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Abstract

Dirac spinor is recognized as a two-dimensional rotation of any generator. For the Lagrangian of rotational symmetry, the linear sigma model of SSB is available. Then it is derivable that a Dirac spinor (lepton or quark) is a looped photon that is rotating along the trough of potential in linear sigma model. In this model, quarks and leptons are derived definitely.

A Lepton and a Quark are a Looped Photon

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1 INTRODUCTION

The boost and rotation generators of Dirac spinor are written as

$$S^{0i} = \frac{i}{4}[\gamma^0, \gamma^i] = -\frac{1}{2}\begin{pmatrix} \sigma^i & 0 \\ 0 & \sigma^i \end{pmatrix},$$

and

$$S^{ij} = \frac{i}{4}[\gamma^i, \gamma^j] = -\frac{1}{2}\epsilon^{ijk}\begin{pmatrix} \sigma^k & 0 \\ 0 & \sigma^k \end{pmatrix},$$

where σ is Pauli sigma matrices [Peskin & Schroeder (1995)]. The rotation generator (S^{ij}) is a three-dimensional spinor transformation matrix ($S^{ij} = \frac{1}{2}\epsilon^{ijk}\sigma^k$) replicated twice. Since S^{ij} are recognized as a two-dimensional representation of rotation groups, it is inferable that Dirac spinor is made of a two-dimensional rotation of any generator. Since S^{0i} are not Hermitean, the each block of the replicated two 2-dimensional representations is written as

$$\psi = \begin{pmatrix} \psi_L \\ \psi_R \end{pmatrix},$$

where ψ_L and ψ_R are called left-handed and right-handed Weyl spinor. After all, Dirac spinor must be made of a rotation generator repeating parity (space reversal) every rotation.

For the Lagrangian of the rotational symmetry, the linear sigma model of SSB (spontaneous symmetry breaking) is available. The Lagrangian of the linear sigma model is written as

$$\mathcal{L} = (1/2)(\partial_\mu\phi^i)^2 + (1/2)\mu^2(\phi^i)^2 - (\lambda/4)[(\phi^i)^2]^2,$$

with an implicit sum over i in each factor $(\phi^i)^2$ [Peskin & Schroeder (1995)]. This Lagrangian is invariant under the symmetry

$$\phi^i \longrightarrow R^{ij}\phi^j$$

for any $N \times N$ orthogonal matrix R. For the case $N = 2$, oscillations along the trough in the potential correspond to the massless field as Fig.1. Therefore, it is derivable that a Dirac spinor (lepton or quark) is a looped photon that is rotating along the trough of potential in SSB.

2 THEORY

2.1 The Transformation from a Photon to a Looped Photon

In the rotation of photon, since parity (space reversal) occurs every rotation, self-inductance must be generated. Inductances generate an opposing voltage proportional to the rate of change in current in a circuit,

$$v = L\frac{di}{dt},$$

where v is voltage, i is current and L is self-inductance. The charge of Dirac spinor is given as

$$Q \equiv \int_{allspace} j^0 d^3x,$$

where j^0 is electric current.

2.2 The Procedures of the Transformation

1) The case that the quantity of nodes is 1 per a circle. (the wave number is 0.5 per a circle)

   Fig.2a: The electrical potential of the ordinary photon is shown.
   Fig.2b: In the looped photon, the sign of the electrical potential is reversed every rotation.
   Fig.2c: The positive inductance voltage is added. This case fits positron. In the opposite sign of electrical potential of

this case, electron will be derived.
Fig.2d: The opposing inductance voltage is subtracted. This case fits neutrino. In the opposite sign of electrical potential of this case the same result is derived. This means that the neutrino is Majorana particle, that the particle and anti-particle are equivalence.

2) The case that the quantity of nodes is 3 per a circle. (the wave number is 1.5 per a circle)

    Fig.3a: The electrical potential of the ordinary photon is shown.
    Fig.3b: The sign of the electrical potential is reversed every rotation.
    Fig.3c: The positive voltage is added. This case fits u-quark. In the opposite sign of the electrical potential of this case, anti-u-quark will be derived
    Fig.3d: The opposing voltage is subtracted. This case fits d-quark. In the opposite sign of the electrical potential of this case, anti-d-quark will be derived.

Fig.4a and 4b: The plane figures of u-quark and d-quark are shown. In these circles, it is recognizable easily that they are charged to 2/3 and $-1/3$ respectively according to the conservation equation of the charge $Q \equiv \int_{allspace} j^0 d^3x$.
Fig.4c $\sim$ 4e: These show u-quarks with the color value "R", "G", and "B" respectively where their phase is different each other as much as $2\pi/3$.

Fig.5a and 5b: A set of three quarks fits proton or neutron, and similarly a set of three anti-quarks fits anti-proton or anti-neutron.
Fig.5c: From a set of quark and anti-quark with the same color respectively, mesons (π mesons) are derivable, which fit π^-, π^0, and π^+ respectively. Although neutrino, π^0 meson and neutron seem to same figure, they are corresponding to a singlet, doublet and triplet respectively.
Fig.5d: β-decay of neutron is shown. The neutron is decomposed to a proton, μ^-, and anti-ν_μ for a start. However, since μ^- and anti-ν_μ are the virtual particles, they decay to an electron and anti-ν_e immediately. Therefore, this interaction must be irreversible.

3 CONCLUSIONS

1. The transformation from a photon to a looped photon can be explained by SSB (linear sigma model).

2. In the case that the quantity of nodes is 1 in the loop, neutrino, anti-neutrino, electron and positron are generated.

3. In the case that the quantity of nodes is 3 in the loop, quarks and anti-quarks are generated.

4. Neutrino and neutron are Majonara particle. that the particle and anti-particle are equivalence.

5. The electric charge is the quantity corresponding to the phase-shift by π in the reversing period of the electric field in the looped photon.

6. The color values "R","G", and "B" of quarks are corresponding to the phase shift as much as $2\pi/3$ in the loop.

7. The force binding quarks is electromagnetic force.

References

[Peskin & Schroeder (1995)] Peskin,M.E., and Schroeder,D.V. 1995. An Introduction to Quantum Field Theory(Westview Press)

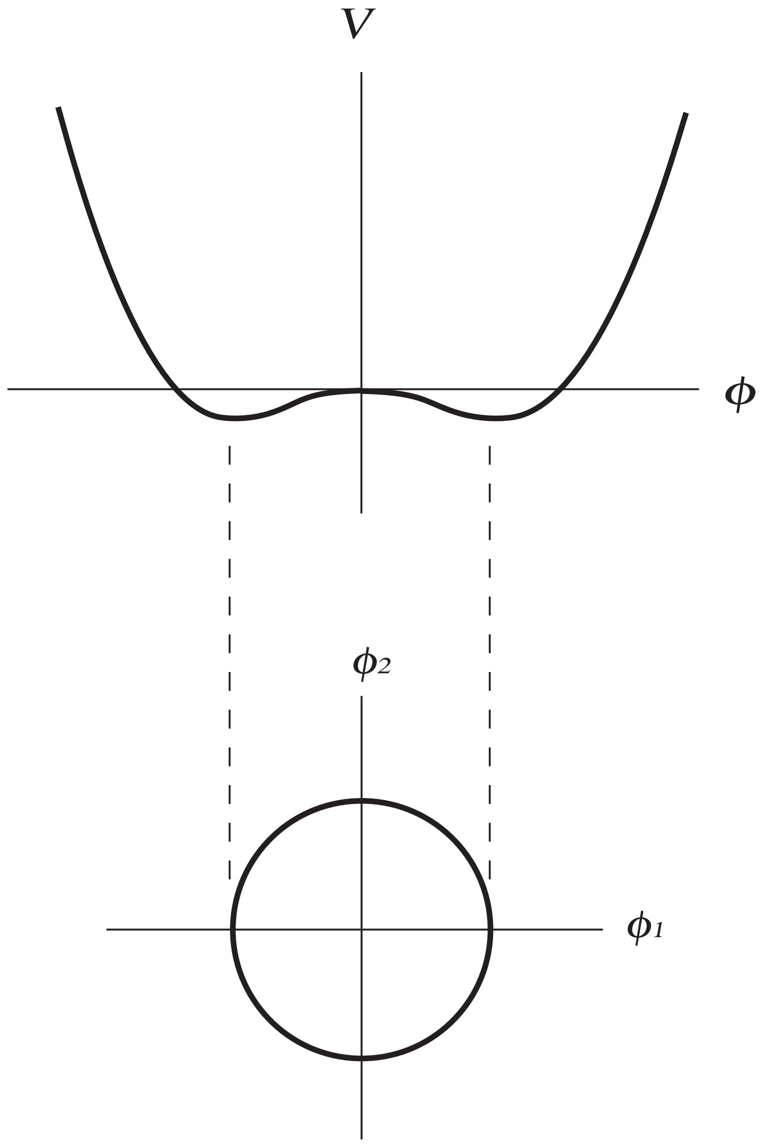

Figure 1: Potential for the linear sigma model (N=2) is shown,

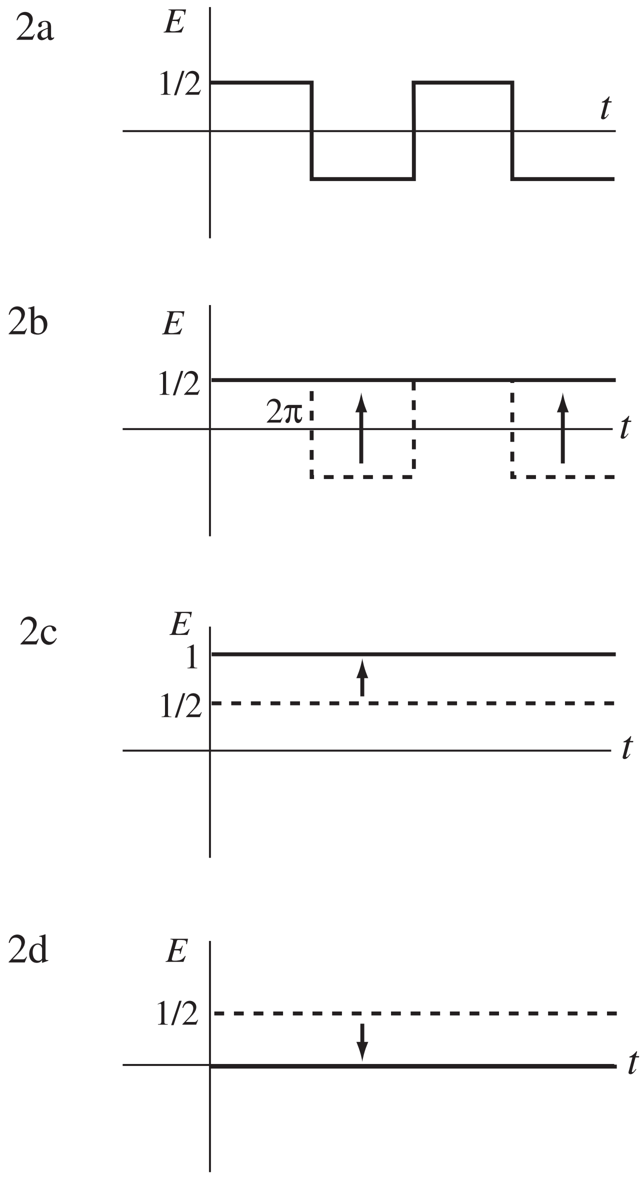

Figure 2: The case that the quantity of nodes is 1 in a circle is shown.

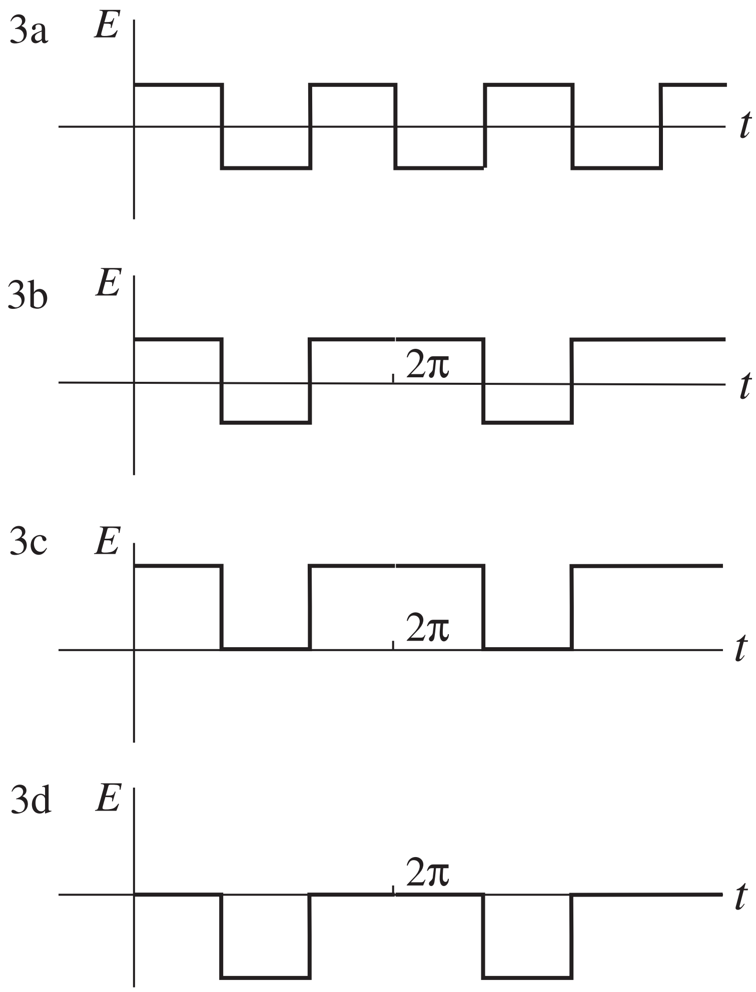

Figure 3: The case that the quantity of nodes is 3 in a circle is shown.

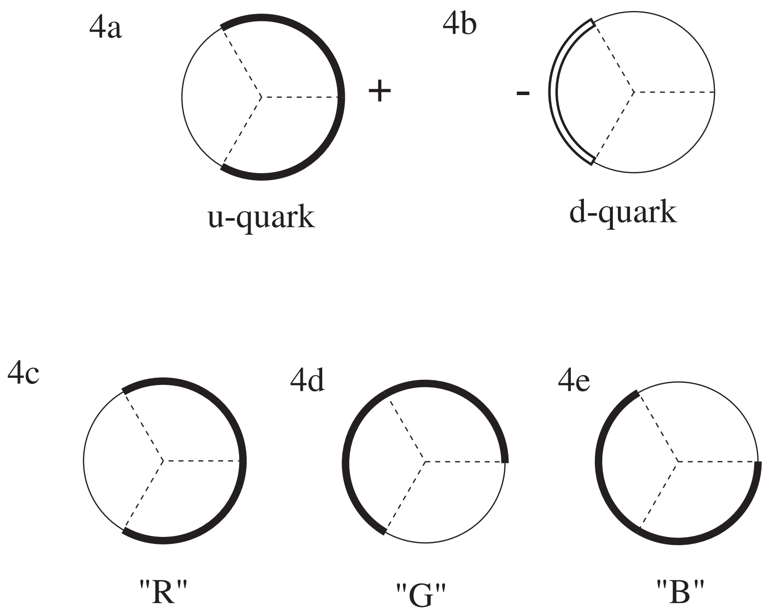

Figure 4: 4a and 4b: The plane figures of u-quark and d-quark are shown. 4c $\sim$ 4e: u-quarks with the color value "R", "G", and "B" respectively are shown.

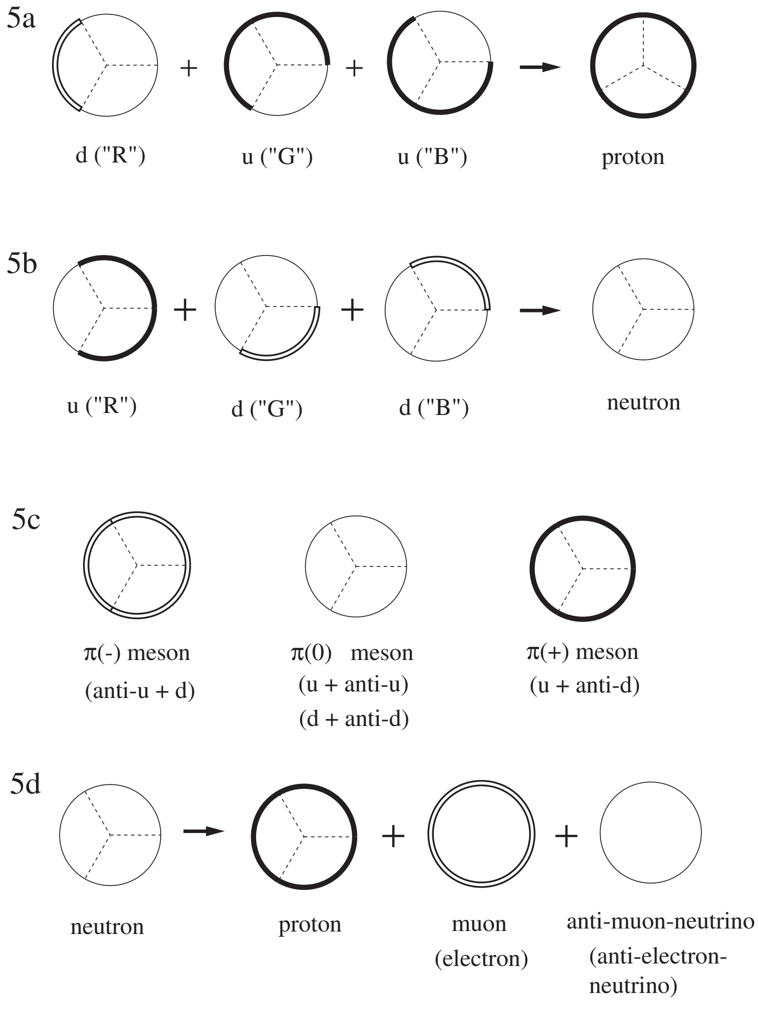

Figure 5: 5a and 5b: A set of three quarks fits proton or neutron. 5c: π mesons (π^-, π^0, and π^+ meson) are shown. 5d: β-decay of neutron is shown.

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