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Left-Right Symmetric Models from Higher Dimensional Space

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Abstract*: We consider higher dimensional gravity-coupled gauge models in D= 8 and 10 dimensions with gauge group G= SU(6).The extra dimensional compact spaces have coset structures SU(3)/SU(2)⊗U(1) and SU(3)/U(1)⊗U(1) respectively. Here both the compact spaces are assumed to have a Kaluza-Klein metric ansatz to generate a color symmetry from the geometry of the compact space.Then using the Coset Space Dimensional Reduction (CSDR) scheme supplemented by orbifold conditions on the compact spaces, we obtain Left-Right symmetric models, extended by U(1)'s. The conventional quarks and leptons are obtained in the effective four dimensions, by using a monopole background field on the compact manifold.*
Keywords*: Kaluza-Klein metric,CSDR scheme, Orbifold compactification, Monopole .*

I. Introduction

The standard model (SM) of particle physics is believed to be the most successful model in the description of nature. However due to lack of some fundamental issues like existence of massive neutrinos, the standard model needs to be extended to Left-Right symmetric model. In such models, parity is spontaneously broken and smallness of neutrino masses arises naturally via seesaw mechanism. However, with the advent of new experimental challenges, it is now believed that all these models may be the remnant of some complete theory in higher dimensional space at the Planck scale. With the success of Supper String Theory (SST) [1], there is revival of interest for higher dimensional gauge theories to build phenomenological viable models. The notion of higher dimensions was initiated with the work of Kaluza and Klein [2] in five dimension with the sole aim to unify gravity with the electro-magnetic interaction. In this present paper we shall investigate two higher dimensional models coupled with Yang-Mills and Dirac field in eight and ten dimensions, to obtain Left-right symmetric models in the effective four dimension as a result of suitable compactification. The extra dimensional space in both the cases assumes a coset structure S/R, with S and R being Lie groups. We shall employ the Coset Space Dimensional Reduction (C.S.D.R.) Scheme [3] with an additional input of Kaluza-Klein (K-K) ansatz for the off-diagonal component of the metric tensor to achieve this. The additional input generates an SU(3) color symmetry from the geometry of the coset spaces, exactly in tune with the original K-K theory. The remaining part of the Left-Right symmetry will be obtained from the higher dimensional gauge group G after usual coset space dimensional reduction scheme, supplemented by non-trivial boundary conditions [4] on the extra dimensional compact space. Further to obtain chiral fermions in four dimension, we introduce background gauge fields corresponding to monopole configuration [5].The main motivation of such a frame-work is to achieve a Left-right symmetric models by utilizing the gauge memory inherent in the coset space structure of the extra dimension.

The paper is organized as follows. In the next section we shall briefly discuss the basic principles involved in the C.S.D.R. scheme in the spirit of Kaluza-Klein ansatz. The section III is devoted to model building.. We shall then conclude in the last section.

II. Basic Principle

Here we consider a D=4+d dimensional gravity coupled theory of Yang-Mills Field with the gauge group G and fermions with appropriate representation F of G. It is assumed that the higher dimensional space has the ground state structure $M^4 \otimes S/R$ with S and R being Lie groups such that $R \subset S$.Then the action integral can be taken as,

$$\mathcal{L} = \int d^M Z\, \mathcal{L}_{total}\text{ , where } \mathcal{L}_{total} = \mathcal{L}_{gravity} + \mathcal{L}_{Yang-Mill} + \mathcal{L}_{Dirac}$$
$$= \int d^M Z(-\det E(x,y))[R + \tfrac{1}{4}\mathrm{Tr}\, F_{MN}F^{MN} + \tfrac{1}{2}\overline{\psi}\Gamma^M D_M \psi] \quad (1)$$

where $Z^M = (x^m, y^\alpha)$, x^m being the four dimensional co-ordinates and y^α refers to the compact space (S/R) co-ordinates. Here E(x,y) denotes the vielbein in (d+4) space, R is the (d+4) dimensional curvature scalar representing the gravity Lagrangian. F_{MN} refers to the Yang-Mills field strength corresponding to the gauge group G. $\psi(\overline{\psi})$ is the Dirac fermion representation which lies in a representation F of G. D_M is the covariant derivative in the higher dimensional space such that,

$$D_M = \partial_M - \tfrac{1}{2}B_{M[AB]}\Sigma^{AB} - i\mathcal{V}_M \quad (2)$$

Here $B_{M[AB]}$ represents the spin connection which contains the gauge memory of S (in S/R) and $\mathcal{V}_M$ is the gauge connection corresponding to the initial gauge group G. We shall now assume the Salam-Strathdee [6] ansatz for the vielbein $E_M^A(x,y)$ given by,

$$E_M^A(x,y) = \begin{pmatrix} e_m^i(x) & e_m^a(x,y) = -A_m^{\hat{a}}(x)D_{\alpha\hat{a}}(L_y) \\ e_\alpha^i(x,y) = 0 & e_\alpha^a(y) \end{pmatrix} \quad (3)$$

In the above A = (i, a) denotes the Lorentz indices and M = (m, α) denotes the Einstein indices. Here the off-diagonal component $e_m^a(x,y)$ transforms like a gauge field $A_m^{\hat{a}}(x)$ belonging to S (= SU(3)) of the coset space S/R. Now as per the Kaluza-Klein mode of compactification, the gravity part $\mathcal{L}_{gravity}$ is effectively reduced to,

$$R^{(D)} = R^{(4)} - \frac{1}{4}S_{ij}^{\hat{a}}S_{ij}^{\hat{b}}D_{\hat{a}}^{c}(L_y)D_{\hat{b}}^{c}(L_y^{-1}) + R^{(k)} \quad (4)$$

Here $R^{(4)}$ denotes the four dimensional curvature scalar, $R^{(k)}$ gives the compact space curvature scalar, the second term denotes the Yang-Mill part corresponding to S≡SU(3) symmetry in the effective four dimension. Here we may note that the Kaluza-Klein theory does not generate any appropriate Higgs scalars to break the symmetry at low energy, which seems to be a bonus in the present case as the colour SU(3) symmetry remains intact till low energy .

We shall then analyse the Yang-Mills part of the Lagrangian (equation 1) by using the conventional approach of coset space dimensional reduction (CSDR) scheme [5]. As per the scheme, after dimensional reduction, the higher dimensional gauge group reduces to H in the effective four dimension, which is the centralizer of R in G. Hence in the present case, the effective theory contains S ⊗ H i.e SU(3) ⊗ H as the resulting gauge group. Further the compact space components of the gauge field appear as the Higgs in the four dimension, subjected to the following constraint. For S ⊃ R, we have Adj S = Adj R + v , where v = $\sum_i s_i$ denotes the tangent vectors of (S/R) space. Then for G⊃ R_G ⊗ H, we have Adj G = (AdjR,1) + (1,AdjH) + (ri, hi) . Here h^i s are the Higgs in the effective four dimension, where r_i and s_i are identical representations of R. Further to obtain Left-Right symmetry group, we have to impose the non-trivial boundary conditions on the compact space for the gauge fields (like orbifold models). By an appropriate choice of parities for the gauge group representation space, H is broken to smaller subgroups on the boundaries (the fixed points of the orbifold symmetry). The details shall be discussed in the next section.

In a similar manner to identify the effective fermion multiplets which remain massless (as per the CSDR scheme), one has to consider the breaking of SO(d) spinors into direct sums of irreducible representations of R as $\sigma = \sum_i \sigma_i$ .The next step is to decompose the complex/real (for D=8 and D=10 respectively) fermion representation F (as has been taken in equation (1)) of G with respect to R⊗H, such that F = (r_k ,f_k). Now for each pair of (r_k , σ_k), which constitute identical irreducible representations, there exists an f_k multiplet in effective four dimension with gauge group H. Further by imposing boundary conditions , the massless fermions are further constrained in the effective four dimension. However the SU(3) color contents of the fermions can be determined in specific models, which we shall discuss in the next section. We shall note here that, the compact spaces do not admit chiral spinors unless it is coupled with topological (monopole) background field [5]

III. The Models

In this section we shall attempt to construct realistic models based on eight and ten dimensional theory treated with the Kaluza-Klein ansatz and C.S.D.R. scheme simultaneously, as has been discussed before. Both the compact spaces have S/R coset structures, such that S=SU(3) to generate SU(3) color symmetry by using K-K ansatz.

3.1. Example –I (D= 8):

Here we consider the extra dimensional space to be a four dimensional coset space SU(3)/SU(2)⊗U(1) which is isomorphic to CP^2 with the gauge group G=SU(6). According to the C.S.D.R. scheme, the tangent space SO(4) vectors in SU(2)⊗U(1) space are $V=2_{\pm3}$ and the SO(4) spinors are $\sigma = 2_0, 1_{\pm2}$. Now to embed R= SU(2)⊗U(1) into G=SU(6) we choose the branching rule to be ,

$$G = SU(6) \longrightarrow SU(4)\otimes[SU(2)\otimes U(1)] \quad (G_{421}) \quad (5)$$

Thus the centralizer of SU(2) ⊗ U(1) in SU(6) is $SU(4)\otimes U(1)_I$ which is the effective gauge group in four dimension. Now the decomposition of the adjoint representation of SU(6) according to above branching rule is

$$\text{Adj(SU(6))} = 35 = (1,1)_0 \oplus (1,3)_0 \oplus (15,1)_0 \oplus (4,2)_{-3} \oplus (\bar{4},2)_3 \quad (6)$$

Therefore by using the constraint of CSDR scheme we obtain $4_{-3}$and $\bar{4}_3$ as the Higgs scalars in the four dimensions, as they have the identical R representation with that of tangent space vectors. However these Higgs are not appropriate to break SU(4) group to the required group $SU(2)\otimes SU(2)\otimes U(1)_{II}$. Hence we have to impose the non-trivial boundary conditions on the CP^2 space by orbifolding of the extra space with Z_2 . Since CP^1 (= S_2) is a subset of CP^2 one can consider the same two parity operations $P_1 : (\theta,\varphi)\rightarrow(\pi-\theta,-\varphi)$ and $P_2 : (\theta,\varphi)\rightarrow(\pi-\theta, 2\pi-\varphi)$, as has been considered in case of S_2 space [7]. The parity assignments P_1 and P_2 for the gauge fields in the adjoint representation, such that,

$SU(4)\otimes U(1) \longrightarrow SU(2)\otimes SU(2)\otimes U(1)_I\otimes U(1)_{II}$ are choosen to be,

$$Adj(SU(4)\otimes U(1)=(15)_0= (3,1)^{++}_{0,0}\oplus(1,3)^{++}_{0,0}\oplus(1,1)^{++}_{0,0} \oplus(1,1)^{++}_{0,0}\oplus(2,2)^{+-}_{0,-2} \oplus(2,2)^{-+}_{0,2} \tag{7}$$

Thus $SU(4)\otimes U(1)_I$ breaks to $SU(2)\otimes SU(2)\otimes U(1)_I\otimes U(1)_{II}$ as the corresponding gauge bosons with even parity (++) are massless. As has been mentioned in section2, the gravity sector and Yang-Mills part will give rise to $SU(3)\otimes SU(2)\otimes SU(2)\otimes U(1)_I\otimes U(1)_{II}$ in the effective four dimension by using Kaluza-Klein ansatz and CSDR scheme simultaneously. Similarly for the Higgs sector, we have,

$$4_{-3}+ \bar{4}_3= (2,1)^{--}_{1,-3}\oplus(1,2)^{++}_{-1,-3}\oplus (2,1)^{++}_{-1,3}\oplus(1,2)^{--}_{1,3} \tag{8}$$

The even parity zero mode scalars $(1,2)^{++}_{-1,-3}$ and $(2,1)^{++}_{-1,3}$ will serve as Higgs to break left- right symmetry respectively in the low energy sector. Now to accommodate the matter sector, we have to take a complex representation F of G in eight dimension. We thus take {84} of SU(6) ,such that its decomposition according to the eq.(5) is given by,

$$F=\{84\}= (1,2)_4\oplus (\bar{4},1)_{10}\oplus (4,1)_{-2}\oplus (4,3)_{-2}\oplus (6,2)_{-8} \oplus (20,1)_{-2}\oplus (15,2)_4 \tag{9}$$

Therefore as per the CSDR scheme, the surviving spinors in the effective four dimension are 4_{-2} and 20_{-2}. Now to obtain the matter sector in the Left-right symmetric model, we have to adopt non-trivial boundary condition of the extra dimensional space by using proper parity assignment under P_1 and P_2 . We choose,

$$4_{-2}= (2,1)^{-+}_{-1,-2,}\oplus(1,2)^{++}_{1,-2} \ ;$$
$$20_{-2}= (1,2)^{+-}_{1,-2}\oplus(2,1)^{++}_{-1,-2}\oplus(2,1)^{++}_{3,-2}\oplus(1,2)^{++}_{-3,-2}\oplus(2,3)^{-+}_{-1,-2}\oplus(3,2)^{--}_{1,-2}; \tag{10}$$

Therefore the multiplets with even parity will be the zero modes serving as the conventional quarks and leptons in the $SU(2)\otimes SU(2)\otimes U(1)_I\otimes U(1)_{II}$ space.

$$\text{Leptons: } \begin{pmatrix} \nu_e \\ e^- \end{pmatrix}_L = (2,1)_{3,-2}; \qquad \begin{pmatrix} \nu_e \\ e \end{pmatrix}_R = (1,2)_{-3,-2};$$
$$\text{Quarks: } \begin{pmatrix} u \\ d \end{pmatrix}_L = (2,1)_{-1,-2}; \qquad \begin{pmatrix} u \\ d \end{pmatrix}_R = (1,2)_{1,-2} \tag{11}$$

Here we may note that, the $U(1)_I$ is the conventional (B-L) symmetry. We shall now discuss the color content of the above fermions, borrowed from the gravity sector (as has been discussed earlier). The colour memory of the fermions will be clearly visible from the effective Dirac Lagrangian (equation 1) in four dimensions as

$$L_D= \int d^4 x\, E(x)\bar{\psi}[\Gamma^i(E^m_i \nabla_m + E^\alpha_i \nabla_\alpha) + \Gamma^a(E^m_a \nabla_m + E^\alpha_a \nabla_\alpha)]\, \psi \tag{12}$$

Here the covariant derivatives in the compact space will include the spin connection corresponding to the SU(3) group as well as the gauge connection. Here using the vielbein components from equation (3) we can write the interaction term between fermion field ψ and SU(3) gauge field $A^{\hat{a}}_m(x)$ as given by , $\bar{\psi}_{\alpha\beta} (\Gamma^i)_{\alpha\rho}A^{\hat{a}}_m(x)\, (D(Q_a))_{\beta\sigma}\, \psi_{\rho\sigma}$. Here α and β are the spinorial indices in d+4 dimensions. Since $A^{\hat{a}}_m(x)$ transforms as an octet under SU(3), we shall take **Ψ** to transform either as a triplet or a singlet under SU(3) so as to maintain SU(3) invariance. We thus note that the surviving fermions (of equation (11)) in four dimension have a colour memory of (3+1), which thus correspond to quarks and leptons. However to distinguish between the triplet and singlet states corresponding to the fermions in equation (11) in $SU(2)\otimes SU(2)\otimes U(1)_I\otimes U(1)_{II}$ space, is not very obvious, since gravity Lagrangian is blind to the initial gauge group G. To do so one has to take an U(1) monopole background field in the compact space as has been proposed by many authors [5].

We know that the CP^2 space does not admit chiral fermions. So we follow the method of [9] by introducing monopoles as background gauge field. This will make fermions massless by cancelling the spin connection term in the covariant derivative. In the usual CSDR scheme, to know which representations of S, i.e. SU(3) occur as massless zero modes, it is necessary to compare the R content of a representation of S with the R content of tangent space group, i.e O(4). However in the presence of topological nontrivial background, i.e. the U(1) monopole fields, the above procedure has to be modified to take effective R content of the tangent group. Following Salam and Strathdee [6], we can have harmonic expansion of the fields on the compact space

S/R. In the present case, the fermionic zero modes are those representations of SU(3), which occur in the harmonic expansion of either Left-handed or right-handed part of the SO(2N) spinor, but not both. These states are massless on the Planck scale, but may have masses on the electroweak scale. Now in the presence of U(1) magnetic monopole [10], the effective R i.e SU(2)⊗U(1) content of the Left handed (ψ_L) and Right handed (ψ_R) spinors in the CP^2 space is given as,

$$\psi_L = \{1_{2+2+(4/3)n}\} + \{1_{-2+2+(4/3)n}\}$$
$$\psi_R = \{2_{0+2+(4/3)n}\} \quad (13)$$

Now the fundamental representation {3} and the singlet {1} of S i.e. SU(3) has the R i.e. SU(2)⊗U(1) content , given as, $\{3\} = 2_{2/3} + 1_{-4/3}$. and $\{1\} = 1_0$. We shall now compare the R content of the spinors ψ_L and ψ_R with {3} + {1} of SU(3) to obtain the zero modes. The triplet of SU(3) occurs as a zero mode (in ψ_L) for n = -4 , singlet of SU(3) occurs as a zero mode (in ψ_L) for n = 0 or -3 . the anti-triplet occurs as a zero mode for n = 1. We can interpret the zero modes as, the distinct harmonics for leptons (anti-leptons), which are color singlets correspond to n = 0 and -3 respectively. Similarly for quarks (anti-quark), which are color triplet (anti-triplet) correspond to harmonics n = -4 and 1 respectively. Thus all the matter contents are in agreement with conventional quarks and leptons in the (Extended) Left- Right symmetric model.

Leptons: $\begin{pmatrix} \nu_e \\ e^- \end{pmatrix}_L = (1,2,1)_{3,-1}$; n = 0 $\quad \begin{pmatrix} \nu_e \\ e \end{pmatrix}_R = (1,1,2)_{-3,-1}$; n = -3

Quarks: $\begin{pmatrix} u \\ d \end{pmatrix}_L = (3,2,1)_{-1,-1}$; n = -4 $\quad \begin{pmatrix} u \\ d \end{pmatrix}_R = (\overline{3},1,2)_{1,-1}$; n = 1 (14)

3.2. Example –II (D=10):

Here the compact space has the coset structure SU(3)/U(1)⊗U(1). The corresponding gauge group is taken to be SU(6). According to the CSDR scheme, the vectors and spinors of the coset space SU(3) /(U(1)⊗ U(1)), are given as V= $(\pm1,\pm3) \oplus (\pm2,0)$. The corresponding spinors are, $\sigma_N = 4 = (0,0) \oplus (1,\pm3) \oplus (-2,0)$ and the conjugate $\overline{4} = (0,0) \oplus (-1,\pm3) \oplus (2,0)$ $under\ R = U(1)$⊗U(1). Now to embed R= U(1)⊗U(1) into G=SU(6) we choose the branching rule to be

$$G = SU(6) \longrightarrow SU(2)\otimes SU(4)\otimes U(1)_z \longrightarrow U(1)_y\otimes SU(4)\otimes U(1)_z$$

Thus the centralizer of U(1) ⊗ U(1) in SU(6) is SU(4)⊗ $U(1)_y$⊗ $U(1)_z$ which is the effective gauge group in four dimension. Now the decomposition of the adjoint representation of SU(6) according to above branching rule is

$$35 = (1,1)_0\oplus(3,1)_0\oplus(1,15)_0\oplus(2,4)_{-3}\oplus(2,\overline{4})_3$$
$$= (0,1)_{0,}\oplus(\pm2,0),1)\oplus(0,15)_0\oplus(\pm1,4)_{-3}\oplus(\pm1,\overline{4})_3 \quad (15)$$

Therefore by using the constraint of CSDR scheme we obtain $4_{\pm1,-3}$and $\overline{4}_{\pm1,3}$ as the Higgs scalars in the four dimensions. However these Higgs are not appropriate to break SU(4) group to the required group SU(2)⊗ SU(2)⊗$U(1)_x$. Hence we have to impose the non-trivial boundary conditions on the compact space by orbifolding of the extra space with Z_2 as has been taken in the earlier case. In the breaking channel, $SU(4)\otimes U(1)_y\otimes U(1)_z \longrightarrow SU(2)\otimes SU(2)\otimes U(1)_x\otimes U(1)_y\otimes U(1)_z$, we have choosen,

$$Adj(SU(4)\otimes U(1)_y\otimes U(1)_z)=(15)_{0,0}$$
$$= (3,1)^{++}_{0,0,0}\oplus(1,3)^{++}_{0,0,0}\oplus(1,1)^{++}_{0,0,0}\oplus(1,1)^{++}_{0,0,0}\oplus(1,1)^{++}_{0,0,0}\oplus(2,2)^{+-}_{-2,0,0} \quad (16)$$

Thus, SU(4)⊗ $U(1)_y$⊗ $U(1)_z$ breaks to SU(2)⊗SU(2)⊗$U(1)_x$⊗$U(1)_y$⊗$U(1)_z$, as the even parity states remain massless. Thus, the gravity sector and Yang-Mills part will give rise to SU(3)⊗ SU(2)⊗ SU(2)⊗ $U(1)_x$⊗$U(1)_y$⊗$U(1)_z$ in the effective four dimension by using Kaluza-Klein ansatz and CSDR scheme simultaneously. Similarly for the Higgs sector, we have,

$$4_{\pm1,-3}+\overline{4}_{\pm1,3} = (2,1)^{--}_{1,\pm1,-3}\oplus(1,2)^{++}_{-1,\pm1,-3}\oplus(2,1)^{++}_{-1,\pm1,3}\oplus(1,2)^{--}_{1,\pm1,3} \quad (17)$$

The even parity zero mode scalars $(1,2)^{++}_{-1,\pm1,-3}$ and $(2,1)^{++}_{-1,\pm1,3}$ will serve as Higgs to break left- right symmetry respectively in the low energy sector. Now to accommodate the matter sector, we have to take a real representation F of G in ten dimension. We thus take {175} of SU(6) ,such that its decomposition according to the eq.(5) is given by,

$$F = \{175\} = (1,10)_6\oplus(1,\overline{10})_{-6}\oplus(1,15)_0\oplus(3,20')_0\oplus(2,20)_{-3}\oplus(2,,\overline{20})_3$$
$$\longrightarrow (0,10)_6\oplus(0,\overline{10})_{-6}\oplus(0,15)_0\oplus((\pm2,0),20')_0\oplus(\pm1,20)_{-3}\oplus(\pm1,,\overline{20})_3 \quad (18)$$

Therefore as per the CSDR scheme, the surviving spinors in the effective four dimension are $20_{\pm1,-3}$ and $\overline{20}_{\pm1,3}$, $20'_{\pm2,0}$ Now to obtain the conventional matter sector in the Left-right symmetric model, we have to adopt non-trivial boundary condition of the extra dimensional space by using proper parity assignment under P_1 and P_2 . We choose,

$$20_{\pm1,-3} \oplus \overline{20}_{\pm1,3}$$
$$= (1,2)^{++}_{1,\pm1,-3} \oplus (2,1)^{++}_{-1,\pm1,-3} \oplus (2,1)^{++}_{3,\pm1,-3} \oplus (1,2)^{++}_{-3,\pm1,-3} \oplus (2,3)^{-+}_{-1,\pm1,-3,} \oplus (3,2)^{--}_{1,\pm1,-3} \oplus \text{h.c.} \qquad (19)$$

Thus we have the even parity zero modes as,

$$\text{Leptons: } \begin{pmatrix} \nu_e \\ e^- \end{pmatrix}_L = (2,1)_{3,\pm1,-3}; \qquad \begin{pmatrix} \nu_e \\ e \end{pmatrix}_R = (1,2)_{-3,\pm1,3};$$
$$\text{Quarks: } \begin{pmatrix} u \\ d \end{pmatrix}_L = (2,1)_{-1,\pm1,-3}; \qquad \begin{pmatrix} u \\ d \end{pmatrix}_R = (1,2)_{1,\pm1,3} \qquad (20)$$

However the color sector of the above chiral fermions can be prescribed by taking $U(1)_z$ monopole configuration in the compact space. It is exactly equivalent as in the previous case. The distinction for the triplet and singlet states will occur as different harmonics.

IV. Conclusion

We have studied D = 8 ,10 dimensional gauge models with SU(6) group, coupled with gravity and Dirac fermions, compactifed on an orbifold in presence of U(1) magnetic monopole. We obtain a Left-right symmetric model extended by an exotic $U(1)_{II}$ with all the conventional quarks and leptons, starting with a minimal set of complex representation {84} of SU(6) in case of D=8. The electro-weak symmetry breaking is achieved by the doublets $(1,2)_{1,-3}$ and $(21)_{-1,3}$. For D= 10, we have obtained the model with two exotic U(1)'s with all the conventional quarks and leptons, starting with a minimal set of real representation {175} of SU(6). However the D=8 model looks to be more promising with only an exotic U(1). However, it is observed that, neither CSDR scheme nor the orbifold scheme can alone reproduce the conventional Left-right symmetric models from higher dimensions. It is revealed that a combined approach of CSDR scheme and the orbifold is capable of producing Left-right symmetric models from higher dimensional space.

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