New Einstein-Hilbert Type Action for Unity of Nature

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Abstract

A new Einstein-Hilbert(E-H) type (SGM) action is obtained by performing the Einstein gravity analogue geometrical arguments in high symmetric (SGM) spacetime. All elementary particles except graviton are regarded as the eigenstates of SO(10) super-Poincaré algebra(SPA) and composed of the fundamental fermion "superons" of nonlinear supersymmetry(NL SUSY). Some phenomenological implications and the linearlization of the action are discussed briefly.

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1 Introduction

The standard model (SM) is established as a unified model for the electroweak interaction. Nevertheless, it is very unsatisfactory in many aspects, e.g. it can not explain the particle quantum numbers ($Q_e, I, Y, color, i.e. 1 \times 2 \times 3$ gauge structure), the three-generations structure and contains more than 28 arbitrary parameters (in the case of neutrino oscillations) even disregarding the mass generation mechanism for neutrino. The simple and beautiful extension to SU(5) GUT has serious difficulties, e.g. the life time of proton, etc and is excluded so far. The SM and GUT equipped naively with supersymmetry (SUSY) have improved the situations, e.g. the unification of the gauge couplings at about $10^{17}$, relatively stable proton (now threatened by experiments), etc., but they possess more than 100 arbitrary parameters and less predictive powers. However SUSY is an essential notion to unify various topological and non-topological charges and gives a natural framework to unify spacetime and matter leading to the birth of supergravity (SUGRA). Unfortunately the maximally extended SO(10) SUGRA is too small to accommodate all observed particles as elementary fields. The straightforward extension to SO(N) SUGRA with $N > 9$ has a difficulty due to so called the no-go theorem on the massless elementary high spin ($> 2$) (gauge) field. The massive high-spin is another. Furthermore, we think that from the viewpoint of simplicity and beauty of nature it is interesting to attempt the accommodation of all observed particles in a single irreducible representation of a certain algebra (group) especially in the case of high symmetric spacetime having a certain boundary, i.e. a boundary condition and the dynamics are described by the spontaneous breakdown of the high symmetry of spacetime by itself, which is encoded in the nonliner realization of the geometrical arguments of spacetime. Also the no-go theorem does not exclude the possibility that the fundamental action, if it exists, possesses the high-spin degrees of freedom not as the elementary fields but as some composite eigenstates of a certain symmetry (algebra) of the fundamental action. In this talk we would like to present a model along this scenario.

2 Superon-Graviton Model (SGM)-Phenomenolgy-

Among all single irreducible representations of all SO(N) extended super-Poincaré (SP) symmetries, the massless irreducible representations of SO(10) SP algebra (SPA) is the only one that accommodates minimally all observed particles including the graviton. 10 generators $Q^N (N = 1, 2, ..., 10)$ of SO(10) SPA are the fundamental representations of SO(10) internal symmetry and decomposed $10 = 5 + 5^*$ with re-
spect to $SU(5)$ following $SO(10) \supset SU(5)$. For the massless case the little algebra of $SO(10)$ SPA for the supercharges in the light-cone frame $P_\mu = \epsilon(1, 0, 0, 1)$ becomes after a suitable rescaling
\[
\{ Q^M_\alpha, Q^N_\beta \} = 0, \quad \{ \bar{Q}^M_\dot{\alpha}, \bar{Q}^N_\dot{\beta} \} = 0, \quad \{ Q^M_\alpha, \bar{Q}^N_\dot{\beta} \} = \delta_{\alpha \dot{\beta}}^1 \delta^{MN}, \quad (1)
\]
where $\alpha, \beta = 1, 2$ and $M, N = 1, 2, \ldots, 5$. By identifying the graviton with the Clifford vacuum $|\Omega\rangle$ (SO(10) singlet) satisfying $Q^M_\alpha |\Omega\rangle = 0$, and performing the ordinary procedures we obtain $2 \cdot 2^{10}$ dimensional irreducible representation of the little algebra (1) of SO(10) SPA as follows:
\[
[10(+2), 10(+1, 0, 0, 1), 120(+1, 120(0), 252(-1), 210(-1), 210(-5/2), 45(-2), 10(-5/2), 1(-3)] + [\text{CPT-conjugate}],
\]
where $d(\lambda)$ represents SO(10) dimension $d$ and the helicity $\lambda$. By noting that the helicities of these states are automatically determined by SO(10) SPA in the light-cone and that $Q^M_\alpha$ and $\bar{Q}^M_\dot{\alpha}$ satisfy the algebra of the annihilation and the creation operators for the massless spin $1/2$ particle, we speculate boldly that these massless states spanned upon the Clifford vacuum $|\Omega(\pm 2)\rangle$ are the massless (gravitational) eigenstates of spacetime and matter with SO(10) SP symmetric structure, which are composed of the fundamental massless object $Q^N$, *superon* with spin $1/2$. Because they correspond merely to all possible nontrivial combinations of the multiplications of the spinor charges(i.e. generators) of SO(10) SP algebra(clustering by a universal force?). Therefore we regard $\bar{5} + \bar{5}^*$ as a *superon-quintet* and an *antisuperon-quintet*. The speculation is discussed later. To survey the physical implications of superon model for matter we assign tentatively the following SM quantum numbers to superons and adopt the following symbols.

\[
10 = \bar{5} + \bar{5}^* = [Q_a(a = 1, 2, 3), Q_m(m = 4, 5)] + [Q_a^*(a = 1, 2, 3), Q_m^*(m = 4, 5)],
\]

\[
= [(3, \frac{1}{3}, -\frac{1}{3}, -\frac{1}{3}, -\frac{1}{3}), (3, 1, 0)] + [(\bar{3}^*, \frac{1}{3}, 1, \frac{1}{3}, \frac{1}{3}), (\bar{3}, 1, -1, 0)], \quad (2)
\]

where we have specified $(SU(3), SU(2); \text{electric charges})$ and $a = 1, 2, 3$ and $m = 4, 5$ represent the color and electroweak components of superons respectively. Interestingly our model needs only five superons which have the same quantum numbers as the fundamental matter multiplet $\bar{5}$ of SU(5) GUT and satisfy the Gell-Mann–Nishijima relation.

\[
Q_e = I_z + \frac{1}{2}(B - L). \quad (3)
\]

Accordingly all $2 \cdot 2^{10}$ states are specified uniquely with respect to $(SU(3), SU(2); \text{electric charges})$. Here we suppose drastically that a field theory of SGM exists and all unnecessary (for SM) higher helicity states become massive in $SU(3) \times SU(2) \times$...
**U(1)** invariant way by eating the lower helicity states corresponding to the super-Higgs mechanism and/or to the diagonalizations of the mass terms of the high-spin fields via \([SO(10)]\) SPA upon the Clifford vacuum \(\rightarrow [ SU(3) \times SU(2) \times U(1)] \rightarrow [ SU(3) \times U(1)]\). We have carried out the recombinations of the states and found surprisingly that all the massless states necessary for the SM with three generations of quarks and leptons appear in the surviving massless states (therefore, no sterile neutrinos). Among predicted new particles one lepton-type electroweak-doublet \((\nu_\tau, \Gamma^-)\) with spin \(\frac{3}{2}\) with the mass of the electroweak scale \((\leq \text{Tev})\) and doubly charged heavy \((> \text{Tev})\) leptons are color singlets and can be observed directly.

As for the assignments of observed particles, we take for simplicity the following left-right symmetric assignment for quarks and leptons by using the conjugate representations naively, i.e. \((\nu_l, l^-) \rightarrow (\bar{\nu}_l, l^+)\), etc. \[^2\] \[^3\]. Furthermore as for the generation assignments we assume simply that the states with more (color-) superons turn to acquiring larger masses in the low energy and no a priori mixings among generations. The surviving massless states identified with \(\text{SM(GUT)}\) are as follows.

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

\[
\left[\left(Q_m \varepsilon_{ln} Q^*_l Q^*_n, (Q_m \varepsilon_{ln} Q^*_l Q^*_n Q_a Q^*_a), (Q_a Q^*_a Q_b Q^*_b Q^*_m)\right)\right] \tag{4}
\]

and the conjugate states respectively.

For three generations of quarks \([u, d], (c, s), (t, b)]\), we have **uniquely**

\[
\left[\left(\varepsilon_{abc} Q^*_b Q^*_c Q^*_m, (\varepsilon_{abc} Q^*_b Q^*_c Q^*_l \varepsilon_{mn} Q^*_m Q^*_n), (\varepsilon_{abc} Q^*_a Q^*_b Q^*_c Q^*_d Q^*_m)\right)\right] \tag{5}
\]

and the conjugate states respectively. For \(SU(2) \times U(1)\) gauge bosons \([W^+, Z, \gamma, W^-]\), \(SU(3)\) color-octet gluons \([G^a|a = 1, 2, ..., 8]\), \(SU(2)\) Higgs boson, \([\{X, Y\}]\) lepto-quark bosons in GUTs, and a color- and \(SU(2)\)-singlet neutral gauge boson from \(3 \times \bar{3}^*\) (which we call simply \(S\) boson to represent the singlet) we have

\[
\left[Q_1 Q_5^*, \frac{1}{\sqrt{2}}(Q_1 Q_4^* \pm Q_5 Q_6^*), Q_5 Q_4^*\right],
\left[Q_1 Q_3^*, Q_2 Q_3^*, -Q_1 Q_2^*, \frac{1}{\sqrt{2}}(Q_1 Q_3^* - Q_2 Q_3^*), Q_2 Q_1^*, \frac{1}{\sqrt{6}}(2Q_3 Q_3^* - Q_2 Q_2^* - Q_1 Q_1^*)\right],
\left[-Q_3 Q_2^*, Q_3 Q_1^*\right], [\varepsilon_{abc} Q_a Q_b Q_c Q_m], [Q^*_a Q^*_m] and Q_a Q^*_a, (and their conjugates) respectively.
\]

Now in order to see the potential of superon-graviton model (SQM) as a composite model of matter we try to interpret the Feynman diagrams of SM(GUT) in terms of the superon pictures of all particles in SM(GUT), i.e. a single line of a particle in the Feynman diagrams of SM(GUT) is replaced by multiple lines of superons constituting the particle with two assumption at the vertex; (i) the analogue of the OZI-rule of the quark model and (ii) the superon number conservation. We find many remarkable results, e.g. in SM, naturalness of the mixing of \(K^0, \bar{K}^0\), \(D^0, \bar{D}^0\) and \(B^0, \bar{B}^0\), no CKM-like mixings among the lepton generations, \(\nu_e \leftrightarrow \nu_\mu \leftrightarrow \nu_\tau\) transitions beyond SM, strong CP-violation, small Yukawa couplings and no \(\mu \rightarrow e + \gamma\) despite compositeness, etc. and in (SUSY)GUT, no dangerous diagrams for proton decay (without R-parity by hand), etc.\[^2\] \[^3\]. SGM may be the most economic one.
3 Fundamental Action of SGM

The supercharges $Q$ of Volkov-Akulov (V-A) model\textsuperscript{4} of the nonlinear SUSY (NL SUSY) is given by the supercurrents

$$J^\mu(x) = \frac{1}{i} \sigma^\mu \psi(x) - \kappa \{ \text{the higher order terms of } \kappa, \psi(x) \text{ and } \partial \psi(x) \}. \quad (6)$$

$(10)$ means the field-current identity between the elementary N-G spinor field $\psi(x)$ and the supercurrent, which justifies our bold assumption that the generator (supercharge) $Q_N$ ($N=1,2,...10$) of SO(10) SPA in the light-cone frame represents the fundamental massless particle, superon with spin $\frac{1}{2}$. Therefore 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 $|\Omega(\pm 2)\rangle$). We extend the arguments of V-A to high symmetric curved SGM spacetime, where NL SUSY SL(2C) degrees of freedom (i.e. the coset space coordinates representing N-G fermions) $\psi(x)$ in addition to Lorentz SO(3,1) coordinates $x^a$ are embedded at every curved spacetime point with GL(4R) invariance. By defining a new tetrad $w^a_\mu(x)$, $w^a_\mu(x)$ and a new metric tensor $s^{\mu\nu}(x) \equiv w^a_\mu(x)w^{a\nu}(x)$ in SGM spacetime we obtain the following Einstein-Hilbert (E-H) type Lagrangian as the fundamental theory of SGM for spacetime and matter\textsuperscript{3}.

$$L = -\frac{c^3}{16\pi G} |w|(\Omega + \Lambda), \quad (7)$$

$$|w| = det w^a_\mu = det(e^a_\mu + t^a_\mu), \quad t^a_\mu = \frac{\kappa}{2i} \sum_{j=1}^{10} (\bar{\psi}^j \gamma^a \partial_\mu \psi^j - \partial_\mu \bar{\psi}^j \gamma^a \psi^j), \quad (8)$$

where $i = 1,2,...,10$, $\kappa$ is a fundamental volume of four dimensional spacetime, $e^a_\mu(x)$ is the vierbein of Einstein general relativity theory (EGRT) and $\Lambda$ is a cosmological constant related to the superon-vacuum coupling constant. $\Omega$ is a new scalar curvature analogous to the Ricci scalar curvature $R$ of EGRT. The explicit expression of $\Omega$ is obtained by just replacing $e^a_\mu(x)$ by $w^a_\mu(x)$ in Ricci scalar $R$. The action $(7)$ is invariant at least under GL(4R), local Lorentz, global SO(10) and the following new (NL) SUSY transformation

$$\delta \psi^i(x) = \zeta^i + i\kappa (\bar{\zeta}^j \gamma^\rho \psi^j(x)) \partial_\rho \psi^i(x), \quad \delta e^a_\mu(x) = i\kappa (\bar{\zeta}^j \gamma^\rho \psi^j(x)) \partial_\rho e^a_\mu(x), \quad (9)$$

where $\zeta^i, (i = 1..10)$ is a constant spinor and $\partial_\rho e^a_\mu(x) = \partial_\rho e^a_\mu - \partial_\mu e^a_\rho$. These results can be understood intuitively by observing that $w^a_\mu(x) = e^a_\mu(x) + t^a_\mu(x)$ defined by $\omega^a = w^a_\mu dx^\mu$, where $\omega^a$ is the NL SUSY invariant differential forms of V-A\textsuperscript{4}, and $w^a_\mu(x)$ and $s^{\mu\nu}(x) \equiv w^a_\mu(x)w^{a\nu}(x)$ are formally a new vierbein and a new metric tensor in SGM spacetime. In fact, it is not difficult to show the same
behaviors of $w_{a}^{\mu}(x)$ and $s^{\mu\nu}(x)$ as those of $e_{a}^{\mu}(x)$ and $g^{\mu\nu}(x)$, i.e., $w_{a}^{\mu}(x)$ and $s^{\mu\nu}(x)$ are invertible, $w_{a}^{\mu}w_{b\mu} = \eta_{ab}$, $s_{\mu\nu}w_{a}^{\mu}w_{b\nu} = \eta_{ab}$, etc. and the following GL(4R) transformations of $w_{a}^{\mu}(x)$ and $s_{\mu\nu}(x)$ under (9)

$$\delta\zeta^{\mu} = \xi^{\nu}\partial_{\nu}w_{\mu} + \partial_{\mu}\xi^{\nu}w_{\nu}, \quad \delta\zeta = \xi^{\mu}e_{\mu}, \quad (10)$$

where $\xi^{\mu} = i\kappa(\tilde{\zeta}^{2}\gamma^{\mu}\zeta^{1})$. Therefore the similar arguments to EGRT in Riemann space can be carried out straightforwardly by using $s^{\mu\nu}(x)$ (or $e^{a}_{\mu}(x)$) in stead of $g^{\mu\nu}(x)$ (or $e^{a}_{\mu}(x)$), which leads to (7) manifestly invariant at least under the above mentioned symmetries, which are isomorphic to SO(10) SP. The commutators of two new supersymmetry transformations on $\psi(x)$ and $e^{a}_{\mu}(x)$ are the general coordinate transformations

$$\left[\delta_{\zeta_{1}}, \delta_{\zeta_{2}}\right]\psi = \Xi^{\mu}\partial_{\mu}\psi, \quad \left[\delta_{\zeta_{1}}, \delta_{\zeta_{2}}\right]e^{a}_{\mu} = \Xi^{\rho}\partial_{\rho}e^{a}_{\mu} + \epsilon^{a}_{bc}\partial_{\mu}\Xi^{\rho}, \quad (11)$$

where $\Xi^{\mu}$ is defined by $\Xi^{\mu} = 2ia(\tilde{\zeta}^{2}\gamma^{\mu}\zeta^{1}) - \xi^{\mu}_{1}\xi^{\mu}_{2}e_{a\mu}(\partial_{\mu}e^{a}_{\sigma})$, which form a closed algebra.

In addition, to embed simply the local Lorentz invariance we follow EGRT formally and require that the new vierbein $w^{a}_{\mu}(x)$ should also have formally a local Lorentz transformation, i.e.,

$$\delta_{L}w^{a}_{\mu} = e^{a}_{b}w^{b}_{\mu} \quad (12)$$

with the local Lorentz transformation parameter $\epsilon_{ab}(x) = (1/2)\epsilon_{[ab]}(x)$. Interestingly, we find that the following generalized local Lorentz transformations on $\psi$ and $e^{a}_{\mu}$

$$\delta_{L}\psi(x) = -\frac{i}{2}\epsilon_{ab}\gamma^{a}\psi, \quad \delta_{L}e^{a}_{\mu}(x) = e^{b}_{\mu}e^{a}_{b} + \frac{\kappa}{4}\epsilon^{abcd}\bar{\psi}\gamma^{c}\gamma^{d}\psi(\partial_{\mu}\epsilon^{bc}) \quad (13)$$

are compatible with (12). [Note that the equation (13) reduces to the familiar form of the Lorentz transformations if the global transformations are considered, e.g., $\delta_{L}g^{\mu\nu} = 0$.] Also the local Lorentz transformation on $e^{a}_{\mu}(x)$ forms a closed algebra.

$$\left[\delta_{L_{1}}, \delta_{L_{2}}\right]e^{a}_{\mu} = \beta^{a}_{b}e^{b}_{\mu} + \frac{\kappa}{4}\epsilon^{abcd}\bar{\psi}\gamma^{c}\gamma^{d}\psi(\partial_{\mu}\beta^{bc}), \quad (14)$$

where $\beta_{ab} = -\beta_{ba}$ is defined by $\beta_{ab} = \epsilon_{2ac}\epsilon_{1}^{c}b - \epsilon_{2bc}\epsilon_{1}^{c}a$. These arguments show that SGM action (7) is invariant at least under (14)

$$\text{[global NL SUSY]} \otimes \text{[local GL(4, R)]} \otimes \text{[local Lorentz]} \otimes \text{[global SO(N)]}. \quad (15)$$

SGM for spacetime and matter is the (isomorphic) case with $N=10$. 

6
4 Toward Low Energy Theory of SGM

For deriving the low energy behavior of the SGM action it is often useful to linearize such a highly nonlinear theory and obtain a low energy effective theory which is renormalizable. Toward the linearization of the SGM we investigate the linearization of V-A model in detail. The linearization of V-A model was investigated\[6\][7] and proved that N=1 V-A model of NL SUSY was equivalent to N=1 scalar supermultiplet action of L SUSY which was renormalizable. The general arguments on the constraints which gives the relations between the linear and the nonlinear realizations of global SUSY have been established\[6\]. Following the general arguments we show explicitly that nonrenormalizable N=1 V-A model is equivalent to a renormalizable total action of a U(1) gauge supermultiplet of the linear SUSY\[8\] with the Fayet-Iliopoulos(F-I) $D$ term indicating a spontaneous SUSY breaking\[9\].

Remarkably we find that the magnitude of F-I $D$ term (vacuum value) is determined to reproduce the correct sign of V-A action and that a U(1) gauge field constructed explicitly in terms of N-G fermion fields is an axial vector for N=1.

An N = 1 U(1) gauge supermultiplet is given by a real superfield 

\[
\text{V}(x, \theta, \bar{\theta}) = C + i\theta\chi - i\bar{\theta}\bar{\chi} + \frac{1}{2}i\bar{\theta}^2(M + iN) - \frac{1}{2}i\theta^2(M - iN) - \theta\sigma^m\bar{\theta}v_m
\]

\[
+ i\theta^2\bar{\theta}\left(\bar{\lambda} + \frac{1}{2}i\sigma^m\partial_m\chi\right) - i\bar{\theta}^2\theta\left(\lambda + \frac{1}{2}i\sigma^m\partial_m\bar{\chi}\right) + \frac{1}{2}\theta^2\bar{\theta}^2 \left( D + \frac{1}{2}\Box C\right),\tag{16}
\]

where $C(x), M(x), N(x), D(x)$ are real scalar fields, $\chi_\alpha(x), \lambda_\alpha(x)$ and $\bar{\chi}_{\dot{\alpha}}(x), \bar{\lambda}_{\dot{\alpha}}(x)$ are Weyl spinors and their complex conjugates, and $v_m(x)$ is a real vector field. We adopt the notations in ref. [1]. Following refs. [3], we define the superfield $\tilde{\text{V}}(x, \theta, \bar{\theta})$ by

\[
\tilde{\text{V}}(x, \theta, \bar{\theta}) = \text{V}(x', \theta', \bar{\theta}'), \tag{17}
\]

\[
x'^m = x^m + i\kappa \left( \zeta(x)\sigma^m\bar{\theta} - \theta\sigma^m\bar{\zeta}(x) \right), \quad \theta' = \theta - \kappa\zeta(x), \quad \bar{\theta}' = \bar{\theta} - \kappa\bar{\zeta}(x). \tag{18}
\]

$\tilde{\text{V}}$ may be expanded as \([16]\) in component fields \{$\tilde{\phi}_i(x)$\} = \{$\tilde{C}(x), \tilde{\chi}(x), \tilde{\bar{\chi}}(x), \cdots$\}, which can be expressed by $C, \chi, \bar{\chi}, \cdots$ and $\zeta, \bar{\zeta}$ by using the relation (17). $\kappa$ is now defined with the dimension (length$^2$). They have the supertransformations of the form

\[
\delta\tilde{\phi}_i = -i\kappa \left( \zeta\sigma^m\bar{\epsilon} - \epsilon\sigma^m\bar{\zeta} \right) \partial_m\tilde{\phi}_i. \tag{19}
\]

Therefore, a condition $\tilde{\phi}_i(x) = \text{constant}$ is invariant under supertransformations. As we are only interested in the sector which only depends on the N-G fields, we eliminate other degrees of freedom than the N-G fields by imposing SUSY invariant constraints

\[
\tilde{C} = \tilde{\chi} = \tilde{M} = \tilde{N} = \tilde{v}_m = \tilde{\lambda} = 0, \quad \tilde{D} = \frac{1}{\kappa}. \tag{20}
\]
Solving these constraints we find that the original component fields $C$, $\chi$, $\bar{\chi}$, $\cdots$ can be expressed by the N-G fields $\zeta$, $\bar{\zeta}$. Among them, the leading terms in the expansion of the fields $v_m$, $\lambda$, $\bar{\lambda}$ and $D$, which contain gauge invariant degrees of freedom, in $\kappa$ are

\[v_m = \kappa \zeta \sigma_m \bar{\zeta} + \cdot, \lambda = i \zeta - \frac{1}{2} \kappa^2 \zeta \left( \zeta \sigma^m \partial_m \bar{\zeta} - \partial_m \zeta \sigma^m \bar{\zeta} \right) + \cdot, D = \frac{1}{\kappa} + i \kappa \left( \zeta \sigma^m \partial_m \bar{\zeta} - \partial_m \zeta \sigma^m \bar{\zeta} \right) + \cdot,\]

(21)

where $\cdot$ are higher order terms in $\kappa$. Our discussion so far does not depend on a particular form of the action. We now consider a free action of a U(1) gauge supermultiplet of L SUSY with a Fayet-Iliopoulos $D$ term. In component fields we have

\[S = \int d^4x \left[ -\frac{1}{4} v_{mn} v^{mn} - i \lambda \sigma^m \partial_m \bar{\lambda} + \frac{1}{2} D^2 - \frac{1}{\kappa} D \right].\]

(22)

The last term proportional to $\kappa^{-1}$ is the Fayet-Iliopoulos $D$ term. The field equation for $D$ gives $D = \frac{1}{\kappa} \neq 0$ in accordance with eq. (21), which indicates the spontaneous breakdown of supersymmetry. We substitute eq. (21) into the action (22) and obtain an action for the N-G fields $\zeta$, $\bar{\zeta}$ which is exactly N=1 V-A action.

\[S = -\frac{1}{2\kappa^2} \int d^4x \left[ \delta^n + i \kappa^2 \left( \zeta \sigma^n \partial_n \bar{\zeta} - \partial_n \zeta \sigma^m \bar{\zeta} \right) \right].\]

(23)

For N=1, U(1) gauge field becomes $v_m \sim \kappa \bar{\zeta} \gamma_m \gamma_5 \zeta + \cdots$ in the four-component spinor notation, which is an axial vector. These are very suggestive and favourable to SGM.

## 5 Discussion

SGM action in SGM spacetime is a nontrivial generalization of E-H action in Riemann spacetime despite the liner relation $w^a_\mu = e^a_\mu + t^a_\mu$. In fact, by the redefinitions (variations) $e^a_\mu \rightarrow e^a_\mu + \delta e^a_\mu = e^a_\mu - t^a_\mu$ and $\delta e^a_\mu = -e^a_\nu e^\nu_\alpha \delta e^\beta_\beta = +t^a_\mu$ the inverse $w^a_\mu = e^a_\mu - t^a_\mu$ and $t^a_\mu$ in the expansion of (7) in terms of $e^a_\mu$ and $t^a_\mu$ is a spontaneous breakdown of the renormalizable (broken SUSY) models of the local field theory containing the massive high spin field by the linearization in the curved spacetime.
$\frac{3}{2}$ N-G fermion and SGM with the extra dimensions to be compactified are also in the same scope. SGM cosmology is open.
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