Stroop Theory: A super unified theory of gravity

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Abstract

Both String theory and Loop Quantum gravity are currently the best theories in explaining gravity at quantum scales. But, both are contradictory to eachother. String theory is a particle theory it's core is based on QFT whereas, LQG is a background independent space-time theory where space time is quantized. Now, both of them can't be the correct theories of gravity at the same time. Also, these two theories have major drawbacks in explaining gravity in both microscopic and macroscopic scales.

Such as string theory defines the space-time metric as graviton metric but doesn't gives us any mechanism how the gravitons pair up to form the space time fabric. Also, according to string theory gravitons are closed strings and can escape our universe that is why it is a weak interacting force at quantum scales. Then how does it gets stronger at macroscopic scales? Also, LQG is inconsistent with general relativity.

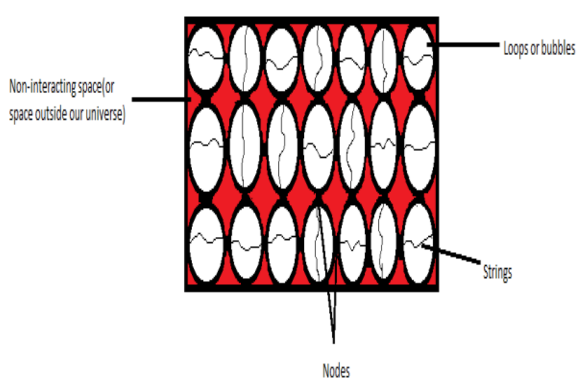
This research paper basically tries to combine string theory and LQG to solve all these problems and forms an unified theory of gravity which explains gravity at every scale also, gravity in interior of a black hole.

Introduction

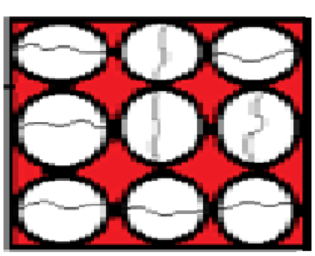
Both the theories have their own sets of drawbacks in explaining gravity, and some of the questions are still not answered by the two theories. So, the first problem is that both theories are contradictory to each other, and no one knows which one is correct. Secondly, string theory exists in a 11-dimentlional (or 26 for Bosonic string theory) manifold whose geometry is still undiscovered. On the other hand, LQG quantizes space-time and defines graviton as a propagator but, doesn't give any specific idea about what the space-time fabric is made of. The answer to all these question lies on the unification of the two theories. This means each loops of LQG consists of a particular string. The open strings are connected to the nodes of the spin-network of LQG and the closed strings i.e the gravitons interacts and go via the non-interacting space of the spinfoam. The movement of the spinfoam makes the strings to vitrate and then it creates a particle whose background geometry depends on the spin-network. The strings could be placed inside the loops via 'dimension compactification'.

The non-interacting space is the space where gravitons enter and leave our dimension that is why it is a weak force. But, at macroscopic scale it gets stronger. It is due to the reason that as we go from quantum scale to the macroscopic scale the loops or bubbles used to combine together which starts reductioning of the non-interacting spaces and because of that gravitons aren't able to escape easily our universe and so, gravity becomes stronger at macroscopic scale.

In each diagram, non interacting space gets decreased. For example, at plank scale, if, all of the gravitons escape via 16 non-interacting spaces than at scale a bit greater than plank scale it now escapes via 9 routes(see figure). This shows the decrease in probability of escaping of graviton. Now, suppose if, 16 gravitons entered our universe at plank length than at scale greater than plank length from the figure 16-9=7 gravitons remains in our universe and at one more greater scale (from figure) 9-6=3 gravitons or atleast 7-6=1 graviton is left permanently over there . These permanent gravitons interacts with the fermions and creates the fabric of spacetime.

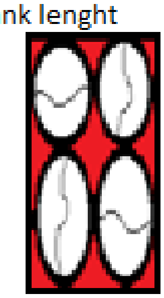


Plank lenght=L



No. of loops= 9, No. of non-interacting spaces=16(red regions)

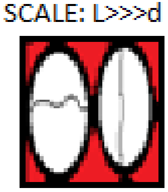
SCALE: d>>L (greater than plank lenght



No. of loops=4

No. of red regions=9

SCALE: L>>>d



No. of loops=2

No. of red regions=6

<u>UNIFICATION</u>: One loop one string

The space of the loops is defined as

$$K_\Gamma = L_2\,[SU(2)^{\wedge}L/SU(2)^{\wedge}N]_\Gamma\,,$$

Where, K=subspace of H

L=number of links

N=number of nodes

Now, for one string to exist in a loop it would be needing two nodes. So, there will exist two triangulation or in 3-D two tetrahedrons.

In the diagram,' Ψ_{+-}' defines the fermionic string with any arbitrary spin. So, now the space will be defined as –

$$K_\Gamma=L_2\,[SU(2)^{\wedge}L/SU(2)^{\wedge}N]_\Gamma$$

$$= \bigoplus_{jl} \bigoplus_{j'l} \bigotimes_n [\mathrm{In}\, V_{SU(2)}[H_{j1} \otimes H_{j2} \otimes H_{j3}) + \mathrm{In}\, V_{SU(2)}[H_{j'1} \otimes H_{j'2} \otimes H_{j'3})]$$

Where, j'=/=j

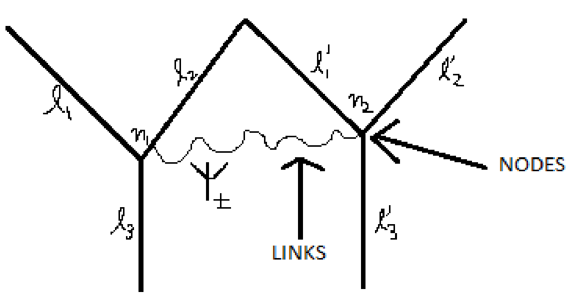
H=Hilbert space

J =Angular momentum

N = 2

L = 1

A point to note is that in here we have a different meaning of link unlike LQG. The open string that is connected to the nodes is considered as the link.



<u>Fermionic spin and Angular Momentum</u>

Under SU(2) representation the angular momentum 'j' can be represented under coordinates (r, $\theta, \emptyset$). The angular momention can be described via angles. But, we can describe particle spin via this representation by proving similar 'j' and '$|+\_>$' . If, we define 'j' under a critical angle $\varphi \in (\theta, \emptyset)$. The angle $'\varphi'$ has rotations along z- direction rotating half - an angle which will define +1/2 $\hbar$ and -1/2 $\hbar$. The relation is

$$|\pm\rangle_z = S_z\left(= \pm \tfrac{1}{2}\hbar\right) = j(j+1)$$

$$j \simeq j|\Psi\rangle = |\pm\rangle$$

As the operator $|\varphi >$ is operated over 'j' than it will give only definite values of 'j' which will define $|+\_>$ particle spin.

Now, as the ferrnions are defined by the strings their oscillations are guided by spinor matrix 'a'

$$d_0^{\mu}\,|a\rangle = \frac{1}{\sqrt{2}}\,\Gamma^{a}_{ba}\,|b\rangle$$

Where,

d,b= oscillators

$$a = \begin{pmatrix} |+\rangle \\ |-\rangle \\ \vdots \end{pmatrix}$$

As the oscillations of the ferrnionic strings will be guided by the spin-network, so, we have to introduce a matrix which shows the rotations on SU(2) in (2j+1) dimensions. This metric is the Wigner-6j metric denoted as-

D[(ij,m,n),$\varphi, \theta, \emptyset$] , D^{ij}_{mn}=(2j+1)matrix

The integral of the number of rotations on SU(2) is defined as

$$\int \mathrm{d}U\overline{D_0^{ij}(U)}D_0^{ij}(U) = \delta^{ij}\delta_{mm'}\delta_{nn'}\frac{1}{2j+1}$$

here,

$$D_{mn}^{ij}(U) = (U|ij, m, n)$$

The Wigner matrix basically is the set of angular momentum 'j'. The 'j' under $|\varphi>$ gives spins $|+\_>$. So, now the spinor could be rewritten as-

$$a = \begin{pmatrix} |+> \\ |-> \\ \vdots \end{pmatrix} = \begin{pmatrix} j_\varphi^+(j_\varphi^+ + 1) \\ j_\varphi^-(j_\varphi^- + 1) \\ \vdots \end{pmatrix}$$

$$|\pm> \sim j_\varphi^\pm(j_\varphi^\pm + 1)$$

This implies, $d_0^\mu \sim \mathrm{D}_{mn}^{Ij}$

This relation simply means that the oscillations of the string is due to the rotations of the spin-network. So, now the integral changes into-

$$\int \mathrm{d}U\overline{d_0^\mu(U)}d_0^\mu(U) = \delta^{ij}\Gamma_{mm'}\Gamma_{nn'}\frac{1}{2j+1}$$

And the oscillations of the strings become-

$$\Psi_\pm^\mu(\tau, \sigma) = \frac{1}{\sqrt{2}}\sum_{n\in\mathbb{Z}} D_{mn}^{ij}\, e^{-in(\tau+\sigma)}$$

τ, σ are space-time coordinates.

Now, the (2j+1) term could be re-written in terms of spins. As follows-

$$s_z = j(j+1)$$

$$\frac{s_z}{j} = j+1$$

$$s_z - j = j^2$$

Therefore,

$$2j+1$$

$$j + (j+1)$$

$$j + \frac{s_z}{j}$$

$$\frac{j^2 + s_z}{j}$$

$$\frac{2s_z}{j|\varphi>} - 1$$

$$(2j+1) \sim \frac{2s_z}{|+\_>} - 1$$

Transition amplitude and space-time metric

The transition amplitude is a function of the boundary states. For this LQG fixes a triangualation of space-time. It is given by the Feynman path integral formulation which gives the sum over the association of a spin to each face.

$$W_\Delta(j_\ell) = \mathcal{N}_\Delta \sum_{j_f} \prod_f (-1)^{h} dj_f \prod_v (-1)^{j_v}\{6j\}$$

N_Δ=Normalization factor, {6j}=Wigner 6-j matrix

Now, we will rewrite this term in terms of fermionic spin and string oscillations.

$$dj_f = (2j_f+1) \sim \frac{2S_z}{|\pm\rangle} - 1$$

$$j_f \simeq |\pm\rangle$$

$$W_\Delta(j_l) = N_\Delta \sum_{j_f} \prod_{f} (-1)^{|\pm\rangle} \left(\sum_{j_f} \left(\frac{2S_z}{|\pm\rangle} - 1 \right) \right) \prod_{v} (-1)^{|\pm\rangle_v} \{6|\pm\rangle\}$$

which is the transition amplitude defined in terms of Spin. Now, the Wigner 6- j matrix can also be written in terms of it as follows-

$$\begin{Bmatrix} j_1 & j_2 & j_3 \\ j_4 & j_5 & j_6 \end{Bmatrix} =$$

$$(-1)^{J-n} \sum_{ma} \begin{pmatrix} |-\rangle & 0 & |+\rangle \\ \mu_1 & \mu_2 & \mu_3 \end{pmatrix} \begin{pmatrix} |-\rangle & |+\rangle & 0 \\ -\mu_1 & \mu_4 & \mu_5 \end{pmatrix}$$

$$\times \begin{pmatrix} 0 & |+\rangle & |+\rangle \\ -\mu_2 & -\mu_4 & -\mu_6 \end{pmatrix} \begin{pmatrix} |-\rangle & 0 & |+\rangle \\ -\mu_3 & -\mu_5 & -\mu_6 \end{pmatrix}$$

$$\sim \{6|\pm\rangle\}$$

here, $j_1, j_3 \sim |-\rangle$, $j_4, j_6 \sim |+\rangle$ and $j_5, j_2 = 0$

since, j_5, j_2 doesn't belong to the critical angle $'\varphi'$

so, it wouldn't give any spin. This matrix can be computed as-

$$g_{mn} = \sqrt{\frac{S_z}{j|\Psi\rangle} - 1} \begin{pmatrix} j & 0 & j \\ \mu & 0 & n \end{pmatrix} = \Gamma_{\mu,-n} (-1)^{\mu-n} \quad [\because \delta_{m,-n} \sim \Gamma_{\mu,-n}]$$

Now, the generator of the open fermionic string i.e the super-virasoro in terms of transition amplitude is given by

$$L_\mu^{(f)} = \frac{1}{2} \sum_{n \in Z} \left(n + \frac{\mu}{2} \right) : D^{ij}_{-n} \cdot D^{ij}_{\mu+n} :$$

The transition amplitude in integral form is given by-

$$W(U_l) = \mathrm{N} \sum_{j_f} \left(\prod_f \left(\frac{2S_z}{j|_\psi >} - 1 \right) \right)$$

$$\int \mathrm{d}Ue \prod_f Tr \left(\frac{1}{\sqrt{2}} \sum_j \prod_f \left(\frac{2s_z}{j|_\psi >} - 1 \right) \Gamma^{\mu}_{ba}(U) \right)$$

D_p- branes mass shell condition and spinfoam action-

The mass shell condition is given by

$$Lo = H = \frac{T}{2} \int_0^{\pi} \left(\dot{x}^2 + x'^2 \right)$$

$$= N - \alpha' M^2 + \frac{1}{4\alpha'} \left(\frac{x_i^I - x_j^I}{\pi} \right)^2$$

Where, $N = \sum_{n=1}^{\infty} \alpha_{-n}^{\nu} \cdot \alpha_{n\nu} \ (\nu = 0, \ldots, 25)$

$$M^2 = \frac{N-1}{\alpha'} + T^2 \left(x_i^I - x_j^I \right)$$

$$\left(T = \frac{1}{2\pi\alpha'} = \frac{1}{\pi l_s^2} \right)$$

The term $(x_i^I - x_j^I)$ basically shows distance between two branes. But, here we will consider the nodal distance. Now, the transition amplitude in terms of the branes.

$$< W|Lo >= \int \mathrm{d}U_{ab} W(U_{ab}) L_0(U_{ab})$$
$$= \int \mathrm{d}U_a L_0(U_a \mathrm{U} b^{-1})$$

Now, for finding the transition amplitude we have to determine the expression for $L_0(U_a)$ and $L_0(U_b)$ which will be given in terms of exponential as follows-

$$L_0(U_a) = N - \alpha' M^2 + \frac{1}{4\alpha'} \exp\left(-\frac{i}{\pi^2} \left(X(N_i) - X(N_j) \right)^2 \right)$$

$$L_0(U_b^{-1}) = N - \alpha' M^2 + \frac{1}{4\alpha'} \exp\left(-\frac{i}{\pi^2} \left(X(N_i) + X(N_j) \right)^2 \right)$$

here, we have defined the nodal distance as a function of position i.e X(N), X defines position and N defines nodes. Putting these two in the transition amplitude gives-

$$< W|Lo >= \int dU_a \frac{1}{16\alpha'} \exp\{ -\frac{i}{\pi^2} \left((X(N_i) + X(N_j))^2 + \left(X(N_i) - X(N_j) \right)^2 \right) \}$$

SPINFOAM MATRIX-

The T-Duality action of open strings is given by

$$S = -\frac{1}{4\pi\alpha'} \int d\tau \, d\sigma \, \eta^{\alpha\beta} \partial_\alpha X^\mu \partial_\beta X_\mu$$

By replacing $n^{\alpha\beta}$ with $g^s_{\alpha\beta}$ which is the spinfoam matrix, we get

$$n^{\alpha\beta} \to g^s_{\alpha\beta}$$

$$S_g = -\frac{1}{4\pi\alpha'} \int d\tau \, d\sigma \, g^s_{\alpha\beta} \partial_\alpha X^\mu \partial_\beta X_\mu$$

This gives the action of branes under the spinfoam geometry.

Loop combination

The combination of loops is given by the equation

$$|\Psi >= \sum_{j_l} C_{j_l} |j_l >$$

Where, $\vec{C_n} = \vec{L_{l_1}} + \vec{L_{l_2}} + \vec{L_{l_3}}$

$\vec{C_n}$ is the generator SU(2).

$$|\Psi >= \sum_{j_l} \vec{L_{l_n}} | +\_ >$$

(since, $j \to j|\Psi > \sim |+\_>$)

And the generator of the combined strings is given by

$$L_0' = \sum L_0 = N - \Sigma\alpha' M^2 + T^2\Sigma\left(X(N_i) - X(N_j)\right)^2$$

The terms $|\Psi\ >$ and $\sum L_0$ basically leads to the idea of the formation of space-time fabric and gravity at large scales which will be demonstrated in the next section.

Gravity at larger scales

Fermion- graviton interaction – 'Scattering process'

According to QFT, scattering of particles is done via Feynman rules. Different theories uses different Feynman methods for the graviton scattering process. Here we will use vertex operators of string theory.

$$g_0 \oint V_\phi(S)\,\mathrm{d}S \text{ ,where,}$$

$$V_0^{ab\sigma\nu} = \frac{ie}{8}\Sigma^{ab}\eta\sigma\nu\left(\gamma^u q_{2\mu} + q_{2\mu}\gamma^\mu\right)$$

This operator is for open strings. For closed strings

$$g_s \oint v_\phi\left(z,\bar{z}\right)\mathrm{d}^2 Z\text{, where,}$$

$$V^{ab\bar{b}\bar{a}\sigma\nu\bar{\sigma}\bar{\nu}} = \frac{ie}{8}\Sigma^{ab}\Sigma^{\bar{a}\bar{b}}\eta^{\sigma\nu}\eta^{\bar{\sigma}\bar{\nu}}\left(\gamma^\mu q_{2\mu} + \bar{q}_{\mu 2}\gamma^{\bar{\mu}}\right)$$

The terms g_0 and g_s are string coupling constants. But, here we have rewritten it in terms of a metric, product of basis vectors. The basis vectors are defined in terms of string oscillations.

$$g_0 = X_{N_i}^{26-n} \cdot X_{N_j}^{26-n}\ ,\ g_s = X_L^{26-n} \cdot X_\mathrm{R}^{26-n}$$

$$X_{N_i}^{26-n} \mapsto \tilde{X}_{N_i}^{26-n} = \tilde{x}^{26-n} + p^{26-n}\sigma + \sum_{N\neq 0}\frac{1}{N}\alpha_N^{26-n} e^{-iN\tau}\sin(N\sigma)$$

(n=/=N)

$$X^{26-n} \mapsto \tilde{X}^{26-n}(\tau,\sigma) = \tilde{X}_L^{26-n} + \left(-\tilde{X}_R^{26-n}\right)$$

$$= \tilde{x}^{26-n} + 2\alpha\frac{K}{R}\sigma + 2RW$$

$$+\frac{i}{2}\sqrt{2\alpha'}\sum_{N\neq 0}\frac{1}{N}\left(\tilde{\alpha}_N^{26-n} e^{-2iN(\tau+\sigma)} - \alpha_N^{26-n} e^{2in(\sigma-\tau)}\right)$$

The term (26-n) simply means dimension compactification upto n dimensions, to get fit inside the loop. Afterall strings are higher dimensional objects so, that it could suitably get fit inside the loop.

VERTEX AMPLITUDE-

For calculating the vertex amplitude we have to define it as follows-

$$w =< 0|g_0(N_i)g_s(N_j)|0 >$$

$$w =< 0|g_0(N_i)g_s(N_j)|\Psi>$$

Let,

$$q^{ab}_{(x)} = \delta^{ij} X^{26-n}_{N_i} \cdot X^{26-n}_{N_j}$$

$$=\delta^{ij} X'_{N_i} \cdot X'_{N_j}$$

$$\bar{q}^{ab}_{(x)} = \delta^{ij} X^{26-n}_{L} \cdot X^{26-n}_{\mathrm{R}}$$

$$=\delta^{ij} X''_{L} \cdot X''_{\mathrm{R}}$$

The correlation function is written as-==

$$G^{abcd}_{ij} = \langle q^{ab}(x)\, q^{\bar{ab}}(x)\rangle - \langle q^{ab}(x)\rangle\langle q^{\bar{ab}}(x)\rangle$$

=

$$\frac{\Sigma_j \Psi_j \int d^4 g\, d^{10} z\, q_i^{ab}\, q_j^{\bar{ab}} e^s}{\Sigma_j \Psi_j \int d^4 g\, d^{10} z\, e^s} - \frac{\Sigma_j \Psi_j \int d^4 g\, d^5 z\, q_i^{ab} e^s}{\Sigma_j \Psi_j \int d^4 g\, d^5 z\, e^s} \cdot \frac{\Sigma_j \Psi_j \int d^4 g\, d^5 z\, q^{\bar{ab}} e^s}{\Sigma_j \Psi_j \int d^4 g\, d^5 z\, e^s}$$

Now, defining the gravitational force at all scales we have to first prove the fermionic action of LQG and string theory similar i.e $S_f \sim S_D$ this will make calculations easier

PROOF-

- LQG (tetrad formalism)

$$s_D = i\int d^4x \bar{\Psi}_D\, \partial^\mu \gamma_\mu \Psi_D$$

$$=i\int \bar{\Psi}\sigma^1\, d\Psi \wedge e^J \wedge e^K \wedge e^L \varepsilon_{IJKL}$$

- String theory (light cone gauge)

$$s_f = -\frac{1}{2\pi}\int d\tau d\sigma \bar{\psi}\rho^\alpha\, \partial_\alpha \Psi_\mu$$

$$=\frac{1}{2\pi}\int d\sigma^+\, d\sigma^-(\Psi_+\partial_-\Psi_+ + \Psi_-\ \partial_-\Psi_-)$$

Let, $d^4x = d^2\, x \cdot d^2x = d\sigma^+\, d\sigma^-$

Also, $\partial^\alpha \rho^\alpha \sim \partial^\mu \gamma^\mu = \begin{pmatrix} 0 & -\partial_- \\ \partial_+ & 0 \end{pmatrix}$

Now, $s_D = i\int d\sigma^+\, d\sigma^- \bar{\Psi}_D \begin{pmatrix} 0 & -\partial_- \\ \partial_+ & 0 \end{pmatrix} \Psi_D$

$$= i\int d\sigma^+\, d\sigma^-\ i(\Psi_+, \Psi_-) \begin{pmatrix} 0 & -\partial_- \\ \partial_+ & 0 \end{pmatrix} \begin{pmatrix} \Psi_- \\ \psi_+ \end{pmatrix}$$

$$=\int d\sigma^+\, d\sigma^-(\Psi_+\partial_-\Psi_+ + \Psi_-\ \partial_-\Psi_-) \sim s_f$$

Therefore, $s_D \sim s_f$.

The equation for the gravitational force is

$$F = \int_{t_{n-1}}^{t_n} \Pi\ \left[\left(\sum s_f\right)\left(\sum V_\phi\right) - \sum(\bar{V_\phi}\ N_s)\right]$$

$V_\emptyset$ = Vertex scattering amplitude

$\bar{V_\phi}$= Vertex descattering amplitude

N_s= Non- interacting regions of space

This equation simply means the difference between scattering and descattering process. The more will be the scattering and lesser the descattering of gravitons the more will be the granvitational force and vice-versa. Because as mentioned earlier, as we move from plank. scale to larger scales the non-interacting spaces gets decreased so less number of gravitons will escape so, lesser will be the descattering and more will be scattering the greater would be the force and vice-versa. Ideally, at plank scale the force should be equal to zero cause there will be equal probability of both scattering and descattering of gravitons. The integral with limit from 't_n' to't_{n-1}' simply means the amount of the gravitons interacts with the fermions before descattering this is apart from the gravitons which stays or interacts permanently with the fermions and forms the space-time fabric.

The non-interacting space could be defined as-

$$\mathrm{N_{s}} = \ln V_{S\cup(2)}[\overline{H_{j1}} \otimes \overline{H_{j2}} \otimes \overline{H_{j3}}), \text{where}$$

$$\overline{H_{ji}} = \text{Anti} - \text{Hilbert space}$$

The space '$\overline{H_{ji}}$' here doesn't mean any kind of new space but, rather it defines the dimensions of space outside our universe. Because the quantum dimensions are defined by Hilbert-space so, to calculate the number of gravitons getting descattered we multiply the descattering vertex

amplitude with it. Rest of the properties of 'H_{ji}' is same as '$\overline{H_{ji}}$'. The vertex scatterrig amplitude depends on the type of fermion it is interacting with but, in general it could be given as

$$V_{\emptyset} \sim \int d\Psi^{+}\, d\Psi^{-} : e^{iP.X^{26-n}}\, \partial\Psi_{\pm}\bar{\partial}\Psi_{\pm} : \varsigma$$

$$\overline{V_{\phi}} \sim \int d\Psi^{+}\, d\Psi^{-} : e^{-iP.X^{26-n}}\, \partial\Psi_{\pm}\bar{\partial}\Psi_{\pm} : \varsigma$$

Deriving Einstein-field equations

The metric tensor ' $g_{\mu\nu}$ ' is defined as follows

$$g_{\mu\nu} \mapsto g_{os} = g_{o} \cdot g_{s}$$

$$g_{o} = X_{N_i}^{26-n} \cdot X_{N_j}^{26-n} (\text{Fermionic})$$

$$g_{s} = X_{L}^{26-n} \cdot X_{R}^{26-n} (\text{Bosonic \{gravitons\}})$$

So, the stress-energy tensor is defined as

$$T_{os} = T_{o,s},\ \ g_{o},\ g_{s},$$

In general, at macroscopic scale $g_{os} = g_{\mu\nu}$ cause quantum effects are not seen . But, with the help of the graviton metric 'g_{os}' at quantum scales we could directly breakdown Einstein's equation for quantum gravity without any complex calculations and the stress-energy tensor becomes quantized.

$$\Gamma^{\mu}_{os} = \frac{1}{2} g^{\mu\lambda}\left[\frac{\partial g_{\lambda o}}{\partial x^{s}} + \frac{\partial g_{\lambda s}}{\partial x^{o}} - \frac{\partial g_{os}}{\partial x^{\lambda}}\right]$$

$$R_{os} = \frac{\partial \Gamma^{\delta}_{os}}{\partial x^{\delta}} - \frac{\partial \Gamma^{\delta}_{o\delta}}{\partial x^{s}} + \Gamma^{\delta}_{\delta\lambda}\Gamma^{\lambda}_{so} - \Gamma^{\delta}_{s\lambda}\Gamma^{\lambda}_{\delta o}$$

The space-time metric '$g_{\mu\nu}$' is equal to product of two basis vectors. Each basis vector is defined as

$\vec{e_i} = \frac{d\vec{R}}{du^{i}}$,as a rate of change of coordinates in curved space. But, in string theory points are stretched to strings. So, now each basis vectors will be equal to the string lenght as the lenght of the string determines the rate of change at plank scale.

$$\vec{e_{ij}} \equiv X_{N_i} \cdot X_{N_j}$$

At, 4-dimension the string dimensions gets compactified and the strings looks like points and are treated as normal basis vectors in GR at macroscopic scales. But, at plank scale extra dimensions gets visible and now the points are treated as strings with nodal ends N_i and N_j .

The closed strings has two parts the left and right movers. The strings (gravitons) will have the same oscillations. So, they could be written as

$$g_{s} = A g_{s} = g_{s} A \quad (A=[1])$$

So, now the metric changes as

$$g_{\mu\nu} \rightarrow g_{os} = g_{o} . g_{s} =$$

=

$$\begin{bmatrix} X_{N_1}\cdot X_{N_1} & X_{N_1}\cdot X_{N_2} & X_{N_1}\cdot X_{N_3} & X_{N_1}\cdot X_{N_4} \\ X_{N_2}\cdot X_{N_1} & X_{N_2}\cdot X_{N_2} & X_{N_2}\cdot X_{N_3} & X_{N_2}\cdot X_{N_4} \\ X_{N_3}\cdot X_{N_1} & X_{N_3}\cdot X_{N_2} & X_{N_3}\cdot X_{N_3} & X_{N_3}\cdot X_{N_4} \\ X_{N_4}\cdot X_{N_1} & X_{N_4}\cdot X_{N_2} & X_{N_4}\cdot X_{N_3} & X_{N_4}\cdot X_{N_4} \end{bmatrix}$$

$$\times \begin{bmatrix} 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 \end{bmatrix} X_{L} \cdot X_{R}$$

=

$$4\begin{bmatrix} X_{N_{12}} \\ X_{N_{21}} + X_{N_{23}} \\ X_{N_{32}} + X_{N_{34}} \\ X_{N_{43}} \end{bmatrix}$$

$$[X_{N_i} \cdot X_{N_j} = X_{N_{ij}}]$$

Now, terms $X_{N_{11}} = X_{N_{22}} = X_{N_{33}} = X_{N_{44}} = 0$ as same as nodal points define a point and here we are dealing with strings. Also, nodal points should be successive there shouldn't be any jump between them

$$X_{N_{13}} = X_{N_{14}} = X_{N_{24}} = X_{N_{31}} = X_{N_{41}} =$$

$X_{N_{42}}$ =0

At, macroscopic scales the strings are treated as points and we get our usual metric ' $g_{\mu v}$ '.

Stress-energy tensor is defined as

$$T \equiv \frac{\gamma mc}{v} \sim \frac{\gamma E}{v} = \gamma \cdot \frac{(-\nabla \hat{E})}{v}$$

$\frac{\gamma E}{v}$ is for macroscopic scales. At, quantum level energy operator is used $(-\nabla \hat{E})$ for discrete energy values. So, the Einstein's equation is rewritten as-

$$R_{0s} - \frac{1}{2} R g_{os} + \Lambda\ g_{os} = \frac{8\pi G}{c^4} T_{os}$$

$$R_{0s} - \frac{1}{2} \hat{R}\ g_{os} = \frac{8\pi G}{c^4} T_{os}, \quad \text{where}$$

$$\hat{R} = \text{Ricci scalar operator}$$

As, the 'Λ ' is needed for cosmological scales only so it is removed.

A point to be noted is that this eaquation is not used for the very plank level as their are no permanent gravitons for making the fabric of space-time. Rather it is used to define the scale at which the very first thinnest layer of space-time fabric would be formed by the graviton, at the quantum scale or larger than it. After that the layer gets thicker and thicker and we get the usual Einstein's equations.

Blackholes : Gravity at singularity

According to Ads / CFT correspondence the interior of a blackhole consists of a 2D surface area projecting out 5-D space. So, the interior of the blackhole has a finite area. So, inside the singularity of a black hole which consists of only one loop which could not further be discretized and it as one open string attached to it. There is no non-interacting space over there for gravitons to escape. Rest of the mass and information stays at the event horizon but, only one fermion remains at the singularity which vibrates or oscillates with infinite number of states. And millions of gravitons depending on the surface area of blackhole interacts with that on fermion without any escape this makes blackholes gravitational force very strong.

Let, $'\varphi'$ be the infinite no. of states and

A α $V_\emptyset$ as no. of gravitons stored inside it is directly proportional to the area of the black hole

A α $V_\emptyset$ => A=k $V_\emptyset$

$s_f| \rightarrow S|\Psi>$

$\overline{V_\phi}$, N_s=0

F=$\int \Pi\ [(\sum S|\Psi>)(\sum V_\phi)$=

$\frac{1}{k}\int \Pi\ [(\sum S|\Psi>)(\sum A)$ [since, A=k $V_\emptyset$]

here, k= $\frac{16\pi M^2}{V_\emptyset}$

Therefore,

$$F = \frac{16\pi M^2}{V_\emptyset} \int \Pi\ [(\sum S|\Psi>)(\sum A)$$

CONCLUSION

The 'Stroop theory' (string+loop) sharpens the theory of gravity and also, gives a complete theory of gravity. It gives us an idea about gravity at all scales. Besides, it also, solves the problem of background dependency and the quantum discreteness or fluctuations and classical steadiness of space-time fabric. As at quantum level (plank lenght) there was no permament gravitons but, as we move to macroscopic scales the gravitons merge together and the space-time fabric gets continous from discrete, 'LQG without string theory is like a house without furnitures, which is incomplete'. One tells the geometry of space-time, the other gives the info of elementary particles. Both are interdependent to eachother. It's further implication would be that it could be used to define all the particles of standardmodel inside this LQG manifold. This will give us the idea why the strings vibrate the way it is due to the spinfoam.