



















massive gluon ( $\gamma_c$ ) and the induced circulated spin magnetic fields ( $\gamma_m$ ) (Figs. 4 and 6).

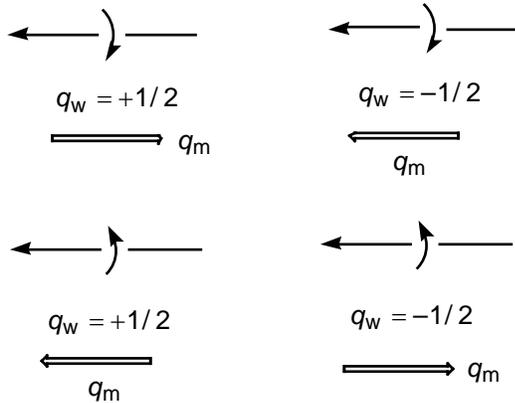


Fig. 5. Relationships between the weak isospin and spin magnetic moment.

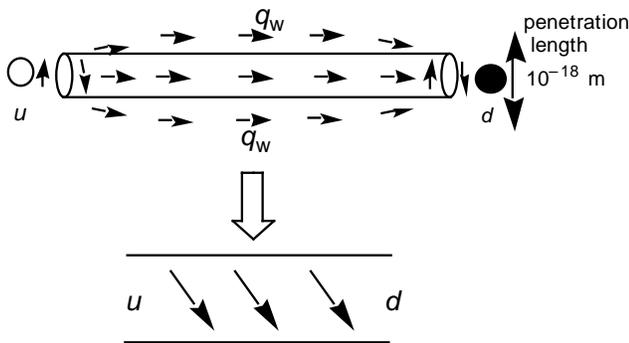


Fig. 6. Synthesized helical magnetic field originating from the magnetic monopoles and the induced spin magnetic moments as a consequence of the Ampère's law.

#### 4.3 Weak Force

The weak isospin charges are the magnetic charges (the magnetic monopole at time axis (Eqs. (25), (26), (31), (32)) and the spin magnetic moment at space axis (Eqs. (7), (14))). The magnetic field originating from the magnetic monopole (color charge) are confined within the one-dimension by the induced spin magnetic field originating from the moving electric charge (Ampère's law), as shown in Fig. 4. On the other hand, such confinement is not perfect, and thus the magnetic fields slightly ( $10^{-18}$  m) penetrate into vacuum from the bond axis between two neighboring quarks and antiquarks, as shown in Fig. 4. This is very similar to the penetration of the magnetic fields into superconductor in the Meissner effects. In superconductivity, it has been considered that the fluctuation of the Cooper pairs is the origin of the

induced circulated magnetic fields (the Higgs mechanism), according to the Ampère's law, by which the magnetic field (magnetic photon) becomes massive in superconductivity. In a similar way, fluctuation of the vibration of the quarks and antiquarks in hadron and vacuum is the origin of the induced circulated magnetic field (the Higgs boson ( $H^+$ ,  $H^-$ , and  $H^0$ )), according to the Ampère's law, by which the magnetic fields (weak bosons) become massive in vacuum. Therefore, the weak bosons are magnetic fields of the superposition of the magnetic monopole and the induced spin magnetic moment originating from the Ampère's law in quarks and antiquarks in hadron and vacuum, within the range of  $10^{-18}$  m from the bonding axis of the neighboring two quarks and antiquarks (Fig. 4). The weak forces can be generated because the photons (magnetic fields) called weak bosons, which are emitted from quarks and antiquarks and absorbed by quarks, antiquarks, leptons, and anti-leptons (the spin magnetic moment and the magnetic monopoles), are exchanged between quarks, antiquarks, leptons, and anti-leptons.

#### 4.4 Weak Isospin Charge

One of weak bosons is the massive magnetic photons originating from the  $\psi_{q_c, \mathbf{R}}(q_e)$  magnetic monopole states. The magnetic photon originating from the  $\psi_{q_c, \mathbf{R}}(q_e)$  magnetic monopole states become massive because the massless magnetic photon ( $\gamma_c$ ) absorbs the Nambu–Goldstone boson called Higgs boson  $H^+$ . Such Higgs boson is closely related to the magnetic field originating from the spin magnetic moments of moving charged quark (Ampère's law), by which the penetration of the magnetic field originating from the magnetic monopole (color charge) into the vacuum is suppressed. The penetration length of the  $W^+$  boson into vacuum is about  $10^{-18}$  m. This is very similar to the Meissner effect in superconductivity.

One of weak bosons is the massive magnetic photon originating from the  $\psi_{q_c, \mathbf{L}}(q_e)$  magnetic monopole states. The magnetic photon originating from the  $\psi_{q_c, \mathbf{L}}(q_e)$  magnetic monopole state become massive because the massless magnetic photon ( $\gamma_c$ ) absorbs the Nambu–Goldstone boson called Higgs boson  $H^-$ . Such Higgs boson is closely related to the magnetic field originating from the spin magnetic moments of moving charged quark (Ampère's law), by which the penetration of the magnetic field originating from the magnetic monopole (color charge) into the vacuum is suppressed. The penetration length of the  $W^-$  boson into vacuum is

about  $10^{-18}$  m. This is very similar to the Meissner effect in superconductivity.

One of weak bosons is the massive magnetic photon originating from the  $\psi_{q_c,RL}(q_e)$  spin magnetic states. The magnetic photon originating from the  $\psi_{q_c,RL}(q_e)$  spin magnetic and magnetic monopole states become massive because the massless magnetic photon ( $\gamma_c$ ) absorbs the Nambu–Goldstone boson called Higgs boson  $H^0$ . Such Higgs boson is closely related to the magnetic field originating from the spin magnetic moments of moving charged quark (Ampère’s law), by which the penetration of the magnetic field originating from the magnetic monopole (color charge) into the vacuum is suppressed. The penetration length of the  $Z^0$  boson into vacuum is about  $10^{-18}$  m. This is very similar to the Meissner effect in superconductivity.

The  $W^+$ ,  $W^-$ , and  $Z^0$  bosons are the massive magnetic photons originating from the  $\psi_{q_c,R}(q_e)$ ,  $\psi_{q_c,L}(q_e)$ , and  $\psi_{q_c,RL}(q_e)$  magnetic monopole and spin magnetic states, respectively.

The weak isospin charges are the magnetic charges (the magnetic monopole at time axis (Eqs. (25), (26), (31), (32)) and the spin magnetic moment at space axis (Eqs. (7), (14))). That is, the weak isospin charge ( $q_w$ ) originates from the spin magnetic moments in the quarks and leptons, and from the magnetic monopoles in quarks. The  $q_w$  values for the positively and negatively electric charged ( $q_e$ ) quarks (and antiquarks) are  $+1/2$  and  $-1/2$ , respectively, those for the leptons with  $q_e = 0$  and  $q_e = -1$  are  $+1/2$  and  $-1/2$ , respectively, and those for the anti-leptons with  $q_e = 0$  and  $q_e = +1$  are  $-1/2$  and  $+1/2$ , respectively.

The direction of the spin magnetic fields for the left-handed particles (and antiparticles) with  $q_w = +1/2$  and  $q_w = -1/2$  are the opposite and the same directions, respectively, with respect to the direction of the particles (and antiparticles) moving. Furthermore, the direction of the spin magnetic fields for the right-handed particles (and antiparticles) with  $q_w = +1/2$  and  $q_w = -1/2$  are the same and the opposite directions, respectively, with respect to the direction of the particles (and antiparticles) moving (Fig. 5).

### 5. The Decay of Neutron

It has been considered that the weak interaction acts only on the left-handed particles and on the right-handed antiparticles. On the other hand, the reason why the weak interaction acts only on the left-handed particles and on the right-handed antiparticles has not been elucidated.

We will show that the right-handed helicity elements as well as the left-handed helicity elements absorb the weak boson (Figs. 7–10). However, we cannot usually observe weak interactions when weak interaction acts on the right-handed particles and the left-handed antiparticles. We will elucidate the reason why we usually observe the parity violation as a consequence of the weak force.

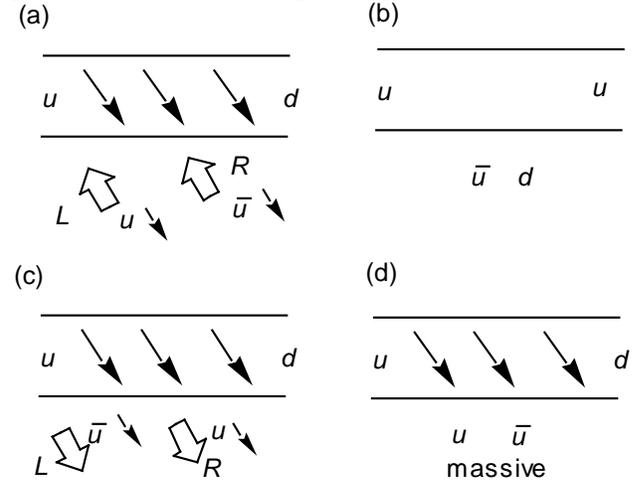


Fig. 7. Decay of neutron. The small arrows indicate the spin magnetic moment, and the large arrows indicate the direction of the particle moving.

#### 5.1 $d \rightarrow u + \pi^-$

Let us first consider the decay of neutron ( $n \rightarrow p + e + \bar{\nu}_e$ ) (Figs. 7–10). A free neutron will decay by emitting a  $W^-$ , which finally produces a proton and a  $\pi^-$  meson.

The strong force becomes very strong because of the sharp confinement of the lines of the magnetic forces between two quarks, and thus the  $u-\bar{u}$  pair production energy is reached before  $u$  and  $d$  quarks in a hadron can be separated (Fig. 7 (a)). In such a case, there is strong magnetic field as a consequence of the penetration of the magnetic field originating from the magnetic monopoles of  $u$  and  $d$  quarks into the vacuum within the range of  $10^{-18}$  m from the bond axis of the two  $u$  and  $d$  quarks. This strong magnetic field can be considered as massive  $W^-$  boson, which can move within the range of  $10^{-18}$  m from the bonding axis of the two  $u$  and  $d$  quarks. Now, strong magnetic fields go from the  $u$  quark (N pole) to the  $d$  quark (S pole). It should be noted that there are right-handed helicity elements as well as the left-handed helicity elements in all massive particles, and there are left-handed helicity elements as well as the right-handed helicity elements in all massive antiparticles. On the other hand, it has been considered that the weak interaction acts only on left-handed particles and right-handed antiparticles.

Let us first look into the case where the weak interaction acts on the left-handed particles and the right-handed antiparticles (Fig. 7 (a), (b)).

If  $u$  quark in the  $u-\bar{u}$  pair comes into the small region and feels the strong magnetic fields, and the weak

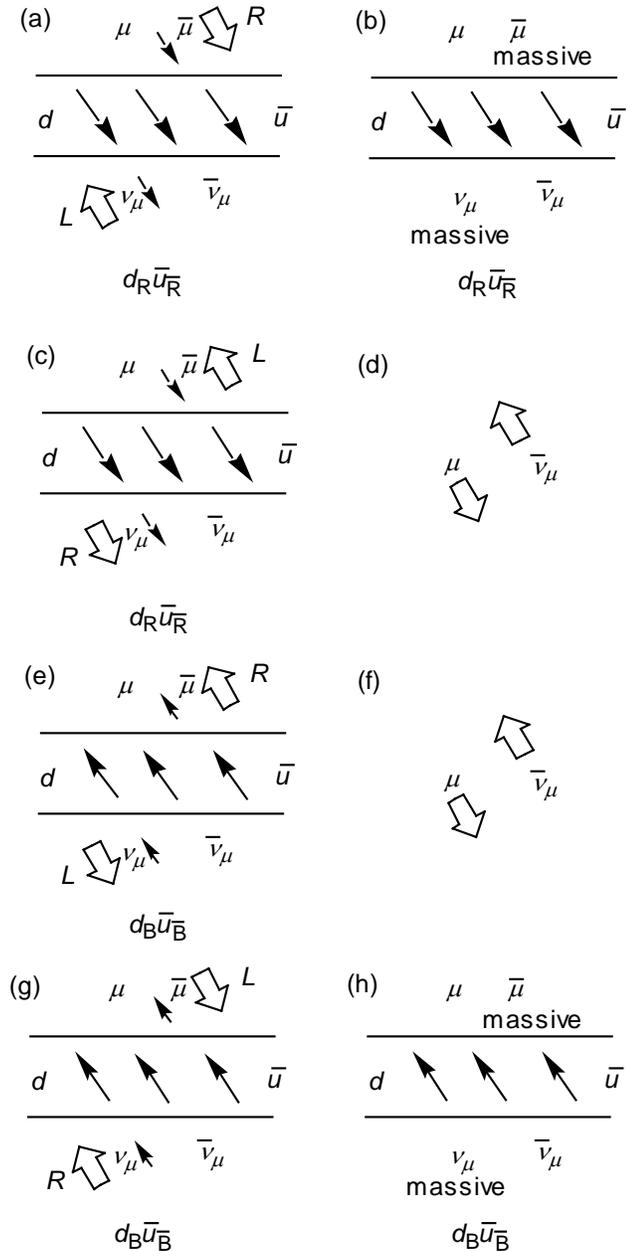


Fig. 8. Decay of minus pion. The small arrows indicate the spin magnetic moment, and the large arrows indicate the direction of the particle moving.

interaction acts on the left-handed helicity element of the  $u$  quark with  $q_w = +1/2$  in the  $u-\bar{u}$  pair, such  $u$  quark tends to move toward the  $u$  quark in a neutron (Fig. 7 (a)). This can be understood as follows. When the  $u$

quark with  $q_w = +1/2$  in the  $u-\bar{u}$  pair moves toward the  $u$  quark in a neutron, the direction of the spin magnetic moment in the  $u$  quark with  $q_w = +1/2$  in the  $u-\bar{u}$  pair becomes the same with that of the magnetic fields of the weak bosons (Fig. 7 (a)). Therefore, the  $u$  quark with  $q_w = +1/2$  in the  $u-\bar{u}$  pair becomes stable in energy. This is the reason why such  $u$  quark tends to move toward the  $u$  quark in a neutron. If the  $u$  quark in the  $u-\bar{u}$  pair moves toward the  $u$  quark in a neutron, new  $u-u$  bonding can be formed (Fig. 7 (b)). In such a case,  $u$  quark in the  $u-\bar{u}$  pair can interact with the  $u$  quark in a neutron, and  $\bar{u}$  antiquark in the  $u-\bar{u}$  pair can interact with the  $d$  quark in a neutron. Therefore,  $u-u$  bonding can be formed in a neutron (proton), and the  $\bar{u}-d$  bonding can be formed in a  $\pi^-$  meson (Fig. 7 (b)). In such a case, we can observe that the weak interaction acts on the left-handed helicity elements in  $u$  quark.

Let us next look into the case where the weak interaction acts on the right-handed particles and the left-handed antiparticles (Fig. 7 (c), (d)).

If  $u$  quark in the  $u-\bar{u}$  pair comes into the small region and feels the strong magnetic fields, and the weak interaction acts on the right-handed helicity element of the  $u$  quark with  $q_w = +1/2$  in the  $u-\bar{u}$  pair, such  $u$  quark tends to move toward the  $d$  quark in a neutron (Fig. 7 (c)). This can be understood as follows. When the  $u$  quark with  $q_w = +1/2$  in the  $u-\bar{u}$  pair moves toward the  $d$  quark in a neutron, the direction of the spin magnetic moment in the  $u$  quark with  $q_w = +1/2$  in the  $u-\bar{u}$  pair becomes the same with that of the magnetic fields of the weak bosons (Fig. 7 (c)). Therefore, the  $u$  quark with  $q_w = +1/2$  in the  $u-\bar{u}$  pair becomes stable in energy. This is the reason why such  $u$  quark tends to move toward the  $d$  quark in a neutron. In such a case,  $u$  quark in the  $u-\bar{u}$  pair can interact with the  $d$  quark in a neutron, and  $\bar{u}$  antiquark in the  $u-\bar{u}$  pair can interact with the  $u$  quark in a neutron. Therefore,  $u-d$  bonding can be formed in a neutron and the  $u-\bar{u}$  pair can be formed in a vacuum (Fig. 7 (d)). The last state (Fig. 7 (d)) is exactly the same with the initial state (Fig. 7 (c)). In such a case, we can observe that the weak interaction does not seem to act on the right-handed helicity elements in  $u$  quark. On the other hand, such  $\bar{u}$  antiquark and  $u$  quark become massive as a consequence of these interactions (Fig. 7 (d)).

Therefore, it should be noted that weak interaction can essentially act on the right-handed helicity elements as well as the left-handed helicity elements in the particle. On the other hand, we cannot observe any change when the weak interaction acts on the right-handed helicity elements in the particle. This is the reason why we can observe that parity is violated and the weak interaction only acts on the left-handed helicity elements in a particle

and on the right-handed helicity elements in an antiparticle (Fig. 7 (a), (b)). On the other hand, when the weak interaction acts on the right-handed helicity elements in a particle and on the left-handed helicity elements in an antiparticle, such particles and antiparticles become massive as a consequence of these interactions (Fig. 7 (c), (d)).

### 5.2 $\pi^- \rightarrow \mu + \bar{\nu}_\mu$

Let us next consider the decay of  $\pi^-$  meson ( $\pi^- \rightarrow \mu + \bar{\nu}_\mu$ ). A free  $\pi^-$  will decay by emitting a  $W^-$ , which finally produces a muon ( $\mu$ ) and anti-muon-neutrino ( $\bar{\nu}_\mu$ ) (Fig. 8).

The strong force becomes very strong because of the sharp confinement of the lines of the magnetic forces between two quarks, and thus the  $\mu - \bar{\mu}$  and  $\nu_\mu - \bar{\nu}_\mu$  pairs production energy is reached before  $\bar{u}$  antiquark and  $d$  quarks in a  $\pi^-$  meson can be separated (Fig. 8). In such a case, there is strong magnetic field as a consequence of the penetration of the magnetic field originating from the magnetic monopoles of  $\bar{u}$  antiquark and  $d$  quark into the vacuum within the range of  $10^{-18}$  m from the bond axis of the two  $\bar{u}$  antiquark and  $d$  quark. This strong magnetic field can be considered as massive  $W^-$  boson, which can move within the range of  $10^{-18}$  m from the bonding axis of the two  $\bar{u}$  antiquark and  $d$  quark. Now, we must consider three cases ( $d_R \bar{u}_R$ ,  $d_B \bar{u}_B$ , and  $d_G \bar{u}_G$ ) because of the white color (colorless) charge within a  $\pi^-$  meson.

Let us first consider the  $d_R \bar{u}_R$  (Fig. 8 (a)–(d)). In such a case, the strong magnetic fields go from the  $d$  quark (N pole) to the  $\bar{u}$  antiquark ( $\bar{N}$  (S) pole). It should be noted that there are right-handed helicity elements as well as the left-handed helicity elements in all massive particles, and there are left-handed helicity elements as well as the right-handed helicity elements in all massive antiparticles. On the other hand, it has been considered that the weak interaction acts only on left-handed particles and right-handed antiparticles (Fig. 8 (a), (b)).

Let us first look into the case where the weak interaction acts on the left-handed particles and the right-handed antiparticles.

If  $\nu_\mu$  in the  $\nu_\mu - \bar{\nu}_\mu$  pair comes into the small region and feels the strong magnetic fields, and the weak interaction acts on the left-handed helicity element of the  $\nu_\mu$  with  $q_w = +1/2$  in the  $\nu_\mu - \bar{\nu}_\mu$  pair, such  $\nu_\mu$  tends to move toward the  $d$  quark in a  $\pi^-$  meson (Fig. 8 (a)). This can be understood as follows. When the  $\nu_\mu$  with

$q_w = +1/2$  in the  $\nu_\mu - \bar{\nu}_\mu$  pair moves toward the  $d$  quark in a  $\pi^-$  meson, the direction of the spin magnetic moment in the  $\nu_\mu$  with  $q_w = +1/2$  in the  $\nu_\mu - \bar{\nu}_\mu$  pair becomes the same with that of the magnetic fields of the weak bosons (Fig. 8 (a)). Therefore, the  $\nu_\mu$  with  $q_w = +1/2$  in the  $\nu_\mu - \bar{\nu}_\mu$  pair becomes stable in energy. This is the reason why such  $\nu_\mu$  tends to move toward the  $d$  quark in a  $\pi^-$  meson (Fig. 8 (a)). If the  $\nu_\mu$  in the  $\nu_\mu - \bar{\nu}_\mu$  pair moves toward the  $d$  quark in a  $\pi^-$  meson, the  $\nu_\mu$  just goes through the  $d$  quark and goes away from a  $\pi^-$  meson. On the other hand,  $\nu_\mu$  becomes massive as a consequence of these interactions (Fig. 8 (b)).

If  $\bar{\mu}$  in the  $\mu - \bar{\mu}$  pair comes into the small region and feels the strong magnetic fields, and the weak interaction acts on the right-handed helicity element of the  $\bar{\mu}$  with  $q_w = +1/2$  in the  $\mu - \bar{\mu}$  pair, such  $\bar{\mu}$  tends to move toward the  $\bar{u}$  antiquark in a  $\pi^-$  meson (Fig. 8 (a)). This can be understood as follows. When the  $\bar{\mu}$  with  $q_w = +1/2$  in the  $\mu - \bar{\mu}$  pair moves toward the  $\bar{u}$  antiquark in a  $\pi^-$  meson, the direction of the spin magnetic moment in the  $\bar{\mu}$  with  $q_w = +1/2$  in the  $\mu - \bar{\mu}$  pair becomes the same with that of the magnetic fields of the weak bosons (Fig. 8 (a)). Therefore, the  $\bar{\mu}$  with  $q_w = +1/2$  in the  $\mu - \bar{\mu}$  pair becomes stable in energy. This is the reason why such  $\bar{\mu}$  tends to move toward the  $\bar{u}$  antiquark in a  $\pi^-$  meson. If the  $\bar{\mu}$  in the  $\mu - \bar{\mu}$  pair moves toward the  $\bar{u}$  antiquark in a  $\pi^-$  meson, the  $\bar{\mu}$  just goes through the  $\bar{u}$  antiquark and goes away from a  $\pi^-$  meson (Fig. 8 (b)). Therefore, we cannot observe weak interaction in this case. On the other hand,  $\bar{\mu}$  becomes massive as a consequence of these interactions (Fig. 8 (b)).

Let us next look into the case where the weak interaction acts on the right-handed particles and the left-handed antiparticles (Fig. 8 (c), (d)).

If  $\nu_\mu$  in the  $\nu_\mu - \bar{\nu}_\mu$  pair comes into the small region and feels the strong magnetic fields, and the weak interaction acts on the right-handed helicity element of the  $\nu_\mu$  with  $q_w = +1/2$  in the  $\nu_\mu - \bar{\nu}_\mu$  pair, such  $\nu_\mu$  tends to move toward the  $\bar{u}$  antiquark in a  $\pi^-$  meson (Fig. 8 (c)). This can be understood as follows. When the  $\nu_\mu$  with  $q_w = +1/2$  in the  $\nu_\mu - \bar{\nu}_\mu$  pair moves toward the  $\bar{u}$  antiquark in a  $\pi^-$  meson, the direction of the spin magnetic moment in the  $\nu_\mu$  with  $q_w = +1/2$  in the  $\nu_\mu - \bar{\nu}_\mu$  pair becomes the same with that of the magnetic fields

of the weak bosons (Fig. 8 (c)). Therefore, the  $\nu_\mu$  with  $q_w = +1/2$  in the  $\nu_\mu - \bar{\nu}_\mu$  pair becomes stable in energy. This is the reason why such  $\nu_\mu$  tends to move toward the  $\bar{u}$  antiquark in a  $\pi^-$  meson. In such a case,  $\nu_\mu$  with  $q_w = +1/2$  in the  $\nu_\mu - \bar{\nu}_\mu$  pair can contact with the  $\bar{u}$  antiquark in a neutron. Therefore,  $\nu_\mu$  and  $\bar{u}$  can vanish (Fig. 8 (d)).

If  $\bar{\mu}$  in the  $\mu - \bar{\mu}$  pair comes into the small region and feels the strong magnetic fields, and the weak interaction acts on the left-handed helicity element of the  $\bar{\mu}$  with  $q_w = +1/2$  in the  $\mu - \bar{\mu}$  pair, such  $\bar{\mu}$  tends to move toward the  $d$  quark in a  $\pi^-$  meson (Fig. 8 (c)). This can be understood as follows. When the  $\bar{\mu}$  with  $q_w = +1/2$  in the  $\mu - \bar{\mu}$  pair moves toward the  $d$  quark in a  $\pi^-$  meson, the direction of the spin magnetic moment in the  $\bar{\mu}$  with  $q_w = +1/2$  in the  $\mu - \bar{\mu}$  pair becomes the same with that of the magnetic fields of the weak bosons (Fig. 8 (c)). Therefore, the  $\bar{\mu}$  with  $q_w = +1/2$  in the  $\mu - \bar{\mu}$  pair becomes stable in energy. This is the reason why such  $\bar{\mu}$  tends to move toward the  $d$  quark in a  $\pi^-$  meson. In such a case,  $\bar{\mu}$  with  $q_w = +1/2$  in the  $\mu - \bar{\mu}$  pair can contact with the  $d$  quark in a  $\pi^-$  meson. Therefore,  $\bar{\mu}$  and  $d$  can vanish (Fig. 8 (d)).

Therefore, we can observe the weak interactions if the weak interaction acts on the right-handed particles and left-handed antiparticles. On the other hand, the left-handed (right-handed) helicity element is much more dominant than the right-handed (left-handed) helicity element in leptons (anti-leptons). Therefore, we cannot usually observe weak interaction in the case of the  $d_R \bar{u}_R$ .

Let us next consider the  $d_B \bar{u}_B$  (Fig. 8 (e)–(h)). In such a case, the strong magnetic fields go from the  $\bar{u}$  antiquark ( $\bar{S}$  (N) pole) to the  $d$  quark (S pole). It should be noted that there are right-handed helicity elements as well as the left-handed helicity elements in all massive particles, and there are left-handed helicity elements as well as the right-handed helicity elements in all massive antiparticles. On the other hand, it has been considered that the weak interaction acts only on left-handed particles and right-handed antiparticles.

Let us first look into the case where the weak interaction acts on the left-handed particles and the right-handed antiparticles (Fig. 8 (e), (f)).

If  $\nu_\mu$  in the  $\nu_\mu - \bar{\nu}_\mu$  pair comes into the small region and feels the strong magnetic fields, and the weak interaction acts on the left-handed helicity element of the  $\nu_\mu$  with  $q_w = +1/2$  in the  $\nu_\mu - \bar{\nu}_\mu$  pair, such  $\nu_\mu$  tends to move toward the  $\bar{u}$  antiquark in a  $\pi^-$  meson (Fig. 8

(e)). This can be understood as follows. When the  $\nu_\mu$  with  $q_w = +1/2$  in the  $\nu_\mu - \bar{\nu}_\mu$  pair moves toward the  $\bar{u}$  antiquark in a  $\pi^-$  meson, the direction of the spin magnetic moment in the  $\nu_\mu$  with  $q_w = +1/2$  in the  $\nu_\mu - \bar{\nu}_\mu$  pair becomes the same with that of the magnetic fields of the weak bosons (Fig. 8 (e)). Therefore, the  $\nu_\mu$  with  $q_w = +1/2$  in the  $\nu_\mu - \bar{\nu}_\mu$  pair becomes stable in energy. This is the reason why such  $\nu_\mu$  tends to move toward the  $\bar{u}$  antiquark in a  $\pi^-$  meson. In such a case,  $\nu_\mu$  with  $q_w = +1/2$  in the  $\nu_\mu - \bar{\nu}_\mu$  pair can contact with the  $\bar{u}$  quark in a  $\pi^-$  meson. Therefore,  $\nu_\mu$  and  $\bar{u}$  can vanish (Fig. 8 (f)).

If  $\bar{\mu}$  in the  $\mu - \bar{\mu}$  pair comes into the small region and feels the strong magnetic fields, and the weak interaction acts on the right-handed helicity element of the  $\bar{\mu}$  with  $q_w = +1/2$  in the  $\mu - \bar{\mu}$  pair, such  $\bar{\mu}$  tends to move toward the  $d$  quark in a  $\pi^-$  meson (Fig. 8 (e)). This can be understood as follows. When the  $\bar{\mu}$  with  $q_w = +1/2$  in the  $\mu - \bar{\mu}$  pair moves toward the  $d$  quark in a  $\pi^-$  meson, the direction of the spin magnetic moment in the  $\bar{\mu}$  with  $q_w = +1/2$  in the  $\mu - \bar{\mu}$  pair becomes the same with that of the magnetic fields of the weak bosons (Fig. 8 (e)). Therefore, the  $\bar{\mu}$  with  $q_w = +1/2$  in the  $\mu - \bar{\mu}$  pair becomes stable in energy. This is the reason why such  $\bar{\mu}$  tends to move toward the  $d$  quark in a  $\pi^-$  meson. In such a case,  $\bar{\mu}$  with  $q_w = +1/2$  in the  $\mu - \bar{\mu}$  pair can contact with the  $d$  quark in a  $\pi^-$  meson. Therefore,  $\bar{\mu}$  and  $d$  can vanish (Fig. 8 (f)).

The left-handed (right-handed) helicity element is much more dominant than the right-handed (left-handed) helicity element in leptons (anti-leptons). Therefore, we can observe weak interaction in the case of the  $d_B \bar{u}_B$ .

Let us next look into the case where the weak interaction acts on the right-handed particles and the left-handed antiparticles (Fig. 8 (g), (h)).

If  $\nu_\mu$  in the  $\nu_\mu - \bar{\nu}_\mu$  pair comes into the small region and feels the strong magnetic fields, and the weak interaction acts on the right-handed helicity element of the  $\nu_\mu$  with  $q_w = +1/2$  in the  $\nu_\mu - \bar{\nu}_\mu$  pair, such  $\nu_\mu$  tends to move toward the  $d$  quark in a  $\pi^-$  meson (Fig. 8 (g)). This can be understood as follows. When the  $\nu_\mu$  with  $q_w = +1/2$  in the  $\nu_\mu - \bar{\nu}_\mu$  pair moves toward the  $d$  quark in a  $\pi^-$  meson, the direction of the spin magnetic moment in the  $\nu_\mu$  with  $q_w = +1/2$  in the  $\nu_\mu - \bar{\nu}_\mu$  pair becomes the same with that of the magnetic fields of the weak bosons (Fig. 8 (g)). Therefore, the  $\nu_\mu$  with

$q_w = +1/2$  in the  $\nu_\mu - \bar{\nu}_\mu$  pair becomes stable in energy. This is the reason why such  $\nu_\mu$  tends to move toward the  $d$  quark in a  $\pi^-$  meson. If the  $\nu_\mu$  in the  $\nu_\mu - \bar{\nu}_\mu$  pair moves toward the  $d$  quark in a  $\pi^-$  meson, the  $\nu_\mu$  just goes through the  $d$  quark and goes away from a  $\pi^-$  meson (Fig. 8 (h)). On the other hand,  $\nu_\mu$  becomes massive as a consequence of these interactions (Fig. 8 (h)).

If  $\bar{\mu}$  in the  $\mu - \bar{\mu}$  pair comes into the small region and feels the strong magnetic fields, and the weak interaction acts on the left-handed helicity element of the  $\bar{\mu}$  with  $q_w = +1/2$  in the  $\mu - \bar{\mu}$  pair, such  $\bar{\mu}$  tends to move toward the  $\bar{u}$  antiquark in a  $\pi^-$  meson (Fig. 8 (g)). This can be understood as follows. When the  $\bar{\mu}$  with  $q_w = +1/2$  in the  $\mu - \bar{\mu}$  pair moves toward the  $\bar{u}$  antiquark in a  $\pi^-$  meson, the direction of the spin magnetic moment in the  $\bar{\mu}$  with  $q_w = +1/2$  in the  $\mu - \bar{\mu}$  pair becomes the same with that of the magnetic fields of the weak bosons (Fig. 8 (g)). Therefore, the  $\bar{\mu}$  with  $q_w = +1/2$  in the  $\mu - \bar{\mu}$  pair becomes stable in energy. This is the reason why such  $\bar{\mu}$  tends to move toward the  $\bar{u}$  antiquark in a  $\pi^-$  meson. If the  $\bar{\mu}$  in the  $\mu - \bar{\mu}$  pair moves toward the  $\bar{u}$  antiquark in a  $\pi^-$  meson, the  $\bar{\mu}$  just goes through the  $\bar{u}$  antiquark and goes away from a  $\pi^-$  meson. Therefore, we cannot observe weak interaction in this case (Fig. 8 (h)). On the other hand,  $\bar{\mu}$  becomes massive as a consequence of these interactions.

Therefore, we can observe the weak interactions if the weak interaction acts on the left-handed particles and right-handed particles. Most of the leptons are left-handed, and most of the anti-leptons are right-handed. Therefore, we can observe weak interaction in the case of the  $d_B \bar{u}_B$ .

Therefore, it should be noted that weak interaction can essentially act on the right- (left-) handed helicity elements as well as the left- (right-) handed helicity elements in the particle (antiparticle). The left-handed (right-handed) helicity element is much more dominant than the right-handed (left-handed) helicity element in leptons (anti-leptons). This is the reason why we can observe that parity is violated and the weak interaction only acts on the left-handed helicity elements in a particle and on the right-handed helicity elements in an antiparticle.

### 5.3 $\mu + \bar{\nu}_\mu \rightarrow e + \bar{\nu}_e$

Let us next consider the case where the  $\mu$  and  $\bar{\nu}_\mu$  are converted to the  $e$  and  $\bar{\nu}_e$  ( $\mu + \bar{\nu}_\mu \rightarrow e + \bar{\nu}_e$ ) (Fig. 9).

Since the left-handed (right-handed) helicity element is much more dominant than the right-handed (left-handed) helicity element in leptons (anti-leptons), we consider only the left-handed (right-handed) helicity element in leptons (anti-leptons) in this section.

Let us first consider the case where the  $\mu$  and  $\bar{\nu}_\mu$  go into the  $u - \bar{u}$  pair in vacuum (Fig. 9 (a)–(d)). The strong force becomes very strong because of the sharp confinement of the lines of the magnetic forces between  $u$  and  $\bar{u}$ , and thus the  $e - \bar{e}$  pair and the  $\nu_e - \bar{\nu}_e$  pair production energy is reached before  $u - \bar{u}$  pair in vacuum can be separated (Fig. 9). The kinds of the particle–antiparticle pairs produced from the vacuum depend on the energy in this environment. In such a case, there is strong magnetic field as a consequence of the magnetic field originating from the magnetic monopoles of  $u$  and  $\bar{u}$  into the vacuum within the range of  $10^{-18}$  m from the bond axis of the two  $u$  quark and  $\bar{u}$  antiquark. This strong magnetic field can be considered as massive  $W^-$  boson, which can move within the range of  $10^{-18}$  m from the bonding axis of the two  $u$  quark and  $\bar{u}$  antiquark. In such a case, the strong magnetic fields go from the  $u$  quark (N pole) to the  $\bar{u}$  antiquark (S pole). It should be noted that there are right-handed helicity elements as well as the left-handed helicity elements in all massive particles, and there are left-handed helicity elements as well as the right-handed helicity elements in all massive antiparticles. On the other hand, it has been considered that the weak interaction acts only on the left-handed particles and the right-handed antiparticles.

If  $\mu$  comes into the small region and feels the strong magnetic fields, and the weak interaction acts on the left-handed helicity element of the  $\mu$  with  $q_w = -1/2$ , such  $\mu$  tends to move toward the  $\bar{u}$  antiquark in a  $u - \bar{u}$  pair (Fig. 9 (a)). This can be understood as follows. When the  $\mu$  with  $q_w = -1/2$  moves toward the  $\bar{u}$  antiquark in a  $u - \bar{u}$  pair, the direction of the spin magnetic moment in the  $\mu$  with  $q_w = -1/2$  becomes the same with that of the magnetic fields of the weak bosons (Fig. 9 (a)). Therefore, the  $\mu$  with  $q_w = -1/2$  becomes stable in energy. This is the reason why such  $\mu$  tends to move toward the  $\bar{u}$  antiquark in a  $u - \bar{u}$  pair. In such a case,  $\mu$  with  $q_w = -1/2$  can contact with the  $\bar{u}$  antiquark in  $u - \bar{u}$  pair. Therefore,  $\mu$  and  $\bar{u}$  can vanish (Fig. 9 (b)).

If  $\bar{\nu}_\mu$  comes into the small region and feels the strong magnetic fields, and the weak interaction acts on the right-handed helicity element of the  $\bar{\nu}_\mu$  with  $q_w = -1/2$ , such  $\bar{\nu}_\mu$  tends to move toward the  $u$  quark in a  $u - \bar{u}$  pair. This can be understood as follows. When the  $\bar{\nu}_\mu$  with  $q_w = -1/2$  moves toward the  $u$  quark in a  $u - \bar{u}$

pair, the direction of the spin magnetic moment in the  $\bar{\nu}_\mu$  with  $q_w = -1/2$  becomes the same with that of the magnetic fields of the weak bosons (Fig. 9 (a)). Therefore, the  $\bar{\nu}_\mu$  with  $q_w = -1/2$  becomes stable in energy. This is the reason why such  $\bar{\nu}_\mu$  tends to move toward the  $u$  quark in a  $u-\bar{u}$  pair. In such a case,  $\bar{\nu}_\mu$  with  $q_w = -1/2$  can contact with the  $u$  quark in  $u-\bar{u}$  pair. Therefore,  $\bar{\nu}_\mu$  and  $u$  can vanish (Fig. 9 (b)).

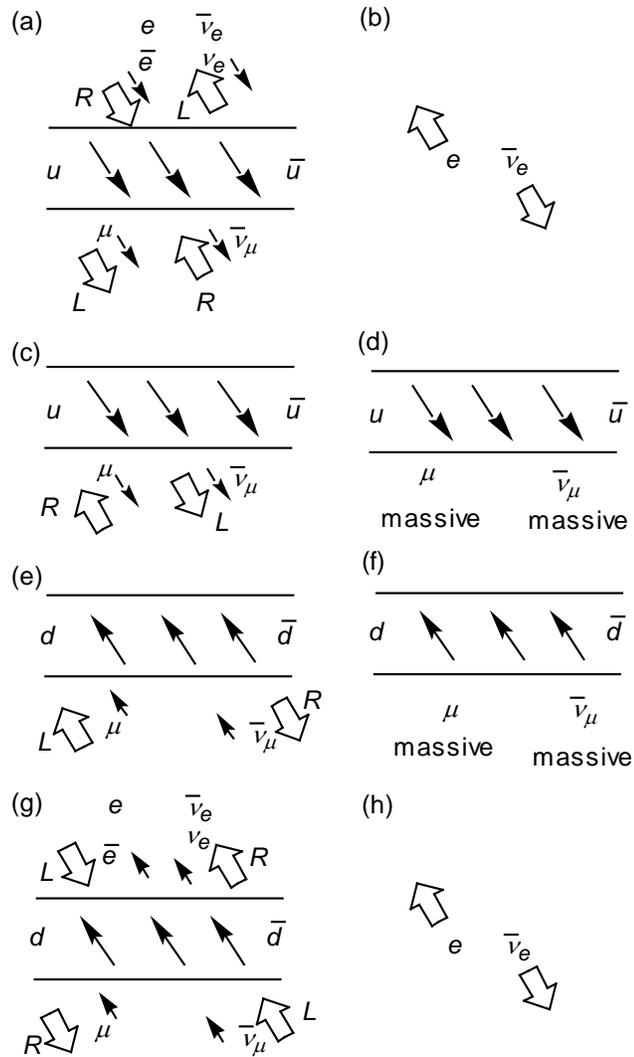


Fig. 9. Converting of the leptons and anti-leptons from the generation 2 to the generation 1. The small arrows indicate the spin magnetic moment, and the large arrows indicate the direction of the particle moving.

If  $\bar{e}$  comes into the small region and feels the strong magnetic fields, and the weak interaction acts on the right-handed helicity element of the  $\bar{e}$  with  $q_w = +1/2$ , such  $\bar{e}$  tends to move toward the  $\bar{u}$  antiquark in a  $u-\bar{u}$

pair in vacuum. This can be understood as follows. When the  $\bar{e}$  with  $q_w = +1/2$  moves toward the  $\bar{u}$  antiquark in a  $u-\bar{u}$  pair, the direction of the spin magnetic moment in the  $\bar{e}$  with  $q_w = +1/2$  becomes the same with that of the magnetic fields of the weak bosons (Fig. 9 (a)). Therefore, the  $\bar{e}$  with  $q_w = +1/2$  becomes stable in energy. This is the reason why such  $\bar{e}$  tends to move toward the  $\bar{u}$  antiquark in a  $u-\bar{u}$  pair.

If  $\nu_e$  comes into the small region and feels the strong magnetic fields, and the weak interaction acts on the left-handed helicity element of the  $\nu_e$  with  $q_w = +1/2$ , such  $\nu_e$  tends to move toward the  $u$  quark in a  $u-\bar{u}$  pair. This can be understood as follows. When the  $\nu_e$  with  $q_w = +1/2$  moves toward the  $u$  quark in a  $u-\bar{u}$  pair, the direction of the spin magnetic moment in the  $\nu_e$  with  $q_w = +1/2$  becomes the same with that of the magnetic fields of the weak bosons (Fig. 9 (a)). Therefore, the  $\nu_e$  with  $q_w = +1/2$  becomes stable in energy. This is the reason why such  $\nu_e$  tends to move toward the  $u$  quark in a  $u-\bar{u}$  pair.

If the  $\bar{e}$  antiparticle in  $e-\bar{e}$  pair and  $\nu_e$  particle in  $\nu_e-\bar{\nu}_e$  pair move toward each other, the  $\bar{e}$  antiparticle can finally contact with the  $\nu_e$  particle (Fig. 9 (a)). In such a case, these  $\bar{e}$  antiparticle and  $\nu_e$  particle vanish. Therefore, the  $e$  particle and the  $\bar{\nu}_e$  antiparticle emerge from vacuum (Fig. 9 (b)). Therefore, finally, we can observe the weak interaction that the  $\mu$  and  $\bar{\nu}_\mu$  (generation 2) are converted to the  $e$  and  $\bar{\nu}_e$  (generation 1) (Fig. 9 (a), (b)). In these cases, the weak interaction acts on the right-handed helicity elements in  $\bar{\nu}_\mu$  antiparticle and on the left-handed helicity elements in  $e$  particle. Since the left-handed (right-handed) helicity element is much more dominant than the right-handed (left-handed) helicity element in  $e$  particle ( $\bar{\nu}_\mu$  antiparticle), such vanishing of particle-antiparticle pairs can usually be observed.

Let us next consider the case where the  $\mu$  and  $\bar{\nu}_\mu$  go into the  $d-\bar{d}$  pair in vacuum (Fig. 9 (e)-(h)).

If  $\mu$  comes into the small region and feels the strong magnetic fields, and the weak interaction acts on the left-handed helicity element of the  $\mu$  with  $q_w = -1/2$ , such  $\mu$  tends to move toward the  $d$  quark in a  $d-\bar{d}$  pair. This can be understood as follows. When the  $\mu$  with  $q_w = -1/2$  moves toward the  $d$  quark in a  $d-\bar{d}$  pair, the direction of the spin magnetic moment in the  $\mu$  with  $q_w = -1/2$  becomes the same with that of the magnetic fields of the weak bosons (Fig. 9 (e)). Therefore, the  $\mu$  with  $q_w = -1/2$  becomes stable in energy. This is the

reason why such  $\mu$  tends to move toward the  $d$  quark in a  $d - \bar{d}$  pair (Fig. 9 (e)). Therefore, the  $\mu$  just goes through the  $d$  quark and goes away from a  $d - \bar{d}$  pair. Therefore, we cannot observe weak interaction in this case. On the other hand,  $\mu$  becomes massive as a consequence of these interactions (Fig. 9 (f)).

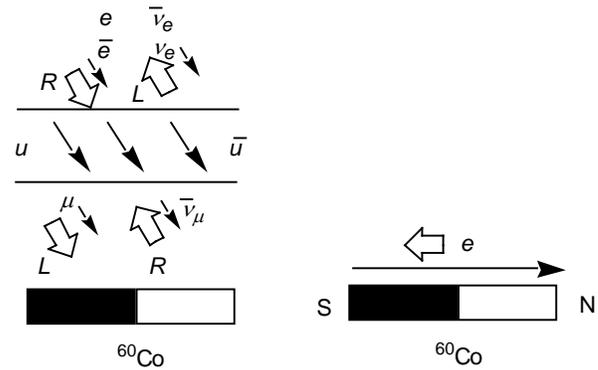
If  $\bar{\nu}_\mu$  comes into the small region and feels the strong magnetic fields, and the weak interaction acts on the right-handed helicity element of the  $\bar{\nu}_\mu$  with  $q_w = -1/2$ , such  $\bar{\nu}_\mu$  tends to move toward the  $\bar{d}$  antiquark in a  $d - \bar{d}$  pair (Fig. 9 (e)). This can be understood as follows. When the  $\bar{\nu}_\mu$  with  $q_w = -1/2$  moves toward the  $\bar{d}$  antiquark in a  $d - \bar{d}$  pair, the direction of the spin magnetic moment in the  $\bar{\nu}_\mu$  with  $q_w = -1/2$  becomes the same with that of the magnetic fields of the weak bosons (Fig. 9 (e)). Therefore, the  $\bar{\nu}_\mu$  with  $q_w = -1/2$  becomes stable in energy. This is the reason why such  $\bar{\nu}_\mu$  tends to move toward the  $\bar{d}$  antiquark in a  $d - \bar{d}$  pair. Therefore, the  $\bar{\nu}_\mu$  just goes through the  $\bar{d}$  antiquark and goes away from a  $d - \bar{d}$  pair. Therefore, we cannot observe weak interaction in this case. On the other hand,  $\bar{\nu}_\mu$  becomes massive as a consequence of these interactions (Fig. 9 (f)).

#### 5.4 Parity Violation of $^{60}\text{Co}$

In the 1950s, Yang and Lee suggested that the weak interaction might violate parity. Wu and collaborators in 1957 discovered that the weak interaction violates parity. The experimental results showed that the number of electrons moving toward the opposite direction of the spin magnetic moments is much larger than that moving toward the same direction of the spin magnetic moment in  $^{60}\text{Co}$  (Fig. 10). This can be understood as follows. We can see from Fig. 10 (a) that most of  $\bar{e}$  moves toward  $\bar{u}$  antiquark, and thus  $\bar{e}$  moves toward the same direction of the spin magnetic moment of the  $u - \bar{u}$  pair, that is, of the  $^{60}\text{Co}$ . Since  $e$  moves toward the opposite direction of  $\bar{e}$  moving,  $e$  moves toward the opposite direction of the spin magnetic moment of the  $u - \bar{u}$  pair, that is, of the  $^{60}\text{Co}$  (Fig. 10 (a)). This is the reason why the number of electrons moving toward the opposite direction (Fig. 10 (a)) of the spin magnetic moments is much larger than that moving toward the same direction (Fig. 10 (b)) of the spin magnetic moment in  $^{60}\text{Co}$ . On the other hand, it should be noted that the number of the electrons moving toward the same direction of the spin magnetic moment (Fig. 10 (b)) in  $^{60}\text{Co}$  is very small, but not exactly zero. This can be understood as follows. Electron and electron-neutrino are massive, and thus the right-handed helicity element is

not zero even though the light-handed helicity elements are much more dominant than the right-handed helicity element in electron and electron-neutrino. Small part of  $\bar{e}$  moves toward  $u$  quark, and thus  $\bar{e}$  moves toward the opposite direction of the spin magnetic moment of the  $u - \bar{u}$  pair, that is, of  $^{60}\text{Co}$  (Fig. 10 (b)). Since  $e$  moves toward the opposite direction of  $\bar{e}$  moving,  $e$  moves toward the same direction of the spin magnetic moment of the  $u - \bar{u}$  pair, that is, of  $^{60}\text{Co}$  (Fig. 10 (b)). This is the reason why the number of the electrons moving

(a) weak interaction acting on the left-handed helicity element in particles (much more dominantly observed)



(b) weak interaction acting on the right-handed helicity element in particles (much less dominantly observed)

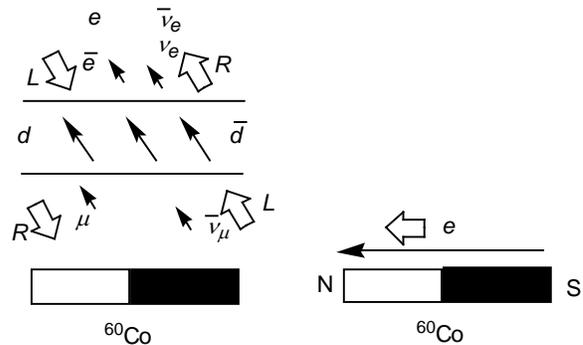


Fig. 10. Relationships between the direction of the electron moving and the spin magnetic moment in  $^{60}\text{Co}$ . The small arrows indicate the spin magnetic moment, and the large arrows indicate the direction of the particle moving.

toward the same direction of the spin magnetic moment in  $^{60}\text{Co}$  is very small, but not exactly zero.

It has been considered that the weak interaction only acts on the left-handed particles and right-handed antiparticles (parity violation). However, according to our theory, weak interaction is not directly related to such parity violation. That is, according to our theory, weak interaction acts on the right- (left-) handed particles

(antiparticles) as well as on the left- (right-) handed particles (antiparticles). That is, weak forces themselves do not violate the parity. Therefore, the parity violation is not essential in weak interaction. On the other hand, the left- (right-) handed helicity elements are much more dominant than the right- (left-) handed helicity elements in leptons (anti-leptons). Therefore, we observe that the weak interaction seems to act only on the left- (right-) handed particles (antiparticles). That is, dominance in the left- (right-) handed helicity elements in leptons (anti-leptons) is the main reason why we observe parity violation even though the weak forces are not directly related to the parity violation.

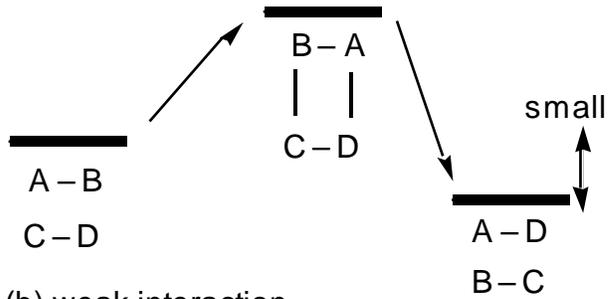
**6. Relationships between the Chemical Interactions and Weak Interactions**

It has been considered that weak interactions are quite different from other interactions. On the other hand, according to our theory, weak interactions are very similar to chemical reactions. In chemical reaction, atomic bonding and types of molecules can be changed via the electron exchange. On the other hand, in weak interactions, the bonding between the quarks and antiquarks and types of the leptons and anti-leptons can be changed via the weak boson exchange. Only the difference is that the product materials (A–D and B–C) can be formed by the elements of the reactants (A–B and C–D (i.e., A, B, C, and D)) in chemical reactions (Fig. 11 (a)), while the final product states ( $u, \bar{u}, e$  and  $\bar{\nu}_e$ ) can be formed by the particle–antiparticles pairs ( $u - \bar{u}, \mu - \bar{\mu}, \nu_\mu - \bar{\nu}_\mu, e - \bar{e},$  and  $\nu_e - \bar{\nu}_e$ ) in vacuum as well as the elements of the reactants ( $u$  and  $d$ ) (Fig. 11 (b)). The kinds of the particle–antiparticle pairs generated from the vacuum depends on the energy states of the environment in vacuum. Furthermore, the area ( $10^{-10}$  [m]) under which chemical reaction occurs is much larger than that ( $10^{-18}$  [m]) under which weak interaction occurs. Furthermore, the produced energies for chemical reaction is much smaller than that for weak interaction (Fig. 11).

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. This is the reason why the gravity is much smaller than other three forces. 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, by the cancellation of the intrinsic extremely large right- and left-handed chirality elements in spin magnetic moments. On the other hand, if weak interaction occurs, the rest energy difference, related to the difference of the masses between the reactant and product, can be produced. This energy as a consequence

of the weak interaction originates from the fact that the cancellation of the intrinsic extremely large right- and left-handed chirality elements in spin magnetic moments is broken by the driving force of the magnetic monopoles. Therefore, the difference of the degree of the cancellation of the intrinsic extremely large right- and left-handed chirality elements in spin magnetic moments between the reactants and products is the origin of the rest energy difference ( $\Delta mc^2 (= \Delta q_g c^2)$ ) as a consequence of the weak interactions.

(a) chemical reaction



(b) weak interaction

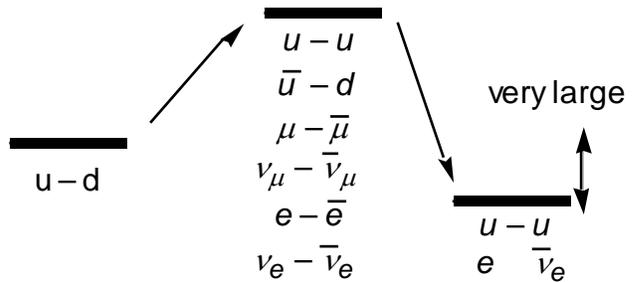


Fig. 11. Comparison of the chemical reaction with the weak interaction.

**7. Relationships between the Meissner Effects in Superconductivity and Weak Interactions in Higgs Mechanism**

In superconductivity, the Cooper pairs can be formed. The Cooper pairs can move according to the external magnetic fields applied to superconducting specimen. The circulated magnetic field can be induced by such moving of Cooper pairs, according to the Ampère’s law. The external applied magnetic fields are expelled from the superconducting specimen by such circulated magnetic fields. This phenomenon is Meissner effect (Fig. 12 (a), Table 1).

Let us next look into this phenomenon in view of the Higgs mechanism. In superconductivity, it has been considered that the fluctuation of the Cooper pairs is the origin of the induced magnetic fields, according to the Ampère’s law, by which the magnetic field (magnetic photon) becomes massive in superconductivity. We can

consider that the fluctuation of the Cooper pairs can induce the circulated magnetic fields. The circulated magnetic fields (massless magnetic photon) is related to the massless Nambu–Goldstone particle (Higgs boson ( $H_{NG}$ )) (Fig. 12 (a)). The external applied magnetic fields are expelled from the superconducting specimen by such circulated magnetic fields. The external applied magnetic field is related to the massless gauge boson (magnetic photon  $\gamma_m$ ) (Fig. 12 (a)). That is, the massless Nambu–Goldstone particle  $H_{NG}$  is absorbed by the

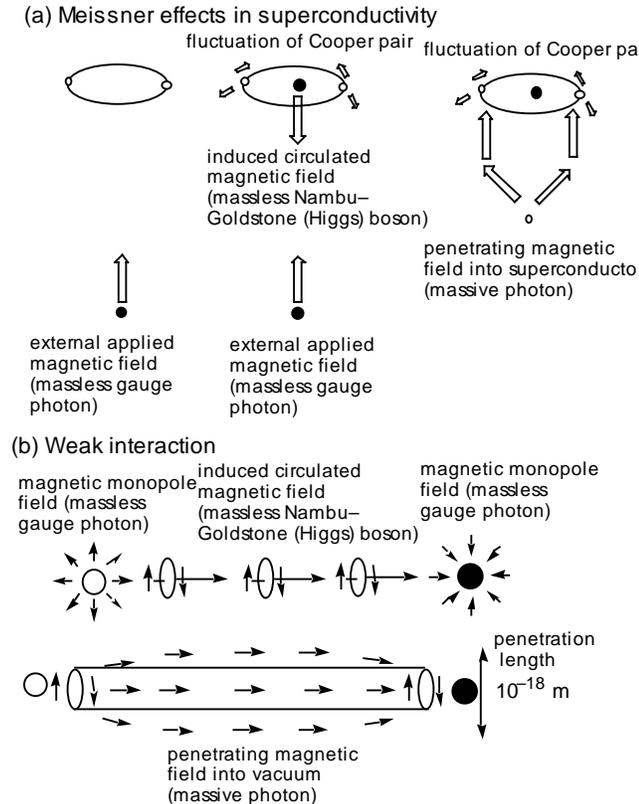


Fig. 12. Higgs mechanism in superconductivity and weak interaction.

massless gauge boson  $\gamma_m$ . Therefore, the penetrating of the external applied magnetic fields is suppressed, and thus the external applied magnetic field can penetrate into the superconducting specimen only within the penetration lengths of the magnetic field. That is, the massless gauge boson  $\gamma_m$  becomes finally massive, and such massive gauge boson can enter into the superconducting specimen only within the penetration depth (Fig. 12 (a)). This is the explanation of the Meissner effect in view of the Higgs mechanism.

Let us next compare the Meissner effects in superconductivity with the weak interactions in our theory. The weak isospin charges are the magnetic

charges (the magnetic monopole at time axis (Eqs. (25), (26), (31), (32)) and the spin magnetic moment at space axis (Eqs. (7), (14))). The magnetic field originating from the magnetic monopole (color charge) are confined within the one-dimensional by the induced spin magnetic field originating from the moving electric charge (Ampère’s law), as shown in Fig. 12 (b). On the other hand, such confinement is not perfect and thus the magnetic fields slightly ( $10^{-18}$  [m]) penetrate into vacuum from the bond axis between two neighboring quarks and antiquarks, as shown in Fig. 12 (b). This is very similar to the

Table 1. Higgs mechanism in the superconductivity and weak interactions.

	superconductivity	weak interactions
gauge boson	external applied magnetic fields	magnetic monopoles from quarks and antiquarks
Nambu–Goldstone (Higgs) boson	induced magnetic fields as a consequence of the Ampère’s law	induced circulated magnetic fields as a consequence of the Ampère’s law
origin of the Nambu–Goldstone (Higgs) boson	fluctuation of the Cooper pairs (electrical current of the Cooper pairs)	fluctuation of the vibration of the quarks and antiquarks
massive boson	external applied magnetic fields mostly canceled by the induced magnetic fields as a consequence of the Ampère’s law	magnetic monopoles from quarks and antiquarks synthesized by the induced circulated magnetic fields as a consequence of the Ampère’s law

penetration of the magnetic fields in superconductor in the Meissner effects. In superconductivity, it has been considered that the fluctuation of the Cooper pairs is the origin of the induced circulated magnetic fields (the Higgs mechanism), according to the Ampère’s law, by which the magnetic field (magnetic photon) becomes massive in superconductivity. In a similar way, fluctuation of the vibration of the quark and antiquarks in hadron and

vacuum is the origin of the induced circulated magnetic field (the massless Nambu–Goldstone particles (Higgs bosons ( $H^+$ ,  $H^-$ , and  $H^0$ )), according to the Ampère’s law, by which the magnetic fields (the massless gauge weak bosons ( $\gamma_c$  and  $\gamma_m$ )) become massive in vacuum. The massless Nambu–Goldstone particles (Higgs bosons) (the circulated magnetic field induced according to the Ampère’s law) originating from the fluctuation of the vibrations of the quarks and antiquarks in hadrons and vacuum, are absorbed by the massless gauge bosons (the magnetic fields originating from the magnetic monopoles in quarks and antiquarks in hadrons and vacuum) (Fig. 12 (b)). Therefore, such massless gauge boson absorbing the Nambu–Goldstone bosons becomes massive. The finally massive bosons are related to the massive weak bosons which are composed from the circulated magnetic field induced according to the Ampère’s law and the magnetic fields originating from the magnetic monopoles in quarks and antiquarks in hadrons and vacuum. Therefore, the weak bosons are massive fields of the superposition of the magnetic monopole ( $\gamma_c$ ) and the induced spin magnetic moment ( $\gamma_m$ ) originating from the Ampère’s law in quarks and antiquarks in hadron and vacuum, within  $10^{-18}$  [m] from the bonding axis of the neighboring two quarks and antiquarks (Fig. 12 (b)). The weak forces can be generated because massive magnetic photons called massive weak bosons, which are emitted from quarks and antiquarks, and absorbed by quarks, antiquarks, leptons, and anti-leptons (the spin magnetic moment and the magnetic monopoles), are exchanged between quarks, antiquarks, leptons, and anti-leptons.

In summary, the weak bosons  $\gamma_w$  such as  $W^+$ ,  $W^-$ , and  $Z^0$  are the magnetic field as a consequence of superposition of the magnetic fields originating from the massive gluon ( $\gamma_g$ ) and the induced circulated spin magnetic fields ( $\gamma_m$ ).

When particles and antiparticles come into the hadrons and particle–antiparticle pairs in vacuum, such particles and antiparticles can be converted to the another particles and antiparticles, or can become massive via the exchange of the weak bosons (including Higgs bosons), by which the Higgs bosons have been absorbed.

### 8. Relationships between the Gauge Bosons in the Electric, Magnetic, and Strong, and Weak Forces

According to our research, it is natural to consider that the  $\gamma_w$  boson as well as the  $\gamma_e$  and  $\gamma_m$  bosons play a role in the same forces. That is, it is natural to consider that the weak force is closely related to the electric force, magnetic force, and electromagnetic force. That is, even though we cannot decide at the moment that the weak

bosons are kinds of photons, there is a possibility that the weak boson is closely related to the photons (Fig. 13).

We can consider that the gauge photonic particle medium ( $\gamma$ ) for electric forces ( $\gamma_e$ ), for magnetic forces ( $\gamma_m$ ), for strong force ( $\gamma_c$ ), and for weak force ( $\gamma_w$ ), were essentially the same at the Big Bang. We can consider that the photon  $\gamma$ , which plays a role in the electric force, is observed as the medium of the electric field  $\gamma_e$ , the photon  $\gamma$ , which plays a role in the magnetic force, is observed as the medium of the magnetic field  $\gamma_m$ , the photon  $\gamma$ , which plays a role in the strong force, is observed as the medium of the color field (gluon)  $\gamma_c$ , and

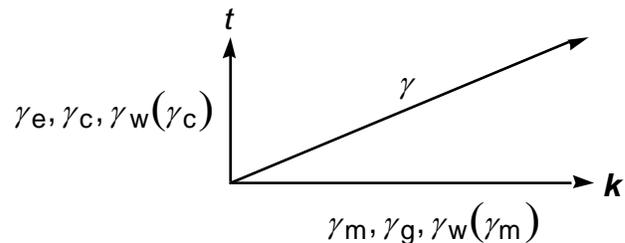


Fig. 13. Relationships between the gauge bosons for the electromagnetic, magnetic, gravitational, electric, strong, and weak forces at the space and time axes.

the photon  $\gamma$ , which plays a role in the weak force, is observed as the medium of the weak field (weak bosons)  $\gamma_w$  (Fig. 13).

We do not completely know whether the substance of the weak force 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 weak force is generated by the right- and left-handed helicity elements of the magnetic angular momentum, and furthermore, by the magnetic monopole.

### 9. Concluding Remarks

In this research, we discussed the origin of the weak forces, by comparing the weak force with the gravitational, electric, magnetic, strong, and electromagnetic forces. We also discussed the essential properties of the weak bosons and weak isospin charges. Furthermore, we also discussed the reason why the parity violation can be observed in the weak interactions.

We discussed the weak isospin charges. The weak isospin charges are the magnetic charges (the magnetic monopole at time axis and the spin magnetic moment at space axis).

We also discussed the weak bosons. The confinement of the strong forces is not perfect. Therefore, the weak bosons are magnetic fields of the superposition of the magnetic monopole and the induced spin magnetic

moment originating from the Ampère's law in quarks and antiquarks in hadron and vacuum, within the  $10^{-18}$  m from the bonding axis of the neighboring two quarks and antiquarks. The weak forces can be generated because the photons (magnetic fields) called weak bosons, which are emitted from quarks and antiquarks and absorbed by quarks, antiquarks, leptons, and anti-leptons (the spin magnetic moment and the magnetic monopoles), are exchanged between quarks, antiquarks, leptons, and anti-leptons.

The reason why the parity violation can be observed in the weak interactions is also discussed. It has been considered that the weak interaction acts only on the left-handed particles and on the right-handed antiparticles. On the other hand, the reason why the weak interaction acts only on the left-handed particles and on the right-handed antiparticles has not been elucidated. We showed that the right-handed helicity elements as well as the left-handed helicity elements absorb the weak boson. However, we cannot usually observe weak interactions when weak interaction acts on the right-handed particles and the left-handed antiparticles. We elucidated the reason why we usually observe the parity violation as a consequence of the weak force.

The weak interaction ( $d \rightarrow u + \pi^-$ ) can essentially act on the right-handed helicity elements as well as the left-handed helicity elements in the particle. On the other hand, we cannot observe any change when the weak interaction acts on the right-handed helicity elements in the particle. This is the reason why we can observe that parity is violated and the weak interaction only acts on the left-handed helicity elements in a particle and on the right-handed helicity elements in an antiparticle. On the other hand, when the weak interaction acts on the right-handed helicity elements in a particle and on the left-handed helicity elements in an antiparticle, such particles and antiparticles become massive as a consequence of these interactions.

The weak interaction ( $\pi^- \rightarrow \mu + \bar{\nu}_\mu$  and  $\mu + \bar{\nu}_\mu \rightarrow e + \bar{\nu}_e$ ) can essentially act on the right- (left-) handed helicity elements as well as the left- (right-) handed helicity elements in the particle (antiparticle). On the other hand, the left-handed (right-handed) helicity element is much more dominant than the right-handed (left-handed) helicity element in leptons (anti-leptons). This is the reason why we can observe that parity is violated and the weak interaction only acts on the left-handed helicity elements in a particle and on the right-handed helicity elements in an antiparticle.

Our theory can also reasonably explain the parity violation of  $^{60}\text{Co}$ . It has been considered that the weak interaction only acts on the left-handed particles and

right-handed antiparticles (parity violation). However, according to our theory, weak interaction is not directly related to such parity violation. That is, according to our theory, weak interaction acts on the right- (left-) handed particles (antiparticles) as well as on the left- (right-) handed particles (antiparticles). That is, weak forces themselves do not violate the parity. Therefore, the parity violation is not essential in weak interaction. On the other hand, the left- (right-) handed helicity elements are much more dominant than the right- (left-) handed helicity elements in leptons (anti-leptons). Therefore, we observe that the weak interaction seems to act only on the left- (right-) handed particles (antiparticles). That is, dominance in the left- (right-) handed helicity elements in leptons (anti-leptons) is the main reason why we observe parity violation even though the weak forces are not directly related to the parity violation.

It has been considered that weak interactions are quite different from other interactions. On the other hand, according to our theory, weak interactions are very similar to chemical reactions. In chemical reaction, atomic bonding and types of molecules can be changed via the electron exchange. On the other hand, in weak interactions, the bonding between the quarks and antiquarks and types of the leptons and anti-leptons can be changed via the weak boson exchange. Only the difference is that the product materials can be formed by the elements of the reactants in chemical reactions, while the final product states can be formed by the particle-antiparticles pairs in vacuum as well as the elements of the reactants. The kinds of the particle-antiparticle pairs generated from the vacuum depends on the energy states of the environment in vacuum.

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, by the cancellation of the intrinsic extremely large right- and left-handed chirality elements in spin magnetic moments. On the other hand, if weak interaction occurs, the rest energy difference, related to the difference of the masses between the reactant and product, can be produced. This energy as a consequence of the weak interaction originates from the fact that the cancellation of the intrinsic extremely large right- and left-handed chirality elements in spin magnetic moments is broken by the driving force of the magnetic monopoles. Therefore, the difference of the degree of the cancellation of the intrinsic extremely large right- and left-handed chirality elements in spin magnetic moments between the reactants and products is the origin of the rest energy difference ( $\Delta mc^2 (= \Delta q_g c^2)$ ) as a consequence of the weak interactions.

We compared the Meissner effects in superconductivity with the weak interactions in our theory. The weak

isospin charges are the magnetic charges (the magnetic monopole at time axis and the spin magnetic moment at space axis). The magnetic field originating from the magnetic monopole (color charge) are confined within the one-dimensional by the induced spin magnetic field originating from the moving electric charge (Ampère's law). On the other hand, such confinement is not perfect and thus the magnetic fields slightly ( $10^{-18}$  [m]) penetrate into vacuum from the bond axis between two neighboring quarks and antiquarks. This is very similar to the penetration of the magnetic fields in superconductor in the Meissner effects. In superconductivity, it has been considered that the fluctuation of the Cooper pairs is the origin of the induced circulated magnetic fields (the Higgs mechanism), according to the Ampère's law, by which the magnetic field (magnetic photon) becomes massive in superconductivity. In a similar way, fluctuation of the vibration of the quark and antiquarks in hadron and vacuum is the origin of the induced circulated magnetic field (the massless Nambu–Goldstone particles (Higgs bosons ( $H^+$ ,  $H^-$ , and  $H^0$ )), according to the Ampère's law, by which the magnetic fields (the massless gauge weak bosons ( $\gamma_c$  and  $\gamma_m$ )) become massive in vacuum. The massless Nambu–Goldstone particles (Higgs bosons) (the circulated magnetic field induced according to the Ampère's law) originating from the fluctuation of the vibrations of the quarks and antiquarks in hadrons and vacuum, are absorbed by the massless gauge bosons (the magnetic fields originating from the magnetic monopoles in quarks and antiquarks in hadrons and vacuum). Therefore, such massless gauge boson absorbing the Nambu–Goldstone bosons becomes massive. The finally massive bosons are related to the massive weak bosons which are composed from the circulated magnetic field induced according to the Ampère's law and the magnetic fields originating from the magnetic monopoles in quarks and antiquarks in hadrons and vacuum. Therefore, the weak bosons are massive fields of the superposition of the magnetic monopole ( $\gamma_c$ ) and the induced spin magnetic moment ( $\gamma_m$ ) originating from the Ampère's law in quarks and antiquarks in hadron and vacuum, within  $10^{-18}$  [m] from the bonding axis of the neighboring two quarks and antiquarks. The weak forces can be generated because massive magnetic photons called massive weak bosons, which are emitted from quarks and antiquarks, and absorbed by quarks, antiquarks, leptons, and anti-leptons (the spin magnetic moment and the magnetic monopoles), are exchanged between quarks, antiquarks, leptons, and anti-leptons.

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