Original Research Article

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

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.

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],

$$\sum\nolimits_s$$

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 $\eta \times \eta$,

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

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

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,

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

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

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],

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

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,

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

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,

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

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: $\partial\partial$, $\bar{\partial}\bar{\partial}$, $\partial\bar{\partial}$, $\bar{\partial}\partial$.

References:

1. Bhattacharjee, D. (2022k). Generalization of Quartic and Quintic Calabi – Yau Manifolds Fibered by Polarized K3 Surfaces. *Research Square (Research Square)*. https://doi.org/10.21203/rs.3.rs-1965255/v1

2. Katz, S. (2007). Enumerative geometry and string theory. Choice Reviews Online, 44(10), 44–5694. https://doi.org/10.5860/choice.44-5694
3. Albeverio, S., Jost, J., Paycha, S., & Scarlatti, S. (1997). A Mathematical Introduction to String Theory. A Mathematical Introduction to String Theory, 143.
4. Bhattacharjee, D. (2022d). Imaginary Cycles of Permutations for Genus g=3 in Complex Geometries. EasyChair Preprint No. 8200. https://easychair.org/publications/preprint/CWFx
5. Bhattacharjee, D. (2022, June 28). An outlined tour of geometry and topology as perceived through physics and mathematics emphasizing geometrization, elliptization, uniformization, and projectivization for Thruston's 8-geometries covering Riemann over Teichmuller spaces. TechRxiv. https://doi.org/10.36227/techrxiv.20134382.v1
6. Penrose, R. (2005). The road to reality: a complete guide to the laws of the universe. Choice Reviews Online, 43(01), 43–0377. https://doi.org/10.5860/choice.43-0377
7. Greene, B. (2000, February 3). The Elegant Universe. In Superstrings, Hidden Dimensions, and the Quest for the Ultimate Theory. Vintage.
8. Bhattacharjee, D. (2022, May 10). Establishing equivalence among hypercomplex structures via Kodaira embedding theorem for non-singular quintic 3-fold having positively closed (1,1)-form Kähler potential $\boldsymbol{i}2{-}1\partial\partial{*}\rho$. Research Square. https://doi.org/10.21203/rs.3.rs-1635957/v1
9. Gross, M. (2002, November 27). Calabi-Yau Manifolds and Related Geometries. In Lectures at a Summer School in Nordfjordeid, Norway, June 2001. Springer. https://doi.org/10.1007/b8363310.1007/978-3-642-19004-9
10. Bhattacharjee, D., Samal, P., Bose, P. N., Behera, A. K., & Das, S. (2023, April 5). Suspension η for β bundles in ±1 geodesics in g≥1 genus creations for loops for a Topological String Theory Formalism. *TechRxiv*. https://doi.org/10.36227/techrxiv.22339732.v1
11. Collier, P. (2013, January 1). A Most Incomprehensible Thing. In Notes Towards a Very Gentle Introduction to the Mathematics of Relativity.
12. Kaku, M. (1994, March 24). Hyperspace. In A Scientific Odyssey Through Parallel Universes, Time Warps, and the Tenth Dimension. https://doi.org/10.1604/9780195085143
13. Bhattacharjee, D. (2022, July 1). Suspension of structures in two-dimensional topologies with or without the presence of $\boldsymbol{g} \geq 1$ genus deformations for canonical $2^2\eta$ stabilizer points. Research Square. https://doi.org/10.21203/rs.3.rs-1798323/v1
14. Bhattacharjee, D. (2022, July 15). M-Theory and F-Theory over Theoretical Analysis on Cosmic Strings and Calabi-Yau Manifolds Subject to Conifold Singularity with Randall-Sundrum Model. *Asian Journal of Research and Reviews in Physics*, 25–40. https://doi.org/10.9734/ajr2p/2022/v6i230181