TMI-96-2
November 1996

Quarks, Leptons as Fermion-Boson Composite Objects and Flavor-Mixings by Substructure Dynamics

TAKEO MATSUSHIMA *

17-1 1-Chome Azura Ichinomiya,†
Aichi-Prefecture 491, Japan

Abstract

A fermion-boson-type composite model for quarks and leptons is proposed. Elementary fields are only one kind of spin-1/2 preon and spin-0 preon. Both of preons are in the global supersymmetric pair with the common electric charge of "$e/6$" and non-Abelian charges of (3,2,2) under the spontaneous unbroken local $SU(3)_C \otimes SU(2)_L \otimes SU(2)_R$ gauge symmetry induced necessarily by the concept of "Cartan connection" equipped with "Soldering Mechanism". Preons are composed into subquarks which are "intermediate clusters" towards quarks and leptons. They are constructed from subquarks holding massless property in confining $SU(2)_L \otimes SU(2)_R$ gauge symmetry owing to Wigner-Weyl realization. Both of left- and right-handed quarks and leptons are composite. The mechanism of making higher generations is obtained by adding the neutral scalar subquark($\mathbf{y}_{L,R}$) of a preon-antipreon pair carrying 3 of $SU(2)_{L,R}$ charge. Quark-flavor-mixings in charged left-handed weak currents occur with $\mathbf{y}_L$ to annihilate into two $SU(2)_L$ gluons. By this mechanism we predict $|V_{ts}| = 2.6 \times 10^{-2}, |V_{td}| = 1.4 \times 10^{-3}$ which are smaller by a factor than the values of them assuming three generations with unitarity.

*† Available mail address is as follows : Nagoya University Department of Physics Nagoya 464-01 Japan

1 Introduction

The discovery of the top-quark[1] has finally confirmed the existence of three quark-lepton symmetric generations. So far the standard $SU(2)_L \otimes U(1)$ model (denoted by **SM**) has successfully explained various experimental evidences. Nevertheless, as is well known, the **SM** is not regarded as the final theory because it has many arbitrary parameters, e.g. quark and lepton masses, quark-mixing parameters and weak mixing parameter, etc . Therefore it is meaningful to investigate the origins of these parameters and the relationship among them. In order to overcome such problems some attempts have done, e.g. grand unification(**GUT**), supersymmetry, composite model, etc. In the **GUT** scenario quarks and leptons are elementary fields in general. To the contrary in the composite scenario they are literally the composite objects constructed from the elementary fields (which we call "preon")[2]. If quarks and leptons are elementary, in order to solve the above problems it is necessary to introduce some external relationship or symmetries among them. On the other hand the composite models have ability to explain the origin of these parameters in terms of the substructure dynamics of quarks and leptons. Further, the composite scenario naturally leads the thought that the intermediate vector bosons of weak interactions($\mathbf{W}, \mathbf{Z}$) are not elementary gauge fields but composite objects constructed from preons(same as ρ -meson from quarks). Many studies based on such conceptoin have done after Bjorken's[3] and Hung and Sakurai's[4] suggestions of the alternative way to unified weak-electromagnetic gauge theory[5-11]. In this scheme the weak interactions are regarded as the effective residual interactions among preons. The fundamental fields for intermediate forces are massless gauge fields belonging to some gauge group and they confine preons into singlet states to build quarks and leptons and $\mathbf{W}, \mathbf{Z}$.

Recently **CDF** Collaboration at the Fermilab Tevatron Collider has released the data that the excess of the inclusive jet differential cross section in the jet transverse energy region of $200 \sim 400$ Gev in the $\overline{\mathbf{p}}\mathbf{p}$ collision experiments at $\sqrt{s} = 1.8$ Tev[12]. Although several arguments are going on concerning next-to-leading order **QCD** calculations[13], they suggest the possibility of the presence of quark substructre around 1.6 Tev[12]. In this article we consider a composite model for quarks and leptons and also quark-flavor-mixing phenomena in terms of the substructure dynamics. The conception of our model is that the fundamental interacting forces are all originated from massless gauge fields belonging to the adjoint representations of some gauge groups which have nothing to do with the spontaneous break down and that the elementary matter fields are only one kind of spin-1/2 preon and spin-0 preon carrying common "$e/6$" electric charge($e > 0$). Quarks, leptons and $\mathbf{W}, \mathbf{Z}$ are all composites of them and usual weak interactions are regarded as effective residual interactions. Based on this model we suggest that there exists a relationship between the quark mass spectrum and the quark-flavor-mixings at the level of the substructure dynamics.

2 Gauge theory inspiring quark-lepton composite scenario

In our model the existence of fundamental matter fields(preon) are inspired by the gauge theory with Cartan connections[14]. Let us briefly summarise the basic features of that. Generally gauge fields, including gravity, are considered as geometrical objects, that is, connection coefficients of principal fiber bundles. It is said that there exist some different points between Yang-Mills gauge theories and gravity, though both theories commonly possess fiber bundle structures. The latter has the fiber bundle related essentially to 4-dimensional space-time freedoms but the former is given, in an ad hoc way, the one with the internal space which has nothing to do with the space-time coordinates. In case of gravity it is usually considered that there exsist ten gauge fields, that is, six spin connection fields in $SO(1,3)$ gauge group and four vierbein fields in $GL(4,R)$ gauge group from which the metric tensor $\mathbf{g}^{\mu\nu}$ is constructed in a bilinear function of them. Both altogether belong to **Poincaré group** $ISO(1,3) = SO(1,3) \otimes R^4$ which is semi-direct product. In this scheme spin connection fields and vierbein fields are independent but only if there is no torsion, both come to have some relationship. Seeing this, $ISO(1,3)$ gauge group theory has the logical weak point not to answer how two kinds of gravity fields are related to each other intrisically.

In the theory of Defferential Geometry, S.Kobayashi has investigated the theory of "Cartan connection"[16]. This theory, in fact, has ability to reinforce the above weak point. The brief recapitulation is as follows. Let $E(B_n, F, G, P)$ be a fiber bundle (which we call Cartan-type bundle) associated with a principal fiber bundle $P(B_n, G)$ where B_n is a base manifold with dimension "n", G is a structure group. F is a fiber space which is homogeneous and diffeomorphic with G/G' where G' is a subgroup of G. Let $P' = P'(B_n, G')$ be a principal fiber bundle, then P' is a subbundle of P. Here let it be possible to decompose the Lie algebra $\mathbf{g}$ of G into the subalgebra $\mathbf{g}'$ of G' and a vector space f such as :

$$\mathbf{g} = \mathbf{g}' + \mathbf{f}, \qquad \mathbf{g}' \cap \mathbf{f} = 0, \tag{1}$$

$$[\mathbf{g}', \mathbf{g}'] \subset \mathbf{g}', \tag{2}$$

$$[\mathbf{g}', \mathbf{f}] \subset \mathbf{f}, \tag{3}$$

$$[\mathbf{f}, \mathbf{f}] \subset \mathbf{g}', \tag{4}$$

where $dim\mathbf{f} = dimF = dimG - dimG' = dimB_n = n$. The homogeneous space $F = G/G'$ is said to be "weakly reductive" if there exists a vector space f satisfying Eq.(1) and (3). Further F satisfying Eq(4) is called "symmetric space". Let ω denote the connection form of P and ϖ be the restriction of ω to P'. Then ϖ is a g-valued linear differential 1-form and we have :

$$\omega = g^{-1}\varpi g + g^{-1}dg, \tag{5}$$

where $g \in G$, $dg \in T_g(G)$. ω is called the form of "Cartan connection" in P.

Let the homogeneous space $F = G/G'$ be weakly reductive. The tangent space $T_O(F)$ at $o \in F$ is isomorphic with f and then $T_O(F)$ can be identified with f and also there exists a linear f-valued differential 1-form(denoted by θ) which we call the "form of soldering". Let ω' denote a g'-valued 1-form in P', we have :

$$\varpi = \omega' + \theta. \tag{6}$$

The dimension of vector space f and the dimension of base manifold B_n is the same "n", and then f can be identified with the tangent space of B_n at the same point in B_n and θs work as n-bein fields. In this case ω' and θ unifyingly belong to group G. Here let us call such a mechanism "Soldering Mechanism".

Drechsler has found out the useful aspects of this theory and investigated a gravitational gauge theory based on the concept of the Cartan-type bundle equipped with the Soldering Mechanism[17]. He considered $F = SO(1,4)/SO(1,3)$ model. Homogeneous space F with $dim = 4$ solders 4-dimensional real space-time. The Lie algebra of $SO(1,4)$ corresponds to g in Eq.(1), that of $SO(1,3)$ corresponds to g' and f is 4-dimensional vector space. The 6-dimensional spin connection fields are g'-valued objects and vierbein fields are f-valued, both of which are unified into the members of $SO(1,4)$ gauge group. We can make the metric tensor $\mathbf{g}^{\mu\nu}$ as a bilinear function of f-valued vierbein fields. Inheriting Drechsler's study the author has investigated the quantum theory of gravity[14]. The key point for this purpose is that F is a symmetric space because fs are satisfied with Eq.(4). Using this symmetric nature we can make a quantum gauge theory, that is, constructing $\mathbf{g}'$-valued Faddeev-Popov ghost, anti-ghost, gauge fixing, gaugeon and its pair field as composite fusion fields of $\mathbf{f}$-valued gauge fields by use of Eq.(4) and also naturally inducing **BRS**-invariance.

Comparing such a scheme of gravity, let us consider Yang-Mills gauge theories. Usually when we make the Lagrangian density $\mathbf{L} = tr(\mathbf{F} \wedge \mathbf{F}^*)$ ($\mathbf{F}$ is a field strength), we must borrow a metric tensor $\mathbf{g}^{\mu\nu}$ from gravity to get $\mathbf{F}^*$ and also for Yang-Mills gauge fields to propagate in the 4-dimensional real space-time. This seems to mean that "there is a hierarchy between gravity and other three gauge fields(electromagnetic, strong, and weak)". But is it really the case ? As an alternative thought we can think that all kinds of gauge fields are "equal". Then it would be natural for the question "What kind of equality is that ?" to arise. In other words, it is the question that "What is the maximum structure of the gauge mechanism which four kinds of forces are commonly equipped with ?". For answering this question, let us make a assumption : "*Gauge fields are Cartan connections equipped with Soldering Mechanism.*" In this meaning all gauge fields are equal. If it is the case three gauge fields except for gravity are also able to have their own metric tensors and to propagate in the real space-time without the help of gravity. Such a model has already investigated in ref.[14].

Let us discuss them briefly. It is found that there are four types of sets of classical groups with smaller dimensions which admit Eq.(1,2,3,4), that is, $F = SO(1,4)/SO(1,3)$, $SU(3)/U(2)$, $SL(2,C)/GL(1,C)$ and $SO(5)/SO(4)$ with $dimF = 4$[18]. Notice that the quality of "$dim\,4$" is very important because it guarantees F to solder to 4-dimensional real space-time and all gauge fields to work in it. The model of $F = SO(1,4)/SO(1,3)$ for gravity is already mentioned. Concerning other gauge fields, it seems to be appropriate to assign $F = SU(3)/U(2)$ to **QCD** gauge fields, $F = SL(2,C)/GL(1,C)$ to **QED** gauge fields and $F = SO(5)/SO(4)$ to weak interacting gauge fields. Some discussions concerned are following. In general, matter fields couple to $\mathbf{g}'$-valued gauge fields. As for **QCD**, matter fields couple to the gauge fields of $U(2)$ subgroup but $SU(3)$ contains, as is well known, three types of $SU(2)$ subgroups and then after all they couple to all members of $SU(3)$ gauge fields. In case of **QED**, $GL(1,C)$ is locally isomorphic with $C^1 \cong U(1) \otimes R$. Then usual Abelian gauge fields are assigned to $U(1)$ subgroup of $GL(1,C)$. Georgi and Glashow suggested that the reason why the electric charge is quantized comes from the fact that $U(1)$ electromagnetic gauge group is a unfactorized subgroup of $SU(5)$[19]. Our model is in the same situation because $GL(1, C)$ a unfactorized subgroup of $SL(2, C)$. For usual electromagnetic $U(1)$ gauge group, the electric charge unit "e"($e > 0$) is for *one generator* of $U(1)$ but in case of $SL(2, C)$ which has *six generators*, the minimal unit of electric charge shared per one generator must be "$e/6$". This suggests that quarks and leptons might have the substructure simply because e, $2e/3$, $e/3 > e/6$. Finally as for weak interactions we adopt $F = SO(5)/SO(4)$. It is well known that $SO(4)$ is locally isomorphic with $SU(2) \otimes SU(2)$. Therefore it is reasonable to think it the left-right symmetric gauge group : $SU(2)_L \otimes SU(2)_R$. As two $SU(2)$s are direct product, it is able to have coupling constants ($\mathbf{g}_L, \mathbf{g}_R$) independently. This is convenient to explain the fact of the disappearance of right-handed weak interactions in the low-energy region. Possibility of composite structure of quarks and leptons suggested by above $SL(2, C)$-QED would introduce the thought that the usual left-handed weak interactions are intermediated by massive composite vector bosons as ρ-meson in QCD and that they are residual interactions due to substructure dynamics of quarks and leptons. The elementary massless gauge fields relate essentially to the structure of the real space-time manifold as the connection fields but on the other hand the composite vector bosons have nothing to do with it. Considering these discussions, we shall set the assumption "*All kinds of gauge fields are elementary massless fields, belonging to spontaneous unbroken $SU(3)_C \otimes SU(2)_L \otimes SU(2)_R \otimes U(1)_{e.m}$ gauge group and quarks and leptons and* W,Z *are all composite objects.*"

3 Composite model

Our direct motivation towards compositeness of quarks and leptons is one of the results of the arguments in Sec.2, that is, e, $2e/3$, $e/3 > e/6$. However, other several phenomenological facts tempt us to consider a composite model, e.g. repetition of generations, quark-lepton parallelism of weak isospin doublet structure, quark-flavor-mixings, etc. Especially Bjorken[3]'s and Hung and Sakurai[4]'s suggestion of an alternative to unified weak-electromagnetic gauge theories have invoked many studies of composite models including composite weak bosons[5-11]. Our model is in the line of those studies. There are two ways to make composite models, that is, "Preons are all fermions." or "Preons are both fermions and bosons(denoted by **FB**-model)." The merit of the former is that it can avoid the probrem of a quadratically divergent self-mass of elementary scalar fields. However, even in the latter case such a disease is overcome if both fermions and bosons are the supersymmetric pairs, both of which carry the same quantum numbers except for the nature of Lorentz transformation(spin-1/2 or spin-0)[20]. Pati and Salam have suggested that the construction of a neutral composite object (neutrino in practice) needs both kinds of preons, fermionic as well as bosonic, if they carry the same charge for the Abelian gauge or belong to the same (fundamental) representation for the non-Abelian gauge[21]. This is a very attractive idea for constructing the minimal model. Further, from the representation theory of **Poincaré group** both integer and half-integer spin angular momentum occur equally for massless particles[22]. If nature chooses "fermionic monism", there must exist the additional special reason to select it. Then in this point also, the thought of **FB**-model is minimal. Based on such considerations we shall propose a **FB**-model : *"only one kind of spin-1/2 preon(denoted by Λ) and of spin-0 preon(denoted by Θ)"*(preliminary version of this model has appeared in ref.[14]). Both have the same electric charge of "$e/6$" (See Sec. 2)[23] and the same transformation properties of the fundamental representation(3, 2, 2) under the unbroken local gauge symmetry of $SU(3)_C \otimes SU(2)_L \otimes SU(2)_R$. Then Λ and Θ come into the supersymmetric pair which guarantees 'tHooft's naturalness condition[24]. The $SU(3)_C$, $SU(2)_L$ and $SU(2)_R$ gauge fields cause the confining forces with confining energy scales of $\Lambda_c << \Lambda_L < (or \cong) \Lambda_R$(Schrempp and Schrempp discussed elaborately in ref.[11]). Here we call positive-charged preons (Λ, Θ) "*matter*" and negative-charged preons ($\overline{\Lambda}$, $\overline{\Theta}$) "*antimatter*". Our final goal is to build quarks, leptons and **W**, **Z** from $\Lambda(\overline{\Lambda})$ and $\Theta(\overline{\Theta})$. Let us discuss that scenario next.

At the very early stage of the developement of the universe, the matter fields (Λ, Θ) and their antimatter fields ($\overline{\Lambda}$, $\overline{\Theta}$) must have broken out from the vaccum. After that they would have combined with each other as the universe was expanding. That would be the first step of the existence of composite matters. There are ten types of them :

spin1/2	*spin0*	*e.m.charge*	*Y.M.charge*
$\Lambda\Theta$	$\Lambda\Lambda$, $\Theta\Theta$	$e/3$	$(\overline{3},1,1)$ $(\overline{3},1,3)$ $(\overline{3},3,1)$, (7a)
$\Lambda\overline{\Theta}$, $\overline{\Lambda}\Theta$	$\Lambda\overline{\Lambda}$, $\Theta\overline{\Theta}$	0	$(1,1,1)$ $(1,3,1)$ $(1,1,3)$, (7b)
$\overline{\Lambda\Theta}$	$\overline{\Lambda\Lambda}$, $\overline{\Theta\Theta}$	$-e/3$	$(3,1,1)$ $(3,1,3)$ $(3,3,1)$. (7c)

In this step the confining forces are in kind in $SU(3) \otimes SU(2)_L \otimes SU(2)_R$ gauge symmetry but the $SU(2)_L \otimes SU(2)_R$ confining forces must be main because of the energy scale of $\Lambda_L, \Lambda_R >> \Lambda_c$ and then the color gauge coupling α_s and e.m. coupling constant α are negligible. As is well known, the coupling constant of $SU(2)$ confining force are characterized by $\varepsilon_i = \sum_a \sigma^a_\alpha \sigma^a_\beta$,where σs are 2×2 matrices of $SU(2)$.

$a = 1,2,3$, $\alpha, \beta = \Lambda, \overline{\Lambda}, \Theta, \overline{\Theta}$, $i = 0$ for singlet and $i = 3$ for triplet. They are calculated as $\varepsilon_0 = -3/4$ which causes the attractive force and and $\varepsilon_3 = 1/4$ causing the repulsive force. As concerns, $SU(3)_C$ octet and sextet states are repulsive but singlet, triplet and antitriplet states are attractive and then the formers are disregarded. Like this, two preons are confined into composite objects with more than one singlet state of any $SU(3)_C \otimes SU(2)_L \otimes SU(2)_R$. Notice that three preon systems cannot make the singlet states of $SU(2)$. Then we omit them. In Eq.(7,b), the $(1,1,1)$ state is the "most attractive channel". Therefore $(\Lambda\overline{\Theta})$,$(\overline{\Lambda}\Theta)$,$(\Lambda\overline{\Lambda})$ and $(\Theta\overline{\Theta})$ of $(1,1,1)$ states with neutral e.m.charge must have been most abundant in the universe. Further $(\overline{3},1,1)$ and $(3,1,1)$ states in Eq.(7,a,c) are next attractive. They presumably go into $\{(\Lambda\Theta)(\overline{\Lambda\Theta})\}, \{(\Lambda\Lambda)(\overline{\Lambda\Lambda})\}$, etc of $(1,1,1)$states with e.m. neutral charge. These objects may be the candidates for the "cold dark matters" if they have even tiny masses. It is presumable that the ratio of the quantities between the ordinary matters and the dark matters firstly depends on the color and hypercolor charges(maybe the ratio is more than $1/3 \times 3$). Finally the $(*,3,1)$ and $(*,1,3)$ ($*$ is $1,3,\overline{3}$)states are remained. They are also stable because $|\varepsilon_0| > |\varepsilon_3|$. They are, so to say, the "intermediate clusters" towards constructing ordinary matters, namely quarks, leptons and $\mathbf{W}, \mathbf{Z}$. Here we call such intermediate clusters "subquarks" and denote them as follows :

		Y.M.charge	spin	e.m.charge	
α	$= (\Lambda\Theta)$,	$\alpha_L : (\overline{3},3,1)$, $\alpha_R : (\overline{3},1,3)$	$1/2$	$e/3$,	(8a)
β	$= (\Lambda\overline{\Theta})$,	$\beta_L : (1,3,1)$, $\beta_R : (1,1,3)$	$1/2$	0,	(8b)
$\mathbf{x}$	$= (\Lambda\Lambda,\ \Theta\Theta)$,	$\mathbf{x}_L : (\overline{3},3,1)$, $\mathbf{x}_R : (\overline{3},1,3)$	0	$e/3$,	(8c)
$\mathbf{y}$	$= (\Lambda\overline{\Lambda},\ \Theta\overline{\Theta})$,	$\mathbf{y}_L : (1,3,1)$, $\mathbf{y}_R : (1,1,3)$	0	0,	(8d)

and there are also their antisubquarks[9].

Now we come to the step to build quarks and leptons. The gauge symmetry of the confining forces in this step is also $SU(2)_L \otimes SU(2)_R$ because the subquarks are in the triplet states of $SU(2)_{L,R}$ and then they are combined into singlet states by the decomposition of $3 \times 3 = 1 + 3 + 5$ in $SU(2)$. We make the first generation as follows :

		e.m.charge	Y.M.charge	
$<\mathbf{u}_i\|$	$= <\alpha_i\mathbf{x}_i\|$	$2e/3$	$(3,1,1)$,	(9a)
$<\mathbf{d}_i\|$	$= <\overline{\alpha}_i\overline{\mathbf{x}}_i\mathbf{x}_i\|$	$-e/3$	$(3,1,1)$,	(9b)
$<\nu_i\|$	$= <\alpha_i\overline{\mathbf{x}}_i\|$	0	$(1,1,1)$,	(9c)
$<\mathbf{e}_i\|$	$= <\overline{\alpha}_i\overline{\mathbf{x}}_i\overline{\mathbf{x}}_i\|$	$-e$	$(1,1,1)$,	(9d)

where $i = L, R$[5]. Here we notice that β and $\mathbf{y}$ do not appear. In practice $((\beta\mathbf{y}) : (1,1,1))$- particle is a candidate for neutrino. But as Bjorken has pointed out[3], non-vanishing charge radius of neutrino is necessary for obtaining the correct low-energy effective weak interaction Lagrangian[11]. Therefore β is assumed not to contribute to forming quarks and leptons. Presumably composite $(\beta\beta)$;$(\beta\overline{\beta})$;$(\overline{\beta}\overline{\beta})$-states may go into the dark matters. It is also noticeable that in this model the leptons have finite color charge radius and then $SU(3)$ gluons interact directly with the leptons at energies of the order of, or larger than Λ_L or Λ_R[20]. Concerning the confinements of preons and subquarks, the confining forces of two steps are in the same *unbroken* $SU(2)_L \otimes SU(2)_R$ local gauge symmetry. Here let us assume that subquarks in quarks are confined at the energy of 1.6 Tev(from **CDF**'s data[12]). We calculate $b_2 = 0.35$ which is the coefficient of $\alpha_W(Q^2)$(the running coupling constant of $SU(2)$ gauge field). This comes from that the number of confined fermionic subquarks are 4 ($\alpha_i, i = 1,2,3$ for color freedom ,β) and 4 for bosons($\mathbf{x}_i, \mathbf{y}$) contributing to the vacuum polarization (Refer Eq.(23,a,b) in Sec.(4)). Using $b_2 = 0.35$ we get $\alpha_W = 0.040$ at $Q=10^{19}$ Gev and extrapolating from this value we get the confining energy of preons (Λ,Θ) is 1.6×10^2 Tev, where we use $b_2 = 0.41$(by Eq.(23.b)) which is calculated with three kinds of Λ and Θ owing to three color freedoms. In sum, the radii of α,β,$\mathbf{x}$ and $\mathbf{y}$ are the inverse of 1.6×10^2 Tev and the radii of quarks are the inverse of 1.6 Tev. The radii of leptons is presumably less than those of quarks because leptons are the singlet states of $SU(3)_C$.

Next let us see the higher generations. Harari and Seiberg have stated that the orbital and radial excitations seem to have the wrong energy scale(order of $\Lambda_{L,R}$) and then the most likely type of excitations is the addition of preon-antipreon pairs[6,26]. Then using $\mathbf{y}_{L,R}$ in Eq.(8,d) we construct them as follows :

$$\begin{cases} <\mathrm{c}| = <\alpha\mathbf{x}\mathbf{y}| \\ <\mathrm{s}| = <\overline{\alpha}\overline{\mathbf{x}}\mathbf{x}\mathbf{y}|, \end{cases} \quad \begin{cases} <\nu_\mu| = <\alpha\overline{\mathbf{x}}\mathbf{y}| \\ <\mu\,| = <\overline{\alpha}\mathbf{x}\overline{\mathbf{x}}\mathbf{y}|, \end{cases} \quad \text{2nd generation (10a)}$$

$$\begin{cases} <\mathrm{t}| = <\alpha\mathbf{x}\mathbf{y}\mathbf{y}| \\ <\mathrm{b}| = <\overline{\alpha}\overline{\mathbf{x}}\mathbf{x}\mathbf{y}\mathbf{y}|, \end{cases} \quad \begin{cases} <\nu_\tau| = <\overline{\alpha}\overline{\mathbf{x}}\mathbf{y}\mathbf{y}| \\ <\tau\,| = <\alpha\mathbf{x}\overline{\mathbf{x}}\mathbf{y}\mathbf{y}|, \end{cases} \quad \text{3rd generation, (10b)}$$

where the suffix L, Rs are omitted for brevity. We can also make vector and scalar particles with (1,1,1) :

$$\begin{cases} <\mathrm{W}^-| = <\alpha^{\downarrow}\alpha^{\uparrow}\mathbf{x}| \\ <\mathrm{W}^-| = <\overline{\alpha}^{\downarrow}\overline{\alpha}^{\downarrow}\overline{\mathbf{x}}|, \end{cases} \quad \begin{cases} <\mathrm{Z}^0_1| = <\alpha^{\uparrow}\overline{\alpha}^{\uparrow} \\ <\mathrm{Z}^0_2| = <\alpha^{\uparrow}\overline{\alpha}^{\downarrow}\mathbf{x}\overline{\mathbf{x}}|, \end{cases} \quad \text{Vector (11a)}$$

$$\begin{cases} <\mathrm{S}^-| = <\alpha^{\uparrow}\alpha^{\downarrow}\mathbf{x}| \\ <\mathrm{S}^-| = <\overline{\alpha}^{\downarrow}\overline{\alpha}^{\downarrow}\mathbf{x}|, \end{cases} \quad \begin{cases} <\mathrm{S}^0_1| = <\alpha^{\uparrow}\overline{\alpha}^{\downarrow}| \\ <\mathrm{s}^0_2| = <\alpha^{\uparrow}\overline{\alpha}^{\downarrow}\mathbf{x}\overline{\mathbf{x}}|, \end{cases} \quad \text{Scalar, (11b)}$$

where the sufix L, Rs are omitted for brevity and $\uparrow, \downarrow$ indicate *spin up*, *spin down* states. They play the role of intermediate bosons same as π, ρ in the strong interactions. As Eq.(9) and Eq.(11) contain only α and $\mathbf{x}$ subquarks, we can draw the "*line diagram*"s of weak interactions as seen in Fig (1). Eq.(9,d) shows that the electron is constructed from antimatters only. We know, phenomenologically, that this universe is mainly made of protons, electrons, neutrinos, antineutrinos and unknown dark matters. It is said that protons and electrons in the universe are almost same in quantity. Our model show that one proton has the configuration of $(\mathbf{uud}) = (2\alpha, \overline{\alpha}, 3\mathbf{x}, \overline{\mathbf{x}})$: electron :$(\overline{\alpha}, 2\overline{\mathbf{x}})$; neutrino :$(\alpha, \overline{\mathbf{x}})$; antineutrino :$(\overline{\alpha}, \mathbf{x})$ and the dark matters are presumably constructed from the same amount of matters and antimatters bcause of their neutral charges. Therefore these facts may lead the thought that "the universe is the matter-antimatter-even object." And then there exists a conception-leap between "baryon-electron abundance" and "matter abundance" if our composte scenario is admitted(as for the possible way to realize the baryon-electron excess universe, see ref.[14]).

Our composite model contains two steps, namely the first is "subquarks made by preons" and the second is "quarks and leptons made by subquarks". Here let us discuss about the mass generation mechanism of quarks and leptons as composite objects. Our model has only one kind of fermion : Λ and boson : Θ. The first step of "subquarks made by preons" seems to have nothing to do with 'tHooft's anomaly matching condition[24] because there is no global symmetry with Λ and Θ. Therefore from this line of thought it is impossible to say anything about that α, β, $\mathbf{x}$ and $\mathbf{y}$ are massless or massive. However, if it is the case that the neutral (1,1,1)-states of preon-antipreon composites(as is stated above) become the dark matters, the masses of them presumably be less than the order of Mev from the phenomenological aspects of astrophysics. Then we may assume that these subquarks are massless or almost massless compared with $\Lambda_{L,R}$ in practice, that is, utmost a few Mev. In the second step, the arguments of 'tHooft's anomaly matching condition are meaningful. The confining of subquarks must occur at the energy scale of $\Lambda_{L,R} >> \Lambda_c$ and then it is natural that $\alpha_s, \alpha \rightarrow 0$ and that the local gauge symmetry group is spontaneous unbroken $SU(2)_L \otimes SU(2)_R$. Seeing Eq.(9), we find quarks and leptons are composed of the mixtures of subquarks and antisubquarks. Therefore it is proper to regard subquarks and antisubquarks as different kinds of particles. From Eq.(8,a,b) we find eight kinds of fermionic subquarks(3 for α,$\overline{\alpha}$ and 1 for β,$\overline{\beta}$). So the global symmetry concerned is $SU(8)_L \otimes SU(8)_R$. Then we arrange :

$$(\beta, \overline{\beta}, \alpha_i, \overline{\alpha}_i \quad i = 1, 2, 3\,)_{L,R} \qquad\qquad in \qquad (SU(8)_L \otimes SU(8)_R)_{global}, \tag{12}$$

where is are color freedoms. Next, the fermions in Eq.(12) are confined into the singlet states of the local $SU(2)_L \otimes SU(2)_R$ gauge symmetry and make up quarks and leptons as seen in Eq.(9)(eight fermions). Then we arrange :

$$(\nu_{\mathrm{e}}, \mathrm{e}, \mathrm{u}_i, \mathrm{d}_i \quad i = 1, 2, 3\,)_{L,R} \qquad\qquad in \qquad (SU(8)_L \otimes SU(8)_R)_{global}, \tag{13}$$

where is are color freedoms. From Eq.(12) and Eq.(13) the anomalies of the subquark level and the quark-lepton level are matched and then all composite quarks and leptons(in the 1st generation) are remained massless. Schrempp and Schrempp have discussed about a confining $SU(2)_L \otimes SU(2)_R$ gauge model with three fermionic preons and stated that it is possible that not only the left-handed quarks and leptons are composite but also the right-handed are so on the condition that Λ_R/Λ_L is at least of the order of 3[11]. If **CDF**'s data[12] truly indicates the compositeness of quarks, Λ_L is presumably around 1.6 Tev. As seen in Eq.(11.a) the existence of composite $\mathbf{W}_R$, Z_R is predicted. As concerning, the fact that they are not observed yet means that the masses of $\mathbf{W}_R$,Z_R are larger than those of $\mathbf{W}_L$, Z_L and that $\Lambda_R > \Lambda_L$. Owing to 'tHooft's anomaly matching condition the small mass nature of the 1st generation comparing to Λ_L is guarranteed but the evidence that the quark masses of the 2nd and the 3rd generations become larger as the generation numbers increase seems to have nothing to do with the anomaly matching mechanism in our model, because as seen in Eq.(10,a,b) these generations are obtained by just adding scalar **y**-particles. This is different from Abott and Farhi's model in which all fermions of three generations are equally embedded in $SU(12)$ global symmetry group and all members take part in the anomaly matching mechanism[8,27]. Concerning this, let us discuss a little about subquark dynamics inside quarks. According to "Uncertainty Principle" the radius of the composite particle is, in general, roughly inverse proportional to the kinetic energy of the constituent particles moving inside it. The radii of quarks may be around $1/\Lambda_{L,R}$. So the kinetic energies of subquarks may be more than hundreds Gev and then it is considerd that the masses of quarks essentially depend on the kinetic energies of subquarks and such a large binding energy as counterbalances them. As seen in Eq.(10,a,b) our model shows that the more the generation number increases the more the number of the constituent particles increases. So assuming that the radii of all quarks do not vary so much(because we have no experimental evidences yet).

the interaction length among subquarks inside quarks becomes shorter as generation numbers increase and accordingly the average kinetic energy per one subquark may increase. Therefore integrating out the details of subquark dynamics it coud be said that the essential feature of increasing masses of the 2nd and the 3rd generations is simply because their masses are described as a increasing function of the sum of the kinetic energes of constituent subquarks. From the Revew of Particles and Fields[30] we can phenomenologically parametrize the mass spectrum of quarks and leptons as follows :

$$
\begin{aligned}
M_{UQ} &= 1.2 \times 10^{-4} \times (10^{2.05})^n \quad \text{Gev} \quad \text{for } \mathbf{u}, \mathbf{c}, \mathbf{t}, && (14a)\\
M_{DQ} &= 3.0 \times 10^{-4} \times (10^{1.39})^n \quad \text{Gev} \quad \text{for } \mathbf{d}, \mathbf{s}, \mathbf{b}, && (14b)\\
M_{DL} &= 3.6 \times 10^{-4} \times (10^{1.23})^n \quad \text{Gev} \quad \text{for } \mathbf{e}, \mu, \tau, && (14c)
\end{aligned}
$$

where $n = 1, 2, 3$ are the generation numbers. They seem to be a geometricratio-like. The slopes of the up-quark sector and down-quark sector are different, so it seems that each has different aspects in subquark dynamics. From Eq.(14) we obtain $M_{\mathbf{u}} = 13.6$ Mev, $M_{\mathbf{d}} = 7.36$ Mev and $M_{\mathbf{e}} = 6.15$ Mev. These are a little unrealistic compared with the experiments[30]. But considering the above discussions about the anomaly matching conditions(Eq.(12,13)), it is natural that the masses of the members of the 1st generation are roughly equal to those of the subquarks, that is, a few Mev. The details of their mass values depend on the subquark dynamics owing to the effects of electromagnetic and color gauge interactions. These mechanism has studied by Weinberg[33] and Fritzsch[34].

One of the expermental evidences inspiring the **SM** is the "universality" of the coupling strength among the weak interactions. Of course if the intermediate bosons are gauge fields, they couple to the matter fields universally. But the inverse of this statement is not always true, namely the quantitative equality of the coupling strength of the interactions does not necessarily imply that the intermediate bosons are elementary gauge bosons. In practice the interactions of ρ and ω are regarded as indirect manifestations of **QCD**. In case of chiral $SU(2) \otimes SU(2)$ the pole dominance works very well and the predictions of current algebra and **PCAC** seem to be fulfilled within about 5%[20]. Fritzsch and Mandelbaum[9,20] and Kögerler, Schildknecht and Gounaris[28] have elaborately discussed about universality of weak interactions appearing as a consequence of current algebra and **W**-pole dominance of the weak spectral functions from the stand point of composite model. Extracting the essential points from their arguments we shall mention the followings .

In the first generation let the weak charged currents be written in terms of the subquark fields as :

$$\mathrm{J}^{+}_{\mu} = \overline{U} h_\mu D, \qquad\qquad \mathrm{J}^{-}_{\mu} = \overline{D} h_\mu U, \tag{15}$$

where $U = (\alpha\mathbf{x})$, $D = (\overline{\alpha}\mathbf{x}\mathbf{x})$ and $h_\mu = \gamma_\mu(1-\gamma_5)$. Further, let U and D belong to the doublet of the global weak isospin $SU(2)$ group and $\mathbf{W}^{+}$, $\mathbf{W}^{-}$, $1/\sqrt{2}(\mathrm{Z}^0_1 - \mathrm{Z}^0_2)$ be in the triplet and $1/\sqrt{2}(\mathrm{Z}^0_1 + \mathrm{Z}^0_2)$ be in the singlet of $SU(2)$. These descriptions seem to be natural if we refer the diagrams in Fig.(1). The universality of the weak interactions are inherited from the universal coupling strength of the algebra of the global weak isospin $SU(2)$ group with the assumption of W-, Z-pole dominance. The universality including the 2nd and the 3rd generations are investigated in the next section based on the above assumptions and in terms of the flavor-mixings.

4 Flavor-mixing by subquark dynamics

The quark-flavor-mixings in the weak interactions are expressed by Cabbibo-Kobayashi-Maskawa(CKM) matrix based on the SM. Its nine matrix elements(in case of three generations) are free parameters and this point is said to be one of the draw-back of the SM along with non-understanding of the origins of the quark-lepton mass spectrum and generations. In the SM, the quark fields(lepton fields also) are elementary and then we are able to investigate, at the utmost, the external relationship among them. On the other hand if quarks are the composites of substructure constituents. the quark-flavor-mixing phenomena must be understood by the substructure dynamics and the values of CKM matrix elements become materials for studying these . Terazawa and Akama have investigated quark-flavor-mixings in a three spinor subquark model with higher generations of radially excited state of the up(down) quark and stated that a quark-flavor-mixing matrix element is given by an overlapping integral of two radial wave functions of the subquarks which depends on the momentum transfer between quarks[29,33]. In our model the quark-flavor-mixings occur by creations or annihilations of "y"-particles inside quarks[15]. The "y"-particle is a neutral scalar subquark carrying 3 of hypercolor charge and then couples to two hypercolor gluons(See Fig.(2)). Here we shall propose the important assumption that *"(y → 2g$_h$)-process is approximately factorized from net W$^{\mp}$ exchange interactions"* (See Fig.(3)) and let us write the contribution of (y → 2g$_h$)-process to charged weak interactions as :

$$A_i = \alpha_W(Q_i^2)^2 \cdot B \qquad\qquad i = \text{s,c,b,t}, \tag{16}$$

where α_W is a running coupling constant of the hypercolor gauge theory, Q_i is the effective momentum of $\mathbf{g}_h$-exchange and B is a dimensionless "free" parameter originated from $< 0|\overline{\Lambda}\gamma_\mu\Lambda(and/or, \overline{\Theta}\partial_\mu\Theta)|\mathbf{y} > / < 0|\overline{\Lambda}\gamma_\mu\Lambda(and/or, \overline{\Theta}\partial_\mu\Theta)|0 >$, because it is from the unknown preon dynamics. The weak charged currents of quarks can be described as the matrix elements of subquark currents which are not weak eigenstates[29].

Using Eq.(10), (15) and (16) we have :

$$
\begin{aligned}
V_{ud}\bar{\mathrm{u}}h_\mu\mathrm{d} &= < \mathrm{u}|\overline{U}h_\mu D|\mathrm{d} >, && (17a)\\
V_{us}\bar{\mathrm{u}}h_\mu\mathrm{s} &= < \mathrm{u}|\overline{U}h_\mu(D\mathbf{y})|\mathrm{s} > \cong < \mathrm{u}|\overline{U}h_\mu D|\mathrm{s} > \cdot A_s, && (17b)\\
V_{ub}\bar{\mathrm{u}}h_\mu\mathrm{b} &= < \mathrm{u}|\overline{U}h_\mu(D\mathbf{yy})|\mathrm{b} > \cong < \mathrm{u}|\overline{U}h_\mu D|\mathrm{b} > \cdot 2A_b^2, && (17c)\\
V_{cd}\bar{\mathrm{c}}h_\mu\mathrm{d} &= < \mathrm{c}|(\overline{U}\mathbf{y})h_\mu(D\mathbf{yy})|\mathrm{d} > \cong < \mathrm{c}|(\overline{U}\mathbf{y})h_\mu(D\mathbf{y})|\mathrm{d} > \cdot A_c, && (17d)\\
V_{cs}\bar{\mathrm{c}}h_\mu\mathrm{s} &= < \mathrm{c}|(\overline{U}\mathbf{y})h_\mu(D\mathbf{y})|\mathrm{s} >, && (17e)\\
V_{cb}\bar{\mathrm{c}}h_\mu\mathrm{b} &= < \mathrm{c}|(\overline{U}\mathbf{y})h_\mu(D\mathbf{yy})|\mathrm{b} > \cong < \mathrm{c}|(\overline{U}\mathbf{y})h_\mu(D\mathbf{y})|\mathrm{b} > \cdot A_b, && (17f)\\
V_{td}\bar{\mathrm{t}}h_\mu\mathrm{d} &= < \mathrm{t}|(\overline{U}\mathbf{yy})h_\mu D|\mathrm{d} > \cong < \mathrm{t}|\overline{U}h_\mu D|\mathrm{d} > \cdot 2A_t^2, && (17g)\\
V_{ts}\bar{\mathrm{t}}h_\mu\mathrm{s} &= < \mathrm{t}|(\overline{U}\mathbf{yy})h_\mu(D\mathbf{y})|\mathrm{s} > \cong < \mathrm{t}|(\overline{U}\mathbf{y})h_\mu(D\mathbf{y})|\mathrm{s} > \cdot A_t, && (17h)\\
V_{tb}\bar{\mathrm{t}}h_\mu\mathrm{b} &= < \mathrm{t}|(\overline{U}\mathbf{yy})h_\mu(D\mathbf{yy})|\mathrm{b} >, && (17i)
\end{aligned}
$$

where V_{ij}s are **CKM**-matrices and {u, d, s, etc.} in the left sides of the equations are their weak eigenstates. Here we need some explanations. In transitions from the 3rd to the 1st generation in Eq.(17,c,g) there are two types of diagrams. One is that two ($\mathbf{y} \to 2\mathbf{g}_h$)-processes occur at the same time(Fig.(3,c)) and the other is that $\mathbf{y}$ annihilates into $2\mathbf{g}_h$ in a cascade way(Fig.(3,d)). Then we can describe as :

$$
\begin{aligned}
< \mathrm{u}|\overline{U}h_\mu(D\mathbf{yy})|\mathrm{b} > &\cong < \mathrm{u}|\overline{U}h_\mu D|\mathrm{b} > \cdot A_b^2 + < \mathrm{u}|\overline{U}h_\mu(D\mathbf{y})|\mathrm{b} > \cdot A_b \\
&\cong < \mathrm{u}|\overline{U}h_\mu D|\mathrm{b} > \cdot A_b^2 + < \mathrm{u}|\overline{U}h_\mu D|\mathrm{b} > \cdot A_b^2 \\
&= < \mathrm{u}|\overline{U}h_\mu D|\mathrm{b} > \cdot 2A_b^2, \qquad (18)
\end{aligned}
$$

which is in case of Eq.(17,c), and Eq.(17,g) is also same as this (here the phase-difference between the 1st and the 2nd term is disregarded for simplicity). If we admit the assumption of factorizability of ($\mathbf{y} \to 2\mathbf{g}_h$)-process, it is natural that the universality of the net weak interactions among three generations are realized. The net weak interactions are essentially same as (u $\to$ d)-transitions in Fig.(1). Then we shall assume :

$$
< \mathrm{u}|\overline{U}h_\mu D|\mathrm{d} > \;\cong\; < \mathrm{u}|\overline{U}h_\mu D|\mathrm{s} > \cong < \mathrm{u}|\overline{U}h_\mu D|\mathrm{b} >,
$$

$$
\begin{aligned}
&\cong\ <\mathrm{c}|\overline{U}h_\mu D|\mathrm{d}>\cong<\mathrm{t}|\overline{U}h_\mu D|\mathrm{d}>, && (19a)\\
&\cong\ <\mathrm{c}|(\overline{U}\mathrm{y})h_\mu(D\mathrm{y})|\mathrm{s}>\cong<\mathrm{c}|(\overline{U}\mathrm{y})h_\mu(D\mathrm{y})|\mathrm{b}>, &&\\
&\cong\ <\mathrm{t}|(\overline{U}\mathrm{y})h_\mu(D\mathrm{y})|\mathrm{s}>, && (19b)\\
&\cong\ <\mathrm{t}|(\overline{U}\mathrm{yy})h_\mu(D\mathrm{yy})|\mathrm{b}>. && (19c)
\end{aligned}
$$

In Eq.(19,b,c) **y**-particles are the spectators for the weak interactions(See Fig.(3,b,e)). Further, concerning the weak eigenstates we can assume :

$$\overline{\mathrm{u}}h_\mu\mathrm{d}=\overline{\mathrm{u}}h_\mu\mathrm{s}=\overline{\mathrm{u}}h_\mu\mathrm{b}=\overline{\mathrm{c}}h_\mu\mathrm{d}=\cdots. \qquad (20)$$

Using Eq.(16),(19,a) and (20) we find :

$$|V_{us}|/|V_{ud}|=|A_s|=\alpha_W(Q_s^2)^2\cdot|B|. \qquad (21)$$

Similarly we have :

$$
\begin{aligned}
|V_{cd}|/|V_{ud}| &= |A_c|=\alpha_W(Q_c^2)^2\cdot|B|, && (22a)\\
|V_{cb}|/|V_{cs}| &= |A_b|=\alpha_W(Q_b^2)^2\cdot|B|, && (22b)\\
|V_{ts}|/|V_{cs}| &= |A_t|=\alpha_W(Q_t^2)^2\cdot|B|, && (22c)\\
|V_{ub}|/|V_{ud}| &= 2|A_b|^2=2\{\alpha_W(Q_b^2)^2\cdot|B|\}^2, && (22d)\\
|V_{td}|/|V_{ud}| &= 2|A_t|^2=2\{\alpha_W(Q_t^2\}^2\cdot|B|\}^2. && (22e)
\end{aligned}
$$

Concerning $\alpha_W(Q^2)$ we know the following equation :

$$
\begin{aligned}
1/\alpha_W(Q_1^2) &= 1/\alpha_W(Q_2^2)+b_2ln(Q_1/Q_2)^2, && (23a)\\
b_2 &= 1/(4\pi)\{22/3-(2/3)\cdot N_f-(1/12)\cdot N_s\}, && (23b)
\end{aligned}
$$

where N_f and N_s are the numbers of fermions and scalars contributing to the vacuum polarizations. The Eq.(23,a) is rewritten as :

$$\alpha_W(Q_1^2)=\{1-\alpha_W(Q_1^2)/\alpha_W(Q_2^2)\}/\{b_2ln(Q_1/Q_2)^2\}. \qquad (24)$$

Here let us investigate the substructue dynamics inside quarks referring the above equations. In our composite model quarks are composed of α,**x**,**y**. Concretely from Eq.(10) c-quark is composed of three subquarks; t-quark : four subquarks; s-quarks : four subquarks; b-quark : five subquarks. From the discussions in Sec.(3), let the quark mass be proportional to the sum of the average kinetic energies of the subquarks(denoted by $<T_i>$, $i=\mathrm{s,c,b,t}$). The proportional constants may be assumed common in the up(down)-quark sector and different between the up- and the down-quark sector referring the discussions in Sec.(3). Then we denote them by K_s ($s = up, down$). The $< T_i >$ may be assumed to be inverse proportional to the average interaction length among subquarks (denoted by $< r_i >$). Further, it is presumable that Q_i (the effective momentum of $\mathbf{g}_h$-exchange in Eq.(16)) is inverse proportional to $< r_i >$.

Then we have :

$$
\begin{aligned}
M_b/M_s &= 5K_{down} < T_b > /(4K_{down} < T_s >) = (5/4) \cdot (< r_s > / < r_b >) \\
&= (5/4) \cdot (Q_b/Q_s), \qquad (25a) \\
M_t/M_c &= 4K_{up} < T_t > /(3K_{up} < T_c >) = (4/3) \cdot (< r_c > / < r_t >) \\
&= (4/3) \cdot (Q_t/Q_c), \qquad (25b)
\end{aligned}
$$

where M_is are the masses of i-quarks. In the Revew of Particle Physics[30] we find : $M_b/M_s = 30 \pm 15$ and $M_t/M_c = 135 \pm 35$, using which we get by Eq.(25) :

$$
\begin{aligned}
Q_b/Q_s &\cong 24.0, \qquad (26a) \\
Q_t/Q_c &\cong 101.0. \qquad (26b)
\end{aligned}
$$

Notice again that it seems to be meaningless to estimate Q_s/Q_t or Q_c/Q_b because the up-quark sector and the down-quark sector possibly have the different aspects of substructre dynamics.

The absolute values of **CKM**-matrix elements: $|V_{ij}|$s are "experimentally" confirmed[30] as :

$$
\begin{aligned}
|V_{ud}| &= 0.9736 \pm 0.0010, \qquad |V_{us}| = 0.2205 \pm 0.0018 \\
|V_{cd}| &= 0.224 \pm 0.016, \qquad |V_{cb}| = 0.041 \pm 0.003, \qquad (27) \\
|V_{cs}| &= 1.01 \pm 0.18 \qquad |V_{ub}|/|V_{cb}| = 0.08 \pm 0.02.
\end{aligned}
$$

Relating these data to the scheme of our composite model, we shall investigate the quark-flavor- mixing phenomena in terms of the substructure dynamics. Using Eq.(21), (22,b) and $|V_{us}|$, $|V_{cb}|$ in Eq.(27) we get :

$$\alpha_W(Q_s^2)/\alpha_W(Q_b^2) = 2.32, \qquad (28)$$

where we assume $|V_{ud}| = |V_{cs}|$. Applying $N_f = N_s = 4$(as is stated in Sec.(3)) to Eq.(23,b) we have :

$$b_2 = 0.345. \qquad (29)$$

Inserting the values of Eq.(26,a), (28) and (29) into Eq.(24) we have :

$$\alpha_W(Q_s^2) = 0.602, \tag{30}$$

where Q_s,(Q_b) corresponds to Q_1,(Q_2) in Eq.(24). Combining $|V_{us}|$, $|V_{ud}|$ in Eq.(27) and Eq.(30) with Eq.(21) we obtain :

$$|B| = 0.629, \tag{31}$$

and using Eq.(30) to Eq.(28) we get :

$$\alpha_W(Q_b^2) = 0.259. \tag{32}$$

By use of $|V_{cd}|$ in Eq.(27) and Eq.(31) to Eq.(22,a) we have :

$$\alpha_W(Q_c^2) = 0.605. \tag{33}$$

Using Eq.(23,a) with Eq.(26,b), (29) and (33) we obtain :

$$\alpha_t(Q_t^2) = 0.207. \tag{34}$$

Inserting Eq.(31), (32) to the right side of Eq.(22,d) we have $|V_{ub}| = 0.00345$. Comparing this with the experimental value of $|V_{ub}| = 0.003 \pm 0.001$(obtained from the values of $|V_{cb}|$ and $|V_{ub}|/|V_{cb}|$ in Eq.(27)), the consistency between the prediction and the experiment seems good .

Finally using Eq.(31), (34) to Eq.(22,c,e) we predict :

$$|V_{ts}| = 2.62 \times 10^{-2}, \qquad |V_{td}| = 1.40 \times 10^{-3}, \tag{35}$$

where we use $|V_{ud}| = 0.9736$, $|V_{cs}| = 0.9743$[30]. Comparing them to $|V_{ts}| = 0.040 \pm 0.006$ and $|V_{td}| = 0.009 \pm 0.005$[30] obtained by assuming the three generations with unitarity, we find that the formers are smaller by a factor than the latters. We wish the direct measurements of $(t \to d, s)$ transitions in leptonic and/or semileptonic decays of top-quark mesons .

5 Summary and Discussion

The motivation of our composite model is inspired by the studies about the gauge mechanisms by which four interacting forces are commonly controlled. Namely, all gauge fields are Cartan connections equipped with "Soldering Mechanism". In case of the electromagnetic gauge field, its gauge symmetry group G(including the habitual $U(1)$ gauge symmetry) is $SL(2,C)$ with six generators, which leads that the minimal electric charge is $|e/6|$. The fact that the charges of u- and d- quark and electron($|2e/3|$, $|-e/3|$, $|e|$) are larger than $|e/6|$ naturally induce the concept of compositeness of quarks and leptons. Following Pati and Salam's investigation we choose the **FB**-model(preons are both fermionic and bosonic). Further, learning Hung and Sakurai's and Bjorken's thought of the alternative to spontaneous broken unified gauge theories we adopt the idea that the weak interactions at low energies are remnants of the spontaneous unbroken confining forces governing the substructure dynamics of quarks and leptons. **W**- and **Z**-bosons are also composites of the preons. As the fundamental confining gauge symmetry we choose $SU(2)_L \otimes SU(2)_R$ gauge symmetry, which is not the ad hoc assumption but induced from the concept of Cartan connection, that is, $SU(2) \otimes SU(2)$ is locally isomorphic to $SO(4)$ which takes part in constructing the homogeneous space : $F = SO(5)/SO(4)$. The preons as the elementary matter fields are only one kind of fermion(Λ) and scalar (Θ), both of which have same Y.M charges $(3,2,2)$ of $SU(3)_C \otimes SU(2)_L \otimes SU(2)_R$ and the electric charge "$e/6$". Following Harari and Seiberg's idea the higher generations are constructed by adding scalar **y**-particles without introducing any more freedoms and just this mechanism explains the flavor-mixing phenomena. Namely, the annihilations of **y**-particles into two hypercolor gluons occur coincidentally with the composite **W**- boson exchange.

Here let us discuss some points. In the stage of this article, the unification of gauge fields are not considered. In fact the insouciant extrapolations of the running coupling constants to the energy of 10^{19} Gev show that $\alpha_W = 0.040$ and $\alpha_s = 0.017$(normalized $\alpha_s = 0.12$ at 10^2 Gev) and then they have no crossing point. But it seems to be dangerous to require the matching of them as the GUT scenario does in which quarks and leptons are the elementary fields, because if we take a stand point of the composite model we have too few informations in the energy range of 10^2 Gev to 10^{19} Gev to understand the dynamics of that energy range. If we pursue the unification of the gauge symmetries, such gauge group must contain $SO(1,4)$, $SU(3)$, $SL(2,C)$, and $SO(5)$. The subquark "**y**"s which are responsible for constructing the higher generations carries the hypercolorcharge and then ($b \rightarrow s\gamma$)-process cannot occur in the subquark level. The ($\mu \rightarrow e\gamma$)-process also cannot. As for the leptonic flavor-mixings, they are not essentially inhibited but it may be presumable that the leptonic size is so small that ($\mathbf{y} \rightarrow 2\mathbf{g}_h$)-process coud hardly occur because the effective α_W is very small. In our model the existence of the 4th generation is, in kind, not inhibited because the generation-making mechanism is just to add "**y**"-subquarks. In fact, if the experimental evidence of 1-($|V_{ud}|^2 + |V_{us}|^2 + |V_{ub}|^2$)=0.0017 $\pm$ 0.0015 at the 1σ level is taken seriously[31], the possibility of the 4th generation is not to be said nothing[32]. But whether the 4th generation really exists or not may depend on the details of the substructue dynamics, that is, the possibility of the existence of the dynamical stable states with the addition of three "**y**"-subquarks : nanmely, whether the sum of the kinetic energies of the constituent subquarks may balance to the binding energy to form the stable states, or not. If the non-existence of the 4th generation is finally confirmed, that fact will offer one of the clue to solve the substructure dynamics. Referring Eq.(14), it predicts $M_{b'} \cong 110$ Gev and $M_{\tau'} \cong 30$ Gev for $n = 4$.

Acknowledgements

We would like to thank to A.Takamura and N.Maru for the usefull discussions and also thank to the hospitality at the laboratory of the elementary particle physics in Nagoya University.

References

[1] F.Abe, et.al. Phys. Rev. **D50**(1994)2966; F.Abe, et.al. Phys. Rev. Lett. **73**(1994) 225.

[2] A comprehensive lists of related works can be found in L. Lyons, Prog. in Partic. & Nucl. Phys. **10**(1984) 227.

[3] J.D.Bjorken, Phys. Rev. **D19**(1979)335.

[4] P.Q.Hung and J.J.Sakurai, Nucl. Phys. **B143**(1978)81; J.J.Sakurai MPI-PAE /PTh44/82. July 1982.

[5] W.Krőlikowski, Act. Phys. Pol. **B11**(1980)431. Subquark configurations in Eq.(9) are essentially the same as his model which contains one fermion and one boson with the same charge $e/3$.

[6] E.G.H.Harari and N.Seiberg, Phys. Lett. **98B**(1981)269.

[7] D.W.Greenberg and J.Sucher, Phys. Lett. **99B**(1981)239.

[8] L. Abbot and E.Farhi, Phys. Lett. **101B**(1981)69.

[9] H.Fritzsch and G.Mandelbaum, **102B**(1981)319; ibid,**109**(1982)224. The notations of α, β,**x**,**y** are inherited from theirs because ours is,in the subquark level, similar to theirs with two fermions and two bosons.

[10] G.Gounaris, R.Kögerler and D.Schildknecht, Phys. Lett. **133B**(1983)118.

[11] B.Schrempp and F.Schrempp, Nucl. Phys. **231**(1984)109.

[12] F.Abe, et al., Phys. Rev. Lett.**77**(1996)438.

[13] J.Huston et al., Phys. Rev. Lett. **77**(1996)444; E.W.N.Glover et al., DTP/96/22, RAL-TR-96-019(1996).

[14] T.Matsushima, DPNU-89-31,unpublished; ibid, Nuovo Cim.**106A**(1993)139.

[15] A preliminary version of this idea is presented in T.Matsushima, TMI-96-1 March(1996), unpublished.

[16] S.Kobayashi, Can. J. Math. **8**(1956)145; Ann.di Math, **43**(1957)119.

[17] W.Drechsler, J, Math. Phys. **18**(1977)1358; Lecture Notes in Physics, 67,edited by J.Ehles ,et.al. (Springer Verlarg).

[18] R.Gilmore, Lie Groups, Lie Algebras, and Some of Their Applications(Jhon Wiley & Sons) 1974 p50.

[19] H.Geogi and S.L.Glashow, Phys. Rev. Lett. **32**(1974)438.

[20] H.Fritzsch, Lectures given at the International School on Subnuclear Physics, Erice, Sicily August(1984),MPI-PAE/PTh 85/84 November(1984).

[21] J.C.Pati and A.Salam, Nucl. Phys. **B214**(1983)109.

[22] Y.Ohnuki, Unitary Representation of the Poincaré Group and Relativistic Wave Equations(World Scientific, Singapore, 1988).

[23] Z.Maki, Proc. of 1981 INS Symposium on Quark and Lepton Physics, edited. by K.Fujikawa et al. p325. Notations of Λ and Θ are inherited from his model because he proposed FB-model with the universal eleciric charge $e/6$.

[24] G.'tHooft, Recent Developements in Gauge Theories, edited by G.'tHooft, et al.(Plenum Press, N.Y.,1980) p135.

[25] M.Peskin, Proc. of the 1981 Int. Symp. on Lepton and Photon Interactions at High Energy, W.Pfeil et al. (Bonn, 1981) p880.

[26] H.Harari and Seiberg Nucl.Phys. **B204**(1982)141.

[27] L.F.Abbot and E.Farhi, Nucl. Phys. **B189**(1981)547.

[28] G.Gounaris, R.Kögerler and D.Schldknecht, Phys. Lett. **133B**(1983)118; D.Schild-knecht, Electro weak Effects at High Energies edited by H.B.Newman (Plenum Pub. Comp. 1985).

[29] H.Terazawa and K.Akama, Phys. Lett. **101B**(1981)190; H.Terasawa, Mod. Phys. Lett. **A36**(1992)3373.

[30] Particle and Fields, Phys. Rev. **D54**(1996)1.

[31] I.S.Towner, PHys. Lett. **B333**(1994)13; A.Sirlin, New York Univ. New York. Rep. No. hep-ph/9504385 , unpublished.

[32] H.Terazawa, INS-Rep. 1131 Jan. 1996.

[33] S.Weinberg, Phys. Lett. **102B**(1981)401.

[34] H.Fritzsch, Lectures in Proc. Arctic School of Physics, Äkäslompolo. Finland (1982).

Figure Caption

Fig.(1) Subquark line-diagrams of the weak interactions.

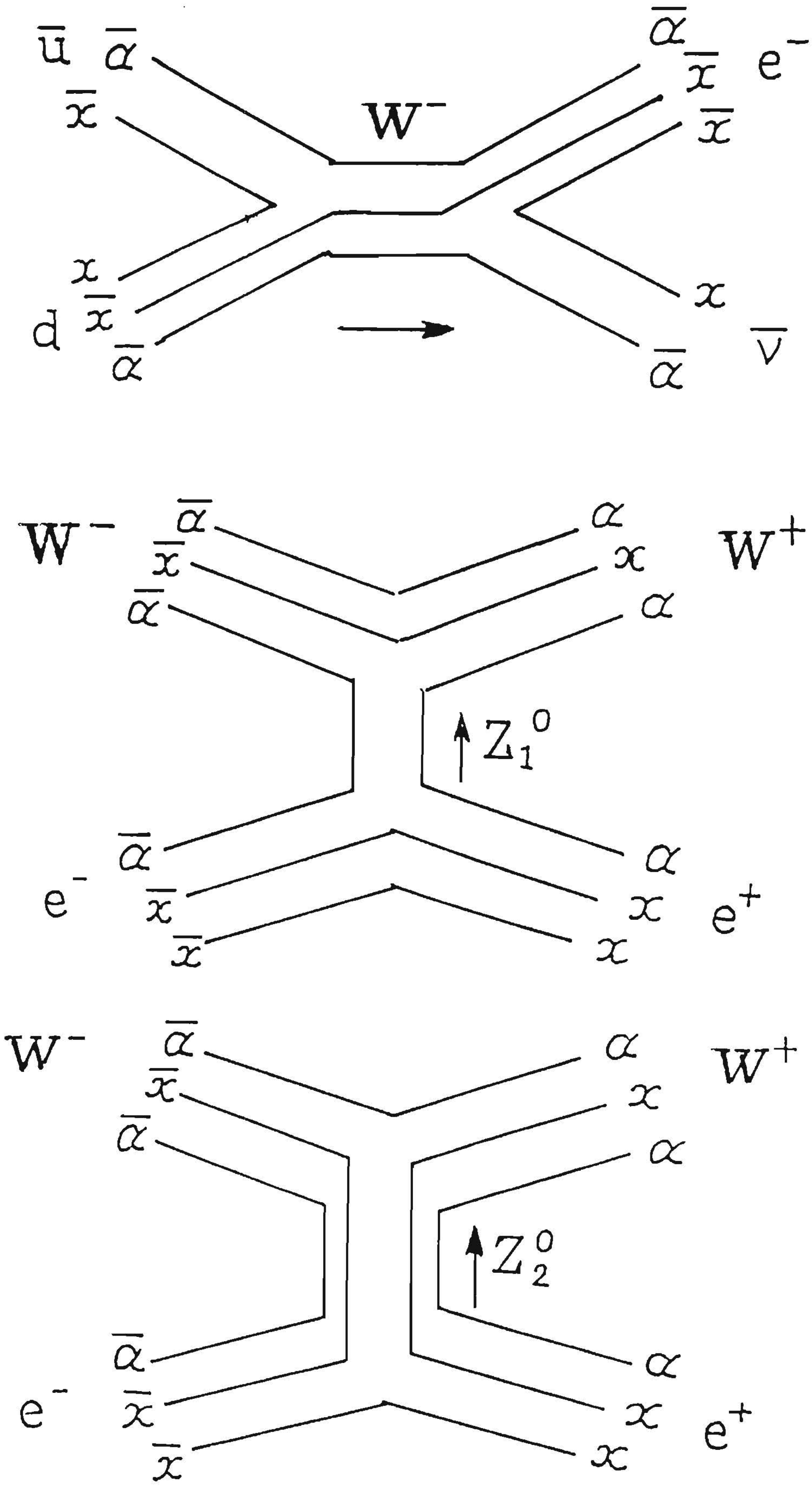
Fig.(2) ($\mathbf{y} \rightarrow 2\mathbf{g}_h$)-process, $\mathbf{g}_h$ is a $\mathbf{SU(2)}$ triplet gluon.

Fig.(3) Schematic pictures of the charged weak interactions.

(a),(b),(c) and (d) are flavor-mixing interactions.

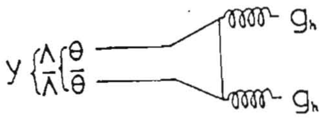
(e) is a flavor-non-mixing interactions .

Fig1



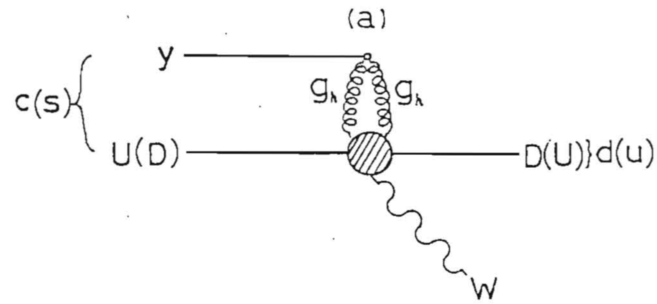
ū ᾱ
x̄
W⁻
ᾱ
x̄ e⁻
x̄
x
d x̄
ᾱ
x
ν̄
ᾱ
W⁻ ᾱ
x̄
ᾱ
α
x W⁺
α
Z₁⁰
ᾱ
e⁻ x̄
x̄
α
x e⁺
x
W⁻ ᾱ
x̄
ᾱ
α W⁺
x
α
Z₂⁰
ᾱ
e⁻ x̄
x̄
α
x e⁺
x

Fig 2

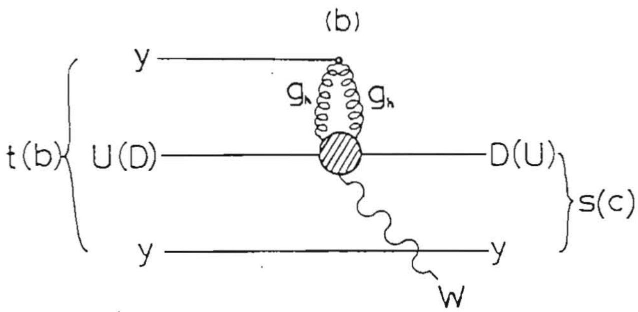


y
θ
θ̄
g_h
g_h

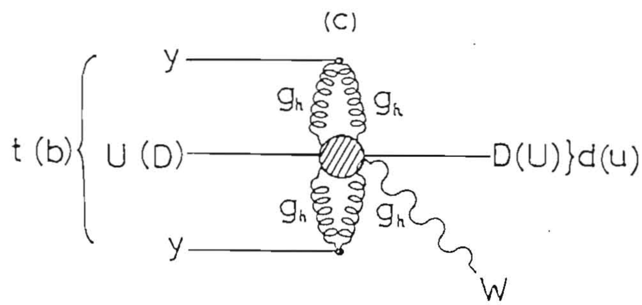
Fig 3



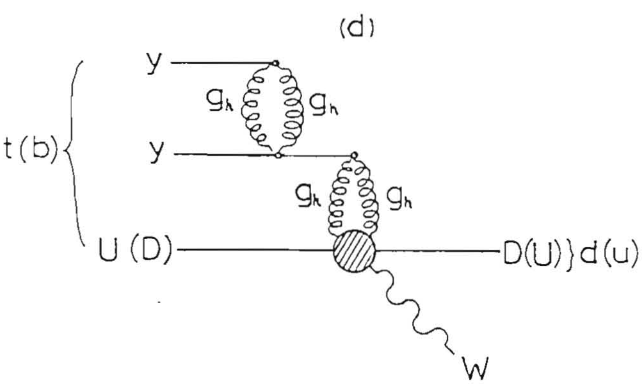
(a)
y
c(s)
U(D)
g_h g_h
D(U)}d(u)
W



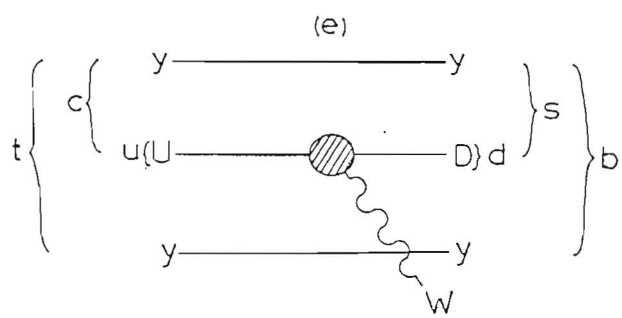
(b)
y
t(b)
U(D)
g_h g_h
D(U)
s(c)
y
y
W



(c)
y
t (b)
U (D)
g_h g_h
D(U)}d(u)
g_h g_h
y
W



(d)
y
t(b)
g_h g_h
y
g_h g_h
U (D)
D(U)}d(u)
W



(e)
y
y
t
c
u(U
D}d
s
b
y
y
W