_R(-\boldsymbol{k})\rangle$ states can be very small but finite values (fluctuated and induced polarization effects). Therefore, the distortion of the spacetime axes can occur.

3.3 Electric Charge

The energy $\varepsilon_{q_e,\boldsymbol{R}}(q_e)$ for the right-handed chirality $|\boldsymbol{R}\uparrow(q_e,+t)\rangle$ element can be defined as Eqs. (23) and (25). At the time of the Big Bang, the $\varepsilon_{q_e,\boldsymbol{R}}(q_e)$ value was the minimum ($c_{\boldsymbol{R}_R}(q_e)=1$), as shown in Fig. 2 (b). That is, there was no mixture between the right- $|\boldsymbol{R}_R(+t)\rangle$ and left- $|\boldsymbol{R}_L(-t)\rangle$ handed helicity elements, and thus the electric field energy was zero at the Big Bang. In other words, the electric charge was not generated at that time. However, after that, temperature significantly decreases, and thus because of any origin (i.e., Higgs boson, broken symmetry of chirality etc.), the mixture between the right- $|\boldsymbol{R}_R(+t)\rangle$ and left- $|\boldsymbol{R}_L(-t)\rangle$ helicity elements at the time axis has begun to occur. The mixture between the right- $|\boldsymbol{R}_R(+t)\rangle$ and left- $|\boldsymbol{R}_L(-t)\rangle$ handed helicity elements at the time axis increases with an increase in time (with a decrease in the $c_{\boldsymbol{R}_R}(q_{\mathrm{e}})$ value). Similar discussions can be made in the $|\boldsymbol{L}\downarrow(q_{\mathrm{e}},+t)\rangle$ state.

The electric field energy is proportional to the $\langle \boldsymbol{R}_R(+t)|H_{1,+t,-t}|\boldsymbol{R}_R(+t)\rangle$ and $\langle \boldsymbol{L}_L(+t)|H_{1,+t,-t}|\boldsymbol{L}_L(+t)\rangle$ values (Fig. 1 (c)).

$$\varepsilon_{q_{\mathrm{e}},\boldsymbol{R}}(q_{\mathrm{e}})=k_{q_{\mathrm{e}},\boldsymbol{R}}\langle \boldsymbol{R}_R(+t)|H_{1,+t,-t}|\boldsymbol{R}_R(+t)\rangle, \qquad (34)$$

$$\varepsilon_{q_{\mathrm{e}},\boldsymbol{L}}(q_{\mathrm{e}})=k_{q_{\mathrm{e}},\boldsymbol{L}}\langle \boldsymbol{L}_L(+t)|H_{1,+t,-t}|\boldsymbol{L}_L(+t)\rangle. \qquad (35)$$

On the other hand, the $k_{q_{\mathrm{e}},\boldsymbol{R}}$ and $k_{q_{\mathrm{e}},\boldsymbol{L}}$ values are different between the kinds of particles.

We can see from Fig. 2 that the $\varepsilon_{q_{\mathrm{e}},\boldsymbol{R}}(q_{\mathrm{e}})$ and $\varepsilon_{q_{\mathrm{e}},\boldsymbol{L}}(q_{\mathrm{e}})$ values are equivalent in the space axis. The total momentum in $\langle \boldsymbol{R}_R(+t)|H_{1,+t,-t}|\boldsymbol{R}_R(+t)\rangle$ and $\langle \boldsymbol{L}_L(+t)|H_{1,+t,-t}|\boldsymbol{L}_L(+t)\rangle$ terms in the both $|\boldsymbol{R}\uparrow(q_{\mathrm{e}},+t)\rangle$ and $|\boldsymbol{L}\downarrow(q_{\mathrm{e}},+t)\rangle$ states are not zero. And the total chirality in the $\langle \boldsymbol{R}_R(+t)|H_{1,+t,-t}|\boldsymbol{R}_R(+t)\rangle$ and $\langle \boldsymbol{L}_L(+t)|H_{1,+t,-t}|\boldsymbol{L}_L(+t)\rangle$ terms in the $|\boldsymbol{R}\uparrow(q_{\mathrm{e}},+t)\rangle$ and $|\boldsymbol{L}\downarrow(q_{\mathrm{e}},+t)\rangle$ states are opposite by each other at time axis, as shown in Fig. 1 (c). We can consider that the electric charge is generated by the mixture of the right- $|\boldsymbol{R}_R(+t)\rangle$ and left-handed $|\boldsymbol{R}_L(-t)\rangle$ handed helicity elements at the time axis. In the real world we live, the reversible process ($-\boldsymbol{k}$) can be possible in the space axis. This is the reason why the total chirality and momentum in the $\langle \boldsymbol{R}_R(+\boldsymbol{k})|H_{1,+\boldsymbol{k},-\boldsymbol{k}}|\boldsymbol{R}_L(-\boldsymbol{k})\rangle$ and $\langle \boldsymbol{L}_L(+\boldsymbol{k})|H_{1,+\boldsymbol{k},-\boldsymbol{k}}|\boldsymbol{L}_R(-\boldsymbol{k})\rangle$ values in the both $|\boldsymbol{R}\uparrow(q_{\mathrm{g}},\boldsymbol{k})\rangle$ and $|\boldsymbol{L}\downarrow(q_{\mathrm{g}},\boldsymbol{k})\rangle$ states are zero at the space axis, and the number of elements for mass is only one, and thus there is only attractive force between two masses. On the other hand, in the real world we live, the reversible process ($-t$) cannot be possible in the time axis (irreversible). Therefore, we must consider the $\langle \boldsymbol{L}_L(+t)|H_{1,+t,-t}|\boldsymbol{L}_L(+t)\rangle$ state instead of the $\langle \boldsymbol{L}_L(+t)|H_{1,+t,-t}|\boldsymbol{L}_R(-t)\rangle$ state. This is the reason why the total chirality in the $\langle \boldsymbol{R}_R(+t)|H_{1,+t,-t}|\boldsymbol{R}_R(+t)\rangle$ and $\langle \boldsymbol{L}_L(+t)|H_{1,+t,-t}|\boldsymbol{L}_L(+t)\rangle$ values in the both $|\boldsymbol{R}\uparrow(q_{\mathrm{e}},+t)\rangle$ and $|\boldsymbol{L}\downarrow(q_{\mathrm{e}},+t)\rangle$ states are not zero, and opposite by each other, and the number of elements for electric charge is two, and thus there are attractive and repulsive forces between two electric charges. Because of the $\langle \boldsymbol{R}_R(+t)|H_{1,+t,-t}|\boldsymbol{R}_R(+t)\rangle$ terms, the electric field only springs out from the infinitesimal source point to any direction in space and time axes. On the other hand, because of the $\langle \boldsymbol{L}_L(+t)|H_{1,+t,-t}|\boldsymbol{L}_L(+t)\rangle$ terms, the electric field only comes into the infinitesimal inlet point from any direction in space and time axes. In summary, because of the $\langle \boldsymbol{R}_R(+t)|H_{1,+t,-t}|\boldsymbol{R}_L(-t)\rangle$ and $\langle \boldsymbol{L}_L(+t)|H_{1,+t,-t}|\boldsymbol{L}_R(-t)\rangle$ terms, originating from the cancellation of the right- and left-handed helicity elements, the electric field springs out from the infinitesimal source point to any direction in time axis, or comes into the infinitesimal inlet point from any direction in time axis.

4. Relationships between the Gravity, Electric Force, Magnetic Force, and Electromagnetic Force

Let us next look into the relationships between the spin magnetic moment, mass, and electric charge, and between the magnetic forces, gravity, and electric forces. We can see from Fig. 2 that at the time of the Big Bang, only spin magnetic moment, which is the element of the magnetic forces, existed. On the other hand, as the temperature decreases, because of any origin (i.e., Higgs boson, broken symmetry of chirality, etc.), the mass, which is the element of gravity, and the electric charge, which is element of electric force, can be generated. That is, we can consider that the elements of the gravity and electric forces can be generated by the cancellation of the elements of the right- and left-handed magnetic forces. Furthermore, the electric and magnetic fields can be considered to be originally independent each other. On the other hand, as soon as the element of the electric force has been generated, the magnetic and electric fields have been related by each other by the Ampère's law and Faraday's law. Now, we observe these elements as elements of two of four forces; spin magnetic moments and electric charge for the electromagnetic forces, and the mass for the gravity.

4.1 Elementary Unit of the Gravity and Electric Force

Let us look into the relationships between the elementary unit of the gravity and electric force. Let us consider two particles with masses $q_{\mathrm{g}1}$ and $q_{\mathrm{g}2}$ [kg] and electric charges $q_{\mathrm{e}1}$ and $q_{\mathrm{e}2}$ [C]. The conventional equation for the gravity between them can be expressed by using distance r [m] between them as

$$F_{\mathrm{gravity}}=G\frac{q_{\mathrm{g}1}q_{\mathrm{g}2}}{r^2}, \qquad (36)$$

where the G is the gravitational constant,

$$G = 6.7 \times 10^{-11} \left[\frac{\mathrm{N \cdot m^2}}{\mathrm{kg}^2} \right]. \tag{37}$$

On the other hand, equation for the electric force between them can be expressed as

$$F_{\text{electric}} = k_{\text{electric}} \frac{q_{e1} q_{e2}}{r^2}, \tag{38}$$

where the k_{electric} is the electric force constant,

$$k_{\text{electric}} = \frac{1}{4\pi\varepsilon_0} = 9.0 \times 10^9 \left[\frac{\mathrm{N \cdot m^2}}{\mathrm{C}^2} \right]. \tag{39}$$

If we consider that the gravity is closely related to the electric force (gravity is one kind of electromagnetic forces), by comparing Eqs. (36) and (37) with Eqs. (38) and (39), the unit for the mass can be related to that for the electric charge, as follows,

$$1\ [\mathrm{kg}] = 8.6 \times 10^{-11}\ [\mathrm{C}]. \tag{40}$$

As an example, let us consider an electron. The rest mass ($q_g = m_e$) and elementary charge ($q_e = e$) for an electron are 9.1×10^{-31} [kg] and 1.6×10^{-19} [C], respectively. If we consider that the gravity is closely related to the electric force (gravity is one kind of electromagnetic forces), the m_e value for electron is estimated to be 7.8×10^{-41} [C]. That is, the m_e value is 4.9×10^{-22} times as large as the e value, as an external force. Therefore, elementary unit of massive charge (m_e) for the gravity is much smaller than that of electric charge (e) for electric force.

We can see from this relation that the unit for the mass is much smaller than that for the electric charge if we consider that the massive charge can be equivalent to the electric charge under the same physical background.

In the conventional classical dynamics, the gravity has been expressed by Eqs. (36) and (37). That is, it has been considered that the gravity is extremely weak because the gravitational constant G is extremely small constant if we consider usual unit for the mass of about 1 kg in the real world.

On the other hand, if we consider that the gravity and electromagnetic forces are essentially the same, we can consider Eqs. (38) and (39) for the gravity. In such a case, we must consider that elementary unit of massive charge (m_e) for the gravity is much smaller than that of electric charge (e) for the electric force. That is, we should consider that the elementary unit of charge (q_g) rather than force constant for the gravity is much smaller than that (q_e) for electromagnetic forces. Therefore, we can consider that the gravity and massive charges are essentially the same as the electromagnetic forces, and electric and magnetic charges, respectively, and they seem to behave as gravity and mass (as one of the elements of the possible unified electromagnetic and gravitational forces), according to the general relativity.

4.2 Relationships between the General Relativity and the Gravity and Electric Force in Various Sizes

The explanation that the spacetime axes are distorted by the gravitational wave (graviton) in the general relativity was derived and confirmed by the experimental results that the moving of the light is curved near the large massive materials such as the sun (Fig. 3 (a)). It has been considered that the spacetime axes are distorted by only gravitational wave (graviton). On the other hand, by considering many experimental phenomena in electromagnetics such as Meissner effect, Lenz's law, and principle of superposition of electric and magnetic fields (photon), the light is often observed to be curved by the electric, magnetic, and electromagnetic forces in the microscopic sized level (Fig. 3 (b)). Therefore, we can consider that the spacetime axes can be distorted by the electric and magnetic forces as well as the gravity. Otherwise, we can consider that spacetime axes are not distorted by gravity as well as electric and magnetic forces, as considered in the conventional electromagnetics.

The elementary unit of the electric force is very large because the internal cancellation of the each right- or left-handed helicity element ($\left\langle \boldsymbol{R}_R(+t) \middle| H_{1,+t,-t} \middle| \boldsymbol{R}_L(-t) \right\rangle$ or $\left\langle \boldsymbol{L}_L(+t) \middle| H_{1,+t,-t} \middle| \boldsymbol{L}_R(-t) \right\rangle$) cannot occur in the time axis. On the other hand, there are attractive and repulsive interactions between two particles with electric charges, and thus the external cancellation can occur (Fig. 4 (a)). That is, the electric force cannot necessarily become larger with an increase in the number of particles with electric charges forming a material. It is very difficult to make a material which has only very large positive (or negative) electric charges because this electric state is extremely unstable. Therefore, the electric forces can become very large in the microscopic sized materials, however, cannot become very large in the macroscopic sized materials even though the elementary unit of electric force is very large. This is the reason why the distortion of the spacetime axes as a consequence of the electric force usually cannot be observed in the macroscopic sized materials such as astronomical objects. On the other hand, we can see significant distortion of the spacetime axes as a consequence of the electric and magnetic forces in the microscopic sized materials (Meissner effect, Lenz's law, and principle of superposition of electric and magnetic fields (photon)).

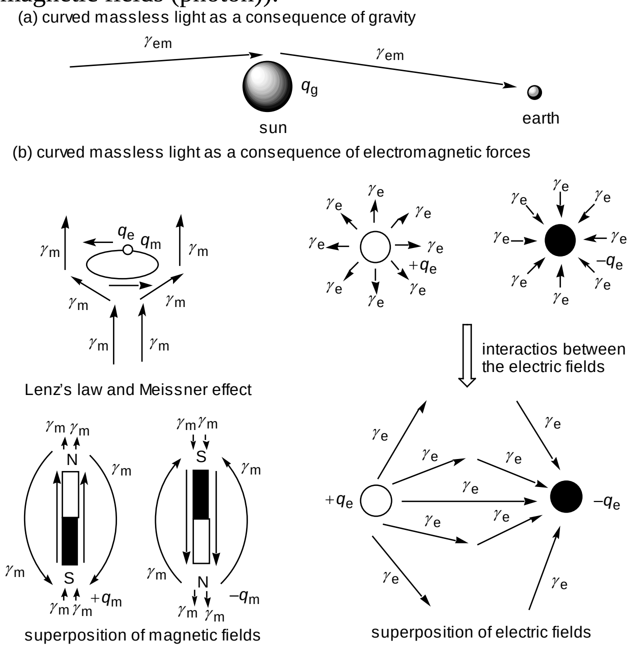

Fig. 3. Curved massless light.

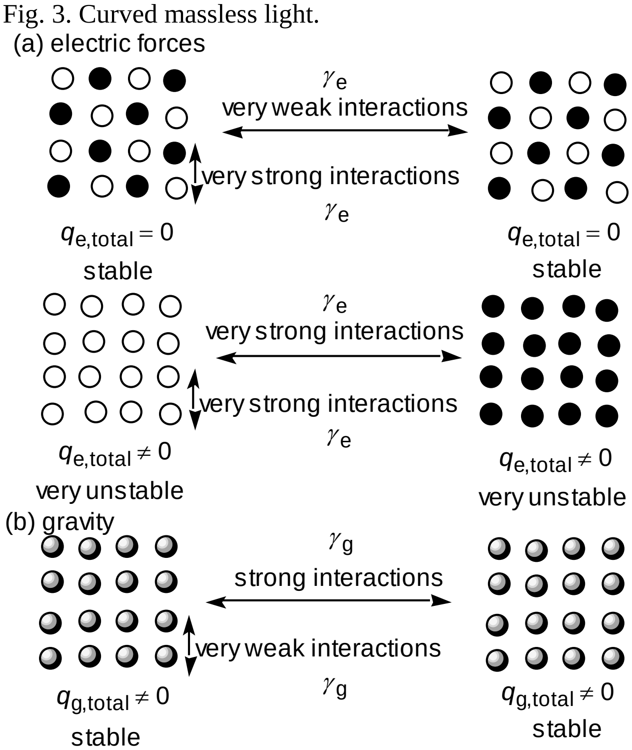

Fig. 4. Interactions between two particles. The opened- and closed-circles indicate the particles with positive and negative electric charges, respectively, and the shaded circles indicate the particles with massive charges.

By considering that the significantly curved lights as a consequence of the electromagnetic forces can often be observed in the microscopic sized materials, we can consider that the gravity and electromagnetic forces are closely related to each other.

The gravity is usually very small. On the other hand, there is only attractive interactions between two particles with massive charges, as described in detail above. The gravity becomes larger with an increase in the number of the particles with massive charges forming a material. It is possible to make a material which has very large massive charges because this state is stable (Fig. 4 (b)). Therefore, the gravity can become extremely large in the macroscopic sized materials such as astronomical objects even though the elementary unit of gravity is extremely small. This is the reason why large distortion of the spacetime axes as a consequence of the gravity can be observed in the macroscopic sized materials such as astronomical objects. The total chirality in the $\left\langle \boldsymbol{R}_R(+\boldsymbol{k}) \middle| H_{1,+\boldsymbol{k},-\boldsymbol{k}} \middle| \boldsymbol{R}_L(-\boldsymbol{k}) \right\rangle$ and $\left\langle \boldsymbol{L}_L(+\boldsymbol{k}) \middle| H_{1,+\boldsymbol{k},-\boldsymbol{k}} \middle| \boldsymbol{L}_R(-\boldsymbol{k}) \right\rangle$ sates are zero not because of the intrinsic zero value but because of the cancellation of the large right- and left-handed helicity elements, which are the origin of the spin magnetic moment and the electric charge. Therefore, there is a possibility that the external potential energy ($\varepsilon_{q_g,\text{external},\boldsymbol{R}}(q_g)$ and $\varepsilon_{q_g,\text{external},\boldsymbol{L}}(q_g)$) for the $\left\langle \boldsymbol{R}_R(+\boldsymbol{k}) \middle| H_{1,+\boldsymbol{k},-\boldsymbol{k}} \middle| \boldsymbol{R}_L(-\boldsymbol{k}) \right\rangle$ and $\left\langle \boldsymbol{L}_L(+\boldsymbol{k}) \middle| H_{1,+\boldsymbol{k},-\boldsymbol{k}} \middle| \boldsymbol{L}_R(-\boldsymbol{k}) \right\rangle$ sates can be very small but finite values (fluctuated and induced polarization effects) (Fig. 5). Therefore, the distortion of the spacetime axes can occur.

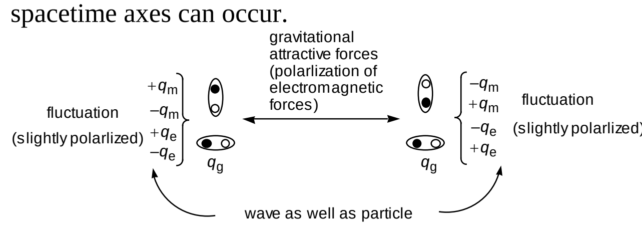

Fig. 5. Attractive gravitational forces.

4.3 Origin of the Gravity

It has been considered that the gravity is observed as a consequence of the exchange of graviton between two massive particles. However, the essential properties of the mass and graviton have not been elucidated in detail. That is, the reason why the gravity is observed as a consequence of the exchange of graviton between two massive particles has not been elucidated. We discuss the mechanism how the particles with massive charge emit and absorb graviton and how gravity is generated as a consequence of this process. We also discuss how the graviton in the gravity is related to the photon in electromagnetic force.

Let us next look into the origin of the gravity. The $\varepsilon_{q_g,\boldsymbol{R}}(q_g)$ value can be divided into the internal potential energy ($\varepsilon_{q_g,\text{internal},\boldsymbol{R}}(q_g)$) and the external potential energy ($\varepsilon_{q_g,\text{external},\boldsymbol{R}}(q_g)$) (Fig. 6).

$$\varepsilon_{q_g,\boldsymbol{R}}(q_g) = k_{q_g}\left\langle \boldsymbol{R}_R(+\boldsymbol{k})\middle| H_{1,+\boldsymbol{k},-\boldsymbol{k}} \middle| \boldsymbol{R}_L(-\boldsymbol{k})\right\rangle = \varepsilon_{q_g,\text{internal},\boldsymbol{R}}(q_g) + \varepsilon_{q_g,\text{external},\boldsymbol{R}}(q_g) \quad (41)$$

where

$$\varepsilon_{q_g,\text{internal},\boldsymbol{R}}(q_g) = mc^2 = q_g c^2, \quad (42)$$

$$\varepsilon_{q_g,\text{external},\boldsymbol{R}}(q_g) = -G\frac{m}{r} = -G\frac{q_g}{r}. \quad (43)$$

Similar discussions can be made in the $\left|\boldsymbol{L}\downarrow(q_g,\boldsymbol{k})\right\rangle$ state,

$$\varepsilon_{q_g,\boldsymbol{L}}(q_g) = k_{q_g}\left\langle \boldsymbol{L}_L(+\boldsymbol{k})\middle| H_{1,+\boldsymbol{k},-\boldsymbol{k}} \middle| \boldsymbol{L}_R(-\boldsymbol{k})\right\rangle = \varepsilon_{q_g,\text{internal},\boldsymbol{L}}(q_g) + \varepsilon_{q_g,\text{external},\boldsymbol{L}}(q_g), \quad (44)$$

$$\varepsilon_{q_g,\text{internal},\boldsymbol{L}}(q_g) = mc^2 = q_g c^2, \quad (45)$$

$$\varepsilon_{q_g,\text{external},\boldsymbol{L}}(q_g) = -G\frac{m}{r} = -G\frac{q_g}{r}. \quad (46)$$

Because of the $\left\langle \boldsymbol{R}_R(+\boldsymbol{k})\middle| H_{1,+\boldsymbol{k},-\boldsymbol{k}} \middle| \boldsymbol{R}_L(-\boldsymbol{k})\right\rangle$ and $\left\langle \boldsymbol{L}_L(+\boldsymbol{k})\middle| H_{1,+\boldsymbol{k},-\boldsymbol{k}} \middle| \boldsymbol{L}_R(-\boldsymbol{k})\right\rangle$ terms, originating from the cancellation of the right- and left-handed helicity at space axis, the gravitational field only springs out from the infinitesimal source point to any direction in space axis, and the reason why the gravity is extremely weak. The elementary unit of the gravity is extremely weak because of such an internal cancellation ($\left\langle \boldsymbol{R}_R(+\boldsymbol{k})\middle| H_{1,+\boldsymbol{k},-\boldsymbol{k}} \middle| \boldsymbol{R}_L(-\boldsymbol{k})\right\rangle$ and $\left\langle \boldsymbol{L}_L(+\boldsymbol{k})\middle| H_{1,+\boldsymbol{k},-\boldsymbol{k}} \middle| \boldsymbol{L}_R(-\boldsymbol{k})\right\rangle$).

Even though the massive charges, which are trigger of the generation of the external kinetic energies ($\varepsilon_{q_g,\text{external},\boldsymbol{R}}(q_g)$ and $\varepsilon_{q_g,\text{external},\boldsymbol{L}}(q_g)$), are extremely small, the rest energy ($\varepsilon_{q_g,\text{internal},\boldsymbol{R}}(q_g)$ and $\varepsilon_{q_g,\text{internal},\boldsymbol{L}}(q_g)$), which is internal potential energy of each particle, is extremely large. That is, the most of extremely large energy ($\varepsilon_{q_g,\boldsymbol{R}}(q_g)$ and $\varepsilon_{q_g,\boldsymbol{L}}(q_g)$)

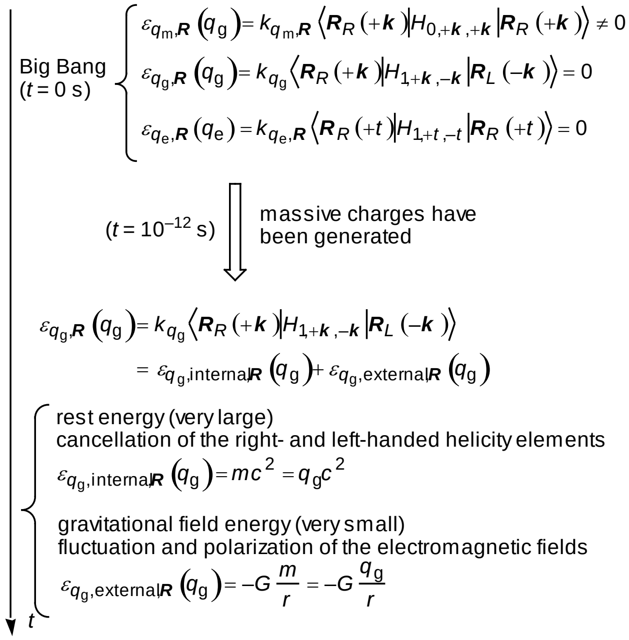

Fig. 6. Very large rest energy and very small gravitational field energy.

generated at the time of the Big Bang has been stored in the particle as a potential rest energy (internal massive energy ($\varepsilon_{q_g,\text{internal},\boldsymbol{R}}(q_g)$ and $\varepsilon_{q_g,\text{internal},\boldsymbol{L}}(q_g)$)), and only small part of it is now used as gravitational energy (origin of which is extremely small massive charge ($\varepsilon_{q_g,\text{external},\boldsymbol{R}}(q_g)$ and $\varepsilon_{q_g,\text{external},\boldsymbol{L}}(q_g)$)) (Fig. 6). The total chirality in the $\left\langle \boldsymbol{R}_R(+\boldsymbol{k})\middle| H_{1,+\boldsymbol{k},-\boldsymbol{k}} \middle| \boldsymbol{R}_L(-\boldsymbol{k})\right\rangle$ and $\left\langle \boldsymbol{L}_L(+\boldsymbol{k})\middle| H_{1,+\boldsymbol{k},-\boldsymbol{k}} \middle| \boldsymbol{L}_R(-\boldsymbol{k})\right\rangle$ sates are zero not because of the intrinsic zero value but because of the cancellation of the large right- and left-handed helicity elements, which are the origin of the spin magnetic moment and the electric charge. This is the reason why the external potential energy ($\varepsilon_{q_g,\text{external},\boldsymbol{R}}(q_g)$ and $\varepsilon_{q_g,\text{external},\boldsymbol{L}}(q_g)$) for the $\left\langle \boldsymbol{R}_R(+\boldsymbol{k})\middle| H_{1,+\boldsymbol{k},-\boldsymbol{k}} \middle| \boldsymbol{R}_L(-\boldsymbol{k})\right\rangle$ and $\left\langle \boldsymbol{L}_L(+\boldsymbol{k})\middle| H_{1,+\boldsymbol{k},-\boldsymbol{k}} \middle| \boldsymbol{L}_R(-\boldsymbol{k})\right\rangle$ sates can be very small but finite values (fluctuated and induced polarization effects), and the reason why the internal potential energy ($\varepsilon_{q_g,\text{internal},\boldsymbol{R}}(q_g)$ and $\varepsilon_{q_g,\text{internal},\boldsymbol{L}}(q_g)$) for the $\left\langle \boldsymbol{R}_R(+\boldsymbol{k})\middle| H_{1,+\boldsymbol{k},-\boldsymbol{k}} \middle| \boldsymbol{R}_L(-\boldsymbol{k})\right\rangle$ and

$\langle \boldsymbol{L}_L(+\boldsymbol{k})|H_{1,+\boldsymbol{k},-\boldsymbol{k}}|\boldsymbol{L}_R(-\boldsymbol{k})\rangle$ sates can be very large ($mc^2(=q_g c^2)$).

The energy for the gravity is related to the $\langle \boldsymbol{R}_R(+\boldsymbol{k})|H_{1,+\boldsymbol{k},-\boldsymbol{k}}|\boldsymbol{R}_L(-\boldsymbol{k})\rangle$ and $\langle \boldsymbol{L}_L(+\boldsymbol{k})|H_{1,+\boldsymbol{k},-\boldsymbol{k}}|\boldsymbol{L}_R(-\boldsymbol{k})\rangle$ terms while that for the electric force is related to the $\langle \boldsymbol{R}_R(+t)|H_{1,+t,-t}|\boldsymbol{R}_L(-t)\rangle$ and $\langle \boldsymbol{L}_L(+t)|H_{1,+t,-t}|\boldsymbol{L}_R(-t)\rangle$ terms. That is, if we consider that the gravity is related to the electric force, the total chirality for the $\langle \boldsymbol{R}_R(+\boldsymbol{k})|H_{1,+\boldsymbol{k},-\boldsymbol{k}}|\boldsymbol{R}_L(-\boldsymbol{k})\rangle$ and $\langle \boldsymbol{L}_L(+\boldsymbol{k})|H_{1,+\boldsymbol{k},-\boldsymbol{k}}|\boldsymbol{L}_R(-\boldsymbol{k})\rangle$ are zero, theoretically, because the mass is generated by the cancellation of the right- $|\boldsymbol{R}_R(+\boldsymbol{k})\rangle$ and left- $|\boldsymbol{R}_L(-\boldsymbol{k})\rangle$ handed helicity elements at the space axis.

The gravitational force between two particles with massive charges is always attractive. This can be understood as follows. For example, an electron is wave as well as particle. Therefore, it is possible that it is fluctuated so that the interactions from all other particles become attractive at the same time because of its wave characteristics, as shown in Fig. 5. There is a possibility that the massive charge is very similar to the induced polarization of the electromagnetism, the size of which is infinitesimal (or very small).

It should be noted that the extreme slight effect originating from the general relativity (mass) can be explained from the electromagnetic forces because the external potential energy ($\varepsilon_{q_g,\mathrm{external},\boldsymbol{R}}(q_g)$) for the $\langle \boldsymbol{R}_R(+\boldsymbol{k})|H_{1,+\boldsymbol{k},-\boldsymbol{k}}|\boldsymbol{R}_L(-\boldsymbol{k})\rangle$ and $\langle \boldsymbol{L}_L(+\boldsymbol{k})|H_{1,+\boldsymbol{k},-\boldsymbol{k}}|\boldsymbol{L}_R(-\boldsymbol{k})\rangle$ states related to the mass is much smaller than the $\langle \boldsymbol{R}_R(+\boldsymbol{k})|H_{1,+\boldsymbol{k},+\boldsymbol{k}}|\boldsymbol{R}_R(+\boldsymbol{k})\rangle$ and $\langle \boldsymbol{L}_L(+\boldsymbol{k})|H_{1,+\boldsymbol{k},+\boldsymbol{k}}|\boldsymbol{L}_L(+\boldsymbol{k})\rangle$ states related to the spin magnetic moment and the $\langle \boldsymbol{R}_R(+t)|H_{1,+t,-t}|\boldsymbol{R}_L(-t)\rangle$ and $\langle \boldsymbol{L}_L(+t)|H_{1,+t,-t}|\boldsymbol{L}_R(-t)\rangle$ states related to the electric charge (Fig. 1). On the other hand, it should be noted that the most of the $\langle \boldsymbol{R}_R(+\boldsymbol{k})|H_{1,+\boldsymbol{k},-\boldsymbol{k}}|\boldsymbol{R}_L(-\boldsymbol{k})\rangle$ and $\langle \boldsymbol{L}_L(+\boldsymbol{k})|H_{1,+\boldsymbol{k},-\boldsymbol{k}}|\boldsymbol{L}_R(-\boldsymbol{k})\rangle$ terms related to the mass exists as the very large potential energy ($\varepsilon_{q_g,\mathrm{internal},\boldsymbol{R}}(q_g)$ and $\varepsilon_{q_g,\mathrm{internal},\boldsymbol{L}}(q_g)$) of the rest mass energy ($mc^2(=q_g c^2)$) (Fig. 6). The external energy as a gravitational field (mass) would be 0. On the other hand, the total chirality and momentum in the $\langle \boldsymbol{R}_R(+\boldsymbol{k})|H_{1,+\boldsymbol{k},-\boldsymbol{k}}|\boldsymbol{R}_L(-\boldsymbol{k})\rangle$ and $\langle \boldsymbol{L}_L(+\boldsymbol{k})|H_{1,+\boldsymbol{k},-\boldsymbol{k}}|\boldsymbol{L}_R(-\boldsymbol{k})\rangle$ values are zero not because of the intrinsic zero value but because of the cancellation of the right- and left-handed helicity elements, which are the origin of the spin magnetic moment and the electric charge. Therefore, there is a possibility that the external potential energy ($\varepsilon_{q_g,\mathrm{external},\boldsymbol{R}}(q_g)$ and $\varepsilon_{q_g,\mathrm{external},\boldsymbol{L}}(q_g)$) for the $\langle \boldsymbol{R}_R(+\boldsymbol{k})|H_{1,+\boldsymbol{k},-\boldsymbol{k}}|\boldsymbol{R}_L(-\boldsymbol{k})\rangle$ and $\langle \boldsymbol{L}_L(+\boldsymbol{k})|H_{1,+\boldsymbol{k},-\boldsymbol{k}}|\boldsymbol{L}_R(-\boldsymbol{k})\rangle$ states can be very small but finite values (fluctuated and induced polarization effects) (Fig. 6). Therefore, the distortion of the spacetime axes can occur. Therefore, if the massive particles are fluctuated, the external energy would have very small finite values (only 4.9×10^{-22} times as large as the e value from which electric field originates. That is, the external terms ($\varepsilon_{q_g,\mathrm{external},\boldsymbol{R}}(q_g)$ and $\varepsilon_{q_g,\mathrm{external},\boldsymbol{L}}(q_g)$) of the $\langle \boldsymbol{R}_R(+\boldsymbol{k})|H_{1,+\boldsymbol{k},-\boldsymbol{k}}|\boldsymbol{R}_L(-\boldsymbol{k})\rangle$ and $\langle \boldsymbol{L}_L(+\boldsymbol{k})|H_{1,+\boldsymbol{k},-\boldsymbol{k}}|\boldsymbol{L}_R(-\boldsymbol{k})\rangle$ states do not become zero by fluctuation of the particle (Fig. 6). This is the origin of the gravitational field (emission and absorption of the graviton). That is, we can consider that such gravitational field originates from the fluctuation of the electromagnetic fields because of the slight polarization of the electric charges and spin magnetic moments at the infinite small ($r=0$) points (or very small finite sizes ($r\approx0$)). This effect is very similar to the van der Waals forces or intermolecular forces in chemistry even though this effect is much smaller than them because of its infinitesimal (or very small) size (Fig. 5).

4.4 Relationships between the Gauge Bosons in the Gravity and the Electromagnetic Forces

Considering that the W^+, W^-, and Z^0 bosons play a role in the weak forces, it is natural to consider that the γ_g boson as well as the γ_e and γ_m bosons play a role in the same forces. That is, it is natural to consider that the gravity is closely related to the electric force, magnetic force, and electromagnetic force. That is, even though we cannot decide at the moment that the graviton is a kind of photons, there is a possibility that the graviton is closely related to the photons (Fig. 7).

We can consider that the gauge photonic particle medium (γ) for electric forces (γ_e), magnetic forces (γ_m), and gravity (γ_g), which originate from the angular momentum at the space and time axes, were essentially the same at the Big Bang. We can consider that the photon γ, which plays a role in the electric force, is observed as the medium of the electric field γ_e, the photon γ, which plays a role in the magnetic force, is observed as the medium of the magnetic field γ_m, and the photon γ,

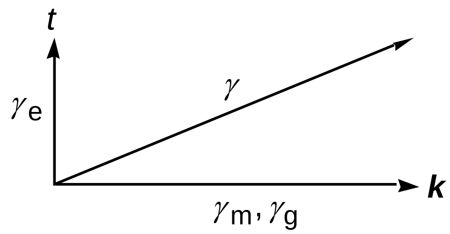

Fig. 7. Relationships between the gauge bosons for the electromagnetic, magnetic, gravitational, and electric forces at the space and time axes.

which plays a role in the gravity, is observed as the medium of the gravitational field (graviton) γ_g (Fig. 7). Even though the origin of the electric force and magnetic force is not essentially the same, as can be understood from Eqs. (31), (32), (34), and (35), now, it seems that the electric field γ_e and the magnetic field γ_m are closely related to each other, according to the Faraday's and Ampère's law [13]. On the other hand, now, the gravitational field γ_g is also closely related to the electromagnetic field γ_{em}, according to the general relativity, in that the direction of the moving of the electromagnetic field (massless light) γ_{em} is changed by the distortions of the spacetime axes as a consequence of the gravity (Fig. 3). Such effect as a consequence of the general relativity is much smaller than that originating from the Faraday's and Ampère's law. At the moment, we cannot fully decide whether the effects from the general relativity (mass) originate from the electromagnetic forces or not.

We do not completely know whether the substance of the gravity is directly related to that of the electromagnetic forces at the moment. On the other hand, we can at least say that the element of the gravity is generated by the cancellation of the right- and left-handed helicity elements of the magnetic force, and furthermore, is closely related to that of the electric force (Fig. 5). There is a possibility that the gravitational field, the electric field, and magnetic field, which are observed as a consequence of the exchange of the three kinds of bosons (graviton (γ_g) and photon (γ_e, γ_m)), are generated originally from the same gauge boson (γ) (Fig. 7). That is, there is a possibility that we observe γ as graviton (γ_g) in the generation of the gravity, we observe γ as electric photon (γ_e) in the generation of the electric force, and we observe γ as magnetic photon (γ_m) in the generation of the magnetic force.

4.5 Possible Origin of the Charges for the Strong (Color Charges) and Weak (Weak Isospin Charges) Forces

Similar discussions can be made in the elementary charges in the strong and weak forces. We usually live in the four dimensional world (time and three-dimensional space axes). And the electric charge, magnetic charge, and massive charges, the mass of the gauge bosons of which are 0, are angular momentum in the time or space axes in the macroscopic sized world we live. In a similar way, there is a possibility that the strong charge (i.e., color charge) in the strong forces is angular momentum in some extra dimensions in the size of the order of 10^{-15} m, and that the weak charge (i.e., weak isospin) in the weak forces is angular momentum in some extra dimensions in the size of the order of 10^{-18} m.

5. Concluding Remarks

In this research, by considering the relationships between the magnetic forces, gravity, electric forces, and electromagnetic forces, we discussed the origin of the gravity. Furthermore, we showed the reason why the gravity is much smaller than the electric and magnetic forces, and the reason why the rest energy ($mc^2 (= q_g c^2)$) is very large.

We looked into the relationships between the spin magnetic moment, mass, and electric charge, and between the magnetic forces, gravity, and electric forces. At the time of the Big Bang, only spin magnetic moment, which is the element of the magnetic forces, existed. On the other hand, as the temperature decreases, because of any origin (i.e., Higgs boson, broken symmetry of chirality, etc.), the mass, which is the element of gravity, and the electric charge, which is element of electric force, can be generated. That is, we can consider that the elements of the gravity and electric forces can be generated by the cancellation of the elements of the right- and left-handed magnetic forces. That is, electric and magnetic forces can be considered to be originally independent each other. On the other hand, as soon as the element of the electric force has been generated, the magnetic and electric fields have been related by each other by the Ampère's law and Faraday's law. Now, we observe these elements as elements of two of four forces; spin magnetic moments and electric charge for the electromagnetic forces, and the mass for the gravity.

Elementary unit of massive charge (q_g) for the gravity is much smaller than that of electric charge (q_e) for electric force. We can see from this relation that the unit for the mass is much smaller than that for the electric charge if we consider that the massive charge can be equivalent to the electric charge under the same physical background. Therefore, we can consider that the gravity and massive charges are essentially the same as the electromagnetic forces, and electric and magnetic charges, respectively, and they seem to behave as gravity and mass (as one of the elements of the possible unified electromagnetic and gravitational forces), as explained in the general relativity.

The explanation that the spacetime axes are distorted by the gravitational wave (graviton) in the general relativity was derived and confirmed by the experimental results that the moving of the light is curved near the large massive materials such as the sun. It has been considered that the spacetime axes are distorted by only gravitational wave (graviton). On the other hand, by considering many experimental phenomena in electromagnetics such as Meissner effect, Lenz's law, and principle of superposition of electric and magnetic fields (photon), the light is often observed to be curved by the electric, magnetic, and electromagnetic forces in the microscopic sized level. Therefore, we can consider that the spacetime axes can be distorted by the electric and magnetic forces as well as the gravity. Otherwise, we can consider that spacetime axes are not distorted by gravity as well as electric and magnetic forces, as explained in the conventional electromagnetics.

By considering that the significantly curved lights as a consequence of the electromagnetic forces can often be observed in the microscopic sized materials, we can consider that the gravity and electromagnetic forces are closely related to each other.

Even though the massive charges, which are trigger of the generation of the external kinetic energies ($\varepsilon_{q_{\mathrm{g}},\mathrm{external},\boldsymbol{R}}\left(q_{\mathrm{g}}\right)$ and $\varepsilon_{q_{\mathrm{g}},\mathrm{external},\boldsymbol{L}}\left(q_{\mathrm{g}}\right)$), are extremely small, the rest energy ($\varepsilon_{q_{\mathrm{g}},\mathrm{internal},\boldsymbol{R}}\left(q_{\mathrm{g}}\right)$ and $\varepsilon_{q_{\mathrm{g}},\mathrm{internal},\boldsymbol{L}}\left(q_{\mathrm{g}}\right)$), which is internal potential energy of each particle, is extremely large. That is, the most of extremely large energy ($\varepsilon_{q_{\mathrm{g}},\boldsymbol{R}}\left(q_{\mathrm{g}}\right)$ and $\varepsilon_{q_{\mathrm{g}},\boldsymbol{L}}\left(q_{\mathrm{g}}\right)$) generated at the time of the Big Bang has been stored in the particle as a potential rest energy (internal massive energy ($\varepsilon_{q_{\mathrm{g}},\mathrm{internal},\boldsymbol{R}}\left(q_{\mathrm{g}}\right)$ and $\varepsilon_{q_{\mathrm{g}},\mathrm{internal},\boldsymbol{L}}\left(q_{\mathrm{g}}\right)$)), and only small part of it is now used as gravitational energy (origin of which is extremely small massive charge ($\varepsilon_{q_{\mathrm{g}},\mathrm{external},\boldsymbol{R}}\left(q_{\mathrm{g}}\right)$ and $\varepsilon_{q_{\mathrm{g}},\mathrm{external},\boldsymbol{L}}\left(q_{\mathrm{g}}\right)$)). The total chirality in the $\left\langle \boldsymbol{R}_R(+\boldsymbol{k})\middle| H_{1,+\boldsymbol{k},-\boldsymbol{k}} \middle| \boldsymbol{R}_L(-\boldsymbol{k})\right\rangle$ and $\left\langle \boldsymbol{L}_L(+\boldsymbol{k})\middle| H_{1,+\boldsymbol{k},-\boldsymbol{k}} \middle| \boldsymbol{L}_R(-\boldsymbol{k})\right\rangle$ sates are zero not because of the intrinsic zero value but because of the cancellation of the large right- and left-handed helicity elements, which are the origin of the spin magnetic moment and the electric charge. This is the reason why the external potential energy ($\varepsilon_{q_{\mathrm{g}},\mathrm{external},\boldsymbol{R}}\left(q_{\mathrm{g}}\right)$ and $\varepsilon_{q_{\mathrm{g}},\mathrm{external},\boldsymbol{L}}\left(q_{\mathrm{g}}\right)$) for the $\left\langle \boldsymbol{R}_R(+\boldsymbol{k})\middle| H_{1,+\boldsymbol{k},-\boldsymbol{k}} \middle| \boldsymbol{R}_L(-\boldsymbol{k})\right\rangle$ and $\left\langle \boldsymbol{L}_L(+\boldsymbol{k})\middle| H_{1,+\boldsymbol{k},-\boldsymbol{k}} \middle| \boldsymbol{L}_R(-\boldsymbol{k})\right\rangle$ sates can be very small but finite values (fluctuated and induced polarization effects), and the reason why the internal potential energy ($\varepsilon_{q_{\mathrm{g}},\mathrm{internal},\boldsymbol{R}}\left(q_{\mathrm{g}}\right)$ and $\varepsilon_{q_{\mathrm{g}},\mathrm{internal},\boldsymbol{L}}\left(q_{\mathrm{g}}\right)$) for the $\left\langle \boldsymbol{R}_R(+\boldsymbol{k})\middle| H_{1,+\boldsymbol{k},-\boldsymbol{k}} \middle| \boldsymbol{R}_L(-\boldsymbol{k})\right\rangle$ and $\left\langle \boldsymbol{L}_L(+\boldsymbol{k})\middle| H_{1,+\boldsymbol{k},-\boldsymbol{k}} \middle| \boldsymbol{L}_R(-\boldsymbol{k})\right\rangle$ sates can be very large ($mc^2\left(= q_{\mathrm{g}}c^2\right)$).

We looked into the origin of the gravity. The gravitational force between two particles with massive charges is always attractive. This can be understood as follows. For example, an electron is wave as well as particle. Therefore, it is possible that it is fluctuated so that the interactions from all other particles become attractive at the same time because of its wave characteristics, as shown in Fig. 5. There is a possibility that the massive charge is very similar to the induced polarization of the electromagnetism, the size of which is infinitesimal (or very small). We can consider that such gravitational field originates from the fluctuation of the electromagnetic fields because of the slight polarization of the electric charges and spin magnetic moments at the infinite small ($r = 0$) points (or very small finite sizes ($r \approx 0$)). This effect is very similar to the van der Waals forces or intermolecular forces in chemistry even though this effect is much smaller than them because of its infinitesimal (or very small) size.

It is natural to consider that the gravity is closely related to the electric force, magnetic force, and electromagnetic force. That is, even though we cannot decide at the moment that the graviton is a kind of photons, there is a possibility that the graviton is closely related to the photons.

We can consider that the photon γ , which plays a role in the electric force, is observed as the medium of the electric field γ_{e} , the photon γ , which plays a role in the magnetic force, is observed as the medium of the magnetic field γ_{m} , and the photon γ , which plays a role in the gravity, is observed as the medium of the gravitational field (graviton) γ_{g} . We do not know whether the substance of the gravity is directly related to that of the electromagnetic forces at the moment. On the other hand, we can at least say that the element of the gravity is generated by the cancellation of the right- and left-handed helicity elements of the magnetic force, and furthermore, is closely related to that of the electric force. There is a possibility that the gravitational field, the electric field, and magnetic field, which are observed as a consequence of the exchange of the three kinds of bosons (graviton (γ_g) and photon (γ_e , γ_m)), are generated originally from the same gauge boson (γ). That is, there is a possibility that we observe γ as graviton (γ_g) in the generation of the gravity, we observe γ as a electric photon (γ_e) in the generation of the electric force, and we observe γ as magnetic photon (γ_m) in the generation of the magnetic force.

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