Particle Origins for String Vibrations

Abstract: Considering the origin of the particles an approach has been provided to show the origin of Bosons, Fermions along with supersymmetry (SUSY) from string vibrations in $g \geq 1$ genus of a hypercomplex manifold through $\eta \times \eta$ matrix for the generator $\nabla_{(p,q)}$.

Keywords: String Theory – Particles – Supersymmetry

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Introduction:

Hypercomplex manifold is an essential ingredient in string theory. The topological string story formalises the concept of compact Kähler manifolds having Ricci flatness that in essence is the Calabi-Yau manifolds where for the Calabi-Yau geometry; Calabi-Yau threefolds are non-trivial in string theoretic foundations. Being the fundamental structure of vibrations; those strings resonant in a specific pattern with each pattern gives rise to each category of particles. All that is needed is the genus of the hypercomplex manifolds to carry out the vibrations and the permutation cycles associated with them as each schemes of permutation corresponds to a generator for each class of particles, be it bosons, fermions or their supersymmetric partner. Thus, the necessity arrives to calculate a formalism that in a precise way formulate those vibration cycles and depict what categories of particle emerge from them. This paper typically focusses on this vibration category and schemes related to the particle generation scenario.

This paper focuses on the hypercomplex manifold with no such specific dimensions although in the cases of general M-Theory, a compact Kähler having Ricci flatness or Calabi-Yau is a hypercomplex manifold of six compactified dimensions. Therefore, generalizing the notion of dimensions the strings being considered here as fibres for a coherent formation goes 'in' and 'out' of the genera and the specific symphony of the vibration cycle with respected permutations gives rise to the particles be it boson, fermion or their supersymmetric partner.

This permutation cycles depend totally on the chirality as computed towards the methodological aspects of the paper where it is necessary to develop the formations as per four signatures of the chiral operator $\mathcal{L}$,

$$\langle +, -, \pm, \mp \rangle$$

Where each of such signature when marks the initiation point then each type of particles arises where in case of a scheme considered here as ϵ_{ij} when $i = j$ then for the directions or chirality as taken $\langle + \rangle$, the cycle starts with even generates boson or ∂ while for the chirality $\langle - \rangle$, the cycle in odd generates fermions or $\bar{\partial}$. The odd and even cycle is same in the matrix operation $\eta \times \eta$ for ϵ_{ij} when $i = j$ in both the cases of $\mathcal{L}^+$ and $\mathcal{L}^-$ which shows the supersymmetric partner for,

$$\left\{ \begin{array}{c} \mathcal{L}^+ \leadsto for\ every\ fermion\ \bar{\partial}\ there\ is\ a\ boson\ \partial \implies \bar{\partial}\partial\ as\ the\ initiation\ point \\ which\ alters\ in\ the\ next\ cycle\ and\ then\ returns\ back\ in\ the\ previous\ cycle \\ \downarrow \\ \downarrow \\ \mathcal{L}^- \leadsto for\ every\ boson\ \partial\ there\ is\ a\ boson\ \partial \implies \bar{\partial}\partial\ as\ the\ initiation\ point \\ which\ alters\ in\ the\ next\ cycle\ and\ then\ returns\ back\ in\ the\ previous\ cycle \end{array} \right. \quad \exists potential\ is\ \rho$$

Whereas the alternative form is considered for the same matrix $\eta \times \eta$ for ϵ_{ij} for $i \neq j$ which shows the chiral operator $\mathcal{L}$ having signatures,

$$\langle \pm, \mp \rangle$$

Extend the notion of the potential having the vibration cycle such that the derivative of the potential $\partial\rho$ is extended into such a state that there is no such supersymmetric formulations or particle formations – that is to say,

$$\begin{cases} \mathcal{L}^{\pm} \rightsquigarrow extends\ \mathcal{L}^{+}\ and\ ultimately\ gives\ rise\ to\ only\ bosons\ \partial\partial\ upto\ k \\ \downarrow \\ \downarrow \\ \mathcal{L}^{\mp} \rightsquigarrow extends\ \mathcal{L}^{-}\ and\ ultimately\ gives\ rise\ to\ only\ fermions\ \overline{\partial\partial}\ upto\ k \end{cases} \exists potential\ is\ \rho^{-1}, \rho^{+1}$$

Where two peculiar instances of particle generation are shown for the chiral operator $\mathcal{L}$ in the same matrix $\eta \times \eta$ upto k such that for the chiral signatures,

$$\langle ++, --\rangle$$

$$\begin{cases} \mathcal{L}^{++} \rightsquigarrow generates\ only\ bosons\ upto\ k \\ \downarrow \\ \downarrow \\ \mathcal{L}^{--} \rightsquigarrow generates\ only\ fermions\ upto\ k \end{cases} \exists potential\ is\ \rho^{+0}, \rho^{-0}$$

The detailed calculations will be computed in the next section.

Methodology:

A topological hypercomplex manifold $T^{\star}$ having genus $g \geq 1$ such that $M \subset T^{\star}$ where M represents the hyperbolic ring of a genus g for the codimension inside the genus being represented as d which in essence is[1-5],

$$g = \{\phi\}$$

There exists the $n-$ dimensions of the hypercomplex manifold $T^{\star}$ having the spacetime coordinate (σ, ρ) it can be shown that there exists a defective unit ϵ for each genus having a signature $(\sigma, \rho)|_{\epsilon}$ where ϵ depends on odd or even cycles of each strings s having a summation of their coherent structure to be represented as[6-8],

$$\sum_{s}$$

Determines the genus signature of $n-$ dimensions for the defective unit ϵ taking the sub i, j for a scheme μ such that[9,10],

$$\text{In } \epsilon_{ij} = \begin{cases} i = j\ for\ \mu = odd\ or\ even \\ i \neq j\ for\ \mu = reciprocal \end{cases}$$

Where the genus signature can be spotted over a multiple sequence of 'in' and 'out' fibrations in such a way that[11-13],

For the coherent fibre $\mathcal{O}$ which in essence determines the summation of the strings $\sum_{s}$ there exists a factor of coherent fibre length $\mathcal{J}$ that determines the length of the cycle ℓ that is exactly the length of the fibre determines the length of the 'in' and 'out' cycle between the genus $g \geq 1$ to input the defective unit ϵ_{ij} where this can be easily shown that the cycle ℓ is given for the matrix $\eta \times \eta$,

$$
\text{for chirality } \mathcal{L}^{+} \begin{pmatrix}
\partial &&&&&&&&&&&& \\
& \bar{\partial} &&&&&&&&&&& \\
&& \partial &&&&&&&&&& \\
&&& \bar{\partial} &&&&&&&&& \\
&&&& \ddots &&&&&&&& \\
&&&&& \ddots &&&&&&& \\
&&&&&& \bar{\partial}\partial &&&&&& \\
&&&&&&& \partial\bar{\partial} &&&&& \\
&&&&&&&& \bar{\partial}\partial &&&& \\
&&&&&&&&& \partial\bar{\partial} &&& \\
&&&&&&&&&& \ddots && \\
&&&&&&&&&&& \ddots & \\
&&&&&&&&&&&& k
\end{pmatrix}_{\eta\times\eta} \equiv \epsilon_{ij} \text{ for } i = j
$$

$$
\xrightarrow{\Rightarrow \mathrm{Tr}(\partial+\bar{\partial}+,\ldots\ldots,k)} \frac{1}{2}(2\pi i) \oint_{\ell} \mathcal{O} \oint_{\ell} \mathcal{O} \oint_{\ell} \mathcal{O}, \ldots\ldots\ldots, \oint_{\ell} \mathcal{O}_k \;\; d\mathcal{J}\, d\mathcal{J}\, d\mathcal{J} \ldots\ldots\ldots d\mathcal{J}_k \approx \partial\rho
$$

Where $\mathcal{L}^{+} \cong \mathcal{L}^{-}\, for \epsilon_{ij}$ for $i = j$ where $\mathcal{L}^{-}$ can be shown to have the opposite identity but still equal in terms of defect unit for the matrix depiction,

$$
\text{for chirality } \mathcal{L}^{-} \begin{pmatrix}
\bar{\partial} &&&&&&&&&&&& \\
& \partial &&&&&&&&&&& \\
&& \bar{\partial} &&&&&&&&&& \\
&&& \partial &&&&&&&&& \\
&&&& \ddots &&&&&&&& \\
&&&&& \ddots &&&&&&& \\
&&&&&& \partial\bar{\partial} &&&&&& \\
&&&&&&& \bar{\partial}\partial &&&&& \\
&&&&&&&& \partial\bar{\partial} &&&& \\
&&&&&&&&& \bar{\partial}\partial &&& \\
&&&&&&&&&& \ddots && \\
&&&&&&&&&&& \ddots & \\
&&&&&&&&&&&& k
\end{pmatrix}_{\eta\times\eta} \equiv \epsilon_{ij} \text{ for } i = j
$$

$$
\xrightarrow{\Rightarrow \mathrm{Tr}(\bar{\partial}+\partial+,\ldots\ldots,k)} \frac{1}{2}(-2\pi i) \oint_{\ell} \mathcal{O} \oint_{\ell} \mathcal{O} \oint_{\ell} \mathcal{O}, \ldots\ldots\ldots, \oint_{\ell} \mathcal{O}_k \;\; d\mathcal{J}\, d\mathcal{J}\, d\mathcal{J} \ldots\ldots\ldots d\mathcal{J}_k \approx \partial\rho
$$

Where the alternative form having the defect parameter ϵ_{ij} for $i \neq j$ can be given to represent a chirality $\mathcal{L}^{\pm}$,

$$\text{for chirality } \mathcal{L}^{\pm} \begin{pmatrix} \partial & & & & & & & & & & & & \\ & \bar{\partial} & & & & & & & & & & & \\ & & \partial & & & & & & & & & & \\ & & & \bar{\partial} & & & & & & & & & \\ & & & & \ddots & & & & & & & & \\ & & & & & \bar{\partial}\partial & & & & & & & \\ & & & & & & \partial\bar{\partial} & & & & & & \\ & & & & & & & \bar{\partial}\partial & & & & & \\ & & & & & & & & \ddots & & & & \\ & & & & & & & & & \partial\partial & & & \\ & & & & & & & & & & \partial\partial & & \\ & & & & & & & & & & & \ddots & \\ & & & & & & & & & & & & k \end{pmatrix}_{\eta\times\eta} \equiv \epsilon_{ij} \text{for } i \neq j$$

$$\xrightarrow{\Rightarrow \mathrm{Tr}(\partial+\bar{\partial}+,\ldots\ldots,,k)} \frac{1}{2}(2\pi i)\oint_{\ell} \mathcal{O} \oint_{\ell} \mathcal{O} \oint_{\ell} \mathcal{O}, \ldots\ldots\ldots, \oint_{\ell} \mathcal{O}_k - \frac{1}{2}(2\pi i)\oint_{\ell} \bar{\mathcal{O}} \oint_{\ell} \bar{\mathcal{O}} \oint_{\ell} \bar{\mathcal{O}}, \ldots\ldots, \oint_{\ell} \bar{\mathcal{O}}_k$$

$$d\mathcal{J}\, d\mathcal{J}\, d\mathcal{J} d\bar{\mathcal{J}}\, d\bar{\mathcal{J}}\, d\bar{\mathcal{J}} \ldots\ldots\ldots d\bar{\mathcal{J}}_k + \approx \partial\rho^{-1}$$

Another alternative form is found representing the chirality $\mathcal{L}^{\mp}$ for the defect unit $\epsilon_{ij}$for $i \neq j$,

$$\text{for chirality } \mathcal{L}^{\mp} \begin{pmatrix} \bar{\partial} & & & & & & & & & & & & \\ & \partial & & & & & & & & & & & \\ & & \bar{\partial} & & & & & & & & & & \\ & & & \partial & & & & & & & & & \\ & & & & \ddots & & & & & & & & \\ & & & & & \partial\bar{\partial} & & & & & & & \\ & & & & & & \bar{\partial}\partial & & & & & & \\ & & & & & & & \partial\bar{\partial} & & & & & \\ & & & & & & & & \ddots & & & & \\ & & & & & & & & & \bar{\partial}\bar{\partial} & & & \\ & & & & & & & & & & \bar{\partial}\bar{\partial} & & \\ & & & & & & & & & & & \ddots & \\ & & & & & & & & & & & & k \end{pmatrix}_{\eta\times\eta} \equiv \epsilon_{ij} \text{for } i \neq j$$

$$\xrightarrow{\Rightarrow \mathrm{Tr}(\bar{\partial}+\partial+,\ldots\ldots,,k)} \frac{1}{2}(2\pi i)\oint_{\ell} \mathcal{O} \oint_{\ell} \mathcal{O} \oint_{\ell} \mathcal{O}, \ldots\ldots\ldots, \oint_{\ell} \mathcal{O}_k + \frac{1}{2}(2\pi i)\oint_{\ell} \bar{\mathcal{O}} \oint_{\ell} \bar{\mathcal{O}} \oint_{\ell} \bar{\mathcal{O}}, \ldots\ldots, \oint_{\ell} \bar{\mathcal{O}}_k$$

$$d\mathcal{J}\, d\mathcal{J}\, d\mathcal{J} d\bar{\mathcal{J}}\, d\bar{\mathcal{J}}\, d\bar{\mathcal{J}} \ldots\ldots\ldots d\bar{\mathcal{J}}_k + \approx \partial\rho^{+1}$$

The bar '$-$' over $\mathcal{O}$ and $\mathcal{J}$ has been given to satisfy the equations of the potentials $\partial\rho^{-1}$ with $\partial\rho^{+1}$ and $\partial\rho^{+0}$ with $\partial\rho^{-0}$ to be given below:

1. Two peculiar instances can be found when the cycles will undergo without an 'out' formation and always in 'in' formation and another instances can be found when the cycles will go without an 'in' formation but always an 'out' formation to be depicted in the matrix below which will arise another two conditions[14],
   a. Either this continue or evolve to any one of the potentials in among this scenario which may contains jumping from one state to another or including its own or eliminating to fall its own potential in the total possibility of its evolution which will carry on for an infinite amount of time representing $\{T^{\infty} \nearrow\}$ for the $\nearrow$ representing the evolution parameter for the orbit[13],

$$\sum\nolimits_{I} \cong cycles\ I_{(p,q|\rho)}$$

Where ρ is a component of time occurs over the potential $\partial^{(6)}\rho\rho\rho^{+1}\rho^{-1}\rho^{+0}\rho^{-0}$ in two domains that mixed in the infinite evolution $\{T^{\infty} \nearrow\}$ governing the process of spacetime (σ, ρ) with normal space σ and frozen space $/_{\sigma}$: more precisely a mixture to be given where there are two possibilities,

1. $/_{\sigma} \nsubseteq \sigma$
2. $/_{\sigma} \subseteq \sigma$

Therefore, the frozen in either of the Points [1 or 2] whichever takes place can be represented via the below matrix,

$$\sigma, \rho|_{/_{\sigma}} \cong \begin{cases} \text{for chirality } \mathcal{L}^{++} \begin{pmatrix} \ddots & & & & \\ & \partial\partial & & & \\ & & \partial\partial & & \\ & & & \partial\partial & \\ & & & & \ddots \\ & & & & & k \end{pmatrix} \xrightarrow{\Rightarrow} \partial\rho^{+0} \\ \\ \text{for chirality } \mathcal{L}^{--} \begin{pmatrix} \ddots & & & & \\ & \bar{\partial}\bar{\partial} & & & \\ & & \bar{\partial}\bar{\partial} & & \\ & & & \bar{\partial}\bar{\partial} & \\ & & & & \ddots \\ & & & & & k \end{pmatrix} \xrightarrow{\Rightarrow} \partial\rho^{-0} \end{cases}$$

Thus, the cycle can be denoted as,

$$\begin{array}{ccccccccccc} \longrightarrow & \longrightarrow & \mathcal{L}^{+} & \longrightarrow & \longrightarrow & \mathcal{L}^{\pm} & \longrightarrow & \longrightarrow & \mathcal{L}^{++} & \longrightarrow & \longrightarrow \\ \uparrow & & & & & & & & & & \downarrow \\ \uparrow & & & & & & & & & & \downarrow \\ \uparrow & & & & & & & & & & \downarrow \\ \longleftarrow & \longleftarrow & \mathcal{L}^{-} & \longleftarrow & \longleftarrow & \mathcal{L}^{--} & \longleftarrow & \longleftarrow & \mathcal{L}^{\mp} & \longleftarrow & \longleftarrow \end{array} \cong \sum\nolimits_{I} I_{(p,q)}$$

Where (p,q) denotes the + and – respectively in all of the chirality where in cases the time coordinate ρ appears because of the infinite temporal evolution $\{T^{\infty} \nearrow\}$ to formulate $I_{(p,q|\rho\ )}$.

Here in the genus signature $(\sigma,\rho)|_{\epsilon}$ – there is a differential operator ϵ for the entire hypercomplex manifold $T^{\star}$: this particular operator singles out each genus from the previous genus and act correspondingly over a summation of all genera with respect to the fibration cycle $\sum_I I_{(p,q)} \equiv \psi$ for each genus such that thee exists the above depicted chain where the independency of the genus is preserved with the connecting operator – the gap between two hyperbolic rings of the genus[1,8,13,14],

$$\kappa \equiv \sum_{m=1}^{\infty} g_m - \sum_{n=1}^{\infty} g_n \ \ \exists m \neq n$$

For the differential operator ϵ to take the value that has been closed through,

$$\coprod_{\psi \in (\sum \kappa)} \int_{\epsilon(\sum \kappa)} /\sim$$

Thus, for,

$$\int_{\psi} \text{with} \coprod_{\psi \in (\sum \kappa)} \int_{\epsilon(\sum \kappa)} /\sim$$

It is easy to determine the (p,q) norms of the vibration cycle $\sum_I I_{(p,q)} \equiv \psi$ one can determine the types of particles being generated where this can be deduced as the generator of (p,q) $\nabla_{(p,q)}$ for $p = +$ and $q = -$ where if we take $\partial \equiv p = +$ and $\bar{\partial} \equiv q = -$: The generator can be introduced via the $\eta \times \eta$ matrix – one gets the boson, fermion and supersymmetry as,

$$\left\{ \nabla_{(p,q)} \Longrightarrow \left| \begin{array}{ll} \partial\partial & \hookrightarrow \\ \bar{\partial}\bar{\partial} & \hookrightarrow \\ \partial\bar{\partial} & \hookrightarrow \\ \bar{\partial}\partial & \hookrightarrow \end{array} \right. \quad \begin{array}{l} generates\ Boson \\ generates\ Fermion \\ generates\ Fermion\ for\ every\ Boson\ (SUSY) \\ generates\ Boson\ for\ every\ Fermion\ (SUSY) \end{array} \right\}$$

Conclusions:

The origin of particles has been shown to represent the scenario for the creation of supersymmetry through the chiral operators $\mathcal{L}$ and $\eta \times \eta$ matrix that in essence creates the generator $\nabla_{\pm} \cong \nabla_{(p,q)}$ for the hypercomplex potential $\partial^{(6)}\rho\rho\rho^{+1}\rho^{-1}\rho^{+0}\rho^{-0}$ to represent (p,q) norms for the particle creation through the permutation cycle of the vibrations ψ via the differential operator ϵ in four–possible ways: $\partial\partial$, $\bar{\partial}\bar{\partial}$, $\partial\bar{\partial}$, $\bar{\partial}\partial$.

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