9

FPRINT-99-07

SUPERON-GRAVITON MODEL FOR SPACETIME AND MATTER

FERMILAB
DEC 2 – 1998
LIBRARY

Kazunari SHIMA

Laboratory of Physics, Saitama Institute of Technology
Okabe-machi, Saitama 369-0293, Japan

October 1998

Fermilab Library
0 1160 0018017 2

Abstract

A unified description of spacetime and matter is proposed by using a single irreducible representation of N=10 extended Super-Poincaré algebra, where all elementary particles except the graviton are the composites of more fundamental objects with spin 1/2, *superons*. The electroweak standard model(SM) and SU(5)(SO(10)) grand unified model(GUTs) are investigated systematically by using the superon diagrams. The stability of the proton, the suppression of the flavour changing neutral currents(FCNC), $K^0 - \overline{K}^0$ mixing, CP-violation, the atmospheric ν_μ deficit and the charmless nonleptonic B decay are understood naturally in the superon pictures of GUTs. The fundamental action of the superon-graviton model(SGM) for spacetime and matter is proposed.

NAME | I.D. No.
RETURN TO FERMILAB LIBRARY

The (local) supersymmetry (SUSY)[1] is the most promising notion for explaining the rationale of beings of all elementary particles including the graviton. However, as shown by Gell-Mann[2], SO(8) maximally extended supergravity theory (SUGRA) is too small to accommodate all observed particles as elementary fields within the framework of the local field theory. On the contrary, at the risk of the local field theory at the moment, it is interesting from the viewpoints of simplicity and beauty of nature to attempt the accomodation of all observed elementary particles in a single irreducible representation of a certain group(algebra). In Ref.[3], by the group theoretical arguments we have shown that among SO(N) extended super-Poincaré algebra(SPA), the massless irreducible representations of SO(10) SPA is the only one that is relevant for the unification of spacetime and matter.
In this article, after the quick summary of ref.[3][4] for the selfcontained arguments we study N=10 SPA further from the viewpoints of the internal structure of the quarks, leptons and gauge bosons except the graviton.
By noting that 10 generators Q^N of SO(10) SPA are the fundamental represemtations of SO(10) internal symmetry and that $SO(10) \supset SU(5) \supset SU(3) \times SU(2) \times U(1)$ we have decomposed 10 generators Q^N of SO(10) SPA as follows with respect to SO(10) internal symmetry

$$\begin{aligned} \underline{10} &= \underline{5}(Q^N; N=1,2,..5) + \underline{5}^*(Q^N; N=6,7,..10) \\ &= \{(\underline{3},\underline{1}; -\frac{1}{3}, -\frac{1}{3}, -\frac{1}{3}) + (\underline{1},\underline{2}; 1, 0)\} + \{(\underline{3}^*,\underline{1}; \frac{1}{3}, \frac{1}{3}, \frac{1}{3}) + (\underline{1},\underline{2}^*; -1, 0)\}, \quad (1) \end{aligned}$$

where we have written (SU(3), SU(2); electric charges). To obtain a smaller single irreducible representation we have studied the massless representation. For massless case the little algebra for the supercharges in the light-like frame $P_\mu = \epsilon(1,0,0,1)$ becomes after a suitable rescaling

$$\{Q^M_\alpha, Q^N_\beta\} = \{\bar{Q}^M_{\dot\alpha}, \bar{Q}^N_{\dot\beta}\} = 0, \quad \{Q^M_\alpha, \bar{Q}^N_{\dot\beta}\} = \delta_{\alpha 1}\delta_{\dot\beta 1}\delta^{MN}, \qquad (2)$$

where $\alpha, \beta = 1,2$ and $M, N = 1,2,...10$. Note that the spinor charges Q^M_1, $\bar{Q}^M_{\dot 1}$ satisfy the algebra of annihilation and creation operators respectively and can be used to construct a 4-dimensional supersymmetric Fock space with positive metric. We identify the graviton with the Clifford vacuum $\mid \Omega(\lambda)\rangle$ (SO(10) singlet but not necessarily the lowest energy state) satisfying $Q^M_\alpha \mid \Omega(\lambda)\rangle = 0$, which produces automatically the adjoint representation with helicity ± 1. We obtain $2 \cdot 2^{10}$ dimensional irreducible representation of the little algebra (2) of SO(10) SPA as follows: $\Big[\underline{1}(+2), \underline{10}(+\frac{3}{2}), \underline{45}(+1), \underline{120}(+\frac{1}{2}), \underline{210}(0), \underline{252}(-\frac{1}{2}), \underline{210}(-1), \underline{120}(-\frac{3}{2}), \underline{45}(-2),$ $\underline{10}(-\frac{5}{2}), 1), \underline{1}(-3)\Big] + \Big[\text{CPT-conjugate}\Big]$, where $\underline{d}(\lambda)$ represent SO(10) dimension $\underline{d}$ and the helicity λ. By noting that the helicities of these states are automatically determined by SO(10) SPA and that Q^M_1 and $\bar{Q}^M_{\dot 1}$ satisfy the algebra of the annihilation and the creation operators for the spin $\frac{1}{2}$ particle, we speculate boldly

that these states spanned upon the mathematical(not the physical true vacuum with the lowest energy) Clifford vacuum $\mid \Omega(\pm 2)\rangle$ are the *relativistic(gravitational)* massless composite states made of the fundamental object Q^N *superon* with spin $\frac{1}{2}$. Therefore we regard (1) as *a superon-quintet* and *an antisuperon-quintet*. The unfamiliar identification of the generators of SO(10) SPA with the fundamental objects(particles) is discussed later. Now we envisage the Planck scale physics as follows: At(above) the Planck energy scale spacetime and matter have the structure described by SO(10) SPA, where the gravity dominates and creates the superon-quintet and the antisuperon-quintet pair from the vacuum in such a way as superon-composites massless states span the massless irreducible representations of SO(10) SPA.

From the viewpoints of the superon-quintet model(SQM) for matter we study more concretely the physical meaning of the results obtained in Ref.[3][4].

Hereafter we use the following symbols for superons Q^N $(N = 1, 2, ..10)$.

For the superon-quintet $\underline{5}$: $\left[(\underline{3},\ \underline{1};\text{-}\frac{1}{3},\text{-}\frac{1}{3},\ \text{-}\frac{1}{3}),(\underline{1},\ \underline{2};1,\ 0)\right]$, we use

$$\left[Q_a, Q_m; a = 1, 2, 3; m = 4, 5\right] \tag{3}$$

and for the antisuperon-quintet $\underline{5}^*$: $\left[(\underline{3}^*, \underline{1}; +\frac{1}{3}, +\frac{1}{3}, +\frac{1}{3}),\ (\underline{1}, \underline{2}^*; -1, 0)\right]$, we use

$$\left[Q_a^*, Q_m^*; a = 1, 2, 3; m = 4, 5\right]. \tag{4}$$

Accordingly all the the states are specified explicitly with respect to (SU(3), SU(2); electric charges). Through the symmetry breaking [SO(10) SPA upon the Clifford vacuum] $\longrightarrow$ [Poincaré algebra(PA) with $SU(3) \times SU(2) \times U(1)$] $\longrightarrow$ [PA with $SU(3) \times U(1)$] which is discussed later, many of the lower helicity $(\pm\frac{3}{2}, \pm 1, \pm\frac{1}{2}, 0)$ states of SO(10) SPA are converted to the longitudinal components of the higher spin massive states of PA in $SU(3) \times SU(2) \times U(1)$ invariant way and others remain massless. We have carried out the recombination among $2 \cdot 2^{10}$ helicity states and found surprisingly all massless states necessary and sufficient for the SM with three generations of quarks and leotons appear in the surviving massless states. A new spin $\frac{3}{2}$ lepton doublet (ν_Γ, Γ^-) with the mass of the electroweak scale is predicted[3].

Now, towards the construction of the fundamental theory of SQM and for surveying the physical(phenomenological) implications of the superons for the unified gauge models(SM and GUTs) it is very important to understand all the gauge and the Yukawa couplings of the unified gauge models in terms of the superon pictures. For simplicity we neglect the mixing between superons and take the following left-right symmetric assignment for quarks and leptons by using the conjugate representations naively , i.e. $(\nu_l, l^-)_R = (\bar{\nu}_l, l^+)_L$, etc[4].

For three generations of leptons $[(\nu_e, e),\ (\nu_\mu, \mu),\ (\nu_\tau, \tau)]$, we take

$$\left[(Q_m \varepsilon_{ln} Q_l^* Q_n^*), (Q_a Q_a^* Q_m^*), (Q_a Q_a^* Q_b Q_b^* Q_m^*)\right] \tag{5}$$

and the conjugate states respectively.
For three generations of quarks $[(u,d),\ (c,s),\ (t,b)]$, we have uniquely

$$\left[(\varepsilon_{abc}Q_b^*Q_c^*Q_m^*), (\varepsilon_{abc}Q_b^*Q_c^*Q_l\varepsilon_{mn}Q_m^*Q_n^*), (\varepsilon_{abc}Q_a^*Q_b^*Q_c^*Q_dQ_m^*)\right] \tag{6}$$

and the conjugate states respectively.
For $[SU(2)\times U(1)$ gauge boson$]$, we have from $\underline{2}\times\underline{2}^*$
$[-Q_4Q_5^*, \frac{1}{\sqrt{2}}(Q_4Q_4^*-Q_5Q_5^*), Q_5Q_4^*; \frac{1}{\sqrt{2}}(Q_4Q_4^*+Q_5Q_5^*)]$.
For $[SU(3)$ gluons$]$, we have
$[Q_1Q_3^*, Q_2Q_3^*, Q_1Q_2^*, \frac{1}{\sqrt{2}}(Q_1Q_1^*-Q_2Q_2^*), Q_2Q_1^*, \frac{-1}{\sqrt{6}}(2Q_3Q_3^*-Q_2Q_2^*-Q_1Q_1^*),$
$Q_3Q_2^*, Q_3Q_1^*]$.
For $[SU(2)$ Higgs Boson$]$, we have $[\varepsilon_{abc}Q_aQ_bQ_cQ_m]$ and the conjugate state.
For $[(X,Y)]$ leptoquark bosons in GUTs, we have $[Q_a^*Q_m]$ and the conjugate state.
For a color- and SU(2)-singlet neutral gauge boson from $\underline{3}\times\underline{3}^*$ (which we call simply S boson to represent the singlet) we have $Q_aQ_a^*$.
The specification of (X,Y) gauge boson is important for the proton decay in SU(5) GUT. The specification of S boson is interesting as an additional U(1) expected from the branching rule $SO(10)\supset SU(5)\times U(1)$. As shown later S boson plays crucial roles in the process concerning the third generation of quarks and leptons. We have considered only two-superons states $\underline{45}$ of the adjoint representation of SO(10) SPA for the gauge bosons.
Now in order to see the physical implications of superon-quintet model(SQM) for matter we try to interpret the Feynman diagrams of SM and GUTs in terms of the Feynman diagrams of SQM. The superon line Feynman diagrm is obtained by replacing the single line in the Feynman diagram of the unified gauge models by the corresponding multiple superon lines. To translate the vertex of the Feynman diagram of the unified gauge models into that of SQM, we assume that the superon-antisuperon pair creations and pair annihilations within a single state for a quark, a lepton and a (gauge) boson (,i.e. within a single SO(10) SPA state) are rigorously forbidden. This rule seems natural because every state is the irreducible representation of SO(10) SPA and is prohibitted from the decay without any remnants, i.e. without the interaction between the superons contained in the different states. Here we just mention that all the states necessary for the SM and GUTs with three genarations of quarks and leptons appear up to five-superons states (i.e. one half of the full occupation ten-superons), which may suggest a mechanism which produces a (large) mass splitting between these states and the rest containing more than five superons. Now the translation is unique and straightforward. We see that in the Yukawa coupling of SQM the observed quark (the observed lepton) interacts with the Higgs boson and a new quark(a new lepton) which is exotic with respect to SU(2) and/or spin. Then the Yukawa coupling of SM(GUTs) appears effectively only in the higher orders of the Yukawa couplings of SQM, which gives the Yukawa coupling of SM(GUTs) a small factor of the order of the inverse of the large masses

of the exotic quark and lepton. This mechanism may give an explanation of CKM mixing matrix for the quark sector but may be dangerous so far for the lepton sector because of the disastrous lepton flavor violations by the lepton mixings. However we find that at every gauge coupling vertex there is a stringent selection rule for generations which is characteristic to SQM, for each generation is identical only with respect to $SU(3) \times SU(2) \times U(1)$ quantum numbers but has another superon content corresponding to the flavor quantum number. This selection rule is the matching of the superons, i.e. the superon number conervation, at the gauge coupling vertex. For the quark sector, surprisingly, the selection rule respects the CKM mixing of the Yukawa coupling sector and maintains the successful gauge current structure of SM. While for the lepton sector, remarkably the selection rule prohibits basically the lepton flavor changing electroweak currents between lepton generations at the tree level and realizes the success of SM.

As a few examples of the gauge boson interactions and the selection rule at the gauge coupling vertex we have discussed the following typical processes[4], i.e. (i) β decay: $n \longrightarrow p + e^- + \bar{\nu}_e$, (ii) $\pi^0 \longrightarrow 2\gamma$, (iii) the proton decay: $p \longrightarrow e^+ + \pi^0$, (iv) a flavor changing neutral current process(FCNC): $K^+ \longrightarrow \pi^+ + \nu_e + \bar{\nu}_e$ and (v) an advocated typical process of the (non-gauged) compositeness: $\mu \longrightarrow e + \gamma$.

Now the translation is unique and straightforward. For the processes (i) and (ii) we can draw the corresponding similar tree-like superon line diagrams easily, where the triangle-like superon diagram does not appear. For the process (iii) we consider the Feynman diagrams for the proton decay of GUTs and find that the corresponding superon line diagrams do not exist due to the selection rule, i.e. the mismatch of the superons contained in the quarks(u and d) and the gauge bosons(X and Y) at the gauge coupling vertices. This means that irrespective of the massses of the gauge bosons the proton is stable at the tree level against $p \longrightarrow e^+ + \pi^0$. For FCNC process (iv) the penguin-type and the box-type superon line diagrams are to be studied corresponding to the penguin- and box-Feynmann diagrams for $K^+ \longrightarrow \pi^+ + \nu_e + \bar{\nu}_e$ of GUTs. Remarkablely the superon line diagrams which have only the u quark for the internal quark line exist due to the selection rule. This is the indication of the strong suppression of the FCNC process, at least for the process $K^+ \longrightarrow \pi^+ + \nu_e + \bar{\nu}_e$. This simple mechanism may hold in general for FCNC processes. For the process (v) the corresponding tree-like superon line diagram does not exist due to the selection rule at the gauge coupling vertex, i.e. $\mu \longrightarrow e + \gamma$ decay mode is absent at the tree-level in the superon (composite) model. The process $\tau \longrightarrow e(\mu) + \gamma$ is suppressed similarly.

As for the CP-violation, the mixing K^0-$\overline{K^0}$ is natural in SQM, for remarkably K^0 and $\overline{K^0}$ are made of the same superons with the different combinations. GIM mechanism works for the superon picture of K^0-$\overline{K^0}$ mixing box diagram of SM but remarkably t quark (the third generation) decouples due to the selection rule at the gauge coupling vertices. However in SQM there is another higher order box doiagram contribut-

ing to K^0-$\overline{K^0}$ mixing amplitude, where S gauge boson emitted by the transition $(u,d) \leftrightarrow (t,b)$ and t quark play crucial roles besides W boson. The relative phase of these two amplitudes may be an origin of CP-violation in the neutral K-meson decay. The mixings B^0-$\overline{B^0}$ are natural in the same sense but the preliminary analyses suggest the similar new mechanisms for mixing and CP violation characteristic to the SQM. As for the charmless nonleotonic B decay[5] we just mention that in SQM the transition $(t,b) \leftrightarrow (c,s)$ occurrs not at the tree level of the charged current but at the higher orders of the gauge couplings due to the selection rule for the quark sector, where the transition $(t,b) \leftrightarrow (c,s)$ is achieved by the emissions of S boson and W boson and may give an explanation of the excess of the charmless(or the suppression of the charm mode) nonleotonic B decay[5]. Furthermore for the lepton sector amazingly S gauge boson induces only $\nu_\mu \leftrightarrow \nu_\tau$ transition (large mixing) at the tree level due to the selection rule, which may solve simply the ν_μ deficit problem of the atomospheric neutrino[6].

Finally we consider the fundamental theory of superon-graviton model(SGM) for supersymmetric spacetime and matter. In carrying through the canonical quantization of the fundamental (Nambu-Goldstone) spinor field $\psi(x)$ of Volkov-Akulov model[7] of the nonlinear SUSY(NL SUSY), we have shown that the supercharges Q given by the supercurrents

$$J^\mu(x) = \frac{1}{i}\sigma^\mu\psi(x) - \kappa\{\text{the higher orders of } \psi(x)\} \tag{7}$$

obtained by the ordinary Noether procedures can satisfy the super-Poincaré algebra at the cnonically quantized level[8]. (7) means the field-current identity between the fundamental Nambu-Goldstone spinor $\psi(x)$ field and the supercurrent, which support our asumption that the generator(supercharge) Q^N (N=1,2,..10) of SO(10) SPA represents the fundamental particle *superon with spin* $\frac{1}{2}$. That is, supersymmetry indicates the existence of the supercharged superons. Therefore we speculate that the fundamental theory of SQM for matter is SO(10) NLSUSY and that the fundamental theory of SGM for spacetime and matter at(above) the Planck scale is SO(10) NL SUSY in the curved spacetime(corresponding to the Clifford vacuum $\mid \Omega(\pm 2)\rangle$). We regard that all the helicity-states including the observed quarks, leptons and gauge bosons except the graviton are the relativistic (gravitational) composite states of Nambu-Goldstone fermions, *superons*.
SGM may indicate that the relativistic composite (quark) model of matter is realized as eigen-states of SO(10) SPA at the superon level. We propose the following Lagrangian as the fudamental theory of SGM of spacetime and matter.

$$L = -\frac{c^3}{16\pi G}e(R+\Lambda)|W|, \tag{8}$$

$$|W| = detW^\nu_\mu = det(\delta^\nu_\mu + \kappa T^\nu_\mu), \quad T^\nu_\mu = \frac{1}{2i}\sum_{i,j=1}^{10}(\bar{s}^i O_{ij}\gamma_\mu D^\nu s^j - D^\nu \bar{s}^i \gamma_\mu O_{ij} s^j), \tag{9}$$

where κ is a four dimensional fundamental volume of the superspace of the NL SUSY, $e = dete^a_\mu$, $D_\mu = \partial_\mu + \frac{1}{2}\omega^{ab}_\mu \sigma_{ab}$ and R and Λ are the scalar curvature and the cosmological constant, respectively. O_{ij} is a 10×10 unitary matrix representing the mixing among the superons, which may be probable but unpleasant from the elementary nature of the superon. The multiplication of the Einstein-Hilbert action by SQM action in (8) is essential and unique for the fundamental theory if we require that (i) it should be reduced to SO(10) NL SUSY *a la* Volkov-Akulov in the flat spacetime by taking only $R \to 0$, (ii) also to the Einstein-Hilbert action (i.e. Clifford vacuum action) by taking the superonless limit $s^i \to 0$ and (iii) (except the graviton) all fields participating in the superHiggs(recombination) mechanism should be the composites of superons. The states with helicity ± 3, $\pm\frac{5}{2}$ and ± 2(except the graviton) made of 10-,9-.and 8-superons appear afetr specifying the contorsion in the spin conection $\omega^\mu_{ab}(e^\mu_a, s^i)$[9]. (8) is manifestly invariant under at least the general coordinate transformation and global SO(10). Furthermore we may anticipate the invariance of (8) under the global SO(10) NL SUSY in the similar sense of Ref.[10] and [11], which may be included in the scope of Ref.[10] and [11]. The fundamental Lagrangian (8) can be rewritten in the following simple form $L = -\frac{c^3}{16\pi G} n(R + \Lambda)$, where $n = detn^a_\mu = det(e^a_\nu W^\nu_\mu)$.

As for the abovementioned (spontaneous) symmetry breaking it is urgent to study the structure of the true vacuum of (8). The order of the mass scale of spontaneous SUSY breaking is given by κ and Λ. To see clearly the (low energy) mass spectrum of the particles spanned upon the true vacuum, we should convert the highly nonlinear fundamental action (8) into the equivalent linear broken SUSY SO(10) Lagrangian. The low-energy structure of the linearized broken SUSY Lagrangian should involve GUTs, at least the SM with three generations. For carrying through the complicated scenario it is encouraging to note that the linearlization of such a nonlinear fermionic system was already carried out explicitly[10][11]. They investigated in detail the conversions between N=1 NL SUSY(Volkov-Akulov) model and the equivalent linear (broken) N=1 SUSY Lagrangian. The generic and the systematic arguments by using the superspace[11] may be useful for the linerization of the N=10 superon model. From the mathematical viewpoint an equivalent linear theory would exist. We expect that by taking *non-perturbatively* the true vaccum the conversions into the linear representation is achieved, where SUSY is broken spontaneously at the tree level and the bosonic and the fermionic high-spin massless states turn out to be massive states. It is very interesting if we can regard the yet hypothetical superon-graviton model(SGM) may be for the unified gauge models(SM and GUTs) what the BCS(electron-phonon) theory is for the Landau-Ginzburg theory of the superconductivity.

Alternatively, disregarding the linearlization it is interesting to fit all the decay data of leptons and low lying hadrons in terms of the quark model analogue[12] SO(10) superon current algebra, which may describe the nonlinear superon dynamics at the

short ditance of the spacetime and may give a qualitative test of SQM[4]. Also it is worth studying other ($R \neq L^*$) SQM than $R = L^*$ symmetric SQM((5) and (6)) for quarks and leptons.
Besides those interesting qualitative aspects of the superon-graviton model(SGM) (8), much more open questions are left.

However we regard that the beautiful complimentality between the gauge unified models(SM and GUTs) and SGM, i.e. the former is strengthened or revived by taking account of the topology of the latter superon diagram, while drawing the superon diagram of the latter is guided by the Feynman diagram of the former, may be an evidence of SO(10) SPA structure of spacetime and matter behind the gauge models, i.e. an evidence of the superon-quintet hypothesis for matter(SQM) and superon-graviton mode(SGM) for spacetime and matter. The experimental searches for a predicted new spin $\frac{3}{2}$ lepton doublet (ν_Γ, Γ^-) with the mass of the electroweak scale[3] and a new gauge boson S are important. From the present experimental data for $\tau^- \longrightarrow \nu_\tau + \bar{\nu}_\mu + \mu^-$, $\nu_\tau + \bar{\nu}_e + e^-$, the S boson mass seems (much) larger than the Z boson mass. The clear signals of (ν_Γ, Γ^-) may be similar to the top-quark pair production event with two(or less) jets production. The evidence of S boson may be seen already and becomes clear in the high energy B meson experiment.

The author would like to express gratitude to J. Wess and G. Takeda for their encouragement and interest at the biginning of this work. Also he would like to thank K. Akama and T. Uematsu for useful discussions, K. Mori, T. Shirafuji and Y. Tanii for useful discussions and the hospitality at Physics Department of Saitama University and H. Terazawa and W. Lang for the hospitality at HEARO(KEK,Tanashi) and at Karlsruhe University respectively.

References

[1] J. Wess and B. Zumino, *Phys. Lett.* **B49**, 52(1974).

[2] M. Gell-Mann, Talk at the APS meeting(Washington,1977). M. Gell-Mann, P. Ramond and R. Slansky, Proceeding of supergravity workshop at Stony Brook, eds. P. van Nieuwenhuisen and D. Z. Freedman(North Holland, Amsterdam,1977).

[3] K. Shima, *Z. Phys.* **C18**, 25 (1983).

[4] K. Shima, *European. Phys. J.* **C**(1998), in press.
K. Shima, Proceeding of the XXth ICGTMP98, Hobart, Australia(1998), in press.

[5] M. Artsuo et al. (CLEO Collabolation), preprint CONF98-20.

[6] T. Kajita(Super-Kamiokande Collabolation),
Talk given at the XVIIth International Conference on Neutrino Physics and Astrophysics, Takayama,1998.

[7] D.V. Volkov and V.P. Akulov, *Phys. Lett.* **B46**, 109(1973).

[8] K. Shima, *Phys. Rev.* **D20**, 574(1979).

[9] D. Z. Freedman, P. van Nieuwenhuisen and S. Ferrara, *Phys. Rev.* **D13**, 3214 (1976). S. Deser and B. Zumino, *Phys. Lett.* **B62**, 335 (1976).

[10] M. Roceck, *Phys. Rev. Lett.* **41**, 451(1978).
E. A. Ivanov and A.A. Kapustnikov, *J. Phys.* 2375(1978).
T. Uematsu and C.K. Zachos, *Nucl. Phys.* **B201**, 254(1982).

[11] J. Wess, Karlsruhe University preprint(Festschrift for J. Lopszanski, December,1982).
S. Samuel and J. Wess, *Nucl. Phys.* **B226**, 289(1983).

[12] M. Gell-Mann and Y. Ne'eMann in *Eightfold Way*(W.A.Benjamin, N.Y.,1964).