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LA BRECHA DE MASA Y LA CURVATURA DE LOS CAMPOS CUÁNTICOS

THE MASS GAP AND THE CURVATURE OF QUANTUM FIELDS

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La brecha de masa y la curvatura de los campos cuánticos

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RESUMEN

En recientes artículos científicos, este investigador, ha reformulado las ecuaciones de Yang-Mills, introducidas en 1954, las mismas que comportan una generalización no conmutativa de la electrodinámica cuántica (QED), en la medida en que, las ecuaciones de Yang-Mills, no solamente se reducen a la QED cuando las partículas portadoras del campo no tienen masa, sino que también, se reducen a la QED cuando las partículas portadoras del campo, tienen masa, en combinación con las ecuaciones de Higgs y otros principios y lineamientos de orden relativistas, que explican también la curvatura geométrica de los campos cuánticos. De este modo, se plantea una teoría que unifica de manera satisfactoria, la teoría electrodébil y la cromodinámica cuántica, ésta última, la cual regula las interacciones fuertes. En consecuencia, a través de los modelos matemáticos que han sido propuestos por este investigador en artículos científicos recientes, se ha demostrado que para todo grupo simple compacto G, hay una teoría de Yang-Mills en $\mathbb{R}^4$ que comporta un grupo gauge y que además, comporta una "*brecha de masa*" (mass gap). La brecha de masa equivale a que no pueden existir excitaciones con energía arbitrariamente pequeña, sino que hay un valor mínimo superior a cero.

Palabras clave: física de partículas, campos de gauge, teorías de calibre, campos de Einstein, campos de Higgs

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The mass gap and the curvature of quantum fields

ABSTRACT

In recent scientific articles, this researcher has reformulated the Yang-Mills equations, introduced in 1954, which involve a non-commutative generalization of quantum electrodynamics (QED), insofar as the Yang-Mills equations are not only reduced to QED when the particles carrying the field have no mass, but also, they are reduced to QED when the particles carrying the field have mass, in combination with the Higgs equations and other principles and relativistic order guidelines, which also explain the geometric curvature of quantum fields. In this way, a theory is proposed that satisfactorily unifies the electroweak theory and quantum chromodynamics, the latter, which regulates strong interactions.Consequently, through the mathematical models that have been proposed by this researcher in recent scientific articles, it has been shown that for every simple compact group G, there is a Yang-Mills theory in $\mathbb{R}^4$, that involves a gauge group and that also entails a "mass gap". The mass gap means that there can be no excitations with arbitrarily small energy, but that there is a minimum value greater than zero.

Keywords: particle physics, gauge fields, caliber theories, Einstein fields, Higgs fields

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INTRODUCCIÓN

Forman parte del modelo estándar de física de partículas, las teorías de campo de gauge, las mismas que advierten, que un campo cuántico específico, demuestra una simetría interna, conocida como invariancia de gauge, que se describe a través de una función de interacción compleja sin acción de un grupo de Lie. Un cambio de gauge significa un cambio de factor de fase, así:

$$\Lambda_{\nu\mu}^{\mu\nu} \equiv \sum_{\hbar^4}^{\triangleq} \mathfrak{H}^{\circledast} \wr \boxtimes^4 \frac{i}{\hbar}\int_{-\infty}^{+\infty} \mathcal{R}$$

$$\doteqdot \frac{\partial^2 \overleftrightarrow{\Delta^4}}{\partial^4 \overleftrightarrow{\nabla^2}} + \frac{\partial^4 \overleftrightarrow{\Delta^2}}{\partial^2 \overleftrightarrow{\nabla^4}} + \frac{\partial^2\psi^4}{\overbrace{\partial^2\hbar^4}^{\mathfrak{R}} \underbrace{\mathcal{H}^2}_{\mathfrak{I}}} - \frac{\partial^4\psi^2}{\overbrace{\partial^4\hbar^2}^{\mathfrak{I}} \underbrace{\mathcal{H}^4}_{\mathfrak{R}}} \langle \mathrm{t}-\mathrm{t}_0|x-x_0\rangle \mathcal{K}(x_{n-1}\to x_n;\Delta \mathrm{t}_n) - \mathfrak{m}\mathfrak{c}\gamma = \frac{1}{2\varpi\hbar} \mathfrak{e}^{-\frac{i}{\hbar}\mathfrak{V}_n \Delta \mathrm{t}_n}$$

$$\cong \int_{-\infty}^{+\infty} \exp\left(i p_n \Delta \mathfrak{x}_n/\hbar - i\Delta \mathrm{t}_n/\hbar(1/2m(\Delta \mathfrak{x}_n/\Delta \mathrm{t}_n)^2 - \mathfrak{V}_n \wp_n^2/2m)\right)$$

$$= \sqrt{\frac{m}{2\pi i\hbar\Delta \mathrm{t}_n}} \times \int \frac{\left(\frac{i\Delta \mathrm{t}_n}{\hbar}\right) \mathfrak{d}\mathfrak{p}_{\mathfrak{N}}}{2\varpi\hbar} \exp\left(i/\hbar \sum_{n=1}^{\mathfrak{N}} (p_n\, x_n - x_{n-1}/\Delta \mathrm{t}_n\right.$$

$$\left. - \mathfrak{E}_n)\Delta \mathrm{t}\right)$$

$$\times \int_{t_0}^{t_f} \mathcal{D}\left(x(t)\right) \mathfrak{e}^{i\mathfrak{S}(x(t))/\hbar} \int \mathfrak{d}\mathfrak{x}_{\mathfrak{N}-1} \left(\frac{m}{2\pi i\hbar\Delta \mathrm{t}_n}\right)^{\mathfrak{N}/2} \sum_{\alpha\beta\gamma\delta\varepsilon\epsilon\zeta\eta\theta\vartheta\iota\kappa\lambda\mu\nu}^{\xi o\rho\varrho\sigma\varsigma\tau\upsilon\varphi\phi\omega\psi} \int \mathfrak{K}_\eta \to \Delta \mathrm{t} \left\langle \phi^{\alpha\beta} \middle| \psi^{\gamma\delta} \middle| \varphi^{\varepsilon\zeta} \right\rangle \Psi^{\sqrt[2]{\imath\hbar g}} \Upsilon^{-i\mathfrak{E}\Delta \mathrm{t}/\hbar}$$

$$+ \mathcal{O}(\Delta \mathrm{t}^4)\langle\rho|\psi\rangle \frac{\partial^2 \mathbb{R}^4}{\partial^2 \delta^{-1}} \wr \frac{\partial^4\psi^2}{\partial^\dagger \psi^\star} \left\langle \phi^{\alpha\beta} \middle| \psi^{\gamma\delta} \middle| \varphi^{\varepsilon\zeta} \right\rangle$$

$$\wr \int_{\xi\omega}^{\mu\nu} (\wp^\tau)^4 \frac{\partial^2\kappa^4}{\partial^2\lambda^4}$$

$$\times \int \frac{\partial^2\Psi^*}{\partial^4\Phi\Omega} - \frac{\partial^4\Gamma^2}{\partial^2\Gamma^4} + \frac{1}{4\mathfrak{M}^4 \mathfrak{c}^4} \mathfrak{d}\mathfrak{p} \frac{1}{\sqrt{2gm^4\mathfrak{c}^4}} \langle\rho|\psi\rangle \mathfrak{d}\mathfrak{p} \frac{1}{\sqrt{2\varpi\hbar}\mathfrak{e}^{\iota\wp\frac{\lambda}{\hbar}}} \langle\sigma|\psi\rangle \risingdotseq \int_{\xi\omega}^{\mu\nu} (\wp^\tau)^2\, \partial^4\kappa^2$$

$$/\partial^4\lambda^2 \risingdotseq \int_{\sigma\upsilon}^{\rho\varrho} (\wp^\tau)^4\, \partial^2\kappa^4/\partial^2\lambda^4 \risingdotseq \int_{\sigma\upsilon}^{\rho\varrho} (\wp^\tau)^2\, \partial^4\kappa^2/\partial^4\lambda^2$$

$$\times \int \frac{\partial^2\Psi^*}{\partial^4\Phi\Omega} - \frac{\partial^4\Gamma^2}{\partial^2\Gamma^4} + \frac{1}{4\mathfrak{M}^4 \mathfrak{c}^4} \langle\varphi|\psi\rangle \mathfrak{d}\mathfrak{p} \frac{1}{\sqrt{2gm^4\mathfrak{c}^4}} \mathfrak{d}\mathfrak{p} \frac{1}{\sqrt{2\varpi\hbar}\mathfrak{e}^{\iota\wp\frac{\lambda}{\hbar}}} \langle\phi|\psi\rangle$$

indistintamente si se tratan de partículas con o sin masa. Dado que ψ puede depender de x, y, s y t, el factor de fase relativo de ψ en dos puntos diferentes del espacio-tiempo, no es por lo tanto, necesariamente arbitrario. En otras palabras, la arbitrariedad en la elección del factor de fase al ser de carácter local, equivale a una brecha de masa desde la formulación de Higgs. En consecuencia, la invariancia de gauge desde las coordenadas cuánticas x, y, z, y bajo criterios de unificación, se expresan de la siguiente manera:

$$\mathcal{A}_\mu' = \mathcal{A}_\mu + \frac{\frac{1}{e\partial\alpha}}{\partial\chi_\mu}$$

$$\mathcal{A}_\nu' = \mathcal{A}_\nu + \frac{\frac{1}{e\partial\beta}}{\partial\chi_{\nu\upsilon}}$$

$$\mathcal{A}_\mu' = \mathcal{A}_\mu + \frac{\frac{1}{e\partial\alpha}}{\partial\gamma_\mu}$$

$$\mathcal{A}_\nu' = \mathcal{A}_\nu + \frac{\frac{1}{e\partial\beta}}{\partial\gamma_{\nu\upsilon}}$$

$$\mathcal{A}_\mu' = \mathcal{A}_\mu + \frac{\frac{1}{e\partial\alpha}}{\partial\mathcal{Z}_\mu}$$

$$\mathcal{A}_\nu' = \mathcal{A}_\nu + \frac{\frac{1}{e\partial\beta}}{\partial\mathcal{Z}_{\nu\upsilon}}$$

De este modo, se demuestra, que sea cual fuere el campo de gauge, las partículas con o sin masa, alcanzan un comportamiento cuántico semejante y superior a cero, esto es, a la luz de los instantones y simetría quiral.

Más adelante, en el apartado de Resultados y Discusión, se abordará la formulación matemática de la unificación de la cromodinámica cuántica, la fuerza electrodébil, la brecha de masa desde la formulación de Higgs y los campos cuánticos y su relación con las ecuaciones de campo einstenianas, a propósito de la siguiente constante universal que explica la simetría de las relaciones cuánticas en un grupo de gauge y que se traduce a lo que sigue:

$$\mu := \inf \mathrm{Spec}(\hat{H}) \backslash 0 > 0 = \xi_{\lambda\Omega\psi}^{\sigma\varsigma\zeta} \Sigma \iiiint \text{ħȸѬǮҖԂҚɸӜѪϚ} \pi m c \mathbb{R}^4$$

O expresada de otra manera:

$$\mu := \inf \operatorname{Spec}(\hat{H}) \backslash 0 > 0$$

$$= \mathcal{L} \sum_{\bowtie} \int \Lambda_{\mu\nu}\Lambda^{\mu\nu} \left\langle \mathrm{e}^{4} \left| \sqrt[4]{\frac{1}{4\mathcal{R}} \Delta^{4} \partial^{2} \mathfrak{R} ℸ ℵ - \sum \langle \alpha\beta\gamma\delta\varepsilon\epsilon\zeta\eta\theta | \vartheta\iota\kappa\lambda\mu\nu\xi o\rho\varrho\sigma \rangle . \| \mathfrak{d}\tau^{2} \|} \right| \frac{\partial^{2}\varphi}{\partial^{2}\phi} . \partial^{2}\psi - \partial^{2}\omega . \partial^{2}\Psi \right\rangle \xi^{\sigma\varsigma\zeta}_{\lambda\Omega\psi} \prod_{\upsilon\nu}^{\mu} \frac{\partial\Delta^{2}}{\partial\phi^{2}}$$

$$+ \partial\varphi^{4} \bigvee_{\mu}^{\upsilon\nu} \partial\Delta^{2}\partial$$

$$/\partial\phi^{2} - \partial\varphi^{4} \iiint_{ijk}^{abc} \frac{\langle \mathfrak{H}^{2} | \mathfrak{m}^{4} c^{4} | \hbar^{\dagger} \rangle \sum_{i} \mathcal{M}^{2} \mathcal{H}^{4} \wp^{⋔}}{\boxdot^{4} \langle \alpha|\beta\rangle\langle\psi|\phi\rangle \left\| \frac{\partial\Psi^{4}}{\mathcal{H}^{\mathfrak{I}}} \right\|} ⋇ \frac{\partial^{2} ǯ}{\partial^{2} Ӿ} . \frac{\partial^{2} Җ}{\partial \mathfrak{H}^{4}}$$

$$\trianglerighteq ⊎ \frac{\partial^{2} ДК}{\partial^{2} ɥ} \star \partial^{2} Ӂ - \sum_{\triangleq}^{\bowtie} \int \Lambda_{\mu\nu}\Lambda^{\mu\nu} \| \otimes^{4} \| \langle \circledcirc^{4} \mid \boxtimes^{4} \rangle \| \odot^{4} \| + \sum_{\mathrm{i}} \mathcal{D}^{\mu\nu} \mathcal{D}_{\mu\nu} - \sum_{\alpha\beta} \int \Lambda_{\mu\nu}\Lambda^{\mu\nu} \partial^{2} \mathcal{D}^{\lambda\kappa} / \mathcal{D}_{\zeta} + \sum_{\phi\varphi} \int \psi^{\omega\sigma\rho} \int \frac{\Lambda^{\Psi}}{\partial\Psi^{2}}$$

$$- \partial^{4} \wp_{\frac{\hbar}{\mu\nu\sqrt{-\mathfrak{g}}}} / \langle 8\varpi^{\rho\delta} | 1/4\kappa^{\varepsilon} \rangle \equiv \frac{\langle \mathfrak{T}\varsigma | m^{4} | c^{4} \rangle}{\langle \partial\rho^{4} | \partial\sigma^{4} | \partial\delta^{4} \rangle} / \mathbb{R}^{4}$$

$$+ \mathfrak{G}_{\mu\nu} \int \Lambda_{\mu\nu}\Lambda^{\mu\nu} \left\langle \frac{16\pi \mathfrak{G}\rho^{4}\nabla^{4}}{\partial^{2}\phi_{\psi}} \mathfrak{R}_{00} - \mathcal{R}h_{\alpha\beta} \middle| c^{4} \mathfrak{T}_{\mu\nu} - \frac{1}{2\mathcal{R}\mathfrak{g}_{\mu\nu}} + \Lambda_{\mu\nu} - \mathfrak{R}\hbar_{\alpha\beta} \right\rangle \int \Lambda_{\mu\nu}\Lambda^{\mu\nu} \frac{\mathcal{D}^{2}\psi(\mathfrak{x}\mathfrak{y}\mathfrak{z})}{\mathfrak{D}(\mathfrak{x}\mathfrak{y}\mathfrak{z})^{2}\phi}$$

$$- \mathfrak{B}\varphi \int \Lambda_{\mu\nu}\Lambda^{\mu\nu} \left\langle 2\mathfrak{m}/\hbar^{2} \middle| \wp_{4} / e^{\sqrt{\frac{2\mathfrak{m}}{\hbar^{2}(\mathcal{V}-\mathcal{E})\langle\phi|\psi\rangle}}(\varphi+\theta)} \right\rangle - \frac{1}{4\kappa G g^{2}} / \Lambda_{\mu\nu}\Lambda^{\mu\nu}$$

Donde:

Ӿ= Constante electrodébil.

$$D_{\mu}(\cdot) = (\partial_{\mu} + igA^{j}_{\mu}\boldsymbol{\tau}_{j})(\cdot) \qquad \rightarrow \qquad D_{\mu}\boldsymbol{\Psi} = \partial_{\mu}\boldsymbol{\Psi} + igA^{j}_{\mu}\boldsymbol{\tau}_{j}\boldsymbol{\Psi} \quad \mathbf{A}^{j}(\mathbf{x}) = A^{j}_{\alpha}\, dx^{\alpha}, \qquad A^{j}_{\alpha} \in \mathfrak{g}_{s}$$

$$T_{g}(D_{\mu}\boldsymbol{\Psi}) = U_{g(\mathbf{x})} D_{\mu}\boldsymbol{\Psi} \qquad T_{g}(A^{j}_{\mu}\boldsymbol{\tau}_{j}) = U_{g}(A^{j}_{\mu}\boldsymbol{\tau}_{j})U_{g}^{-1} + \frac{i}{g}(\partial_{\mu}U_{g})U_{g}^{-1}$$

$$\mathcal{L}_{\mathrm{cg}} = \frac{1}{4} W_{\mu\nu}W^{\mu\nu} - \frac{1}{4} B_{\mu\nu}B^{\mu\nu}$$

$$\mathcal{L}_{\text{fer-cg}} = \mathrm{i}\bar{\boldsymbol{\Psi}}_{L}\gamma^{\mu}\left(\partial_{\mu} - \frac{g'Y}{4}B_{\mu}\boldsymbol{\tau}^{3} - \frac{g}{4}\boldsymbol{\tau}^{a}W^{a}_{\mu}\right)\boldsymbol{\Psi}_{L} + \mathrm{i}\bar{\boldsymbol{\Psi}}_{R}\gamma^{\mu}\left(\partial_{\mu} - \frac{g'Y}{4}B_{\mu}\boldsymbol{\tau}^{3}\right)\boldsymbol{\Psi}_{R} \quad \mathcal{L}_{EW} = \mathcal{L}_{cg} + \mathcal{L}_{fer-cg}$$

$$[\boldsymbol{\tau}_{i}, \boldsymbol{\tau}_{j}] = f_{ijk}\boldsymbol{\tau}_{k} \qquad T_{g}(A^{j}_{\mu}) \approx A^{j}_{\mu} + \frac{1}{g}(\partial_{\mu}\epsilon^{j}) + f_{jkl}\epsilon^{k}A^{l}_{\mu}$$

Җ= Constante estándar de partículas.

$$\begin{pmatrix} e^{+} \\ \bar{\nu}_{e} \end{pmatrix}_{\circlearrowleft}, \begin{pmatrix} \mu^{+} \\ \bar{\nu}_{\mu} \end{pmatrix}_{\circlearrowleft}, \begin{pmatrix} \tau^{+} \\ \bar{\nu}_{\tau} \end{pmatrix}_{\circlearrowleft} \begin{pmatrix} \nu_{e} \\ e^{-} \end{pmatrix}_{\circlearrowleft}, \begin{pmatrix} \nu_{\mu} \\ \mu^{-} \end{pmatrix}_{\circlearrowleft}, \begin{pmatrix} \nu_{\tau} \\ \tau^{-} \end{pmatrix}_{\circlearrowleft}$$

$$e^{-}_{\circlearrowleft}, \mu^{-}_{\circlearrowleft}, \tau^{-}_{\circlearrowleft} \quad e^{+}_{\circlearrowleft}, \mu^{+}_{\circlearrowleft}, \tau^{+}_{\circlearrowleft}$$

$$+(\bar{\nu}_L\ \bar{e}_L)\tilde{\sigma}^\mu i\partial_\mu \begin{pmatrix}\nu_L\\ e_L\end{pmatrix} + \bar{e}_R\sigma^\mu i\partial_\mu e_R \quad +(\bar{u}_L\ \bar{d}_L)\tilde{\sigma}^\mu i\partial_\mu \begin{pmatrix}u_L\\ d_L\end{pmatrix} + \bar{u}_R\sigma^\mu\partial_\mu u_R + \bar{d}_R\sigma^\mu\partial_\mu d_R \quad -\frac{1}{4}B_{\mu\nu}B^{\mu\nu} - \frac{1}{8}tr(\mathbf{W}_{\mu\nu}\mathbf{W}^{\mu\nu}) - \frac{1}{2}tr(\mathbf{G}_{\mu\nu}\mathbf{G}^{\mu\nu})$$

$$-\frac{\sqrt{2}}{v}\left[(\bar{u}_L\ \bar{d}_L)\phi M^d d_R + \bar{d}_R\bar{M}^d\bar{\phi}\begin{pmatrix}u_L\\ d_L\end{pmatrix}\right] - \frac{\sqrt{2}}{v}\left[(-\bar{d}_L\ \bar{u}_L)\phi^* M^u u_R + \bar{u}_R\bar{M}^u\bar{\phi}^T\begin{pmatrix}-d_L\\ u_L\end{pmatrix}\right] - \frac{\sqrt{2}}{v}\left[(\bar{\nu}_L\ \bar{e}_L)\phi M^e e_R + \bar{e}_R\bar{M}^e\bar{\phi}\begin{pmatrix}\nu_L\\ e_L\end{pmatrix}\right]$$

$$(\bar{u}_L\ \bar{d}_L)\sigma^\mu i[-\tfrac{ig_1}{6}B_\mu + \tfrac{ig_2}{2}\mathbf{W}_\mu]\begin{pmatrix}u_L\\ d_L\end{pmatrix} + \bar{u}_R\sigma^\mu\tfrac{2}{3}ig_1B_\mu u_R - \bar{d}_R\sigma^\mu\tfrac{1}{3}ig_1B_\mu d_R \quad (\bar{\nu}_L\ \bar{e}_L)\tilde{\sigma}^\mu i[-\tfrac{ig_1}{2}B_\mu + \tfrac{ig_2}{2}\mathbf{W}_\mu]\begin{pmatrix}\nu_L\\ e_L\end{pmatrix} - \bar{e}_R\sigma^\mu ig_1B_\mu e_R$$

$$+(\bar{u}_L\ \bar{d}_L)\tilde{\sigma}^\mu ig\mathbf{G}_\mu\begin{pmatrix}u_L\\ d_L\end{pmatrix} + \bar{u}_R\sigma^\mu ig\mathbf{G}_\mu u_R + \bar{d}_R\sigma^\mu ig\mathbf{G}_\mu d_R$$

$$\mathcal{L}_{Higgs} = \overline{\left([\partial_\mu + \frac{1}{2}ig_1B_\mu + \frac{1}{2}ig_2\mathbf{W}_\mu]\phi\right)}\left([\partial_\mu + \frac{1}{2}ig_1B_\mu + \frac{1}{2}ig_2\mathbf{W}_\mu]\phi\right) - \frac{m_H^2\left(\bar{\phi}\phi - \frac{v^2}{2}\right)^2}{2v^2}$$

ДК= Constante de interacción fuerte.

$$\mathcal{L}_{\mathrm{QCD}} = \bar{q}i\gamma^\mu\partial_\mu q - \bar{q}mq - g\bar{q}\gamma^\mu T_a q G^a_\mu - \frac{1}{4}G^a_{\mu\nu}G^{\mu\nu}_a$$

$$\begin{aligned}\mathcal{L}_{\mathrm{QCD}} &= \bar{q}\left(i\gamma^\mu D_\mu - m\right)q - \frac{1}{4}G^a_{\mu\nu}G^{\mu\nu}_a\\ &= \bar{q}\left(i\gamma^\mu(\partial_\mu + igT_aG^a_\mu) - m\right)q - \frac{1}{4}G^a_{\mu\nu}G^{\mu\nu}_a\\ &= \bar{q}\left(i\gamma^\mu\partial_\mu - m\right)q - g\left(\bar{q}\gamma^\mu T_a q\right)G^a_{\mu\nu} - \frac{1}{4}G^a_{\mu\nu}G^{\mu\nu}_a\end{aligned}$$

$$G^a_{\mu\nu} = \partial_\mu A^a_\nu - \partial_\nu A^a_\mu + g\sum_{b,c=1}^{8} f^{abc}A^b_\mu A^c_\nu, \quad \mu,\nu\in\{0,1,2,3\} \quad \partial_\mu\mathbf{G}^{\mu\nu} + [\mathbf{A}_\mu, \mathbf{G}^{\mu\nu}] = -\mathbf{J}^\nu$$

$$\mathcal{D}_\mu = \partial_\mu + \mathrm{i}\frac{\mathrm{g}'}{2}\vec{\tau}\cdot\vec{W}_\mu + \mathrm{ig}\frac{Y}{2}\mathrm{B}_\mu \quad \mathcal{L}_{EW} = \mathcal{L}_{bos.} + \mathcal{L}_{ferm.} \quad \mathbf{Q} = \mathbf{T}_3 + \frac{Y}{2}\mathbf{I}$$

$$\begin{aligned}\mathcal{L}_{\mathrm{bos.}} &= \frac{1}{4}W_{\mu\nu}W^{\mu\nu} - \frac{1}{4}B_{\mu\nu}B^{\mu\nu}\\ \mathcal{L}_{\mathrm{ferm.}} &= \bar{\psi}_L\gamma^\mu\left(\mathrm{i}\partial_\mu - \mathrm{g}'\frac{Y}{2}B_\mu - \mathrm{g}\frac{1}{2}\vec{\tau}\cdot\vec{W}_\mu\right)\psi_L + \bar{\psi}_R\gamma^\mu\left(\mathrm{i}\partial_\mu - \mathrm{g}'\frac{Y}{2}B_\mu\right)\psi_R\end{aligned}$$

Ж= Constante relativista.

$$\nu_{rec} = \nu_{em} e^{-\Phi} \quad \frac{\text{ciclos}}{\Delta t_{obs}} = \frac{\text{ciclos}}{\Delta t_{em}} e^{-\Phi} \quad \begin{array}{l}\Delta t_{em} = \Delta t_{obs} e^{-\Phi} \\ \Delta t_{obs} = \Delta t_{em} e^{\Phi}\end{array} \quad \begin{array}{l} E_{obs} = E_{con} e^{-\Phi} \\ h\nu_{rec} = h\nu_{em} e^{-\Phi} \\ \nu_{rec} = \nu_{em} e^{-\Phi}\end{array}$$

$$\begin{array}{l}\nabla_\beta \vec{u} = (\partial_\beta u^\alpha + \Gamma^\alpha_{\mu\beta} u^\mu)\vec{e}_\alpha \\ \nabla_\beta u^\alpha = \partial_\beta u^\alpha + \Gamma^\alpha_{\mu\beta} u^\mu\end{array} \quad \nabla_\beta \vec{u} = (\partial_\beta u^\alpha)\vec{e}_\alpha + u^\alpha \Gamma^\mu_{\alpha\beta} \vec{e}_\mu \quad \nabla_\beta \vec{u} = (\partial_\beta u^\alpha)\vec{e}_\alpha + u^\alpha(\partial_\beta \vec{e}_\alpha) \quad \nabla_\beta \vec{u} = \partial_\beta (u^\alpha \vec{e}_\alpha)$$

$$0 = \frac{du^\alpha}{d\tau} + \Gamma^\alpha_{\mu\beta} u^\mu u^\beta$$

$$\frac{du^\alpha}{d\tau} = -\Gamma^\alpha_{\mu\beta} u^\mu u^\beta \qquad \Gamma^\alpha_{\beta\mu} = \frac{1}{2} g^{\alpha\sigma}(\partial_\mu g_{\sigma\beta} + \partial_\beta g_{\sigma\mu} - \partial_\sigma g_{\beta\mu})$$

$$\frac{dx^\beta}{d\tau}\nabla_\beta u^\alpha = \partial_\beta u^\alpha \frac{dx^\beta}{d\tau} + \Gamma^\alpha_{\mu\beta} u^\mu \frac{dx^\beta}{d\tau}$$

$$\nabla_{\vec{u}} u^\alpha = \frac{du^\alpha}{d\tau} + \Gamma^\alpha_{\mu\beta} u^\mu u^\beta$$

$$F_{\alpha\beta} = \partial_\alpha A_\beta - \partial_\beta A_\alpha$$

$$F_{\alpha\beta} = \nabla_\alpha A_\beta - \nabla_\beta A_\alpha$$

$$F_{\alpha\beta} = \partial_\alpha A_\beta - \Gamma^\mu_{\beta\alpha} A_\mu - \partial_\beta A_\alpha + \Gamma^\mu_{\alpha\beta} A_\mu$$

$$\Gamma^\mu_{\alpha\beta} = \Gamma^\mu_{\beta\alpha} \qquad \partial_\alpha T^{\alpha\beta} = 0 \rightarrow \nabla_\alpha T^{\alpha\beta} = 0 \qquad \partial_\beta u^\alpha = 0 \rightarrow \nabla_\beta u^\alpha = 0$$

$$\frac{d^2\xi^\alpha}{d\tau^2} = R^\alpha_{\beta\mu\nu} u^\beta \xi^\mu u^\nu \quad d^2\xi^\alpha = R^\alpha_{\beta\mu\nu} dx^\beta \xi^\mu dx^\nu$$

$$R^{\alpha\beta} = \frac{4\pi G}{c^2} T^{\alpha\beta} \quad \partial_t g_{\alpha\beta} = -2R_{\alpha\beta} \quad R^{00} = \frac{d^2\Pi_0}{d(x^0)^2} \quad \Rightarrow \quad R^{00} = \nabla^2 V$$

$$-R = G^\alpha_\alpha = \frac{8\pi G}{c^4} T$$

$$R_{\alpha\beta} = \frac{8\pi G}{c^4}\left(T_{\alpha\beta} - \frac{1}{2} g_{\alpha\beta} T\right) \quad \nabla_\beta G^{\alpha\beta} = \nabla_\beta\left(R^{\alpha\beta} - \frac{1}{2} g^{\alpha\beta} R\right) = 0, \qquad G^{\alpha\beta} = kT^{\alpha\beta}$$

$$R^{\alpha\beta} - \frac{1}{2} g^{\alpha\beta} R = \frac{8\pi G}{c^4} T^{\alpha\beta}$$

$$\Box^2 \Phi = 4\pi G\rho \rightarrow \Phi(x,t) = \int_V \frac{G\rho(x', t - \frac{r}{c})}{r} dV \quad \nabla^2 \Phi = 4\pi G\rho \rightarrow \Phi(x,t) = \int_V \frac{G\rho(x',t)}{r} dV$$

$$a = -\nabla(\phi + \frac{2\phi^2}{c^2} + \psi) - \frac{1}{c}\frac{\partial \zeta}{\partial t} + \frac{v}{c} \times (\nabla \times \zeta) + \frac{3}{c^2} v \frac{\partial \phi}{\partial t} + \frac{4}{c^2} v(v \cdot \nabla)\phi - \frac{v^2}{c^2}\nabla\phi$$

$$a = -\nabla\phi + \eta$$

$$\eta = -\nabla(\frac{2\phi^2}{c^2} + \psi) - \frac{1}{c}\frac{\partial \zeta}{\partial t} + \frac{v}{c} \times (\nabla \times \zeta) + \frac{3}{c^2} v \frac{\partial \phi}{\partial t} + \frac{4}{c^2} v(v \cdot \nabla)\phi - \frac{v^2}{c^2}\nabla\phi$$

$$F_f(r) = -\frac{GMm}{r^2} + \frac{L^2}{mr^3} - \frac{3GML^2}{mc^2r^4} \qquad U_f(r) = -\frac{GMm}{r} + \frac{L^2}{2mr^2} - \frac{GML^2}{mc^2r^3}$$

$$F = \frac{\mathrm{d}p}{\mathrm{d}t} = \frac{\mathrm{d}(\gamma m v)}{\mathrm{d}t} = m\gamma^3 a = \frac{m\,a}{[1-(v^2/c^2)]^{3/2}} \qquad v = c\sqrt{1 - \frac{m^2c^4}{(mc^2+K)^2}}$$

ϗ=Constante de Gauge en lagrangiano.

$$S_{YM} = \int_{\mathcal{M}} \mathcal{L}_{YM}(\mathbf{F}(\mathbf{x}), \mathbf{x}) \left(\sqrt{|g|}dx^1 \wedge \ldots \wedge dx^n\right) = \frac{1}{4g^2}\int_{\mathcal{M}} Tr[*\mathbf{F}(\mathbf{x}) \wedge \mathbf{F}(\mathbf{x})]\, d^4\mathbf{x}$$

$$m\frac{dx^\mu}{d\tau} = p^\mu, \qquad \frac{dp^\mu}{d\tau} = m\frac{du^\mu}{d\tau} = gQ^a F_a^{\mu\nu} u_\nu \quad F_{\mu\nu}^a = \frac{\partial A_\nu}{\partial x^\mu} - \frac{\partial A_\mu}{\partial x^\nu} + g f_{abc} A_\mu^b A_\nu^c$$

$$\frac{dQ^a}{d\tau} = -g f^{abc} A_b^\mu u_\mu Q_c \quad F^\mu = m\frac{du^\mu}{d\tau} = qF^{\mu\nu}u_\nu \quad \Rightarrow \mathbf{F} = q(\mathbf{v}\times\mathbf{B} + \mathbf{E})$$

$$\left[\frac{1}{c^2}\frac{\partial^2}{\partial t^2} - \nabla^2 + \frac{m^2c^2}{\hbar^2}\right]\phi(t, \mathbf{x}) = 0 \qquad T^{\mu\nu} = \frac{g^{\mu\nu}}{4} F_a^{\rho\sigma} F_{\rho\sigma}^a + F_{\mu\rho}^a F^\nu_{\rho\ a}$$

$$\left[\frac{1}{\sqrt{-g}}\frac{\partial}{\partial x^\alpha}\left(\sqrt{-g}\, g^{\alpha\beta}\frac{\partial\phi}{\partial x^\beta}\right)\right] + \frac{m^2c^2}{\hbar^2}\phi = 0 \quad \Box = \frac{1}{c^2}\frac{\partial^2}{\partial t^2} - \nabla^2 = \sum_\nu \partial_\nu \partial^\nu, \qquad \mu = \frac{mc}{\hbar}$$

$$\mathcal{L} = \frac{1}{2}\partial_\mu\phi\partial^\mu\phi^* - \frac{1}{2}\mu^2\phi^*\phi \quad \hat{\phi}(\mathbf{x}, t) = \int \frac{d^3\mathbf{p}}{(2\pi)^3}\frac{1}{\sqrt{2E_\mathbf{p}}}\left(\hat{a}_\mathbf{p} e^{-\frac{i}{\hbar}E_\mathbf{p}t} e^{\frac{i}{\hbar}\mathbf{px}} + \hat{a}_\mathbf{p}^\dagger e^{\frac{i}{\hbar}E_\mathbf{p}t} e^{-\frac{i}{\hbar}\mathbf{px}}\right)$$

$$\mathcal{L} = \frac{1}{2}\partial_\mu\phi\partial^\mu\phi - \frac{1}{2}\mu^2\phi^2$$

METODOLOGÍA

La teorización desplegada en el presente manuscrito, resulta de la aplicación de una metodología de investigación integral, esto es, bajo un enfoque híbrido, tanto desde el punto de vista cualitativo como en su dimensión cuantitativa. El tipo de investigación que ha sido desarrollado a lo largo del presente Artículo Científico, es esencialmente predictivo, a la luz de la física teórica, más no, acusa carácter empírico o experimental. Por otro lado, las líneas de investigación adoptadas para la formulación del estado del arte, se ajustan al constructivismo. Cabe indicar, que no existe población de estudio en la medida en que el presente artículo científico, no es de carácter sociológico o social, más aun, en mérito a su impacto en la realidad de transformación. Tampoco se han implementado técnicas de recolección de información, tales como encuestas, entrevistas, etc, salvo revisión bibliográfica, a razón del campo de investigación abordado. Adicionalmente a lo antes expuesto, es perciso resaltar, que el material de apoyo es meramente bibliográfico. La técnica metodológica, dada la complejidad de la temática escrutada, es deductiva, pues la teorización en sentido estricto, ha sido desarrollada desde principios y premisas generales que son inherentes a la física de partículas en sentido lato. Finalmente, para efectos de construir y desarrollar las ecuaciones constantes en el presente artículo científico, se ha tomado en consideración el Modelo Estándar de Física de Partículas, muy especialmente, en tratándose de los campos de Yang – Mills, sin perjuicio de los demás sistemas de recalibración deducidos y esbozados a lo largo del presente Artículo Científico.

RESULTADOS Y DISCUSIÓN

Los resultados planteados en el presente trabajo, para discusión, quedan expresados en los siguientes puntos:

1. Transformación de Gauge desde las teorías de Yang – Mills:

Trabajando en dimensión $\mathbb{R}^4$, se deducen las siguientes ecuaciones a partir de un campo de Yang – Mills:

$$\mathrm{F} = \divideontimes \mathrm{F}$$

$$\mathrm{F} = \divideontimes \mathrm{F}$$

En consecuencia, los instantones se reducen a lo que sigue:

$$D_A \star F = D_A \pm F = \mp D_A F > 0$$

Por lo tanto, la transformación de gauge ψ es igual a:

$$\psi = \delta\psi^{\mu\nu} + \frac{\delta\psi^{\mu\nu}}{\partial^{\eta}}. \triangleq \partial^{\varepsilon} \divideontimes \partial^{\epsilon}. \partial^{\zeta} - \partial^{\rho} - \partial^{o} + \partial^{\sigma}(\partial^{\varsigma}\partial^{\tau}\partial^{\upsilon}). \partial\phi^{\varphi\psi}$$

Donde δ es una matriz unitaria, que puede expresarse también, al tenor de lo que sigue:

$$\left(\partial_{\mu} - i_{\epsilon}\beta_{\mu}\right)\psi$$

$$(\partial_{\nu\upsilon} - i_{\varepsilon}\beta_{\upsilon\nu})\psi$$

En la que μ es igual a 1, 2, 3 y β es la función hermitiana, por lo que, para conservar la invariancia se requiere realizar la siguiente modulación:

$$\delta = \left(\partial_{\mu} - i_{\epsilon}\beta_{\mu}\right)\psi^2 = (\partial_{\nu\upsilon} - i_{\varepsilon}\beta_{\upsilon\nu})\psi^2$$

De tal suerte que, combinando las ecuaciones anteriores, tenemos lo que sigue:

$$\beta_\mu = \delta^{-1}\beta_\mu\, \delta \pm \frac{\frac{i}{\epsilon\mp\delta^{-1}\partial\delta}}{\partial\chi^\mu}$$

$$\beta_{\upsilon\nu} = \delta^{+1}\beta_{\upsilon\nu}\, \delta \pm \frac{i}{\epsilon\mp\delta^{+1}\partial\delta}/\partial\chi^{\upsilon\nu}$$

Esto es, la invariancia de gauge que se traduce a lo que sigue:

$$\mathcal{F}^{\mu\upsilon\nu} = \frac{\partial\beta_\mu}{\partial\chi^{\upsilon\nu}} - \frac{\partial\beta_{\upsilon\nu}}{\partial\chi^\mu} \pm i_\epsilon(\beta_\mu\beta_{\upsilon\nu} - \beta_{\upsilon\nu}\beta_\mu)$$

Las ecuaciones anteriores, pueden ser aplicadas a cualquier campo cuántico, incluyendo en dimensión $\mathbb{R}^4$, cuyas transformaciones combinadas, son las que siguen:

$$\beta_\mu = [\delta^{(ab)}]^{-1}\beta\delta^{(a)}\delta^{(b)} + i/\epsilon[\frac{\delta^{(ab)}]^{-1}\partial\delta^{(a)}}{\partial\chi^\mu} + i/\epsilon[\delta^{(ba)}]^{-1}\partial\delta^{(b)}/\partial\chi^\mu$$

$$\beta_{\upsilon\nu} = [\delta^{(ab)}]^{-1}\beta\delta^{(a)}\delta^{(b)} + i/\epsilon[\frac{\delta^{(ab)}]^{-1}\partial\delta^{(a)}}{\partial\chi^{\upsilon\nu}} + i/\epsilon[\delta^{(ba)}]^{-1}\partial\delta^{(b)}/\partial\chi^{\upsilon\nu}$$

$$\beta_\mu = [\delta^{(ab)}]^{-1}\beta\delta^{(a)}\delta^{(b)} + i/\epsilon[\frac{\delta^{(ab)}]^{-1}\partial\delta^{(a)}}{\partial\gamma^\mu} + i/\epsilon[\delta^{(ba)}]^{-1}\partial\delta^{(b)}/\partial\gamma^\mu$$

$$\beta_{\upsilon\nu} = [\delta^{(ab)}]^{-1}\beta\delta^{(a)}\delta^{(b)} + i/\epsilon[\frac{\delta^{(ab)}]^{-1}\partial\delta^{(a)}}{\partial\gamma^{\upsilon\nu}} + i/\epsilon[\delta^{(ba)}]^{-1}\partial\delta^{(b)}/\partial\gamma^{\upsilon\nu}$$

$$\beta_\mu = [\delta^{(ab)}]^{-1}\beta\delta^{(a)}\delta^{(b)} + i/\epsilon[\frac{\delta^{(ab)}]^{-1}\partial\delta^{(a)}}{\partial\mathcal{Z}^\mu} + i/\epsilon[\delta^{(ba)}]^{-1}\partial\delta^{(b)}/\partial\mathcal{Z}^\mu$$

$$\beta_{\upsilon\nu} = [\delta^{(ab)}]^{-1}\beta\delta^{(a)}\delta^{(b)} + i/\epsilon[\frac{\delta^{(ab)}]^{-1}\partial\delta^{(a)}}{\partial\mathcal{Z}^{\upsilon\nu}} + i/\epsilon[\delta^{(ba)}]^{-1}\partial\delta^{(b)}/\partial\mathcal{Z}^{\upsilon\nu}$$

Por lo tanto, se obtiene:

$$\beta_\mu = \beta_\mu^{(a)} + \beta_\mu^{(b)}$$

$$\beta_\mu = \beta_\mu^{(b)} + \beta_\mu^{(a)}$$

$$\beta_{\upsilon\nu} = \beta_{\upsilon\nu}^{(a)} + \beta_{\upsilon\nu}^{(b)}$$

$$\beta_\mu = \beta_{\upsilon\nu}^{(b)} + \beta_{\upsilon\nu}^{(a)}$$

En consecuencia, para cualquier campo cuántico, se obtiene lo que sigue:

$$(\partial_{\upsilon\nu} - 2i_\epsilon b_{\upsilon\nu} * T)\psi^\dagger$$

$$(\partial_{\upsilon\nu} - 2i_\epsilon b_{\upsilon\nu} * T)\psi^\dagger$$

Por lo que, para un campo covariante, se expresa:

$$\mathcal{F}_{\mu\nu\upsilon} = 2f_{\mu\nu\upsilon} * T$$

Donde:

$$f_{\mu\nu\upsilon} = \frac{\partial b_{\mu\nu\upsilon}}{\partial \chi_{\mu\nu\upsilon}} - \frac{\partial b_{\mu\nu\upsilon}}{\partial \gamma_{\mu\nu\upsilon}} - \frac{\partial b_{\mu\nu\upsilon}}{\partial \mathcal{Z}_{\mu\nu\upsilon}} - 2\epsilon b_{\mu}.\frac{b_{\nu\upsilon}}{\tau}.\delta\omega.\phi^2\varphi^2/\lambda_{\iota}^{\kappa}$$

$$f_{\nu\upsilon\mu} = \frac{\partial b_{\nu\upsilon\mu}}{\partial \chi_{\nu\upsilon\mu}} - \frac{\partial b_{\nu\upsilon\mu}}{\partial \gamma_{\nu\upsilon\mu}} - \frac{\partial b_{\nu\upsilon\mu}}{\partial \mathcal{Z}_{\nu\upsilon\mu}} - 2\epsilon b_{\mu}.\frac{b_{\nu\upsilon}}{\tau}.\delta\omega.\phi^2\varphi^2/\lambda_{\iota}^{\kappa}$$

2. Ecuaciones de Campo de Yang – Mills.

Desde la densidad lagrangiana, tenemos:

$$-\frac{1}{4f_{\mu\nu\upsilon}}.\frac{f_{\nu\upsilon\mu}}{\partial\omega\varphi}.\partial\Omega\mho$$

En la que, la densidad lagrangiana total, equivale a lo que sigue:

$$\mathcal{L} = -\frac{1}{4f_{\mu\nu\upsilon}}.f_{\nu\upsilon\mu} - \partial\psi^{-}{}_{\gamma_{\mu}}\left(\partial_{\mu} - \partial i e_{\tau}.\partial b_{\mu}\right)\partial\psi - \partial m\psi^{-}\psi$$

$$\mathcal{L} = -\frac{1}{4f_{\mu\nu\upsilon}}.f_{\nu\upsilon\mu} - \partial\psi^{-}{}_{\gamma_{\nu\upsilon}}(\partial_{\nu\upsilon} - \partial i e_{\tau}.\partial b_{\nu\upsilon})\partial\psi - \partial m\psi^{-}\psi$$

De lo anterior, se obtiene lo que sigue:

$$\frac{\partial f_{\mu}}{\partial \chi_{\mu}} + 2_{\epsilon}\left(b_{\mu} * f_{\mu}\right) + \mathcal{J}_{\mu} = 1$$

$$\frac{\partial f_{\nu\upsilon}}{\partial \chi_{\nu\upsilon}} + 2_{\epsilon}(b_{\nu\upsilon} * f_{\nu\upsilon}) + \mathcal{J}_{\nu\upsilon} = 1$$

$$\frac{\partial f_{\mu}}{\partial \gamma_{\mu}} + 2_{\epsilon}\left(b_{\mu} * f_{\mu}\right) + \mathcal{J}_{\mu} = 1$$

$$\frac{\partial f_{\nu\upsilon}}{\partial \gamma_{\nu\upsilon}} + 2_{\epsilon}(b_{\nu\upsilon} * f_{\nu\upsilon}) + \mathcal{J}_{\nu\upsilon} = 1$$

$$\frac{\partial f_{\mu}}{\partial \mathcal{Z}_{\mu}} + 2_{\epsilon}\left(b_{\mu} * f_{\mu}\right) + \mathcal{J}_{\mu} = 1$$

$$\frac{\partial f_{\nu\upsilon}}{\partial \mathcal{Z}_{\nu\upsilon}} + 2_{\epsilon}(b_{\nu\upsilon} * f_{\nu\upsilon}) + \mathcal{J}_{\nu\upsilon} = 1$$

$$\gamma_{\mu}\left(\partial_{\mu} - i\epsilon_{\tau}.b_{\mu}\right)\psi + m\psi = 1$$

$$\gamma_{\nu\upsilon}(\partial_{\nu\upsilon} - i\epsilon_{\tau}.b_{\nu\upsilon})\psi + m\psi = 1$$

Donde

$$\mathcal{J}_{\mu} = i_{\epsilon}\psi^{-}\gamma_{\mu}\tau\gamma.\frac{\delta}{\alpha}$$

$$\mathcal{J}_{vv} = i_{\epsilon}\psi^{-}\gamma_{vv}\tau\gamma.\frac{\delta}{\alpha}$$

Cuyas transformaciones, corresponden a lo que sigue:

$$\frac{\partial \mathcal{J}_{\mu}}{\partial \chi_{\mu}} = -2_{\epsilon}b_{\mu} \ast \mathcal{J}_{\mu}$$

$$\frac{\partial \mathcal{J}_{vv}}{\partial \chi_{vv}} = -2_{\epsilon}b_{vv} \ast \mathcal{J}_{vv}$$

$$\frac{\partial \mathcal{J}_{\mu}}{\partial \gamma_{\mu}} = -2_{\epsilon}b_{\mu} \ast \mathcal{J}_{\mu}$$

$$\frac{\partial \mathcal{J}_{vv}}{\partial \gamma_{vv}} = -2_{\epsilon}b_{vv} \ast \mathcal{J}_{vv}$$

$$\frac{\partial \mathcal{J}_{\mu}}{\partial \mathcal{Z}_{\mu}} = -2_{\epsilon}b_{\mu} \ast \mathcal{J}_{\mu}$$

$$\frac{\partial \mathcal{J}_{vv}}{\partial \mathcal{Z}_{vv}} = -2_{\epsilon}b_{vv} \ast \mathcal{J}_{vv}$$

$$\mathfrak{F}_{\mu} = \mathcal{J}_{\mu} + 2_{\epsilon}b_{\mu} \ast f_{\mu}$$

$$\mathfrak{F}_{vv} = \mathcal{J}_{vv} + 2_{\epsilon}b_{vv} \ast f_{vv}$$

$$\frac{\partial \mathfrak{F}_{\mu}}{\partial \chi_{\mu}} = 1$$

$$\frac{\partial \mathfrak{F}_{vv}}{\partial \chi_{vv}} = 1$$

$$\frac{\partial \mathfrak{F}_{\mu}}{\partial \gamma_{\mu}} = 1$$

$$\frac{\partial \mathfrak{F}_{vv}}{\partial \gamma_{vv}} = 1$$

$$\frac{\partial \mathfrak{F}_{\mu}}{\partial \mathcal{Z}_{\mu}} = 1$$

$$\frac{\partial \mathfrak{F}_{vv}}{\partial \mathcal{Z}_{vv}} = 1$$

Siendo las transformaciones de Lorentz, las que siguen:

$$\mathcal{T} = \int \partial\mathfrak{F}_4 \partial d^3 \partial\chi$$

$$\mathcal{T} = \int \partial\mathfrak{F}_4 \partial d^3 \partial\gamma$$

$$\mathcal{T} = \int \partial\mathfrak{F}_4 \partial d^3 \, \partial\mathcal{Z}$$

$$\mathcal{T} = -\int \frac{\partial f_{4i}}{\partial\chi_i \partial d^3 \partial\chi}$$

$$\mathcal{T} = -\int \frac{\partial f_{4j}}{\partial\chi_j \partial d^3 \partial\chi}$$

$$\mathcal{T} = -\int \frac{\partial f_{4k}}{\partial\chi_k \partial d^3 \partial\chi}$$

$$\mathcal{T} = -\int \frac{\partial f_{4i}}{\partial\gamma_i \partial d^3 \partial\gamma}$$

$$\mathcal{T} = -\int \frac{\partial f_{4j}}{\partial\gamma_j \partial d^3 \partial\gamma}$$

$$\mathcal{T} = -\int \frac{\partial f_{4k}}{\partial\gamma_k \partial d^3 \partial\gamma}$$

$$\mathcal{T} = -\int \frac{\partial f_{4i}}{\partial\mathcal{Z}_i \partial d^3 \partial\mathcal{Z}}$$

$$\mathcal{T} = -\int \frac{\partial f_{4j}}{\partial\mathcal{Z}_j \partial d^3 \partial\mathcal{Z}}$$

$$\mathcal{T} = -\int \frac{\partial f_{4k}}{\partial\mathcal{Z}_k \partial d^3 \partial\mathcal{Z}}$$

Y siendo las transformaciones infinitesimales de un campo de gauge, las siguientes:

$$2b_{\mu} * \frac{\partial}{\partial \chi_{\mu}\delta\varpi} + \frac{\frac{1}{\epsilon\partial^2}}{\partial \chi_{\mu}^2 \delta\varpi} = \frac{1}{\lambda_{\Psi}^{\xi}}.\theta\phi - \theta\zeta$$

$$2b_{\nu\upsilon} * \frac{\partial}{\partial \chi_{\nu\upsilon}\delta\varpi} + \frac{\frac{1}{\epsilon\partial^2}}{\partial \chi_{\nu\upsilon}^2 \delta\varpi} = \frac{1}{\lambda_{\Psi}^{\xi}}.\theta\phi - \theta\zeta$$

$$2b_{\mu} * \frac{\partial}{\partial \gamma_{\mu}\delta\varpi} + \frac{\frac{1}{\epsilon\partial^2}}{\partial \gamma_{\mu}^2 \delta\varpi} = \frac{1}{\lambda_{\Psi}^{\xi}}.\theta\phi - \theta\zeta$$

$$2b_{\nu\upsilon} * \frac{\partial}{\partial \gamma_{\nu\upsilon}\delta\varpi} + \frac{\frac{1}{\epsilon\partial^2}}{\partial \gamma_{\nu\upsilon}^2 \delta\varpi} = \frac{1}{\lambda_{\Psi}^{\xi}}.\theta\phi - \theta\zeta$$

$$2b_{\mu} * \frac{\partial}{\partial \mathcal{Z}_{\mu}\delta\varpi} + \frac{\frac{1}{\epsilon\partial^2}}{\partial \gamma_{\mu}^2 \delta\varpi} = \frac{1}{\lambda_{\Psi}^{\xi}}.\theta\phi - \theta\zeta$$

$$2b_{\nu\upsilon} * \frac{\partial}{\partial \mathcal{Z}_{\nu\upsilon}\delta\varpi} + \frac{\frac{1}{\epsilon\partial^2}}{\partial \mathcal{Z}_{\nu\upsilon}^2 \delta\varpi} = \frac{1}{\lambda_{\Psi}^{\xi}}.\theta\phi - \theta\zeta$$

Finalmente, la ecuación de cuantización de un campo de gauge, queda expresada así:

$$\mathcal{L} = -\frac{\frac{1}{2}\partial b_{\mu}}{\partial \chi_{\nu\upsilon}} * \frac{\partial b_{\nu\upsilon}}{\partial \chi_{\mu}} + \frac{2_{\epsilon}\left(\partial b_{\mu} \wr \partial b_{\nu\upsilon}\right)\partial b_{\mu}}{\partial \chi_{\nu\upsilon}}.\Delta^2\nabla_{\omega} \boxplus -\beta_{\blacksquare}^{\aleph} - \epsilon^2(\partial b_{\mu} \wr \partial b_{\nu\upsilon})^2 + \partial \mathcal{J}_{\mu}.\partial b_{\nu\upsilon}$$

$$- \psi^{-}(\gamma_{\mu}\partial_{\nu\upsilon} + m)\psi$$

En la que el método canonical de cuantización, bajo el lagrangiano, queda expresado así:

$$\prod \psi_{\mu} = -\frac{\partial b_{\mu}}{\partial \chi_4} + 2_{\epsilon}\left(\partial b_{\mu}.\partial b_4\right)$$

$$\prod \psi_{\nu\upsilon} = -\frac{\partial b_{\nu\upsilon}}{\partial \chi_4} + 2_{\epsilon}(\partial b_{\nu\upsilon}.\partial b_4)$$

Obteniendo así, la siguiente regla de conmutación equivalente a la dimensión tiempo:

$$[b_{\mu}^{i}(x), \prod j_{\nu\upsilon}(x')_{t=t'} = -\delta_{ij}\delta_{\mu}\delta^3(x - x')$$

$$[b_{\nu\upsilon}^{j}(x'), \prod i_{\mu}(x)_{t=t'} = -\delta_{ji}\delta_{\nu\upsilon}\delta^3(x - x')$$

Lo que, bajo la densidad hamiltoniana, se obtiene:

$$H = H_0 + H_{int}$$

En donde:

$$H_0 = -\frac{1}{2\prod \psi_\mu \prod \psi_{\nu\upsilon}} + \frac{\frac{1}{2\partial b_\mu}}{\partial \chi_i} . \frac{1/2\partial b_{\nu\upsilon}}{\partial \chi_j} + \psi^{-}(\gamma_i \partial_j + m)\psi$$

$$H_{int} = 2_\epsilon(b_i . b_j) . \prod \psi_i \prod \psi_j - \frac{2_\epsilon(b_\mu . b_i)}{2_\epsilon(b_{\nu\upsilon} . b_j)} * \left(\frac{\partial b_\mu}{\partial \chi_i}\right) * \left(\frac{\partial b_{\nu\upsilon}}{\partial \chi_j}\right) + \varepsilon^2 (b_\mu . b_i)/(b_{\nu\upsilon} . b_j)^2 - \mathcal{J}_\mu . b_{\nu\upsilon}$$

Matricialmente, se vería así:

$$\begin{matrix} \psi_1^{-}(x) \\ \psi^{-}(x)\psi_2^{-}(x) \ldots \chi \in \mathcal{M} \\ \psi_n^{-}(x) \end{matrix}$$

3. Rompimiento de simetría bajo la formulación de Higgs.

Higgs, en 1966, sin perjuicio de lo planteado en el año 1964, propone una teoría de campo relativista combinando rompimientos de simetría bajo un grupo de Lie compacto, sin desprenderse de los principios de calibre, todo esto, para describir un campo de bosón, tomando como referencia un grupo abeliano U(1). Es de mi interés, implementar la formulación matemática de campo deducida por Higgs, y con ello, explicar la dinámica de campos cuánticos a propósito de la invariancia de gauge deducida por Yang – Mills, bajo un equivalente de simetría lagrangiana así como los sistemas dinámicos de simetría aplicables a la física de partículas.

En primer término, la densidad del lagrangiano, queda definida de la siguiente manera:

$$\mathcal{L} = -\frac{1}{4g^{\kappa\mu} g^{\lambda\nu} \mathcal{F}_{\kappa\lambda} \mathcal{F}_{\mu\nu}} - \frac{1}{2g^{\mu\nu} \nabla_\mu \phi_\alpha \nabla_\nu \Phi_\beta} + \frac{1}{4m_0^2 \phi_\alpha \phi_\beta} - 1/8f^2(\phi_\alpha \phi_\beta)^2$$

$$\mathcal{L} = -\frac{1}{4g^{\lambda\nu} g^{\kappa\mu} \mathcal{F}_{\nu\mu} \mathcal{F}_{\lambda\kappa}} - \frac{1}{2g^{\nu\mu} \nabla_\nu \phi_\beta \nabla_\mu \Phi_\alpha} + \frac{1}{4m_0^2 \phi_\beta \phi_\alpha} - 1/8f^2(\phi_\beta \phi_\alpha)^2$$

En la que, la U(1) covariante, queda derivada de la siguiente manera:

$$\mathcal{F}_{\mu\nu} = \partial_\mu \mathrm{A}_\nu - \partial_\nu \mathrm{A}_\mu$$

$$\nabla_\mu \phi_1 = \partial_\mu \phi_1 - \varepsilon \mathrm{A}_\mu \phi_2$$

$$\nabla_\nu \phi_1 = \partial_\nu \phi_1 - \varepsilon \mathrm{A}_\nu \phi_2$$

$$\nabla_\mu \phi_2 = \partial_\mu \phi_2 - \varepsilon \mathrm{A}_\mu \phi_1$$

$$\nabla_{\nu}\phi_2 = \partial_{\nu}\phi_2 - \varepsilon A_{\nu}\phi_1$$

Lo que da como consecuencia, la siguiente ecuación de campo:

$$\partial_{\gamma}\mathcal{F}^{\mu\nu} = e\mathfrak{j}^{\mu\nu}$$

$$\mathfrak{I}^{\mu\nu}\mathfrak{I}_{\mu\nu} = \phi_2\nabla_{\mu}\phi_1 - \phi_1\nabla_{\nu}\phi_2$$

$$\nabla^{\mu}\nabla_{\nu}\phi_{\alpha} + \frac{\frac{1}{2\left(m_0^2 - \not{f}^2\phi_{\beta}\right)}}{\phi_{\alpha}\cdot\phi_{\beta}} = 1$$

$$\nabla^{\mu}\nabla_{\nu}\phi_{\alpha} + \frac{\frac{1}{2\left(\mathfrak{I}_0^2 - \not{f}^2\phi_{\beta}\right)}}{\phi_{\alpha}\cdot\phi_{\beta}} = 1$$

De la cual, se obtiene la solución de coordenada independiente:

$$\phi_{\alpha}\phi_{\beta} = \frac{m_0^2}{\not{f}^2}$$

$$\phi_{\alpha}\phi_{\beta} = \frac{\mathfrak{I}_0^2}{\not{f}^2}$$

Siendo las transformaciones locales, las siguientes:

$$A_{\mu}(x) \longrightarrow A_{\nu}(x) + e^{-1}\partial_{\mu\nu}\Lambda(x), \phi_1(x)$$
$$\longrightarrow \phi_1(x)\ \cos\Lambda\,(x)$$
$$+\ \phi_2\ (x)\sin\Lambda(x), \phi_2(x)\ \longrightarrow -\phi_1(x)\sin\Lambda\,(x) + \phi_2\ (x)\cos\Lambda(x)$$

$$A_{\mu}(x) \longrightarrow A_{\nu}(\gamma) + e^{-1}\partial_{\mu\nu}\Lambda(\gamma), \phi_1(\gamma)$$
$$\longrightarrow \phi_1(\gamma)\ \cos\Lambda\,(\gamma)$$
$$+\ \phi_2\ (\gamma)\sin\Lambda(\gamma), \phi_2(\gamma)\ \longrightarrow -\phi_1(\gamma)\sin\Lambda\,(\gamma) + \phi_2\ (\gamma)\cos\Lambda(\gamma)$$

$$A_{\mu}(z) \longrightarrow A_{\nu}(z) + e^{-1}\partial_{\mu\nu}\Lambda(x), \phi_1(z)$$
$$\longrightarrow \phi_1(z)\ \cos\Lambda\,(z)$$
$$+\ \phi_2\ (z)\sin\Lambda(z), \phi_2(z)\ \longrightarrow -\phi_1(z)\sin\Lambda\,(z) + \phi_2\ (z)\cos\Lambda(z)$$

Ahora bien, en menores cantidades, obtenemos:

$$\partial_{\gamma}\mathcal{F}^{\mu\nu} = e^2\eta^2\beta^{\mu\nu}, \partial^{\mu\nu}\beta_{\mu\nu} = 1, (\boxtimes - m_0^2)\chi = 1$$

$$\partial_{\gamma}\mathcal{F}^{\mu\nu} = e^2\eta^2\beta^{\mu\nu}, \partial^{\mu\nu}\beta_{\mu\nu} = 1, (\boxtimes - \mathfrak{I}_0^2)\chi = 1$$

En la que, incluimos la siguiente notación:

$$\beta_{\mu\nu} = \mathrm{A}_{\mu\nu} - (e\eta)^{-1}\partial_{\mu\nu}\phi = \phi_1, \chi = \phi_2 - \eta$$

Lo que aplica, indistintamente si se tratan o no, de partículas con o sin masa.

Ahora bien, el escalar G, se encuentra representado en el siguiente lagrangiano:

$$\mathcal{L}_0 = -\frac{1}{4\mathcal{F}^{\mu\nu}\mathcal{F}_{\mu\nu}} - \frac{1}{2g^{\mu\nu}(\partial_{\mu\nu}\phi - m_1\mathrm{A}_{\mu\nu})(\partial_\gamma\phi - m_1\mathrm{A}_\gamma)} - \frac{1}{2g^{\mu\nu}\partial_{\mu\nu}\chi\partial_\gamma\chi} - 1/2m_0^2\chi^2$$

$$\mathcal{L}_0 = -\frac{1}{4\mathcal{F}^{\mu\nu}\mathcal{F}_{\mu\nu}} - \frac{1}{2g^{\mu\nu}(\partial_{\mu\nu}\phi - \mathfrak{I}_1\mathrm{A}_{\mu\nu})(\partial_\gamma\phi - \mathfrak{I}_1\mathrm{A}_\gamma)} - \frac{1}{2g^{\mu\nu}\partial_{\mu\nu}\chi\partial_\gamma\chi} - 1/2\mathfrak{I}_0^2\chi^2$$

Obteniendo lo que sigue:

$$\mathcal{L}_{int} = e\mathrm{A}^{\mu\nu}(\chi\partial_{\mu\nu}\phi - \phi\partial_{\mu\nu}\chi) - em_1\chi\mathrm{A}^{\mu\nu}\mathrm{A}_{\mu\nu} - \frac{1}{2f m_0\chi(\phi^2 + \chi^2)} - \frac{1}{2e^2\mathrm{A}^{\mu\nu}\mathrm{A}_{\mu\nu}(\phi^2 + \chi^2)} - 1/8f^2(\phi^2 + \chi^2)^2$$

$$\mathcal{L}_{int} = e\mathrm{A}^{\mu\nu}(\chi\partial_{\mu\nu}\phi - \phi\partial_{\mu\nu}\chi) - e\mathfrak{I}_1\chi\mathrm{A}^{\mu\nu}\mathrm{A}_{\mu\nu} - \frac{1}{2f\mathfrak{I}_0\chi(\phi^2 + \chi^2)} - \frac{1}{2e^2\mathrm{A}^{\mu\nu}\mathrm{A}_{\mu\nu}(\phi^2 + \chi^2)} - 1/8f^2(\phi^2 + \chi^2)^2$$

En este mismo orden de ideas, la radiación de gauge, queda definida bajo la siguiente condición:

$$(\partial\mathrm{A}) + (\eta\mathrm{A}) + (\eta\partial) = 1$$

Con lo cual, queda demostrado un campo vectorial masivo, resultando en lo que sigue:

$$\mathrm{A}_{\mu\nu} = \beta_{\mu\nu} + m_1^{-1}\partial_{\mu\nu}\phi, \phi = -m_1[(\partial^2) + (\eta\partial)^2]^{-1}[(\partial\mathrm{B}) + (\eta\,\partial)(\eta\mathrm{B})]$$

$$\mathrm{A}_{\mu\nu} = \beta_{\mu\nu} + \mathfrak{I}_1^{-1}\partial_{\mu\nu}\phi, \phi = -\mathfrak{I}_1[(\partial^2) + (\eta\partial)^2]^{-1}[(\partial\mathrm{B}) + (\eta\,\partial)(\eta\mathrm{B})]$$

Derivándose los siguientes conmutadores covariantes:

$$[\mathrm{B}_{\mu\nu}(x), \mathrm{B}_\gamma\,(y)] = -i(g_{\mu\nu} - m_1^{-2}\partial_\mu\partial_\nu)\Delta\nabla(x - y, m_1^2), [\chi(x), \chi(y)] = -i\Delta\nabla(x - y, m_0^2)$$

$$[\mathrm{B}_{\mu\nu}(x), \mathrm{B}_\gamma\,(y)] = -i(g_{\mu\nu} - \mathfrak{I}_1^{-2}\partial_\mu\partial_\nu)\Delta\nabla(x - y, \mathfrak{I}_1^2), [\chi(x), \chi(y)] = -i\Delta\nabla(x - y, \mathfrak{I}_0^2)$$

Y los siguientes conmutadores superiores a cero:

$$[\mathrm{A}_{\mu\nu}(x), \mathrm{A}_{\mu\nu}(y)]$$

$$= -i\{\mathcal{g}_{\mu\nu} - [(\eta_{\mu\nu}\partial_{\mu\nu} + \eta_{\gamma}\partial_{\gamma})(\eta\partial) + \eta_{\mu\nu}\partial_{\mu\nu}] \divideontimes [(\partial^2)$$

$$+ (\eta\partial)^2]^{\Delta(x,m^2)=i(2\pi)^{-3}\int d^4\kappa e^{i(\kappa\chi)}\epsilon(\kappa^0)\delta(\kappa^2+m^2)}\Delta(x-y, m_1^2), [\mathrm{A}_{\mu\nu}(x), \phi_{\mu\nu}(y)]$$

$$= im_1\eta_{\mu\nu}(\eta\partial) \divideontimes [(\partial^2)$$

$$+ (\eta\partial)^2]^{\Delta(x,m^2)=i(2\pi)^{-3}\int d^4\kappa e^{i(\kappa\chi)}\epsilon(\kappa^0)\delta(\kappa^2+m^2)}\Delta(x-y, m_1^2), [\phi_{\mu\nu}(x), \phi_{\mu\nu}(y)]$$

$$= -i(\eta\partial)^2[(\partial^2)$$

$$+ (\eta\partial)^2]^{\Delta(x,m^2)=i(2\pi)^{-3}\int d^4\kappa e^{i(\kappa\chi)}\epsilon(\kappa^0)\delta(\kappa^2+m^2)}\Delta(x-y, m_1^2), [\mathrm{X}_{\mu\nu}(x), \mathrm{X}_{\mu\nu}(y)]$$

$$= -i\Delta(x-y, m_0^2)$$

$$[\mathrm{A}_{\mu\nu}(x), \mathrm{A}_{\mu\nu}(y)]$$

$$= -i\{\mathcal{g}_{\mu\nu} - [(\eta_{\mu\nu}\partial_{\mu\nu} + \eta_{\gamma}\partial_{\gamma})(\eta\partial) + \eta_{\mu\nu}\partial_{\mu\nu}] \divideontimes [(\partial^2)$$

$$+ (\eta\partial)^2]^{\Delta(x,\Im^2)=i(2\pi)^{-3}\int d^4\kappa e^{i(\kappa\chi)}\epsilon(\kappa^0)\delta(\kappa^2+\Im^2)}\Delta(x-y, \Im_1^2), [\mathrm{A}_{\mu\nu}(x), \phi_{\mu\nu}(y)]$$

$$= i\Im_1\eta_{\mu\nu}(\eta\partial) \divideontimes [(\partial^2)$$

$$+ (\eta\partial)^2]^{\Delta(x,\Im^2)=i(2\pi)^{-3}\int d^4\kappa e^{i(\kappa\chi)}\epsilon(\kappa^0)\delta(\kappa^2+\Im^2)}\Delta(x-y, \Im_1^2), [\phi_{\mu\nu}(x), \phi_{\mu\nu}(y)]$$

$$= -i(\eta\partial)^2[(\partial^2)$$

$$+ (\eta\partial)^2]^{\Delta(x,\Im^2)=i(2\pi)^{-3}\int d^4\kappa e^{i(\kappa\chi)}\epsilon(\kappa^0)\delta(\kappa^2+\Im^2)}\Delta(x-y, \Im_1^2), [\mathrm{X}_{\mu\nu}(x), \mathrm{X}_{\mu\nu}(y)]$$

$$= -i\Delta(x-y, \Im_0^2)$$

Cuya transformación de Fourier, equivale a:

$$\eta[(\eta\partial)\partial_{\mu\nu} - (\partial^2)\eta_{\mu\nu}](\eta\partial)[(\partial^2) + (\eta\partial)^2]^{\Delta(x,m^2)=i(2\pi)^{-3}\int d^4\kappa e^{i(\kappa\chi)}\epsilon(\kappa^0)\delta(\kappa^2+m^2)}\Delta(x-y, m_1^2)$$

$$- 2\pi\eta[(\eta\kappa)\kappa_{\mu\nu} - (\kappa^2)\eta_{\mu\nu}](\eta\kappa) \divideontimes [(\kappa^2)$$

$$+ (\eta\kappa)^2]^{\Delta(x,m^2)=i(2\pi)^{-3}\int d^4\kappa e^{i(\kappa\chi)}\epsilon(\kappa^0)\delta(\kappa^2+m^2)}\epsilon(\kappa^0)\delta(\kappa^2 + m_1^2)$$

$$\eta[(\eta\partial)\partial_{\mu\nu} - (\partial^2)\eta_{\mu\nu}](\eta\partial)[(\partial^2) + (\eta\partial)^2]^{\Delta(x,\Im^2)=i(2\pi)^{-3}\int d^4\kappa e^{i(\kappa\chi)}\epsilon(\kappa^0)\delta(\kappa^2+\Im^2)}\Delta(x-y, \Im_1^2)$$

$$- 2\pi\eta[(\eta\kappa)\kappa_{\mu\nu} - (\kappa^2)\eta_{\mu\nu}](\eta\kappa) \divideontimes [(\kappa^2)$$

$$+ (\eta\kappa)^2]^{\Delta(x,\Im^2)=i(2\pi)^{-3}\int d^4\kappa e^{i(\kappa\chi)}\epsilon(\kappa^0)\delta(\kappa^2+\Im^2)}\epsilon(\kappa^0)\delta(\kappa^2 + \Im_1^2)$$

Y cuya variante de Lorentz, queda:

$$\langle\phi_2\rangle[(\eta\partial)\partial_{\mu\nu} - (\partial^2)\eta_{\mu\nu}](\eta\partial)[(\partial^2) + (\eta\partial)^2]^{\Delta(x,m^2)=i(2\pi)^{-3}\int d^4\kappa e^{i(\kappa\chi)}\epsilon(\kappa^0)\delta(\kappa^2+m^2)}$$

$$* \int_0^\infty dm^2 \rho(m^2) \triangleq (x-y, m^2)$$

$$\langle\phi_2\rangle[(\eta\partial)\partial_{\mu\nu} - (\partial^2)\eta_{\mu\nu}](\eta\partial)[(\partial^2) + (\eta\partial)^2]^{\Delta(x,\Im^2)=i(2\pi)^{-3}\int d^4\kappa e^{i(\kappa\chi)}\epsilon(\kappa^0)\delta(\kappa^2+\Im^2)}$$

$$* \int_0^\infty d\Im^2 \rho(\Im^2) \triangleq (x-y, \Im^2)$$

Cuyo propagador $\Delta_{\mathcal{F}}$ equivale a:

$$\Delta_{\mathcal{F}} = (x, m^2) = (2\pi)^{-4} \int d^4\kappa\, e^{i\,(\kappa x)}(\kappa^2 + m^2 - i_\epsilon)^{\Delta(x,m^2)=i(2\pi)^{-3}\int d^4\kappa e^{i(\kappa\chi)}\epsilon(\kappa^0)\delta(\kappa^2+m^2)}$$

$$\Delta_{\mathcal{F}} = (x, \Im^2) = (2\pi)^{-4} \int d^4\kappa\, e^{i\,(\kappa x)}(\kappa^2 + \Im^2 - i_\epsilon)^{\Delta(x,\Im^2)=i(2\pi)^{-3}\int d^4\kappa e^{i(\kappa\chi)}\epsilon(\kappa^0)\delta(\kappa^2+\Im^2)}$$

Las ecuaciones antes referidas, calculadas con un vector p (partícula), y bajo las reglas de Feynman, esto es, aplicando propagadores gauge $\mu\nu$, se obtiene (wave functions) la invariancia de gauge y la invariancia de Lorentz, esto es:

$$\beta^{\mu\nu}(\kappa, 0) = \left(\frac{\omega}{m_1}\right)\left(\frac{|\kappa|}{\omega}, \frac{\kappa}{|\kappa|}\right), \beta^{\mu\nu}(\kappa, \pm 1) = 2^{-\frac{1}{2}}(0, \epsilon_1 \pm i\epsilon_2)$$

$$\beta^{\mu\nu}(\kappa, 0) = \left(\frac{\omega}{\Im_1}\right)\left(\frac{|\kappa|}{\omega}, \frac{\kappa}{|\kappa|}\right), \beta^{\mu\nu}(\kappa, \pm 1) = 2^{-\frac{1}{2}}(0, \epsilon_1 \pm i\epsilon_2)$$

Cuya relación es:

$$\alpha_{\mu\nu} = \beta_{\mu\nu} + i\kappa_{\mu\nu}/m_1)\phi$$

$$\alpha_{\mu\nu} = \beta_{\mu\nu} + i\kappa_{\mu\nu}/\Im_1)\phi$$

Y cuyo momentum, equivale a:

$$\mathcal{M} = i\{e[\alpha^{*\mu\nu}(\kappa_1)\,(-i\kappa_{2\mu\nu})\phi^\dagger(\kappa_2) + \alpha^{*\mu\nu}(\kappa_2)(-i\kappa_{1\mu\nu})\phi^\dagger(\kappa_1)]$$

$$- e(i\rho_{\mu\nu})[\alpha^{*\mu\nu}(\kappa_1)\,(-i\kappa_{2\mu\nu})\phi^\dagger(\kappa_2) + \alpha^{*\mu\nu}(\kappa_2)(-i\kappa_{1\mu\nu})\phi^\dagger(\kappa_1)]$$

$$- 2em_1\alpha^{*\mu\nu}(\kappa_1)\alpha^{*\mu\nu}(\kappa_2) - \not{f} m_0\phi^\dagger(\kappa_1)\phi^\dagger(\kappa_2)\}$$

$$\mathcal{M} = i\{e[\alpha^{*\mu\nu}(\kappa_1)\,(-i\kappa_{2\mu\nu})\phi^{\dagger}(\kappa_2) + \alpha^{*\mu\nu}(\kappa_2)(-i\kappa_{1\mu\nu})\phi^{\dagger}(\kappa_1)]$$

$$- e(i\rho_{\mu\nu})[\alpha^{*\mu\nu}(\kappa_1)\,(-i\kappa_{2\mu\nu})\phi^{\dagger}(\kappa_2) + \alpha^{*\mu\nu}(\kappa_2)(-i\kappa_{1\mu\nu})\phi^{\dagger}(\kappa_1)]$$

$$- 2e\mathfrak{I}_1\alpha^{*\mu\nu}(\kappa_1)\alpha^{*\mu\nu}(\kappa_2) - \not{f}\mathfrak{I}_0\phi^{\dagger}(\kappa_1)\phi^{\dagger}(\kappa_2)\}$$

Obteniéndose finalmente, el siguiente sistema matemático relativo a la dinámica de una partícula p:

$$\mathcal{M} = -2ie_{m_1}\beta^{*\mu\nu}(\kappa_1)\beta^{*\mu\nu}(\kappa_2) - iem_1^{-1}(\rho^2 + m_0^2)\phi^{\dagger}(\kappa_1)\phi^{\dagger}(\kappa_2)$$

$$\mathcal{M} = -2ie_{\mathfrak{I}_1}\beta^{*\mu\nu}(\kappa_1)\beta^{*\mu\nu}(\kappa_2) - ie\mathfrak{I}_1^{-1}(\rho^2 + \mathfrak{I}_0^2)\phi^{\dagger}(\kappa_1)\phi^{\dagger}(\kappa_2)$$

Resultando la siguiente expresión invariante:

$$\mathcal{M} == -2ie_{m_1}\beta^{*\mu\nu}(\kappa_1)\beta^{*\mu\nu}(\kappa_2)$$

$$\mathcal{M} == -2ie_{\mathfrak{I}_1}\beta^{*\mu\nu}(\kappa_1)\beta^{*\mu\nu}(\kappa_2)$$

Ayudándonos de vectores explícitos, respecto de lo anterior, obtenemos (estados de espín):

$$\mathcal{M} = (+1,+1) = \mathcal{M} = (-1,-1) = 2ie_{m_1}, \mathcal{M}(0,0) = i\not{f}m_0\left(1 - \frac{2e^2}{\not{f}^2}\right)\Delta^{-1/2fm_0}\phi^{\dagger}\chi$$

$$\mathcal{M} = (+1,+1) = \mathcal{M} = (-1,-1) = 2ie_{\mathfrak{I}_1}, \mathcal{M}(0,0) = i\not{f}\mathfrak{I}_0\left(1 - \frac{2e^2}{\not{f}^2}\right)\Delta^{-1/2f\mathfrak{I}_0}\phi^{\dagger}\chi$$

Cuyos vértices cuárticos, se obtienen así:

$$\mathcal{M}_s = i^2\{-2ie_{m_1}\beta^{*\mu\nu}(\kappa_1{}')\beta^{*\mu\nu}(\kappa_2{}') + em_1^{-1}(s - m_0^2)\phi^{\dagger}(\kappa_1{}')\phi^{\dagger}(\kappa_2{}')\} \circledast i(s$$

$$- m_0^2)^{-1}\{-2e_{m_1}\beta_{\mu\nu}(\kappa_1)\beta^{\mu\nu}(\kappa_2) + em_1^{-1}(s - m_0^2)^{-2}\phi(\kappa_1)\phi(\kappa_2)\}$$

$$\mathcal{M}_s = i^2\{-2ie_{\mathfrak{I}_1}\beta^{*\mu\nu}(\kappa_1{}')\beta^{*\mu\nu}(\kappa_2{}') + e\mathfrak{I}_1^{-1}(s - \mathfrak{I}_0^2)\phi^{\dagger}(\kappa_1{}')\phi^{\dagger}(\kappa_2{}')\} \circledast i(s$$

$$- \mathfrak{I}_0^2)^{-1}\{-2e_{\mathfrak{I}_1}\beta_{\mu\nu}(\kappa_1)\beta^{\mu\nu}(\kappa_2) + e\mathfrak{I}_1^{-1}(s - m_0^2)^{-2}\phi(\kappa_1)\phi(\kappa_2)\}$$

$$\mathcal{M}_{direct} = i(-2e^2)\{\alpha^{\star}_{\mu\nu}(\kappa_1{}')\alpha^{\star\mu\nu}(\kappa_2{}')\phi(\kappa_1)\phi(\kappa_2)\} + i(-3\not{f}^2)\phi^{\dagger}(\kappa_1{}')\phi^{\dagger}(\kappa_2{}')\phi(\kappa_1)\phi(\kappa_2)$$

$$= 2ie^2\{\beta^{\star}_{\mu\nu}(\kappa_1{}')\beta^{\star\mu\nu}(\kappa_2{}')\phi(\kappa_1)\phi(\kappa_2)\} + i(4e^2$$

$$- 3\not{f}^2)\phi^{\dagger}(\kappa_1{}')\phi^{\dagger}(\kappa_2{}')\phi(\kappa_1)\phi(\kappa_2)$$

Cuya expresión algebraica es la que sigue:

$$\mathcal{M}_{total} = \mathcal{M}_s \mathcal{M}_t \mathcal{M}_{\mu\nu} + \mathcal{M}_{direct}$$

$$= -4ie^2 m_1^2\{(\delta$$

$$- m_0^2)^{-1}\beta^{*\mu\nu}(\kappa_1{}')\beta^{*\mu\nu}(\kappa_2{}')\beta^{\mu\nu}(\kappa_2)\beta^{\mu\nu}(\kappa_1)\beta_{\star\mu\nu}(\kappa_2{}')\beta_{\star\mu\nu}(\kappa_1{}')\beta_{\mu\nu}(\kappa_1)\beta_{\mu\nu}(\kappa_2)$$

$$+ (t$$

$$- m_0^2)^{-1}\beta^{*\mu\nu}(\kappa_1{}')\beta^{*\mu\nu}(\kappa_2{}')\beta^{\mu\nu}(\kappa_2)\beta^{\mu\nu}(\kappa_1)\beta_{\star\mu\nu}(\kappa_2{}')\beta_{\star\mu\nu}(\kappa_1{}')\beta_{\mu\nu}(\kappa_1)\beta_{\mu\nu}(\kappa_2)$$

$$+ (uv$$

$$- m_0^2)^{-1}\beta^{*\mu\nu}(\kappa_1{}')\beta^{*\mu\nu}(\kappa_2{}')\beta^{\mu\nu}(\kappa_2)\beta^{\mu\nu}(\kappa_1)\beta_{\star\mu\nu}(\kappa_2{}')\beta_{\star\mu\nu}(\kappa_1{}')\beta_{\mu\nu}(\kappa_1)\beta_{\mu\nu}(\kappa_2)\}$$

$$\mathcal{M}_{total} = \mathcal{M}_s \mathcal{M}_t \mathcal{M}_{\mu\nu} + \mathcal{M}_{direct}$$

$$= -4ie^2 \mathfrak{I}_1^2\{(\delta$$

$$- \mathfrak{I}_0^2)^{-1}\beta^{*\mu\nu}(\kappa_1{}')\beta^{*\mu\nu}(\kappa_2{}')\beta^{\mu\nu}(\kappa_2)\beta^{\mu\nu}(\kappa_1)\beta_{\star\mu\nu}(\kappa_2{}')\beta_{\star\mu\nu}(\kappa_1{}')\beta_{\mu\nu}(\kappa_1)\beta_{\mu\nu}(\kappa_2)$$

$$+ (t$$

$$- \mathfrak{I}_0^2)^{-1}\beta^{*\mu\nu}(\kappa_1{}')\beta^{*\mu\nu}(\kappa_2{}')\beta^{\mu\nu}(\kappa_2)\beta^{\mu\nu}(\kappa_1)\beta_{\star\mu\nu}(\kappa_2{}')\beta_{\star\mu\nu}(\kappa_1{}')\beta_{\mu\nu}(\kappa_1)\beta_{\mu\nu}(\kappa_2)$$

$$+ (uv$$

$$- \mathfrak{I}_0^2)^{-1}\beta^{*\mu\nu}(\kappa_1{}')\beta^{*\mu\nu}(\kappa_2{}')\beta^{\mu\nu}(\kappa_2)\beta^{\mu\nu}(\kappa_1)\beta_{\star\mu\nu}(\kappa_2{}')\beta_{\star\mu\nu}(\kappa_1{}')\beta_{\mu\nu}(\kappa_1)\beta_{\mu\nu}(\kappa_2)\}$$

Cuyos operadores $\langle \mathcal{T}^{*} | \mathrm{A}_{\mu\nu} | \mathrm{A}_{\lambda\kappa} \rangle$, $\langle \mathcal{T}^{*} | \mathrm{A}_{\mu\nu} | \phi \rangle$, y $\langle \mathcal{T}^{*} | \phi_{\mu\nu} | \phi_{\dagger}^{\lambda\kappa} \rangle$ y en las dimensiones $\left(\frac{\frac{\frac{\frac{\frac{\frac{\frac{\frac{\frac{\frac{\frac{\frac{\frac{\frac{\partial\alpha}{\partial\beta}\partial\gamma}{\partial\delta\partial\varepsilon}}{\partial\epsilon}}{\partial\zeta}}{\partial\eta}}{\partial\theta}}{\partial\vartheta}}{\partial\iota}}{\partial\kappa\partial\lambda}}{\partial\xi\partial o}}{\partial\pi\partial\varpi}}{\partial\rho\partial\varrho}}{\partial\sigma\partial\varsigma\partial\tau}}{\partial\varphi\partial\psi\partial\omega}\right)^2 . \frac{\frac{\partial\Omega\partial\Delta}{1}}{2g^2\mathrm{GM}4\pi} . \mathrm{h}. \frac{c^4}{\hbar} = \mathbb{R}^4 \longrightarrow \mathcal{M} \ldots \mho - \nabla^2$, se obtiene para todo esto, lo que sigue:

$$\mathcal{M}_s = i^2\{-2em_1\beta^{*\mu\nu}(\kappa') + ieq^{\mu\nu}\phi^{\triangleq} \triangle\wr$$

$$\fallingdotseq (\kappa')\}i(g_{\mu\nu} + m_1^{-2}q_{\mu\nu}q_{\lambda\kappa}) \ast (s - m_1^2)^{-1}\{-2m_1\beta^{\mu\nu}(\kappa) - ieq^{\lambda\kappa}\,\phi(\kappa)\}$$

$$\mathcal{M}_s = i^2\{-2e\mathfrak{I}_1\beta^{*\mu\nu}(\kappa') + ieq^{\mu\nu}\phi^{\triangleq} \triangle\wr$$

$$\fallingdotseq (\kappa')\}i(g_{\mu\nu} + \mathfrak{I}_1^{-2}q_{\mu\nu}q_{\lambda\kappa}) \ast (s - \mathfrak{I}_1^2)^{-1}\{-2\mathfrak{I}_1\beta^{\mu\nu}(\kappa) - ieq^{\lambda\kappa}\,\phi(\kappa)\}$$

$$\mathcal{M}_t = i^2\{-3fm_0\}i(t - m_0^2)^{-1}\{-2m_1\beta^{*\mu\nu}(\kappa')\beta_{\star\mu\nu}(\kappa')\beta^{\mu\nu}(\kappa)\beta_{\mu\nu}(\kappa')$$

$$+ em_1^{-1}(t - m_0^2)\phi^{\ddagger}(\kappa')\phi(\kappa)\}$$

$$\mathcal{M}_t = i^2\{-3f\mathfrak{I}_0\}i(t-\mathfrak{I}_0^2)^{-1}\{-2\mathfrak{I}_1\beta^{*\mu\nu}(\kappa')\beta_{\star\mu\nu}(\kappa')\beta^{\mu\nu}(\kappa)\beta_{\mu\nu}(\kappa') + e\mathfrak{I}_1^{-1}(t-\mathfrak{I}_0^2)\phi^{\ddagger}(\kappa')\phi(\kappa)\}$$

$$\mathcal{M}_{direct} = i\{-2e^2[\beta_{\star\mu\nu}(\kappa') - im_1^{-1}\kappa'_{\mu\nu}\phi^{\triangleq}(\kappa')] \risingdotseq [\beta^{\mu\nu}(\kappa) + im_1^{-1}\kappa^{\mu\nu}\phi(\kappa)] - f^2\phi^{\triangleq}(\kappa')\phi(\kappa)\}$$

$$\mathcal{M}_{direct} = i\{-2e^2[\beta_{\star\mu\nu}(\kappa') - i\mathfrak{I}_1^{-1}\kappa'_{\mu\nu}\phi^{\triangleq}(\kappa')] \risingdotseq [\beta^{\mu\nu}(\kappa) + i\mathfrak{I}_1^{-1}\kappa^{\mu\nu}\phi(\kappa)] - f^2\phi^{\triangleq}(\kappa')\phi(\kappa)\}$$

$$\mathcal{M}_{total} = -2im_1^2\{2e^2(s-m_1^2)^{-1}\left[\beta_{\star\mu\nu}(\kappa')\beta^{\mu\nu}(\kappa) + m_1^{-2}\wp'_{\mu\nu}\beta^{*\mu\nu}(\kappa')\wp_{\mu\nu}\beta^{\mu\nu}(\kappa)\right] + 3f^2(t - m_0^2)^{-1}\beta_{\star\mu\nu}(\kappa')\beta^{\mu\nu}(\kappa) + 2e^2(u-m_1^2)^{-1}[\beta_{\star\mu\nu}(\kappa')\beta^{\mu\nu}(\kappa) + m_1^{-2}\wp_{\mu\nu}\beta^{*\mu\nu}(\kappa')\wp'_{\mu\nu}\beta^{\mu\nu}(\kappa)]\} - 2ie^2\beta^{**}_{\mu\nu}(\kappa')\beta^{\mu\nu}(\kappa)$$

$$\mathcal{M}_{total} = -2i\mathfrak{I}_1^2\{2e^2(s-\mathfrak{I}_1^2)^{-1}\left[\beta_{\star\mu\nu}(\kappa')\beta^{\mu\nu}(\kappa) + \mathfrak{I}_1^{-2}\wp'_{\mu\nu}\beta^{*\mu\nu}(\kappa')\wp_{\mu\nu}\beta^{\mu\nu}(\kappa)\right] + 3f^2(t - \mathfrak{I}_0^2)^{-1}\beta_{\star\mu\nu}(\kappa')\beta^{\mu\nu}(\kappa) + 2e^2(u-\mathfrak{I}_1^2)^{-1}[\beta_{\star\mu\nu}(\kappa')\beta^{\mu\nu}(\kappa) + \mathfrak{I}_1^{-2}\wp_{\mu\nu}\beta^{*\mu\nu}(\kappa')\wp'_{\mu\nu}\beta^{\mu\nu}(\kappa)]\} - 2ie^2\beta^{**}_{\mu\nu}(\kappa')\beta^{\mu\nu}(\kappa)$$

$$\mathcal{M}_{total} = \mathcal{M}_s + \mathcal{M}_t + \mathcal{M}_{\mu\nu} + \mathcal{M}_{direct} = -9if^2m_0^2\{(s-m_0^2)^{-1} + (t-m_0^2)^{-1} + (uv - m_0^2)^{-1} + (3m_0^2)^{-1}\}$$

$$\mathcal{M}_{total} = \mathcal{M}_s + \mathcal{M}_t + \mathcal{M}_{\mu\nu} + \mathcal{M}_{direct} = -9if^2\mathfrak{I}_0^2\{(s-\mathfrak{I}_0^2)^{-1} + (t-\mathfrak{I}_0^2)^{-1} + (uv - \mathfrak{I}_0^2)^{-1} + (3\mathfrak{I}_0^2)^{-1}\}$$

Cuyo equivalente lagrangiano, se expresa así:

$$\mathcal{L}'_{int} = em_1\beta^{\mu\nu}\beta_{\mu\nu}\chi - \frac{1}{2fm_0\chi^3} - \frac{1}{2e^2\beta^{\mu\nu}\beta_{\mu\nu}\chi^2} - 1/8f^2\chi^4$$

$$\mathcal{L}'_{int} = e\mathfrak{I}_1\beta^{\mu\nu}\beta_{\mu\nu}\chi - \frac{1}{2f\mathfrak{I}_0\chi^3} - \frac{1}{2e^2\beta^{\mu\nu}\beta_{\mu\nu}\mathfrak{I}^2} - 1/8f^2\mathfrak{I}^4$$

$$\Phi_1(x) = \mathcal{R}(x)\cos\boxtimes(x)$$

$$\Phi_2(x) = \mathcal{R}(x)\sin\boxtimes(x)$$

$$\mathrm{A}_{\mu\nu}(x)\mathrm{B}_{\mu\nu}(x) - e^{-1}\partial_{\mu\nu}\boxtimes(x)$$

Y cuya representación del lagrangiano en $\mathbb{R}^4$ es igual a:

$$\mathcal{L}' = -\frac{1}{4\mathcal{F}^{\mu\nu}\mathcal{F}_{\mu\nu}} - \frac{1}{2g^{\mu\nu}\partial_{\mu\nu}\mathcal{R}\partial^{\mu\nu}\mathfrak{R}} - \frac{1}{2e^2\beta^{\mu\nu}\beta_{\mu\nu}\mathcal{R}^2} + \frac{1}{4m_0^2\mathfrak{R}^2} - 1/8f^2\mathbb{R}^4$$

$$\mathcal{L}' = -\frac{1}{4\mathcal{F}^{\mu\nu}\mathcal{F}_{\mu\nu}} - \frac{1}{2g^{\mu\nu}\partial_{\mu\nu}\mathcal{R}\partial^{\mu\nu}\mathfrak{R}} - \frac{1}{2e^2\beta^{\mu\nu}\beta_{\mu\nu}\mathcal{R}^2} + \frac{1}{4\mathfrak{I}_0^2\mathfrak{R}^2} - 1/8f^2\mathbb{R}^4$$

$$\mathcal{L}'_0 = -\frac{1}{4\mathcal{F}^{\mu\nu}\mathcal{F}_{\mu\nu}} - \frac{1}{2m_1^2\beta^{\mu\nu}\beta_{\mu\nu}} - \frac{1}{2g^{\mu\nu}\partial_{\mu\nu}\chi\partial_{\lambda\kappa}\chi} - 1/2m_0^2\chi^2$$

$$\mathcal{L}_0' = -\frac{1}{4\mathcal{F}^{\mu\nu}\mathcal{F}_{\mu\nu}} - \frac{1}{2\Im_1^2\beta^{\mu\nu}\beta_{\mu\nu}} - \frac{1}{2g^{\mu\nu}\partial_{\mu\nu}\chi\partial_{\lambda\kappa}\chi} - 1/2\Im_0^2\chi^2$$

$$\mathcal{L}_{total} = \mathcal{L}(\mathrm{A},\phi) - \psi_{\bar{\alpha}}\left(\gamma^{\mu\nu}\nabla_{\mu\nu} + \mathcal{M}\right)\psi_\alpha + g[\phi_1(\psi_{\bar{1}}\psi_2 + \psi_{\bar{2}}\psi_1) + \phi_2(\psi_{\bar{1}}\psi_1 + \psi_{\bar{2}}\psi_2)$$

Reduciéndose la simetría de Yukawa, a lo que sigue:

$$\partial_{\mu\nu}j^{\mu\nu}(\psi) = g[\phi_1(\psi_{\bar{1}}\psi_1 + \psi_{\bar{2}}\psi_2) + \phi_2(\psi_{\bar{1}}\psi_2 + \psi_{\bar{2}}\psi_1)] = -\partial_{\mu\nu}j^{\mu\nu}(\phi)$$

$$\partial_{\mu\nu}j^{\mu\nu}(\varphi) = g\eta[\varphi_1(\psi_{\bar{1}}\psi_1 + \psi_{\bar{2}}\psi_2) + \varphi_2(\psi_{\bar{1}}\psi_2 + \psi_{\bar{2}}\psi_1)] = -\partial_{\mu\nu}j^{\mu\nu}(\varphi)$$

Finalmente, la densidad del lagrangiano, queda expresada así:

$$\mathcal{L} = -1/2(\nabla\varphi_1)^2 - 1/2(\nabla\varphi_2)^2 - \mathcal{V}(\varphi_1^2 + \varphi_2^2) - 1/4\mathcal{F}^{\mu\nu}\mathcal{F}_{\mu\nu}$$

En la que:

$$\nabla_{\mu\nu}\varphi_1 = \frac{\partial_{\mu\nu}\varphi_1 \overset{-e}{\phi}\mathrm{AB}_{\mu\nu}\varphi_2}{\xi\lambda\kappa}.\omega$$

$$\nabla_{\mu\nu}\varphi_2 = \frac{\partial_{\mu\nu}\varphi_2 \overset{+e}{\phi}\mathrm{AB}_{\mu\nu}\varphi_1}{\lambda\kappa}.\rho$$

$$\mathcal{F}_{\mu\nu} = \partial_{\mu\nu}\eth_{\mu\nu}\mathrm{AB}_{\mu\nu} - \frac{\partial^{\mu\nu}\eth^{\mu\nu}h.\frac{c^{\mu\nu}}{\hbar}}{\lambda\kappa}.\sigma\varrho(\tau)^2$$

En ese mismo orden de ideas, para efectos de conservar la invariancia de gauge, es preciso calcular lo que sigue:

$$\partial^{\mu\nu}\{\partial_{\mu\nu}(\Delta\varphi_1) - e\varphi_0\mathrm{A}_{\mu\nu}\} = 1$$

$$\{\partial^2 - 4\varphi_0^2\mathcal{V}'')(\varphi_0^2)\}(\Delta\varphi_2) = 1$$

$$\partial_{\mu\nu_{\kappa\lambda}}\mathcal{F}^{\mu\nu}\mathcal{F}_{\mu\nu} = e\varphi_0\{\partial^{\mu\nu}(\Delta\varphi_1) - e\varphi_0\mathrm{A}_{\mu\nu}\}$$

Cuyas variables, corresponden:

$$\mathrm{B}_{\mu\nu} = \mathrm{A}_{\mu\nu} - (e\varphi_0)^{-1}\partial_{\mu\nu}(\Delta\varphi_1), \mathbb{G}_{\mu\nu} = \partial_{\mu\nu}\mathrm{B}_{\mu\nu} - \partial^{\mu\nu}\mathrm{B}^{\mu\nu} = \mathcal{F}_{\mu\nu}$$

Bajo la forma de:

$$\partial_{\mu\nu}\mathrm{B}^{\mu\nu} = 1, \partial_{\mu\nu}\mathbb{G}^{\mu\nu} + e^2\,\varphi_0^2\mathrm{B}^{\mu\nu} = 1$$

CONCLUSIONES.

A través del presente Artículo Científico, pretendo, no solamente reforzar las líneas teóricas contenidas en trabajos anteriores, sino también, formular algunas precisiones adicionales, siendo éstas:

Que, las ecuaciones de Yang – Mills, son aplicables a los campos cuánticos, indistintamente, si se tratan o no, de partículas con o sin masa, verbigracia, los campos electrodébiles o cromodinámicos cuánticos, según sea el caso.

Que, la trayectoria y movimiento de partículas, puede ser trazada, no necesariamente de forma arbitraria o imaginaria, sino en relación al momentum de las mismas y su configuración vectorial – escalar, sea rompiendo o no, las simetrías existentes.

Que los espacios o campos cuánticos, son susceptibles de curvatura geométrica, lo que ocurre con las partículas con masa, deformando su entorno, afectando la dinámica de las partículas sin masa, a propósito de un campo cuántico cuatridimensional $\mathbb{R}^4$, lo que funde la teoría cuántica de campos y la teoría de la relatividad general, en sentido estricto.

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APÉNDICE A

En relación a las conclusiones contenidas en este manuscrito, cabe precisar, que la curvatura geométrica o deformación de los campos cuánticos, se materializa cuando las partículas con o sin masa, en sus trayectorias de movimiento, se aproximan, alcanzan o superan la velocidad de la luz, lo que ocurre, a propósito de la brecha de masa o salto de energía inherente a una partícula η respecto del estado de vacío, que es igual a cero.

Ahora bien, para demostrar la hipótesis antes referida, se aplicará el siguiente esquema relativo de campos, a propósito de la mecánica einsteniana aplicable en escala cuántica:

1. Teorización inicial.

$$\int \mathfrak{H} d\mathcal{S} = \frac{1}{c\int i_{\mu\nu}\, d\vartheta} + \int \mathfrak{H} d\mathcal{S} = (curl\mathfrak{H})_{\mu\nu} d\vartheta - curl\mathfrak{H} = \frac{1}{c}.\mu\nu(u+\nu)$$

$$0 = \frac{\partial}{\partial ℸ(div\ \mu\nu)} + div\ \nu\mu$$

$$curl\mathfrak{H} = \frac{1}{c}\Bigg(\mu\nu + \nu\mu + \frac{\lambda}{\phi}.\partial\varphi^2\partial\psi_{\omega-gt}\delta_{\varsigma\ \mathbb{R}\aleph}^{\tau\ \hbar h} ℮ \frac{\mathcal{E}}{ℸℷ\Psi^{\Delta\triangleq}} \text{Ꝺ} \frac{\text{Å}}{\otimes\mathcal{B}} \mathbb{Q}\mathbb{N}\wp^4 + \mathcal{M}\mathcal{F}^{\mathcal{F}}/_{\mathcal{M}} - {}_{\sigma\rho\varpi}^{klm}\mathcal{E} + \Omega\Phi - \boxplus\triangle^{\aleph}\Bigg)$$

2. Variable de Lorentz.

$$-div\ c\|\mu,\nu\| = \frac{\partial}{\partial\left(\mu^2 + \frac{\nu^2}{\eta}\right)} + \rho\blacksquare ꝗ\mu\nu + \frac{\partial}{\partial ȶ} \rightsquigarrow \int \mu\nu\, \langle c|\varepsilon_{\mathfrak{H}}|\epsilon_{\sigma}^{\varsigma}\rangle d\varrho$$

$$[curl\mu,\mu] + [curl\nu,\nu] = \frac{\partial c}{\partial x\left\{\frac{1}{c}\middle|\mu,\nu\right\}} + ꞡ\wp\frac{\mu\nu}{c}$$

$$-[\![curl\mu,\mu]\!]\frac{\delta y^{y}}{\delta x}_{x} = \frac{\partial}{\partial x}\left(\frac{\mu^2}{2} - \mu_x\mu_x\right) - \frac{\partial}{\partial y}\left(\frac{\mu^2}{2} - \mu_x\mu_y\right) - \frac{\partial}{\partial z}\left(\frac{\mu^2}{2} - \mu_x\mu_z\right)$$

$$-[\![curl\nu,\nu]\!]\frac{\delta y^{y}}{\delta x}_{x} = \frac{\partial}{\partial x}\left(\frac{\nu^2}{2} - \nu_x\nu_x\right) - \frac{\partial}{\partial y}\left(\frac{\nu^2}{2} - \nu_x\nu_y\right) - \frac{\partial}{\partial z}\left(\frac{\nu^2}{2} - \nu_x\nu_z\right)$$

$$\wp_{\mu\nu} = \frac{1}{2(\mu^2+\nu^2)} - \mu_x\mu_x - \nu_y\nu_y|\wp_{xy} - \wp_{yx} + \mu_x\mu_y - \nu_y\nu_x|$$

$$\wp\langle ℮ + \frac{ꝗ}{\hbar}.c\rangle \overset{y}{\tilde{\tilde{x}}} \underset{\nu}{\underset{\smile}{\mu}} = \frac{\partial\wp_{xx}}{\partial x} - \frac{\partial\wp_{xy}}{\partial y} - \frac{\partial\wp_{xz}}{\partial z} - \frac{1}{c^2\partial\mathfrak{R}_{xyz}}/\partial\tau$$

$$\int \ddagger_{xyz}\, d^{\tau} = \frac{\partial}{\partial\mathfrak{R}\left\|\int\frac{1}{c^4\mathcal{S}_{xyz}}d^{\tau}\right\|} + \int \wp_{xyz}\cos(xyz)d\sigma$$

$$‡_{xyz} = -\frac{\partial \wp_{xx}}{\partial x} - \frac{\partial \wp_{xy}}{\partial y} - \frac{\partial \wp_{xz}}{\partial z} - \frac{1}{c^4 \partial \mathcal{S}_{xyz}} / \partial ך$$

$$ð\ell = \frac{\partial \mathcal{S}_x}{\partial x} - \frac{\partial \mathcal{S}_y}{\partial y} - \frac{\partial \mathcal{S}_z}{\partial z} - \frac{\partial \mathfrak{I}}{\partial ב\exists_t}$$

$$\frac{\partial \varkappa}{\partial ƛ_ך} = \partial \forall \frac{\sum_\nu^\mu \wp_{\mathscr{g}}^{\overset{def}{=}} \mathbb{Q}_{\mathscr{g}}^{\overset{def}{=}}}{\partial \mathfrak{I} (\sum_\mu^\nu \wp_{\mathscr{g}}^{\overset{def}{=}} \mathbb{Q}_{\mathscr{g}}^{\overset{def}{=}})} = \sqrt[\kappa]{\varphi_{\mathscr{g}}}$$

$$\mathfrak{e}\iota = -div\mathbb{Z} - \frac{\partial}{\partial \mathcal{M}} . \partial t \left(\mu \epsilon \mathfrak{H} + \frac{\nu \varepsilon \beta}{2} \right)$$

$$\frac{\partial}{\partial t \left\| \int \mu \epsilon \mathfrak{H} + \frac{\nu \varepsilon \beta}{2} . dך \right\|} = \int \mathcal{S}_\varrho d\sigma - \int_\varpi \mu \nu dך$$

$$\omega = \mu^2 - \frac{\nu^2}{2} + \omega_\varepsilon = \frac{1}{\epsilon} - \frac{1\mathfrak{R}^2}{2} + \omega_m = \frac{1}{\mu\nu} - \frac{1\mathcal{M}^2}{2}$$

$$\mu\nu = div\, \mathfrak{I} - \frac{\partial \omega}{\partial t} - \frac{\partial \omega_{\frac{\varepsilon}{\epsilon}}}{\partial t} - \frac{\partial \omega_{\frac{m}{\mathcal{M}}}}{\partial t}$$

$$\Lambda^{\mu\nu} = -\delta \left| \int \mathfrak{R}\mathfrak{I}/2!\, \varphi \phi \rho d\tau \,/ grad^2 \right|$$

$$\mathcal{E} = \int \left(\varphi \rho - \frac{1}{2\varepsilon grad^2 \varphi} \right) d\tau$$

$$\delta_\varphi \mathcal{E} = \int \left[\rho \delta \varphi - \varepsilon \left(\frac{\partial \varphi}{\partial x \delta} \frac{\partial \varphi}{\partial x} \ldots \right) d\tau \right] = \int \left[\rho \delta \varphi + \left(\frac{\beta_{xyz} \partial \delta \varphi}{\partial xyz} \ldots \right) d\tau \right] = \int |\rho - div\, \mathfrak{H}|\, \delta \varphi d\tau \equiv 0$$

$$\delta \mathcal{E} = \int \varphi \delta \rho - \frac{\frac{1}{2e^{-i\omega t} \delta \varepsilon \epsilon}}{\delta m \mathcal{M}} . dך$$

$$\delta \mathcal{E} = \int -\varphi\, grad\, (\rho \varrho) + \frac{1}{2\mathfrak{e}^2 \mathcal{E}^4} grad\, \mathcal{E}_{\varepsilon \epsilon_\psi} . \frac{\begin{matrix} \rho^2 & \varrho^2 & \sigma^2 \\ \lambda \tau^4 & \phi^4 & \omega^4 \\ \pi^\infty & \eta^\infty & \zeta^\infty \end{matrix}}{\Psi \sqrt[\Upsilon]{\Phi}} + \mathrm{K} \Lambda_\nu^\mu$$

$$\delta_{xyz} \mathcal{E} = \int -\mathfrak{e}_{xyz} \rho + \frac{\frac{1}{2\mathfrak{e}^2} \partial \mathcal{E}}{\partial xyz} . \delta_{xyz} d\tau$$

$$\frac{\frac{1}{2\mathfrak{e}^2 \partial \mathcal{E}}}{\partial xyz} = \partial xyz \left(\frac{\mu\nu}{2\varepsilon \epsilon^2} \right) - \varepsilon \left(\frac{\varepsilon_x \partial \varepsilon_x}{\partial x} + \frac{\varepsilon_y \partial \varepsilon_y}{\partial y} + \frac{\varepsilon_z \partial \varepsilon_z}{\partial z} \right) = \frac{\frac{1}{2\mathfrak{e}^2 \partial \epsilon}}{\partial x}$$
$$= \frac{\partial}{\partial x \left(\frac{\mu\nu}{2} - \mu_x \nu_x \right)} - \frac{\partial}{\partial y \left(\frac{\mu\nu}{2} - \mu_x \nu_y \right)} - \frac{\partial}{\partial z \left(\frac{\mu\nu}{2} - \mu_x \nu_z \right)} + \epsilon_{xyz} \rho$$

$$\wp_{xx} = \mu^2 + \frac{\nu^2}{2} - \mu_x^2 - \nu_x^2$$

$$\wp_{xy} = -\mu_x \mu_y - \nu_x \nu_y$$

$$\wp_{xx}^{(e)} = \frac{1}{\varepsilon} - 1\left(\frac{\mathfrak{H}^2}{2} - \mathfrak{H}_x^2\right)$$

$$\wp_{xy}^{(e)} = \frac{1}{\mathcal{E}} - 1\mathfrak{I}_x\mathfrak{I}_y$$

$$\wp_{xx}^{(m\mathcal{M})} = \frac{1}{\mu\nu} - 1\left(\frac{\mathcal{M}^2}{2} - m_x^2\right)$$

$$\wp_{xx}^{(m\mathcal{M})} = \frac{1}{\mu\nu} - 1\mathcal{M}_x m_x$$

$$\mathfrak{f}_x = \frac{\partial\wp_{xx}^{(e)}}{\partial x} - \frac{\partial\wp_{xy}^{(e)}}{\partial y} - \frac{\partial\wp_{xz}^{(e)}}{\partial z} - \frac{\partial\wp_{xx}^{(m\mathcal{M})}}{\partial x} - \frac{\partial\wp_{xy}^{(m\mathcal{M})}}{\partial y} - \frac{\partial\wp_{xz}^{(m\mathcal{M})}}{\partial z} - \frac{1}{c^4\partial\delta_{xyz}}/\partial\tau$$

$$\dagger = \mathrm{e}\wp + \frac{1}{c}(\mu,\nu) - \frac{1}{2}grad\ (\xi g) + (g\nabla)\mu\nu + \frac{1}{c(\xi g)} + (g\Delta) - \frac{1}{2grad}\ (\nu,\mu) + (\mathcal{M}m\nabla)\hbar - 1/c(\nu,\mu) + (\mathcal{M}m\nabla)\hbar$$

$$curl\ \mathfrak{H} = \frac{1}{c\left(\mathcal{E}\mathcal{E} \pm \sum \mathbb{Q}_g\rho_g + \sum \mathbb{Q}_i\rho_i\right)} div\ \mathcal{E}\mathcal{E} = \sum \mathbb{Q}_g\rho_g + \sum \mathbb{Q}_i\rho_i$$

$$\wp = (\mathcal{E} - 1)\ (\mathcal{E}\mathrm{e} + \frac{1}{c(\mu,\nu)})$$

$$\mathcal{M}m = (\mu\nu - 1)\ (\lambda\hbar - \frac{1}{c(\mu,\nu)})$$

$$\imath = (\mathcal{L}\lambda - 1)\ (\mathcal{E}\mathrm{e} + \frac{1}{c(\mu,\nu)})$$

3. Variable de Fizeau.

$$\mathcal{V}_x = \mathcal{V}_o + \varrho_i\left(1 - \frac{1}{\eta^2}\right)$$

$$\wp_y = (\mathcal{E}\mathcal{E} - 1)\left(1 - \frac{\alpha\varrho_x}{c}\right)\zeta$$

$$\mathcal{M}m_y = (\mu\nu - 1)\left(1 - \frac{\alpha\varrho_x}{c}\right)\zeta$$

$$\mathbb{C}\alpha = \mathcal{V}_e - \frac{\mathcal{V}(\mathcal{E}\mathcal{E} - 1)\alpha\varrho_x}{c} + \varrho_x(\mathcal{E}\mathcal{E} - 1)$$

$$\mathbb{C} = \mathcal{V}\mu\alpha\frac{(\mu\nu - 1)\varrho_x}{c} + \varrho_x(\mu\nu - 1)\alpha$$

$$\mathcal{V} = \mathcal{V}_o + \varrho_x\left(1 - \frac{1}{\eta^2}\right)$$

4. Variable de la velocidad de la luz.

$$\Delta\varphi - \frac{\frac{1}{c^2\partial^2\varphi}}{\partial\tau^2} = \frac{1}{c\overset{\mathrm{e}}{\leftrightarrow}} = curl\ \hbar = c\ curl\ (curl\ \mathrm{e}) = -c\left(\Delta\Gamma\varepsilon + grad\ (div\ \mathrm{e})\right) = \mathbb{C}\alpha\mathrm{e}$$

5. Principio de Relatividad.

$$\frac{\varpi_{\mu\nu} d^2 \tau_{\mu\nu}}{dt^2} = \mathbb{R}^{\mu\nu} \mathfrak{R}_{\mu\nu} / \mathcal{R}\mathfrak{e}$$

$$X_{\mu}^{\triangleq} X_{\nu}^{\triangleq} = X_{\mu}^{\overset{m}{=}} X_{\nu}^{\overset{m}{=}}$$

$$\frac{dx_{\mu}^{\triangleq}}{dt_{\nu}^{\triangleq}} = dx_{\mu}^{\overset{m}{=}} dt_{\nu}^{\overset{m}{=}} - \mathcal{V}$$

$$\frac{d^2 x_{\mu}^{\triangleq}}{d^2 t_{\nu}^{\triangleq}} = d^2 x_{\mu}^{\overset{m}{=}} d^2 t_{\nu}^{\overset{m}{=}} - \mathcal{V}$$

$$V = \left\| \mathcal{V}_o + \varrho_i \left(1 - \frac{1}{\eta^2}\right) \right\| - \varrho_i = \mathcal{V}_o - \frac{\varrho_i}{\eta^2}$$

6. Transformaciones de Lorentz.

$$\lambda^2(\chi^2 + y^2 + z^2 - c^2 t^2) = \left(\chi^{\overset{def}{=}2} + y^{\overset{def}{=}2} + z^{\overset{def}{=}2} - c^{\overset{def}{=}2} t^{\overset{def}{=}2}\right) = \alpha_{1\mu 1\nu}^2 + \alpha_{2\mu 2\nu}^2 + \alpha_{3\mu 3\nu}^2 + \alpha_{\eta\mu\eta\nu}^2 = 1$$

$$\alpha_\eta = \frac{1}{\sqrt{1-\beta^2}} + \frac{i\beta}{\sqrt{1-\beta^2}} - \frac{-1}{\sqrt{1-\beta^2}} + \frac{-i\beta}{\sqrt{1-\beta^2}}$$

$$x' = x + \frac{i\beta_{\mu\nu}}{\sqrt{1-\beta^2}} + \mu\nu' = \frac{\mu\nu - i\beta_{xyz}}{\sqrt{1-\beta^2}} + x' = \frac{x - \beta_{ct}}{\sqrt{1-\beta^2}} = \mathrm{t} = \mathrm{t} - \frac{\beta}{c} x / \sqrt{1-\beta^2}$$

$$x' = x - \frac{\mathfrak{v}\mathrm{t}}{\sqrt{1 - \frac{\mathfrak{v}^2}{\mathrm{c}^2}}}$$

$$\mu\nu' = \mathrm{t} - \frac{\frac{\mathfrak{v}}{\mathrm{c}^2} x}{\sqrt{1 - \frac{\mathfrak{v}^2}{\mathrm{c}^2}}}$$

$$\frac{\mathfrak{X}^2}{\sqrt[\mathfrak{R}]{1 - \frac{\mathfrak{v}^2}{\mathrm{c}^2}}} + \frac{\mathfrak{Y}^2}{\mathfrak{R}^2} + \frac{\mathfrak{Z}^2}{\mathfrak{R}^2} = 1$$

$$\mathfrak{B}_{\mathfrak{o}} = \mathfrak{B} / \sqrt{1 - \frac{\mathrm{q}^2}{\mathrm{c}^2}}$$

$$\Delta \mathrm{t} = \Delta \mathrm{t}' \frac{\aleph}{\sqrt{1 - \frac{\mathfrak{v}^2}{\mathrm{c}^2}}}$$

$$\sum \Delta \mathrm{t} = \sum \Delta \mathrm{t}' \frac{\aleph}{\sqrt{1 - \frac{\mathrm{q}^2}{\mathrm{c}^2}}}$$

$$\sum \Delta \mathrm{t}' = \sum \Delta \mathrm{t} . \sqrt{1 - \frac{\mathrm{q}^2}{\mathrm{c}^2}}$$

$$x' = \lambda(\mu\nu)x - vt/\sqrt{1-\frac{v^2}{c^2}}$$

$$t = \lambda(\mu\nu)t - v/c^2x/\sqrt{1-\frac{v^2}{c^2}}$$

7. Teorema de Velocidades.

$$\mathfrak{q}_{\mathfrak{x}} = \mathfrak{q}'_{\mathfrak{x}} + \frac{\mathfrak{v}}{1} + \mathfrak{q}'_{\mathfrak{x}}\mathfrak{v}/\mathfrak{c}^2$$

$$\mathfrak{q}_{\mathfrak{y}} = \frac{\sqrt{1-\frac{v^2}{c^2}}\,\mathfrak{q}'_{\mathfrak{y}}}{1} + \mathfrak{q}'_{\mathfrak{x}}\mu\nu/\mathfrak{c}^2$$

$$\mathfrak{q}_{\mathfrak{z}} = \frac{\sqrt{1-\frac{v^2}{c^2}}\,\mathfrak{q}'_{\mathfrak{z}}}{1} + \mathfrak{q}'_{\mathfrak{x}}\mu\nu/\mathfrak{c}^2$$

$$\mathfrak{q}^2 = \mathfrak{q}'^2 + \mathfrak{v}^2 + 2\mathfrak{q}'^{\mu\nu}\cos\theta' - (\frac{\mathfrak{q}'^{\mu\nu}}{\mathfrak{c}}\sin\theta'\frac{)^2}{1} + \frac{\mathfrak{q}'^{\mu\nu}}{\mathfrak{c}^2}\cos\theta')^2$$

$$\frac{\mathfrak{q}^2}{\mathfrak{c}^2} = 1 + \frac{\mathfrak{q}'^{\mu\nu}}{\mathfrak{c}}\cos\theta')^2 - \frac{\left(1-\frac{\mathfrak{q}'^2}{\mathfrak{c}^2}\right)\left(1-\frac{\mathfrak{v}^2}{\mathfrak{c}^2}\right)}{(1+\frac{\mathfrak{q}'^{\mu\nu}}{\mathfrak{c}}\cos\theta')^2}$$

$$\mathfrak{q} = \mathfrak{q}' + \frac{\mathfrak{v}}{1} + \frac{\mathfrak{q}'^{\mu\nu}}{\mathfrak{c}^2}$$

$$\mathcal{V} = \mathcal{V}_o + \frac{\mathfrak{q}}{1+\frac{\mathcal{V}_o\mathfrak{q}}{\mathfrak{c}^2}}$$

$$\mathcal{V} = \mathcal{V}_o + q\left(1-\frac{1}{\mathfrak{n}^2}\right)$$

$$\sin\omega\left(t - lx + my + \frac{nz}{c}\right)$$

$$\sin\omega'\left(t' - l'x' + m'y' + \frac{n'z'}{c'}\right)$$

$$\omega' = \omega 1 - \frac{l\frac{lv}{c}}{\sqrt{1-\frac{v^2}{c^2}}}$$

$$l' = l - \frac{\frac{v}{c}}{1} - l\frac{lv}{c}$$

$$m' = \frac{m}{1-\frac{lv}{c}}\sqrt{1-\frac{v^2}{c^2}}$$

$$n' = \frac{n}{1 - \frac{lv}{c}} \sqrt{1 - \frac{v^2}{c^2}}$$

$$\frac{\partial}{\partial x} = b\left(\frac{\partial}{\partial x} - \frac{v}{c^2 \frac{\partial}{\partial t'}}\right) + \frac{\partial}{\partial y} = b\left(\frac{\partial}{\partial y} - \frac{v}{c^2 \frac{\partial}{\partial t'}}\right) + \frac{\partial}{\partial z} = b\left(\frac{\partial}{\partial z} - \frac{v}{c^2 \frac{\partial}{\partial t'}}\right)$$

$$\rho' = \mathfrak{b}(1 - \frac{\mathfrak{v}\mathfrak{q}_{\mathfrak{x}}}{\mathfrak{c}^2})\rho$$

$$\mathcal{q}'_x = \mathfrak{q}_{\mathfrak{x}} - \frac{\mathfrak{v}}{1 - \frac{\mathfrak{q}_{\mathfrak{x}}\mathfrak{v}}{\mathfrak{c}^2}}$$

$$\mathcal{q}'_{\mathfrak{y}} = \mathfrak{q}_{\mathfrak{y}}/\mathfrak{b}\left(1 - \frac{\mathfrak{q}_{\mathfrak{x}}\mathfrak{v}}{\mathfrak{c}^2}\right)$$

$$\mathcal{q}'_{\mathfrak{z}} = \mathfrak{q}_{\mathfrak{z}}/\mathfrak{b}\left(1 - \frac{\mathfrak{q}_{\mathfrak{x}}\mathfrak{v}}{\mathfrak{c}^2}\right)$$

$$\rho = \rho'/\sqrt{1 - \frac{v^2}{c^2}}$$

$$d\tau_0 = d\tau' = \frac{d\tau}{\sqrt{1 - \frac{v^2}{c^2}}}$$

$$\rho_0 = \rho/\sqrt{1 - \frac{\mathfrak{q}^2}{c^2}}$$

$$\phi = \omega\left(\mathfrak{t} - \mathfrak{l}\mathfrak{x} + \mathfrak{m}\mathfrak{y} + \frac{\mathfrak{n}\mathfrak{z}}{\mathfrak{c}}\right)$$

$$\phi' = \omega'\left(\mathfrak{t}' - \mathfrak{l}'\mathfrak{x}' + \mathfrak{m}'\mathfrak{y}' + \frac{\mathfrak{n}'\mathfrak{z}'}{\mathfrak{c}'}\right) sin\phi$$

$$\mathfrak{A}' = \mathfrak{A}1 - \frac{\frac{\mathfrak{v}}{\mathfrak{c}} cos\varphi}{\sqrt{1 - \frac{v^2}{c^2}}}$$

8. Ecuaciones de Movimiento.

$$\mathfrak{d}\mathfrak{q}' = \frac{\mathfrak{d}\mathfrak{q}}{1} - \frac{\mathfrak{q}\mathfrak{v}}{\mathfrak{c}^2} + \frac{\mathcal{q}\frac{v}{\mathfrak{c}^2}\mathfrak{d}\mathfrak{q}}{(1 - \mathfrak{q}\mathfrak{v}/\mathfrak{c}^2)^2} = \mathfrak{d}\mathfrak{q}/(1 - \mathfrak{q}\mathfrak{v}/\mathfrak{c}^2)^2$$

$$\mathfrak{d}\mathfrak{t} = \mathfrak{d}\mathfrak{t}' + \frac{\frac{\mathfrak{v}}{\mathfrak{c}^2\mathfrak{d}\mathfrak{x}'}}{\sqrt{1 - \frac{v^2}{c^2}}} = \mathfrak{d}\mathfrak{t}'/\sqrt{1 - \frac{\mathfrak{q}^2}{\mathfrak{c}^2}}$$

$$\mathfrak{m}.\frac{\mathfrak{d}\mathfrak{q}}{\mathfrak{d}\mathfrak{t}}/(\sqrt{1 - \frac{\mathfrak{q}^2}{c^2}})^{\frac{3}{2}} = \varepsilon \mathfrak{e}_{\mathfrak{x}} \mathcal{E}_{\mathfrak{P}} \mathfrak{E}_{\mathfrak{v}}^{\mathfrak{u}}$$

$$\frac{\mathfrak{d}\mathfrak{q}}{\mathfrak{d}\mathfrak{t}}/(\sqrt{1-\frac{\mathfrak{q}^2}{c^2}})^{\frac{3}{2}} = \frac{d}{dt\left\|\frac{\mathfrak{q}}{\sqrt{1-\frac{\mathfrak{q}^2}{\mathfrak{c}^2}}}\right\|} = \frac{d}{dt\left|\frac{\mathfrak{m}\mathfrak{q}}{\sqrt{1-\frac{\mathfrak{q}^2}{\mathfrak{c}^2}}}\right|} = \mathfrak{f}_{xyz}$$

$$\frac{d}{dt\,\langle\frac{\mathfrak{m}\mathfrak{q}}{\sqrt{1-\frac{\mathfrak{q}^2}{\mathfrak{c}^2}}}\rangle} = \mathfrak{f}\kappa$$

$$\mathfrak{f}\kappa\mathfrak{q} = \mathfrak{q}.\frac{d}{dt}\left|\frac{\mathfrak{m}\mathfrak{q}}{\sqrt{1-\frac{\mathfrak{q}^2}{\mathfrak{c}^2}}}\right| = \frac{d}{dt\left|\frac{\mathfrak{m}q^2}{\sqrt{1-\frac{\mathfrak{q}^2}{\mathfrak{c}^2}}}\right|} - \frac{\mathfrak{m}\mathfrak{q}q}{\sqrt{\mathfrak{I}}} = \frac{d}{dt\left|\frac{\mathfrak{m}q^2}{\sqrt{1-\frac{\mathfrak{q}^2}{\mathfrak{c}^2}}}\right|} + \mathfrak{m}\mathfrak{c}^2\sqrt{1-\frac{\mathfrak{q}^2}{\mathfrak{c}^2}}$$

$$\mathfrak{f}\kappa\mathfrak{q} = d/dt\left|\frac{\mathfrak{m}\mathfrak{c}^2}{\sqrt{1-\frac{\mathfrak{q}^2}{\mathfrak{c}^2}}}\right|$$

$$\mathcal{E}_{\stackrel{\text{def}}{\equiv}} = \mathfrak{m}\mathfrak{c}^2/\sqrt{1-\frac{\mathfrak{q}^2}{\mathfrak{c}^2}}$$

$$\mathcal{E}_{\stackrel{\text{def}}{\equiv}} = \mathfrak{m}\mathfrak{c}^2 + \mathcal{M}/2\mathfrak{q}^2$$

9. Energía Inercial.

$$\mathrm{x} = \mathrm{ct} + \alpha + \mathfrak{l}'/\mathfrak{b}\left(1+\frac{\mathfrak{v}}{\mathfrak{c}}\right)$$

$$\mathfrak{l}_1 = \mathfrak{l}'\sqrt{1-\frac{\frac{v}{c}}{1}-\frac{v}{c}}$$

$$\mathfrak{l}_2 = \mathfrak{l}'\sqrt{1+\frac{\frac{v}{c}}{1}-\frac{v}{c}}$$

$$\mathfrak{A}_1 = \mathfrak{A}'\sqrt{1+\frac{\frac{v}{c}}{1}-\frac{v}{c}}$$

$$\mathfrak{A}_2 = \mathfrak{A}'\sqrt{1-\frac{\frac{v}{c}}{1}+\frac{v}{c}}$$

$$\eta_1 = \frac{\mathfrak{f}\mathfrak{t}_1 1}{2\mathrm{A}_1^2} = \frac{1}{2\mathfrak{f}\mathfrak{t}'}A'^2\sqrt{1+\frac{\frac{v}{c}}{1}-\frac{v}{c}}$$

$$\eta_2 = \frac{\mathfrak{f}\mathfrak{t}_2 1}{2\mathrm{A}_2^2} = \frac{1}{2\mathfrak{f}\mathfrak{t}'}A'^2\sqrt{1-\frac{\frac{v}{c}}{1}+\frac{v}{c}}$$

$$\eta_1 + \eta_2 = 2\eta' / \sqrt{1 - \frac{v^2}{c^2}}$$

$$\mathfrak{I}_1 = \frac{\mathfrak{f}\mathfrak{t}_1 1}{2\mathfrak{c}\mathfrak{A}_1^2} = \frac{1}{2\mathfrak{c}\mathfrak{f}\mathfrak{t}'} A'^2 \sqrt{1 + \frac{\frac{v}{c}}{1} - \frac{v}{c}}$$

$$\mathfrak{I}_2 = \frac{\mathfrak{f}\mathfrak{t}_2 1}{2\mathfrak{c}\mathfrak{A}_2^2} = \frac{1}{2\mathfrak{c}\mathfrak{f}\mathfrak{t}'} A'^2 \sqrt{1 - \frac{\frac{v}{c}}{1} + \frac{v}{c}}$$

$$\mathfrak{I}_1 - \mathfrak{I}_2 = 2\eta' / c^2 . \mathcal{V} / \sqrt{1 - \frac{v^2}{c^2}}$$

$$\mathcal{E}_{\stackrel{\text{def}}{\equiv}} = \mathfrak{m}\mathfrak{c}^2 / \sqrt{1 - \frac{v^2}{c^2}}$$

$$\Delta\mathcal{E}_{\stackrel{\text{def}}{\equiv}} = \Delta\mathcal{E}_{\stackrel{\text{def}}{\equiv}}' / \sqrt{1 - \frac{v^2}{c^2}}$$

$$(\mathcal{E}_{\stackrel{\text{def}}{\equiv}} + \Delta\mathcal{E}_{\stackrel{\text{def}}{\equiv}}) = [\![\mathcal{M} + \Delta\mathcal{E}_{\stackrel{\text{def}}{\equiv}}'/c^2]\!] / \sqrt{1 - \frac{v^2}{c^2}}$$

$$\beta = \frac{\mathcal{M}\mathfrak{v}}{\sqrt{1 - \frac{v^2}{c^2}}}$$

$$\Delta\beta = (\mathfrak{I}_1 - \mathfrak{I}_2) = \frac{\Delta\mathcal{E}'_{\mathfrak{v}}}{c^2} / \sqrt{1 - \frac{v^2}{c^2}}$$

$$(\beta + \Delta\beta) = [\mathcal{M} + \Delta\mathcal{E}_{\stackrel{\text{def}}{\equiv}}'/c^2]\mathfrak{v} / \sqrt{1 - \frac{v^2}{c^2}}$$

10. Variable de cuatro dimensiones de Minkowski:

$$A'_{xyz} = A_{xyz} + i\beta A_{\mu\nu} / \sqrt{1 - \beta^2}$$

$$A'_{\mu\nu} = A_{\mu\nu} - i\beta A_{xyz} / \sqrt{1 - \beta^2}$$

$$\mathfrak{X}'_{\mu\nu} = \sum \alpha_{\mu\nu} \mathfrak{X}_{\mu\nu}$$

$$\mathfrak{A}'_{\mu\nu} = \sum_{\mu\nu} \alpha_{\mu\nu} \mathfrak{A}_{\mu\nu}$$

$$\mathfrak{T}'_{\mu\nu} = \sum_{\sigma\tau} \alpha_{\mu\sigma} \mathfrak{A}_{\nu\tau} \mathfrak{T}_{\mu\nu}$$

$$\mathfrak{T}'_{\mathfrak{r}_1 \dots \mathfrak{r}_\mathfrak{n}} = \sum_{\sigma_1 \dots \sigma_\eta} \alpha_{\mathfrak{r}_1\sigma_1}\, \alpha_{\mathfrak{r}_2\sigma_2} \dots \alpha_{\mathfrak{r}_\eta\sigma_\eta} \mathfrak{T}_{\sigma_1 \dots \sigma_\eta}$$

$$\begin{matrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{matrix}$$

11. Variable tensorial.

$$\left(\mathfrak{T}_{\sigma_1 \dots \sigma_\eta}\right) \pm \left(\mathfrak{U}_{\sigma_1 \dots \sigma_\eta}\right) = \left(\mathfrak{T}_{\sigma_1 \dots \sigma_\eta} \pm \mathfrak{U}_{\sigma_1 \dots \sigma_\eta}\right)$$

$$\mathfrak{T}_{\sigma_1 \dots \sigma_\eta} \mathfrak{U}_{\tau_1 \dots \tau_\eta}$$

$$\mathfrak{T}'_{\delta_1 \dots \delta_\eta} = \sum_{\sigma_1 \dots \sigma_\eta} \alpha_{\delta_1\sigma_1} \alpha_{\delta_2\sigma_2} \dots \alpha_{\delta_\eta\sigma_\eta} \mathfrak{T}_{\sigma_1 \dots \sigma_\eta}$$

$$\mathfrak{U}'_{\mathfrak{t}_1 \dots \mathfrak{t}_\eta} = \sum_{\tau_1 \dots \tau_\eta} \alpha_{\mathfrak{t}_1\tau_1} \alpha_{\mathfrak{t}_2\tau_2} \dots \alpha_{\mathfrak{t}_\eta\tau_\eta} \mathfrak{U}_{\tau_1 \dots \tau_\eta}$$

$$\mathfrak{T}'_{\delta_1 \dots \delta_\eta} \mathfrak{U}'_{\mathfrak{t}_1 \dots \mathfrak{t}_\eta} = \sum_{\sigma_1 \dots \sigma_\eta \tau_1 \dots \tau_\eta} \alpha_{\delta_1\sigma_1} \dots \alpha_{\delta_\eta\sigma_\eta} \alpha_{\mathfrak{t}_1\tau_1} \dots \alpha_{\mathfrak{t}_\eta\tau_\eta} \mathfrak{T}_{\sigma_1 \dots \sigma_\eta} \mathfrak{U}_{\tau_1 \dots \tau_\eta}$$

$$\left(\mathfrak{T}_{\sigma_1 \dots \sigma_\eta}\right)\left(\mathfrak{U}_{\tau_1 \dots \tau_\eta}\right) = \left(\mathfrak{T}_{\sigma_1 \dots \sigma_\eta} \mathfrak{U}_{\tau_1 \dots \tau_\eta}\right)$$

$$\sum_{\sigma_1 \dots \sigma_\eta} \mathfrak{U}_{\sigma_1 \dots \sigma_\eta} \mathfrak{T}_{\sigma_1 \dots \sigma_\eta} = \mathfrak{V}_{\sigma_{\eta+1} \dots \sigma_\mathfrak{m}}$$

$$\mathfrak{U}'_{\delta_1 \dots \delta_\eta} = \sum_{\tau_1 \dots \tau_\eta} \alpha_{\delta_1\tau_1} \alpha_{\delta_2\tau_2} \dots \alpha_{\delta_\eta\tau_\eta} \mathfrak{U}'_{\tau_1 \dots \tau_\eta}$$

$$\mathfrak{T}'_{\sigma_1 \dots \sigma_\eta} = \sum_{\sigma_1 \dots \sigma_\eta} \alpha_{\delta_1\sigma_1} \alpha_{\delta_2\sigma_2} \dots \alpha_{\delta_\eta\sigma_\eta} \mathfrak{T}_{\sigma_1 \dots \sigma_\eta}$$

$$\mathfrak{V}'_{\delta_{\eta+1} \dots \delta_\mathfrak{m}} = \sum_{\delta_1 \dots \delta_\eta \tau_1 \dots \tau_\eta \sigma_1 \dots \sigma_\eta} \alpha_{\delta_1\tau_1} \dots \alpha_{\delta_\eta\tau_\eta} \alpha_{\delta_1\sigma_1} \dots \alpha_{\delta_\eta\sigma_\eta} \mathfrak{U}_{\tau_1 \dots \tau_\eta} \mathfrak{T}_{\sigma_1 \dots \sigma_\eta}$$

$$\mathfrak{V}'_{\delta_{\eta+1} \dots \delta_\mathfrak{m}} = \sum_{\sigma_{\eta+1} \dots \sigma_\mathfrak{m}} \alpha_{\delta_{\eta+1}\sigma_{\eta+1}} \dots \alpha_{\delta_\mathfrak{m}\sigma_\mathfrak{m}} \mathfrak{U}'_{\sigma_{\eta+1} \dots \sigma_\mathfrak{m}}$$

$$\left(\mathfrak{U}'_{\sigma_1 \dots \sigma_\mathfrak{n}}\right)\left(\mathfrak{T}'_{\sigma_1 \dots \sigma_\mathfrak{n}}\right) = \left(\mathfrak{V}'_{\sigma_{\mathfrak{n}+1} \dots \sigma_\mathfrak{m}}\right)$$

$$\left(\mathfrak{T}_{\mu\nu}\right)\left(\mathfrak{U}_{\mu\nu}\right) = (\mathfrak{V})$$

$$\mathfrak{V} = \frac{\dfrac{\sum_{\mathfrak{u}} \mathfrak{v} \dfrac{\sum_{\mu\nu}(\mathfrak{T}_{\mu\nu}\, \mathfrak{U}_{\mu\nu} \mathfrak{S}_{\mu\nu} \mathfrak{T}^2_{\mu\nu} \mathfrak{U}^2_{\mu\nu} \mathfrak{S}^2_{\mu\nu})^{\rho}\, 1}{2} \sum_{\mathfrak{i}\mathfrak{k}} \mathfrak{l}\mathfrak{m}\, 1}{6} 1}{24} (\mathfrak{V}_{\mathfrak{i}\mathfrak{k}\mathfrak{l}\mathfrak{m}})(\mathfrak{E}_{\mathfrak{i}\mathfrak{k}\mathfrak{l}\mathfrak{m}})$$

$$\mathfrak{x}_{\mu\nu} = \sum_{\mu\nu} \alpha_{\mu\nu}\, \mathfrak{X}'_{\mu\nu}$$

$$\frac{\partial}{\mathfrak{X}'_{\mu\nu}} = \sum_{\mu\nu} \alpha_{\mu\nu} \frac{\partial}{\mathfrak{X}'_{\nu\mu}}$$

$$\left(\frac{\partial}{\partial_{\chi_\tau}}\right)(\mathfrak{T}_{\sigma_1\ldots\sigma_n}) = \|\partial\mathfrak{T}_{\sigma_1\ldots\sigma_n}/\partial_{\chi_\tau}\|$$

$$\left(\frac{\partial}{\partial_{\chi_{\sigma_{\mu\nu}}}}\right)(\mathfrak{T}_{\sigma_1\ldots\sigma_n}) = \sum_{\sigma_{\mu\nu}} \frac{\partial}{\partial_{\chi_{\sigma_{\mu\nu}}}}\left(\mathfrak{T}_{\sigma_{\mu\nu}\ldots\sigma_{\mu\nu-1}\sigma_{\nu\mu+1}\ldots\sigma_{\nu\mu}}\right)$$

$$\left(\frac{\partial}{\partial_{\mu\nu}}\right)\mathfrak{T} = \left(\frac{\partial\mathfrak{T}}{\partial_{\chi_{\mu\nu}}}\right)$$

$$\left(\frac{\partial}{\partial_{\chi_{\mu\nu}}}\right)(\mathfrak{T}_{\mu\nu}) = \sum_{\mu\nu}\left(\frac{\partial\mathfrak{T}_{\mu\nu}}{\partial_{\chi_{\mu\nu}}}\right)$$

$$\left(\frac{\partial}{\partial \mathrm{X}_\tau}\right)\left|\left(\frac{\partial}{\partial \mathrm{X}_\tau}\right)(\mathfrak{T}_{\sigma_1\ldots\sigma_n})\right| = \left(\frac{\partial}{\partial \mathrm{X}_\tau}\right)\left(\frac{\partial\mathfrak{T}_{\sigma_1\ldots\sigma_n}}{\partial \mathrm{X}_\tau}\right) = \left(\frac{\sum_\tau \partial^2\,\mathfrak{T}_{\sigma_1\ldots\sigma_n}}{\partial \mathrm{X}_\tau^2}\right)(\boxdot\,\mathfrak{T}_{\sigma_1\ldots\sigma_n})$$

12. Estado de vacío.

$$\frac{1}{2\left\|\frac{1}{v} - V + \frac{1}{v} + V\right\|\partial\tau}\partial \mathrm{t} = \frac{\partial\tau}{\partial \mathrm{X}^\Gamma} + \frac{1}{v} - V\frac{\partial\tau}{\partial \mathrm{t}}, \frac{\partial\tau}{\partial \mathrm{X}^\Gamma} + \frac{v}{\sqrt{V^2 - v^2}\,\frac{\partial\tau}{\partial \mathrm{t}}} = 0$$

$$\tau = \alpha\left(\mathrm{t} - \frac{\mathfrak{v}}{V^2} - v^2 x'\right)$$

$$\xi = V\tau$$

$$\xi = \alpha V\left(t - \frac{v}{V^2} - v^2 x'\right)$$

$$x'/v - V = t$$

$$\xi = \alpha . V^2/\sqrt{\frac{V^2 - v^2}{x'}}$$

$$\eta = V_\tau = \alpha V\left(t - \frac{v}{V^2} - v^2\, x'\right)$$

$$\beta = \frac{1}{1} - (v/V)^2$$

$$\varphi X^2/(\sqrt{1 - (v/V)^2})^2 + y^2 + z^2 = \mathcal{R}^2$$

$$\tau = 1/\sqrt{1 - (v/V)^2}|t - v/V^2 x|$$

$$\tau = t\sqrt{1 - (v/V)^2} = t - \langle 1 - \sqrt{1 - (v/V)^2}\rangle\, t$$

$$x = \omega_\xi + \frac{v}{1} + \frac{v\omega_\xi}{V^2 t}$$

$$y = \frac{\sqrt{1 - (v/V)^2}}{1} + \frac{v\omega_\xi}{V^2}\omega_{\eta^\dagger}$$

$$\mathcal{U}^2 = (\frac{dx}{dt)^2} + \frac{dy}{dt)^2}$$

$$\omega^2 = \omega_\xi^2 + \omega_\eta^2$$

$$\alpha = arctg\omega_y/\omega_x$$

$$\mathcal{U} = \frac{\sqrt{v^2 + \omega^2 + 2v\omega\cos\alpha - (v\omega\sin\frac{a}{V})^2}}{1 + v\omega\cos\alpha / V^2}$$

$$U = v + \frac{\omega}{1} + v\omega/V^2$$

$$U = V.2V - \kappa - \frac{\lambda}{2V} - \kappa - \lambda + \frac{\kappa\lambda}{V} \lll V$$

$$U = V + \frac{\omega}{1} + \frac{\omega}{v} = V$$

$$v + \frac{\omega}{1} + \frac{v\omega}{V^2}$$

$$\frac{\frac{1}{V\partial X}}{\partial\tau} = \partial\beta\left(N - \frac{v}{V}Y\right) - \frac{\partial\beta\left(M + \frac{v}{V}Z\right)1}{V}\frac{\partial\beta\left(Y - \frac{v}{V}N\right)}{\partial\tau} = \frac{\partial L}{\partial\zeta} - \frac{\partial\beta\left(N - \frac{v}{V}Y\right)}{\partial\zeta}$$

$$\beta = \frac{1}{\sqrt{1 - (v/V)^2}}$$

$$(\beta\xi - \frac{\alpha\beta v}{V}\xi)^2 + (\eta - \frac{b\beta v}{V\xi)^2} + (\zeta - \frac{c\beta v}{V)^2} = \mathcal{R}^2$$

$$S'/S = \sqrt{1 - (\frac{\frac{v}{V)^2}}{1} - v/Vcos\varphi}$$

$$\frac{E'}{E} = \frac{A'^2}{16\pi}S'\frac{A^2}{16\pi}S = 1 \ - \frac{v}{V}cos\varphi/\sqrt{1 - (v/V)^2}$$

$$\frac{E'}{E} = \sqrt{1 - \frac{\frac{v}{V}}{1} + \frac{v}{V}}$$

$$A^t = A.1 - \frac{\frac{v}{V}\cos\varphi}{\sqrt{1 - (v/V)^2}}$$

$$\cos\varphi^t = \cos\varphi - \frac{\frac{v}{V}}{1} - \frac{v}{V}\cos\varphi$$

$$v^t = v.1 - \frac{v}{V}\cos\frac{\varphi}{\sqrt{1 - (v/V)^2}}$$

$$A^m = A^n.1 + \frac{v}{V}\cos\varphi^n/\sqrt{1 - (v/V)^2} = A.1 - \frac{2.v}{V}\cos\varphi + \left(\frac{\frac{v}{V)^2}}{1} - \left(\frac{v}{V)^2}\right)\right)$$

$$\cos\varphi^m = \cos\varphi^n + \frac{\frac{v}{V}}{1} + \frac{v}{V}\cos\varphi^n = -(1 + \left(\frac{v}{V)^2}\right)\cos\varphi - \frac{2.\frac{v}{V}}{1} - 2.\frac{v}{V}\cos\varphi + (\frac{v}{V})^2$$

$$v^m = v^n.1 + \frac{v}{V}\cos\frac{\varphi^n}{\sqrt{1-(v/V)^2}} = v.1 - 2.\frac{v}{V}\cos\varphi + (\frac{\frac{v}{V})^2}{1} - \left(\frac{v}{V})^2\right)$$

$$P = 2.\frac{A^2}{16\pi}(\cos\varphi - \frac{\frac{v}{V})^2}{1} - (\frac{v}{V})^2/\cos\varphi^2$$

$$\frac{1}{V\left(\mu_\xi \eta\zeta\rho^\dagger + \frac{\partial X^\dagger}{\partial \tau}\right)} = \frac{\partial N^\dagger}{\partial \eta} - \frac{\partial M^\dagger}{\partial \zeta}$$

$$\frac{\mu d^2 x}{dt^2} = \epsilon(X, Y, Z)$$

$$\frac{\mu d^2 \xi\eta\zeta}{d\tau^2} = \frac{\epsilon}{\mu} - \frac{\frac{1}{\beta^3(X^\dagger, Y^\dagger, Z^\dagger)}}{\frac{v}{V(M,N)}}$$

$$\mathcal{L}m = \mathfrak{u}/(\sqrt{1 - v/V)^2})^3$$

$$\mathcal{T}m = \frac{\mathfrak{u}}{1} - (v/V)^2$$

$$\mathcal{W} = \int \epsilon X dx = \int_0^v \beta^3\, v d\mu = \mu v V^2(1/\sqrt{1-(v/V)^2} - 1)$$

$$P = \int X dx = \frac{\mu v}{\epsilon}.V^2\left(\frac{1}{\sqrt{1-(\frac{v}{V})^2}} - 1\right)$$

$$-\frac{d^2 y}{dt^2} = \frac{\mathfrak{v}^2}{\mathfrak{R}} = \frac{\epsilon}{\mu}.\frac{v}{V}.N.\sqrt{1-(\frac{v}{V})^2}$$

$$\mathfrak{R} = V^2.\frac{\mu}{\epsilon}.\frac{\frac{v}{V}}{\sqrt{1-(\frac{v}{V})^2}}.1/N$$

13. Estado Fundamental de Vacío.

$$\left(\frac{\partial}{\partial \mathfrak{X}_{\mu\nu}}\right)(\mathfrak{F}_{\mu\nu}) = (\mathfrak{T}_{\mu\nu})\left(\mathfrak{F}^{\star}{}_{\mu\nu}\right) = 0$$

$$\frac{1}{2(\mathfrak{F}_{\mu\nu})}(\mathfrak{F}_{\mu\nu}) = \mathfrak{h}^2 - \mathfrak{e}^2$$

$$\frac{1}{2\mathfrak{i}(\mathfrak{F}_{\mu\nu})\left(\mathfrak{F}^{\star}{}_{\mu\nu}\right)} = (\mathfrak{e}\mathfrak{h})$$

$$-(\mathfrak{F}_{\mu\nu})(\mathfrak{F}_{\mu\nu}) = \rho^2\left(1 - \frac{\varrho^2}{\mathfrak{c}^2}\right) = \mathfrak{p}_0^2$$

$$(\mathfrak{F}_{\mu\nu})\,(\mathfrak{I}_{\mu\nu}) = (\mathfrak{K}_{\mu\nu})$$

$$(\mathfrak{K}_{\mu\nu}) = -\left(\frac{\partial}{\partial \mathfrak{X}_{\mu\nu}}\right)(\mathfrak{T}_{\mu\nu}) = 1/2\|(\mathfrak{F}_{u\sigma})(\mathfrak{F}_{\nu\sigma}) - (\mathfrak{F}^{*}{}_{u\sigma})(\mathfrak{F}^{*}{}_{\nu\sigma})\|$$

14. Movimiento Isotrópico.

$$(\mathfrak{S}_{\mu\nu}) = \left(\frac{dx_{\mu\nu}}{\sqrt{-\sum dx_{\sigma}^{2}}}\right)$$

$$\left(\mathfrak{F}_{\mu\nu}^{(e)}\right) = (\mathfrak{F}_{\mu\nu})(\mathfrak{S}_{\mu\nu})$$

$$\mathfrak{F}_{\eta}^{(e)} = \frac{\dfrac{1}{\sqrt{1-\dfrac{\varrho^{2}}{c^{2}}\mathfrak{e}_{x}}}\mathfrak{q}_{x}}{\mathfrak{c}}.\mathfrak{e}_{x} + \frac{\mathfrak{q}_{\mathfrak{y}}}{\mathfrak{c}}.\mathfrak{e}_{\mathfrak{y}} + \frac{\mathfrak{q}_{\mathfrak{z}}}{\mathfrak{c}}.\mathfrak{e}_{z}$$

$$\left(\mathfrak{F}_{\mu\nu}^{(\mathfrak{m})}\right) = -\mathfrak{i}\left(\mathfrak{F}^{*}{}_{\mu\nu}\right)(\mathfrak{S}_{\mu\nu})$$

$$\mathfrak{F}_{\eta}^{(\mathfrak{m})} = \mathfrak{i}/\sqrt{1-\frac{\varrho^{2}}{c^{2}}.\frac{\mathfrak{q}_{x}}{\mathfrak{c}}.\mathfrak{h}_{\mathfrak{x}} + \frac{\mathfrak{q}_{\mathfrak{y}}}{\mathfrak{c}}.\mathfrak{h}_{\mathfrak{y}}} + \frac{\mathfrak{q}_{\mathfrak{z}}}{\mathfrak{c}}.\mathfrak{h}_{\mathfrak{z}}$$

$$\mathfrak{I}_{\mathfrak{i}}^{\mathfrak{k}} = \frac{\dfrac{\rho_{0}}{\sqrt{1-\dfrac{\varrho^{2}}{c^{2}}\mathfrak{q}_{x}}}}{\mathfrak{c}} = \rho.\mathfrak{q}_{x}/\mathfrak{c}$$

$$\left(\frac{\partial}{\partial \mathfrak{X}_{\mu\nu}}\right)(\mathfrak{F}_{\mu\nu} + \mathfrak{P}_{\mu\nu}) = \frac{1}{\mathfrak{c}\left(\mathfrak{F}_{\mu\nu}^{\mathfrak{ij}}\right)} + \mathfrak{p}_{0}(\mathfrak{S}_{\mu\nu}) - \left(\frac{\partial}{\partial \mathfrak{X}_{\mu\nu}}\right)\left(\mathfrak{F}^{*}{}_{\mu\nu} + \mathfrak{i}\mathfrak{W}_{\mu\nu}\right) = 0$$

$$(\mathfrak{S}_{\mu\nu})\left(\frac{\partial(\mathfrak{F}_{\mu\nu} + \mathfrak{P}_{\mu\nu})}{\partial \mathfrak{X}_{\mu\nu}}\right) = (\mathfrak{I}_{\mu}^{\mathfrak{k}})(\mathfrak{S}_{\mu\nu}) = \rho_{0}(\mathfrak{S}_{\mu\nu})(\mathfrak{S}_{\mu\nu}) = -\rho_{0}$$

$$\rho_{0} = -(\mathfrak{S}_{\mu\nu})\left(\partial(\mathfrak{F}_{\mu\nu} + \mathfrak{P}_{\mu\nu})/\partial \mathfrak{X}_{\mu\nu}\right)$$

15. Tensor de Energía.

$$(\mathfrak{T}_{\mu\nu}^{0}) = \left(\frac{1}{2(\mathfrak{F}_{\mu\sigma})(\mathfrak{F}_{\nu\sigma})} - \left(\mathfrak{F}^{\dagger}{}_{\mu\sigma}\right)(\mathfrak{F}^{*}{}_{\nu\sigma})\right)$$

$$(\mathfrak{T}_{\mu\nu}^{\mathfrak{e}}) = \frac{1}{\varepsilon} - 1\left((\mathfrak{T}_{\mu\sigma})(\mathfrak{T}_{\nu\sigma}) - \frac{1}{4(\delta_{\mu\sigma})(\delta_{\nu\sigma})(\mathfrak{T}_{\sigma\tau})(\mathfrak{T}_{\sigma\tau})}\right)$$

$$\mathfrak{f}^{0} = -\mathfrak{e}div\,\mathfrak{p}^{**} - \mathfrak{h}div\,\mathfrak{m}^{**} + \mathfrak{e}\left(\frac{1}{\mathfrak{c}}\left(\mathfrak{i},\frac{\mathfrak{q}}{\mathfrak{c}}\right) + \rho\right) + \left|\frac{\mathfrak{i}}{\mathfrak{c}} + \frac{\mathfrak{q}}{\mathfrak{c}}.\mathfrak{p},\mathfrak{h}\right| + \left\|\frac{\rho^{**}}{\mathfrak{c}} - rot\rho^{*},\mathfrak{h}\right\| - \left\|\frac{\mathfrak{m}^{**}}{\mathfrak{c}} - rot\mathfrak{m}^{*},\mathfrak{e}\right\|$$

$$\varphi^{0} = \mathfrak{e}(\mathfrak{i} + \rho\mathfrak{q}) + \mathfrak{c}\left(\mathfrak{e},\frac{\rho^{**}}{\mathfrak{c}} - rot\,\rho^{*}\right) + \mathfrak{c}\left(\mathfrak{h},\frac{\mathfrak{m}^{**}}{\mathfrak{c}} - rot\,\mathfrak{m}^{*}\right)$$

$$\omega = \sigma,\varphi,\phi(\mathfrak{e}^{*2} - \left(\frac{\mathfrak{q}}{\mathfrak{c}},\mathfrak{e}^{*})^{2}\right)\sqrt{1-\mathfrak{q}^{2}/\mathfrak{c}^{2}}$$

$$-\mathfrak{f}_x = \frac{\partial \rho}{\partial x} + \frac{\frac{\mu^x \lambda \mathfrak{q}_x}{\mathfrak{w}^2 \partial \mathfrak{q}_x}}{\partial x} + \frac{\frac{\mu^x \lambda \mathfrak{q}_y}{\mathfrak{w}^2 \partial \mathfrak{q}_x}}{\partial y} + \frac{\frac{\mu^x \lambda \mathfrak{q}_z}{\mathfrak{w}^2 \partial \mathfrak{q}_x}}{\partial z} + \frac{\frac{\mu^x \lambda \mathfrak{q}_x}{\mathfrak{w}^2 \partial \mathfrak{q}_x}}{\partial \mathrm{t}}$$

$$+ \mathfrak{q}_x \left(\frac{\partial}{\partial x}\left(\frac{\frac{\mu^x \lambda \mathfrak{q}_x}{\mathfrak{w}^2 \partial \mathfrak{q}_x}}{\partial x} \right) + \frac{\partial}{\partial y}\left(\frac{\frac{\mu^x \lambda \mathfrak{q}_y}{\mathfrak{w}^2 \partial \mathfrak{q}_x}}{\partial y} \right) + \frac{\partial}{\partial z}\left(\frac{\frac{\mu^x \lambda \mathfrak{q}_z}{\mathfrak{w}^2 \partial \mathfrak{q}_x}}{\partial z} \right) + \frac{\partial}{\partial \mathrm{t}}\left(\frac{\mu^x}{\mathfrak{w}^2} \right) \right) - \frac{\mathfrak{i}}{\mathfrak{c}}.\eta$$

$$= -\frac{\mathfrak{i}}{\mathfrak{c}} \frac{\partial \rho}{\partial \mathrm{t}} - \mathfrak{f}_x$$

$$= \frac{\partial \rho}{\partial x} + \frac{\mu^*}{1} - \frac{\mathfrak{q}^2}{\mathfrak{c}^2 \left(\frac{\lambda \mathfrak{q}_x \partial \mathfrak{q}_x}{\partial x} + \frac{\lambda \mathfrak{q}_y \partial \mathfrak{q}_x}{\partial y} + \frac{\lambda \mathfrak{q}_z \partial \mathfrak{q}_x}{\partial z} + \frac{\partial \mathfrak{q}_x}{\partial \mathrm{t}} \right)} + \lambda \mathfrak{q}_x \mathfrak{A} - \frac{1}{\mathfrak{c}^2}.\eta.\kappa_4$$

$$= -\frac{1}{\mathfrak{c}^2} \frac{\partial \rho}{\partial \mathrm{t}}.\kappa_4 + \mathcal{A}$$

16. Dinámica del punto de masa.

$$-\frac{\int \mathfrak{K}_{\mu\nu} dx_1 \ldots dx_4 = \int \sum \partial\, \mathfrak{T}_{\mu\nu}}{\partial \mathfrak{X}_{\mu\nu} dx_1} \ldots dx_4 = \frac{\partial \mathfrak{T}_{\mu\nu 4}}{\partial \mathfrak{X}_{\mu\nu 4} dx_1} \ldots dx_4$$

$$\int dx_4 \frac{\partial}{\partial x_4 (\int \mathfrak{T}_{\mu\nu 4} \ \int dx_1 dx_2 dx_3)}$$

$$-\int_{\overrightarrow{\mathfrak{K}_{\mu\nu 4}}} dx_4 = |\mathfrak{T}_{\mu\nu 4}| \left\| \mathfrak{G}^{\mathfrak{x}^{\dagger\ddagger}{}_4}_{\mathfrak{x}^{\dagger}{}_4} \right\| -\overrightarrow{\mathfrak{K}_{\mu\nu 4}} = \frac{d\mathfrak{T}_{\mu\nu 4}}{dx_4} \int \frac{\mathfrak{i}}{\mathfrak{c}} \varphi \mathfrak{f}_x \mathfrak{g}_x \eta$$

17. Ecuaciones einstenianas de campo.

$$\sum_{\mu\nu} \partial/\partial \mathcal{X}_{\mu\nu} (\sqrt{-\mathfrak{g}\gamma_{\sigma\mu}\mathcal{T}_{\mu\nu}}) = \frac{\frac{1}{2\sum_{\mu\nu}\sqrt{-\mathfrak{g}}.\partial\gamma_{\mu\nu}}}{\partial \mathcal{X}_\sigma \mathcal{T}_{\mu\nu}} = \frac{1}{2\sum_{\mu\nu} \frac{\partial}{\partial \mathcal{X}_{\mu\nu}} (\sqrt{-\mathfrak{g}\mathfrak{g}_{\sigma\mu}\Theta_{\mu\nu}})}$$

$$= 1/2 \sum_{\mu\nu} \sqrt{-\mathfrak{g}.\partial \mathfrak{g}_{\mu\nu}/\partial \mathcal{X}_\sigma.\Theta_{\mu\nu}}$$

$$-2x\mathfrak{t}_{\sigma\gamma} = \sqrt{-\mathfrak{g}}\Big(\frac{\frac{\sum_{\rho\varrho\tau} \gamma_{\beta\mu\nu} \partial \mathfrak{g}_{\varrho\tau}}{\partial \mathcal{X}_\sigma} \partial \gamma_{\varrho\tau}}{\partial \mathcal{X}_\rho} - 1/2 \sum_{\alpha\rho\varrho\tau} \frac{\frac{\delta_{\sigma\mu\nu} \gamma_{\alpha\tau} \partial \mathfrak{g}_{\varrho\tau}}{\partial \mathcal{X}_\alpha} \partial \gamma_{\varrho\tau}}{\partial \mathcal{X}_\rho}$$

17.1. Variable hamiltoniana.

$$\int (\delta\mathcal{H} - 2x \sum_{\mu\nu} \sqrt{-\mathfrak{g}}\, \mathcal{T}_{\mu\nu} \delta\gamma_{\mu\nu}) d\tau = 0$$

$$\mathcal{H} = \frac{\frac{1}{2\sqrt{-\mathfrak{g}}\sum_{\alpha\beta\rho\varrho\sigma} \gamma_{\varsigma\varpi o}\, \partial \mathfrak{g}_{\alpha\beta\rho\varrho\sigma}}}{dx_\varphi} \partial \mathcal{X}_{\varsigma\varpi o}$$

$$\delta(\sqrt{-\mathfrak{g}}) = -\frac{1}{2\sum_{\mu\nu} -\mathfrak{g}\mathfrak{g}_{\mu\nu}\delta\gamma_{\mu\nu}}$$

$$\delta\left(\frac{\partial \mathfrak{g}_{\mu\nu}}{\partial \mathcal{X}_{\mu\nu}}\right) = \frac{\partial}{\partial \mathcal{X}_\alpha(\delta \mathfrak{g}_{\mu\nu})} = -\sum_{\mu\nu} \partial/\partial \mathcal{X}_\alpha(\mathfrak{g}_{\mu\nu}\delta\gamma_{\mu\nu})\delta(\partial\gamma_{\mu\nu}/\partial \mathcal{X}_{\mu\nu}) = \partial/\partial \mathcal{X}_\alpha(\delta\gamma_{\mu\nu})$$

$$\int \delta\mathcal{H} d\tau = \sum_{\mu\nu}(-\frac{\partial}{\partial \mathcal{X}_\alpha}\left(\frac{\sqrt{-g\gamma_{\mu\nu}}\partial g_{\mu\nu}}{\partial \mathcal{X}_\beta}\right) + \sqrt{-\frac{g\gamma_{\mu\nu}g\gamma_{\nu\mu}\partial g_{\mu\nu}}{\partial \mathcal{X}_\beta \atop \mu\nu\nu\mu}} + \frac{1}{2\sqrt{-g.\frac{\partial g_{\mu\nu}}{\partial \mathcal{X}_\alpha}\frac{\partial g_{\mu\nu}}{\partial \mathcal{X}_\beta}}}$$

$$- 1/4 g_{\mu\nu}\gamma_{\nu\mu}\frac{\partial g_{\mu\nu}}{\partial \mathcal{X}_\alpha}\frac{\partial g_{\mu\nu}}{\partial \mathcal{X}_\beta})\delta\gamma_{\mu\nu}.dt$$

17.2. Sistema de Coordenadas.

$$\mathcal{J}' = \int \sqrt{-g} \sum_{\substack{\mu\nu \\ \nu\mu \\ \alpha\beta\gamma\delta \\ \varepsilon\epsilon\zeta\eta \\ \rho\varrho\sigma\varsigma}} \pi_{\mu\nu}\pi_{\nu\mu}\gamma_{\mu\nu}\gamma_{\nu\mu}\mathfrak{P}_{\mu\nu}\mathfrak{P}_{\nu\mu}\partial/\partial \mathcal{X}_{\mu\nu}(\pi_{\mu\nu}\pi_{\nu\mu}\gamma_{\mu\nu}\gamma_{\nu\mu}\mathfrak{P}_{\mu\nu}\mathfrak{P}_{\nu\mu})\mathfrak{P}_{\mu\nu}\mathfrak{P}_{\nu\mu}\partial/\partial \mathcal{X}_{\nu\mu})d\tau$$

$$\rho_{\mu\nu}\int -4\int +4\int\sum_{\mu\nu}\int \alpha\beta\gamma\delta\varepsilon\epsilon\zeta\eta\theta\vartheta\iota\kappa\lambda\xi o\pi\varpi\rho\varrho\sigma\varsigma\tau\upsilon\varphi\phi\psi\omega = \frac{\partial \mathcal{X}_{\mu\nu}}{\partial \mathcal{X}_{\nu\mu}} = \delta\gamma_{\mu\nu} - \frac{\partial(\Delta \mathcal{X}_{\mu\nu})}{\partial \mathcal{X}_{\mu\nu}}$$

$$= \delta\gamma_{\nu\mu} - \frac{\partial(\Delta \mathcal{X}_{\nu\mu})}{\partial \mathcal{X}_{\nu\mu}}.d\tau - \frac{\partial^2(\Delta \mathcal{X}_{\mu\nu})}{\partial \mathcal{X}_{\nu\mu}}$$

17.3. Formalización de las ecuaciones einstenianas de campo.

$$\delta\left|\int \mathfrak{ds} = 0\right|$$

$$\mathfrak{ds}^2 = \sum_{\mu\nu} \mathfrak{dx}_{\mu\nu}^2$$

$$\mathfrak{ds}^2 = \sum_{\mu\nu} \mathfrak{g}_{\mu\nu}\,\mathfrak{dx}_\mu \mathfrak{dx}_\nu$$

$$\mathfrak{ds}^2 = \sum_{\mu\nu} \mathfrak{g}_{\mu\nu}\,\mathfrak{dx}_\mu \mathfrak{dx}_\nu = -\sum_{\mu\nu} \mathfrak{dx}_{\mu\nu}^2$$

$$\sum\nolimits_{\mu\nu} \mathfrak{A}_{\mu\nu}\mathfrak{dx}_{\mu\nu} = \phi$$

$$\sum\nolimits_{\mu\nu} \mathfrak{A}'_{\mu\nu}\mathfrak{dx}'_{\mu\nu} = \sum\nolimits_\alpha \mathfrak{A}'_\alpha \mathfrak{dx}'_\alpha = \sum\nolimits_{\alpha\mu\nu} \frac{\mathfrak{A}'_{\alpha\mu\nu}.\partial\mathfrak{x}'_\alpha}{\partial\mathfrak{x}'_{\mu\nu}}.\mathfrak{dx}_{\mu\nu\alpha} = \phi$$

$$\sum_{\mu\nu} \mathrm{A}_{\mu\nu}\,\mathfrak{d}_\mu^{(1)}\mathfrak{d}_\nu^{(2)} = \Phi$$

$$\sum_{\mu\nu} \mathrm{A}'_{\mu\nu}\,\mathfrak{d}_\mu^{(1)'}\mathfrak{d}_\nu^{(2)'} = \sum_{\mu\nu} \mathrm{A}_{\alpha\beta}\,\mathfrak{d}_\alpha^{(1)}\mathfrak{d}_\beta^{(2)} = \frac{\sum_{\mu\nu\alpha\beta}\partial\mathfrak{x}_\alpha}{\partial\mathfrak{x}'_\mu}.\partial\mathfrak{x}_\beta/\partial\mathfrak{x}'_\nu \mathrm{A}_{\alpha\beta}\mathfrak{d}_\mu^{(1)'}\mathfrak{d}_\nu^{(2)'}$$

$$\sum_{\mu\nu} \mathrm{A}'_{\mu\nu}\,\mathfrak{d}'_\mu\mathfrak{d}'_\nu = \sum_{\mu\nu} \mathrm{A}_{\alpha\beta}\,\mathfrak{d}_\alpha^\beta\mathfrak{d}_\beta^\alpha = \frac{\sum_{\mu\nu\alpha\beta}\partial\mathfrak{x}_\alpha}{\partial\mathfrak{x}'_\mu}.\partial\mathfrak{x}_\beta/\partial\mathfrak{x}'_\nu \mathrm{A}_{\alpha\beta}\mathfrak{d}'_\mu\mathfrak{d}'_\nu$$

$$A'_{\mu\nu} = A'_{\mu}B'_{\nu} = \frac{\sum_{\alpha\beta}\frac{\partial \mathfrak{x}_{\alpha}}{\partial \mathfrak{x}'_{\mu}}\partial \mathfrak{x}_{\beta}}{\partial \mathfrak{x}'_{\nu}} A'_{\alpha}B'_{\beta} = \sum_{\alpha\beta}\frac{\partial \mathfrak{x}_{\alpha}}{\partial \mathfrak{x}'_{\mu}}.\frac{\partial \mathfrak{x}_{\beta}}{\partial \mathfrak{x}'_{\nu}}.A_{\alpha\beta}\,A^{\alpha\beta}$$

$$\sum_{\substack{\alpha\beta\gamma\rho\varrho\sigma\\ \varsigma\tau\upsilon\mu\nu}} \left\| A^{\alpha\beta\gamma\rho\varrho\sigma}_{\varsigma\tau\upsilon\mu\nu} B^{\alpha\beta\gamma\rho\varrho\sigma}_{\varsigma\tau\upsilon\mu\nu} \right\| = \Gamma^{\alpha\beta\gamma\rho\varrho\sigma}_{\varsigma\tau\upsilon\mu\nu}$$

$$\left|\sum_{\alpha\beta\mu\nu} \mathfrak{g}_{\mu\nu}\mathfrak{g}_{\alpha\beta}\mathfrak{g}^{\mu\nu\alpha\beta}\right|.\left\|\mathfrak{d}\xi_{\mu\nu}\mathfrak{d}\xi_{\alpha\beta}\mathfrak{d}\xi^{\mu\nu\alpha\beta}\right\|.\langle\delta_{\mu\nu}\delta_{\alpha\beta}\delta^{\nu\alpha\beta}\rangle = 1$$

$$|\mathfrak{g}_{\mu\nu}| = \left|\sum_{\sigma}(\alpha_{\sigma\mu}\alpha_{\sigma\nu})\right| = (\alpha_{\mu\nu\sigma})^2 - \sqrt{\mathfrak{g}\delta_{\varepsilon\epsilon\zeta\vartheta\iota\kappa}\mathfrak{d}\tau}.\frac{\mathfrak{d}\tau_0}{\sum_{\alpha\beta\lambda\mu}\mathbb{C}_{\alpha\beta\lambda\mu}}.\mathcal{g}^{\mu\nu}\mathcal{g}^{\rho\varrho}\mathcal{g}^{\sigma\varsigma}$$

$$= \mathbb{C}_{\mu\nu\rho\varrho\sigma\varsigma}.\sqrt{\mathcal{g}V}/\mathfrak{d}\mathfrak{x}^{\eta}{}^{\mu\nu\lambda\kappa}_{\sigma\varsigma\tau\varrho\rho}$$

$$\mathbb{C}^{\alpha\beta\gamma\varepsilon\epsilon\zeta\vartheta\iota\kappa}{}_{\mu\nu\rho\varrho\sigma\varsigma}$$

$$= \sum_{\substack{\alpha\beta\gamma\varepsilon\epsilon\zeta\vartheta\iota\kappa\\ \mu\nu\rho\varrho\sigma\varsigma}} \sqrt{\mathfrak{g}\delta_{\mu\nu\rho\varrho\sigma\varsigma}}\mathfrak{g}^{\mu\nu\rho\varrho\sigma\varsigma}\mathfrak{g}^{\alpha\beta\gamma\varepsilon\epsilon\zeta\vartheta\iota\kappa}$$

$$= \sum_{\substack{\alpha\beta\gamma\varepsilon\epsilon\zeta\vartheta\iota\kappa\\ \mu\nu\rho\varrho\sigma\varsigma}} 1/\sqrt{\mathfrak{g}\delta_{\mu\nu\rho\varrho\sigma\varsigma}}\mathfrak{g}^{\mu\nu\rho\varrho\sigma\varsigma}\mathfrak{g}^{\alpha\beta\gamma\varepsilon\epsilon\zeta\vartheta\iota\kappa} = \Gamma^{\mu\nu\rho\varrho\sigma\varsigma}_{\alpha\beta\gamma\varepsilon\epsilon\zeta\vartheta\iota\kappa}$$

$$\Gamma^{\mu\nu\rho\varrho\sigma\varsigma}_{\alpha\beta\gamma\varepsilon\epsilon\zeta\vartheta\iota\kappa} = \sum_{\substack{\alpha\beta\gamma\varepsilon\epsilon\zeta\vartheta\iota\kappa\\ \mu\nu\rho\varrho\sigma\varsigma}} \Gamma^{\alpha\beta\gamma\varepsilon\epsilon\zeta\vartheta\iota\kappa}_{\mu\nu\rho\varrho\sigma\varsigma}\,\mathfrak{g}^{\mu\nu\rho\varrho\sigma\varsigma}\mathfrak{g}^{\alpha\beta\gamma\varepsilon\epsilon\zeta\vartheta\iota\kappa}$$

$$F^{\mu\nu} = \frac{1}{2\hbar\sum_{\alpha\beta}\mathfrak{G}^{\mu\nu}_{\alpha\beta}\,F^{\alpha\beta}} = \frac{1}{2\sum_{\mu\nu\alpha\beta}\mathfrak{G}^{\mu\nu}_{\alpha\beta}\,F^{\mu\nu}}$$

$$= \frac{1}{4\omega\psi\varphi\sum_{\alpha\beta\mu\nu}\mathfrak{G}^{\mu\nu\lambda}_{\alpha\beta\sigma}\,\mathfrak{G}^{\delta\varepsilon\epsilon\tau\upsilon\omega}_{\kappa\lambda\xi\rho\sigma\varsigma\varrho}}$$

$$- \frac{\sum_{\mu\nu}\mathfrak{G}^{\mu\nu\lambda}_{\alpha\beta\sigma}\mathfrak{G}^{\delta\varepsilon\epsilon\tau\upsilon\omega}_{\kappa\lambda\xi\rho\sigma\varsigma\varrho} = \sum_{\substack{\alpha\beta\gamma\varepsilon\epsilon\zeta\vartheta\iota\kappa\\ \mu\nu\rho\varrho\sigma\varsigma}}\sqrt{\mathfrak{g}\delta_{\mu\nu\rho\varrho\sigma\varsigma}}\mathfrak{g}^{\mu\nu\rho\varrho\sigma\varsigma}\mathfrak{g}^{\alpha\beta\gamma\varepsilon\epsilon\zeta\vartheta\iota\kappa}.1}{\sqrt{\mathfrak{g}\delta_{\mu\nu\rho\varrho\sigma\varsigma}}\mathfrak{g}^{\mu\nu\rho\varrho\sigma\varsigma}\mathfrak{g}^{\alpha\beta\gamma\varepsilon\epsilon\zeta\vartheta\iota\kappa}}$$

$$= 2(\delta^{\mu\nu\lambda}\delta_{\alpha\beta\hbar\sigma\tau} - \delta^{\alpha\beta\hbar}\delta_{\mu\nu\lambda\sigma\tau}$$

$$\delta\omega = 1/\omega\left\|\frac{\frac{1}{2\sum_{\mu\nu\sigma}\frac{\partial\mathfrak{g}_{\mu\nu}}{\partial\mathfrak{x}_{\sigma}}.\mathfrak{d}\mathfrak{x}_{\mu\nu}}}{\mathfrak{d}\lambda}.\frac{\mathfrak{d}\mathfrak{x}_{\alpha\beta}}{\mathfrak{d}\lambda} + \sum_{\mu\nu}\mathfrak{g}_{\mu\nu}.\frac{\mathfrak{d}\mathfrak{x}_{\mu\nu}}{\mathfrak{d}\lambda}\,\delta\left(\frac{\mathfrak{d}\mathfrak{x}_{\nu\mu}}{\mathfrak{d}\lambda}\right)\right\|$$

$$\frac{\sum_{\mu\nu}\mathfrak{g}_{\mu\nu\sigma}.\mathfrak{d}^2\,\mathfrak{x}_{\mu\nu}}{\mathfrak{d}\mathfrak{s}^2} + \frac{\sum_{\mu\nu}\begin{matrix}\mu\nu\\ \sigma\end{matrix}\,\mathfrak{d}\mathfrak{x}_{\mu\nu}}{\mathfrak{d}\mathfrak{s}}.\frac{\mathfrak{d}\mathfrak{x}_{\alpha\beta\sigma}}{\mathfrak{d}\mathfrak{s}}$$

$$\begin{matrix}\mu\nu\\ \sigma\end{matrix} = 1/2(\frac{\partial\mathfrak{x}_{\mu\sigma}}{\partial\mathfrak{x}_{\mu\nu}} + \frac{\partial\mathfrak{x}_{\nu\sigma}}{\partial\mathfrak{x}_{\mu\nu}} - \frac{\partial\mathfrak{g}_{\mu\nu\sigma}}{\partial\mathfrak{x}_{\sigma}} - \frac{\partial\mathfrak{g}_{\mu\nu\tau}}{\partial\mathfrak{x}_{\tau\varsigma}} = \partial\phi\int\mathfrak{I}\psi\varphi\,\mathfrak{d}\omega.\mathfrak{d}\phi$$

$$\frac{\mathfrak{d}^2\phi}{\mathfrak{d}\mathfrak{s}^2} = \frac{\sum_{\mu\nu}\frac{\partial^2\phi}{\partial\mathfrak{x}_{\mu}\partial\mathfrak{x}_{\nu}}.\mathfrak{d}\mathfrak{x}_{\mu}}{\mathfrak{d}\mathfrak{s}}.\frac{\mathfrak{d}\mathfrak{x}_{\nu}}{\mathfrak{d}\mathfrak{s}} + \frac{\sum_{\tau}\partial\phi}{\partial\chi_{\tau}}.\mathfrak{d}^2\chi_{\tau}/\mathfrak{d}\mathfrak{s}^2$$

$$\frac{\mathfrak{d}^2\phi}{\mathfrak{d}\mathfrak{s}^2} = \sum_{\mu\nu}(\frac{\partial^2\phi}{\partial\mathfrak{x}_{\mu}\partial\mathfrak{x}_{\nu}} - \sum_{\tau}\begin{matrix}\mu\nu\\ \tau\end{matrix}\,\partial\phi/\partial\chi_{\tau}).\mathfrak{d}\mathfrak{x}_{\mu}/\mathfrak{d}\mathfrak{s}\,.\frac{\mathfrak{d}\mathfrak{x}_{\nu}}{\mathfrak{d}\mathfrak{s}}$$

$$\frac{\partial}{\partial \mathfrak{x}_\nu \left(\psi.\frac{\partial \phi}{\partial \mathfrak{x}_\mu}\right)} - \sum_\tau {\mu\nu \atop \tau} \left(\psi.\frac{\partial \phi}{\partial \mathfrak{x}_\tau}\right)$$

$$\frac{1}{\mathscr{g}}.\frac{\partial \mathscr{g}}{\partial \mathfrak{x}_\alpha} = \sum_{\mu\nu} \frac{\partial \mathfrak{g}_{\mu\nu}}{\partial \mathfrak{x}_\alpha} - \mathfrak{g}^{\mu\nu} = \frac{2}{\sqrt{\mathscr{g}}}.\frac{\partial \sqrt{\mathscr{g}}}{\partial \mathfrak{x}_\alpha}$$

$$\sum_\tau {\mu\nu \atop \tau} = \sum_\tau {\tau \atop \mu\nu} = \frac{1}{2}\sum_{\tau\alpha} \mathfrak{g}^{\tau\alpha} \frac{\partial \mathscr{g}_{\tau\alpha}}{\partial \mathfrak{x}_{\mu\nu}} = \frac{1}{\sqrt{\mathscr{g}}}.\frac{\partial \sqrt{\mathscr{g}}}{\partial \mathfrak{x}_\mu}$$

$$\mathrm{A}_\sigma = \frac{1}{\sqrt{\mathscr{g}}}\left(\sum_{\mu\nu} \mathscr{g}_{\mu\nu\sigma}.\frac{\partial(\mathrm{A}_{\mu\nu}\sqrt{\mathscr{g}})}{\partial \mathfrak{x}_\nu} + \sqrt{\mathscr{g}}\sum_{\tau\mu\nu} {\tau\upsilon \atop \sigma} \mathrm{A}^{\tau\upsilon}\right)$$

$$= 1/\sqrt{\mathscr{g}}\,(\sum_{\mu\nu} \partial\left(\frac{\mathscr{g}_{\mu\nu\sigma}\mathrm{A}^{\mu\nu}\sqrt{\mathscr{g}}}{\partial \mathfrak{x}_\nu} + \frac{1}{2\sqrt{\mathscr{g}}\sum_{\mu\nu}(\frac{\partial \mathscr{g}_{\mu\nu\sigma}}{\partial \mathfrak{x}_\mu} + \frac{\partial \mathscr{g}_{\nu\mu\sigma}}{\partial \mathfrak{x}_\nu}} - \frac{\partial \mathscr{g}_{\mu\nu}}{\partial \mathfrak{x}_\sigma}\right)\mathrm{A}^{\mu\nu})$$

$$\mathrm{A}_\sigma = \frac{1}{\sqrt{\mathscr{g}}}\left(\sum_{\mu\nu} \mathscr{g}_{\mu\nu\sigma}.\frac{\partial(\mathrm{A}_{\mu\nu}\sqrt{\mathscr{g}})}{\partial \mathfrak{x}_\nu} - \sqrt{\mathscr{g}}\sum_{\tau\mu\nu} {\tau\upsilon \atop \sigma} \mathrm{A}^{\tau\upsilon}\right)$$

$$= 1/\sqrt{\mathscr{g}}\,(\sum_{\mu\nu} \partial\left(\frac{\mathscr{g}_{\mu\nu\sigma}\mathrm{A}^{\mu\nu}\sqrt{\mathscr{g}}}{\partial \mathfrak{x}_\nu} - \frac{1}{2\sqrt{\mathscr{g}}\sum_{\mu\nu}(\frac{\partial \mathscr{g}_{\mu\nu\sigma}}{\partial \mathfrak{x}_\mu} + \frac{\partial \mathscr{g}_{\nu\mu\sigma}}{\partial \mathfrak{x}_\nu}} - \frac{\partial \mathscr{g}_{\mu\nu}}{\partial \mathfrak{x}_\sigma}\right)\mathrm{A}^{\mu\nu})$$

$$\mathrm{A}_{\mu\nu\lambda} = \frac{\partial^2 \mathrm{A}_\mu}{\partial \mathfrak{x}_\mu \partial \mathfrak{x}_\lambda} - \frac{\sum_\tau {\mu\lambda \atop \tau} \partial \mathrm{A}_\tau}{\partial \mathfrak{x}_\nu} + \frac{{\mu\nu \atop \tau} \partial \mathrm{A}_\tau}{\partial \mathfrak{x}_\lambda} - \sum_\tau \frac{{\nu\lambda \atop \tau} \partial \mathrm{A}_\mu}{\partial \mathfrak{x}_\tau} + \sum_{\sigma\tau} \frac{{\nu\lambda\tau\mu \atop \tau\ \sigma} \partial \mathrm{A}_\sigma}{\partial \mathfrak{x}_{\sigma\tau\lambda\nu}} - \sum_\sigma \frac{{\mu\nu \atop \sigma} \partial}{\partial \mathfrak{x}_\lambda} - \sum_\tau \frac{{\mu\lambda\nu\tau \atop \tau\ \sigma} \partial \mathrm{A}_\sigma}{\partial \mathfrak{x}_{\sigma\tau\lambda\nu}}$$

$$\mathfrak{E}_\sigma = \sum_{\mu\nu} \frac{\partial \mathfrak{E}_\sigma^{\mu\nu}}{\partial \mathfrak{x}_\mu} - \frac{\frac{1}{2\sum_{\mu\tau\nu} \mathscr{g}^{\tau\mu}\, \partial \mathscr{g}_{\mu\nu}}}{\partial \mathfrak{x}_\lambda} \mathfrak{E}_\sigma^{\mu\nu}$$

$$\sum_{\mu\nu} \partial \mathfrak{I}_{\lambda\sigma}^{\mu\nu} / \partial \mathfrak{H}_\mu = \frac{\frac{1}{2\hbar\sum_{\mu\tau\nu} \mathscr{g}^{\tau\mu}}\, \partial \mathscr{g}_{\mu\nu}}{\partial \mathfrak{x}_\lambda}.\mathfrak{I}_{\lambda\sigma}^{\mu\nu} + \mathfrak{R}_{\lambda\sigma}$$

$$\begin{matrix} -1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & -1 \end{matrix}$$

$$\sum_{\mu\nu} \partial(\mathfrak{I}_{\lambda\sigma}^{\mu\nu} + \mathfrak{t}_{\lambda\sigma}^{\mu\nu}) \frac{\partial \mathfrak{x}_\lambda}{\mathbb{R}^{\alpha\beta\gamma\delta\epsilon\varepsilon\zeta\eta\iota\kappa\lambda\mu\nu\xi}_{o\pi\varpi\rho\varrho\sigma\varsigma\tau\upsilon\phi\varphi\psi\omega}} = 0$$

$$\Gamma^\Lambda = \int \frac{\tau\upsilon\sigma}{d\omega^2}(\frac{1}{2dl^2} \triangleq \frac{\sum_{\mu\nu} \mathcal{G}\Delta^{\mu\nu}\, \partial \mathscr{g}_{\mu\nu}}{\partial \mathfrak{x}_\sigma}.d\tau^2/ds^2$$

$$ds^2 = \sum_{\mu\nu} \int \mathfrak{g}_{\mu\nu}\, d\chi_\mu d\chi_\nu = -d\xi_1^2 - d\xi_2^2 - d\xi_3^2 - d\xi_\eta^2/\sqrt{-g}$$

$$\frac{d}{d\chi_4} = \left(m \sum_{\mu\nu} g_{\mu\nu\sigma}.\frac{d\chi_\mu}{ds}\right) = \sum_{\upsilon\tau} \Gamma_{\upsilon\sigma}^\tau.\frac{d\chi_\nu}{d\chi_4} m \sum_{\mu\nu} \mathscr{g}_{\tau\upsilon}.\frac{d\chi_\mu}{ds} + \int d\nabla \mathfrak{R}_{\lambda\sigma} d\upsilon$$

$$-\delta_{\sigma\lambda}^{\mu\nu}\sqrt{-g}.\frac{\partial\rho}{\partial\chi_\sigma}+\frac{\rho}{\rho_{o\,\stackrel{\text{def}}{=}}}+\mathfrak{I}_{\lambda\sigma}^{\mu\nu}+\sum\nolimits_{\mu\nu}\frac{\partial}{\partial\chi_\upsilon}\left(\rho*g_{\dagger\sigma\upsilon}.\frac{d\chi_\omega}{ds}.\frac{d\chi_\psi}{ds}\right)$$

$$=\frac{\dfrac{1}{2\sum_{\mu\nu}\rho\circledast\partial g_{\mu\nu\sigma}}}{\mathfrak{R}_{\lambda\sigma}}\partial\chi_\sigma\frac{d\chi_\omega}{ds}.\frac{d\chi_\psi}{ds}+\mathfrak{R}_{\lambda\sigma}=1$$

$$\sum_{\mu\nu}\partial(\mathfrak{I}_{\lambda\sigma}^{\mu\nu}-\mathfrak{B}_{\epsilon}^{\mu\nu})/\partial\chi_\sigma=\rho_\varepsilon.d\chi_\mu/ds+\mathfrak{T}^{\mu\nu}$$

$$\sum_{\mu\nu}\partial(\mathfrak{I}_{\lambda\sigma}^{\mu\nu\dagger}-\mathfrak{B}_{(m)}^{\mu\nu\circledast})/\partial\chi_\sigma=\rho_{(m)}.d\chi_\mu/ds+\mathfrak{T}^{\mu\nu}$$

$$\left\langle \mathfrak{B}_{\epsilon}^{\mu\nu}=\sigma_\epsilon\sum\nolimits_{\alpha\beta}\frac{\frac{g_{\alpha\beta}\mathfrak{F}^{\mu\nu}d\chi_\beta}{ds}}{\mathfrak{B}_{\epsilon\dagger}^{\mu\nu*}=\mathfrak{B}_{\epsilon}^{\mu\nu}\sum_{\alpha\beta}\mathfrak{B}_{\epsilon}^{\mu\nu}\frac{g_{\alpha\beta}\mathfrak{F}^{\mu\nu}d\chi_{\mu\nu}}{ds}e^{-i\omega t}}\middle|\mathfrak{B}_{(m)}^{\mu\nu}=\sigma_{(m)}\sum\nolimits_{\alpha\beta}\frac{\frac{g_{\alpha\beta}\mathfrak{F}^{\mu\nu}d\chi_\beta}{ds}}{\mathfrak{B}_{(m)\dagger}^{\mu\nu*}=\mathfrak{B}_{(m)}^{\mu\nu}\sum_{\alpha\beta}\mathfrak{B}_{(m)}^{\mu\nu}\frac{g_{\alpha\beta}\mathfrak{F}^{\mu\nu}d\chi_{\mu\nu}}{ds}e^{-i\omega t}}\middle|\mathfrak{Q}^{\mu\nu}=-\lambda\sum\nolimits_{\alpha\beta}g_{\alpha\beta}\mathfrak{F}^{\mu\nu\sigma\lambda}.\frac{d\chi_\beta}{ds}\right\rangle$$

$$\Delta g_{\sigma}^{\mu\nu}=\sum_{\alpha}\frac{\partial}{\partial\chi_\sigma}(g^{\mu\sigma}.\frac{\partial\Delta\chi_\mu}{\partial\chi_\alpha}+g^{\nu\sigma}.\frac{\partial\Delta\chi_\nu}{\partial\chi_\tau})-\frac{\partial g^{\mu\nu}}{\partial\chi_\alpha}\frac{\partial\Delta\chi_\alpha}{\partial\chi_\sigma}$$

$$-\frac{\frac{1}{2\Delta\mathcal{H}}\sum_{\mu\nu\sigma\alpha}\frac{\mathfrak{G}_{\mu\nu}{}^{\sigma\tau}}{\partial^2}\Delta g_{\sigma}^{\mu\nu}\int d\tau.\partial\mathcal{H}\sqrt{-g}}{\Delta\mathfrak{I}}.\partial^2\Delta\chi_\nu$$

$$\mathfrak{F}=\int d\tau\sum_{\mu\nu\alpha\sigma}\frac{\partial^2}{\partial\mathfrak{f}_\alpha}\partial\chi_\sigma\left(\frac{\frac{g^{\nu\alpha}\partial\mathcal{H}\sqrt{-g}}{\partial g_{\sigma}^{\mu\nu}}\partial\Delta\chi_{\mu\nu}}{\partial\chi_\sigma}-\frac{\partial}{\partial\chi_\tau}\left(\frac{g^{\nu\sigma}\partial\mathcal{H}\sqrt{-g}}{\partial g_{\alpha}^{\mu\nu}}\right)\Delta\chi_\tau\right)$$

$$\mathfrak{d}\mathfrak{I}=\delta\left(\int\mathcal{H}\sqrt{-g}\,d\tau\right)=\frac{\int d\tau\sum_{\mu\nu\sigma}(\partial\mathcal{H}\sqrt{-g}}{\partial g^{\mu\nu}}\delta g^{\mu\nu}+\partial\left(\mathcal{H}\sqrt{-g}\right)/\partial g_{\sigma}^{\mu\nu}\delta g_{\sigma}^{\mu\nu}$$

$$\mathfrak{G}_{\mu\nu}=\frac{\partial\mathcal{H}\sqrt{-g}}{\partial g^{\mu\nu}}-\sum\nolimits_{\mu\nu\sigma}\frac{\partial^2}{\partial\chi_\sigma}(\frac{\partial\mathcal{H}\sqrt{-g}\mathcal{S}_{\sigma\tau}^{\mu\nu}}{\partial g_{\sigma\tau}^{\mu\nu}}-\frac{\partial\mathcal{H}\sqrt{-g}}{\partial g_{\alpha\beta}^{\mu\nu}}-\frac{\partial\mathcal{H}\sqrt{-g}}{\partial g^{\kappa}}$$

$$\mathcal{S}_{\sigma}^{\mu\nu}=\frac{\partial}{\partial\chi_\upsilon}(g^{\tau\nu}\mathfrak{G}_{\sigma\tau})+\frac{\frac{1}{2\sum_{\mu\nu}\partial g^{\mu\nu}}}{\partial\chi_\sigma}.\mathfrak{G}_{\mu\nu}$$

$$=\frac{\sum_{\mu\nu\tau}(g^{\upsilon\tau}.\partial\mathcal{H}\sqrt{-g}}{\partial g_{\sigma\tau}^{\mu\nu}}+g_{\sigma\tau}^{\mu\nu}.\frac{\partial\mathcal{H}\sqrt{-g}}{\partial g_{\mu\nu}^{\sigma\tau}}+g_{\alpha\beta}^{\mu\nu}.\frac{\partial\mathcal{H}\sqrt{-g}}{\partial g_{\mu\nu}^{\alpha\beta}}+\frac{1}{2\mathcal{S}_{\sigma\tau}^{\mu\nu}\mathcal{H}\sqrt{-g}}$$

$$-\frac{1}{4g_{\sigma\tau}^{\mu\nu}}.\frac{\frac{\frac{\partial\mathcal{H}\sqrt{-g}}{\partial g_{\mu\nu}^{\alpha\beta}}}{dg^{\mu\nu}}}{\frac{dg^{\sigma\tau}}{d^2g^{\mu\nu\sigma\tau}}}.g_{\rho\alpha\beta}^{\mu\nu}-\frac{\partial g_\kappa}{\partial\chi_\rho}.\frac{1}{{}_{\sigma}^{\mu\nu}\mathfrak{L}\kappa_{o\varpi\rho\varrho\sigma\varsigma\tau\upsilon\varphi\phi\chi\psi\omega}^{\alpha\beta\gamma\delta\varepsilon\epsilon\zeta\eta\vartheta\iota\lambda\mu\nu\xi}}-\frac{\sqrt{-g}}{4\kappa}+\frac{1}{2\mathcal{S}_{\sigma\tau}^{\mu\nu}g_{\mu\nu}^{\sigma\tau}\Gamma_{\rho\omega r}^{\alpha\beta}}-$$

$$\boxplus\,\hbar_{\sigma\tau.\atop\rho\kappa}^{\mu\nu}\kappa\rho_o-\frac{\frac{1}{2\sum_\zeta\partial\hbar_{\sigma\tau\atop\rho\kappa}^{\mu\nu}}}{\partial\chi_\tau}$$

$$\begin{matrix}-1 & 0 & 0\\ 0 & -1 & 0\\ 0 & 0 & -1\end{matrix}$$

17.4. Ecuaciones relativistas aplicables a campos cuánticos curvos o con deformación geométrica.

$$\mathfrak{G}_{ijkl} = \mathfrak{G}^{ijkl} = \frac{1}{2\sqrt{-\mathfrak{g}}} . \delta_{ijkl}$$

$$\mathfrak{G}_{ijkl} = \mathfrak{G}^{ijkl} = \frac{1}{2\sqrt{-\mathfrak{g}'}} . \delta_{ijkl}$$

$$\mathcal{A}^{\alpha_i \ldots \alpha_j} = \frac{\sum_s \partial \mathcal{A}^{\alpha_i \ldots \alpha_s^j}}{\partial \text{ד}_s} + \sum_{s\text{ד}} \binom{\mathbb{Z}\text{ד}}{\text{ג}} \mathcal{A}^{\lambda_i \ldots \alpha_s^{\text{ד}}}$$

$$\sum_{\text{בד}} \binom{s\text{ב}}{\text{ג}} = \frac{1}{2\hbar \sum_{\alpha s} \mathscr{g}^{\mathfrak{H}\varkappa} \left(\frac{\partial \mathscr{g}_{\alpha\mathfrak{s}}}{\partial \text{ד}_\lambda} + \frac{\partial \mathscr{g}_{\alpha\lambda}}{\partial \text{ד}_s} - \frac{\partial \mathscr{g}_{\alpha\aleph}}{\partial \text{ד}_\alpha} \right)} = \frac{1}{2 \sum \mathscr{g}^{\alpha\mathfrak{s}}} . \frac{\partial \mathscr{g}_{\alpha\mathfrak{s}}}{\partial \text{ד}_\lambda} = \partial \left(\frac{\ell \mathscr{g} \sqrt{-\mathfrak{g}}}{\partial \text{ד}_s} \right)$$

$$\Phi = 1/\sqrt{-\mathfrak{g}} \sum_{\mu\nu} \partial/\partial \text{ד}_{\mu\nu} \, (\sqrt{-\mathfrak{g}} \mathrm{A}^{\mu\nu}$$

$$\mathrm{A}_\sigma = \sum_{\mu\nu} \partial \mathrm{A}_\sigma^{\mu\nu} / \partial \Re_{\mu\nu} - \frac{1}{2 \sum_{\mu\nu\tau} \mathscr{g}^{\tau\mu\nu}} . \frac{\partial \mathscr{g}_{\mu\nu}}{\partial \Re_\sigma} . \mathrm{A}_\sigma^{\mu\nu}$$

$$(ik, lm) = \frac{1}{2} \left(\frac{\partial^2 \mathscr{g}_{im}}{\partial \text{ד}_{ik} \partial \text{ד}_{lm}} + \frac{\partial^2 \mathscr{g}_{ik}}{\partial \text{ד}_{il} \partial \text{ד}_{kl}} - \frac{\partial^2 \mathscr{g}_{il}}{\partial \text{ד}_{im} \partial \text{ד}_{il}} - \frac{\partial^2 \mathscr{g}_{kiml}}{\partial \text{ד}_{lmi} \partial \text{ד}_{klm}} \right) + \sum_{\rho\sigma} \mathscr{g}^{\rho\sigma} \left(\left\| \begin{matrix} im \\ \rho \end{matrix} \right\| \left\| \begin{matrix} kl \\ \sigma \end{matrix} \right\| - \left\| \begin{matrix} il \\ \rho \end{matrix} \right\| \left\| \begin{matrix} km \\ \sigma \end{matrix} \right\| \right)$$

$$(ik, lm) = \sum_\rho \mathscr{g}^{\kappa\rho} (i\rho, lm) = \frac{\partial \left\| \begin{matrix} il \\ \kappa \end{matrix} \right\|}{\partial \text{ד}_m} - \frac{\partial \left\| \begin{matrix} im \\ \kappa \end{matrix} \right\|}{\partial \text{ד}_i} + \sum_{\rho\sigma} \mathscr{g}^{\rho\sigma} \left(\left\| \begin{matrix} im \\ \rho \end{matrix} \right\| \left\| \begin{matrix} kl \\ \sigma \end{matrix} \right\| - \left\| \begin{matrix} il \\ \rho \end{matrix} \right\| \left\| \begin{matrix} km \\ \sigma \end{matrix} \right\| \right)$$

$$\sum_{\mu\nu} \partial \Lambda_{\rho\sigma}^{\mu\nu} = \frac{1}{2 \sum_{\mu\nu\tau} \mathscr{g}^{\mu\nu\tau}} . \frac{\partial \mathscr{g}_{\mu\nu}}{\partial \Re_\sigma \Gamma_{\rho\sigma}^{\mu\nu}} + \mathrm{K}_\Lambda$$

$$\Gamma_{\rho\sigma}^{\mu\nu} = - \left\| \begin{matrix} \mu\nu \\ \sigma \end{matrix} \right\| = - \sum_\alpha \mathscr{g}^{\sigma\alpha} \left\| \begin{matrix} \mu\nu \\ \alpha \end{matrix} \right\| = -1/2 \sum_\alpha \mathscr{g}^{\sigma\alpha} \left(\frac{\partial \mathscr{g}_{\mu\alpha}}{\partial \Re_{\mu\nu}} + \frac{\partial \mathscr{g}_{\nu\alpha}}{\partial \Re_{\nu\mu}} - \frac{\partial \mathscr{g}_{\mu\nu}}{\partial \Re_\alpha} \right)$$

$$\frac{\sum_\alpha \partial \Lambda_\sigma^\alpha}{\partial \Re_\alpha} = - \sum_{\alpha\beta} \Gamma_{\sigma\beta}^\alpha \Gamma_\alpha^\beta$$

$$\frac{d^2 \chi_\tau}{d\mathfrak{s}^2} = \sum_{\mu\nu} \Gamma_{\mu\nu}^\tau . \frac{d\chi_\mu}{ds} \frac{d\chi_\nu}{ds}$$

$$\Re_{\mu\nu} = -\kappa \text{ד}_{\mu\nu} = \frac{\sum_\alpha \partial \Gamma_{\mu\nu}^{\alpha\sigma}}{\partial \Re_\alpha} + \sum_{\alpha\beta} \Gamma_{\mu\beta}^\alpha \Gamma_{\nu\alpha}^\beta = - \kappa \text{ד}_{\mu\nu}$$

$$\delta \left\| \int \mathfrak{G} - \kappa \sum_{\mu\nu} \mathscr{g}^{\mu\nu} \text{ד}_{\mu\nu} \right\| d\tau$$

$$\mathfrak{G} = \sum_{\sigma\tau\alpha\beta} \mathscr{g}^{\sigma\tau}\Gamma^{\alpha}_{\sigma\beta}\Gamma^{\beta}_{\tau\alpha}$$

$$\sum_{\alpha}\frac{\partial}{\partial\mathfrak{R}_{\alpha}}\left(\frac{\partial\mathfrak{G}}{\partial\mathscr{g}^{\alpha\sigma}_{\mu\nu}}\right)-\frac{\partial\mathfrak{G}}{\partial\mathscr{g}^{\alpha\sigma}_{\mu\nu}} = -\kappa\daleth_{\mu\nu}\,\frac{\partial\mathfrak{G}}{\partial\mathscr{g}^{\alpha\sigma}_{\mu\nu}} = -\sum_{\alpha\beta}\Gamma^{\alpha}_{\mu\beta}\Gamma^{\beta}_{\nu\alpha} - \frac{\partial\mathfrak{G}}{\partial\mathscr{g}^{\alpha\sigma}_{\mu\nu}} = \Gamma^{\alpha}_{\mu\nu}$$

$$\sum_{\sigma\mu\nu}\frac{\partial}{\partial\mathfrak{R}_{\alpha}}\partial\mathfrak{R}_{\alpha}\left(\mathscr{g}^{\alpha\sigma}_{\mu\nu}.\frac{\partial\mathfrak{G}}{\mathscr{g}^{\alpha\sigma}_{\mu\nu}}\right)-\frac{\partial\mathfrak{G}}{\partial\mathfrak{R}_{\sigma}} = -\kappa\sum_{\mu\nu}\daleth_{\mu\nu}\,\mathscr{g}^{\alpha\sigma}_{\mu\nu}$$

$$\sum_{\lambda}\frac{\partial\daleth^{\lambda}_{\sigma}}{\partial\mathfrak{R}_{\lambda}} = \frac{\frac{1}{2\sum_{\mu\nu}\partial\mathscr{g}^{\mu\nu}}}{\partial\mathfrak{R}_{\sigma}\daleth_{\mu\nu}}$$

$$\sum_{\lambda}\frac{\partial\daleth^{\lambda}_{\sigma}}{\partial\mathfrak{R}_{\lambda}} = \sum_{\mu\nu}\Gamma^{\mu}_{\sigma\nu}\daleth^{\nu}_{\mu}$$

$$\sum_{\lambda}\frac{\partial}{\partial\mathfrak{R}_{\lambda}}\left(\daleth^{\lambda}_{\sigma}+\mathfrak{t}^{\lambda}_{\sigma}\right)$$

$$\kappa\mathfrak{t}^{\lambda}_{\sigma} = \frac{1}{2}\delta^{\lambda}_{\sigma}\sum_{\mu\nu\alpha\beta}\mathscr{g}^{\mu\nu}\,\Gamma^{\alpha}_{\mu\beta}\Gamma^{\beta}_{\nu\alpha} - \sum_{\mu\nu\alpha}\mathscr{g}^{\mu\nu}\Gamma^{\alpha}_{\mu\sigma}\Gamma^{\lambda}_{\nu\alpha}$$

$$\mathfrak{t}^{\lambda}_{\sigma} = \frac{1}{2\kappa\left(\mathfrak{G}\delta^{\lambda}_{\sigma} - \sum_{\mu\nu}\mathscr{g}^{\sigma}_{\mu\nu}\frac{\partial\mathfrak{G}}{\mathscr{g}^{\mu\nu}_{\lambda}}\right)}$$

$$\daleth^{\lambda}_{\sigma} = \frac{1}{2\delta^{\lambda}_{\sigma}\sum_{\mu\nu\alpha\beta}\mathscr{g}^{\mu\nu}\,\Gamma^{\alpha}_{\mu\beta}\Gamma^{\beta}_{\nu\alpha}} - \sum_{\mu\nu\alpha}\mathscr{g}^{\mu\nu}\,\Gamma^{\alpha}_{\mu\sigma}\Gamma^{\lambda}_{\nu\alpha}$$

$$\frac{\sum_{\alpha\beta}\partial^{2}\mathscr{g}^{\alpha\beta}}{\partial\mathfrak{R}_{\alpha}\partial\mathfrak{R}_{\beta}} - \sum_{\sigma\tau\alpha\beta}\mathscr{g}^{\sigma\tau}\Gamma^{\alpha}_{\sigma\beta}\Gamma^{\beta}_{\tau\alpha} + \sum\nolimits_{\alpha\beta}\partial/\partial\mathfrak{R}_{\alpha}(\mathscr{g}^{\alpha\beta}\partial lg\sqrt{-\mathfrak{g}}/\partial\mathfrak{R}_{\beta}) = -\kappa\sum_{\sigma}\daleth^{\rho}_{\sigma}$$

$$\sum_{\alpha\nu}\partial/\partial\mathfrak{R}_{\alpha}(\mathscr{g}^{\nu\lambda}\,\Gamma^{\alpha}_{\mu\nu}) - \sum_{\alpha\beta\nu}\mathscr{g}^{\nu\beta}\Gamma^{\alpha}_{\nu\mu}\Gamma^{\lambda}_{\beta\alpha} = -\kappa\,\daleth^{\tau}_{\mu\nu}$$

$$\sum_{\alpha\nu}\partial/\partial\mathfrak{R}_{\alpha}(\mathscr{g}^{\nu\lambda}\,\Gamma^{\alpha}_{\mu\nu}) - 1/2\delta^{\lambda}_{\mu}\sum_{\alpha\beta\mu\nu}\mathscr{g}^{\mu\nu}\Gamma^{\alpha}_{\mu\beta}\Gamma^{\beta}_{\nu\alpha} = -\kappa\left(\daleth^{\lambda}_{\mu}+\mathfrak{t}^{\lambda}_{\mu}\right)$$

$$\frac{\partial}{\partial\mathfrak{R}_{\mu\nu}}\left\Vert\sum_{\alpha\beta}\frac{\partial^{2}\mathscr{g}^{\alpha\beta}}{\partial\mathfrak{R}_{\alpha}\partial\mathfrak{R}_{\beta}} - \sum_{\sigma\tau\alpha\beta}\mathscr{g}^{\sigma\tau}\Gamma^{\alpha}_{\sigma\beta}\Gamma^{\beta}_{\tau\alpha}\right\Vert = \frac{\sum_{\alpha\beta}\partial}{\partial\mathfrak{R}_{\alpha}}\left(\mathscr{g}^{\alpha\beta}\frac{\partial lg\sqrt{-\mathfrak{g}}}{\partial\mathfrak{R}_{\beta}}\right) = -\kappa\sum\nolimits_{\sigma}\daleth^{\rho}_{\sigma}$$

$$\daleth^{\mu\nu} = \sqrt{-\mathfrak{g}}\rho_{0}\,.\frac{d\chi_{\mu}}{ds}\frac{d\chi_{\nu}}{ds}$$

$$\sum_{\mu}\daleth^{\mu}_{\nu} = \sum_{\mu\nu}\mathscr{g}_{\mu\nu}\,\daleth^{\mu\nu} = \rho_{0}\sqrt{-\mathfrak{g}}$$

$$\mathfrak{G}_{im} = \sum_{l}(il,lm) = \mathfrak{R}_{im} + \mathfrak{S}_{im}$$

$$\mathfrak{R}_{im} = -\sum_{l}\frac{\partial\left\Vert\begin{matrix}im\\l\end{matrix}\right\Vert}{\partial\mathfrak{R}_{l}} + \sum\nolimits_{\rho l}\left|\begin{matrix}il\\\rho\end{matrix}\right|\left|\begin{matrix}\rho m\\l\end{matrix}\right|$$

$$\mathfrak{R}_{im} = \frac{\sum_{l}\partial\Gamma^{l}_{im}}{\partial\mathfrak{R}_{l}} + \sum_{\rho l}\Gamma^{l}_{i\rho}\Gamma^{\rho}_{ml}$$

$$\mathfrak{R}_{im}=\sum_{l}\partial\Gamma_{im}^{l}/\partial\mathfrak{R}_{l}+\sum_{\rho l}\Gamma_{i\rho}^{l}\Gamma_{ml}^{\rho}=-\kappa\left(\daleth_{im}-\frac{1}{2\mathscr{g}_{im}\mathfrak{I}}\right)$$

$$\mathfrak{S}_{im}=\sum_{l}\frac{\partial\left\|\begin{matrix}im\\ l\end{matrix}\right\|}{\partial\mathfrak{R}_{m}}-\sum_{\rho l}\left|\begin{matrix}im\\ \rho\end{matrix}\right|\left|\begin{matrix}\rho l\\ l\end{matrix}\right|$$

$$\mathfrak{S}_{im}=-\kappa\left(\daleth_{im}-\frac{1}{2\mathscr{g}_{im}\mathfrak{I}}\right)$$

$$\sum_{\varrho\sigma}\mathscr{g}^{\varrho\sigma}\daleth_{\varrho\sigma}=\sum_{\sigma}\daleth_{\sigma}^{\varrho}=\mathrm{T}$$

$$\mathfrak{G}_{\mu\nu}=-\kappa\daleth_{\mu\nu}$$

$$\mathfrak{R}_{\mu\nu}=-\kappa\daleth_{\mu\nu}$$

$$\sum_{\alpha\beta}\frac{\partial}{\partial\mathfrak{R}_{\alpha}}\left(\frac{\mathscr{g}^{\alpha\beta}\partial lg\sqrt{-\mathfrak{g}}}{\partial\mathfrak{R}_{\beta}}\right)=-\kappa\sum_{\sigma}\daleth_{\sigma}^{\rho}$$

$$\frac{1}{2\sum_{im}\mathscr{g}_{im}}=\frac{\partial\mathscr{g}^{im}}{\partial\mathfrak{R}_{\sigma}}=-\frac{\partial lg\sqrt{-\mathfrak{g}}}{\partial\mathfrak{R}_{\sigma}}$$

$$\partial/\partial\mathfrak{R}_{\mu\nu}\left[\!\left[\sum_{\alpha\beta}\frac{\partial^{2}\mathscr{g}^{\alpha\beta}}{\partial\mathfrak{R}_{\alpha}\partial\mathfrak{R}_{\beta}}-\kappa(\daleth+\mathfrak{t})\right]\!\right]$$

$$\mathbb{A}'^{\sigma\tau}=\frac{\partial\mathfrak{R}_{\sigma}'}{\partial\mathfrak{R}_{\mu}}\frac{\partial\mathfrak{R}_{\tau}'}{\partial\mathfrak{R}_{\nu}}\mathbb{A}^{\mu\nu}=\frac{\partial\mathfrak{R}_{\sigma}'}{\partial\mathfrak{R}_{\mu}}\frac{\partial\mathfrak{R}_{\tau}'}{\partial\mathfrak{R}_{\nu}}\mathbb{A}^{\nu\mu}=\frac{\partial\mathfrak{R}_{\sigma}'}{\partial\mathfrak{R}_{\nu}}\frac{\partial\mathfrak{R}_{\tau}'}{\partial\mathfrak{R}_{\mu}}\mathbb{A}^{\mu\nu}=\mathbb{A}'^{\tau\sigma}$$

$$\mathbb{G}=\left|\frac{\partial\mathfrak{R}_{\mu}}{\partial\mathfrak{R}_{\sigma}'}\right|\cdot\left|\frac{\partial\mathfrak{R}_{\nu}}{\partial\mathfrak{R}_{\tau}'}\right|\cdot\left|\mathbb{g}_{\mu\nu}\right|=\left(\frac{\partial\mathfrak{R}_{\mu}}{\partial\mathfrak{R}_{\sigma}'}\right)^{2}\mathbb{g},\sqrt{-\mathfrak{g}}'=\left|\frac{\partial\mathfrak{R}_{\mu}}{\partial\mathfrak{R}_{\sigma}'}\right|\sqrt{-\mathfrak{g}}$$

$$d\tau'=\left|\frac{\partial\mathfrak{R}_{\mu}}{\partial\mathfrak{R}_{\sigma}'}\right|.d\tau$$

$$\delta\omega=1/\omega\left|\frac{\frac{\frac{\frac{1}{2}\partial\mathscr{g}^{\mu\nu}}{\partial\mathfrak{R}_{\sigma}}d\chi_{\mu}}{d\lambda}d\chi_{\nu}}{d\lambda}\delta\chi_{\sigma}+\frac{\mathscr{g}^{\mu\nu}d\chi_{\mu}}{d\lambda}\delta\left(\frac{d\chi_{\nu}}{d\lambda}\right)=\frac{d}{d\lambda}(\delta\chi_{\nu})\right|$$

$$\kappa\omega=\frac{d}{d\lambda}\left(\frac{\mathscr{g}^{\mu\nu}}{\omega}\frac{d\chi_{\mu}}{d\lambda}\right)-\frac{\frac{1}{2\omega}\partial\mathscr{g}^{\mu\nu}}{\partial\mathfrak{R}_{\sigma}}\frac{d\chi_{\mu}}{d\lambda}\frac{d\chi_{\nu}}{d\lambda}$$

$$\mathscr{g}^{\mu\nu}=\frac{d^{2}\chi_{\mu}}{ds^{2}}+\frac{\partial\mathscr{g}^{\mu\nu}}{\partial\mathfrak{R}_{\sigma}}\frac{d\chi_{\sigma}}{ds}\frac{d\chi_{\mu}}{ds}-\frac{1}{2}\frac{\partial\mathscr{g}^{\mu\nu}}{\partial\mathfrak{R}_{\sigma}}\frac{d\chi_{\mu}}{ds}\frac{d\chi_{\nu}}{ds}$$

$$[\mu\nu,\sigma]=\frac{1}{2}\left(\frac{\partial\mathscr{g}_{\mu\sigma}}{\partial\mathfrak{R}_{\nu}}+\frac{\partial\mathscr{g}_{\nu\sigma}}{\partial\mathfrak{R}_{\mu}}-\frac{\partial\mathscr{g}_{\mu\nu}}{\partial\mathfrak{R}_{\sigma}}\right)$$

$$\frac{d\phi}{ds}=\frac{\partial\phi}{\partial\mathfrak{R}_{\mu}}\frac{d\chi_{\mu}}{ds}$$

$$\psi=\frac{\frac{\partial\phi}{d\chi_{\mu}}\frac{d\chi_{\mu}}{ds}}{d\psi}$$

$$\chi=\frac{\partial^{2}\phi}{\partial\mathfrak{R}_{\mu}\partial\mathfrak{R}_{\nu}}\frac{d\chi_{\mu}}{ds}\frac{d\chi_{\nu}}{ds}+\frac{\partial\phi}{\partial\mathfrak{R}_{\mu}}\frac{d^{2}\chi_{\mu}}{ds^{2}}\left(\frac{\partial^{2}\phi}{\partial\mathfrak{R}_{\mu}\partial\mathfrak{R}_{\nu}}-[\mu\nu,\sigma]\frac{\partial\phi}{\partial\mathfrak{R}_{\tau}}\right)\frac{d\chi_{\mu}}{ds}\frac{d\chi_{\nu}}{ds}$$

$$\psi\frac{\partial^{2}\phi}{\partial\mathfrak{R}_{\mu}\partial\mathfrak{R}_{\nu}}-[\mu\nu,\tau]\psi\frac{\partial\phi}{\partial\mathfrak{R}_{\tau}}$$

$$\frac{\partial}{\partial\mathfrak{R}_{\nu}}\left(\psi\frac{\partial\phi}{\partial\mathfrak{R}_{\mu}}\right)-[\mu\nu,\tau]\left(\psi\frac{\partial\phi}{\partial\mathfrak{R}_{\tau}}\right)$$

$$\mathbb{A}_{\mu\nu\sigma} = \frac{\partial \mathrm{A}_{\mu\nu}}{\partial \mathfrak{R}_\sigma} - [\sigma\mu,\tau]\mathbb{A}_{\tau\nu} - [\sigma\nu,\tau]\mathbb{A}_{\mu\tau}$$

$$\frac{\frac{1}{\sqrt{-\mathfrak{g}}}\partial\sqrt{-\mathfrak{g}}}{\partial \mathfrak{R}_\sigma} = \frac{\frac{1}{2}\partial \log(-\mathfrak{g})}{\partial \mathfrak{R}_\sigma} = \frac{\frac{\frac{1}{2g^{\mu\nu}}}{\partial g_{\mu\nu}}}{\partial \mathfrak{R}_\sigma} = \frac{1}{2g_{\mu\nu}}\partial g^{\mu\nu}/\partial \mathfrak{R}_\tau$$

$$\left\{\begin{matrix} g_{\mu\sigma} d g^{\nu\sigma} = -g^{\nu\sigma} d g_{\mu\sigma} \\ \frac{g_{\mu\sigma}\partial g^{\nu\sigma}}{\partial \mathfrak{R}_\lambda} = \frac{-g^{\nu\sigma}\partial g_{\mu\sigma}}{\partial \mathfrak{R}_\lambda} \end{matrix}\right\}$$

$$\left\{\begin{matrix} d g^{\mu\nu} = -g^{\mu\alpha} g^{\nu\beta} d g_{\alpha\beta} \\ \frac{\partial g^{\mu\nu}}{\partial \mathfrak{R}_\sigma} = \frac{-g^{\mu\alpha} g^{\nu\beta}\partial g_{\alpha\beta}}{\partial \mathfrak{R}_\sigma} \end{matrix}\right\}$$

$$\frac{\partial g_{\alpha\beta}}{\partial \mathfrak{R}_\sigma} = [\alpha\sigma,\beta] + [\beta\sigma,\alpha]$$

$$\frac{\partial g^{\mu\nu}}{\partial \mathfrak{R}_\sigma} = -g^{\mu\tau}[\tau\sigma,\nu] - g^{\nu\tau}[\tau\sigma,\mu]$$

$$\frac{\frac{1}{\sqrt{-\mathfrak{g}}}\partial\sqrt{-\mathfrak{g}}}{\partial \mathfrak{R}_\sigma} = [\mu\sigma,\mu]$$

$$\frac{\partial}{\partial \mathfrak{R}_\nu\left(g^{\mu\nu}\mathbb{A}_{\mu\nu}\right)} - \frac{\mathbb{A}_{\mu\nu}\partial g^{\mu\nu}}{\partial \mathfrak{R}_\nu} - \frac{1}{2}\, g^{\tau\alpha}\left(\frac{\partial g_{\mu\alpha}}{\partial \mathfrak{R}_\nu} + \frac{\partial g_{\nu\alpha}}{\partial \mathfrak{R}_\mu} - \frac{\partial g_{\mu\nu}}{\partial \mathfrak{R}_\alpha}\right) g^{\mu\nu}\mathbb{A}_{\mu\nu}$$

$$\frac{\frac{1}{2}\partial g^{\tau\nu}}{\partial \mathfrak{R}_\nu}\mathbb{A}_\tau + \frac{\frac{1}{2\partial g^{\tau\mu}}}{\partial \mathfrak{R}_\mu \mathbb{A}_\tau} + \frac{\frac{1}{\sqrt{-\mathfrak{g}}}\partial\sqrt{-\mathfrak{g}}}{\partial \mathfrak{R}_\sigma} g^{\mu\nu}\mathbb{A}_\tau$$

$$\Phi = \frac{\frac{1}{\sqrt{-\mathfrak{g}}}\partial}{\partial \mathfrak{R}_\nu(\sqrt{-\mathfrak{g}}\mathbb{A}^{\mu\nu})}$$

$$\mathbb{B}_{\mu\nu\sigma} = \mathbb{A}_{\mu\nu\sigma} + \mathbb{A}_{\nu\sigma\mu} + \mathbb{A}_{\sigma\mu\nu} = \frac{\partial \mathbb{A}_{\mu\nu}}{\partial \mathfrak{R}_\sigma} + \frac{\partial \mathbb{A}_{\nu\sigma}}{\partial \mathfrak{R}_\mu} + \frac{\partial \mathbb{A}_{\mu\sigma}}{\partial \mathfrak{R}_\nu}$$

$$\frac{\partial}{\partial \mathfrak{R}_\sigma}\left(g^{\mu\alpha} g^{\nu\beta}\mathbb{A}_{\mu\nu}\right) - \frac{g^{\mu\alpha}\partial g^{\nu\beta}}{\partial \mathfrak{R}_\sigma}\mathbb{A}_{\mu\nu} - \frac{g^{\nu\beta}\partial g^{\mu\alpha}}{\partial \mathfrak{R}_\sigma}\mathbb{A}_{\mu\nu}$$

$$\sqrt{-\mathfrak{g}}\mathbb{A}_\mu = \frac{\partial\left(\sqrt{-\mathfrak{g}}\mathbb{A}_\mu^\sigma\right)}{\partial \mathfrak{R}_\sigma} - \frac{1}{2}\frac{\partial g_{\rho\sigma}}{\partial \mathfrak{R}_\mu}\sqrt{-\mathfrak{g}}\mathbb{A}^{\rho\sigma}$$

$$\sqrt{-\mathfrak{g}}\mathbb{A}_\mu = \frac{\partial\left(\sqrt{-\mathfrak{g}}\mathbb{A}_\mu^\sigma\right)}{\partial \mathfrak{R}_\sigma} + \frac{1}{2}\frac{\partial g^{\rho\sigma}}{\partial \mathfrak{R}_\mu}\sqrt{-\mathfrak{g}}\mathbb{A}_{\rho\sigma}$$

$$\mathbb{A}_{\mu\sigma\tau} = \frac{\partial^2 \mathbb{A}_\mu}{\partial \mathfrak{R}_\sigma \partial \mathfrak{R}_\tau} - \frac{[\mu\sigma,\rho]\partial \mathbb{A}_\rho}{\partial \mathfrak{R}_\tau} - \frac{[\mu\tau,\rho]\partial \mathbb{A}_\rho}{\partial \mathfrak{R}_\sigma} - \frac{[\sigma\tau,\rho]\partial \mathbb{A}_\mu}{\partial \mathfrak{R}_\rho}$$
$$+ \left[\!\left[\frac{\partial}{\partial \mathfrak{R}_\tau}[\mu\sigma,\rho] + [\mu\tau,\alpha][\alpha\sigma,\rho] + [\sigma\tau,\alpha][\sigma\mu,\rho]\right]\!\right]\mathbb{A}_\rho$$

$$\mathbb{B}_{\mu\sigma\tau}^{\rho} = \frac{\partial}{\partial \mathfrak{R}_\tau}\,[\mu\sigma,\rho] + \frac{\partial}{\partial \mathfrak{R}_\sigma}[\mu\tau,\rho] - [\mu\sigma,\alpha][\alpha\tau,\rho] + [\mu\tau,\alpha][\alpha\sigma,\rho]$$

$$\mathcal{R}_{\mu\nu} = -\frac{\partial}{\partial \mathfrak{R}_\alpha[\mu\nu,\alpha]} + [\mu\alpha,\beta][\nu\beta,\alpha]$$

$$\mathbb{S}_{\mu\nu} = \partial^2 \log\frac{\sqrt{-\mathfrak{g}}}{\partial \mathfrak{R}_\mu \partial \mathfrak{R}_\nu} - \frac{[\mu\nu,\alpha]\partial \log\sqrt{-\mathfrak{g}}}{\partial \mathfrak{R}_\alpha}$$

$$\langle \delta \int \begin{matrix} \mathcal{H} d\tau = 0 \\ \mathcal{H} = g^{\mu\nu}\Gamma_{\mu\beta}^{\alpha}\Gamma_{\nu\alpha}^{\beta}\sqrt{-\mathfrak{g}} = 1 \end{matrix} \rangle$$

$$\delta\mathcal{H} = \Gamma_{\mu\beta}^{\alpha}\Gamma_{\nu\alpha}^{\beta}\delta g^{\mu\nu} + 2g^{\mu\nu}\Gamma_{\mu\beta}^{\alpha}\Gamma_{\nu\alpha}^{\beta} = -\Gamma_{\mu\beta}^{\alpha}\Gamma_{\nu\alpha}^{\beta} + 2\Gamma_{\mu\beta}^{\alpha}\Gamma_{\nu\alpha}^{\beta}\delta\left(\Gamma_{\mu\beta}^{\alpha}\Gamma_{\nu\alpha}^{\beta}\right)$$

$$\delta\left(\mathscr{g}^{\mu\nu}\Gamma^{\alpha}_{\mu\beta}\Gamma^{\beta}_{\nu\alpha}\right)=\frac{1}{2}\delta\left(\mathscr{g}^{\mu\nu}\mathscr{g}^{\beta\lambda}\left(\frac{\partial\mathscr{g}_{\nu\lambda}}{\partial\mathfrak{R}_{\alpha}}+\frac{\partial\mathscr{g}_{\alpha\lambda}}{\partial\mathfrak{R}_{\nu}}+\frac{\partial\mathscr{g}_{\alpha\nu}}{\partial\mathfrak{R}_{\lambda}}\right)\right)$$

$$\delta\mathcal{H}=-\Gamma^{\alpha}_{\mu\beta}\Gamma^{\beta}_{\nu\alpha}\,\delta\mathscr{g}^{\mu\nu}-\Gamma^{\alpha}_{\mu\beta}\Gamma^{\beta}_{\nu\alpha}\delta\mathscr{g}^{\mu\beta}_{\alpha}$$

$$\begin{Bmatrix}\dfrac{\partial\mathcal{H}}{\partial\mathscr{g}^{\mu\nu}}=-\Gamma^{\alpha}_{\mu\beta}\Gamma^{\beta}_{\nu\alpha}\\ \dfrac{\partial\mathcal{H}}{\partial\mathscr{g}^{\mu\nu}_{\sigma}}=\Gamma^{\sigma}_{\mu\nu}\end{Bmatrix}$$

$$\frac{\partial}{\partial\mathfrak{R}_{\alpha}}\left(\frac{\partial\mathcal{H}}{\partial\mathscr{g}^{\mu\nu}_{\alpha}}\right)-\frac{\partial\mathcal{H}}{\partial\mathscr{g}^{\mu\nu}}=\mathscr{g}^{\mu\nu}_{\sigma}\frac{\partial}{\partial\mathfrak{R}_{\alpha}}\left(\frac{\partial\mathcal{H}}{\partial\mathscr{g}^{\mu\nu}_{\alpha}}\right)=\frac{\partial}{\partial\mathfrak{R}_{\alpha}}\left(\mathscr{g}^{\mu\nu}_{\sigma}\frac{\partial\mathcal{H}}{\partial\mathscr{g}^{\mu\nu}_{\alpha}}\right)-\frac{\partial\mathcal{H}}{\partial\mathscr{g}^{\mu\nu}_{\alpha}}\frac{\partial\mathscr{g}^{\mu\nu}_{\alpha}}{\partial\mathfrak{R}_{\sigma}}-2\kappa\mathfrak{t}^{\alpha}_{\sigma}\frac{\partial\mathcal{H}}{\partial\mathscr{g}^{\mu\nu}_{\alpha}}-\delta^{\alpha}_{\sigma}\mathcal{H}$$

$$\kappa\mathfrak{t}^{\alpha}_{\sigma}=\frac{1}{2\delta^{\alpha}_{\sigma}\mathscr{g}^{\mu\nu}\Gamma^{\lambda}_{\mu\beta}\Gamma^{\beta}_{\nu\lambda}}-\mathscr{g}^{\mu\nu}\Gamma^{\alpha}_{\mu\beta}\Gamma^{\beta}_{\nu\alpha}$$

$$\frac{\mathscr{g}^{\nu\sigma}\partial\Gamma^{\alpha}_{\mu\nu}}{\partial\mathfrak{R}_{\alpha}}=\frac{\partial}{\partial\mathfrak{R}_{\alpha}\left(\mathscr{g}^{\nu\sigma}\mathscr{g}^{\nu\beta}\partial\Gamma^{\alpha}_{\mu\nu}\Gamma^{\sigma}_{\alpha\beta}\right)}-\frac{\partial\mathscr{g}^{\nu\sigma}\mathscr{g}^{\sigma\beta}}{\partial\mathfrak{R}_{\alpha}\Gamma^{\alpha}_{\mu\nu}\Gamma^{\sigma}_{\alpha\beta}}$$

$$\frac{\partial}{\partial\mathfrak{R}_{\alpha}}\left(\mathscr{g}^{\sigma\beta}\Gamma^{\alpha}_{\mu\beta}\right)=-\kappa\left(\mathfrak{t}^{\sigma}_{\mu}-\frac{1}{2\delta^{\sigma}_{\mu}\mathfrak{t}}\right)\sqrt{-\mathfrak{g}}=1$$

$$\frac{\partial}{\partial\mathfrak{R}_{\alpha}}\left(\mathscr{g}^{\sigma\beta}\Gamma^{\alpha}_{\mu\beta}\right)=-\kappa\left(\left(\mathfrak{t}^{\sigma}_{\mu}-\frac{1}{2\delta^{\sigma}_{\mu}\mathfrak{t}}\right)-\frac{1}{2}\delta^{\sigma}_{\mu}(\mathfrak{t}+\daleth)\right)\sqrt{-\mathfrak{g}}=1$$

$$\frac{\partial}{\partial\mathfrak{R}_{\alpha}}\Gamma^{\alpha}_{\mu\nu}+\Gamma^{\alpha}_{\mu\beta}\Gamma^{\beta}_{\nu\alpha}=-\kappa\left(\daleth_{\mu\nu}-\frac{1}{2\mathscr{g}_{\mu\nu}\daleth}\right)\sqrt{-\mathfrak{g}}=1$$

$$\frac{\partial}{\partial\mathfrak{R}_{\alpha}}\left(\mathscr{g}^{\sigma\beta}\Gamma^{\alpha}_{\mu\beta}-\frac{1}{2\delta^{\sigma}_{\mu}\mathscr{g}^{\lambda\beta}\Gamma^{\alpha}_{\lambda\beta}}\right)=-\kappa\left(\mathfrak{t}^{\sigma}_{\mu}+\daleth^{\sigma}_{\mu}\right)$$

$$\frac{\partial^{2}}{\partial\mathfrak{R}_{\alpha}\partial\mathfrak{R}_{\sigma}\left(\mathscr{g}^{\sigma}\Gamma^{\alpha}_{\beta\mu}\right)}=-\frac{\frac{1}{2}\partial^{2}}{\partial\mathfrak{R}_{\alpha}\partial\mathfrak{R}_{\sigma}}\left(\mathscr{g}^{\sigma\beta}\mathscr{g}^{\alpha\lambda}\left(\frac{\partial\mathscr{g}_{\mu\lambda}}{\partial\mathfrak{R}_{\beta}}+\frac{\partial\mathscr{g}_{\beta\lambda}}{\partial\mathfrak{R}_{\mu}}+\frac{\partial\mathscr{g}_{\mu\beta}}{\partial\mathfrak{R}_{\lambda}}\right)\right)$$

$$\mathfrak{R}_{\mu\nu}+\mathfrak{S}_{\mu\nu}=-\kappa\left(\daleth_{\mu\nu}+\frac{1}{2\mathscr{g}_{\mu\nu}\daleth}\right)$$

$$\mathfrak{R}_{\mu\nu}=-\sum_{\alpha}\frac{\partial}{\partial\mathfrak{R}_{\alpha}\begin{vmatrix}\mu\nu\\ \alpha\end{vmatrix}}+\sum_{\alpha\beta}\begin{vmatrix}\mu\alpha\\ \beta\end{vmatrix}\begin{vmatrix}\nu\beta\\ \alpha\end{vmatrix}$$

$$\mathfrak{S}_{\mu\nu}=\frac{\partial^{2}\log\sqrt{\mathfrak{g}}}{\partial\mathfrak{R}_{\mu}\partial\mathfrak{R}_{\nu}}-\frac{\sum_{\alpha}\begin{vmatrix}\mu\nu\\ \alpha\end{vmatrix}\partial\log\sqrt{\mathfrak{g}}}{\partial\mathfrak{R}_{\alpha}}$$

$$\sum_{\alpha}\frac{\partial^{2}\gamma_{\mu\omega}}{\partial\mathfrak{R}_{\nu}\partial\mathfrak{R}_{\alpha}}+\sum_{\alpha}\frac{\partial^{2}\gamma_{\nu\alpha}}{\partial\mathfrak{R}_{\mu}\partial\mathfrak{R}_{\alpha}}\partial\mathfrak{R}_{\mu}\partial\mathfrak{R}_{\alpha}-\sum_{\alpha}\frac{\partial^{2}\gamma_{\mu\nu}}{\partial\mathfrak{R}^{2}_{\alpha}}-\frac{\partial^{2}}{\partial\mathfrak{R}_{\mu}\partial\mathfrak{R}_{\nu}}\left(\sum_{\alpha}\gamma_{\alpha\alpha}\right)$$
$$=-2\kappa(\daleth_{\mu\nu}-\frac{1}{2\delta_{\mu\nu}\sum_{\alpha}\daleth_{\alpha\alpha}}+\frac{2\partial^{2}\psi}{\partial\mathfrak{R}_{\mu}\partial\mathfrak{R}_{\nu}}-\delta_{\mu\nu}\sum_{\alpha}\frac{\partial^{2}\psi}{\partial\mathfrak{R}^{2}_{\alpha}}-4\frac{\partial^{2}\psi}{\partial\mathfrak{R}_{\mu}\partial\mathfrak{R}_{\nu}}+\frac{\partial\mathscr{g}^{\rho\sigma}}{\partial\mathfrak{R}_{\alpha}}$$

$$-\frac{\partial\sqrt{-\mathfrak{g}}\daleth^{\sigma}_{\rho}}{\partial\mathfrak{R}_{\mu}\partial\mathfrak{R}_{\nu}}=\frac{\dfrac{\sum_{\alpha\beta\tau}\frac{\left(\partial\gamma^{\dagger}_{\alpha\beta}\right)}{\partial\mathfrak{R}_{\Lambda}d\tau}}{\partial\Delta\mathfrak{R}_{\Lambda}}}{\partial\mathfrak{R}_{\mu}\partial\mathfrak{R}_{\nu}}-\frac{\partial^{2}\Delta\mathfrak{R}_{\Lambda}}{\sqrt{-\mathfrak{g}}\Delta}-\int\frac{1}{2}\eth\aleph^{*}-\int-\frac{1}{4}\otimes\mathscr{g}^{\mu\nu}_{\alpha\beta}.\,\delta\partial\Delta\mathscr{g}^{\mu\nu}$$

17.5. Perturbaciones de los campos cuánticos curvos por el movimiento acelerado de partículas masivas (ondas a escala cuántica).

$$\mathfrak{g}_{\mu\nu} = -\delta_{\mu\nu} + \gamma_{\mu\nu}$$

$$-\sum\nolimits_{\alpha} \frac{\partial}{\partial\chi_\alpha} \begin{matrix}\mu\nu\\ \alpha\end{matrix} + \sum\nolimits_{\alpha} \frac{\partial}{\partial\chi_\nu} \begin{matrix}\mu\alpha\\ \alpha\end{matrix} + \sum_{\alpha\beta} \begin{matrix}\mu\alpha\\ \beta\end{matrix} \begin{matrix}\nu\beta\\ \alpha\end{matrix} - \sum_{\alpha\beta} \begin{matrix}\mu\nu\\ \alpha\end{matrix} \begin{matrix}\alpha\beta\\ \beta\end{matrix} = -\kappa\left(\mathfrak{T}_{\mu\nu} - \frac{1}{2\mathfrak{g}_{\mu\nu}\mathfrak{T}}\right)$$

$$\frac{\sum_\alpha(\frac{\partial^2\gamma_{\mu\nu}}{\partial\chi_\alpha^2} + \frac{\partial^2\gamma_{\alpha\alpha}}{\partial\chi_\mu\partial\chi_\nu} - \frac{\partial^2\gamma_{\mu\alpha}}{\partial\chi_\nu\partial\chi_\alpha} - \partial^2\gamma_{\nu\alpha}}{\partial\chi_\mu\partial\chi_\alpha}) = 2\kappa\left(\mathfrak{T}_{\mu\nu} - \frac{1}{2\mathfrak{g}_{\mu\nu}}\sum_\alpha \mathfrak{T}_{\alpha\alpha}\right)$$

$$\frac{\sum_\alpha(\frac{\partial^2\gamma'_{\mu\nu}}{\partial\chi_\alpha^2} + \frac{\partial^2\gamma'_{\alpha\beta}}{\partial\chi_\nu\partial\chi_\alpha} - \frac{\partial^2\gamma'_{\mu\alpha}}{\partial\chi_\mu\partial\chi_\alpha} - \partial^2\gamma'_{\nu\alpha}}{\partial\chi_\alpha\partial\chi_\beta}) = 2\kappa\left(\mathfrak{T}_{\mu\nu} - \frac{1}{2\mathfrak{g}_{\mu\nu}}\sum_\alpha \mathfrak{T}_{\alpha\alpha}\right)$$

$$\gamma'_{\mu\nu} = -\kappa/2\pi \int \frac{\mathfrak{T}_{\mu\nu}(\chi_O y_o z_0, t-r)}{r} d\mathfrak{V}_0$$

$$\frac{\sum_\sigma \partial\mathfrak{T}_\mu^\sigma}{\partial\chi_\sigma} + \frac{1}{2\sum_{\rho\sigma}\frac{\partial\mathfrak{g}^{\rho\sigma}}{\partial\chi_\mu\mathfrak{T}_{\rho\sigma}}}$$

$$\gamma_{\mu\nu} = \gamma'_{\mu\nu} - \frac{1}{2\delta_{\mu\nu}\sum_\alpha\gamma'_{\alpha\alpha}} = \gamma'_{\mu\nu} - \frac{1}{2\delta_{\mu\nu}\gamma'}$$

$$\sum_\alpha \partial\mathfrak{t}_{\mu\sigma}/\partial\chi_\sigma = \sum_\alpha \partial/\partial\chi_\sigma \left(\frac{1}{4\kappa}\left(\sum_{\alpha\beta}\left(\frac{\frac{\partial\gamma'_{\alpha\beta}}{\partial\chi_\mu\partial\gamma'_{\alpha\beta}}}{\partial\chi_\sigma}\right) - \frac{1}{2}\frac{\partial\gamma'}{\partial\chi_\mu}\frac{\partial\gamma'}{\partial\chi_\sigma}\right) - \frac{1}{8\kappa\delta_{\mu\sigma}\left(\sum_{\alpha\beta\lambda}(\frac{\partial\gamma'_{\alpha\beta}}{\partial\chi_\lambda})^2 - \frac{1}{2\sum_\lambda(\partial\gamma'\frac{\hbar}{\mathfrak{H}}/\partial\chi_\lambda)^2}\right)}\right)$$

$$4\kappa\daleth_{\mu\sigma} = \left(\frac{\sum_{\alpha\beta}\left(\frac{\frac{\partial\gamma'_{\alpha\beta}}{\partial\chi_\mu\partial\gamma'_{\alpha\beta}}}{\partial\chi_\sigma}\right) - 1}{2\frac{\partial\gamma'}{\partial\chi_\mu}\frac{\partial\gamma'}{\partial\chi_\sigma}}\right) - \frac{1}{2\delta_{\mu\sigma}\left(\sum_{\alpha\beta\lambda}(\frac{\partial\gamma'_{\alpha\beta}}{\partial\chi_\lambda})^2 - \frac{1}{\frac{\frac{\hbar}{\mathfrak{H}}}{2\sum_\lambda(\partial\gamma'\frac{\varkappa}{\mathcal{R}}/\partial\chi_\lambda)^2}}\right)}$$

$$\kappa\mathfrak{J}_{\sigma}^{\alpha}=\frac{1}{2\delta_{\sigma}^{\alpha}\sum_{\mu\nu\lambda\beta}\mathrm{g}^{\mu\nu}\begin{matrix}\mu\lambda\nu\beta\\ \beta\ \ \lambda\end{matrix}}-\sum_{\mu\nu\lambda}\mathrm{g}^{\mu\nu}\begin{matrix}\mu\lambda\nu\sigma\\ \alpha\ \ \lambda\end{matrix}$$

$$S=-1/4(\sum_{\mu}\mathrm{A}_{\mu\mu})^{2}+\frac{1}{2\sum_{\mu}\mathrm{A}_{\mu\mu}}\sum_{\rho\sigma}\mathrm{A}_{\rho\sigma}\,\alpha_{\rho}\alpha_{\sigma}+\frac{1}{4}(\sum_{\rho\sigma}\mathrm{A}_{\rho\sigma}\alpha_{\rho}\alpha_{\sigma})^{2}+\frac{1}{2\sum_{\mu\nu}\mathrm{A}_{\mu\nu}^{2}}-\sum_{\mu\sigma\tau}\mathrm{A}_{\mu\sigma}\mathrm{A}_{\mu\tau}\alpha_{\sigma}\alpha_{\tau}$$

17.6. Puente Einstein – Rosen en un campo cuántico geométricamente deformado o curvo, generado por una partícula masiva acelerada, explica (1) la superposición cuántica; (2) la aniquilación de partículas y antipartículas; y, (3) el entrelazamiento cuántico.

$$\mathfrak{d}\mathfrak{s}^{2}=\mathfrak{d}\chi_{1}^{2}-\mathfrak{d}\chi_{2}^{2}-\mathfrak{d}\chi_{3}^{2}+\alpha^{2}\chi_{1}^{2}\mathfrak{d}\chi_{4}^{2}$$

$$\mathcal{R}^{ik}{}_{lm}=\mathrm{g}^{2}\mathcal{R}^{kl}\mathfrak{R}_{kl}=\mathbb{R}_{ik}-\frac{1}{2\mathrm{g}_{ik}\daleth}=-\mathfrak{J}_{ik}$$

$$\mathfrak{J}_{ik}=\frac{1}{4\mathrm{g}_{ik}\varphi_{\alpha\beta}\varphi^{\alpha\beta}}-\varphi_{\iota\alpha}\varphi_{\lambda}^{\kappa}/{}_{\sigma}^{\mu}\varrho^{\nu\sigma}$$

$$\mathfrak{d}\mathfrak{s}^{2}=-\mathfrak{d}\chi_{1}^{2}-\mathfrak{d}\chi_{2}^{2}-\mathfrak{d}\chi_{3}^{2}+(\alpha^{2}\chi_{1}^{2}+\sigma)\mathfrak{d}\chi_{4}^{2}$$

$$\mathfrak{d}\mathfrak{s}^{2}=-\frac{1}{1}-\frac{2m}{r}dr^{2}-r^{2}(d\theta^{2}+sin^{2}\theta d\phi^{2})+\left(1-\frac{2m}{r}\right)dt^{2}$$

$$\mathfrak{d}\mathfrak{s}^{2}=-4(\mu^{2}+2m)d\mu^{2}+(\mu^{2}+2m)^{2}\,(d\theta^{2}+sin^{2}\theta d\phi^{2})+\frac{\mu^{2}}{\mu^{2}+2m}\,dt^{2}$$

$$\mathfrak{d}\mathfrak{s}^{2}=-\frac{1}{1}-\frac{2m}{r-\varepsilon^{2}/2\mathrm{r}^{2}}dr^{2}-r^{2}(d\theta^{2}+sin^{2}\theta d\phi^{2})+\left(1-\frac{2m}{r}-\varepsilon^{2}/2\mathrm{r}^{2}\right)dt^{2}$$

$$\varphi_{\mu\nu}=\varphi_{\mu,\nu}-\varphi_{\nu,\mu}+\mathrm{g}^{2}\varphi_{\mu\nu}{}_{\sigma}^{\mu}\varrho^{\nu\sigma}=\mathrm{g}^{2}\left(\mathfrak{R}_{ik}+\varphi_{\alpha\beta}\varphi^{\alpha\beta}\right)$$

$$\frac{\sum_{\alpha}\partial^{2}}{\partial\mathfrak{R}_{\alpha}^{2}\left(\gamma'_{\mu\nu}-\frac{1}{2}\delta_{\mu\nu}\sum_{\alpha}\gamma'_{\alpha\alpha}\right)}=2\kappa\mathfrak{J}_{\mu\nu}\left(\mathfrak{J}_{\mu\nu}-\frac{1}{2}\delta_{\mu\nu}\sum_{\alpha}\mathfrak{T}_{\alpha\alpha}\right)$$

$$\gamma_{\mu\nu}=\gamma'_{\mu\nu}-\frac{1}{2}\delta_{\mu\nu}\sum_{\alpha}\gamma'_{\alpha\alpha}$$

$$\gamma'_{\mu\nu}=\gamma_{\mu\nu}-\frac{1}{2}\delta_{\mu\nu}\sum_{\alpha}\gamma_{\alpha\alpha}$$

$$\gamma'_{\mu\nu}=-\frac{\kappa}{\frac{\overline{2\pi\int\mathfrak{J}_{\mu\nu}\left(\chi_{O}y_{o}z_{0},t-r\right)}}{r}}.d\mathfrak{B}_{0}$$

$$\sum_{\alpha}\frac{\partial}{\partial\mathfrak{R}_{\alpha}}\left(\frac{\frac{\partial\gamma'_{\mu\nu}}{\partial\mathfrak{R}_{\sigma}}\partial\gamma'_{\mu\nu}}{\partial\mathfrak{R}_{\alpha}}\frac{1}{2}\delta_{\alpha\sigma}\sum_{\mu\nu\beta}\left(\frac{\partial\gamma'_{\mu\nu}}{\partial\mathfrak{R}_{\beta})^{2}}\right)\right.$$

$$\sum_{\sigma}\frac{\partial\sqrt{-\mathfrak{g}}\mathfrak{J}_{\mu}^{\sigma}}{\partial\mathfrak{R}_{\sigma}}+\frac{\frac{1}{2\sum_{\rho\sigma}\partial\mathfrak{g}^{\rho\sigma}}}{\partial\mathfrak{R}_{\mu}}\sqrt{-\mathfrak{g}}\mathfrak{J}_{\sigma}^{\rho}\mathfrak{J}^{\rho\sigma}\mathfrak{J}_{\rho\sigma}-4\kappa\sum_{\nu}\frac{\partial\mathfrak{J}_{\rho\sigma}}{\partial\mathfrak{R}_{\nu}}$$

$$\mathfrak{t}_{\mu\nu}=\frac{1}{4\kappa}\left(\frac{\frac{\sum_{\alpha\beta}\partial\gamma'_{\alpha\beta}}{\partial\mathfrak{R}_{\mu}}\partial\gamma'_{\alpha\beta}}{\partial\mathfrak{R}_{\nu}}-\frac{\frac{1}{2}\delta_{\mu\nu}\sum_{\alpha\beta\tau}(\partial\gamma'_{\alpha\beta}}{\partial\mathfrak{R}_{\tau})^{2}}\right)$$

$$\frac{\partial}{\partial\mathfrak{R}_{\alpha}\left(\frac{\partial\mathfrak{G}^{*}}{\partial\mathfrak{g}_{\alpha}^{\mu\nu}}\right)}-\frac{\partial\mathfrak{G}^{*}}{\partial\mathfrak{g}^{\mu\nu}}=\frac{\partial\mathfrak{M}}{\partial\mathfrak{g}^{\mu\nu}}=\frac{\partial}{\partial\mathfrak{R}_{\alpha}}\left(\frac{\partial\mathfrak{M}}{\partial\mathfrak{q}_{(p)_{\alpha}}}\right)-\partial\mathfrak{M}\partial\mathfrak{q}_{(p)_{\beta}}$$

$$\mathfrak{G}^{*}=\sqrt{-\mathfrak{g}}\mathfrak{g}^{\mu\nu}\left(\binom{\mu\alpha}{\beta}\binom{\mu\beta}{\alpha}-\binom{\mu\nu}{\alpha}\binom{\alpha\beta}{\beta}\right)$$

$$\Delta\mathfrak{g}^{\mu\nu}=\frac{\mathfrak{g}^{\mu\alpha}\partial\Delta\chi_{\nu}}{\partial\mathfrak{R}_{\alpha}}+\frac{\mathfrak{g}^{\nu\alpha}\partial\Delta\chi_{\mu}}{\partial\mathfrak{R}_{\alpha}}+\Delta\mathfrak{g}_{\sigma}^{\mu\nu\rho}=\frac{\partial\Delta\mathfrak{g}^{\mu\nu}}{\partial\mathfrak{R}_{\sigma}}-\frac{\mathfrak{g}_{\sigma}^{\mu\nu\rho}\partial\Delta\chi_{\alpha}}{\partial\mathfrak{R}_{\sigma}}$$

$$\sqrt{-\mathfrak{g}}\Delta\left(\frac{\mathfrak{G}^{*}}{\sqrt{-\mathfrak{g}}}\right)=\delta_{\sigma}^{\nu}\frac{\partial\Delta\chi_{\sigma}}{\partial\mathfrak{R}_{\nu}}+2\frac{\partial\mathfrak{G}^{*}}{\partial\mathfrak{g}_{\alpha}^{\mu\nu}}+\mathfrak{G}^{*}\frac{\mathfrak{g}^{\mu\nu}\partial^{2}\Delta\chi_{\sigma}}{\partial\mathfrak{R}_{\nu}\partial\mathfrak{R}_{\alpha}}+\delta_{\sigma}^{\nu}$$
$$=\frac{2\partial\mathfrak{G}^{*}}{\partial\mathfrak{g}^{\mu\sigma}\mathfrak{g}^{\mu\nu}}+\frac{2\partial\mathfrak{G}^{*}}{\partial\mathfrak{g}_{\alpha}^{\mu\sigma}}+\frac{1}{2}\mathfrak{G}^{*}\delta_{\sigma}^{\nu}-\partial\mathfrak{G}^{*}/\partial\mathfrak{g}_{\nu}^{\mu\alpha}\mathfrak{g}_{\sigma}^{\mu\alpha}$$

$$\mathfrak{G}_{\mu\nu}=-\kappa\left(\mathfrak{T}_{\mu\nu}-\frac{1}{2\mathfrak{g}^{\mu\nu}\mathfrak{T}}\right)$$

$$\mathfrak{G}_{\mu\nu}=-\frac{\partial}{\partial\mathfrak{R}_{\alpha}(\mu\nu,\alpha)}+(\mu\alpha,\beta)(\nu\beta,\alpha)+\partial^{2}log\frac{\sqrt{-\mathfrak{g}}}{\partial\mathfrak{R}_{\mu}\partial\mathfrak{R}_{\nu}}-\frac{(\mu\nu,\alpha)\partial log\sqrt{-\mathfrak{g}}}{\partial\mathfrak{R}_{\alpha}}\lambda\mathfrak{g}_{\mu\nu}$$