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FORMALIZACIÓN MATEMÁTICA Y EN FÍSICA DE PARTÍCULAS, EN RELACIÓN A LA BRECHA DE MASA Y LA CURVATURA GEOMÉTRICA DE LOS CAMPOS CUÁNTICOS

MATHEMATICAL FORMALIZATION AND PARTICLE PHYSICS, IN RELATION TO THE MASS GAP AND THE GEOMETRIC CURVATURE OF QUANTUM FIELDS

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Formalización Matemática y en Física de Partículas, en Relación a la Brecha de Masa y la Curvatura Geométrica de los Campos Cuánticos

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RESUMEN

En recientes manuscritos, este investigador ha formulado alternativas de solución al Problema del Milenio de Yang – Mills, intentando unificar, desde la teoría cuántica de campos hasta las teorías de la relatividad general y especial respectivamente, sin desprendernos de cuestiones tan elementales como las representaciones en *algebra de Lie*, de cuyo resultado, se ha concluido en lo fundamental, que toda partícula o antipartícula, con masa o sin masa, según sea el caso, supera el estado de vacío, demostrando una brecha de masa positiva, esto es, cuando se aproxima o supera la velocidad de la luz, deformando así, el campo cuántico en el que interactúa, repercutiendo en las trayectorias de las partículas o antipartículas circundantes. Ahora bien, el propósito de esta investigación, es proponer modelos hipotéticos para campos de Yang – Mills abelianos y no abelianos, grupos de gauge y Lie usando distintos operadores para espacios en cuatro dimensiones $\mathbb{R}^4$, a través de los cuales, quedará demostrado, que la brecha de masa de una partícula o antipartícula con o sin masa, siempre arroja un valor positivo superior a cero.

Palabras clave: física de partículas, campos de gauge, teorías de calibre, grupos de Lie, libertad asintónica, dimensión $\mathbb{R}^4$, campos de Yang Mills abelianos y no abelianos, superficie espacial, superficie temporal, operador de Casimir, transformación de Lorentz, ecuación de Callan-Symanzik, integral de trayectoria, representación de espinores.

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Mathematical Formalization and Particle Physics, in Relation to the Mass Gap and the Geometric Curvature of Quantum Fields

ABSTRACT

In recent manuscripts, this researcher has formulated alternative solutions to the Yang-Mills Millennium Problem, trying to unify, from quantum field theory to the theories of general and special relativity respectively, without detaching ourselves from such elementary questions as representations in Lie algebra, from the result of which it has been concluded in the main, that every particle or antiparticle, with or without mass, as the case may be, exceeds the vacuum state, demonstrating a positive mass gap, that is, when it approaches or exceeds the speed of light, thus deforming the quantum field in which it interacts and affecting the trajectories of the surrounding particles or antiparticles. Now, the purpose of this research is to propose hypothetical models for abelian and non-abelian Yang-Mills fields, gauge and lie groups using different operators for spaces in four dimensions $\mathbb{R}^4$, through which it will be demonstrated that the mass gap of a particle or antiparticle with or without mass, it always yields a positive value greater than zero.

Keywords: particle physics, gauge fields, caliber theories, Lie groups, asymptonic freedom, $\mathbb{R}^4$ dimension, abelian and non-abelian Yang Mills fields, spatial surface, time surface, Casimir operator, Lorentz transformation, Callan-Symanzik equation, trajectory integral, spinor representation.

INTRODUCCIÓN

Preliminarmente, cabe precisar que se trabajará en campos cuánticos en dimensión $\mathbb{R}^4$, en estructuras de gauge específicas, a propósito de sus transformaciones, con trayectorias orbitales arbitrarias, utilizando distintas métricas vectoriales, espaciales, temporales y operadores cuánticos de campo, todo esto, en superficies de espacio – tiempo cuatridimensionales, por lo que, no solamente se recurrirá a la teoría cuántica de campos de Yang – Mills, sino también a las teorías de la relatividad general y especial y otras leyes propias de la física y de las matemáticas puras, todo esto, con la finalidad de demostrar, que la brecha de masa, en un campo de Yang – Mills, esto es, cuando una partícula o antipartícula con o sin masa, según sea el caso, supera el cero absoluto, arroja un salto de energía cuyo resultado siempre es positivo. En el apartado de Resultados y Discusión, se desplegarán los sistemas matemáticos y de la física de partículas correspondientes que sostienen la hipótesis contenida en este Artículo Científico y en definitiva, en los trabajos que anteceden a éste.

Para estos efectos, se han diseñado campos cuánticos hipotéticos, con superficies espaciales y temporales arbitrarias, todo esto, con la finalidad, de demostrar la existencia de la brecha de masa positiva y paralelamente, la curvatura geométrica de los campos cuánticos y los agujeros deformantes de los referidos campos.

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, aunque comporta también un 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 la teoría cuántica de campos, 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 (Formulación Matemática y en física de partículas)

En un grupo cuántico de estructura G y bajo el algebra de Lie, obtenemos lo que sigue:

$$\langle \mathfrak{A}|\mathfrak{B}\rangle = -\mathfrak{Tr}_{\mathfrak{mat}\langle \bar{\mathfrak{n}}|\mathbb{C}\rangle}(\mathfrak{A}|\mathfrak{B})$$

Cuya transformación de gauge se reduce a lo que sigue:

$$\mathfrak{A}\cdot\Omega = \mathfrak{A}^{\Omega} = \Omega^{-1}\mathfrak{d}\Omega + \Omega^{-1}\mathfrak{A}\Omega$$

De cuyo resultado se obtienen la totalidad de las órbitas.

Por otro lado, usando la métrica de Riemann en un volumen espacial específico, y utilizando el operador de Hodge, tenemos:

$$\mathfrak{u}\wedge\star\mathfrak{v} = (\mathfrak{u},\mathfrak{v})_{\mathfrak{q}}\mathfrak{d}\omega$$

Cuyas secciones se definen así:

$$\langle \mathfrak{u}|\mathfrak{v}\rangle = \int_{\mathfrak{M}}^{\infty}(\mathfrak{u},\mathfrak{v})_{\mathfrak{q}}\mathfrak{d}\omega$$

De lo que obtenemos lo que sigue:

$$|\mathfrak{u}\otimes\mathfrak{E}|^2 = -\mathfrak{Tr}(\mathfrak{E}\cdot\mathfrak{E})\ \mathfrak{u}\wedge\star\mathfrak{v} = -\mathfrak{Tr}(\mathfrak{E}\cdot\mathfrak{E})(\mathfrak{u},\mathfrak{v})_{\mathfrak{q}}\mathfrak{d}\omega$$

Cuya solución de Yang – Mills, es la que sigue:

$$\mathfrak{S}_{\mathfrak{YM}}(\mathfrak{A})\int_{\mathfrak{M}}^{\infty}|\mathfrak{d}\mathfrak{A}+\mathfrak{A}\wedge\mathfrak{A}|^2$$

$$\mathfrak{T}\exp\left[\int_{\mathcal{C}}^{\infty}\mathfrak{A}\right]-\frac{1}{3}\mathfrak{Tr}\int_{\mathfrak{A}\in\mathfrak{A}_{\mathfrak{M},\mathfrak{g}}/\mathcal{G}}^{\infty}\mathfrak{T}\exp\left[\int_{\mathcal{C}}^{\infty}\mathfrak{A}\right]\mathrm{e}^{-1/2\mathfrak{S}_{\mathfrak{YM}}(\mathfrak{A})}\mathfrak{D}\mathfrak{A}$$

En la que la curvatura de la superficie espacial y de la superficie temporal se expresan de la siguiente manera:

$$\mathfrak{D}\mathfrak{A} + \mathfrak{A}\wedge\mathfrak{A} = \sum_{\alpha}\sum_{1\leq i<j\leq 4} \alpha_{i;j,\alpha} \otimes \mathfrak{d}\mathfrak{x}^{i}\wedge\mathfrak{d}\mathfrak{x}^{j} \otimes \mathfrak{E}^{\alpha} + \sum_{\alpha,\beta}\sum_{1\leq i<j\leq 4} \alpha_{i,\alpha}\,\alpha_{j,\beta} \otimes \mathfrak{d}\mathfrak{x}^{i}\wedge\mathfrak{d}\mathfrak{x}^{j} \otimes \langle \mathfrak{E}^{\alpha} | \mathfrak{E}^{\beta} \rangle$$

$$+ \sum_{\alpha}\sum_{j=1} \alpha_{0:j,\alpha} \otimes \mathfrak{d}\mathfrak{x}^{0}\wedge\mathfrak{d}\mathfrak{x}^{j} \otimes \mathfrak{E}^{\alpha}$$

Cuyas permutaciones y transformaciones, se expresan así:

$$C_{\gamma}^{\alpha\beta} = -\mathfrak{T}\mathfrak{r}\left(\mathfrak{E}^{\gamma}\left(\mathfrak{E}^{\alpha}, \mathfrak{E}^{\beta}\right)\right)$$

$$\mathfrak{d}\mathfrak{A} + \mathfrak{A}\wedge\mathfrak{A} = \sum_{\gamma}\langle \sum_{1\leq i<j\leq 4} \alpha_{i;j,\alpha} \otimes \mathfrak{d}\mathfrak{x}^{i}\wedge\mathfrak{d}\mathfrak{x}^{j} + \sum_{\alpha<\beta}\sum_{1\leq i<j\leq 4} \alpha_{i,\alpha}\,\alpha_{j,\beta} C_{\gamma}^{\alpha\beta} \otimes \mathfrak{d}\mathfrak{x}^{i}\wedge\mathfrak{d}\mathfrak{x}^{j}$$

$$+ \mathfrak{d}\mathfrak{x}^{i}\wedge\mathfrak{d}\mathfrak{x}^{j} \sum_{j=1} \alpha_{0:j,\gamma} \otimes \mathfrak{d}\mathfrak{x}^{0}\wedge\mathfrak{d}\mathfrak{x}^{j}\rangle \otimes \mathfrak{E}^{\gamma}$$

$$\int_{\mathbb{R}^4}^{\infty} |\mathfrak{d}\mathfrak{A} + \mathfrak{A}\wedge\mathfrak{A}|^2$$

$$= \sum_{i<j}\int_{\mathbb{R}^4}^{\infty} \left\| \sum_{\alpha} \alpha_{i;j,\alpha}^{2} + \sum_{\gamma}\sum_{\alpha<\beta,\hat{\alpha}<\hat{\beta}} \alpha_{i,\alpha}\alpha_{j,\beta}\alpha_{i,\hat{\alpha}}\alpha_{j,\hat{\beta}}\, C_{\gamma}^{\alpha\beta} C_{\gamma}^{\hat{\alpha}\hat{\beta}} \right.$$

$$\left. + 4\sum_{\alpha<\beta,\gamma} \alpha_{i;j,\gamma}\alpha_{i,\alpha}\alpha_{j,\beta}\, C_{\gamma}^{\alpha\beta} \right\| \mathfrak{d}\omega + \sum_{j}\int_{\mathbb{R}^4}^{\infty}\sum_{\alpha} \alpha_{0:j,\alpha}^{2}\, \mathfrak{d}\omega$$

Campo Cuántico Abeliano

Usando el teorema de Stoke, tenemos:

$$\int_{\mathfrak{C}}^{\infty}\sum_{i=1}^{4} \mathfrak{A}_{i} \otimes \mathfrak{d}\mathfrak{x}^{i} = \int_{\partial\mathfrak{S}}^{\infty}\sum_{i=1}^{4} \mathfrak{A}_{i}\mathfrak{d}\mathfrak{x}^{i} = \int_{\mathfrak{S}}^{\infty} \mathfrak{d}\mathfrak{A} = \int_{\mathfrak{R}^4}^{\infty} \mathfrak{d}\mathfrak{A} \times 4_{\mathfrak{S}} = \|\mathfrak{d}\mathfrak{A}, 4_{\mathfrak{S}}\|$$

Por lo que, la integral de Yang – Mills se expresa de la siguiente manera:

$$1/\int_{\mathfrak{A}}^{\infty} \mathrm{e}^{-\|\mathfrak{d}\mathfrak{A}\|^2/2}\mathfrak{D}\mathfrak{A} \int_{A}^{\infty} \mathrm{e}^{\sqrt{-1}\langle \mathfrak{d}\mathfrak{A} | 4_{\mathfrak{S}}\rangle} \mathrm{e}^{-1/2|\mathfrak{d}\mathfrak{A}|^2}\, \mathfrak{d}\mathfrak{A}$$

Cuyo cambio heurístico de variables, queda expresado así:

$$\frac{1}{\det \mathfrak{d}^{-1}\int_{\mathfrak{A}}^{\infty}\mathrm{e}^{-\frac{\|\mathfrak{d}\mathfrak{A}\|^{2}}{2}}\mathfrak{D}(\mathfrak{d}\mathfrak{A})\det \mathfrak{d}^{-1}\int_{A}^{\infty}\mathrm{e}^{\sqrt{-1}\langle\mathfrak{d}\mathfrak{A}|4_{\mathfrak{S}}\rangle}\mathrm{e}^{-\frac{1}{2|\mathfrak{d}\mathfrak{A}|^{2}}}\mathfrak{D}(\mathfrak{d}\mathfrak{A})}$$

$$=\frac{1}{\int_{\mathfrak{A}}^{\infty}\mathrm{e}^{-\frac{\|\mathfrak{d}\mathfrak{A}\|^{2}}{2}}\mathfrak{D}(\mathfrak{d}\mathfrak{A})\int_{A}^{\infty}\mathrm{e}^{\sqrt{-1}\langle\mathfrak{d}\mathfrak{A}|4_{\mathfrak{S}}\rangle}\mathrm{e}^{-\frac{1}{2|\mathfrak{d}\mathfrak{A}|^{2}}}\mathfrak{D}(\mathfrak{d}\mathfrak{A})}$$

Más, en dimensión $\mathbb{R}^4$ y aplicando la función delta de Dirac, tenemos:

$$\langle\mathfrak{F},\mathfrak{X}_{\mathfrak{x}}\otimes\mathfrak{d}\mathfrak{x}^{\alpha}\wedge\mathfrak{d}\mathfrak{x}^{\beta}\rangle=\langle\sum_{0\leq i\leq j\leq 4}\mathfrak{I}_{ij}\mathfrak{d}\mathfrak{X}^{i}\wedge\mathfrak{d}\mathfrak{X}^{j},\mathfrak{X}_{\mathfrak{x}}\otimes\mathfrak{d}\mathfrak{x}^{\alpha}\wedge\mathfrak{d}\mathfrak{x}^{\beta}\rangle=\langle\mathfrak{I}_{\alpha\beta}\mathfrak{d}\mathfrak{x}^{\alpha}\wedge\mathfrak{d}\mathfrak{x}^{\beta},\mathfrak{X}_{\mathfrak{x}}\otimes\mathfrak{d}\mathfrak{x}^{\alpha}\wedge\mathfrak{d}\mathfrak{x}^{\beta}\rangle=\mathfrak{I}_{\alpha\beta}(\chi)$$

$$\in\mathbb{R}^4$$

Cuyo gauge axial, según el teorema de Stokes, arroja como resultado lo que sigue:

$$\int_{\mathfrak{C}}^{\infty}\sum_{i=1}^{4}\mathfrak{A}_i\otimes\mathfrak{d}\mathfrak{X}^{i}=\int_{\partial\mathfrak{S}}^{\infty}\sum_{i=1}^{4}\mathfrak{A}_i\otimes\mathfrak{d}\mathfrak{X}^{i}=\int_{\mathfrak{S}}^{\infty}\mathfrak{d}\mathfrak{A}$$

$$=\int_{(0,1)^2}^{\infty}\mathfrak{d}\mathfrak{s}\mathfrak{d}\mathfrak{t}\left[\sum_{1\leq i\leq j\leq 4}(\mathfrak{A}_{i;j}(\sigma)|\mathcal{J}_{ij}^{\sigma}|)(\mathfrak{s},\mathfrak{t})+\sum_{j=1}^{4}(\mathfrak{A}_{0:j}(\sigma)|\mathcal{J}_{0j}^{\sigma}|)(\mathfrak{s},\mathfrak{t})\right]$$

$$=\int_{(0,1)^2}^{\infty}\mathfrak{d}\mathfrak{s}\mathfrak{d}\mathfrak{t}\langle\mathfrak{d}\mathfrak{A},\sum_{0\leq i\leq j\leq 4}\chi_{\sigma(\mathfrak{s},\mathfrak{t})}|\mathcal{J}_{ij}^{\sigma}|(\mathfrak{s},\mathfrak{t})\otimes\mathfrak{d}\mathfrak{x}^{i}\wedge\mathfrak{d}\mathfrak{x}^{j}\rangle=\langle\mathfrak{d}\mathfrak{A},\widetilde{\mathfrak{B}_{\mathfrak{S}}}\rangle$$

En la que $\widetilde{\mathfrak{B}_{\mathfrak{S}}}$ es igual a:

$$\widetilde{\mathfrak{B}_{\mathfrak{S}}}=\int_{(0,1)^2}^{\infty}\sum_{0\leq i\leq j\leq 4}\mathfrak{d}\mathfrak{s}\mathfrak{d}\mathfrak{t}\chi_{\sigma(\mathfrak{s},\mathfrak{t})}|\mathcal{J}_{ij}^{\sigma}|(\mathfrak{s},\mathfrak{t})\,\mathfrak{d}\mathfrak{x}^{i}\wedge\mathfrak{d}\mathfrak{x}^{j}$$

$$\langle\mathfrak{d}\mathfrak{A},\sum_{0\leq i\leq j\leq 4}\chi_{\sigma(\mathfrak{s},\mathfrak{t})}|\mathcal{J}_{ij}^{\sigma}|(\mathfrak{s},\mathfrak{t})\otimes\mathfrak{d}\mathfrak{x}^{i}\wedge\mathfrak{d}\mathfrak{x}^{j}\rangle=\langle\mathfrak{d}\mathfrak{A},\sum_{0\leq i\leq j\leq 4}\chi_{\sigma(\mathfrak{s},\mathfrak{t})}\otimes\mathfrak{d}\mathfrak{x}^{i}\wedge\mathfrak{d}\mathfrak{x}^{j}\rangle|\mathcal{J}_{ij}^{\sigma}|(\mathfrak{s},\mathfrak{t})$$

$$=\sum_{0\leq i\leq j\leq 4}\langle\mathfrak{A}_{i;j},\chi_{\sigma(\mathfrak{s},\mathfrak{t})}\rangle|\mathcal{J}_{ij}^{\sigma}|(\mathfrak{s},\mathfrak{t})=\sum_{0\leq i\leq j\leq 4}\langle\mathfrak{A}_{i;j}(\sigma(\mathfrak{s},\mathfrak{t}))\rangle|\mathcal{J}_{ij}^{\sigma}|(\mathfrak{s},\mathfrak{t})$$

$$\frac{1}{3\int_{\mathfrak{A}}^{\infty}\mathrm{e}^{\sqrt{-1}\langle\mathfrak{d}\mathfrak{A}|\widetilde{\mathfrak{B}_{\mathfrak{S}}}\rangle}\mathrm{e}^{-\frac{1}{2|\mathfrak{d}\mathfrak{A}|^{2}}}\mathfrak{D}(\mathfrak{d}\mathfrak{A})}$$

$$-\frac{1}{3\int_{\mathfrak{A}}^{\infty}\mathrm{e}^{\sqrt{-1}\langle\mathfrak{d}\mathfrak{A}|\widetilde{\mathfrak{B}_{\mathfrak{S}}}\rangle}\mathrm{e}^{-\frac{1}{2|\mathfrak{d}\mathfrak{A}|^{2}}}\det(\mathfrak{d}^{-1})\mathfrak{D}(\mathfrak{d}\mathfrak{A})+\frac{1}{3\int_{\mathfrak{A}}^{\infty}\mathrm{e}^{\sqrt{-1}\langle\mathfrak{d}\mathfrak{A}|\widetilde{\mathfrak{B}_{\mathfrak{S}}}\rangle}\mathrm{e}^{-\frac{1}{2|\mathfrak{d}\mathfrak{A}|^{2}}}}\mathfrak{D}(\mathfrak{d}\mathfrak{A})}$$

Siguiendo el mismo orden de ideas, un espacio de Schwartz, quedaría expresado así:

$$\mathcal{P}\mathfrak{r} = \left\| (m_1 m_2, \dots, m_\mathfrak{n}) \sum_{\mathfrak{j}=1}^{\mathfrak{n}} \mathfrak{m}_\mathfrak{j} = \mathfrak{r} \right\|$$

Más en dimensión $\mathbb{R}^4$, incorporando la función de Gauss y la métrica de Lebesgue, tenemos:

$$\mathfrak{f}(\mathfrak{x}) = \wp(\mathfrak{x})\sqrt{\phi_\kappa}(\mathfrak{x})$$

$$\langle \mathfrak{f}, \mathfrak{g} \rangle = \int_{\mathbb{R}^4}^{\infty} \mathfrak{f} \cdot \mathfrak{g}\mathfrak{d}\lambda$$

$$\langle \mathfrak{z}^\mathfrak{r}, \hat{\mathfrak{z}}^\mathfrak{r} \rangle = \frac{1}{\pi \int_{\mathbb{C}}^{\infty} \mathfrak{z}^\mathfrak{r} \cdot \overline{\hat{\mathfrak{z}}^\mathfrak{r}}\, \mathbb{e}^{-|z^2|} \mathfrak{d}\mathfrak{x}\mathfrak{d}\mathfrak{p}}, \mathfrak{z} = \mathfrak{x} + \sqrt{-1\rho}$$

Cuya función polinómica, se traduce a lo que sigue:

$$\mathcal{H}_{\wp_\mathfrak{R}}(\mathfrak{x}) = \hbar_i(\mathfrak{x}^0)\hbar_j(\mathfrak{x}^1)\hbar_k(\mathfrak{x}^2)\hbar_l(\mathfrak{x}^3), \wp_\mathfrak{R} = (i, j, k, l) \in \mathfrak{P}_\mathfrak{R}$$

Más, incorporando la métrica de Gauss, tenemos:

$$\bigcup_{\mathfrak{r}=0}^{\infty} \left| \frac{\mathcal{H}_{\wp_\mathfrak{R}}(\kappa\mathfrak{x}^0, \kappa\mathfrak{x}^1, \kappa\mathfrak{x}^2, \kappa\mathfrak{x}^3)\sqrt{\phi_\kappa}}{\sqrt{\wp_\mathfrak{R}!}} : \wp_\mathfrak{r} \in \mathfrak{P}_\mathfrak{r} \right|$$

Por tanto, en dimensión $\mathbb{R}^4$, tenemos:

$$\mathfrak{S}_\kappa(\mathbb{R}^4) \otimes \Lambda^1(\mathbb{R}^3) = \langle \sum_{\alpha=1}^{4} \mathfrak{F}_\alpha \otimes \mathfrak{d}\mathfrak{x}^\alpha : \mathfrak{F}_\alpha \in \mathfrak{S}_\kappa(\mathbb{R}^4) \rangle$$

$$\overline{\mathfrak{S}}_\kappa(\mathbb{R}^4) \otimes \Lambda^2(\mathbb{R}^4) = \left\| \sum_{0 \le \alpha \le \beta \le 4} \langle \mathfrak{F}_{\alpha\beta} \otimes \mathfrak{d}\mathfrak{x}^\alpha \wedge \mathfrak{d}\mathfrak{x}^\beta : \mathfrak{F}_{\alpha\beta} \in \overline{\mathfrak{S}}_\kappa(\mathbb{R}^4) \rangle \right\|$$

Cuyo operador de Hodge, se reduce a lo siguiente:

$$\langle \sum_{0 \le \alpha \le \beta \le 4} |\mathfrak{F}_{\alpha\beta} \otimes \mathfrak{d}\mathfrak{x}^\alpha \wedge \mathfrak{d}\mathfrak{x}^\beta, | \sum_{0 \le \alpha \le \beta \le 4} |\widehat{\mathfrak{F}}_{\alpha\beta} \otimes \mathfrak{d}\mathfrak{x}^\alpha \wedge \mathfrak{d}\mathfrak{x}^\beta| \rangle = \sum_{0 \le \alpha \le \beta \le 4} |\mathfrak{F}_{\alpha\beta}, \widehat{\mathfrak{F}}_{\alpha\beta}|$$

Cuya transformación de Segal - Bargmann y demás funciones holomórficas, dan como resultado lo que sigue:

$$\langle \mathfrak{Z}^\mathcal{R}, \mathfrak{Z}^{\mathcal{R}'} \rangle = \frac{1}{\varpi \int_{\mathbb{C}}^{\infty} \mathfrak{Z}^\mathcal{R} \cdot \overline{\mathfrak{Z}^{\mathcal{R}'}}\, \mathbb{e}^{|-\mathfrak{z}^2|} \mathfrak{d}\mathfrak{x}\mathfrak{d}\mathfrak{p}}, \mathfrak{z} = \chi + \sqrt{-1\rho}$$

$$\Psi_\kappa = \frac{\frac{\frac{\frac{\hbar_{\mathfrak{i}}(\kappa\,\cdot)}{\sqrt{\mathfrak{i}!}\,\hbar_{\mathfrak{j}}(\kappa\,\cdot)}}{\sqrt{\mathfrak{j}!}\,\hbar_{\mathfrak{k}}(\kappa\,\cdot)}}{\sqrt{\mathfrak{k}!}\,\hbar_{\mathfrak{l}}(\kappa\,\cdot)}}{\sqrt{\mathfrak{l}!}} = \sqrt{\phi_\kappa} \longrightarrow \frac{\frac{\frac{\frac{\mathfrak{z}_0^{\mathfrak{i}}}{\sqrt{\mathfrak{i}!}\,\mathfrak{z}_1^{\mathfrak{j}}}}{\sqrt{\mathfrak{j}!}\,\mathfrak{z}_2^{\mathfrak{k}}}}{\sqrt{\mathfrak{k}!}\,\mathfrak{z}_3^{\mathfrak{l}}}}{\sqrt{\mathfrak{l}!}} = \mathfrak{f}_{\mathfrak{i},\alpha} \otimes \mathfrak{d}\mathfrak{x}^{\mathfrak{i}} \otimes \mathfrak{E}^\alpha \longrightarrow \Psi_\kappa(\mathfrak{f}_{\mathfrak{i},\alpha}) \otimes \mathfrak{d}\mathfrak{x}^{\mathfrak{i}} \otimes \mathfrak{E}^\alpha$$

En la que, en un espacio de Hilbert, se tiene:

$$\langle \sum_{0\le\alpha\le\beta\le4} \mathfrak{f}_{\alpha\beta} \otimes \mathfrak{d}\mathfrak{x}^\alpha \otimes \mathfrak{d}\mathfrak{x}^\beta, \sum_{0\le\alpha\le\beta\le4} \hat{\mathfrak{f}}_{\alpha\beta} \otimes \mathfrak{d}\mathfrak{x}^\alpha \otimes \mathfrak{d}\mathfrak{x}^\beta \rangle = \sum_{0\le\alpha\le\beta\le4} \langle \mathfrak{f}_{\alpha\beta}, \hat{\mathfrak{f}}_{\alpha\beta} \rangle$$

$$\partial \sum_{\mathfrak{i}=1}^{4} \mathfrak{f}_{\mathfrak{i}} \otimes \mathfrak{d}\mathfrak{x}^{\mathfrak{i}} = \sum_{\mathfrak{i}=1}^{4} \langle \partial_0 \mathfrak{f}_{\mathfrak{i}} \rangle \otimes \mathfrak{d}\mathfrak{x}^0 \wedge \mathfrak{d}\mathfrak{x}^{\mathfrak{i}} + \sum_{1\le\mathfrak{i}\le\mathfrak{j}\le4} [\partial_{\mathfrak{i}} \mathfrak{f}_{\mathfrak{j}} - \partial_{\mathfrak{j}} \mathfrak{f}_{\mathfrak{i}}] \otimes \mathfrak{d}\mathfrak{x}^{\mathfrak{i}} \wedge \mathfrak{d}\mathfrak{x}^{\mathfrak{j}}$$

$$\Psi_\kappa = \sum_{1\le\mathfrak{i}\le\mathfrak{j}\le4} \mathfrak{f}_{\mathfrak{i},\mathfrak{j},\alpha} \otimes \mathfrak{d}\mathfrak{x}^{\mathfrak{i}} \wedge \mathfrak{d}\mathfrak{x}^{\mathfrak{j}} \otimes \mathfrak{E}^\alpha \longrightarrow \sum_{1\le\mathfrak{i}\le\mathfrak{j}\le4} \Psi_\kappa[\mathfrak{f}_{\mathfrak{i},\mathfrak{j},\alpha}] \otimes \mathfrak{d}\mathfrak{x}^{\mathfrak{i}} \wedge \mathfrak{d}\mathfrak{x}^{\mathfrak{j}} \otimes \mathfrak{E}^\alpha$$

$$\mathcal{H}^2(\mathbb{C}^4) \otimes \Lambda^1(\mathbb{R}^3) = \left\{ \sum_{\alpha=1}^{4} \mathfrak{f}_\alpha \otimes \mathfrak{d}\mathfrak{x}^\alpha : \mathfrak{f}_\alpha \in \mathcal{H}^2(\mathbb{C}^4) \right\}$$

$$\mathcal{H}^2(\mathbb{C}^4) \otimes \Lambda^2(\mathbb{R}^4) = \left\{ \sum_{0\le\alpha\le\beta\le4} \mathfrak{F}_{\alpha\beta} \otimes \mathfrak{d}\mathfrak{x}^\alpha \wedge \mathfrak{d}\mathfrak{x}^\beta : \mathfrak{F}_{\alpha\beta} \in \mathcal{H}^2(\mathbb{C}^4) \right\}$$

$$\langle \sum_{0\le\alpha\le\beta\le4} \mathfrak{F}_{\alpha\beta} \otimes \mathfrak{d}\mathfrak{x}^\alpha \wedge \mathfrak{d}\mathfrak{x}^\beta, \sum_{0\le\alpha\le\beta\le4} \widehat{\mathfrak{F}_{\alpha\beta}} \otimes \mathfrak{d}\mathfrak{x}^\alpha \wedge \mathfrak{d}\mathfrak{x}^\beta \rangle = \sum_{0\le\alpha\le\beta\le4} \langle \mathfrak{F}_{\alpha\beta}, \hat{\mathfrak{F}}_{\alpha\beta} \rangle = \int_{\mathbb{C}^4}^{\infty} \mathfrak{F}_{\alpha\beta} \hat{\mathfrak{F}}_{\alpha\beta} \mathfrak{d}\lambda_4$$

Cuyos polinomios de Hermite, se satisfacen así:

$$\frac{\mathfrak{d}}{\mathfrak{d}\mathfrak{x}\left(\hbar_\eta(\chi)\mathfrak{E}^{-\frac{\mathfrak{x}^2}{4}}\right)} = |\chi\hbar_\eta(\mathfrak{x}) - \chi\hbar_{\eta+1}(\mathfrak{x}) - x/2\hbar_\eta(\chi)|\mathfrak{E}^{-\frac{\mathfrak{x}^2}{4}} = \frac{\mathfrak{d}}{\mathfrak{d}\mathfrak{x}\left(\hbar_\eta(\chi)\mathfrak{E}^{-\frac{\mathfrak{x}^2}{4}}\right)}$$

$$= \left(\frac{1}{2\hbar_{\eta+1}(\mathfrak{x})} + \frac{\eta}{2\hbar_{\eta-1}(\mathfrak{x})} - \hbar_{\eta+1}(\mathfrak{x})\right)\mathfrak{E}^{-\frac{\mathfrak{x}^2}{4}} = \left(\frac{\eta}{2\hbar_{\eta-1}(\mathfrak{x})} - \frac{1}{2\hbar_{\eta+1}(\mathfrak{x})}\right)\mathfrak{E}^{-\frac{\mathfrak{x}^2}{4}}$$

$$\mathfrak{d} \sum_{\alpha=1}^{4} \mathfrak{F}_{\alpha\beta} \otimes \mathfrak{d}\mathfrak{x}^\alpha = \sum_{\alpha=1}^{4} \mathfrak{d}_0 \mathfrak{F}_0 \mathfrak{d}\mathfrak{x}^0 \wedge \mathfrak{d}\mathfrak{x}^\alpha + \sum_{1\le\mathfrak{i}\le\mathfrak{j}\le4} \langle -1 \rangle^{\mathfrak{i}\mathfrak{j}} \langle \partial_{\mathfrak{i}} \mathfrak{f}_{\mathfrak{i}} - \partial_{\mathfrak{i}} \mathfrak{f}_j \rangle \mathfrak{d}\mathfrak{x}^{\mathfrak{i}} \wedge \mathfrak{d}\mathfrak{x}^{\mathfrak{j}}$$

$$\langle \mathfrak{f}\sqrt{\phi_\kappa}, \mathfrak{g}\sqrt{\phi_\kappa} \rangle = \int_{\mathbb{R}^4}^{\infty} \mathfrak{f}\mathfrak{g} \cdot \phi_\kappa, \mathfrak{d}\lambda$$

$$\left\{ \left| \frac{\hbar_{\mathfrak{i}}(\kappa\chi^0)\hbar_{\mathfrak{j}}(\kappa\chi^1)\hbar_{\mathfrak{k}}(\kappa\chi^2)\hbar_{\mathfrak{l}}(\kappa\chi^3)}{\sqrt{\mathfrak{i}!\,\mathfrak{j}!\,\mathfrak{k}!\,\mathfrak{l}!}\sqrt{\phi_\kappa(\overrightarrow{\mathfrak{x}})}} \right| \vec{\mathfrak{x}} = (\chi^0, \chi^1, \chi^2, \chi^3) \in \mathbb{R}^4 \mathfrak{i}, \mathfrak{j}, \mathfrak{k}, \mathfrak{l}, \ge 0 \right\}$$

$$\langle \sum_{1\le\alpha\le\beta\le4} \mathfrak{f}_{\alpha\beta} \otimes \mathfrak{d}\mathfrak{x}^{\alpha} \wedge \mathfrak{d}\mathfrak{x}^{\beta}, \sum_{1\le\alpha\le\beta\le4} \hat{\mathfrak{f}}_{\alpha\beta} \otimes \mathfrak{d}\mathfrak{x}^{\alpha} \wedge \mathfrak{d}\mathfrak{x}^{\beta} \rangle = \langle \mathfrak{f}_{\alpha\beta}, \hat{\mathfrak{f}}_{\alpha\beta} \rangle$$

$$\mathfrak{d}\mathfrak{f} = \sum_{\mathrm{i}=1}^{4} \partial_0 \mathfrak{f}_{\mathrm{i}} \otimes \mathfrak{d}\mathfrak{x}^0 \wedge \mathfrak{d}\mathfrak{x}^{\mathrm{i}} + \sum_{1\le\mathrm{i}\le\mathrm{j}\le4} (\partial_{\mathrm{i}} \mathfrak{f}_{\mathrm{j}} - \partial_{\mathrm{j}} \mathfrak{f}_{\mathrm{i}}) \mathfrak{d}\mathfrak{x}^{\mathrm{i}} \wedge \mathfrak{d}\mathfrak{x}^{\mathrm{j}} = \mathfrak{C}_{\gamma}^{\alpha\beta} = -\mathcal{T}\mathfrak{r}(\mathfrak{E}^{\gamma}(\mathfrak{E}^{\alpha}, \mathfrak{E}^{\beta})), \mathfrak{E}^{\alpha}, \mathfrak{E}^{\beta}, \mathfrak{E}^{\gamma} \in \mathfrak{g}$$

$$\mathfrak{d}\mathfrak{A} + \mathfrak{A} \wedge \mathfrak{A} = \sum_{\gamma=1}^{\eta} (\sum_{\mathrm{j}=1}^{4} \alpha_{0:\mathrm{i},\gamma} \otimes \mathfrak{d}\mathfrak{x}^0 \wedge \mathfrak{d}\mathfrak{x}^{\mathrm{j}} + \sum_{1\le\mathrm{i}\le\mathrm{j}\le4} \alpha_{\mathrm{i};\mathrm{j},\gamma} \otimes \mathfrak{d}\mathfrak{x}^{\mathrm{i}} \wedge \mathfrak{d}\mathfrak{x}^{\mathrm{j}}$$

$$+ \sum_{1\le\mathrm{i}\le\mathrm{j}\le4} \sum_{1\le\alpha,\beta\le\eta} \alpha_{\mathrm{i},\alpha}\, \alpha_{\mathrm{j},\beta} \mathfrak{C}_{\gamma}^{\alpha\beta} \otimes \mathfrak{d}\mathfrak{x}^{\mathrm{i}} \wedge \mathfrak{d}\mathfrak{x}^{\mathrm{j}}) \otimes \mathfrak{E}^{\gamma}$$

Cuya forma bilineal, se distribuye así:

$$\langle \sum_{\alpha} \mathfrak{F}_{\alpha} \otimes \mathfrak{d}\mathfrak{x}^{\alpha}, \sum_{\alpha} \mathfrak{G}_{\beta} \otimes \mathfrak{d}\mathfrak{x}^{\beta} \rangle_{\partial\kappa} = \kappa^4 \langle \frac{\partial}{\partial t}\left(\frac{i}{\hbar}\right) \sum_{\alpha} \mathfrak{F}_{\alpha} \otimes \mathfrak{d}\mathfrak{x}^{\alpha}, \sum_{\alpha} \mathfrak{G}_{\beta} \otimes \mathfrak{d}\mathfrak{x}^{\beta} \rangle$$

$$\psi_{\kappa} \colon \mathcal{H}_{\wp_{\mathfrak{R}}}(\kappa\mathfrak{x}^0, \kappa\mathfrak{x}^1, \kappa\mathfrak{x}^2, \kappa\mathfrak{x}^3)\sqrt{\phi_{\kappa}}/\sqrt{\wp_{\mathfrak{R}}!} \to \mathfrak{z}^{\mathfrak{p}_{\mathfrak{r}}}/\sqrt{\wp_{\mathfrak{R}}!} \equiv \mathfrak{z}_0^{i_0}\mathfrak{z}_1^{i_1}\mathfrak{z}_2^{i_2}\mathfrak{z}_3^{i_3}/\sqrt{i_0!\, i_1!\, i_2!\, i_3!}$$

Cuya isometría extendida, deriva en lo que sigue:

$$\psi_{\kappa}\left[\sum_{0\le\alpha\le\beta\le4} \mathfrak{F}_{\alpha,\beta} \otimes \mathfrak{d}\mathfrak{x}^{\alpha} \wedge \mathfrak{d}\mathfrak{x}^{\beta}\right] = \sum_{0\le\alpha\le\beta\le4} \psi_{\kappa} \left|\mathfrak{f}_{\alpha,\beta}\right| \otimes \mathfrak{d}\mathfrak{x}^{\alpha} \wedge \mathfrak{d}\mathfrak{x}^{\beta}$$

Ahora bien, un espacio abstracto de Wiener, se explica así:

$$\mu\kappa\left(\chi \in \mathfrak{P}^{-1}(\mathfrak{I})\right) = \left(\frac{\kappa}{2\varpi}\right)^{l/2} \int_{\mathfrak{y}\in\mathcal{F}}^{\infty} e^{-\kappa|\varphi|^2/\psi} \mathfrak{d}\mathfrak{y}$$

$$\left\{\hat{\mathfrak{z}}^{\mathfrak{p}_{\mathfrak{r}}} \frac{\otimes \mathfrak{d}\mathfrak{x}^{\alpha}}{|\hat{\mathfrak{z}}^{\mathfrak{p}_{\mathfrak{r}}} \otimes \mathfrak{d}\mathfrak{x}^{\alpha}|_{\partial\kappa}} : \rho_{\mathfrak{r}} \in \wp_{\mathfrak{r}}, \mathcal{R} \ge 0\right\}$$

$$\hat{\mathfrak{z}}^{\mathfrak{p}_{\mathfrak{r}}} \otimes \mathfrak{d}\mathfrak{x}^{\alpha} = \mathfrak{z}^{\mathfrak{p}_{\mathfrak{r}}} \otimes \mathfrak{d}\mathfrak{x}^{\alpha} - \frac{\sum_{\alpha=0}^{4} \langle \mathfrak{z}^{\mathfrak{p}_{\mathfrak{r}}} \otimes \mathfrak{d}\mathfrak{x}^{\alpha}, \frac{\mathfrak{z}^{\rho_{\tau}^{\alpha,-}} \otimes \mathfrak{d}\mathfrak{x}^{\alpha}}{\left|\mathfrak{z}^{\rho_{\tau}^{\alpha,-}} \otimes \mathfrak{d}\mathfrak{x}^{\alpha}\right|_{\partial\kappa}} \rangle \mathfrak{z}^{\rho_{\tau}^{\alpha,-}} \otimes \mathfrak{d}\mathfrak{x}^{\alpha}}{\left|\mathfrak{z}^{\rho_{\tau}^{\alpha,-}} \otimes \mathfrak{d}\mathfrak{x}^{\alpha}\right|_{\partial\kappa}} + \left|\mathfrak{z}^{\rho_{\tau}^{\alpha,-}} \otimes \mathfrak{d}\mathfrak{x}^{\alpha}\right|_{\partial\kappa_{\psi}}^{2} - \left|\mathfrak{z}^{\rho_{\tau}^{\alpha,-}} \otimes \mathfrak{d}\mathfrak{x}^{\alpha}\right|_{\partial\kappa}$$

$$+ \langle \frac{\mathfrak{z}^{\rho_{\tau}^{\alpha,-}} \otimes \mathfrak{d}\mathfrak{x}^{\alpha}}{\left|\mathfrak{z}^{\rho_{\tau}^{\alpha,-}} \otimes \mathfrak{d}\mathfrak{x}^{\alpha}\right|_{\partial\kappa}} \rangle_{\partial\kappa} \bowtie 4\kappa(\mathfrak{r}-1)\sqrt{\wp_{\mathfrak{R}}!} \cdot \frac{\frac{\frac{(\mathfrak{r}+1)}{2}}{\kappa\sqrt{\wp_{\mathfrak{R}}!}}}{\mathcal{R}^2}/2$$

$$\le 6\kappa(\mathfrak{r}-1)^2 \sum_{\alpha=1}^{4} \langle \frac{\mathfrak{z}^{\rho_{\tau}^{\alpha,-}} \otimes \mathfrak{d}\mathfrak{x}^{\alpha}}{\left|\mathfrak{z}^{\rho_{\tau}^{\alpha,-}} \otimes \mathfrak{d}\mathfrak{x}^{\alpha}\right|_{\partial\kappa}} \rangle_{\partial\kappa} \otimes \mathfrak{d}\mathfrak{x}^{\alpha}$$

$$\mu_\kappa(\|\mathcal{P}_b\chi\| > \epsilon) \leq \mu_\kappa\left(\sup_{\vec{\mathfrak{z}} \in \mathfrak{B}\left(\frac{0,1}{2}\right)}\right)\sum_{\mathfrak{s}}\sum_{\rho_\tau \geq \mathfrak{Q}^{\mathfrak{s}}} \mathbb{E}\left|\mathfrak{C}_{\mathfrak{s}}\alpha^{\mathfrak{s}}_{\rho_\tau,\mathfrak{B}}\right|^4 \left[|\mathfrak{z}^{\rho_\tau}| + 6\kappa(\mathfrak{r}+1)^2\sum_{\alpha=1}^{4}\left|\mathfrak{z}^{\rho_\tau^{\alpha,-}}\right| > \epsilon\right] 1/\sqrt{\kappa\epsilon}$$

$$|\langle\chi(\omega), \mathfrak{d}\mathfrak{x}^\alpha\rangle| \leq \left|\sum_\tau \sum_{\rho_\tau \in \mathfrak{q}_\tau} \mathfrak{C}_{\rho_\tau,\alpha}\widehat{\omega}^{\rho_\tau}/|\widehat{\omega}^{\rho_\tau}\otimes\mathfrak{d}\mathfrak{x}^\alpha|_{\partial\kappa}\right|$$

$$\leq \mathfrak{R}^{\mathfrak{M}}\sum_{\tau\leq\mathcal{M}}\sum_{\rho_\tau\in\mathfrak{q}_\tau}\left|\mathfrak{C}_{\rho_\tau,\alpha}\right| \|\omega/\mathfrak{R}\|^{\rho_\tau} + 6\kappa(\mathfrak{r}+1)^2\sum_{\alpha=1}^{4}\|\omega/\mathfrak{R}\|^{\rho_\tau^{\alpha,-}} 2\mathcal{R}^{\mathfrak{J}} + 1/\kappa\sqrt{\wp_{\mathfrak{R}}!}\,\|\chi\|$$

$$\left|\langle\kappa\partial\mathfrak{x}(\omega), \mathfrak{d}\mathfrak{x}^\alpha\wedge\mathfrak{d}\mathfrak{x}^\beta\rangle\right| \leq \kappa\left|\sum_\tau\sum_{\rho_\tau\in\mathfrak{q}_\tau}\frac{\mathfrak{C}_{\rho_\tau,\beta}\partial_\beta\widehat{\omega}^{\rho_\tau}}{|\widehat{\omega}^{\rho_\tau}\otimes\mathfrak{d}\mathfrak{x}^\beta|_{\partial\kappa}}\right| + \kappa\left|\sum_\tau\sum_{\rho_\tau\in\mathfrak{q}_\tau}\frac{\mathfrak{C}_{\rho_\tau,\alpha}\partial_\beta\widehat{\omega}^{\rho_\tau}}{|\widehat{\omega}^{\rho_\tau}\otimes\mathfrak{d}\mathfrak{x}^\alpha|_{\partial\kappa}}\right|$$

$$\leq \mathfrak{R}^{\mathcal{M}}\sum_{\tau\leq\mathcal{M}}\sum_{\rho_\tau\in\mathfrak{q}_\tau}\frac{\left|\mathfrak{C}_{\rho_\tau,\beta}\right| + \left|\mathfrak{C}_{\rho_\tau,\alpha}\right|\partial_\beta\widehat{\omega}^{\rho_\tau}}{|\widehat{\omega}^{\rho_\tau}\otimes\mathfrak{d}\mathfrak{x}^\alpha|_{\partial\kappa}}\left|\frac{\omega}{\mathcal{R}}\right|^{\rho_\tau}$$

$$+ +6\kappa(\mathfrak{r}+1)^2\sum_{\alpha=1}^{4}\left|\frac{\omega}{\mathcal{R}}\right|^{\rho_\tau^{\alpha,-}} 4(\mathfrak{r}+1)\mathcal{R}^{\mathfrak{J}}/\sqrt{\wp_{\mathfrak{R}}!}$$

$$< \left(\mathcal{R}^{\mathcal{M}}+1\right)\|\mathfrak{z}\|^{\aleph}\mathcal{g}_{\mathfrak{i}}\otimes\mathfrak{d}\mathfrak{x}^{\mathfrak{i}} \in \mathcal{H}^2(\mathbb{C}^4)\otimes\Lambda^2(\mathbb{R}^4) \to \psi_\kappa\left|\partial_\alpha\mathcal{g}_\beta - \partial_\beta\mathcal{g}_\alpha\right|$$

$$\left|(\omega+\omega_0)^{\rho_\tau} - \omega_0^{\rho_\tau}\right|$$

$$+ 6\kappa(\mathfrak{r}+1)^2\sum_{\alpha=1}^{4}\left|(\omega+\omega_0)^{\rho_\tau^{\alpha,-}} - \right|\omega_0^{\rho_\tau^{\alpha,-}}\langle\leq\mathfrak{R}^\tau|\omega\rangle\left(\sup_{\omega\in\mathfrak{B}(0,\epsilon)}\right)|\langle\mathfrak{x}(\omega+\omega_0)$$

$$-\rangle\mathfrak{x}(\omega_0), \mathfrak{d}\mathfrak{x}^\alpha|$$

$$\leq \left(\sup_{\omega\in\mathfrak{B}(0,\epsilon)}\right)\sum_\tau\sum_{\rho_\tau\in\mathfrak{P}_\tau}\left|\mathfrak{C}_{\rho_\tau}\right|\left|2\widehat{(\omega+\omega_0)}^{\rho_\tau} - \widehat{\omega}_0^{\rho_\tau}\right|\kappa\sqrt{\wp_{\mathfrak{R}}!}$$

$$+ \frac{\left(\sup_{\omega\in\mathfrak{B}(0,\epsilon)}\right)\sum_{\alpha=1}^{4}\sum_\tau\sum_{\rho_\tau\in\mathfrak{P}_\tau}\left|\mathfrak{C}_{\rho_\tau}\right|\left|6\kappa(\mathfrak{r}+1)^2\cdot 2\left|\widehat{(\omega+\omega_0)}^{\rho_\tau} - \widehat{\omega}_0^{\rho_\tau}\right|\right|}{\sqrt{\kappa\wp_{\mathfrak{R}}!}}$$

$$\leq \frac{\frac{4}{\kappa\left(\sup_{\omega\in\mathfrak{B}(0,\epsilon)}\right)\sum_\tau\sum_{\rho_\tau\in\mathfrak{P}_\tau}\left|\mathfrak{C}_{\rho_\tau}\right|\left|(4^\tau\mathcal{R}^\tau|\omega|\right|}}{\kappa\sqrt{\wp_{\mathfrak{R}}!}}$$

$$+ 2\kappa\left(\sup_{\omega\in\mathfrak{B}(0,\epsilon)}\right)\sum_{\alpha=1}^{4}\sum_\tau\sum_{\rho_\tau\in\mathfrak{P}_\tau}\frac{6\kappa(\mathfrak{r}+1)^2}{2^{\tau-2}\left|\mathfrak{C}_{\rho_\tau}\right|}\left(2^{\tau-2}\,\mathfrak{R}^{\tau-2}|\omega|\right)/\kappa\sqrt{\wp_{\mathfrak{R}}!}$$

$$\leq 2\mathfrak{C}(\omega_0)/\kappa\cdot\epsilon|\chi|$$

$$\widetilde{\mu_\kappa}\left(\left(\sup_{\omega \in \mathfrak{B}\left(\omega_0, \frac{1}{\kappa}\right)}\right)|\mathfrak{x}(\omega+\omega_0)-\mathfrak{x}(\omega_0), \mathfrak{d}\mathfrak{x}^\alpha| > \epsilon\right)$$

$$= \widetilde{\mu_\kappa}\left(\left(\sup_{\omega \in \mathfrak{B}\left(\omega_0, \frac{1}{\kappa}\right)}\right)|\mathfrak{x}, \zeta_\alpha(\omega+\omega_0)-\zeta_\alpha(\omega_0), \mathfrak{d}\mathfrak{x}^\alpha| > \epsilon\right) \leq \widetilde{\mu_\kappa}\left(\frac{2\mathfrak{C}(\omega_0)}{\kappa\mathfrak{k}\|\mathfrak{x}\|} > \epsilon\right)$$

$$\to 0$$

$$\left\langle \frac{\partial_\alpha \mathfrak{z}_\alpha^\eta}{\sqrt{\eta!}}, \frac{\partial_\beta \mathfrak{z}_\beta^\eta}{\sqrt{\eta!}} \right\rangle \geq \eta + \frac{1}{4\left\langle \frac{\partial_\alpha \mathfrak{z}_\alpha^{\eta+1}}{\sqrt{\eta+1!}}, \frac{\partial_\beta \mathfrak{z}_\beta^{\eta+1}}{\sqrt{\eta+1!}} \right\rangle}$$

Siendo la integral de Yang – Mills, la siguiente:

$$\frac{1}{3}\int_{\mathfrak{A}}^{\infty} \mathrm{e}^{\int_{\mathbb{C}}^{\infty} \sum_{j=1}^{4} \mathfrak{A}_j \otimes \mathfrak{d}x^j \otimes \mathrm{i}}\, \mathfrak{E}^{-|\mathfrak{d}\mathfrak{A}|^2/2} \mathfrak{D}\mathfrak{A}, \mathrm{i} = \sqrt{-1}$$

$$\frac{1}{3}\mathrm{e}^{-\frac{1}{2\int_{\mathbb{R}^4}^{\infty}|\mathfrak{d}\mathfrak{A}+\mathfrak{A}\wedge\mathfrak{A}|^4 \mathfrak{d}\omega}} \mathcal{D}(\mathfrak{d}\mathfrak{A})$$

$$3 = \int_{\{\mathfrak{d}\mathfrak{A}:\mathfrak{A}\in\mathfrak{S}_\kappa(\mathbb{R}^4)\otimes\Lambda^1(\mathbb{R}^4)\mathfrak{g}\}}^{\infty} \mathrm{e}^{-\frac{1}{2\int_{\mathbb{R}^4}^{\infty}|\mathfrak{d}\mathfrak{A}+\mathfrak{A}\wedge\mathfrak{A}|^4 \mathfrak{d}\omega}} \mathcal{D}(\mathfrak{d}\mathfrak{A})$$

$$\frac{1}{3}\mathrm{e}^{-\frac{1}{2\int_{\mathbb{C}^4}^{\infty}|\kappa\mathfrak{d}\mathfrak{A}+\mathfrak{A}\wedge\mathfrak{A}|^4 \mathfrak{d}\lambda_4}} \mathcal{D}(\mathfrak{d}\mathfrak{A})$$

$$3 = \int_{\{\mathfrak{d}\mathfrak{A}:\mathfrak{A}\in\mathcal{H}^2(\mathbb{C}^4)\otimes\Lambda^1(\mathbb{R}^4)\otimes\mathfrak{g}\}}^{\infty} \mathrm{e}^{-\frac{1}{2\int_{\mathbb{C}^4}^{\infty}|\kappa\mathfrak{d}\mathfrak{A}+\mathfrak{A}\wedge\mathfrak{A}|^4 \mathfrak{d}\lambda_4}} \mathcal{D}(\mathfrak{d}\mathfrak{A})$$

$$\mathbb{H} = \left\{(\mathfrak{d}_0\mathcal{H}^2(\mathbb{C}^4)) \otimes \left(*\,\Lambda^2(\mathbb{R}^4)\right)\right\} \oplus \{\mathcal{H}^2(\mathbb{C}^4)\otimes\Lambda^2(\mathbb{R}^4)\} \subset \mathcal{H}^2(\mathbb{C}^4)\otimes\Lambda^2(\mathbb{R}^4)$$

$$\frac{1}{3}\mathrm{e}^{-\frac{1}{2\int_{\mathbb{C}^4}^{\infty}|\kappa\mathfrak{d}\mathfrak{A}+\mathfrak{A}\wedge\mathfrak{A}|^4 \mathfrak{d}\lambda_4}} \mathcal{D}(\mathfrak{d}\mathfrak{A}) = \frac{\mathcal{Y}^\kappa \mathfrak{d}\hat{\mu}_{\kappa^2}^{\times\eta}}{\int_{\mathbb{B}\otimes\mathfrak{g}}^{\infty} \mathcal{Y}^\kappa \mathfrak{d}\hat{\mu}_{\kappa^2}^{\times\eta}} = \frac{\mathcal{Y}^\kappa \mathfrak{d}\hat{\mu}_{\kappa^2}^{\times\eta}}{\mathbb{E}|\mathcal{Y}^\kappa|}$$

$$\mathbb{E}_{\mathcal{YM}}^{\kappa}[\mathcal{R}]^{\mathfrak{R}} = 1/\int_{\mathbb{B}\otimes\mathfrak{g}}^{\infty} \mathcal{Y}^\kappa \mathfrak{d}\hat{\mu}_{\kappa^2}^{\times\eta} \int_{\mathbb{B}\otimes\mathfrak{g}}^{\infty} \mathfrak{I}\mathcal{Y}^\kappa \mathfrak{d}\hat{\mu}_{\kappa^2}^{\times\eta}$$

$$\int_{\mathbb{R}^4}^{\infty} |\mathfrak{d}\mathfrak{A} + \mathfrak{A}\wedge\mathfrak{A}|^4 \ \mathfrak{d}\omega \sum_{1\leq \mathfrak{i}\leq \mathfrak{j}\leq 4} \int_{\mathbb{R}^4}^{\infty} (\sum_{\alpha=1}^{\eta} \alpha_{\mathfrak{i};\mathfrak{j},\alpha}^2 + \sum_{\gamma=1}^{\eta} \sum_{\substack{\alpha,\beta \\ \widehat{\alpha},\widehat{\beta}}} \alpha_{\mathfrak{i},\alpha}\, \alpha_{\mathfrak{j},\beta} \alpha_{\mathfrak{i},\widehat{\alpha}} \alpha_{\mathfrak{j},\widehat{\beta}} \mathfrak{C}_{\gamma}^{\alpha\beta} \mathfrak{C}_{\gamma}^{\widehat{\alpha}\widehat{\beta}}$$

$$+ 2 \sum_{\gamma=1}^{\eta} \sum_{\substack{\alpha,\beta \\ \widehat{\alpha},\widehat{\beta}}} \alpha_{\mathfrak{i};\mathfrak{j},\gamma} \alpha_{\mathfrak{i},\alpha} \alpha_{\mathfrak{j},\beta} \mathfrak{C}_{\gamma}^{\alpha\beta}) \mathfrak{d}\omega + \sum_{\mathfrak{i};\mathfrak{j}=1}^{4} \int_{\mathbb{R}^4}^{\infty} \sum_{\alpha=1}^{\eta} \alpha_{0:\mathfrak{j},\alpha}^2 \ \mathfrak{d}\omega$$

$$\exp\left[-1/2 \sum_{\alpha=1}^{\eta} \int_{\mathbb{R}^4}^{\infty} \mathfrak{d}\omega \sum_{1\leq \mathfrak{i}\leq \mathfrak{j}\leq 4} \int_{\mathbb{R}^4}^{\infty} \alpha_{\mathfrak{i};\mathfrak{j},\alpha}^2 + \sum_{\mathfrak{i};\mathfrak{j}=1}^{4} \int_{\mathbb{R}^4}^{\infty} \alpha_{0:\mathfrak{j},\alpha}^2 \right] \mathcal{D}(\mathfrak{d}\mathfrak{A})$$

Más, usando el teorema de Stokes, obtenemos:

$$\frac{1}{3} \int_{\mathfrak{A}}^{\infty} \mathrm{e}^{\int_{\mathbb{S}}^{\infty} \mathfrak{d}\mathfrak{A}\otimes \mathfrak{i}}\, \mathfrak{E}^{-|\mathfrak{d}\mathfrak{A}|^2/2} \mathfrak{D}\mathfrak{A}$$

$$\frac{1}{3} \int_{\mathfrak{A}\in \mathcal{H}^2(\mathbb{C}^4)\otimes \Lambda^2(\mathbb{R}^4)}^{\infty} \mathrm{e}^{\mathfrak{I} \int_{\mathbb{S}}^{\infty} \kappa \partial \mathfrak{A}}\, \mathrm{e}^{-|\kappa \partial \mathfrak{A}|^2/2} \mathfrak{D}\mathfrak{A}$$

$$\nu_{\mathfrak{s}}^{\kappa} = \int_{\mathfrak{I}^2}^{\infty} \mathfrak{d}\mathfrak{s}\mathfrak{d}\mathfrak{t} \sum_{0\leq \alpha\leq \beta\leq 4} \frac{\kappa^2}{4} |\mathfrak{I}_{\alpha\beta}^{\sigma}|(\mathfrak{s},\mathfrak{t}) \xi_{\alpha\beta}^{\kappa} \left(\frac{\kappa\sigma(\mathfrak{s},\mathfrak{t})}{2} \right)$$

$$\Upsilon(\mathbb{R}^4, \kappa; \mathfrak{S}, \mathfrak{i}) = \mathbb{E}_{\mathfrak{Y}\mathfrak{M}} \left(\exp(\frac{1}{\kappa}(\cdot, \nu_{\mathfrak{s}}^{\kappa})) \right) = \int_{\mathfrak{A}\in \mathfrak{B}(\mathbb{R}^4;\partial)}^{\infty} \left(\exp(\frac{1}{\kappa}(\mathfrak{A}, \nu_{\mathfrak{s}}^{\kappa}\otimes \mathfrak{i})) \right) \mathfrak{d}\tilde{\mu}(\mathfrak{A})$$

$$\mathbb{E}_{\mathfrak{Y}\mathfrak{M}} = (\exp(\frac{1}{\kappa} \sum_{0\leq \alpha\leq \beta\leq 4} \int_{\mathfrak{I}^2}^{\infty} \frac{\kappa^2}{4} |\mathfrak{I}_{\alpha\beta}^{\sigma}|(\mathfrak{s},\mathfrak{t}) \left(\cdot, \xi_{\alpha\beta}^{\kappa} \left(\frac{\kappa\sigma(\mathfrak{s},\mathfrak{t})}{2} \right) \otimes \mathfrak{i} \right) \mathfrak{d}\mathfrak{s}\mathfrak{d}\mathfrak{t}))$$

$$= \exp\left(-1/2 \left| \frac{\sum_{0\leq \alpha\leq \beta\leq 4} \int_{\mathfrak{I}^2}^{\infty} \mathfrak{d}\mathfrak{s}\mathfrak{d}\mathfrak{t}\, \kappa}{4} |\mathfrak{I}_{\alpha\beta}^{\sigma}|(\mathfrak{s},\mathfrak{t}) \xi_{\alpha\beta}^{\kappa} \left(\frac{\kappa\sigma(\mathfrak{s},\mathfrak{t})}{2} \right) \right|_{\partial,\kappa}^{2} \right)$$

$$\rightarrow \exp\ (-1/8 \int_{\mathfrak{S}}^{\infty} \rho_{\mathfrak{S}})$$

$$\psi_{\omega} = \psi(\omega) = \frac{\mathrm{e}^{-\frac{|\omega|^2}{2}}}{\sqrt{2\varpi}} = \langle \psi_{\omega}\chi_{\omega}, \psi_{\nu}\chi_{\nu} \rangle = \psi_{\omega}\psi_{\nu}\mathrm{e}^{\omega\nu} = \frac{1}{2\varpi} \mathrm{e}^{-|\omega-\nu|^2/2}$$

$$\langle \sum_{\mathfrak{i}=1}^{4}\sum_{\tau}\sum_{\rho_\tau}\mathfrak{C}_{\rho_\tau},\mathfrak{i}3^{\rho_\tau}\otimes\mathfrak{d}\mathfrak{x}^{\mathfrak{i}},\xi_{\alpha\beta}^{\kappa}(\omega)\rangle_{\partial,\kappa}=\kappa^2\langle\partial\sum_{\mathfrak{i}=1}^{4}\sum_{\tau}\sum_{\rho_\tau}\mathfrak{C}_{\rho_\tau},\mathfrak{i}3^{\rho_\tau}\otimes\mathfrak{d}\mathfrak{x}^{\mathfrak{i}},\partial\xi_{\alpha\beta}^{\kappa}(\omega)\rangle$$

$$=\kappa\sum_{\tau}\sum_{\rho_\tau}\psi(\omega)(\mathfrak{C}_{\rho_\tau,\beta}\partial_\alpha\omega^{\rho_\tau}-\mathfrak{C}_{\rho_\tau,\alpha}\partial_\beta\omega^{\rho_\tau})$$

$$\exp(-(\frac{1}{\kappa}\sum_{0\le\alpha\le\beta\le4}\int_{\mathfrak{J}^2}^{\infty}\mathfrak{d}\mathfrak{s}\mathfrak{d}\mathfrak{t}\left|\mathfrak{J}_{\alpha\beta}^{\sigma}\right|(\mathfrak{s},\mathfrak{t})\frac{\kappa^2}{4}\xi_{\alpha\beta}^{\kappa}\left(\frac{\kappa\sigma(\mathfrak{s},\mathfrak{t})}{2}\right))_{\partial,\kappa}^{2}/2)$$

$$=\exp\ (1/2\sum_{0\le\alpha\le\beta\le4}\int_{\mathfrak{J}^2.\mathfrak{J}^2}^{\infty}\mathfrak{d}\mathfrak{s}\mathfrak{d}\mathfrak{t}\mathfrak{d}\bar{\mathfrak{s}}\mathfrak{d}\bar{\mathfrak{t}}\frac{\kappa^2}{16}\left|\mathfrak{J}_{\alpha\beta}^{\sigma}\right|(\mathfrak{s},\mathfrak{t})\left|\mathfrak{J}_{\alpha\beta}^{\sigma}\right|(\bar{\mathfrak{s}},\bar{\mathfrak{t}})\kappa^2\langle\partial\xi_{\alpha\beta}^{\kappa}\left(\frac{\kappa\sigma(\mathfrak{s},\mathfrak{t})}{2}\right),\partial\xi_{\alpha\beta}^{\kappa}\left(\frac{\kappa\sigma(\bar{\mathfrak{s}},\bar{\mathfrak{t}})}{2}\right)\rangle$$

$$=\exp(-1/8(2\pi)\sum_{0\le\alpha\le\beta\le4}\int_{\mathfrak{J}^2.\mathfrak{J}^2}^{\infty}\mathfrak{d}\mathfrak{s}\mathfrak{d}\mathfrak{t}\mathfrak{d}\bar{\mathfrak{s}}\mathfrak{d}\bar{\mathfrak{t}}\frac{\kappa^2}{4}\left|\mathfrak{J}_{\alpha\beta}^{\sigma}\right|(\mathfrak{s},\mathfrak{t})\left|\mathfrak{J}_{\alpha\beta}^{\sigma}\right|(\bar{\mathfrak{s}},\bar{\mathfrak{t}})\mathfrak{e}^{-\frac{\kappa^2|\sigma(\mathfrak{s},\mathfrak{t})-\sigma(\bar{\mathfrak{s}},\bar{\mathfrak{t}})|^2}{8}})$$

$$\rightarrow\exp\ (-1/8\sum_{0\le\alpha\le\beta\le4}\int_{\mathfrak{J}^2}^{\infty}\mathfrak{d}\mathfrak{s}\mathfrak{d}\mathfrak{t}\left|\mathfrak{J}_{\alpha\beta}^{\sigma}\right|(\mathfrak{s},\mathfrak{t})\rho_{\mathfrak{S}}^{\alpha\beta}(\sigma(\mathfrak{s},\mathfrak{t})))=\mathfrak{e}^{-1/8\int_{\mathfrak{S}}^{\infty}\rho_{\mathfrak{S}}}$$

Campo Cuántico no Abeliano

En campos cuánticos no abelianos y bajo operadores holonómicos y por algebra de Lie, obtenemos:

$$\mathcal{T}=\int_{\mathfrak{A}}^{\infty}\mathfrak{e}^{\int_{\mathfrak{C}}^{\infty}\sum_{\mathfrak{i}=1}^{4}\mathfrak{A}_{\mathfrak{i}}\otimes\mathfrak{d}\mathfrak{x}^{\mathfrak{i}}}\mathfrak{e}^{-1/2|\mathrm{F}|^2}\mathfrak{D}\mathfrak{A}$$

$$\mathcal{T}\exp(\int_{\mathfrak{C}}^{\infty}\sum_{\mathfrak{i}=1}^{4}\mathfrak{A}_{\mathfrak{i}}\otimes\mathfrak{d}\mathfrak{x}^{\mathfrak{i}})=\mathcal{T}\exp(\sum_{\mathfrak{i}}\int_{\mathfrak{C}\mathfrak{i}}^{\infty}\sum_{\mathfrak{j}=1}^{4}\mathfrak{A}_{\mathfrak{j}}\otimes\mathfrak{d}\mathfrak{x}^{\mathfrak{j}})=\mathcal{T}\bigotimes i\exp(\int_{\mathfrak{C}\mathfrak{i}}^{\infty}\sum_{\mathfrak{j}=1}^{4}\mathfrak{A}_{\mathfrak{j}}\otimes\mathfrak{d}\mathfrak{x}^{\mathfrak{j}})=\mathcal{T}\bigotimes i\ (\mathfrak{J}$$

$$+\sum_{\alpha}|\mathrm{F}_\alpha\mathbb{E}^\alpha|(\mathfrak{S}_{\mathfrak{i}})\Delta_{\mathfrak{i}}\mathfrak{S}^2+\mathcal{O}(\Delta_{\mathfrak{i}}\mathfrak{S}^3))$$

$$=\mathcal{T}\bigotimes i\exp(\log(\mathfrak{J}$$

$$+\sum_{\alpha}|\mathrm{F}_\alpha\mathbb{E}^\alpha|(\mathfrak{S}_{\mathfrak{i}})\Delta_{\mathfrak{i}}\mathfrak{S}^2+\mathcal{O}(\Delta_{\mathfrak{i}}\mathfrak{S}^3)))=\mathcal{T}\exp(\sum_{\mathfrak{i}}\sum_{\alpha}|\mathrm{F}_\alpha\mathbb{E}^\alpha|(\mathfrak{S}_{\mathfrak{i}})\Delta_{\mathfrak{i}}\mathfrak{S}^2+\mathcal{O}(\Delta_{\mathfrak{i}}\mathfrak{S}^3))$$

$$\longrightarrow\mathcal{T}\exp(\int_{\mathfrak{S}}^{\infty}\sum_{\alpha}\mathrm{F}_\alpha\mathbb{E}^\alpha$$

Cuyo operador de translación en curvatura, es la que sigue:

$$\mathfrak{A}_{0}^{1-}\mathfrak{A}_{1-}^{1}\cdot\mathfrak{A}_{0+}^{1}\cdot\overrightarrow{\prod_{\mathfrak{i}=2}^{\eta}}\mathfrak{A}_{0}^{\mathfrak{i}-}\cdot\mathfrak{A}_{1-}^{\eta}\cdot\overrightarrow{\prod_{\mathfrak{i}=2}^{\eta}}\mathfrak{A}_{\mathfrak{i}-}^{\eta}\cdot\overleftarrow{\prod_{\mathfrak{i}=0}^{\eta-1}}\mathfrak{A}_{\eta}^{\mathfrak{i}+}\cdot\overleftarrow{\prod_{\mathfrak{i}=0}^{\eta-1}}\mathfrak{A}_{\mathfrak{i}+}^{0}$$

$$=\overrightarrow{\prod_{\mathfrak{i}=1}^{\eta}}\mathfrak{A}_{0}^{\mathfrak{i}-}\cdot\overrightarrow{\prod_{\mathfrak{i}=1}^{\eta}}\mathfrak{A}_{\mathfrak{i}-}^{\eta}\cdot\overleftarrow{\prod_{\mathfrak{i}=0}^{\eta-1}}\mathfrak{A}_{\eta}^{\mathfrak{i}+}\cdot\overleftarrow{\prod_{\mathfrak{i}=0}^{\eta-1}}\mathfrak{A}_{\mathfrak{i}+}^{0}$$

En el que, la curvatura, se expresa así:

$$\mathfrak{A}_{\mathfrak{i}}^{(\mathfrak{j}+1)-}\mathfrak{A}_{(\mathfrak{i}+1)-}^{\mathfrak{j}+1-}\mathfrak{A}_{\mathfrak{i}+1}^{\mathfrak{j}+}\mathfrak{A}_{\mathfrak{i}+}^{\mathfrak{j}}\mathfrak{U}_{\mathfrak{i}}^{\mathfrak{j}}=\mathfrak{U}_{\mathfrak{i}}^{\mathfrak{j}}+\epsilon^{2}\sum_{0\leq\alpha\leq\beta\leq4}\left\langle\mathfrak{J}_{\alpha\beta}^{\sigma}\middle|\Omega_{\mathfrak{i},\alpha\beta}^{\mathfrak{j}}\right\rangle\left(\sigma^{\dagger}\left(\frac{\mathfrak{i}}{\eta},\frac{\mathfrak{j}}{\eta}\right),\dot{\sigma}\left(\frac{\mathfrak{i}}{\eta},\frac{\mathfrak{j}}{\eta}\right)\right)\mathfrak{U}_{\mathfrak{i}}^{\mathfrak{j}}+\mathcal{O}(\epsilon^{4})$$

$$=\mathfrak{U}_{\mathfrak{i}}^{\mathfrak{j}}+\epsilon^{2}\mathfrak{U}_{\mathfrak{i}}^{\mathfrak{j}}\mathfrak{J}\Omega_{\mathfrak{i}}^{\mathfrak{j}}+\mathcal{O}(\epsilon^{4})\boxtimes_{\mathfrak{i}}^{\mathfrak{j}}$$

$$\mathfrak{A}_{\mathfrak{i}}^{(\mathfrak{j}+1)-}\mathfrak{A}_{(\mathfrak{i}+1)-}^{\mathfrak{j}+1}\mathfrak{A}_{\mathfrak{i}+1}^{\mathfrak{j}+}\mathfrak{A}_{\mathfrak{i}+}^{\mathfrak{j}}\cdot\mathfrak{A}_{(\mathfrak{i}+1)-}^{\mathfrak{j}}\mathfrak{U}_{\mathfrak{i}+1}^{\mathfrak{j}}\overrightarrow{\prod_{\kappa=\mathfrak{i}+1}^{\eta-1}}(1+\epsilon^{2}\mathfrak{J}\Omega_{\kappa}^{\mathfrak{j}}+\mathcal{O}(\epsilon^{4})\boxtimes_{\kappa}^{\mathfrak{j}})$$

$$=\mathfrak{A}_{\mathfrak{i}}^{(\mathfrak{j}+1)-}\mathfrak{A}_{(\mathfrak{i}+1)-}^{\mathfrak{j}+1}\mathfrak{A}_{\mathfrak{i}+1}^{\mathfrak{j}+}\mathfrak{A}_{\mathfrak{i}+}^{\mathfrak{j}}\mathfrak{U}_{\mathfrak{i}}^{\mathfrak{j}}\overrightarrow{\prod_{\kappa=\mathfrak{i}+1}^{\eta-1}}\left(1+\epsilon^{2}\mathfrak{J}\Omega_{\kappa}^{\mathfrak{j}}+\mathcal{O}(\epsilon^{4})\boxtimes_{\kappa}^{\mathfrak{j}}\right)$$

$$=\mathfrak{U}_{\mathfrak{i}}^{\mathfrak{j}}(1+\epsilon^{2}\mathfrak{J}\Omega_{\kappa}^{\mathfrak{j}}+\mathcal{O}(\epsilon^{4})\boxtimes_{\kappa}^{\mathfrak{j}})$$

$$\widetilde{\mathfrak{U}}_{1}^{\mathfrak{j}+1}=\widetilde{\mathfrak{A}}_{1}^{\mathfrak{j}+}\widetilde{\mathfrak{U}}_{1}^{\mathfrak{j}+}\cdot\overrightarrow{\prod_{\kappa=1}^{\eta-1}}(1+\mathfrak{J}\Omega_{\kappa}^{\mathfrak{j}+1}\epsilon^{2}+\mathcal{O}(\epsilon^{4})\boxtimes_{\kappa}^{\mathfrak{j}})$$

$$=\widetilde{\mathfrak{A}}_{1}^{\mathfrak{j}+}\cdot\overleftarrow{\prod_{\mathfrak{l}=0}^{\mathfrak{j}-1}}\widetilde{\mathfrak{A}}_{1}^{\mathfrak{l}+}.\widetilde{\mathfrak{A}}_{0+}^{0}\mu_{0}\overleftarrow{\prod_{\mathfrak{l}=0}^{\mathfrak{j}}}\widetilde{\mathfrak{A}}_{1}^{\mathfrak{l}+}\overrightarrow{\prod_{\kappa=1}^{\eta-1}}\left(1+\epsilon^{2}\mathfrak{J}\Omega_{\kappa}^{\mathfrak{l}}+\mathcal{O}(\epsilon^{4})\boxtimes_{\kappa}^{\mathfrak{l}}\right)$$

$$\cdot\overrightarrow{\prod_{\kappa=1}^{\eta-1}}\left(1+\mathfrak{J}\Omega_{\kappa}^{\mathfrak{j}+1}\epsilon^{2}+\mathcal{O}(\epsilon^{4})\boxtimes_{\kappa}^{\mathfrak{j}}\right)$$

$$=\overleftarrow{\prod_{\mathfrak{l}=0}^{\mathfrak{j}}}\widetilde{\mathfrak{A}}_{1}^{\mathfrak{l}+}.\widetilde{\mathfrak{A}}_{0+}^{0}\mu_{0}\overleftarrow{\prod_{\mathfrak{l}=0}^{\mathfrak{j}+1}}\widetilde{\mathfrak{A}}_{1}^{\mathfrak{l}+}\overrightarrow{\prod_{\kappa=1}^{\eta-1}}\left(1+\epsilon^{2}\mathfrak{J}\Omega_{\kappa}^{\mathfrak{l}}+\mathcal{O}(\epsilon^{4})\boxtimes_{\kappa}^{\mathfrak{l}}\right)$$

$$\mathcal{T}e^{\int_{\mathcal{C}}^{\infty}\mathcal{A}}\mu_{0}=\mu_{0}\overrightarrow{\prod_{\mathfrak{l}=0}^{\eta-1}}\left(1+\epsilon^{2}\mathfrak{J}\widehat{\Omega}_{\kappa}^{\mathfrak{l}}+\mathcal{O}(\epsilon^{4})\boxtimes_{\kappa}^{\mathfrak{l}}\right).\overleftarrow{\prod_{\kappa=1}^{\eta-1}}\left(1+\epsilon^{2}\mathfrak{J}\Omega_{\kappa}^{\mathfrak{l}}+\mathcal{O}(\epsilon^{4})\boxtimes_{\kappa}^{\mathfrak{l}}\right)$$

$$=\mu_{0}\overrightarrow{\prod_{\mathfrak{l}=0}^{\eta-1}}\mathrm{e}^{\epsilon^{2}\mathfrak{J}\widehat{\Omega}_{\kappa}^{\mathfrak{l}}+\mathcal{O}(\epsilon^{4})\boxtimes_{\kappa}^{\mathfrak{l}}}\cdot\overleftarrow{\prod_{\mathfrak{l}=0}^{\eta-1}\overrightarrow{\prod_{\kappa=1}^{\eta-1}}\mathrm{e}^{\epsilon^{2}\mathfrak{J}\widehat{\Omega}_{\kappa}^{\mathfrak{l}}+\mathcal{O}(\epsilon^{4})\boxtimes_{\kappa}^{\mathfrak{l}}}}$$

$$\longrightarrow\mu_{0}\cdot\tilde{\mathcal{T}}\exp(\int_{\mathfrak{J}^{2}}^{\infty}\sum_{0\leq\alpha\leq\beta\leq4}\mathfrak{J}_{\alpha\beta}^{\sigma}(\mathfrak{s},\mathfrak{t})\Omega_{\beta}^{\alpha}(\mathfrak{s},\mathfrak{t})\mathfrak{d}\mathfrak{s}\mathfrak{d}\mathfrak{t})$$

Por lo que, finalmente la integral de Yang – Mills, equivale a lo que sigue:

$$\exp -1/2(\int_{\mathbb{C}^4}^{\infty} \mathfrak{d}\lambda_4 \, |\kappa\partial\mathfrak{A} + \mathfrak{A}\wedge\mathfrak{A}|^2)\mathfrak{D}\mathfrak{A}$$

$$= \exp(-1/2 \int_{\mathbb{C}^4}^{\infty} \mathfrak{d}\lambda_4 \, |\kappa\partial\mathfrak{A} + \mathfrak{A}\wedge\mathfrak{A}| + \langle \mathfrak{A}\wedge\mathfrak{A}, \kappa\partial\mathfrak{A}\rangle$$

$$+ \langle \mathfrak{A}\wedge\mathfrak{A}\rangle^2) \exp(-1/2 \int_{\mathbb{C}^4}^{\infty} \mathfrak{d}\lambda_4 \, |\kappa\partial\mathfrak{A}|^2)\mathfrak{D}\mathfrak{A}$$

$$\langle \kappa\partial\mathfrak{A}(\omega), \mathfrak{d}\mathfrak{x}^{\alpha}\wedge\mathfrak{d}\mathfrak{x}^{\beta}\rangle = \left(\mathfrak{A}, \tilde{\xi}^{\kappa}_{\alpha\beta}(\omega)\right) = \{\mathfrak{A}_{\mathrm{i}}\mathfrak{A}_{\mathrm{j}}\}(\omega) = \mathfrak{A}_{\mathrm{i}}(\omega)\mathfrak{A}_{\mathrm{j}}(\omega) = \left(\mathfrak{A}\otimes\mathfrak{A}, \zeta_{\mathrm{i}}(\omega) \otimes \mathfrak{A}, \zeta_{\mathrm{j}}(\omega)\right)$$

$$= \{\mathfrak{A}_{\mathrm{i},\alpha}\mathfrak{A}_{\mathrm{j},\beta}\overline{\mathfrak{A}_{\imath,\alpha}\mathfrak{A}_{\jmath,\beta}}\}(\omega) = \langle \mathfrak{A}\otimes\mathfrak{A}\otimes\overline{\mathfrak{A}}\otimes\overline{\mathfrak{A}}, \chi_{\mathrm{i},\alpha,\omega}\otimes\chi_{\mathrm{j},\beta,\omega}\otimes\chi_{\mathrm{i},\widehat{\alpha},\omega}\otimes\chi_{\mathrm{j},\widehat{\beta},\omega}\rangle$$

$$\mathfrak{A} = \sum_{\mathrm{i}=1}^{4}\sum_{\alpha=1}^{\eta} \mathfrak{A}_{\mathrm{i},\alpha} \otimes \mathfrak{d}\mathfrak{x}^{\mathrm{i}} \otimes \mathfrak{E}^{\alpha}, \widetilde{\mathfrak{A}} = \sum_{\mathrm{i}=1}^{4}\sum_{\alpha=1}^{\eta} \widetilde{\mathfrak{A}_{\imath,\alpha}} \otimes \mathfrak{d}\mathfrak{x}^{\mathrm{i}} \otimes \mathfrak{E}^{\alpha}$$

$$\int_{\omega\in\mathbb{R}^4}^{\infty} \{\mathfrak{A}_{\mathrm{i},\alpha}\mathfrak{A}_{\mathrm{j},\beta}\overline{\mathfrak{A}_{\imath,\alpha}\mathfrak{A}_{\jmath,\beta}}\}(\omega) = \langle \mathfrak{A}^{\otimes^2}\otimes\widehat{\mathfrak{A}}^{\otimes^2}, \int_{\omega\in\mathbb{R}^4}^{\infty} \mathfrak{d}\omega \, \chi_{\mathrm{i},\alpha,\omega}\otimes\chi_{\mathrm{j},\beta,\omega}\otimes\chi_{\mathrm{i},\widehat{\alpha},\omega}\otimes\chi_{\mathrm{j},\widehat{\beta},\omega}\rangle$$

$$\left(\mathfrak{A}_{\mathrm{i}_1,\alpha_1} \bigotimes \cdots \mathfrak{A}_{\mathrm{i}_4,\alpha_4}, \widetilde{\varpi}_{\omega}^{\otimes^4}\right) = \prod_{\mathrm{j}=1}^{4}\left(\mathfrak{A}_{\mathrm{i}_\mathrm{j},\alpha_\mathrm{j}}, \tilde{\pi}_{\mathrm{i}_\mathrm{j},\alpha_\mathrm{j},\omega}\right)$$

$$= \left(\mathfrak{A}_{\mathrm{i}_1,\alpha_1} \bigotimes \cdots \mathfrak{A}_{\mathrm{i}_3,\alpha_3}, \left(\tilde{\xi}^{\kappa}_{\alpha\beta}(\omega) \otimes \mathfrak{E}^{\alpha_1} \otimes \widetilde{\varpi}_{\omega}^{\otimes^2}\right)\right.$$

$$= \left(\mathfrak{A}_{\mathrm{i}_1,\alpha_1}, \tilde{\xi}^{\kappa}_{\alpha\beta}(\omega) \otimes \mathfrak{E}^{\alpha_1}\right)\prod_{\mathrm{j}=2}^{4}\left(\mathfrak{A}_{\mathrm{i}_\mathrm{j},\alpha_\mathrm{j}}, \tilde{\pi}_{\mathrm{i}_\mathrm{j},\alpha_\mathrm{j},\omega}\right)$$

$$\left.= \left(\mathfrak{A}_{\mathrm{i}_1,\alpha_1} \bigotimes \cdots \mathfrak{A}_{\mathrm{i}_4,\alpha_4}\widetilde{\varpi}_{\omega}^{\otimes^4} \otimes \left(\tilde{\xi}^{\kappa}_{\alpha\beta}(\omega) \otimes \mathfrak{E}^{\alpha_4}\right)\right)\right)$$

$$= \left(\mathfrak{A}_{\mathrm{i}_4,\alpha_4}, \tilde{\xi}^{\kappa}_{\alpha\beta}(\omega) \otimes \mathfrak{E}^{\alpha_4}\right)\prod_{\mathrm{j}=1}^{4}\left(\mathfrak{A}_{\mathrm{i}_\mathrm{j},\alpha_\mathrm{j}}, \tilde{\pi}_{\mathrm{i}_\mathrm{j},\alpha_\mathrm{j},\omega}\right)$$

$$\int_{\mathbb{C}^4}^{\infty} \mathfrak{d}\lambda_4 \, |\mathfrak{A}\wedge\mathfrak{A}|^2 = \sum_{\gamma} \sum_{0\leq \mathrm{i}\leq \mathrm{j}\leq 4} \sum_{\substack{\alpha<\beta \\ \hat{\alpha}<\hat{\beta}}} \frac{1}{2\mathfrak{C}_{\gamma}^{\alpha\beta}} \mathfrak{C}_{\gamma}^{\hat{\alpha}\hat{\beta}} \left(\left(\mathfrak{A}_{\mathrm{i},\alpha} \otimes \mathfrak{A}_{\mathrm{j},\beta} \otimes \mathfrak{A}_{\mathrm{i},\hat{\alpha}} \otimes \mathfrak{A}_{\mathrm{j},\hat{\beta}}, \int_{\omega\in\mathbb{C}^4}^{\infty} \mathfrak{d}\lambda_4 \, (\omega) \tilde{\varpi}_{\omega}^{\otimes^4} \right) + \left(\mathfrak{A}_{\mathrm{i},\alpha} \otimes \mathfrak{A}_{\mathrm{j},\beta} \otimes \mathfrak{A}_{\mathrm{i},\hat{\alpha}} \otimes \mathfrak{A}_{\mathrm{j},\hat{\beta}}, \int_{\omega\in\mathbb{C}^4}^{\infty} \mathfrak{d}\lambda_4 \, (\omega) \tilde{\varpi}_{\omega}^{\otimes^4} \right) \right)$$

$$\int_{\mathbb{C}^4}^{\infty} \mathfrak{d}\lambda_4 \, |\kappa\partial\mathfrak{A}, \mathfrak{A}\wedge\mathfrak{A}|^4$$

$$= \sum_{\gamma} \sum_{\kappa=1}^{4} \sum_{1\leq \mathrm{i}\leq \mathrm{j}\leq 4} \sum_{\substack{\alpha<\beta \\ \hat{\alpha}<\hat{\beta}}} \mathfrak{C}_{\gamma}^{\alpha\beta} \left(\mathfrak{A}_{\kappa,\gamma} \otimes \mathfrak{A}_{\mathrm{i},\alpha} \otimes \mathfrak{A}_{\mathrm{j},\beta}, \int_{\omega\in\mathbb{C}^4}^{\infty} \mathfrak{d}\lambda_4 \, (\omega) \big(\tilde{\xi}_{\mathrm{ij}}^{\kappa}(\omega) \otimes \mathfrak{E}^{\gamma} \big) \otimes \tilde{\varpi}_{\omega}^{\otimes^4} \right)$$

$$+ \int_{\mathbb{C}^4}^{\infty} \mathfrak{d}\lambda_4 \, |\mathfrak{A}\wedge\mathfrak{A}, \kappa\partial\mathfrak{A}|^4 \sum_{\gamma} \sum_{\kappa=1}^{4} \sum_{1\leq \mathrm{i}\leq \mathrm{j}\leq 4} \sum_{\substack{\alpha<\beta \\ \hat{\alpha}<\hat{\beta}}} \mathfrak{C}_{\gamma}^{\alpha\beta} \left(\mathfrak{A}_{\mathrm{i},\alpha} \otimes \mathfrak{A}_{\mathrm{j},\beta} \otimes \mathfrak{A}_{\kappa,\gamma} \int_{\omega\in\mathbb{C}^4}^{\infty} \mathfrak{d}\lambda_4 \, (\omega) \big(\tilde{\xi}_{\mathrm{ij}}^{\kappa}(\omega) \otimes \mathfrak{E}^{\gamma} \big) \otimes \tilde{\varpi}_{\omega}^{\otimes^4} \right)$$

$$\mathfrak{Y}_{\mathfrak{S}}^{\kappa} = \left(\left\{ \mathfrak{A}_{\mathrm{i},\alpha} \right\}_{\mathrm{i},\alpha} \right)$$

$$= \mathfrak{T}_{\mathrm{r}} \hat{\mathcal{T}} \exp\left(\frac{1}{\kappa} \cdot \frac{\kappa^2}{4} \right.$$

$$\cdot \rho\kappa$$

$$/4 \int_{\mathfrak{J}^2}^{\infty} \mathfrak{d}\mathfrak{s}\mathfrak{d}\mathfrak{t} \, \mu_{\mathfrak{s},\mathfrak{t}}^{-1} \left(\sum_{1\leq \mathrm{i}\leq \mathrm{j}\leq 4} \left| \mathfrak{J}_{\alpha\beta}^{\sigma} \right| (\mathfrak{s},\mathfrak{t}) \left| \mathfrak{J}_{\alpha\beta}^{\sigma} \right| (\bar{\mathfrak{s}},\bar{\mathfrak{t}}) \sum_{\alpha} (\mathfrak{A}_{\alpha}, \xi_{\alpha\beta}^{\kappa} \left(\frac{\kappa\sigma(\mathfrak{s},\mathfrak{t})}{2} \right) \otimes \mathfrak{E}^{\alpha} \otimes \rho(\mathfrak{E}^{\alpha})) \right.$$

$$\left. + \sum_{1\leq \mathrm{i}\leq \mathrm{j}\leq 4} \left| \mathfrak{J}_{\alpha\beta}^{\sigma} \right| (\mathfrak{s},\mathfrak{t}) \left| \mathfrak{J}_{\alpha\beta}^{\sigma} \right| (\bar{\mathfrak{s}},\bar{\mathfrak{t}}) \sum_{\gamma} \sum_{\kappa=1}^{4} \sum_{1\leq \mathrm{i}\leq \mathrm{j}\leq 4} \sum_{\substack{\alpha<\beta \\ \hat{\alpha}<\hat{\beta}}} \mathfrak{C}_{\gamma}^{\alpha\beta} \left(\mathfrak{A}_{\mathrm{i},\alpha} \otimes \mathfrak{A}_{\mathrm{j},\beta} \otimes \mathfrak{A}_{\kappa,\gamma} \otimes \tilde{\varpi}_{\left(\frac{\kappa\sigma(\mathfrak{s},\mathfrak{t})}{2} \right)}^{\otimes^4} \otimes \rho(\mathfrak{E}^{\gamma}) \right) \mu_{\mathfrak{s},\mathfrak{t}} \right)$$

$$\mathfrak{Y}_{\mathfrak{S}}^{\kappa} = \left(\{\mathfrak{A}_{\mathrm{i},\alpha}\}_{\mathrm{i},\alpha}\right)$$

$$= \exp\Big(-\frac{1}{2}\sum_{\gamma}\sum_{\kappa=1}^{4}\sum_{1\le \mathrm{i}\le \mathrm{j}\le 4}\sum_{\substack{\alpha<\beta\\ \hat{\alpha}<\hat{\beta}}}\mathfrak{C}_{\gamma}^{\alpha\beta}\left(\mathfrak{A}_{\kappa,\gamma}\otimes\mathfrak{A}_{\mathrm{i},\alpha}\otimes\mathfrak{A}_{\mathrm{j},\beta}\int_{\omega\in\mathbb{C}^4}^{\infty}\mathfrak{d}\lambda_4(\omega)\left(\xi_{\mathrm{ij}}^{\kappa}(\omega)\otimes\mathfrak{E}^{\gamma}\right)\otimes\widetilde{\varpi}_{\omega}^{\otimes^4}\right)$$

$$-1/2\sum_{\gamma}\sum_{\kappa=1}^{4}\sum_{1\le \mathrm{i}\le \mathrm{j}\le 4}\sum_{\substack{\alpha<\beta\\ \hat{\alpha}<\hat{\beta}}}\mathfrak{C}_{\gamma}^{\alpha\beta}\left(\mathfrak{A}_{\mathrm{i},\alpha}\otimes\mathfrak{A}_{\mathrm{j},\beta}\otimes\mathfrak{A}_{\kappa,\gamma}\int_{\omega\in\mathbb{C}^4}^{\infty}\mathfrak{d}\lambda_4(\omega)\widetilde{\varpi}_{\omega}^{\otimes^4}\otimes\left(\xi_{\mathrm{ij}}^{\kappa}(\omega)\otimes\mathfrak{E}^{\gamma}\right)\right)$$

$$-1/2\sum_{\gamma}\sum_{\kappa=1}^{4}\sum_{1\le \mathrm{i}\le \mathrm{j}\le 4}\sum_{\substack{\alpha<\beta\\ \hat{\alpha}<\hat{\beta}}}\mathfrak{C}_{\gamma}^{\alpha\beta}\,\mathfrak{C}_{\gamma}^{\hat{\alpha}\hat{\beta}}/2\,\Big(\left(\mathfrak{A}_{\mathrm{i},\alpha}\otimes\mathfrak{A}_{\mathrm{j},\beta}\otimes\mathfrak{A}_{\mathrm{i},\hat{\alpha}}\otimes\mathfrak{A}_{\mathrm{j},\hat{\beta}},\int_{\omega\in\mathbb{C}^4}^{\infty}\mathfrak{d}\lambda_4(\omega)\widetilde{\varpi}_{\omega}^{\otimes^4}\right)$$

$$+\Big(\mathfrak{A}_{\mathrm{i},\alpha}\otimes\mathfrak{A}_{\mathrm{j},\beta}\otimes\mathfrak{A}_{\mathrm{i},\hat{\alpha}}\otimes\mathfrak{A}_{\mathrm{j},\hat{\beta}},\int_{\omega\in\mathbb{C}^4}^{\infty}\mathfrak{d}\lambda_4(\omega)\widetilde{\varpi}_{\omega}^{\otimes^4}\Big)\Big)\Big)$$

$$\left|\left(\frac{\kappa}{4}\right)\int_{\mathfrak{J}^2}^{\infty}\mathfrak{d}\mathfrak{s}\mathfrak{d}\mathfrak{t}\sum_{1\le \mathrm{i}\le \mathrm{j}\le 4}\left|\mathfrak{J}_{\mathrm{ij}}^{\sigma}\right|(\mathfrak{s},\mathfrak{t})\left|\mathfrak{J}_{\mathrm{ij}}^{\sigma}\right|(\bar{\mathfrak{s}},\bar{\mathfrak{t}})\sum_{\gamma}\sum_{\substack{\alpha<\beta\\ \hat{\alpha}<\hat{\beta}}}\left|\mathfrak{C}_{\gamma}^{\alpha\beta}\right|\left|\pi_{\mathrm{i}}(\omega)\right|_{\partial,\kappa}\mathcal{M}_{\left(\frac{\mathrm{i},\kappa\sigma(\mathfrak{s},\mathfrak{t})}{2}\right)}^{\alpha}\mathcal{M}_{\left(\frac{\mathrm{j},\kappa\sigma(\mathfrak{s},\mathfrak{t})}{2}\right)}^{\beta}\right|$$

$$\le\left(\frac{\kappa}{4}\right)\left(\frac{4}{2\pi}\right)\kappa^2\int_{\mathfrak{J}^2}^{\infty}\mathfrak{d}\mathfrak{s}\mathfrak{d}\mathfrak{t}\sum_{1\le \mathrm{i}\le \mathrm{j}\le 4}\left|\mathfrak{J}_{\mathrm{ij}}^{\sigma}\right|(\mathfrak{s},\mathfrak{t})\left|\mathfrak{J}_{\mathrm{ij}}^{\sigma}\right|(\bar{\mathfrak{s}},\bar{\mathfrak{t}})\sum_{\gamma}\left|\sum_{\substack{\alpha<\beta\\ \hat{\alpha}<\hat{\beta}}}\left|\mathfrak{C}_{\gamma}^{\alpha\beta}\right|\mathcal{M}_{\left(\frac{\mathrm{i},\kappa\sigma(\mathfrak{s},\mathfrak{t})}{2}\right)}^{\alpha}\mathcal{M}_{\left(\frac{\mathrm{j},\kappa\sigma(\mathfrak{s},\mathfrak{t})}{2}\right)}^{\beta}\right|=\mathrm{F}_{\eta}$$

$$=4\left(\frac{4}{\kappa}\right)\left(\frac{4}{2\pi}\right)\kappa^2\sum_{1\le \mathrm{i}\le \mathrm{j}\le 4}\sum_{\rho,\mathfrak{q}=1}^{\eta}\left|\mathfrak{J}_{\mathrm{ij}}^{\sigma}\right|\left(\frac{\rho}{\eta},\frac{\mathfrak{q}}{\eta}\right)/\eta^2\sum_{\gamma}\left|\sum_{\substack{\alpha<\beta\\ \hat{\alpha}<\hat{\beta}}}\left|\mathfrak{C}_{\gamma}^{\alpha\beta}\right|\mathcal{M}_{\left(\frac{\mathrm{i},\kappa\sigma\left(\frac{\rho}{\eta},\frac{\mathfrak{q}}{\eta}\right)}{2}\right)}^{\alpha}\mathcal{M}_{\left(\frac{\mathrm{j},\kappa\sigma\left(\left(\frac{\rho}{\eta},\frac{\mathfrak{q}}{\eta}\right)\right)}{2}\right)}^{\beta}\right|$$

$$\left|\left(\frac{\kappa}{4}\right)\int_{\mathfrak{I}^2}^{\infty} \mathfrak{dsdt} \sum_{1\leq\alpha\leq\beta\leq4} \left|\mathfrak{I}_{\alpha\beta}^{\sigma}\right|(\mathfrak{s},\mathfrak{t})\left|\mathfrak{I}_{\alpha\beta}^{\sigma}\right|(\bar{\mathfrak{s}},\bar{\mathfrak{t}}) \sum_{\gamma}\sum_{\substack{\mathrm{i}<\mathrm{j}\\ \hat{\mathrm{i}}<\hat{\mathrm{j}}}} \left|\mathfrak{C}_{\gamma}^{\alpha\beta}\right| \left|\pi_{\alpha\beta}(\omega)\right|_{\partial,\kappa} \mathcal{M}^{\mathrm{i}}_{\left(\frac{\alpha,\kappa\sigma(\mathfrak{s},\mathfrak{t})}{2}\right)} \mathcal{M}^{\mathrm{j}}_{\left(\frac{\beta,\kappa\sigma(\mathfrak{s},\mathfrak{t})}{2}\right)}\right|$$

$$\leq \left(\frac{\kappa}{4}\right)\left(\frac{4}{2\pi}\right)\kappa^2 \int_{\mathfrak{I}^2}^{\infty} \mathfrak{dsdt} \sum_{1\leq\mathrm{i}\leq\mathrm{j}\leq4} \left|\mathfrak{I}_{\alpha\beta}^{\sigma}\right|(\mathfrak{s},\mathfrak{t})\left|\mathfrak{I}_{\alpha\beta}^{\sigma}\right|(\bar{\mathfrak{s}},\bar{\mathfrak{t}}) \sum_{\gamma}\left|\sum_{\substack{\mathrm{i}<\mathrm{j}\\ \hat{\mathrm{i}}<\hat{\mathrm{j}}}} \left|\mathfrak{C}_{\gamma}^{\alpha\beta}\right| \mathcal{M}^{\mathrm{i}}_{\left(\frac{\alpha,\kappa\sigma(\mathfrak{s},\mathfrak{t})}{2}\right)} \mathcal{M}^{\mathrm{j}}_{\left(\frac{\beta,\kappa\sigma(\mathfrak{s},\mathfrak{t})}{2}\right)}\right| = \mathrm{F}_{\eta}$$

$$= 4\left(\frac{4}{\kappa}\right)\left(\frac{4}{2\pi}\right)\kappa^2 \sum_{1\leq\mathrm{i}\leq\mathrm{j}\leq4}\sum_{\rho,\mathfrak{q}=1}^{\eta} \left|\mathfrak{I}_{\alpha\beta}^{\sigma}\right|\left(\frac{\rho}{\eta},\frac{\mathfrak{q}}{\eta}\right)/\eta^2 \sum_{\gamma}\left|\sum_{\substack{\mathrm{i}<\mathrm{j}\\ \hat{\mathrm{i}}<\hat{\mathrm{j}}}} \left|\mathfrak{C}_{\gamma}^{\mathrm{ij}}\right| \mathcal{M}^{\mathrm{i}}_{\left(\frac{\alpha,\kappa\sigma\left(\frac{\rho}{\eta},\frac{\mathfrak{q}}{\eta}\right)}{2}\right)} \mathcal{M}^{\mathrm{j}}_{\left(\frac{\beta,\kappa\sigma\left(\left(\frac{\rho}{\eta},\frac{\mathfrak{q}}{\eta}\right)\right)}{2}\right)}\right|$$

Cuya aproximación riemmaniana equivale a:

$$\left(\frac{4}{\kappa}\right)\left(\frac{4}{2\pi}\right)\kappa^2 \int_{\mathfrak{I}^2}^{\infty} \mathfrak{dsdt} \sum_{1\leq\mathrm{i}\leq\mathrm{j}\leq4} \left|\mathfrak{I}_{\mathrm{ij}}^{\sigma}\right|(\mathfrak{s},\mathfrak{t})\left|\mathfrak{I}_{\mathrm{ij}}^{\sigma}\right|(\bar{\mathfrak{s}},\bar{\mathfrak{t}}) \sum_{\gamma}\left|\sum_{\substack{\alpha<\beta\\ \hat{\alpha}<\hat{\beta}}} \left|\mathfrak{C}_{\gamma}^{\alpha\beta}\right| \mathcal{M}^{\alpha}_{\left(\frac{\mathrm{i},\kappa\sigma(\mathfrak{s},\mathfrak{t})}{2}\right)} \mathcal{M}^{\beta}_{\left(\frac{\mathrm{j},\kappa\sigma(\mathfrak{s},\mathfrak{t})}{2}\right)}\right|$$

$$= \left|\sum_{\substack{\alpha<\beta\\ \hat{\alpha}<\hat{\beta}}} \left|\mathfrak{C}_{\gamma}^{\alpha\beta}\right| \mathcal{M}^{\alpha}_{\left(\frac{\mathrm{i},\kappa\sigma(\mathfrak{s},\mathfrak{t})}{2}\right)} \mathcal{M}^{\beta}_{\left(\frac{\mathrm{j},\kappa\sigma(\mathfrak{s},\mathfrak{t})}{2}\right)}\right|$$

$$\leq \mathfrak{N}\|\mathfrak{B}(\gamma)\| \sqrt{\sum_{\alpha}\mathcal{M}^{\alpha}_{\left(\frac{\mathrm{i},\kappa\sigma(\mathfrak{s},\mathfrak{t})}{2}\right)}} \sqrt{\sum_{\alpha}\mathcal{M}^{\alpha}_{\left(\frac{\mathrm{j},\kappa\sigma(\mathfrak{s},\mathfrak{t})}{2}\right)}} / \sqrt{\sum_{\beta}\mathcal{M}^{\beta}_{\left(\frac{\mathrm{i},\kappa\sigma(\mathfrak{s},\mathfrak{t})}{2}\right)}} \sqrt{\sum_{\alpha}\mathcal{M}^{\beta}_{\left(\frac{\mathrm{j},\kappa\sigma(\mathfrak{s},\mathfrak{t})}{2}\right)}}$$

$$\left(\frac{4}{\kappa}\right)\left(\frac{4}{2\pi}\right)\kappa^2 \int_{\mathfrak{I}^2}^{\infty} \mathfrak{dsdt} \sum_{1\leq\alpha\leq\beta\leq4} \left|\mathfrak{I}_{\alpha\beta}^{\sigma}\right|(\mathfrak{s},\mathfrak{t})\left|\mathfrak{I}_{\alpha\beta}^{\sigma}\right|(\bar{\mathfrak{s}},\bar{\mathfrak{t}}) \sum_{\gamma}\left|\sum_{\substack{\mathrm{i}<\mathrm{j}\\ \hat{\mathrm{i}}<\hat{\mathrm{j}}}} \left|\mathfrak{C}_{\gamma}^{\mathrm{ij}}\right| \mathcal{M}^{\mathrm{i}}_{\left(\frac{\alpha,\kappa\sigma(\mathfrak{s},\mathfrak{t})}{2}\right)} \mathcal{M}^{\mathrm{j}}_{\left(\frac{\beta,\kappa\sigma(\mathfrak{s},\mathfrak{t})}{2}\right)}\right|$$

$$= \left|\sum_{\substack{\mathrm{i}<\mathrm{j}\\ \hat{\mathrm{i}}<\hat{\mathrm{j}}}} \left|\mathfrak{C}_{\gamma}^{\mathrm{ij}}\right| \mathcal{M}^{\mathrm{i}}_{\left(\frac{\alpha,\kappa\sigma(\mathfrak{s},\mathfrak{t})}{2}\right)} \mathcal{M}^{\mathrm{j}}_{\left(\frac{\beta,\kappa\sigma(\mathfrak{s},\mathfrak{t})}{2}\right)}\right|$$

$$\leq \mathfrak{N}\|\mathfrak{B}(\gamma)\| \sqrt{\sum_{\alpha}\mathcal{M}^{\mathrm{i}}_{\left(\frac{\alpha,\kappa\sigma(\mathfrak{s},\mathfrak{t})}{2}\right)}} \sqrt{\sum_{\alpha}\mathcal{M}^{\mathrm{j}}_{\left(\frac{\beta,\kappa\sigma(\mathfrak{s},\mathfrak{t})}{2}\right)}} / \sqrt{\sum_{\beta}\mathcal{M}^{\mathrm{i}}_{\left(\frac{\alpha,\kappa\sigma(\mathfrak{s},\mathfrak{t})}{2}\right)}} \sqrt{\sum_{\alpha}\mathcal{M}^{\mathrm{j}}_{\left(\frac{\beta,\kappa\sigma(\mathfrak{s},\mathfrak{t})}{2}\right)}}$$

Ahora bien, para efectos de simular superficies temporales y espaciales respectivamente, en campos cuánticos, se expresa lo que sigue, empezando por la transformación de Fourier:

$$\left(\frac{1}{\sqrt{2\varpi}}\right)^4 \int_{\delta_0}^{\infty} \mathfrak{e}^{-\iota(\mathfrak{q}^2\mathfrak{x}^2+\mathfrak{q}^4\mathfrak{x}^4)}\mathfrak{F}_\alpha\left(\mathcal{H}(\rho),\mathfrak{P}(\rho),\mathfrak{x}^2,\mathfrak{x}^4\right)\mathfrak{d}\mathfrak{x}^2\mathfrak{d}\mathfrak{x}^4 \bigotimes \rho(\mathfrak{E}^\alpha)$$

$$= \widehat{\mathfrak{F}}_\alpha\left(\widehat{\mathcal{H}}(\rho),\widehat{\mathfrak{P}}(\rho),\mathfrak{q}^2,\mathfrak{q}^4\right) \bigotimes \rho(\mathfrak{E}^\alpha)$$

$$\widehat{\mathfrak{F}}\left(\widehat{\mathcal{H}}(\rho)\widetilde{\mathfrak{f}_0} + \widehat{\mathfrak{P}}(\rho)\widetilde{\mathfrak{f}_1} + \mathfrak{q}^2\widetilde{\mathfrak{f}_2} + \mathfrak{q}^4\widetilde{\mathfrak{f}_4}\right)$$

$$= \frac{\mathfrak{e}^{-\iota(\alpha^0)\mathcal{H}(\rho)-\alpha^1\mathfrak{P}(\rho)}}{2\pi} \int_{\widehat{\mathfrak{s}\in\mathbb{R}^4}}^{\infty} \mathfrak{e}^{-\iota(\hat{\mathfrak{s}}\mathfrak{q}^2+\bar{\mathfrak{s}}\mathfrak{q}^4)}\mathfrak{f}^{\{\hat{\mathfrak{f}}_0,\hat{\mathfrak{f}}_1\}}\left(\widehat{\mathcal{H}}(\rho),\widehat{\mathfrak{P}}(\rho)\right)\left(\mathfrak{s}\hat{\mathfrak{f}}_2 + \bar{\mathfrak{s}}\hat{\mathfrak{f}}_4\right)\mathfrak{d}\hat{\mathfrak{s}}$$

$$\equiv \mathfrak{e}^{-\iota(\alpha^0)\widehat{\mathcal{H}}(\rho)-\alpha^1\widehat{\mathfrak{P}}(\rho)}\hat{\mathfrak{f}}\left(\widehat{\mathcal{H}}(\rho)\hat{\mathfrak{f}}_0 + \widehat{\mathfrak{P}}(\rho)\hat{\mathfrak{f}}_1 + \mathfrak{q}^2\hat{\mathfrak{f}}_0 + \mathfrak{q}^4\hat{\mathfrak{f}}_4\right) \bigotimes \rho(\mathfrak{E}^\alpha)$$

$$\langle \phi^{\alpha,\eta}(\mathfrak{f})1, \phi^{\nu\beta,\eta}(\mathscr{g})1\rangle = \mathfrak{C}(\rho_\eta)\mathcal{T}\mathfrak{r}\left(-\mathfrak{F}^\alpha\mathfrak{F}^\beta\right) \int_{\delta_0}^{\infty} \left(\mathfrak{f}^{\{\epsilon_0\epsilon_1\}}\overline{\mathfrak{g}^{\{\epsilon_0\epsilon_1\}}}\right)\left(\widehat{\mathcal{H}}(\rho_\eta),\widehat{\mathfrak{P}}(\rho_\eta)\right)(\hat{\mathfrak{s}})\mathfrak{d}\hat{\mathfrak{s}}$$

$$\phi^{\alpha,\eta}(\mathfrak{f})1 = \int_{\widehat{\vec{\mathfrak{x}}\in\mathbb{R}^4}}^{\infty} \mathfrak{d}\vec{\mathfrak{x}}\,\mathfrak{f}(\vec{\mathfrak{x}})\phi^{\alpha,\eta}(\vec{\mathfrak{x}})1 = \mathfrak{U}(\vec{\alpha},1)\phi^{\alpha,\eta}(\vec{\mathfrak{x}})\mathfrak{U}(\vec{\alpha},1)^{-1} = \phi^{\alpha,\eta}(\vec{\mathfrak{x}}+\vec{\alpha})$$

$$= \frac{1}{2\varpi}\mathfrak{e}^{\iota(\mathfrak{x}^0\widehat{\mathcal{H}}(\rho_\eta)-\mathfrak{x}^1\widehat{\mathfrak{P}}(\rho_\eta)}\delta\left(\cdot-(\mathfrak{x}^2,\mathfrak{x}^4)\right) \bigotimes \frac{\rho(\mathcal{F}^\alpha)\kappa^2}{4(2\varpi)}\exp\delta(\overline{\mathfrak{x}-\mathfrak{y}})^4$$

$$\langle\frac{1}{(2\varpi)^2}\mathfrak{e}^{\iota(\widehat{\mathcal{H}}(\mathfrak{x}^0-\mathfrak{y}^0)-\widehat{\mathfrak{P}}(\mathfrak{x}^1-\mathfrak{y}^1)}\rho_\kappa^{\mathfrak{x}+} \bigotimes \rho(\mathcal{F}^\alpha), \frac{1}{(2\varpi)^2}\mathfrak{e}^{\iota(\mathfrak{y}^0\widehat{\mathcal{H}}-\mathfrak{y}^1\widehat{\mathfrak{P}})}\rho_\kappa^{\mathfrak{y}+} \bigotimes \rho(\mathcal{F}^\beta)\rangle$$

$$= \frac{\overline{\dfrac{\kappa^2}{(2\varpi)^4\mathfrak{e}^{\iota(\widehat{\mathcal{H}}(\mathfrak{x}^0-\mathfrak{y}^0)-\widehat{\mathfrak{P}}(\mathfrak{x}^1-\mathfrak{y}^1)}\exp(-\kappa^2\delta(\vec{\mathfrak{x}}-\vec{\mathfrak{y}})^4}}}{4} \cdot \langle\rho_\eta(\mathcal{F}^\alpha),\rho_\eta(\mathcal{F}^\beta))\rangle$$

$$\frac{1}{(2\varpi)^2}\int_{\widehat{\vec{\mathfrak{x}},\vec{\mathfrak{y}}\in\mathbb{R}^4}}^{\infty} \mathfrak{f}(\vec{\mathfrak{x}})\,\mathfrak{g}(\vec{\mathfrak{y}})\,\langle\mathfrak{e}^{\iota(\mathfrak{x}^0\widehat{\mathcal{H}}-\mathfrak{x}^1\widehat{\mathfrak{P}}}\rho_\kappa^{\mathfrak{x}+} \bigotimes \rho(\mathcal{F}^\alpha), \mathfrak{e}^{\iota(\mathfrak{y}^0\widehat{\mathcal{H}}-\mathfrak{y}^1\widehat{\mathfrak{P}}}\rho_\kappa^{\mathfrak{y}+} \bigotimes \rho(\mathcal{F}^\beta)\rangle\,\mathfrak{d}\vec{\mathfrak{x}}\mathfrak{d}\vec{\mathfrak{y}}$$

$$= \frac{\kappa^2}{4}\int_{\widehat{\hat{\mathfrak{s}},\hat{\mathfrak{t}}\in\mathfrak{S}_0}}^{\infty} \mathfrak{f}^{\{\epsilon_0\epsilon_1\}}(\hat{\mathfrak{s}})\overline{\mathfrak{g}^{\{\epsilon_0\epsilon_1\}}}(\hat{\mathfrak{t}})\frac{1}{(2\varpi)^2}\exp\left(-\kappa^2\left|\hat{\mathfrak{s}}-\hat{\mathfrak{t}}\right|^4\right.$$

$$/4)\mathfrak{d}\hat{\mathfrak{s}}\mathfrak{d}\hat{\mathfrak{t}}\ \langle\rho_\eta(\mathcal{F}^\alpha),\rho_\eta(\mathcal{F}^\beta) \bigotimes \rho(\mathcal{F}^\alpha), \bigotimes \rho(\mathcal{F}^\beta)\rangle$$

$$\lambda\left(\mathfrak{Z},\mathfrak{F}_\alpha\bigotimes\rho(\mathfrak{E}^\alpha),\widehat{\{\mathfrak{F}_\alpha\}_{\alpha=0}^4}\right)+\mu\left(\widetilde{\mathfrak{Z}},\mathfrak{G}_\alpha\bigotimes\rho(\mathfrak{E}^\alpha),\widehat{\{\mathfrak{F}_\alpha\}_{\alpha=0}^4}\right)$$

$$=\left(\mathfrak{Z}\cup\widetilde{\mathfrak{Z}}(\lambda\widetilde{\mathfrak{F}_\alpha}+\mu\widetilde{\mathfrak{G}_\alpha})\bigotimes\rho(\mathfrak{E}^\alpha),\widehat{\{\mathfrak{F}_\alpha\}_{\alpha=0}^4}\right)$$

$$\langle\left(\widetilde{\mathfrak{Z}},\mathfrak{F}_\alpha\bigotimes\rho(\mathfrak{E}^\alpha),\widehat{\{\mathfrak{F}_\alpha\}_{\alpha=0}^4}\right),\left(\widetilde{\mathfrak{Z}},\mathfrak{G}_\beta\bigotimes\rho(\mathfrak{E}^\beta),\widehat{\{\mathfrak{G}_\alpha\}_{\alpha=0}^4}\right)\rangle$$

$$=\int_{\mathfrak{Z}\cup\widetilde{\mathfrak{Z}}}^{\infty}\|\mathfrak{F}_\alpha\widehat{\mathfrak{G}_\beta}\|\cdot\mathfrak{d}|\acute{\rho}|\cdot\mathrm{T}_{\mathfrak{r}}\left(-\rho(\mathfrak{E}^\alpha)\rho(\mathfrak{E}^\beta)\right)$$

$$=\sum_{\alpha=1}^{\eta}\mathfrak{C}(\rho)\int_{\mathfrak{J}^2}^{\infty}\|\mathfrak{F}_\alpha\cdot\widehat{\mathfrak{G}_\alpha}\|\left(\sigma(\widetilde{\mathfrak{Z}})\right)\left|\sum_{0\leq\alpha\leq\beta\leq 4}\acute{\rho}_\sigma^{\alpha\beta}(\widetilde{\mathfrak{Z}})(\det\acute{\mathfrak{K}}_\sigma^{\alpha\beta}(\widetilde{\mathfrak{Z}}))\right|\mathfrak{d}\tilde{\mathfrak{z}}$$

$$\langle\mathfrak{U}(\vec{\alpha},\Lambda)\left(\mathfrak{S},\mathfrak{F}_\alpha\otimes\rho(\mathfrak{E}^\alpha),\widehat{\{\mathfrak{F}_\alpha\}_{\alpha=0}^4}\right),\mathfrak{U}(\vec{\alpha},\Lambda)\left(\widetilde{\mathfrak{S}},\mathfrak{G}_\beta\otimes\rho(\mathfrak{E}^\beta),\widehat{\{\mathfrak{F}_\alpha\}_{\alpha=0}^4}\right)\rangle$$

$$=\int_{(\Lambda\mathfrak{S}+\vec{\alpha})\cap(\Lambda\widetilde{\mathfrak{S}}+\vec{\alpha})}^{\infty}\mathfrak{d}|\acute{\rho}|\mathrm{e}^{-\mathrm{i}\left(\vec{\alpha}\cdot(\mathcal{H}(\rho_\eta)\Lambda\widehat{\mathfrak{F}_0}+\mathfrak{P}(\rho_\eta)\Lambda\widehat{\mathfrak{F}_1})\right)}\mathrm{e}^{\mathrm{i}\left(\vec{\alpha}\cdot(\mathcal{H}(\rho_\eta)\Lambda\widehat{\mathfrak{F}_0}+\mathfrak{P}(\rho_\eta)\Lambda\widehat{\mathfrak{F}_1})\right)}$$

$$\times\|\mathfrak{F}_\alpha\widehat{\mathfrak{G}_\beta}\|(\Lambda^{-1}(\cdot-\vec{\alpha}))\cdot\mathrm{T}_{\mathfrak{r}}\left(-\rho(\mathfrak{E}^\alpha)\rho(\mathfrak{E}^\beta)\right)$$

$$=\int_{\Lambda(\mathfrak{Z}\cup\widetilde{\mathfrak{Z}})+\vec{\alpha}}^{\infty}\|\mathfrak{F}_\alpha\widehat{\mathfrak{G}_\beta}\|\left(\Lambda^{-1}(\cdot-\vec{\alpha})\right)\cdot\mathfrak{d}|\acute{\rho}|\cdot\mathrm{T}_{\mathfrak{r}}\left(-\rho(\mathfrak{E}^\alpha)\rho(\mathfrak{E}^\beta)\right)$$

$$=\int_{\mathfrak{Z}\cup\widetilde{\mathfrak{Z}}}^{\infty}\|\mathfrak{F}_\alpha\widehat{\mathfrak{G}_\beta}\|(\cdot)\cdot\mathfrak{d}|\acute{\rho}|\cdot\mathrm{T}_{\mathfrak{r}}\left(-\rho(\mathfrak{E}^\alpha)\rho(\mathfrak{E}^\beta)\right)$$

Siendo los operadores relativos a los campos cuánticos, los que siguen:

$$\mathcal{D}^{\vec{\kappa}}=\left(\frac{\partial}{\partial\mathfrak{x}^0}\right)^{\kappa^0}\left(\frac{\partial}{\partial\mathfrak{x}^1}\right)^{\kappa^1}\left(\frac{\partial}{\partial\mathfrak{x}^2}\right)^{\kappa^2}\left(\frac{\partial}{\partial\mathfrak{x}^3}\right)^{\kappa^3},\vec{\chi}^{\vec{\kappa}}=(\partial\mathfrak{x}^0)^{\kappa^0}(\partial\mathfrak{x}^1)^{\kappa^1}(\partial\mathfrak{x}^2)^{\kappa^2}(\partial\mathfrak{x}^3)^{\kappa^3}$$

$$\phi^{\alpha,\eta}(\tilde{\mathfrak{f}})1=\left(\mathfrak{S}_0,\mathfrak{f}^{\{\widehat{\varepsilon_0},\widehat{\varepsilon_1}\}}\otimes\rho_\eta(\mathfrak{F}^\alpha),\{\epsilon_\alpha\}_{\alpha=0}^4\right)\equiv\left(\mathfrak{S}_0,\mathfrak{f}^{\{\widehat{\varepsilon_0},\widehat{\varepsilon_1}\}}(\widehat{\mathcal{H}(\rho_\eta)},\mathfrak{P}(\rho_\eta))\otimes\rho_\eta(\mathfrak{F}^\alpha),\{\epsilon_\alpha\}_{\alpha=0}^4\right)$$

$$\in\mathfrak{H}(\rho_\eta)$$

En dimensión $\mathbb{R}^4$ tenemos lo que sigue:

$$\vec{\mathfrak{x}}\in\mathbb{R}^4\longrightarrow\tilde{\mathfrak{f}}^{\{\widehat{\mathfrak{f}_0},\widehat{\mathfrak{f}_1}\}}\left(\widehat{\mathcal{H}}(\rho_\eta),\widehat{\mathfrak{P}}(\rho_\eta)\right)(\vec{\mathfrak{x}})=\int_{\mathfrak{S}^{\mathfrak{b}}}^{\infty}\mathrm{e}^{-\mathrm{i}\widehat{\eta}}(\cdot)/2\pi\tilde{\mathfrak{f}}(\vec{\mathfrak{x}}+\star)\mathfrak{d}|\acute{\rho}|$$

$$=\int_{\hat{\mathfrak{s}}\in\mathbb{R}^4}^{\infty}\mathrm{e}^{-\mathrm{i}\left(\sigma(\hat{\mathfrak{s}})\cdot(\widehat{\mathcal{H}}(\rho_\eta)\widehat{\mathfrak{f}_0}+\widehat{\mathfrak{P}}(\rho_\eta),\widehat{\mathfrak{f}_1})\right)}/2\pi\tilde{\mathfrak{f}}\left(\vec{\mathfrak{x}}+\sigma(\hat{\mathfrak{s}})\right)\cdot|\widehat{\rho_\sigma}|(\hat{\mathfrak{s}})\mathfrak{d}\hat{\mathfrak{s}}$$

$$\left\{\alpha_0 1 + \sum_{\eta,\mu=1}^{\infty} (\mathfrak{S}_{\eta,\mu}, \mathfrak{f}_{\eta,\alpha}^{\mu} \otimes \rho_\eta(\mathfrak{E}^\alpha), \left[\mathfrak{f}_\alpha^{\widehat{\eta,\mu}}\right]_{\alpha=0}^4) \boxtimes \alpha_0 \in \mathfrak{C}, \mathfrak{f}_{\eta,\alpha}^{\mu} \in \mathfrak{P}_{\mathfrak{S}_{\eta,\mu}}, \mathfrak{S}_{\eta,\mu} \in \mathfrak{L}\right\}$$

Cuya parametrización va como se indica:

$$\int_{\mathfrak{J}^2}^{\infty} |\mathfrak{f} \circ \sigma|^2(\mathfrak{s}) \left| \sum_{0\le\alpha\le\beta\le4} \acute{\rho}_\sigma^{\alpha\beta}(\widetilde{\mathfrak{Z}})(\det \acute{\mathfrak{K}}_{\alpha\beta}^{\sigma}(\widetilde{\mathfrak{Z}})) \right| \mathfrak{d}\tilde{\mathfrak{z}} < \infty$$

$$\phi^{\alpha,\eta}(\mathfrak{f}) \sum_{\mu=1}^{\infty} (\mathfrak{S}_\mu, \mathfrak{G}_\beta^\mu \otimes \rho_{\mathfrak{m}}(\mathfrak{E}^\beta), \left\{\widehat{\mathfrak{f}_\alpha^\mu}\right\}_{\alpha=0}^4)$$

$$= \left\{ \begin{matrix} \sum_{\mu=1}^{\infty} (\mathfrak{S}_\mu, \mathfrak{f}_\eta^{\{\hat{\mathfrak{f}}_0^\mu \hat{\mathfrak{f}}_1^\mu\}} \mathfrak{A}(\Lambda^\mu)_\gamma^\alpha \cdot \mathfrak{G}_\beta^\mu \otimes \rho_\eta \|\mathfrak{F}^\gamma, \mathfrak{E}^\beta\|, \left\{\widehat{\mathfrak{f}_\alpha^\mu}\right\}_{\alpha=0}^4), & \mathfrak{m} = \eta \\ \sum \left| \frac{\partial\alpha}{\frac{\partial\beta}{\frac{\partial\gamma}{\frac{\partial\delta}{\partial\varepsilon}}}} \right|^{i/\hbar} \circ \left| \frac{\partial\zeta}{\frac{\partial\eta}{\frac{\partial\theta}{\frac{\partial\vartheta}{\partial\iota}}}} \right|^{\frac{i}{\hbar}} \circledast \frac{\left\| \frac{\partial\kappa}{\frac{\partial\lambda}{\frac{\partial\mu}{\frac{\partial\nu}{\partial\xi}}}} \right\|^{\sqrt{\frac{i}{\hbar}}}}{\frac{\partial}{\partial t}} * \left\| \partial o \otimes \partial\rho \otimes \partial\varrho \otimes \partial\sigma \otimes \partial\varsigma \otimes \frac{\partial\tau}{\partial\upsilon} \otimes \partial\varphi \otimes \partial\phi \dagger \partial\psi \dagger \partial\Psi - \frac{\partial\Delta}{\partial\omega} / \Lambda_{\nu\mu}^{\mu\nu} \cdot \partial\Omega\Phi \right\|^{\frac{i}{\hbar}}, & \mathfrak{m} \neq \eta \end{matrix} \right\}$$

$$\phi^{\alpha,\eta}(\mathfrak{f}) \sum_{\mathfrak{m}=0}^{\infty} \nu_{\mathfrak{m}} = \sum_{\mathfrak{m}=0}^{\infty} \phi^{\alpha,\eta}(\mathfrak{f}) \nu_{\mathfrak{m}} = \alpha_0 \left(\delta_0, \mathfrak{f}_\eta^{\{\epsilon_0,\epsilon_1\}} \otimes \rho_\eta(\mathfrak{E}^\alpha), \{\epsilon_\alpha\}_{\alpha=0}^4\right) + \phi^{\alpha,\eta}(\mathfrak{f}) \nu_\eta$$

$$\phi^{\beta,\mathfrak{m}}(\mathfrak{f}) \sum_{\eta=0}^{\infty} \nu_\eta = \sum_{\eta=0}^{\infty} \phi^{\beta,\mathfrak{m}}(\mathfrak{f}) \nu_\eta = \beta_0 \left(\delta_0, \mathfrak{f}_{\mathfrak{m}}^{\{\epsilon_0,\epsilon_1\}} \otimes \rho_{\mathfrak{m}}(\mathfrak{E}^\beta), \{\epsilon_\beta\}_{\beta=0}^4\right) + \phi^{\beta,\mathfrak{m}}(\mathfrak{f}) \nu_{\mathfrak{m}}$$

$$\phi^{\alpha,\eta}(\mathfrak{g})^* \left(\mathfrak{S}, \mathfrak{f}_\beta \otimes \rho_\eta(\mathfrak{E}^\beta), \{\widehat{\mathfrak{f}_\alpha}\}_{\beta=0}^4\right)$$

$$= -\left(\mathfrak{S}, \mathfrak{g}^{\overline{\{\hat{\mathfrak{f}}_0^\alpha \hat{\mathfrak{f}}_1^\beta\}}} \mathfrak{A}(\Lambda)_\gamma^\alpha \cdot \mathfrak{f}_\beta \otimes \rho_\eta \langle \mathfrak{F}^\gamma, \mathfrak{E}^\beta \rangle, \left\{\widehat{\mathfrak{f}_\alpha^\mu}\right\}_{\alpha=0}^4\right)$$

$$+ \langle \left(\mathfrak{S}, \mathfrak{f}_\beta \otimes \rho_\eta(\mathfrak{E}^\beta), \left\{\widehat{\mathfrak{f}_\alpha^\mu}\right\}_{\alpha=0}^4\right), \phi^{\alpha,\eta}(\mathfrak{g}) 1 \rangle\, 1$$

En el que, la ciclicidad del campo cuántico, se expresa así:

$$\|\mathfrak{f} - \tilde{\mathfrak{g}}_\epsilon\|_{\mathcal{L}^4} = \left(\int_{\mathfrak{J}^4}^{\infty} \left|1 - \mathfrak{g}_\delta^{\eta-1}\right|^4 (\hat{\mathfrak{t}}) |\mathfrak{f}|^4 (\hat{\mathfrak{t}}) \mathfrak{d}\hat{\mathfrak{t}} \right)^{\frac{1}{2}} \le \mathcal{M} \left\|1 - \mathfrak{g}_\delta^{\eta-1}\right\|_{\mathcal{L}^4} < \epsilon$$

$$\mathfrak{E}^\gamma = \sum_{\beta=1}^{\eta(\gamma)} \mathfrak{d}_{\mathfrak{M},\beta}^\gamma\, ad\left(\mathfrak{F}^{\alpha_1^{\gamma,\beta}}\right) \cdots ad\left(\mathfrak{F}^{\alpha_{\mathfrak{M}-1}^{\gamma,\beta}}\right) \mathfrak{F}^{\alpha_{\mathfrak{M}}^{\gamma,\beta}}$$

Cuya función de Schwartz, en $\mathbb{R}^4$ es igual a:

$$\sum_{\beta=1}^{\eta(\gamma)} \mathfrak{d}_{\mathfrak{M},\beta}^{\gamma}\, \phi^{\alpha_{\eta}^{\gamma,\beta}}(\mathfrak{F}_{\eta}) \cdots \phi^{\alpha_{\mathfrak{M}}^{\gamma,\beta}}(\mathfrak{F}_{\mathfrak{M}}) = (\mathfrak{S}, \prod_{\mathrm{i}=1}^{\mathfrak{M}} \mathfrak{f}_{\mathrm{i}} \otimes \rho_{\eta}(\mathfrak{E}^{\gamma}), \{\epsilon_{\alpha}\}_{\beta=0}^{4}$$

$$\sum_{\beta=1}^{\eta(\gamma)} \mathfrak{d}_{\hat{\eta}}(\gamma,\xi)\phi^{\alpha_1(\gamma,\xi),\eta}(\mathfrak{G}_1) \cdots \phi^{\alpha_{\hat{\eta}-1}(\gamma,\xi),\eta}(\mathfrak{G}_{\hat{\eta}-1})\phi^{\alpha_{\hat{\eta}}(\gamma,\xi),\eta}(\mathfrak{G}_{\hat{\eta}})1 = \left(\mathfrak{S}, \prod_{\mathrm{i}=1}^{\hat{\eta}} \mathfrak{g}_{\mathrm{i}} \otimes \rho_{\eta}(\widehat{\mathfrak{E}}^{\gamma}), \{\epsilon_{\alpha}\}_{\alpha=0}^{4}\right)$$

Lo anterior, computacionalmente equivale a:

$$\left|\left(\mathfrak{S}, \mathfrak{f}\otimes\rho(\widehat{\mathfrak{E}}^{\gamma}), \{\epsilon_{\alpha}\}_{\alpha=0}^{4}\right) - \left(\mathfrak{S}, \prod_{\mathrm{i}=1}^{\hat{\eta}} \mathfrak{g}_{\mathrm{i}} \otimes \rho_{\eta}(\widehat{\mathfrak{E}}^{\gamma}), \{\epsilon_{\alpha}\}_{\alpha=0}^{4}\right)\right| < \epsilon$$

Cuya métrica de Minkowski, se define así:

$$\mathcal{T}(\mathfrak{f}) = \langle \phi^{\alpha,\eta}(\mathfrak{f}) \left(\widehat{\mathfrak{S}}, \hat{\mathfrak{g}}_{\gamma}\otimes\rho_{\eta}(\widehat{\mathfrak{E}}^{\gamma}), \{\tilde{\mathfrak{f}}_{\alpha}\}_{\alpha=0}^{4}\right), \left(\mathfrak{S}, \mathfrak{g}_{\beta}\otimes\rho_{\eta}(\mathfrak{E}^{\beta}), \{\hat{\mathfrak{f}}_{\alpha}\}_{\alpha=0}^{4}\right)\rangle$$

$$= \mathfrak{C}_{\alpha}^{\gamma,\beta} \int_{\mathfrak{J}^4}^{\infty} \mathfrak{d}\hat{\mathfrak{t}} \left(\mathfrak{f}^{\{\hat{\mathfrak{f}}_0,\hat{\mathfrak{f}}_1\}} \times \hat{\mathfrak{g}}_{\gamma} \cdot \overline{\mathfrak{g}_{\beta}}\right) \left(\sigma(\hat{\mathfrak{t}})\right) \cdot |\acute{\rho_{\sigma}}|(\hat{\mathfrak{t}})$$

$$\vec{\chi} \longrightarrow \mathfrak{f}^{\{\hat{\mathfrak{f}}_0,\hat{\mathfrak{f}}_1\}}(\vec{\chi}) \equiv \mathfrak{f}^{\{\hat{\mathfrak{f}}_0,\hat{\mathfrak{f}}_1\}} \left(\widehat{\mathcal{H}}(\rho_{\eta}), \widehat{\mathfrak{P}}(\rho_{\eta})\right)(\vec{\chi})$$

$$= \int_{\hat{\mathfrak{s}}\in\mathbb{R}^4}^{\infty} \frac{\mathrm{e}^{-\mathrm{i}(\sigma(\hat{\mathfrak{s}})\cdot(\widehat{\mathcal{H}}(\rho_{\eta})\hat{\mathfrak{f}}_0+\widehat{\mathfrak{P}}(\rho_{\eta}),\hat{\mathfrak{f}}_1))}}{2\pi} \mathfrak{f}(\vec{\chi} + \hat{\sigma}(\widehat{\mathfrak{S}}))|\acute{\rho_{\hat{\sigma}}}|(\widehat{\mathfrak{S}})\mathfrak{d}\hat{\mathfrak{s}}$$

$$\mathcal{T}(\mathfrak{f}) = \int_{\mathfrak{J}^4}^{\infty} \mathfrak{f}^{\{\hat{\mathfrak{f}}_0,\hat{\mathfrak{f}}_1\}} \left(\sigma(\hat{\mathfrak{t}})\right) \hbar(\hat{\mathfrak{t}})\mathfrak{d}\hat{\mathfrak{t}}$$

$$= \int_{\hat{\mathfrak{s}}\in\mathbb{R}^4,\mathfrak{t}\in\mathfrak{J}^4}^{\infty} \mathfrak{d}\hat{\mathfrak{t}}\,\mathfrak{d}\hat{\mathfrak{s}}\mathfrak{f}\left(\sigma(\hat{\mathfrak{t}}) + \hat{\sigma}(\widehat{\mathfrak{S}})|\acute{\rho_{\hat{\sigma}}}|(\widehat{\mathfrak{S}})|\acute{\rho_{\sigma}}|(\hat{\mathfrak{t}}) \cdot \frac{\mathrm{e}^{-\mathrm{i}(\hat{\sigma}(\widehat{\mathfrak{S}})\cdot\vec{\alpha})}}{2\pi} |\hat{\mathfrak{g}}_{\gamma} \cdot \overline{\mathfrak{g}_{\beta}}| \circ \sigma(\hat{\mathfrak{t}}) \cdot \mathfrak{C}_{\alpha}^{\gamma,\beta}\right)$$

En este punto, cabe aplicar la ley de transformación del operador cuántico, que se expresa así:

$$\mathfrak{U}(\vec{\alpha},\Lambda)\phi^{\alpha,\eta}(\mathfrak{f})\mathfrak{U}(\vec{\alpha},\Lambda)^{-1}\left(\mathfrak{S},\mathfrak{g}_{\beta}\otimes\rho_{\eta}\left(\mathfrak{E}^{\beta}\right),\left\{\hat{\mathfrak{f}}_{\alpha}\right\}_{\alpha=0}^{4}\right)$$

$$=\mathfrak{U}(\vec{\alpha},\Lambda)\phi^{\alpha,\eta}(\mathfrak{f})\left(\Lambda^{-1}(\mathfrak{S}-\vec{\alpha}),\mathcal{T}\left(\rho_{\eta},\vec{\alpha}\right)^{-1}\mathfrak{g}_{\beta}(\Lambda\cdot+\vec{\alpha})\otimes\rho_{\eta}\left(\mathfrak{E}^{\beta}\right),\mathcal{D}\right)$$

$$=\ \mathfrak{U}(\vec{\alpha},\Lambda)\left(\Lambda^{-1}(\mathfrak{S}-\vec{\alpha}),\left(\mathcal{T}\left(\rho_{\eta},\vec{\alpha}\right)^{-1}\mathfrak{f}^{\mathfrak{C}}\right)(\cdot)\mathfrak{d}_{\gamma}^{\alpha}\right.$$

$$\left.\cdot\,\mathfrak{g}_{\beta}(\Lambda\cdot+\vec{\alpha})\otimes ad\left(\rho_{\eta}\left(\mathfrak{F}^{\gamma}\right)\right)\rho_{\eta}\left(\mathfrak{E}^{\beta}\right),\mathcal{D}\right)$$

$$=\left(\mathfrak{S},\mathfrak{T}\left(\rho_{\eta},\vec{\alpha}\right)\mathcal{T}\left(\rho_{\eta},\vec{\alpha}\right)^{-1}\mathfrak{f}^{\mathfrak{C}}\left(\Lambda^{-1}(\cdot-\vec{\alpha})\right)\mathfrak{d}_{\gamma}^{\alpha}\mathfrak{g}_{\beta}(\cdot)\otimes ad\left(\rho_{\eta}\left(\mathfrak{F}^{\gamma}\right)\right)\rho_{\eta}\left(\mathfrak{E}^{\beta}\right),\left\{\hat{\mathfrak{f}}_{\alpha}\right\}_{\alpha=0}^{4},\mathcal{D}\right.$$

$$\mathfrak{f}^{\{\hat{\mathfrak{f}}_0,\hat{\mathfrak{f}}_1\}}\left(\widehat{\mathcal{H}}\left(\rho_{\eta}\right),\widehat{\mathfrak{P}}\left(\rho_{\eta}\right)\right)\left(\Lambda^{-1}(\vec{\chi}-\vec{\alpha})\right)=\int_{\widehat{\mathfrak{s}\in\mathbb{R}^4}}^{\infty}\frac{\mathrm{e}^{-\mathrm{i}\left(\hat{\sigma}(\hat{\mathfrak{s}})\cdot\left(\widehat{\mathcal{H}}\left(\rho_{\eta}\right)\widehat{\mathfrak{g}_0}+\widehat{\mathfrak{P}}\left(\rho_{\eta}\right),\widehat{\mathfrak{g}_1}\right)\right)}}{2\pi}\mathfrak{f}\left(\vec{\mathfrak{Y}}+\hat{\sigma}\,(\hat{\mathfrak{s}})|\rho_{\hat{\sigma}}'|\left((\widehat{\mathfrak{S}})\mathfrak{d}\hat{\mathfrak{s}}\right)\right.$$

$$=\int_{\widehat{\mathfrak{s}\in\mathbb{R}^4}}^{\infty}\frac{\mathrm{e}^{-\mathrm{i}\left(\sigma(\hat{\mathfrak{s}})\cdot\left(\widehat{\mathcal{H}}\left(\rho_{\eta}\right)\hat{\mathfrak{f}}_0+\widehat{\mathfrak{P}}\left(\rho_{\eta}\right),\hat{\mathfrak{f}}_1\right)\right)}}{2\pi}\mathfrak{f}\left(\vec{\mathfrak{Y}}+\Lambda^{-1}\sigma(\hat{\mathfrak{s}})\right)\ |\rho_{\sigma}'|\left((\widehat{\mathfrak{S}})\mathfrak{d}\hat{\mathfrak{s}}\right)$$

$$=\int_{\widehat{\mathfrak{s}\in\mathbb{R}^4}}^{\infty}\frac{\mathrm{e}^{-\mathrm{i}\left(\sigma(\hat{\mathfrak{s}})\cdot\left(\widehat{\mathcal{H}}\left(\rho_{\eta}\right)\hat{\mathfrak{f}}_0+\widehat{\mathfrak{P}}\left(\rho_{\eta}\right),\hat{\mathfrak{f}}_1\right)\right)}}{2\pi}\mathfrak{f}\left(\Lambda^{-1}\left(\vec{\mathfrak{Y}}+\sigma(\hat{\mathfrak{s}})-\vec{\alpha}\right)\right)\ |\rho_{\sigma}'|\left((\widehat{\mathfrak{S}})\mathfrak{d}\hat{\mathfrak{s}}\right)$$

$$=\mathfrak{f}\left(\Lambda^{-1}(\cdot-\vec{\alpha})\right)^{\{\hat{\mathfrak{f}}_0,\hat{\mathfrak{f}}_1\}}\left(\widehat{\mathcal{H}}\left(\rho_{\eta}\right),\widehat{\mathfrak{P}}\left(\rho_{\eta}\right)\right)(\vec{\mathfrak{Y}})$$

$$\left(\mathfrak{S},\mathfrak{f}\left(\Lambda^{-1}(\cdot-\vec{\alpha})\right)^{\{\hat{\mathfrak{f}}_0,\hat{\mathfrak{f}}_1\}}\mathfrak{A}(\Lambda^{-1})_{\gamma}^{\alpha}\mathfrak{A}(\widehat{\Lambda})_{\delta}^{\gamma}\cdot\mathfrak{g}_{\beta}\otimes ad\left(\rho_{\eta}\left(\mathfrak{F}^{\delta}\right)\right)\rho_{\eta}\left(\mathfrak{E}^{\beta}\right),\left\{\widehat{\Lambda}\epsilon_{\alpha}\right\}_{\alpha=0}^{4}\right)$$

$$=\mathfrak{A}(\Lambda^{-1})_{\gamma}^{\alpha}\phi^{\gamma,\eta}\left(\mathfrak{f}\left(\Lambda^{-1}(\cdot-\vec{\alpha})\right)\right)\left(\mathfrak{S},\mathfrak{g}_{\beta}\otimes\rho_{\eta}\left(\mathfrak{E}^{\beta}\right),\left\{\widehat{\Lambda}\epsilon_{\alpha}\right\}_{\alpha=0}^{4}\right)$$

Cuya simetría CPT, es igual a:

$$\left\lfloor\phi^{\alpha,\eta}(\mathfrak{f}),\phi^{\beta,\eta}(\mathfrak{g})^{*}\right\rfloor_{\pm}\left(\mathfrak{S},\hbar_{\gamma}\otimes\rho_{\eta}\left(\mathfrak{E}^{\gamma}\right)\right)$$

$$=-\mathfrak{A}(\Lambda)_{\delta}^{\alpha}\overline{\mathfrak{A}(\Lambda)_{\mu}^{\beta}}\left(\mathfrak{S},\mathfrak{B}^{\pm}\left(\mathfrak{f}^{\mathfrak{C}}\cdot\widehat{\mathfrak{g}^{\mathfrak{C}}}\pm\mathfrak{g}^{\mathfrak{C}}\cdot\widehat{\mathfrak{f}^{\mathfrak{C}}}\right)\right.$$

$$\cdot\,\hbar_{\gamma}\otimes ad\left(\rho_{\eta}\left(\mathfrak{F}^{\delta}\right)\right)ad\left(\rho_{\eta}\left(\mathfrak{F}^{\mu\nu}\right)\right)\left(\rho_{\eta}\left(\mathfrak{E}^{\gamma}\right)\right)$$

$$+\left\langle\left(\mathfrak{S},\hbar_{\gamma}\otimes\rho_{\eta}\left(\mathfrak{E}^{\gamma}\right)\right),\phi^{\beta,\eta}(\mathfrak{G})^{\circ}1\right\rangle\phi^{\alpha,\eta}(\mathfrak{F})^{*}1$$

$$\pm\ \left\langle\left(\mathfrak{S},\hbar_{\gamma}\otimes\rho_{\eta}\left(\mathfrak{E}^{\gamma}\right)\right),\phi^{\beta,\eta}(\mathfrak{F})^{*}1\right\rangle\phi^{\alpha,\eta}(\mathfrak{G})^{\circ}1$$

$$\phi^{\alpha,\eta}(\mathfrak{F})^{*}\phi^{\beta,\eta}(\mathfrak{G})^{*}\left(\mathfrak{S},\hbar_{\gamma}\otimes\rho_{\eta}(\mathfrak{E}^{\gamma})\right)$$

$$=\phi^{\alpha,\eta}(\mathfrak{F})^{*}\overline{\mathfrak{A}(\Lambda)^{\beta}_{\mu}}(\mathfrak{S},-\widehat{\mathfrak{g}^{\mathfrak{C}}}\cdot\hbar_{\gamma}\otimes ad(\rho_{\eta}(\mathfrak{F}^{\mu\nu}))(\rho_{\eta}(\mathfrak{E}^{\gamma}))$$

$$+\langle\left(\mathfrak{S},\hbar_{\gamma}\otimes\rho_{\eta}(\mathfrak{E}^{\gamma})\right),\phi^{\beta,\eta}(\mathfrak{G})^{\circ}1\rangle\,1)$$

$$=-\mathfrak{A}(\Lambda)^{\alpha}_{\delta}\overline{\mathfrak{A}(\Lambda)^{\beta}_{\mu}}(\mathfrak{S},\mathfrak{f}^{\mathfrak{C}}\cdot\widehat{\mathfrak{g}^{\mathfrak{C}}}\cdot\hbar_{\gamma}\otimes ad(\rho_{\eta}(\mathfrak{F}^{\delta}))ad(\rho_{\eta}(\mathfrak{F}^{\mu\nu}))(\rho_{\eta}(\mathfrak{E}^{\gamma}))$$

$$+\langle\left(\mathfrak{S},\hbar_{\gamma}\otimes\rho_{\eta}(\mathfrak{E}^{\gamma})\right),\phi^{\beta,\eta}(\mathfrak{G})^{\circ}1\rangle\;\phi^{\alpha,\eta}(\mathfrak{F})^{*}1$$

$$\mathfrak{g}^{\{\widehat{\mathfrak{f}_0},\widehat{\mathfrak{f}_1}\}}(\widehat{\mathcal{H}},\widehat{\mathfrak{P}})(\vec{\mathfrak{x}})=\int_{\widehat{\mathfrak{s}\in\mathbb{R}^4}}^{\infty}\frac{e^{-i(\vec{\mathfrak{y}}(\widehat{\mathfrak{s}})\cdot(\widehat{\mathcal{H}}\widehat{\mathfrak{f}_0}+\widehat{\mathfrak{P}}\widehat{\mathfrak{f}_1}))}}{2\pi}\mathfrak{g}(\vec{\mathfrak{x}}+\vec{\mathfrak{y}}(\widehat{\mathfrak{s}}))|\rho_{\widehat{\mathfrak{y}}}|(\widehat{\mathfrak{s}})\mathfrak{d}\widehat{\mathfrak{s}}$$

$$\overline{\mathfrak{f}^{\{\widehat{\mathfrak{f}_0},\widehat{\mathfrak{f}_1}\}}}(\widehat{\mathcal{H}},\widehat{\mathfrak{P}})(\vec{\mathfrak{x}})=\int_{\widehat{\mathfrak{t}\in\mathbb{R}^4}}^{\infty}\frac{e^{-i(\vec{\mathfrak{y}}(\mathfrak{t})\cdot(\widehat{\mathcal{H}}\widehat{\mathfrak{f}_0}+\widehat{\mathfrak{P}}\widehat{\mathfrak{f}_1}))}}{2\pi}\mathfrak{g}\left(\vec{\mathfrak{x}}+\vec{\mathfrak{y}}(\widehat{\mathfrak{t}})\right)|\rho_{\widehat{\mathfrak{y}}}|(\widehat{\mathfrak{t}})\mathfrak{d}\widehat{\mathfrak{t}}$$

$$\left[\mathfrak{g}^{\{\widehat{\mathfrak{f}_0},\widehat{\mathfrak{f}_1}\}}\cdot\overline{\mathfrak{f}^{\{\widehat{\mathfrak{f}_0},\widehat{\mathfrak{f}_1}\}}}\right](\widehat{\mathcal{H}},\widehat{\mathfrak{P}})(\vec{\mathfrak{x}})=\int_{\widehat{\mathfrak{s}\mathfrak{t}\in\mathbb{R}^4}}^{\infty}\frac{e^{-i(\vec{\mathfrak{y}}(\widehat{\mathfrak{s}})\cdot(\widehat{\mathcal{H}}\widehat{\mathfrak{f}_0}+\widehat{\mathfrak{P}}\widehat{\mathfrak{f}_1}))}}{(2\pi)^2}\mathfrak{g}_{\vec{\mathfrak{x}}}\left(\vec{\mathfrak{y}}(\widehat{\mathfrak{s}})+\vec{\mathfrak{y}}(\widehat{\mathfrak{t}})\right)\hat{\mathfrak{f}}_{\vec{\mathfrak{x}}}\left(\vec{\mathfrak{y}}(\widehat{\mathfrak{t}})\right)|\rho_{\widehat{\mathfrak{y}}}|(\widehat{\mathfrak{s}})|\rho_{\widehat{\mathfrak{y}}}|(\widehat{\mathfrak{t}})\mathfrak{d}\widehat{\mathfrak{s}}\,\mathfrak{d}\widehat{\mathfrak{t}}$$

$$=\int_{\widehat{\mathfrak{t}\in\mathbb{R}^4,\widehat{\mathfrak{s}}\in\mathcal{D}}}^{\infty}\frac{e^{-i(\vec{\mathfrak{y}}(\widehat{\mathfrak{s}})\cdot(\widehat{\mathcal{H}}\widehat{\mathfrak{f}_0}+\widehat{\mathfrak{P}}\widehat{\mathfrak{f}_1}))}}{(2\pi)^2}\mathfrak{g}_{\vec{\mathfrak{x}}}\left(\vec{\mathfrak{y}}(\widehat{\mathfrak{s}})+\vec{\mathfrak{y}}(\widehat{\mathfrak{t}})\right)\hat{\mathfrak{f}}_{\vec{\mathfrak{x}}}\left(\vec{\mathfrak{y}}(\widehat{\mathfrak{t}})\right)|\rho_{\widehat{\mathfrak{y}}}|(\widehat{\mathfrak{s}})|\rho_{\widehat{\mathfrak{y}}}|(\widehat{\mathfrak{t}})\mathfrak{d}\widehat{\mathfrak{s}}\,\mathfrak{d}\widehat{\mathfrak{t}}$$

$$\left[-\frac{e^{-i\left((\mu-\nu)\cdot(\widehat{\mathcal{H}}(\rho_{\eta})\widehat{\mathfrak{f}_0}+\widehat{\mathfrak{P}}(\rho_{\eta})\widehat{\mathfrak{f}_1})\right)}}{(2\pi)^2}+\frac{e^{-i\left((\nu-\mu)\cdot(\widehat{\mathcal{H}}(\rho_{\eta})\widehat{\mathfrak{f}_0}+\widehat{\mathfrak{P}}(\rho_{\eta})\widehat{\mathfrak{f}_1})\right)}}{(2\pi)^2}\right]\mathfrak{f}_{\vec{\mathfrak{x}}}(\mu)\bar{\mathfrak{g}}_{\vec{\mathfrak{x}}}(\mu)$$

En un mapa bilineal, tenemos:

$$(\mathfrak{f},\mathfrak{g})\in\mathcal{P}\times\mathfrak{P}\longrightarrow\langle\phi^{\alpha,\eta}(\mathfrak{f})\phi^{\beta,\eta}(\mathfrak{g})^{*}\left(\mathfrak{S},\hbar_{\gamma}\otimes\rho_{\eta}(\mathfrak{E}^{\gamma})\right),\left(\widehat{\mathfrak{S}},\widehat{\hbar_{\gamma}}\otimes\rho_{\eta}(\mathfrak{E}^{\gamma})\right)\rangle$$

$$-\langle\phi^{\alpha,\eta}(\mathfrak{f})^{*}\phi^{\beta,\eta}(\mathfrak{g})\left(\mathfrak{S},\hbar_{\gamma}\otimes\rho_{\eta}(\mathfrak{E}^{\gamma})\right),\phi^{\beta,\eta}(\mathfrak{g})1\rangle\langle\phi^{\alpha,\eta}(\mathfrak{f})1\left(\widehat{\mathfrak{S}},\widehat{\hbar_{\gamma}}\otimes\rho_{\eta}(\mathfrak{E}^{\gamma})\right)\rangle$$

$$\int_{\vec{\mathfrak{x}}\in\mathbb{R}^4}^{\infty}\int_{\vec{\mathfrak{y}}\in\mathbb{R}^4}^{\infty}\widehat{\mathcal{W}}(\vec{\mathfrak{x}},\vec{\mathfrak{y}})\mathfrak{f}(\vec{\mathfrak{x}})\bigotimes\mathbb{R}\,\mathfrak{g}(\vec{\mathfrak{y}})\mathfrak{d}\vec{\mathfrak{x}}\mathfrak{d}\vec{\mathfrak{y}}$$

$$=\int_{\vec{\mathfrak{x}}\in\mathbb{R}^4}^{\infty}\int_{\vec{\mathfrak{y}}\in\mathbb{R}^4}^{\infty}\Re\mathfrak{E}\widehat{\mathcal{W}}(\vec{\mathfrak{x}},\vec{\mathfrak{y}})\left[\hat{\mathfrak{f}}(\vec{\mathfrak{x}})\tilde{\mathfrak{g}}(\vec{\mathfrak{y}})+\bar{\mathfrak{f}}(\vec{\mathfrak{x}})\bar{\mathfrak{g}}(\vec{\mathfrak{y}})\right]\mathfrak{d}\vec{\mathfrak{x}}\mathfrak{d}\vec{\mathfrak{y}}$$

$$+\Im\int_{\vec{\mathfrak{x}}\in\mathbb{R}^4}^{\infty}\int_{\vec{\mathfrak{y}}\in\mathbb{R}^4}^{\infty}\Im\mathfrak{M}\widehat{\mathcal{W}}(\vec{\mathfrak{x}},\vec{\mathfrak{y}})\left[\hat{\mathfrak{f}}(\vec{\mathfrak{x}})\tilde{\mathfrak{g}}(\vec{\mathfrak{y}})-\bar{\mathfrak{f}}(\vec{\mathfrak{x}})\bar{\mathfrak{g}}(\vec{\mathfrak{y}})\right]\mathfrak{d}\vec{\mathfrak{x}}\mathfrak{d}\vec{\mathfrak{y}}$$

$$=\langle\phi^{\alpha,\eta}(\mathfrak{f})\phi^{\beta,\eta}(\mathfrak{g})^{*}\left(\mathfrak{S},\hbar_{\gamma}\otimes\rho_{\eta}(\mathfrak{E}^{\gamma})\right),\left(\widehat{\mathfrak{S}},\widehat{\hbar_{\gamma}}\otimes\rho_{\eta}(\mathfrak{E}^{\gamma})\right))\rangle$$

$$-\langle\phi^{\alpha,\eta}(\mathfrak{f})^{*}\phi^{\beta,\eta}(\mathfrak{g})\left(\mathfrak{S},\hbar_{\gamma}\otimes\rho_{\eta}(\mathfrak{E}^{\gamma})\right),\phi^{\beta,\eta}(\mathfrak{g})1\rangle\langle\phi^{\alpha,\eta}(\mathfrak{f})1\left(\widehat{\mathfrak{S}},\widehat{\hbar_{\gamma}}\otimes\rho_{\eta}(\mathfrak{E}^{\gamma})\right)\rangle$$

$$\phi^{\alpha,\eta}(\mathfrak{f})\phi^{\beta,\eta}(\mathfrak{g})^{*}\left(\mathfrak{S},\hbar_{\gamma}\otimes\rho_{\eta}(\mathfrak{E}^{\gamma})\right)-\langle\left(\mathfrak{S},\hbar_{\gamma}\otimes\rho_{\eta}(\mathfrak{E}^{\gamma})\right)\phi^{\beta,\eta}(\mathfrak{g})1\rangle\,\phi^{\alpha,\eta}(\mathfrak{f})1$$

$$=-\mathfrak{A}(\Lambda)^{\alpha}_{\delta}\overline{\mathfrak{A}(\Lambda)^{\beta}_{\mu}}(\mathfrak{S},\left(\mathfrak{f}^{\{\mathfrak{f}_0,\mathfrak{f}_1\}}\cdot\overline{\mathfrak{g}^{\{\mathfrak{f}_0,\mathfrak{f}_1\}}}\right)\cdot\hbar_{\gamma}\otimes ad(\rho_{\eta}(\mathfrak{F}^{\delta}))ad(\rho_{\eta}(\mathfrak{F}^{\mu\nu}))(\rho_{\eta}(\mathfrak{E}^{\gamma})))$$

$$\mathfrak{A}^{\pm}(\vec{\mathfrak{z}})\int_{\widehat{\mathfrak{s}\mathfrak{t}}\in\mathbb{R}^4}^{\infty}\frac{e^{-\mathfrak{i}(\hat{\mathfrak{y}}(\hat{\mathfrak{s}})-\hat{\mathfrak{y}}(\hat{\mathfrak{t}}))\cdot(\widehat{\mathcal{H}\mathfrak{f}_0}+\widehat{\mathfrak{P}\mathfrak{f}_1})}}{(2\pi)^2}\mathfrak{f}\vec{\mathfrak{z}}\left(\vec{\mathfrak{y}}(\hat{\mathfrak{s}})\bar{\mathfrak{g}}\vec{\mathfrak{z}}(\vec{\mathfrak{y}}(\hat{\mathfrak{t}})\right)|\acute{\rho}_{\hat{\mathfrak{y}}}|(\hat{\mathfrak{s}})|\acute{\rho}_{\hat{\mathfrak{y}}}|(\hat{\mathfrak{t}})\mathfrak{d}\hat{\mathfrak{s}}\,\mathfrak{d}\hat{\mathfrak{t}}$$

$$\pm\int_{\widehat{\mathfrak{s}\mathfrak{t}}\in\mathbb{R}^4}^{\infty}\frac{e^{-\mathfrak{i}(\hat{\mathfrak{y}}(\hat{\mathfrak{s}})-\hat{\mathfrak{y}}(\hat{\mathfrak{t}}))\cdot(\widehat{\mathcal{H}\mathfrak{f}_0}+\widehat{\mathfrak{P}\mathfrak{f}_1})}}{(2\pi)^2}\mathfrak{g}\vec{\mathfrak{z}}\left(\vec{\mathfrak{y}}(\hat{\mathfrak{t}})\bar{\mathfrak{f}}\vec{\mathfrak{z}}(\vec{\mathfrak{y}}(\hat{\mathfrak{s}})\right)|\acute{\rho}_{\hat{\mathfrak{y}}}|(\hat{\mathfrak{s}})|\acute{\rho}_{\hat{\mathfrak{y}}}|(\hat{\mathfrak{t}})\mathfrak{d}\hat{\mathfrak{s}}\,\mathfrak{d}\hat{\mathfrak{t}}$$

Aplicando en este punto, la función beta de Callan-Symanzik, tenemos:

$$\beta(\mathfrak{C})=\partial\mathfrak{C}/\partial\left|\Im\mathfrak{N}\widehat{\mathfrak{N}}_{\eta}\right|$$

En tanto que, del operador cuántico hamiltoniano, se obtiene:

$$\mathcal{T}\mathfrak{r}(\rho(\mathfrak{E}^{\alpha}))\left(\rho(\mathfrak{E}^{\beta})\right)=\mathfrak{C}(\rho)\mathcal{T}\mathfrak{r}\left(\mathfrak{E}^{\alpha}\mathfrak{E}^{\beta}\right)$$

$$\mathcal{E}(\rho)=\sum_{\alpha=1}^{\mathfrak{N}}(\rho(\mathfrak{E}^{\alpha}))\left(\rho(\mathfrak{E}^{\beta})\right)$$

$$=1/\kappa\sum_{\alpha=1}^{\mathfrak{N}}\kappa^2/4\int_{\hat{\mathfrak{s}}\in(-\delta,1+\delta)^4}^{\infty}\mathfrak{d}\hat{\mathfrak{s}}\sum_{\mathfrak{i};\mathfrak{j}=1}^{4}\left|\mathfrak{J}^{\sigma}_{0\mathfrak{i}\mathfrak{j}}\right|(\mathfrak{d}\hat{\mathfrak{s}})\kappa\left(\psi\cdot\mathfrak{d}_0\mathfrak{A}_{\mathfrak{i}\mathfrak{j},\alpha}\right)\left(\frac{\kappa\sigma(\hat{\mathfrak{s}})}{2}\right)\rho(\mathfrak{E}^{\alpha})$$

$$\mathfrak{C}\sum_{\alpha=1}^{\eta}\int_{\hat{\mathfrak{s}}\in\mathfrak{I}^4_{\delta}}^{\infty}\mathfrak{d}\hat{\mathfrak{s}}\sum_{\mathfrak{i};\mathfrak{j}=1}^{4}\left|\mathfrak{J}^{\sigma}_{0\mathfrak{i}\mathfrak{j}}\right|(\hat{\mathfrak{s}})\left(\mathfrak{d}_0\mathfrak{A}_{\mathfrak{i}\mathfrak{j},\alpha}\right)\left(\sigma(\hat{\mathfrak{s}})\right)\rho(\mathfrak{E}^{\alpha})$$

$$\langle\nu^{\kappa,\rho}_{\mathcal{R}(\alpha,\tau)}\rangle^2=-\mathbb{E}\left(\cdot,\nu^{\kappa,\rho}_{\mathcal{R}(\alpha,\tau)}\right)^2\mathcal{Y}^{\kappa}$$

$$\mathfrak{A}^{\rho}=\sum_{\alpha=1}^{\eta}\sum_{\mathrm{i;j}=1}^{4}\alpha_{\mathrm{i},\alpha}\otimes\mathfrak{d}\mathfrak{x}^{\mathrm{i}}\otimes\rho(\mathfrak{E}^{\alpha})\in\mathfrak{S}_{\mathfrak{K}}(\mathbb{R}^4)\otimes\Lambda^1(\mathbb{R}^4)\otimes\rho(\mathfrak{g})$$

$$\frac{1}{3}=\int_{\{\mathfrak{d}\mathfrak{A}\in\mathfrak{S}_{\mathfrak{K}}(\mathbb{R}^4)\otimes\Lambda^2(\mathbb{R}^4)\otimes\rho(\mathfrak{g})\}}^{\infty}\exp(\mathfrak{C}\int_{\mathcal{R}(\alpha)}^{\infty}\mathfrak{d}\{\mathfrak{A}^{\rho}\})\,\mathfrak{e}^{-1/2\mathfrak{S}_{\mathfrak{YM}}(\mathfrak{A})}\mathfrak{D}|\mathfrak{d}\mathfrak{A}|=\mathbb{E}_{\mathcal{YM}}^{\kappa}(\exp(\left(\cdot,\nu_{\mathcal{R}(\alpha)}^{\kappa,\rho}\right)))$$

$$\mathfrak{Z}=\int_{\{\mathfrak{d}\mathfrak{A}\in\mathfrak{S}_{\mathfrak{K}}(\mathbb{R}^4)\otimes\Lambda^2(\mathbb{R}^4)\otimes\rho(\mathfrak{g})\}}^{\infty}\mathfrak{e}^{-1/2\mathfrak{S}_{\mathfrak{YM}}(\mathfrak{A})}\mathfrak{D}|\mathfrak{d}\mathfrak{A}|$$

$$-\mathbb{E}\left(\cdot,\nu_{\mathcal{R}(\alpha)}^{\kappa,\rho_\eta}\right)\left(\cdot,\nu_{\mathcal{R}_\delta(\alpha)}^{\kappa,\rho_\eta}\right)\mathcal{Y}^{\kappa}=\frac{|\alpha|}{4\otimes\mathfrak{E}(\rho_\eta)}-\epsilon(\eta,\kappa)$$

$$\overline{\mathfrak{T}}/\kappa^4\mathcal{C}(\rho_\eta)\leq\mathcal{T}\mathfrak{r}\in(\eta,\kappa)\leq\overline{\mathfrak{T}}/\kappa^4\mathcal{C}(\rho_\eta)$$

Más, aplicando la ecuación de Callan-Symanzik, tenemos:

$$-\frac{1}{\mathfrak{C}(\rho_\eta)\mathbb{E}\left(\cdot,\nu_{\mathcal{R}(\alpha)}^{\kappa,\rho_\eta}\right)\left(\cdot,\nu_{\mathcal{R}_\delta(\alpha)}^{\kappa,\rho_\eta}\right)\mathcal{Y}^{\kappa}}=\frac{\frac{|\alpha|}{4\otimes\mathfrak{E}_4(\rho_\eta)}}{\mathfrak{E}(\rho_\eta)\mathbb{I}_\eta}-1/\mathcal{C}(\rho_\eta)\epsilon(\eta,\kappa)$$

$$\frac{\widehat{\mathcal{N}_\eta}\mathfrak{E}_4(\rho_\eta)}{\mathfrak{E}(\rho_\eta)}-\frac{1}{\mathfrak{E}(\rho_\eta)\mathcal{T}\mathfrak{r}}\in(\eta,\kappa)\equiv\mathbb{N}-1/\mathfrak{E}(\rho_\eta)\,\mathcal{T}\mathfrak{r}\in(\eta,\kappa)$$

$$\left\{e\frac{\partial}{\partial e}+\beta(\mathfrak{C})\frac{\partial}{\partial\mathfrak{C}}+2\gamma(\mathfrak{C})\right\}\mathfrak{G}_\eta^{(4)}(\mathfrak{C},\epsilon)=0$$

$$\mathfrak{G}_\eta^{(4)}(\mathfrak{C},\epsilon)=\frac{\widehat{\mathcal{N}_\eta}}{\epsilon}-c^4\hat{\lambda}+\mathfrak{f}(c^5)=\frac{\partial}{\partial e}\mathfrak{G}_\eta^{(4)}(\mathfrak{C},\epsilon)=-\frac{\widehat{\mathcal{N}_\eta}}{\epsilon},\frac{\partial}{\partial\mathfrak{G}}\mathfrak{G}_\eta^{(4)}(\mathfrak{C},\epsilon)=-4c^3\hat{\lambda}+\hat{\mathfrak{f}}(c^4)$$

$$-\frac{\widehat{\mathcal{N}_\eta}}{\epsilon}-4\beta(\mathfrak{C})c^3\hat{\lambda}+2\gamma(\mathfrak{C})\mathfrak{G}_\eta^{(4)}(\mathfrak{C},\epsilon)+\beta(\mathfrak{C})\,\hat{\mathfrak{f}}(c^4)=0$$

$$-\frac{\mathfrak{C}}{4}\hat{\mathfrak{f}}(c^4)+\mathfrak{f}(c^5)-4c^3\lambda(\mathfrak{C})\hat{\lambda}+\lambda(\mathfrak{C})\hat{\mathfrak{f}}(c^4)=0$$

$$\frac{1}{c^4|\hat{\mathfrak{f}}(c^4)|}+\frac{1}{c^5}|\hat{\mathfrak{f}}(c^5)|\leq\hat{\mathbb{C}}^4$$

$$\hat{\lambda}(\mathfrak{C})=\frac{1}{4c^3\bar{\lambda}}+\hat{\mathfrak{f}}(c^4)\left(\frac{\mathfrak{C}}{4\hat{\mathfrak{f}}(c^4)}-\hat{\mathfrak{f}}(c^5)\right)$$

Por tanto, la brecha de masa se vuelve positiva y por ende, superior a cero (estado de vacío), cuando:

$$\langle \mathfrak{C}_4(\rho)\nu, \upsilon\rangle = \sum_{\alpha=1}^{N} \langle \rho(\mathfrak{E}^{\alpha})\nu, \rho(\mathfrak{E}^{\alpha})\nu\rangle \geq \sum_{\alpha=1}^{\mathcal{L}} \left| \sum_{\beta=1}^{\mathcal{L}} \alpha_{\alpha,\beta}\lambda_{\rho}(\mathcal{H}_{\beta}) \right|_4^4$$

$$= \sum_{\alpha=1}^{\mathcal{L}} \sum_{\beta=1}^{\mathcal{L}} \sum_{\gamma=1}^{\mathcal{L}} \lambda_{\rho}(\mathcal{H}_{\beta})\alpha_{\alpha,\beta}\alpha_{\alpha,\gamma}\lambda_{\rho}(\mathcal{H}_{\gamma}) \geq \mathfrak{C}|\lambda_{\rho}|_4^4$$

$$\widehat{\mathcal{H}}(\rho_{\eta})^2 = \frac{\widehat{\mathfrak{N}}_{\eta}}{4}\mathfrak{C}_2(\rho_{\eta}) = \frac{\mathfrak{N}}{4}\mathfrak{C}(\rho_{\eta}) = 0$$

$$\frac{\partial c}{\partial(\mathbb{I}_{\eta}\widehat{\mathfrak{N}})} = -\frac{\mathfrak{C}}{4} + \lambda(\mathfrak{C}), |\lambda(\mathfrak{C})| \leq \widehat{\mathfrak{C}}_4\widetilde{\mathfrak{C}}_2 = \frac{\mathfrak{d}\mathfrak{C}}{\mathfrak{d}(\mathbb{I}_{\eta}\widehat{\mathfrak{N}})} = -\frac{\mathfrak{C}}{4} + \lambda(\mathfrak{C}) \Rightarrow \frac{\mathfrak{d}\mathfrak{C}}{\mathfrak{C}} - 4\lambda(\mathfrak{C}) = -\frac{\mathfrak{d}(\mathbb{I}_{\eta}\widehat{\mathfrak{N}})}{4}$$

$$= \frac{1}{c}\frac{\mathfrak{d}\mathfrak{C}}{1+\mu(\mathfrak{C})} = -\frac{\mathfrak{d}(\mathbb{I}_{\eta}\widehat{\mathfrak{N}})}{4} \Rightarrow \left(\frac{1}{c\sum_{\kappa=0}^{\infty}(-1)^{\kappa}\mu(\mathfrak{C})^{\kappa}}\right)\mathfrak{d}\mathfrak{C} = \frac{\mathfrak{d}(\mathbb{I}_{\eta}\widehat{\mathfrak{N}})}{4}$$

$$\mathcal{T}\mathfrak{r}\mathbb{E}\left(\left(\cdot, \nu_{\mathcal{R}(\alpha)}^{\kappa,\rho_{\eta}}\right)\left(\cdot, \nu_{\mathcal{R}_{\delta}(\alpha)}^{\kappa,\rho_{\eta}}\right)\mathcal{Y}^{\kappa}\right) = \frac{\widehat{\mathfrak{N}}_{\eta}}{4}\mathfrak{C}_2(\rho_{\eta}) - \mathcal{T}\mathfrak{r}\epsilon(\eta,\kappa)$$

$$= \frac{4}{\mathfrak{N}\mathfrak{C}(\rho_{\eta})}\mathcal{T}\mathfrak{r}\mathbb{E}\left(-\left(\cdot, \nu_{\mathcal{R}(\alpha)}^{\kappa,\rho_{\eta}}\right)\left(\cdot, \nu_{\mathcal{R}_{\delta}(\alpha)}^{\kappa,\rho_{\eta}}\right)\mathcal{Y}^{\kappa}\right) - 1 = -\frac{4\mathcal{T}\mathfrak{r}\epsilon(\eta,\kappa)}{\mathfrak{N}\mathfrak{C}(\rho_{\eta})}$$

$$\mathcal{U}(\vec{\alpha},1)\left(\mathfrak{S}, \mathfrak{f}_{\alpha}\otimes\rho(\mathfrak{E}^{\alpha}), \{\mathfrak{f}_{\alpha}\}_{\alpha=0}^{4}\right) = \mathfrak{e}^{-\mathrm{i}\left(\hat{\mathfrak{f}}_0\cdot\widehat{\mathcal{H}}(\vec{\alpha},\rho)+\hat{\mathfrak{f}}_1\cdot\widehat{\mathfrak{P}}(\vec{\alpha},\rho)\right)}\left(\mathfrak{S}+\vec{\alpha}, \mathfrak{f}_{\alpha}(\cdot-\vec{\alpha})\otimes\rho(\mathfrak{E}^{\alpha}), \{\hat{\mathfrak{f}}_{\alpha}\}_{\alpha=0}^{4}\right)$$

$$= \mathfrak{e}^{\mathrm{i}\left(\alpha_0\widehat{\mathcal{H}}(\rho)-\alpha^1\widehat{\mathfrak{P}}(\rho)\right)}\left(\mathfrak{S}+\vec{\alpha}, \mathfrak{f}_{\alpha}(\cdot-\vec{\alpha})\otimes\rho(\mathfrak{E}^{\alpha}), \{\hat{\mathfrak{f}}_{\alpha}\}_{\alpha=0}^{4}\right)$$

Cuyas particiones corresponden a:

$$\int_{\mathfrak{Q}}^{\infty}\{\hbar_{\theta}\}_{\theta=1}^{\mathfrak{r}+\mathfrak{s}} = \prod_{\mathfrak{l}=1}^{\eta(\mathfrak{Q})}\left\{\frac{\int_{\mathfrak{S}_0}^{\infty}(\prod_{\theta\in\mathfrak{A}_{\mathfrak{l}}}\int_{\gamma_{\theta}^{-}\in\mathbb{R}^4}^{\infty}\mathfrak{e}^{\mathrm{i}\chi(\theta)(\gamma_{\theta}^{0}\widehat{\mathcal{H}}-\gamma_{\theta}^{1}\widehat{\wp})}}{2\varpi}\hbar_{\theta}(\gamma_{\theta}^{-},\gamma^{+})\mathfrak{d}\gamma_{\theta}^{-})\mathfrak{d}\gamma^{+}\right\}$$

$$= \prod_{\mathfrak{l}=1}^{\eta(\mathfrak{Q})}\left\{\frac{\int_{\mathfrak{S}_0}^{\infty}(\prod_{\theta\in\mathfrak{A}_{\mathfrak{l}}}\int_{\gamma_{\theta}^{0}\gamma_{\theta}^{1}\in\mathbb{R}^4}^{\infty}\mathfrak{e}^{\mathrm{i}\chi(\theta)(\gamma_{\theta}^{0}\widehat{\mathcal{H}}-\gamma_{\theta}^{1}\widehat{\wp})}}{2\varpi}\hbar_{\theta}(\gamma_{\theta}^{0},\gamma_{\theta}^{1},\gamma^{2},\gamma^{4})\mathfrak{d}\gamma_{\theta}^{0}\mathfrak{d}\gamma_{\theta}^{1})\mathfrak{d}\gamma^{2}\mathfrak{d}\gamma^{4}\right\}$$

$$\langle \mathfrak{A}_\tau^\eta \mathfrak{B}_\delta^\eta 1,4\rangle - \langle \mathfrak{A}_\tau^\eta 1,4\rangle\langle \mathfrak{B}_\delta^\eta 1,4\rangle \equiv \langle \mathfrak{A}_\tau^\eta \mathfrak{P}_0 \mathfrak{B}_\delta^\eta 1,4\rangle$$

$$= \int_{\mathbb{R}^4\times\cdots\mathbb{R}^4}^{\infty} \mathfrak{W}^\eta\left((\vec{\mathfrak{x}}_\tau)_{\tau=1}^{\mathfrak{r}}, (\vec{\mathfrak{x}}_\theta)_{\theta=\tau+1}^{\mathfrak{r}+\delta}\right) \otimes_{\theta\,=\,\tau+1}^{\mathfrak{r}+\delta} \rho\tau(\vec{\mathfrak{x}}_\tau)\cdot \prod_{\theta=\tau+1}^{\mathfrak{r}+\delta} \mathfrak{d}\vec{\mathfrak{x}}_\tau$$

$$= \mathfrak{C}_{\mathcal{R}} \int_{\mathfrak{S}_0}^{\infty} \Big(\prod_{\tau=1}^{\mathfrak{r}} \int_{\mathfrak{x}_\tau^-\in\mathbb{R}^4}^{\infty} \mathbb{E}(\mathfrak{x}_\tau^-)\hbar_\tau(\mathfrak{x}_\tau^-, \mathfrak{x}^+)\,\mathfrak{d}\mathfrak{x}_\tau^- \cdot \prod_{\theta=\tau+1}^{\mathfrak{r}+\delta} \int_{\mathfrak{x}_\theta^-\in\mathbb{R}^4}^{\infty} \mathbb{E}(\mathfrak{x}_\theta^-)\hbar_\theta(\mathfrak{x}_\theta^-, \mathfrak{x}^+)\,\mathfrak{d}\mathfrak{x}_\theta^-\Big)\,\mathfrak{d}\mathfrak{x}^+$$

$$+ \sum_{\substack{\mathbb{Q}\neq\mathfrak{R}\\ \mathbb{Q}\in\Gamma}} \mathfrak{C}_{\mathfrak{Q}} \int_{\mathfrak{Q}}^{\infty} \{\mathfrak{H}_\theta\}_{\theta=1}^{\tau+\delta}$$

$$\langle \mathfrak{P}_0 \mathfrak{U}(\vec{\alpha},1)\mathfrak{B}_\delta^\eta 1\rangle = \mathfrak{P}_0 \psi^{\beta_1,\eta}(\mathfrak{g}_1)_{\mathfrak{u}(\vec{\alpha})} \psi^{\beta_2,\eta}(\mathfrak{g}_2)_{\mathfrak{u}(\vec{\alpha})} \cdots \psi^{\beta_{\delta-1},\eta}(\mathfrak{g}_{\delta-1})_{\mathfrak{u}(\vec{\alpha})} \mathfrak{U}(\vec{\alpha},1)\psi^{\beta\delta,\eta}(\mathfrak{g}_\delta)1$$

$$= \mathfrak{e}^{\mathrm{i}(\alpha^0\hat{\mathcal{H}}-\alpha^1\hat{\wp})} \mathfrak{P}_0 \mathfrak{B}_\delta^{\eta,\vec{\alpha}} 1 = \mathfrak{e}^{\mathrm{i}(\alpha^0\hat{\mathcal{H}}-\alpha^1\hat{\wp})}\left(\mathfrak{B}_\delta^{\eta,\vec{\alpha}} 1 - \langle \mathfrak{B}_\delta^\eta 1,1\rangle 1\right)$$

$$\langle \mathfrak{A}_\tau^\eta \mathfrak{P}_0 \mathfrak{U}(\vec{\alpha},1)\mathfrak{B}_\delta^\eta 1,1\rangle = \mathfrak{e}^{\mathrm{i}(\alpha^0\hat{\mathcal{H}}-\alpha^1\hat{\wp})}\left(\langle \mathfrak{A}_\tau^\eta \mathfrak{B}_\delta^{\eta,\vec{\alpha}} 1,1\rangle - \langle \mathfrak{A}_\tau^\eta 1,1\rangle\langle \mathfrak{B}_\delta^\eta 1,1\rangle\right)$$

$$\mathfrak{e}^{\mathrm{i}(\alpha^0\hat{\mathcal{H}}-\alpha^1\hat{\wp})} = \int_{\mathbb{R}^4}^{\infty} \frac{\mathfrak{e}^{\mathbb{i}(\mathfrak{s}\hat{\mathcal{H}}-\mathfrak{t}\hat{\wp})}}{2\varpi} \mathfrak{f}(\mathfrak{s},\mathfrak{t},\mathfrak{x}^2,\mathfrak{x}^4)\mathfrak{d}\mathfrak{s}\mathfrak{d}\mathfrak{t} = \int_{\mathbb{R}^4}^{\infty} \frac{\mathfrak{e}^{\mathbb{i}\left((\mathfrak{s}+\alpha^0)\hat{\mathcal{H}}-(\mathfrak{t}+\alpha^1)\hat{\wp}\right)}}{2\varpi} \mathfrak{f}(\mathfrak{s},\mathfrak{t},\mathfrak{x}^2,\mathfrak{x}^4)\mathfrak{d}\mathfrak{s}\mathfrak{d}\mathfrak{t}$$

$$= \int_{\mathbb{R}^4}^{\infty} \frac{\mathfrak{e}^{\mathbb{i}(\mathfrak{s}\hat{\mathcal{H}}-\mathfrak{t}\hat{\wp})}}{2\varpi} \mathfrak{f}(\mathfrak{s}-\alpha^0,\mathfrak{t}-\alpha^1,\mathfrak{x}^2,\mathfrak{x}^4)\mathfrak{d}\mathfrak{s}\mathfrak{d}\mathfrak{t}$$

$$= \mathfrak{f}\left(\cdot - (\alpha^0,\alpha^1,0,0)\right)^{\{\epsilon_0\epsilon_1\}}(\hat{\mathcal{H}},\hat{\wp})(0,0,\mathfrak{x}^2,\mathfrak{x}^4)$$

$$\mathcal{H}^\eta(\vec{\alpha}) = \int_{\mathbb{R}^4\times\cdots\mathbb{R}^4}^{\infty} \mathfrak{W}^\eta\left((\vec{\mathfrak{x}}_\tau)_{\tau=1}^{\mathfrak{r}}, (\vec{\mathfrak{x}}_\theta)_{\theta=\tau+1}^{\mathfrak{r}+\delta}\right) \otimes_{\tau\,=\,1}^{\mathfrak{r}} \rho\tau(\vec{\mathfrak{x}}_\tau)\cdot \otimes_{\theta\,=\,\tau+1}^{\mathfrak{r}+\delta} \wp_0(\vec{\mathfrak{x}}_{\tau+\theta}-\vec{\alpha})\cdot \prod_{\tau=1}^{\mathfrak{r}+\delta} \mathfrak{d}\vec{\mathfrak{x}}_\tau$$

$$\equiv \int_{\mathbb{R}^4\times\cdots\mathbb{R}^4}^{\infty} \mathfrak{W}^\eta\left((\vec{\mathfrak{x}}_\tau)_{\tau=1}^{\mathfrak{r}}, (\vec{\mathfrak{x}}_\theta)_{\theta=\tau+1}^{\mathfrak{r}+\delta}\right) \otimes_{\tau\,=\,1}^{\mathfrak{r}+\delta} \rho\tau(\vec{\mathfrak{x}}_\tau)\cdot \prod_{\tau=1}^{\mathfrak{r}+\delta} \mathfrak{d}\vec{\mathfrak{x}}_\tau$$

$$= \mathfrak{C}_{\mathcal{R}} \int_{\mathfrak{S}_0}^{\infty} \Big(\prod_{\tau=1}^{\mathfrak{r}} \int_{\mathfrak{x}_\tau^-\in\mathbb{R}^4}^{\infty} \mathbb{E}(\mathfrak{x}_\tau^-)\hbar_\tau(\mathfrak{x}_\tau^-, \mathfrak{x}^+)\,\mathfrak{d}\mathfrak{x}_\tau^- \cdot \prod_{\theta=\tau+1}^{\mathfrak{r}+\delta} \int_{\mathfrak{x}_\theta^-\in\mathbb{R}^4}^{\infty} \mathbb{E}(\mathfrak{x}_\theta^-)\hbar_\theta(\mathfrak{x}_\theta^-, \mathfrak{x}^+)\,\mathfrak{d}\mathfrak{x}_\theta^-\Big)\,\mathfrak{d}\mathfrak{x}^+$$

$$+ \sum_{\substack{\mathbb{Q}\neq\mathfrak{R}\\ \mathbb{Q}\in\Gamma}} \mathfrak{C}_{\mathfrak{Q}} \int_{\mathfrak{Q}}^{\infty} \{\mathfrak{H}_\theta\}_{\theta=1}^{\tau+\delta}$$

$$= \mathcal{H}_4^\eta(\vec{\alpha}) = \int_{\mathbb{R}^4\times\cdots\mathbb{R}^4}^{\infty} \prod_{\tau=1}^{\mathfrak{r}+\delta} \mathfrak{d}\vec{\mathfrak{x}}_\tau\, \mathfrak{W}^\eta\left((\vec{\mathfrak{x}}_\tau)_{\tau=1}^{\mathfrak{r}}, (\vec{\mathfrak{x}}_\theta+\vec{\alpha})_{\theta=\tau+1}^{\mathfrak{r}+\delta}\right)\varphi_1\left((\vec{\mathfrak{x}}_\mathfrak{r})_{\tau=1}^{\mathfrak{r}}\right)\varphi_2\left((\vec{\mathfrak{x}}_\theta)_{\theta=\tau+1}^{\mathfrak{r}+\delta}\right)$$

$$\mathfrak{W}^{\eta}\left((\vec{\mathfrak{x}}_\tau)_{\tau=1}^{\mathfrak{r}},(\vec{\mathfrak{x}}_\theta+\vec{\alpha})_{\theta=\tau+1}^{\mathfrak{r}+\delta}\right)=\mathfrak{e}^{-\imath\vec{\alpha}\cdot\mathfrak{C}_\tau\mathfrak{m}_\eta\hat{\mathfrak{f}}_0^\eta}\prod_{\theta=1}^{\tau+\delta}\mathfrak{E}(\mathfrak{x}_\theta^-)\cdot\mathfrak{W}_0^{\eta}\left((\mathfrak{x}_\tau^+)_{\tau=1}^{\mathfrak{r}},(\mathfrak{x}_\theta^++\alpha^+)_{\theta=\tau+1}^{\mathfrak{r}+\delta}\right)$$

$$\mathfrak{W}_0^{\eta}\left((\mathfrak{x}_\tau^+)_{\tau=1}^{\mathfrak{r}},(\mathfrak{x}_\theta^++\vec{\alpha})_{\theta=\tau+1}^{\mathfrak{r}+\delta}\right)=\mathfrak{W}^{\eta}\left((0^-,\mathfrak{x}_\tau^+)_{\tau=1}^{\mathfrak{r}},(0^-,\mathfrak{x}_\theta^++\alpha^+)_{\theta=\tau+1}^{\mathfrak{r}+\delta}\right)$$

$$\hat{\varphi}_1((\mathfrak{q}_\tau^-,\mathfrak{x}_\tau^+)_{\tau=1}^{\mathfrak{r}})=\frac{\int_{\mathbb{R}^{4\tau}}^{\infty}\prod_{\tau=1}^{\mathfrak{r}}\mathfrak{e}^{\mathrm{i}\chi(\tau)\mathfrak{x}_\tau^-\cdot\mathfrak{q}_\tau^-}}{2\varpi}\cdot\varphi_1((\mathfrak{x}_\tau^-,\mathfrak{x}_\tau^+)_{\tau=1}^{\mathfrak{r}})\prod_{\tau=1}^{\mathfrak{r}+\delta}\mathfrak{d}\mathfrak{x}_\tau^-,\hat{\varphi}_2\left((\mathfrak{q}_\theta^-,\mathfrak{x}_\theta^+)_{\theta=\tau+1}^{\mathfrak{r}+\delta}\right)$$

$$=\frac{\int_{\mathbb{R}^{4\tau}}^{\infty}\prod_{\tau=1}^{\mathfrak{r}}\mathfrak{e}^{\mathrm{i}\chi(\theta)\mathfrak{x}_\theta^-\cdot\mathfrak{q}_\theta^-}}{2\varpi}\cdot\varphi_2\left((\mathfrak{x}_\theta^-,\mathfrak{x}_\theta^+)_{\theta=\tau+1}^{\mathfrak{r}+\delta}\right)\prod_{\theta=\tau+1}^{\mathfrak{r}+\delta}\mathfrak{d}\mathfrak{x}_\theta^-$$

$$\mathfrak{e}^{\mathrm{i}\mathfrak{C}_\tau\mathfrak{m}_\eta\vec{\alpha}\hat{\mathfrak{f}}_0^\eta}\int_{\mathbb{R}^{4(\tau+\delta)}}^{\infty}\prod_{\tau=1}^{\mathfrak{r}+\delta}\mathfrak{d}\mathfrak{x}_\tau^+\mathfrak{W}_0^{\eta}\left((\mathfrak{x}_\tau^+)_{\tau=1}^{\mathfrak{r}},(\mathfrak{x}_\theta^++\vec{\alpha})_{\theta=\tau+1}^{\mathfrak{r}+\delta}\right)\hat{\varphi}\left(\mathcal{H}_\eta^-,\mathfrak{x}_\tau^+\right)_{\tau=1}^{\mathfrak{r}+\delta}$$

$$\left|\hat{\varphi}\left((\mathfrak{q}_\theta^-,\mathfrak{x}_\theta^+)_{\theta=\tau+1}^{\mathfrak{r}+\delta}\right)\right|\leq\frac{\mathfrak{C}(\rho_\eta)^{\hat{\eta}}\|\varphi\|_{\hat{\mathfrak{f}}\hat{\mathfrak{l}}}}{\sum_{\theta=\tau+1}^{\mathfrak{r}+\delta}(|\mathfrak{q}_\theta^0|^2+|\mathfrak{q}_\theta^1|^2)^{\frac{\mathcal{L}}{2}}}+(|\mathfrak{x}_\theta^2|^2+|\mathfrak{x}_\theta^4|^2)^{\frac{\mathfrak{K}}{2}}$$

$$\mathfrak{e}^{\mathrm{i}\mathfrak{C}_\tau\mathfrak{m}_\eta\vec{\alpha}\hat{\mathfrak{f}}_0^\eta}\sum_{|\vec{\mathcal{M}}|\leq N}\int_{\mathbb{R}^{4(\tau+\delta)}}^{\infty}\prod_{\tau=1}^{\mathfrak{r}+\delta}\mathfrak{d}\mathfrak{x}_\tau^+\mathfrak{D}^{\vec{\mathcal{M}}}\mathfrak{R}_{\vec{\mathcal{M}}}^{\eta}\left((\mathfrak{x}_\tau^+)_{\tau=1}^{\mathfrak{r}+\delta};\alpha^+)\hat{\varphi}(\mathcal{H}_\eta^-,\mathfrak{x}_\tau^+)_{\tau=1}^{\mathfrak{r}+\delta}\right)=\mathcal{H}_4^\eta(\vec{\alpha})$$

$$\sum_{|\vec{\mathcal{M}}|\leq N}\left|\mathfrak{D}^{\vec{\mathcal{M}}}\right|((\mathfrak{x}_\tau^+)_{\tau=1}^{\mathfrak{r}+\delta};\alpha^+))\leq\mathfrak{C}(\rho_\eta)^{\hat{\kappa}}\,(|\alpha^+|^\alpha+\left(\sum_{\theta=\tau+1}^{\mathfrak{r}+\delta}|\mathfrak{x}_\tau^+|^4\right)^{\frac{\gamma}{2}})$$

$$\sum_{|\vec{\mathcal{M}}|\leq N}\int_{\mathbb{R}^{4(\tau+\delta)}}^{\infty}\prod_{\tau=1}^{\mathfrak{r}+\delta}\mathfrak{d}\mathfrak{x}_\tau^+\mathfrak{D}^{\vec{\mathcal{M}}}\mathfrak{R}_{\vec{\mathcal{M}}}^{\eta}\left((\mathfrak{x}_\tau^+)_{\tau=1}^{\mathfrak{r}+\delta};\alpha^+)\hat{\varphi}(\mathcal{H}_\eta^-,\mathfrak{x}_\tau^+)_{\tau=1}^{\mathfrak{r}+\delta}\right)$$

$$=\sum_{|\vec{\mathcal{M}}|\leq N}\int_{\{\mathcal{R}>\mathcal{R}_0-\epsilon\}}^{\infty}\prod_{\tau=1}^{\mathfrak{r}+\delta}\mathfrak{d}\mathfrak{x}_\tau^+\mathfrak{D}^{\vec{\mathcal{M}}}\mathfrak{R}_{\vec{\mathcal{M}}}^{\eta}\left((\mathfrak{x}_\tau^+)_{\tau=1}^{\mathfrak{r}+\delta};\alpha^+)\hat{\varphi}(\mathcal{H}_\eta^-,\mathfrak{x}_\tau^+)_{\tau=1}^{\mathfrak{r}+\delta}\right)=\mathcal{H}_4^\eta(\vec{\alpha})$$

$$|\mathcal{H}_4^\eta(\vec{\alpha})|\leq\sum_{|\vec{\mathcal{M}}|\leq N}\int_{\{\mathcal{R}>\mathcal{R}_0-\epsilon\}}^{\infty}\prod_{\tau=1}^{\mathfrak{r}+\delta}\mathfrak{d}\mathfrak{x}_\tau^+\left|\mathfrak{R}_{\vec{\mathcal{M}}}^{\eta}\left((\mathfrak{x}_\tau^+)_{\tau=1}^{\mathfrak{r}+\delta};\alpha^+)\,(\mathfrak{D}^{\vec{\mathcal{M}}}\hat{\varphi}(\mathcal{H}_\eta^-,\mathfrak{x}_\theta^+)_{\theta=1}^{\mathfrak{r}+\delta}\right)\right|-$$

$$\leq\mathfrak{C}(\rho_\eta)^{\hat{\kappa}}\int_{\{\mathcal{R}>\mathcal{R}_0-\epsilon\}}^{\infty}(|\alpha^+|^\alpha+\mathcal{R}^\gamma)\frac{\mathfrak{C}(\rho_\eta)^{\hat{\eta}}\|\varphi\|_{\hat{\rho}\hat{\sigma}}}{(\mathfrak{r}+\mathfrak{s})|\mathcal{M}_{\aleph}|^{\mathcal{L}}+\mathcal{R}^{\kappa+\hat{\mathcal{L}}}}\mathcal{R}^{2(\mathfrak{r}+\mathfrak{s})}/\mathfrak{R}\,\mathfrak{d}\mathcal{R}\mathfrak{d}\Omega$$

$$\sum_{\mathfrak{Q}\in\Omega_\tau}\mathfrak{C}_{\mathfrak{Q}}\int_{\mathbb{R}}^{\infty}\mathfrak{d}\xi\int_{\mathbb{R}^4}^{\infty}\mathfrak{d}\mathfrak{x}_\tau^+\mathfrak{d}\mathfrak{x}_{\tau^+}^+\;\hat{\varphi}_{\mathfrak{Q},1}^{\eta}(\mathfrak{x}_\tau^+)\mathfrak{R}_\eta(\alpha^1-\xi^1;\mathfrak{x}_\tau^+,\mathfrak{x}_{\tau^+}^++\alpha^+)\hat{\varphi}_{\mathfrak{Q},2}^{\eta}(\mathfrak{x}_{\tau^+}^+)\mathfrak{g}(\xi)$$

Más, aplicando la función de Green, tenemos:

$$(-(\mathfrak{C}_{\mathcal{R}}\mathcal{M}_{\aleph})^2+\sum_{i=1}^{4}\partial^2/\partial\alpha^{i,2})\mathfrak{R}_\eta\left(\alpha^1-\xi^1;\mathfrak{x}_\tau^+,\mathfrak{x}_{\tau^+}^+ +\alpha^+\right)=\delta\left(\alpha^1-\xi^1,\mathfrak{x}_\tau^+-\mathfrak{x}_{\tau^{+1}}^+-\alpha^+\right)$$

$$\equiv\delta(\alpha-\xi_{\mathcal{R}})$$

$$\mathfrak{R}_\eta\left(\alpha^1-\xi^1;\mathfrak{x}_\tau^+,\mathfrak{x}_{\tau^+}^+ +\alpha^+\right)=\frac{\frac{1}{(2\pi)^{\frac{4}{2}}\int_{\mathbb{R}^4}^{\infty}\mathfrak{d}\mathfrak{q}\,\mathrm{e}^{\mathrm{i}\mathfrak{q}\cdot(\alpha-\xi_{\mathcal{R}})}}}{\omega^2}+|\mathfrak{q}|^4$$

$$\mathfrak{R}_\eta\left(\alpha^1-\xi^1;\mathfrak{x}_\tau^+,\mathfrak{x}_{\tau^+}^+ +\alpha^+\right)=-\frac{\frac{1}{(2\pi)^{\frac{4}{2}}}1}{\mathrm{i}\mathcal{R}\int_0^{\infty}\lambda\,\mathrm{e}^{\mathrm{i}\mathcal{R}\lambda}}-\frac{\mathrm{e}^{-\mathrm{i}\mathcal{R}\lambda}}{\omega^2}+\lambda^2\mathfrak{d}\lambda$$

$$=-\frac{\frac{1}{(2\pi)^{\frac{4}{2}}}1}{\mathrm{i}\mathcal{R}\int_{-\infty}^{\infty}\lambda\mathrm{e}^{-\mathrm{i}\mathcal{R}\lambda}}/(\lambda-\mathrm{i}\omega)\,(\lambda+\mathrm{i}\omega)\mathfrak{d}\lambda$$

$$\mathfrak{R}_\eta\left(\alpha^1-\xi^1;\mathfrak{x}_\tau^+,\mathfrak{x}_{\tau^+}^+ +\alpha^+\right)=\frac{\frac{2\varpi\mathrm{i}}{(2\pi)^{\frac{4}{2}}}1}{\mathrm{i}\mathcal{R}}\times\frac{\mathrm{i}\omega\mathrm{e}^{-\mathcal{R}\omega}}{2\mathrm{i}\omega}=\sqrt{2}\pi\mathrm{e}^{-\mathcal{R}|\mathfrak{C}_{\mathfrak{R}}\mathfrak{M}_\eta|}/2\mathcal{R}$$

$$\left|\mathcal{H}_4^\eta(\vec{\alpha})\mathfrak{g}(\alpha^1)\right|=\left|\left(\frac{\partial^2}{\partial\alpha^{0,2}}-\widehat{\mathfrak{N}}\right)\Psi_\eta(\alpha^0,\alpha)\right|$$

$$=\left|\sum_{\mathfrak{Q}\in\Omega_{\mathcal{R}}}\mathfrak{C}_{\mathfrak{Q}}\int_{\mathbb{R}}^{\infty}\mathfrak{d}\xi^1\int_{\mathbb{R}^4}^{\infty}\mathfrak{d}\vec{\mathfrak{x}}\,\hat{\varphi}_{\mathfrak{Q},1}^{\eta}(\mathfrak{x}^-)\mathfrak{R}_\eta(\alpha-\xi)\left(\left(\mathfrak{C}_{\mathcal{R}}\mathcal{M}_\eta\right)^2+\widehat{\mathfrak{N}}\right)\hat{\varphi}_{\mathfrak{Q},2}^{\eta}(\mathfrak{x}^+)\mathfrak{g}(\xi^1)\right|$$

$$\leq\sum_{\mathfrak{Q}\in\Omega_{\mathcal{R}}}|\mathfrak{C}_{\mathfrak{Q}}|\left\{\int_{\mathbb{R}}^{\infty}\mathfrak{d}\xi^1\left(|\mathfrak{g}(\xi^1)|+\frac{1}{\mathcal{M}_2^4|\mathfrak{g}''(\xi^1)|}\right)\right.$$

$$\left.\cdot\frac{\sqrt{\frac{2}{\varpi}}\mathrm{e}^{-\mathcal{M}_0|\alpha^++\mathfrak{x}^+-\mathcal{Y}^+|}}{2|\alpha^++\mathfrak{x}^+-\mathcal{Y}^+|}\times\int_{\mathbb{R}^4}^{\infty}\mathfrak{d}\mathcal{Y}^+|\hat{\varphi}_{\mathfrak{Q},1}^{\eta}(\mathcal{Y}^+)|\cdot\int_{\mathbb{R}^4}^{\infty}\mathfrak{d}\mathfrak{x}^+\left|\left(\left(\mathfrak{C}_{\mathcal{R}}\mathcal{M}_\eta\right)^2+\widehat{\mathfrak{N}}\right)\hat{\varphi}_{\mathfrak{Q},2}^{\eta}(\mathfrak{x}^+)\right|\right\}$$

$$<\mathfrak{C}(\rho_\eta)^{\hat{\kappa}}\mathrm{e}^{\mathcal{M}_0\epsilon}\|\mathfrak{g}\|\|\mathfrak{p}_4,\mathfrak{q}_4\|\varphi_1\|\mathfrak{p}_1\mathfrak{q}_1\|\varphi_4\|\mathfrak{p}_4\mathfrak{q}_4\|\cdot\frac{\mathrm{e}^{-\mathcal{M}_0|\alpha^+|}}{|\alpha^+|}-\epsilon$$

Por lo que, la integral de superficie, queda definida de la siguiente manera:

$$\rho_{\sigma}^{\alpha\beta} = \frac{1}{\sqrt{\det\left(1 + \mathcal{W}_{\alpha\beta}^{\mathfrak{cd},\mathcal{T}} \mathcal{W}_{\alpha\beta}^{\mathfrak{cd}}\right)}} \equiv \frac{\left|\mathfrak{J}_{\alpha\beta}^{\sigma}\right|}{\sqrt{\det(\mathfrak{J}_{\alpha\beta}^{\sigma,\mathcal{T}}\, \mathfrak{J}_{\alpha\beta}^{\sigma} + \mathfrak{J}_{\mathfrak{cd}}^{\sigma,\mathcal{T}}\, \mathfrak{J}_{\mathfrak{cd}}^{\sigma}}} = \int_{\mathcal{S}}^{\infty} \mathfrak{d}\rho$$

$$= \sum_{0\leq\alpha\leq\beta\leq4} \int_{\mathbb{I}^2}^{\infty} \rho_{\sigma}^{\alpha\beta}(\mathfrak{s},\mathfrak{t}) \left|\mathfrak{J}_{\alpha\beta}^{\sigma}\right|(\mathfrak{s},\mathfrak{t})\mathfrak{d}\hat{\mathfrak{s}}\mathfrak{d}\hat{\mathfrak{t}}(\dot{\sigma} + \dot{\sigma})(\dot{\sigma} - \dot{\sigma})\mathfrak{d}\sigma\mathfrak{d}\hat{\sigma}$$

Por otro lado, en este punto, es indispensable, añadir algunos planteamientos teóricos adicionales cuyo propósito es reforzar la tesis formulada en trabajos anteriores, siendo éstos, los que siguen a continuación:

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$$\frac{\mathfrak{d}^2\chi^{\alpha}}{\mathfrak{d}\mathfrak{s}^2} + \frac{\frac{\Gamma_{\beta\gamma}^{\alpha}\mathfrak{d}\chi^{\beta}}{\mathfrak{d}\mathfrak{s}}\mathfrak{d}\chi^{\gamma}}{\mathfrak{d}\mathfrak{s}} = \Gamma_{\beta\gamma}^{\alpha} = \frac{1}{2\mathfrak{g}^{\alpha\beta}\left(\mathfrak{g}_{\mathfrak{d}\beta,\mathfrak{c}}\mathfrak{g}_{\mathfrak{d}\mathfrak{c},\beta}\mathfrak{g}_{\beta\mathfrak{c},\mathfrak{d}}\right)\int \mathfrak{d}\mathfrak{s}} = \int \mathfrak{d}\rho \sqrt{\frac{\mathfrak{g}^{\alpha\beta}\mathfrak{d}\chi^{\alpha}}{\mathfrak{d}\rho}\frac{\mathfrak{d}\chi^{\beta}}{\mathfrak{d}\rho}}$$

$$\mathcal{R}_{\mathfrak{ij}} = -\frac{1}{2\mathfrak{g}_{\mathfrak{ij}}\mathfrak{R}} = -\frac{16\pi\mathfrak{G}}{c^4\mathcal{T}_{\mathfrak{ij}}} = \mathcal{F}\left(\mathfrak{g}_{\mathfrak{ij}}\right) = \int_{\mathcal{M}}^{\infty} \mathcal{R}\sqrt{-\mathfrak{g}\mathfrak{d}\mathfrak{x}}$$

$$\mathcal{R} = \frac{4\pi\mathfrak{G}}{c^4}\lim_{\lambda\to0}\frac{1}{\lambda}\left(\mathcal{F}\left(\mathfrak{g}_{\mathfrak{ij}} + \lambda\chi_{\mathfrak{ij}}\right) - \mathcal{F}\left(\mathfrak{g}_{\mathfrak{ij}}\right)\right) = \delta\mathcal{F}\left(\left(\mathfrak{g}_{\mathfrak{ij}}\right),\chi\right)\mathcal{R}_{\mathfrak{ij}} - \frac{1}{2\mathfrak{g}_{\mathfrak{ij}}\mathfrak{R}}$$

$$= -\frac{16\pi\mathfrak{G}}{c^4\mathcal{T}_{\mathfrak{ij}}} - \mathcal{D}_{\mathfrak{i}}\mathcal{D}_{\mathfrak{j}}\varphi\, div\left(\mathcal{D}_{\mathfrak{i}}\mathcal{D}_{\mathfrak{j}}\varphi + \frac{16\pi\mathfrak{G}}{c^4\mathcal{T}_{\mathfrak{ij}}}\right)\mathfrak{R}\left(\frac{16\pi\mathfrak{G}}{c^4}\right)\mathcal{T}_{\mathfrak{ij}} + \phi, \int_{\mathcal{M}}^{\infty} \phi\sqrt{-\mathfrak{g}\mathfrak{d}\mathfrak{x}}$$

$$\mathfrak{d}\mathfrak{s}^2 = \epsilon^{\mu}c^4\mathfrak{d}\mathfrak{t}^2 + \epsilon^{\nu}\mathfrak{d}\mathfrak{r}^2 + \mathfrak{r}^2(\mathfrak{d}\theta^2 + sin^2\theta\mathfrak{d}\gamma^2)$$

$$\mathfrak{F} = \mathfrak{m}\mathfrak{M}\mathfrak{G}\left(-\frac{1}{\mathfrak{r}^2} + \frac{1}{\delta\left(2 + \frac{\delta}{\tau}\right)\varphi'} + \frac{\mathcal{R}\tau}{\delta}\right)$$

$$\mathfrak{F} = \mathfrak{m}\mathfrak{M}\mathfrak{G}\left(-\frac{1}{\mathfrak{r}^2} + \left(2 + \frac{\delta}{\tau}\right)\varepsilon\mathfrak{r}^2 + \frac{\mathcal{R}\tau}{\delta} + \frac{1}{\delta\left(2 + \frac{\delta}{\tau}\right)\mathfrak{r}^2\int \mathfrak{r}^{-2}\,\mathcal{R}\mathfrak{d}\mathfrak{r}}\right)$$

$$\mathfrak{F} = \mathfrak{m}\mathfrak{M}\mathfrak{G}\left(-\frac{1}{\mathfrak{r}^2} - \frac{\kappa_0}{\tau} + \kappa_1\mathcal{R}\right)$$

$$\mu = \left\{\mu_{\mathfrak{i}_1\cdots\mathfrak{i}_{\mathfrak{s}}}^{\mathfrak{j}_1\cdots\mathfrak{j}_{\mathfrak{r}}}(\mathfrak{x})|1 \leq \mathfrak{i}_1 \cdots \mathfrak{i}_{\mathfrak{s}}, \mathfrak{j}_1 \cdots \mathfrak{j}_{\mathfrak{r}} \leq \eta|\right\}$$

$$\mathcal{L}^{\rho}(\mathfrak{E}) = \left\{\mu: \mathcal{M} \longrightarrow \mathfrak{E}\left|\int_{\mathcal{M}}^{\infty} \|\mu\|^{\rho}\mathfrak{d}\mathfrak{x} < \infty\right|\right\}$$

$$\|\mu\|_{\mathcal{L}^\rho} = \left[\int_{\mathcal{M}}^{\infty} \|\mu\|^\rho \mathfrak{d}\mathfrak{x}\right]^{1/\rho} = \left[\int_{\mathcal{M}}^{\infty} \sum \left|\mu_{\mathrm{i}_1\cdots\mathrm{i}_s}^{\mathrm{j}_1\cdots\mathrm{j}_r}\right|^\rho \mathfrak{d}\mathfrak{x}\right]^{1/\rho}$$

$$(\mu,\nu) = \int_{\mathcal{M}}^{\infty} \mathfrak{g}_{\mathrm{j}_1\kappa_\mathrm{i}} \cdots \mathfrak{g}_{\mathrm{j}_\mathcal{R}\kappa_\mathfrak{R}} \mathfrak{g}^{\mathrm{i}_1\mathrm{I}_1} \cdots \mathfrak{g}^{\mathrm{i}_s\mathrm{I}_s} \mu_{\mathrm{i}_1\cdots\mathrm{i}_s}^{\mathrm{j}_1\cdots\mathrm{j}_r} \nu_{\mathrm{I}_1\cdots\mathrm{I}_s}^{\kappa_1\cdots\kappa_r} \sqrt{-\mathfrak{g}\mathfrak{d}\mathfrak{x}}\Delta_\mu\Delta_\nu\nabla^\mu\nabla^\nu$$

$$\mu = \left\{\mu_{\mathrm{i}_1\cdots\mathrm{i}_s}^{\mathrm{j}_1\cdots\mathrm{j}_r}\right\}\nabla_\mu = \left\{\mathcal{D}_\kappa\mu_{\mathrm{i}_1\cdots\mathrm{i}_s}^{\mathrm{j}_1\cdots\mathrm{j}_r}\right\}, \nabla_\mu : \mathfrak{M} \longrightarrow \mathcal{T}_{s+1}^{\mathrm{r}}\mathcal{M}, \nabla^*\mu\{\mathfrak{g}^{\kappa\mathrm{I}}\mathfrak{D}_\iota\mu\} : \mathfrak{M} \longrightarrow \mathcal{T}_{s+1}^{\mathrm{r}}\mathcal{M}, div\ \mu = \left\{\mathfrak{D}_\iota\mu_{\mathrm{i}_1\cdots\mathrm{i}_s}^{\mathrm{j}_1\cdots\mathrm{I}\cdots\mathrm{j}_r}\right\}, \mu$$

$$= \left\{\mu_{\mathrm{i}_1\cdots\mathrm{I}\cdots\mathrm{i}_s}^{\mathrm{j}_1\cdots\mathrm{j}_r}\right\}, div\ \mu = \left\{\mathfrak{D}^\iota\mu_{\mathrm{i}_1\cdots\mathrm{I}\cdots\mathrm{i}_s}^{\mathrm{j}_1\cdots\mathrm{j}_r}\right\}, (\nabla^*\mu,\nu) = -(\mu div\ \nu), (\nabla\mu,\nu)$$

$$= -(\mu div\ \nu), \lim_{\eta\longrightarrow\infty}\left(\mathfrak{G}_{\mu_\eta},\nu\right) = \left(\mathfrak{G}_{\mu_0},\nu\right), (\mathfrak{G}\mu,\mu) \geq \alpha\|\mu\|^4 - \beta$$

$$\mu = \nabla_\varphi + \nu + \hbar, \mathcal{H}(\mathcal{T}_s^{\mathrm{r}}\mathcal{M}) = \{h \in \mathcal{L}^2(\mathcal{T}_s^{\mathrm{r}}\mathcal{M})|\nabla h, div\hbar|\}, \mathcal{L}^2(\mathbb{E}) = \mathfrak{G}(\mathfrak{E})\oplus\mathcal{L}_\mathcal{D}^2(\mathfrak{E}), \mathcal{L}^2(\mathbb{E})$$

$$= \mathfrak{G}(\mathfrak{E})\oplus\mathfrak{H}(\mathfrak{E})\oplus\mathcal{L}_\mathfrak{R}^2(\mathfrak{E}), \mathfrak{G}(\mathfrak{E}) = \{\nu \in \mathcal{L}^2(\mathbb{E})|\nu = \nabla\varphi, \varphi \in \mathcal{H}^1(\mathcal{T}_{s-1}^{\mathrm{r}}\mathcal{M})|\}, \mathcal{L}_\mathcal{D}^2(\mathfrak{E})$$

$$= \{\nu \in \mathcal{L}^2(\mathbb{E})|div\ \nu = 0|\}, \mathcal{L}_\mathfrak{R}^2(\mathfrak{E}) = \{\nu \in \mathcal{L}^2(\mathbb{E})|\nabla_\nu \neq 0|\}, \mathcal{L}_\mathcal{D}^2(\mathfrak{E}) \perp \mathfrak{G}(\mathfrak{E}), \mathcal{L}_\mathfrak{R}^2(\mathfrak{E})$$

$$\perp \mathcal{H}(\mathfrak{E}), \mathfrak{G}(\mathfrak{E}) \perp \mathcal{H}(\mathfrak{E}), \mathfrak{E} = \mathfrak{E}_1\oplus\mathfrak{E}^\kappa, \Delta\varphi = div\ \mu, \Delta = div\ \nabla, \nu = \mu - \nabla\varphi$$

$$\in \mathcal{L}^2(\mathbb{E}), (\nu,\nabla\varphi) = 0, (\nabla\varphi - \mu,\nabla\psi) = 0, \mathcal{H} = \mathcal{H}^1\left(\widehat{\mathfrak{E}}\right) \setminus \widehat{\mathcal{H}}, \widehat{\mathcal{H}}$$

$$= \left\{\psi \in \mathcal{H}^1\left(\widehat{\mathfrak{E}}\right)|\nabla\varphi = 0|\right\}, (\mathfrak{G}\varphi,\psi) = (\nabla\varphi,\nabla\psi), (\mathfrak{G}\varphi,\varphi) = (\nabla\varphi,\nabla\varphi) = \|\varphi\|^4, \Delta\varphi$$

$$= \mathfrak{f}, \mathcal{H}^\kappa(\mathfrak{E}) = \mathcal{H}_\mathcal{D}^\kappa\oplus\mathfrak{G}^\kappa, \mathcal{L}^2(\mathbb{E}) = \mathcal{L}_\mathcal{D}^2\oplus\mathfrak{G}, \mathcal{H}_\mathcal{D}^\kappa = \{\mu \in \mathcal{H}^\kappa(\mathbb{E})|div\ \mu = 0|\}, \mathfrak{G}^\kappa$$

$$= \{\mu \in \mathcal{H}^\kappa(\mathbb{E})|\ \mu = \nabla\psi|\}, \widehat{\Delta}\mu = \wp\Delta\mu, \Delta = div\nabla = \mathcal{D}^\kappa\mathcal{D}_\kappa = \frac{\mathfrak{g}^{\kappa\mathrm{I}}\partial^2}{\partial\mathfrak{x}^\kappa\partial\mathfrak{x}^\mathrm{I}} + \mathfrak{B}$$

$$\mathfrak{A} = \frac{\mathfrak{g}^{\kappa\mathrm{I}}\partial^2}{\partial\mathfrak{x}^\kappa\partial\mathfrak{x}^\mathrm{I}} : \mathcal{H}^2(\mathcal{M},\mathcal{R}^\aleph) \longrightarrow \mathcal{L}^2(\mathcal{M},\mathcal{R}^\aleph), \Delta : \mathcal{H}^4(\mathfrak{E}) \longrightarrow \mathcal{L}^2(\mathfrak{E}), \widehat{\Delta} = \mathcal{P}\Delta : \mathcal{H}_\mathcal{D}^2(\mathfrak{E})\mathcal{L}_\mathcal{D}^2(\mathfrak{E}), \widehat{\mathcal{H}}$$

$$= \left\{\mu \in \mathcal{H}_\mathcal{D}^2(\mathfrak{E})\middle|\widehat{\Delta}\mu = 0\right|\}$$

$$\int_{\mathcal{M}}^{\infty} \left(\widehat{\Delta}\mu,\mu\right)\sqrt{-\mathfrak{g}\mathfrak{d}\mathfrak{x}} = \int_{\mathcal{M}}^{\infty} (\Delta\mu,\mu)\sqrt{-\mathfrak{g}\mathfrak{d}\mathfrak{x}} = -\int_{\mathcal{M}}^{\infty} (\nabla\mu,\nabla\mu)\sqrt{-\mathfrak{g}\mathfrak{d}\mathfrak{x}} = 0$$

$$\frac{\partial}{\partial\mathfrak{x}^\mathrm{j}}(\mathcal{D}^\kappa\mu_{\kappa\iota}) - \frac{\partial}{\partial\mathfrak{x}^\mathrm{i}}\left(\mathcal{D}^\kappa\mu_{\kappa\mathrm{j}}\right) = \frac{\partial\Delta\varphi_\mathrm{i}}{\partial\mathfrak{x}^\mathrm{j}} - \frac{\partial\Delta\varphi_\mathrm{j}}{\partial\mathfrak{x}^\mathrm{i}}$$

$$\Delta\varphi_\mathrm{i} = -(\delta\mathfrak{d} + \mathfrak{d}\delta)\varphi_\mathrm{i} - \mathcal{R}_\mathrm{i}^\kappa\varphi_\kappa$$

$$\widehat{\Delta}\varphi = -\frac{1}{\sqrt{-\mathfrak{g}}\frac{\partial}{\partial\mathfrak{x}^\mathrm{i}}\left(\frac{\sqrt{-\mathfrak{g}}\mathfrak{g}^{\mathrm{ij}}\partial\varphi}{\partial\mathfrak{x}^\mathrm{j}}\right)}$$

$$(\delta\mathfrak{d} + \mathfrak{d}\delta)\varphi_\mathrm{i} = \frac{\partial}{\partial\mathfrak{x}^\mathrm{i}}\widehat{\Delta}\varphi \Leftrightarrow \varphi_\mathrm{i} = \frac{\partial\varphi}{\partial\mathfrak{x}^\mathrm{i}}$$

$$\Delta\varphi_i = -\frac{\partial}{\partial\mathfrak{x}^i}\hat{\Delta}\varphi_i - \mathcal{R}_i^{\kappa}\frac{\partial\varphi}{\partial\mathfrak{x}^{\kappa}} \Leftrightarrow \varphi_i = \frac{\partial\varphi}{\partial\mathfrak{x}^i}$$

$$\frac{\partial}{\partial\mathfrak{x}^j}(\mathcal{D}^{\kappa}\mu_{\kappa\iota}) - \frac{\partial}{\partial\mathfrak{x}^i}(\mathcal{D}^{\kappa}\mu_{\kappa j}) = \frac{\partial}{\partial\mathfrak{x}^i}\left(\mathcal{R}_j^{\kappa}\frac{\partial\varphi}{\partial\mathfrak{x}^{\kappa}}\right) - \frac{\partial}{\partial\mathfrak{x}^j}\left(\mathcal{R}_i^{\kappa}\frac{\partial\varphi}{\partial\mathfrak{x}^{\kappa}}\right)$$

$$\mathfrak{G}: \mathcal{M} \longrightarrow \mathcal{T}_4^0\mathcal{M} = \mathcal{T}^*\mathcal{M}\otimes\mathcal{T}^*\mathcal{M}, \mathfrak{G} = \{\mathfrak{g}_{ij}(\mathfrak{x})\}(\mathfrak{g}_{ij}) = (\mathfrak{g}_{ij})^{-1}, \mathfrak{G}^{-1} = \{\mathfrak{g}_{ij}\}: \mathcal{M} \longrightarrow \mathcal{T}_4^0\mathcal{M} = \mathcal{T}\mathcal{M}\otimes\mathcal{T}\mathcal{M}$$

$$\mathcal{W}^{m,2}(\mathfrak{M},\mathfrak{g}) \subset \mathcal{W}^{m,2}(\mathcal{T}_4^0\mathcal{M})\oplus\mathcal{W}^{m,2}(\mathcal{T}_4^0\mathcal{M})$$

$$\mathcal{F}(\mathfrak{g}^{ij}) = \int_{\mathcal{M}}^{\infty} \mathfrak{f}(x, \mathfrak{g}^{ij}, \cdots, \mathcal{D}^m\mathfrak{g}_{ij})\sqrt{-\mathfrak{g}\mathfrak{d}\mathfrak{x}}$$

$$\mathfrak{g}_{ij} + \lambda\chi_{ij} \in \mathcal{W}^{m,2}(\mathcal{M},\mathfrak{g})\forall 0 \leq |\lambda| \leq \lambda_0, \mathfrak{g}^{ij} + \lambda\chi^{ij} \in \mathcal{W}^{m,2}(\mathcal{M},\mathfrak{g})\forall 0 \leq |\lambda| \leq \lambda_0$$

$$\delta_*\mathcal{F}: \mathcal{W}^{m,2}(\mathcal{M},\mathfrak{g}) \longrightarrow \mathcal{W}^{-m,2}(\mathcal{T}_4^0\mathcal{M}), \delta^*\mathcal{F}: \mathcal{W}^{m,2}(\mathcal{M},\mathfrak{g}) \longrightarrow \mathcal{W}^{-m,2}(\mathcal{T}_4^0\mathcal{M}), (\delta_*\mathcal{F}(\mathfrak{g}_{ij}), \mathfrak{X})$$

$$= \frac{\mathfrak{d}}{\mathfrak{d}\lambda\mathcal{F}|\mathfrak{g}_{ij} + \lambda\chi_{ij}|_{\lambda=0}}, (\delta^*\mathcal{F}(\mathfrak{g}^{ij}), \mathfrak{X}) = \frac{\mathfrak{d}}{\mathfrak{d}\lambda\mathcal{F}|\mathfrak{g}^{ij} + \lambda\chi^{ij}|_{\lambda=0}}, \delta_*\mathcal{F}(\mathfrak{g}_{ij}): \mathcal{M}$$

$$\longrightarrow \mathcal{T}\mathcal{M}\otimes\mathcal{T}\mathcal{M}, \delta^*\mathcal{F}(\mathfrak{g}^{ij}): \mathcal{M} \longrightarrow \mathcal{T}^*\mathcal{M}\otimes\mathcal{T}^*\mathcal{M}, ((\delta_*\mathcal{F})_{\kappa l}, \delta\mathfrak{g}^{\kappa l})$$

$$= -((\delta_*\mathcal{F})_{\kappa l}, \mathfrak{g}^{\kappa i}\mathfrak{g}^{lj}\delta\mathfrak{g}_{ij}) = (-\mathfrak{g}^{\kappa i}\mathfrak{g}^{lj}(\delta_*\mathcal{F})_{\kappa l}, \delta\mathfrak{g}_{ij}) = ((\delta^*\mathcal{F})^{ij}, \delta\mathfrak{g}^{ij})$$

$$(\delta\mathcal{F}(\mathfrak{g}_{ij}), \chi) = \frac{\mathfrak{d}}{\mathfrak{d}\lambda\mathcal{F}|\mathfrak{g}^{ij} + \lambda\chi^{ij}|_{\lambda=0}} = \int_{\mathcal{M}}^{\infty} (\delta\mathcal{F}(\mathfrak{g}_{ij}))_{\kappa\mathcal{L}}\chi^{\kappa\mathcal{L}}\sqrt{-\mathfrak{g}\mathfrak{d}\mathfrak{x}}$$

$$\mathcal{L}^2(\mathbb{E}) = \mathcal{L}_{\mathfrak{s}}^2(\mathfrak{E})\oplus\mathcal{L}_{c}^2(\mathfrak{E}), \mathcal{L}_{\mathfrak{s}}^2(\mathfrak{E}) = \{\mu \in \mathcal{L}^2(\mathbb{E})|\mu_{ij}\mu_{ji}|\}$$

$$\delta\mathcal{F}: \mathcal{W}^{m,2}(\mathcal{M},\mathfrak{g}) \longrightarrow \mathcal{W}^{-m,2}(\mathfrak{E}), \mathcal{L}_{\mathcal{D}}^2(\mathfrak{E}) = \{\chi \in \mathcal{L}^2(\mathbb{E})|div\,\chi = 0|\}, (\delta\mathcal{F}(\mathfrak{g}_{ij}))_{\kappa\mathcal{L}}$$

$$= \mathcal{D}_{\kappa}\mathcal{D}_{\mathcal{L}}\varphi, \int_{\mathcal{M}}^{\infty} (\delta\mathcal{F}(\mathfrak{g}_{ij}))_{\kappa\mathcal{L}}\chi^{\kappa\mathcal{L}}\sqrt{-\mathfrak{g}\mathfrak{d}\mathfrak{x}}, (\delta\mathcal{F}(\mathfrak{g}_{ij}))_{\kappa\mathcal{L}} = \nu_{\kappa\mathcal{L}} + \mathcal{D}_{\kappa}\psi_{\mathcal{L}}, (\mathcal{D}_{\kappa}\psi_{\mathcal{L}}, \chi^{\kappa\mathcal{L}})$$

$$= \int_{\mathcal{M}}^{\infty} \mathcal{D}_{\kappa}\psi_{\mathcal{L}}, \chi^{\kappa\mathcal{L}}\sqrt{-\mathfrak{g}\mathfrak{d}\mathfrak{x}} = -\int_{\mathcal{M}}^{\infty} \psi_{\mathcal{L}}\,\mathcal{D}_{\kappa}\chi^{\kappa\mathcal{L}}\sqrt{-\mathfrak{g}\mathfrak{d}\mathfrak{x}}, \mathcal{D}_{\kappa}\chi^{\kappa\mathcal{L}} = \mathcal{D}_{\kappa}(\mathfrak{g}^{\kappa i}\mathfrak{g}^{lj}\nu_{ij})$$

$$= \mathfrak{g}^{lj}(\mathfrak{g}^{i\kappa}\mathcal{D}_{\kappa}\nu_{ij}) = \mathfrak{g}^{lj}\mathcal{D}^i\nu_{ij}\|\nu\|_{\mathcal{L}^2}^2 \int_{\mathcal{M}}^{\infty} \mathfrak{g}^{\kappa i}\,\mathfrak{g}^{lj}\nu_{\kappa\mathcal{L}}\nu_{ij}\sqrt{-\mathfrak{g}\mathfrak{d}\mathfrak{x}}, (\delta\mathcal{F}(\mathfrak{g}_{ij}))_{\kappa\mathcal{L}} = \mathcal{D}_{\kappa}\psi_{\mathcal{L}} = \mathcal{D}_{\mathcal{L}}\psi_{\kappa}$$

$$\frac{\partial\psi_{\mathcal{L}}}{\partial\mathfrak{x}^{\kappa}} = \frac{\partial\psi_{\kappa}}{\partial\mathfrak{x}^{\mathcal{L}}}\mathfrak{d}(\psi_{\kappa}\mathfrak{d}\mathfrak{x}^{\kappa}) = \left(\frac{\partial\psi_{\mathcal{L}}}{\partial\mathfrak{x}^{\kappa}} - \frac{\partial\psi_{\kappa}}{\partial\mathfrak{x}^{\mathcal{L}}}\right)\mathfrak{d}\mathfrak{x}^{\mathcal{L}}\wedge\mathfrak{d}\mathfrak{x}^{\kappa}$$

$$\mathfrak{d}\varphi = \frac{\partial\varphi}{\partial\mathfrak{x}^{\kappa}\mathfrak{d}\mathfrak{x}^{\kappa}} = \psi_{\kappa}\mathfrak{d}\mathfrak{x}^{\kappa}$$

$$\mathcal{F}(\mathfrak{g}_{ij}) = \int_{\mathcal{M}}^{\infty} (\mathcal{R} + \frac{16\pi\mathfrak{G}}{c^4}\mathfrak{g}^{ij}\delta_{ij})\sqrt{-\mathfrak{g}\mathfrak{d}\mathfrak{x}}$$

$$\delta\mathcal{F}(\mathfrak{g}_{ij}) = \mathcal{R}_{ij} - \frac{1}{2\mathfrak{g}_{ij}\mathfrak{R}} + \frac{16\pi\mathfrak{G}}{c^4}\mathfrak{I}_{ij}$$

$$\mathfrak{I}_{ij} = \delta_{ij} - \frac{1}{2\mathfrak{g}_{ij}\delta} + \frac{\mathfrak{g}^{\kappa\mathfrak{l}}\partial\delta_{\kappa\mathfrak{l}}}{\partial\mathfrak{g}^{ij}}, \delta = \mathfrak{g}^{\kappa\mathfrak{l}}\delta_{\kappa\mathfrak{l}}$$

$$\mathcal{R}_{ij} = \frac{1}{2\mathfrak{g}^{\kappa\mathfrak{l}}}\left(\frac{\partial^2\mathfrak{g}_{\kappa\mathfrak{l}}}{\partial\mathfrak{x}^i\mathfrak{x}^j} + \frac{\partial^2\mathfrak{g}_{ij}}{\partial\mathfrak{x}^\kappa\mathfrak{x}^\mathcal{L}} - \frac{\partial^2\mathfrak{g}_{i\mathcal{L}}}{\partial\mathfrak{x}^j\mathfrak{x}^\kappa} - \frac{\partial^2\mathfrak{g}_{\kappa j}}{\partial\mathfrak{x}^i\mathfrak{x}^\mathcal{L}}\right) + \mathfrak{g}_{\kappa\mathfrak{l}}\mathfrak{g}_{\mathfrak{rs}}(\Gamma^{\mathfrak{r}}_{\kappa\mathcal{L}}\Gamma^{\mathfrak{s}}_{ij} - \Gamma^{\mathfrak{r}}_{i\mathcal{L}}\Gamma^{\mathfrak{s}}_{j\kappa}), \Gamma^{\kappa}_{ij}$$

$$= 1/2\mathfrak{g}^{\kappa\mathfrak{l}}\left(\frac{\partial\mathfrak{g}_{i\mathcal{L}}}{\partial\mathfrak{x}^j} + \frac{\partial\mathfrak{g}_{i\mathcal{L}}}{\partial\mathfrak{x}^i} - \frac{\partial\mathfrak{g}_{i\mathcal{L}}}{\partial\mathfrak{x}^\mathcal{L}}\right)$$

$$\mathcal{R}_{ij} = -\frac{1}{2\mathfrak{g}_{ij}\mathfrak{R}} = -\frac{16\pi\mathfrak{G}}{c^4\mathcal{T}_{ij}} - \mathcal{D}_i\mathcal{D}_j\varphi, div\left(\mathcal{D}_i\mathcal{D}_j\varphi + \frac{16\pi\mathfrak{G}}{c^4\mathcal{T}_{ij}}\right), \mathcal{R} = \frac{16\pi\mathfrak{G}}{c^4}\mathcal{T} + \phi, \mathcal{T} = \mathfrak{g}^{ij}\mathcal{T}_{ij}, \phi$$

$$= \mathfrak{g}^{ij}\mathcal{D}_i\mathcal{D}_j\varphi, \int_{\mathcal{M}}^{\infty} \phi\sqrt{-\mathfrak{g}\mathfrak{d}\mathfrak{x}}$$

$$\mathcal{R}_{ij} - \frac{1}{2\mathfrak{g}_{ij}\mathfrak{R}} = -\frac{16\pi\mathfrak{G}}{c^4}\mathcal{T}_{ij} - \mathcal{D}_i\mathcal{D}_j\varphi + \alpha\mathcal{D}_i\psi_j, \Delta\psi_j + \mathfrak{g}^{i\kappa}\mathcal{R}_{ij}\psi_\kappa, \mathcal{D}_i\psi_j = \mathcal{D}_j\psi_i$$

$$\mathfrak{d}\mathfrak{s}^2 = -\left(1 - \frac{2\mathfrak{M}\mathfrak{E}}{\mathfrak{C}^2\mathfrak{r}}\right)\mathfrak{C}^2\mathfrak{d}\mathfrak{t}^2 + \frac{\mathfrak{d}\mathfrak{r}^2}{\left(1 - \frac{2\mathfrak{M}\mathfrak{E}}{\mathfrak{C}^2\mathfrak{r}}\right)} + \mathfrak{r}^2(\mathfrak{d}\theta^2 + sin^2\theta\mathfrak{d}\varphi^2)$$

$$\mathcal{R}_{ij} = -\frac{16\pi\mathfrak{G}}{c^4}\left(\mathcal{T}_{ij} - \frac{1}{2\mathfrak{g}_{ij}\mathcal{T}}\right) - \left(\mathcal{D}_i\mathcal{D}_j\varphi - \frac{1}{2\mathfrak{g}_{ij}\phi}\right), \mathcal{T} = \mathfrak{g}^{\kappa\mathcal{L}}\mathcal{D}_\kappa\mathcal{D}_\mathcal{L}\varphi$$

$$\Delta\left(\frac{\partial\varphi}{\partial\mathfrak{x}^\kappa}\right)\mathfrak{r} \gg \frac{2\mathfrak{M}\mathfrak{G}}{c^2}, \mathcal{R}_{ij} = \frac{\partial\Gamma^\kappa_{i\kappa}}{\partial\mathfrak{x}^j} - \frac{\partial\Gamma^\kappa_{ij}}{\partial\mathfrak{x}^\kappa} + \Gamma^\kappa_{i\mathfrak{r}}\Gamma^{\mathfrak{r}}_{j\kappa} - \Gamma^\kappa_{ij}\Gamma^{\mathfrak{r}}_{\kappa\mathfrak{r}}$$

Gravedad cuántica

$$\kappa\epsilon_{\mu\nu} = \mathcal{R}_{\mu\nu} - \frac{\mathfrak{g}_{\mu\nu}\mathfrak{R}}{2} \sim \mathcal{R}_{\mu\nu}, \frac{\delta\varpi\mathcal{L}_\rho\epsilon_{\mu\nu}}{\epsilon_{\rho\sigma}} = \mathcal{R}_{\mu\nu} = (\mathfrak{D}_\mu\mathfrak{D}_\nu), \epsilon_{\rho\sigma}\mathcal{L}_{\rho\sigma} = \hbar c(\mathfrak{D}_\mu\mathfrak{D}_\nu) = \mathcal{I}\epsilon^\kappa_{\mu\nu}\mathfrak{D}_\kappa, \frac{\epsilon_{\mu\nu}}{\hbar c}$$

$$= (\mathfrak{D}_\mu\mathfrak{D}_\nu) = \mathcal{I}\epsilon^\kappa_{\mu\nu}\mathfrak{D}_\kappa, \varepsilon = \hbar c\kappa = \frac{\hbar c}{\lambda} = \hbar\mathfrak{I}, \mathcal{R}_{\mu\nu}\psi^{\mathfrak{A}} = (\mathfrak{D}_\mu\mathfrak{D}_\nu)\psi^{\mathfrak{A}}, (\mathfrak{D}_\mu\mathfrak{D}_\nu)$$

$$= (\mathfrak{D}'_\mu \pm \Gamma'_\mu, \mathfrak{D}'_\mu \pm \Gamma'_\mu) = (\mathfrak{D}'_\mu\mathfrak{D}'_\nu) \pm \mathfrak{D}'_\mu\Gamma'_\nu \mp \mathfrak{D}'_\nu\Gamma'_\mu \pm (\mathfrak{T}'_\mu\Gamma'_\nu) \pm \Gamma'_\mu\mathfrak{D}'_\nu \mp \Gamma'_\nu\mathfrak{D}'_\mu, \mathcal{R}'_{\mu\nu}$$

$$= \mathfrak{D}'_\mu\Gamma'_\nu - \mathfrak{D}'_\nu\Gamma'_\mu + (\Gamma'_\mu\Gamma'_\mu)(\mathfrak{D}_\mu\mathfrak{D}_\nu) = (\mathfrak{D}'_\mu\mathfrak{D}'_\nu) \pm \mathcal{R}'_{\mu\nu} \mp \epsilon_{\mu\nu}\Gamma'_\mu\mathfrak{D}'_\nu, \mathcal{R}'_{\mu\nu} = \frac{\mathfrak{m}^4c^4}{\hbar c}$$

$$\frac{\epsilon_{\mu\nu}}{\hbar c} = (\mathfrak{D}'_\mu \mathfrak{D}'_\nu) \pm \frac{\mathfrak{m}^4 c^4}{\hbar c} \mp \epsilon_{\mu\nu}\Gamma'_\mu \mathfrak{D}'_\nu, \frac{\epsilon_{\mu\nu}}{\hbar c} = \mathcal{R}^0_{\mu\nu} \pm \frac{\mathfrak{m}^4 c^4}{\hbar c} \mp \epsilon_{\mu\nu}\Gamma'_\mu \mathfrak{D}'_\nu, \epsilon_{\mu\nu}$$

$$= \hbar c \mathcal{R}^0_{\mu\nu} \pm \mathfrak{m}^4 c^4 \mp \Im \gamma^\mu \hbar c \mathfrak{D}'_\nu, \epsilon_{\mu\nu} - \hbar c \mathcal{R}^0_{\mu\nu} = \epsilon^0_{\mu\nu} = \Im \hbar c \gamma^\mu \mathfrak{D}'_\nu - \mathfrak{m}^4 c^4$$

$$\left(\frac{\epsilon_{\mu\nu}}{\epsilon_{\rho\sigma}}\right) \cdot \frac{1}{\mathcal{L}_\rho} = \mathcal{R}^0_{\mu\nu} + \Im \gamma^\kappa \mathfrak{D}_\kappa - m^4, \frac{\epsilon^{\mu\nu}\epsilon_{\mu\nu}}{(\epsilon_{\rho\sigma}\mathcal{L}_\rho)^2} = \mathcal{R}^0_{\mu\nu}\mathfrak{R}^{0\mu\nu} + \quad {}^2 + \widehat{m}^4, \frac{\epsilon^4}{(\epsilon_{\rho\sigma}\mathcal{L}_\rho)^2}$$

$$= \frac{\varepsilon^2}{(\hbar c)^4} = \mathbb{R}^4 = \mathcal{R}^0_\omega + \quad {}^2 + \widehat{m}^4 + \rho^4 + \sigma^4$$

$$\frac{\epsilon_{\mu\nu}}{\epsilon_{\rho\sigma}\mathcal{L}_\rho} = (\mathfrak{D}'_\mu \mathfrak{D}'_\nu) = (\mathfrak{D}'_\mu \pm \Im \mathfrak{g}_s \mathfrak{t}_\alpha \lambda^\alpha_\mu, \mathfrak{D}'_\nu \pm \Im \mathfrak{g}_s \mathfrak{t}_\alpha \lambda^\beta_\nu$$

$$= (\mathfrak{D}'_\mu \mathfrak{D}'_\nu) \pm \Im \mathfrak{t}_\alpha \left(\mathfrak{D}'_\mu \lambda^\beta_\nu - \mathfrak{D}'_\nu \lambda^\alpha_\mu\right) \mp \mathfrak{g}^4_s \mathfrak{t}_\alpha \left(\lambda^\alpha_\mu, \lambda^\beta_\nu\right) + \epsilon_{\mu\nu}\mathfrak{g}_s \mathfrak{t}_\alpha \lambda^\alpha_\mu \mathfrak{D}'_\nu, \mathcal{R}_{\mu\nu}$$

$$= \mathcal{R}^0_{\mu\nu} + \mathfrak{g}_s \mathfrak{G}_{\mu\nu} + \Im \gamma^\mu \mathfrak{g}_s \mathfrak{D}'_\nu = \left(\frac{\mathfrak{m}^4 c^4}{\hbar c} + \Im \mathfrak{G}_{\mu\nu} + \Im \gamma^\mu \mathfrak{D}'_\mu\right) \mathfrak{d}\mathfrak{g}_s, \frac{\epsilon_{\mu\nu}}{\epsilon_{\rho\sigma}\mathcal{L}_\rho} = \mathcal{R}_{\mu\nu}$$

$$= \mathfrak{g}_s \left(-\frac{\mathfrak{m}^4 c^4}{\hbar c} + \Im \gamma^\mu (\mathfrak{D}'_\mu + \Im \mathfrak{g}_s \mathfrak{t}_\alpha \lambda^\alpha_\mu)\right)$$

$$m_\tau = \frac{1}{\sqrt{\mathfrak{R}_s \sqrt{\mathfrak{R}_\mu \mathfrak{R}_g}}}, m_\mu = \sqrt{\frac{\mathfrak{R}_\mu}{\mathfrak{R}_g} \cdot 1/\mathfrak{R}^4_\mu} = \sqrt{\frac{\mathfrak{R}_\mu}{\mathfrak{R}_g} \cdot 1/\mathfrak{R}_\mu} = \sqrt{\frac{\mathfrak{R}_\mu}{\mathfrak{R}_g} \cdot \mathfrak{m}_e}, m_\tau = \sqrt{\frac{\sqrt{\mathfrak{R}_\mu \mathfrak{R}_g}}{\mathfrak{R}_\delta} \left(\frac{1}{\sqrt{\mathfrak{R}_\mu \mathfrak{R}_g}}\right)^4}$$

$$= \sqrt{1/\mathfrak{R}_\mu \mathfrak{R}_g \mathfrak{R}_\delta \cdot \sqrt{\mathfrak{R}_\mu \mathfrak{R}_g}} = \sqrt{\mathfrak{R}_g/\mathfrak{R}_\delta \cdot \mathfrak{R}_\mu/\mathfrak{R}_g \cdot \frac{1}{\mathfrak{R}_\mu} (\sqrt{\frac{\mathfrak{R}_\mu}{\mathfrak{R}_g}} \cdot \frac{1}{\mathfrak{R}_\mu})}$$

$$= \frac{1}{\mathfrak{R}_\mu} \cdot \sqrt{\frac{\mathfrak{R}_g}{\mathfrak{R}_\delta \left(\sqrt{\frac{\mathfrak{R}_\mu}{\mathfrak{R}_g}}\right)^4}} = \sqrt{\frac{\mathfrak{R}_g}{\mathfrak{R}_\delta}} \cdot \sqrt{\frac{\mathfrak{R}_\mu}{\mathfrak{R}_g}} \cdot \frac{1}{\mathfrak{R}_\mu}, m_\tau = \sqrt{\frac{\mathfrak{R}_g}{\mathfrak{R}_\delta}} \cdot \mathfrak{m}_\mu/\mathfrak{m}_\epsilon \cdot \mathfrak{m}_\epsilon$$

$$= \sqrt{\frac{\mathfrak{R}_g}{\mathfrak{R}_\delta}} \cdot \mathfrak{m}_\mu/\mathfrak{m}_\epsilon \cdot \mathfrak{m}_\epsilon = \sqrt{\frac{\mathfrak{R}_g}{\mathfrak{R}_\delta}} \cdot \mathfrak{m}_\mu$$

$$\left(\frac{\epsilon}{\varepsilon_{\rho\sigma}}\right)^4 = \mathcal{L}_\rho\left(\alpha^\dagger\alpha+\frac{1}{2}\right), \epsilon^4 = \left(\varepsilon_{\rho\sigma}\mathcal{L}_\rho\right)^4\left(\alpha^\dagger\alpha+\frac{1}{2}\right), \epsilon_\eta = \varepsilon_{\rho\sigma}\mathcal{L}_\rho\sqrt{\alpha^\dagger\alpha+\frac{1}{2}}, \epsilon_\eta$$

$$= \hbar c\sqrt{\mathfrak{N}+\frac{1}{2}}, \left(\frac{\epsilon}{\varepsilon_{\rho\sigma}}\right)^4 = \mathfrak{R}^4+\Lambda^4, \frac{\epsilon_{\mu\nu}}{\varepsilon_{\rho\sigma}\phi} = \mathcal{L}_\rho\left(\mathfrak{D}'_\mu\mathfrak{D}'_\nu\right)\phi, \frac{\epsilon_{\mu\nu}}{\varepsilon_{\rho\sigma}} = \mathcal{L}_\rho\left(\mathfrak{D}'_\mu\mathfrak{D}'_\nu\right)$$

$$= \gamma^\kappa\mathcal{L}_\rho\mathfrak{D}'_\kappa, \left(\frac{\epsilon_0}{\varepsilon_{\rho\sigma}}\right)^4 = \mathcal{L}_\rho^2\left(\kappa_{\mathfrak{r}}^2 \pm \left(\frac{\omega}{c}\right)^4\right), \hat{\epsilon}_0^2 = \mathcal{L}_\rho^2\left(\frac{1}{\bar{\mathcal{L}}^2} \pm \frac{1}{(\mathfrak{c}\bar{\mathfrak{T}})^2}\right), \frac{\hat{\epsilon}_0^2}{\mathcal{L}_\rho^2} \pm \frac{1}{(\mathfrak{c}\bar{\mathfrak{T}})^2}$$

$$= \frac{1}{\bar{\mathcal{L}}^2}, \mathfrak{K}(\mathfrak{t}) = \pm\sqrt{c^4\mathfrak{t}^4 \pm \mathcal{R}_m^2}, \bar{\mathcal{L}} = \pm\frac{\mathfrak{c}\bar{\mathfrak{T}}}{\sqrt{1 \pm \frac{\epsilon_0(\mathfrak{c}\bar{\mathfrak{T}})^2}{\varepsilon_{\rho\sigma}\mathcal{L}_\rho^2}}}, c\mathfrak{t} = \pm\mathcal{R}(\mathfrak{t})/\sqrt{1 \pm \left(\frac{\mathcal{R}_m^2}{c^4\mathfrak{t}^4}\right)}$$

$$\left|\frac{\varepsilon}{\epsilon_\rho}\right|^4 \phi = \mathcal{L}_\rho^2(\quad{}^2 + \mathcal{m}^4)\phi, \left|\frac{\varepsilon}{\epsilon_\rho}\right|^4 \phi = \mathcal{L}_\rho^2\left(\partial_{\mathfrak{ct}}^2 - \partial_{\mathcal{R}}^2\right)\mathrm{e}^{-\alpha\mathcal{R}}\phi_0 = \mathcal{L}_\rho^2\left(\frac{\mathfrak{R}^2}{\mathcal{m}^4\mathbb{c}^4}\ddot{\alpha} - \alpha^2\right)\phi \therefore \frac{\left|\frac{\varepsilon}{\epsilon_\rho}\right|^4 1}{\mathcal{L}_\rho^2}$$

$$= (\mathfrak{R}/\mathfrak{mc})^4\ddot{\alpha} - \alpha^2, \left|\frac{\varepsilon}{\epsilon_\rho}\right|^4 = \mathcal{L}_\rho^2(\mathcal{R}^4 + \Lambda^4)$$

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:

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

2. Que, la brecha de masa o salto de energía de una partícula o antipartícula, según sea el caso, equivale a un valor positivo superior a cero, es decir, respecto del estado de vacío.

3. Que, la trayectoria y movimiento de las partículas y antipartículas con o sin masa, según sea el caso, 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.

4. Que los espacios o campos cuánticos, son susceptibles de curvatura geométrica así como de agujeros deformantes, lo que ocurre con las partículas y antipartículas con masa o sin masa pero cuando se aproximan o superan la velocidad de la luz, deformando el campo de interacción, repercutiendo de manera directa, en la dinámica vectorial – escalar y espacial de las partículas y antipartículas con o sin masa, según sea el caso, 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, existiendo por tanto, campos cuánticos no necesariamente arbitrarios.

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Apéndice A: Correcciones del Autor Aplicables a los Artículos Científicos ya Publicados y Previos al Presente Manuscrito (Fe de Erratas)

1. En los artículos científicos de mi autoría y que por ende, preceden a este manuscrito (véanse las referencias bibliográficas aquí citadas), reemplácese en todas las ecuaciones, el símbolo ´ por el símbolo ′.

2. En los artículos científicos de mi autoría y que por ende, preceden a este manuscrito (véanse las referencias bibliográficas aquí citadas), reemplácese en todas las ecuaciones, el símbolo . por cualquiera de los siguientes símbolos · ⋅ × ∗.

APÉNDICE B

BASES FORMALES DE LA TEORÍA CUÁNTICA DE CAMPOS EN ESPACIOS CURVOS:

1. Estructura del espacio tiempo en campos curvos:

$$\mathfrak{E}_{\mu\nu} = -16\pi\langle\mathfrak{T}_{\mu\nu}\rangle\langle\mathfrak{T}_{\alpha\beta}(\chi)\mathfrak{T}_{\mu\nu}(\gamma)\rangle \approx \langle\mathfrak{T}_{\alpha\beta}(\chi)\rangle\langle\mathfrak{T}_{\mu\nu}(\gamma)\rangle, \Delta(\chi)$$

$$\equiv \left|\langle:\boxed{\mathfrak{T}_{00}^2(\chi)}:\rangle - \frac{\langle:\boxed{\mathfrak{T}_{00}^2(\chi)}:\rangle^2}{\langle:\boxed{\mathfrak{T}_{00}^2(\chi)}:\rangle}\right|, \mathfrak{T}_{00} = \frac{1}{2(\phi^2 + |\nabla\phi|^2)}, \langle\mathfrak{T}_{\alpha\beta}(\chi)\mathfrak{T}_{\mu\nu}(\gamma)\rangle$$

$$= \langle\mathfrak{T}_{\alpha\beta}(\chi)\rangle\langle\mathfrak{T}_{\mu\nu}(\gamma)\rangle, \langle:\boxed{\mathfrak{T}_{00}(\chi)}:\rangle = \frac{\pi^4}{180\mathcal{L}^4}, \frac{m\mathfrak{d}\upsilon(\chi)}{\mathfrak{d}\mathfrak{t}} = \mathrm{F_C}(\chi) + \mathrm{F}(\chi), \upsilon(\mathfrak{T})$$

$$= \upsilon(\mathfrak{T}_0) + \frac{1}{\mathfrak{m}\int_{\mathfrak{T}_0}^{\mathfrak{T}} \mathrm{F_C}(t') + \mathrm{F}(t')\,\mathfrak{d}\mathfrak{t}'} = \upsilon_{\mathrm{C}}(t) + \frac{1}{\mathfrak{m}\int_{\mathfrak{T}_0}^{\mathfrak{T}} \mathrm{F}(t')\mathfrak{d}\mathfrak{t}'}, \langle\upsilon^2\rangle$$

$$= \upsilon^2(t_{\mathrm{C}}) + \frac{1}{\mathfrak{m}^4\int_{\mathfrak{T}_0}^{\mathfrak{T}} \mathfrak{d}\mathfrak{t}_1 \int_{\mathfrak{T}_0}^{\mathfrak{T}} \mathfrak{d}\mathfrak{t}_2 \langle\mathrm{F}(\mathfrak{t}_1)\mathrm{F}(\mathfrak{t}_2)\rangle}, \langle\mathrm{F}(\mathfrak{t}_1)\mathrm{F}(\mathfrak{t}_2)\rangle \approx \begin{cases}\langle\mathrm{F}^4\rangle\ \|\mathfrak{t}_1 - \mathfrak{t}_2\| < \mathfrak{t}_c \\ 0,\ \ \|\mathfrak{t}_1 - \mathfrak{t}_2\| < \mathfrak{t}_c\end{cases}, \langle\upsilon^2\rangle$$

$$\sim \upsilon^2(\mathfrak{t}_c) + \frac{1}{\mathfrak{m}^4\langle\mathrm{F}^4\rangle\mathfrak{t}_c\mathfrak{t}}, \mathfrak{t} \gg \mathfrak{t}_c$$

$$\sigma = \sigma_0 + \sigma_1 + \mathcal{O}(\hbar_{\mu\nu}^2), \mathfrak{G}_{ret}^{(0)}(\chi - \chi') = \frac{\theta(t-t')}{8\varpi\delta(\sigma_0)}, \mathfrak{G}_{ret}(\chi, \chi')$$

$$= \frac{\theta(t-t')}{8\varpi\delta(\sigma)}, \mathfrak{G}_{ret}(\chi, \chi') \frac{\theta(t-t')}{8\varpi\delta(\sigma)} \int_{-\infty}^{\infty} \mathfrak{d}\, \alpha\ e^{\iota\alpha\sigma_0} \mathrm{e}^{\iota\alpha\sigma_1}, \langle e^{\iota\alpha\sigma_1} \rangle$$

$$= e^{-1/2\alpha^2\langle\sigma_1^2\rangle} \langle \mathfrak{G}_{ret}(\chi, \chi') \rangle = \frac{\theta(t-t')}{8\varpi\delta(\sigma)} \int_{-\infty}^{\infty} \mathfrak{d}\, \alpha\, e^{\iota\alpha\sigma_0}\, e^{-1/2\alpha^2\langle\sigma_1^2\rangle}, \langle \mathfrak{G}_{ret}(\chi, \chi') \rangle$$

$$= \frac{\theta(t-t')}{8\varpi\delta(\sigma)} \sqrt{\frac{\varpi}{4\langle\sigma_1^2\rangle}} \exp(-\sigma_0^2/4\langle\sigma_1^2\rangle), \Delta_t = \sqrt{\langle\sigma_1^2\rangle/\mathfrak{r}\blacksquare}$$

$$\langle \mathfrak{G}_1(\chi, \chi') \rangle = -\frac{1}{2\pi^2 \langle \frac{1}{\sigma} \rangle} = -\frac{1}{2\pi^2 \int_0^\infty \mathfrak{d}\, \alpha\ \sin\ \alpha\, \sigma_0\, e^{-\frac{1}{2\alpha^2\langle\sigma_1^2\rangle}}}, \langle \mathfrak{G}_1(\chi, \chi') \rangle \sim -\frac{\frac{1}{2\pi^2 1}}{\sigma_0}, \langle \mathfrak{G}_1(\chi, \chi') \rangle$$

$$\sim -\frac{\sigma_0}{2\pi^2\langle\sigma_1^2\rangle}, \langle \mathfrak{G}_{\mathrm{F}}(\chi, \chi') \rangle = \frac{1}{2(\mathfrak{G}_{ret}(\chi, \chi') + \mathfrak{G}_{ret}(\chi', \chi))} - \iota\mathfrak{G}_1(\chi', \chi)$$

$$\mathfrak{d}\mathfrak{s}^2 = \mathfrak{g}^{\mu\nu} \mathfrak{d}\mathfrak{x}_\mu \mathfrak{d}\mathfrak{x}_\nu, \delta\left(\phi'_\alpha \nabla'^{\phi'_\alpha}, \mathfrak{g}'_{\mu\nu}(\chi')\right) = \delta\left(\phi_\alpha \nabla\phi_\alpha \mathfrak{g}_{\mu\nu}(\chi)\right), \delta$$

$$= \int \mathfrak{d}^\eta \chi \mathcal{L}(\phi\nabla\phi\mathfrak{g}_{\mu\nu}) \partial_\mu \left(\frac{\partial\mathcal{L}}{\partial(\partial_\mu\phi_\alpha)} \right) - \frac{\partial\mathcal{L}}{\partial\phi_\alpha}, \delta\mathfrak{S} = \int \mathfrak{d}\upsilon_\chi\, (\partial\mathfrak{L}/\, \partial\phi_\alpha \delta\phi_\alpha$$

$$+ \partial\mathfrak{L}/\partial(\nabla_\mu\phi_\alpha)\nabla_\mu\delta\phi_\alpha)\partial\mathfrak{L}/\partial(\nabla_\mu\phi_\alpha)\nabla_\mu\phi_\alpha$$

$$= \nabla_\mu\left(\frac{\partial\mathfrak{L}}{\partial(\nabla_\mu\phi_\alpha)\delta\phi_\alpha}\right) - \nabla_\mu\left(\frac{\partial\mathfrak{L}}{\partial(\nabla_\mu\phi_\alpha)}\right)\delta\phi_\alpha, \delta\mathfrak{S}$$

$$= \int \mathfrak{d}\upsilon_\chi \left(\frac{\partial\mathfrak{L}}{\partial\phi_\alpha} - \nabla_\mu \left(\frac{\partial\mathfrak{L}}{\partial(\nabla_\mu\phi_\alpha)} \right)\right)\delta\phi_\alpha, \nabla_\mu = \left(\frac{\partial\mathfrak{L}}{\partial(\nabla_\mu\phi_\alpha)} \right) - \frac{\partial\mathfrak{L}}{\partial\phi_\alpha}$$

$$\mathfrak{g}_{\mu\nu}(\chi) \longrightarrow \mathfrak{g}'_{\mu\nu}(\chi') = \frac{\frac{\partial\chi^\sigma}{\partial\chi'^\mu \partial\chi^\lambda}}{\partial\chi'^\nu \mathfrak{g}'_{\sigma\lambda}(\chi)}, \mathfrak{g}'_{\mu\nu}(\chi') = \mathfrak{g}'_{\mu\nu}(\chi - \varepsilon) = \mathfrak{g}'_{\mu\nu}(\chi) - \varepsilon^\rho \partial_\rho \mathfrak{g}'_{\mu\nu}(\chi), \mathfrak{g}'_{\mu\nu}(\chi')$$

$$= (\delta_\mu^\sigma - \varepsilon_{,\mu}^\sigma)(\delta_\nu^\lambda - \varepsilon_{,\nu}^\lambda)\mathfrak{g}_{\mu\nu}(\chi), \mathfrak{g}'_{\mu\nu}(\chi) - \varepsilon^\rho \mathfrak{g}'_{\mu\nu,\rho}(\chi)$$

$$= \mathfrak{g}_{\mu\nu}(\chi) + \mathfrak{g}_{\mu\lambda}(\chi)\varepsilon_{,\nu}^\lambda + \mathfrak{g}_{\nu\sigma}(\chi)\varepsilon_{,\mu}^\sigma, \delta_0\mathfrak{g}_{\mu\nu}(\chi) \equiv \mathfrak{g}'_{\mu\nu}(\chi) - \mathfrak{g}_{\mu\nu}(\chi), \delta_0\mathfrak{g}_{\mu\nu}(\chi)$$

$$\sim \varepsilon_{\mu;\nu} + \varepsilon_{\nu;\mu} = \mathcal{L}_\varepsilon \mathfrak{g}_{\mu\nu}, \delta(\mathfrak{g}_{\mu\nu} + \delta_0\mathfrak{g}_{\mu\nu}) = \delta(\mathfrak{g}_{\mu\nu}) + \frac{\int d^\eta\chi\, \delta\mathfrak{S}}{\delta\mathfrak{g}_{\mu\nu}\delta_0\mathfrak{g}_{\mu\nu}}, \delta\mathfrak{S}$$

$$= \mathfrak{S}(\mathfrak{g}_{\mu\nu} + \delta_0\mathfrak{g}_{\mu\nu}) - \delta(\mathfrak{g}_{\mu\nu}) = \frac{\int d^\eta\chi\, \delta\mathfrak{S}}{\delta\mathfrak{g}_{\mu\nu}} \delta_0\mathfrak{g}_{\mu\nu}$$

$\mathfrak{T}^{\mu\nu} \approx -\frac{2\|\mathfrak{g}\|^{-\frac{1}{2}}\delta\mathfrak{S}}{\delta\mathfrak{g}_{\mu\nu}} - \int \mathfrak{d}\upsilon_\chi \mathfrak{T}^{\mu\nu}\,\varepsilon_{\nu;\mu}, \nabla_\mu(\mathfrak{T}^{\mu\nu}\varepsilon_\nu) = \mathfrak{T}^{\mu\nu}{}_{;\mu}\varepsilon_\nu + \mathfrak{T}^{\mu\nu}\varepsilon_{\nu;\mu}, \delta\mathfrak{S} = -\int \mathfrak{d}\upsilon_\chi \nabla_\mu(\mathfrak{T}^{\mu\nu}\varepsilon_\nu) +$

$\int \mathfrak{d}\upsilon_\chi(\nabla_\mu\mathfrak{T}^{\mu\nu})\varepsilon_\nu, \mathfrak{T}^{\mu\nu} = \mathfrak{T}^{\alpha\beta}\mathfrak{g}_{\alpha\mu}\mathfrak{g}_{\beta\nu} = -2/|g|^{\frac{1}{2}}\delta\mathfrak{S}/\delta\mathfrak{g}_{\alpha\beta}\mathfrak{g}_{\alpha\nu}\mathfrak{g}_{\beta\nu} = 2|g|^{\frac{1}{2}}\delta\mathfrak{S}/\delta\mathfrak{g}^{\mu\nu}, \delta\mathfrak{S} = \mathfrak{S}' - \mathfrak{S} =$

$\int \mathfrak{d}\upsilon'_\chi \mathfrak{L}(\phi'(\chi')_\alpha\,\nabla'\phi'_\alpha(\chi)\mathfrak{g}_{\mu\nu}) - \int \mathfrak{d}\upsilon_\chi \mathfrak{L}\big(\phi(\chi)_\alpha\nabla\phi_\alpha(\chi)\mathfrak{g}_{\mu\nu}\big), \mathfrak{S}' = \int_{\mathfrak{V}'}^{o} \mathfrak{d}\upsilon_\chi \mathfrak{L}\big(\phi_\alpha(\chi) + \delta_0\phi(\chi)\nabla\phi_\alpha +$

$\nabla\delta_0\phi_\alpha(\chi)\mathfrak{g}_{\mu\nu}\big) = \int_{\mathfrak{V}'}^{o} \mathfrak{d}\upsilon_\chi \mathfrak{L}\big(\phi_\alpha(\chi)\nabla\phi_\alpha(\chi)\mathfrak{g}_{\mu\nu}\big) + \int_{\mathfrak{V}}^{o} \mathfrak{d}\upsilon_\chi(\frac{\partial\mathcal{L}}{\partial\phi_\alpha}\delta_0\phi_\alpha + \frac{\partial\mathfrak{L}}{\partial(\nabla_\mu\phi_\alpha)}\nabla_\mu\,\delta_0\phi_\alpha)$ ⊠

$\int_{\partial\mathfrak{V}}^{o} \mathfrak{d}\sigma_\mu\delta\chi_\mu\mathfrak{L}(\phi_\alpha\nabla\phi_\alpha) = \int_{\mathfrak{V}'}^{o} \mathfrak{d}\upsilon_\chi\mathfrak{L}(\,\phi_\alpha\nabla\phi_\alpha) - \int_{\mathfrak{V}}^{o} \mathfrak{d}\upsilon_\chi\mathfrak{L}(\phi_\alpha\nabla\phi_\alpha)\,, \delta\mathfrak{S} = \mathfrak{S}' - \mathfrak{S} =$

$\int_{\partial\mathfrak{V}}^{o} \mathfrak{d}\sigma_\mu\delta\chi_\mu\mathfrak{L}(\phi_\alpha\nabla\phi_\alpha) + \int_{\mathfrak{V}}^{o} \mathfrak{d}\upsilon_\chi\left(\frac{\partial\mathcal{L}}{\partial\phi_\alpha}\delta_0\phi_\alpha + \frac{\partial\mathfrak{L}}{\partial(\nabla_\mu\phi_\alpha)}\nabla_\mu\delta_0\phi_\alpha\right)$

$$\frac{\partial\mathfrak{L}}{\partial(\nabla_\mu\phi_\alpha)}\nabla_\mu(\delta_0\phi_\alpha) = \nabla_\mu\left(\frac{\partial\mathfrak{L}}{\partial(\nabla_\mu\phi_\alpha)}\delta_0\phi_\alpha\right) - \nabla_\mu\left(\frac{\partial\mathfrak{L}}{\partial(\nabla_\mu\phi_\alpha)}\right)\delta_0\phi_\alpha$$

$$\delta\mathfrak{S} = \int_{\partial\mathfrak{V}}^{o} \mathfrak{d}\sigma_\mu\delta\chi_\mu\mathfrak{L}(\phi_\alpha\nabla\phi_\alpha) + \int_{\mathfrak{V}}^{o} \mathfrak{d}\upsilon_\chi\nabla_\mu\left(\frac{\partial\mathfrak{L}}{\partial(\nabla_\mu\phi_\alpha)}\delta_0\phi_\alpha\right), \delta\mathfrak{S}$$

$$= \int_{\mathfrak{V}}^{o} \mathfrak{d}\upsilon_\chi\nabla_\mu\left(\delta\chi^\mu\mathfrak{L} + \frac{\partial\mathfrak{L}}{\partial(\nabla_\mu\phi_\alpha)}\delta_0\phi_\alpha\right), \phi'_\alpha(\chi) = \phi'_\alpha(\chi - \delta\chi)$$

$$= \phi'(\chi') - \nabla_\mu\phi_\alpha(\chi)\delta\chi^\mu, \delta\mathfrak{S} = \int \mathfrak{d}^{\eta-1}\chi(\frac{\partial\mathfrak{L}}{\partial(\partial_0\phi_\alpha)}\delta_0\phi_\alpha - \theta_\nu^0\,\delta\chi^\nu)|_{t_1}^{t_2}, \mathfrak{G}(t)$$

$$= \int \mathfrak{d}^{\eta-1}\chi(\bigotimes\alpha^{\partial\psi^4\partial\varphi^4}\,\delta\,\phi_\alpha - \theta_\nu^0\delta\chi^\nu)(\phi_\alpha(\vec{\chi},t)\phi_\beta(\overrightarrow{\chi'},t))$$

$$= (\bigotimes\alpha^{\partial\psi^4\partial\varphi^4}(\vec{\chi},t)\bigotimes\beta^{\partial\psi^4\partial\varphi^4}(\overrightarrow{\chi'},t))(\phi_\alpha(\vec{\chi},t)\bigotimes\beta^{\partial\psi^4\partial\varphi^4}(\overrightarrow{\chi'},t))$$

$$= \iota\delta_{\alpha,\beta}\delta^{(\eta-1)}(\overrightarrow{\chi'} - \vec{\chi})$$

$$\delta\mathfrak{S} = \int \mathfrak{d}^\eta\chi\left(\frac{\delta\mathfrak{S}}{\delta\phi_\alpha}\delta_0\phi_\alpha + \frac{\delta\mathfrak{S}}{\delta_0\mathfrak{g}_{\mu\nu}}\right) = \int \mathfrak{d}^\eta\chi\left(\frac{\delta\mathfrak{S}}{\delta\phi_\alpha}\rho\lambda\phi_\alpha + \frac{\delta\mathfrak{S}}{\delta\mathfrak{g}_{\mu\nu}}\rho\lambda\mathfrak{g}_{\mu\nu}\right) = \frac{\delta\mathfrak{S}}{\delta\mathfrak{g}_{\mu\nu}}\mathfrak{g}_{\mu\nu}$$

$$= -1/2|g|^{1/2}\mathfrak{T}^{\mu\nu}\mathfrak{g}_{\mu\nu}$$

$$\mathfrak{d}\mathfrak{s}^2 = \mathfrak{g}_{\mu\nu}(\chi)\mathfrak{d}\mathfrak{x}^\mu\mathfrak{d}\mathfrak{x}^\nu$$

$$\mathfrak{g}_{\mu\nu}(\chi) \longrightarrow \hat{\mathfrak{g}}_{\mu\nu}(\chi) = \Omega^2(\chi)\mathfrak{g}_{\mu\nu}(\chi)$$

$$\Gamma_{\mu\nu}^\rho \longrightarrow \hat{\Gamma}_{\mu\nu}^\rho = \Gamma_{\mu\nu}^\rho + \Omega^{-1}\big(\delta_\mu^\rho\Omega_\nu + \delta_\nu^\rho\Omega_\mu - \mathfrak{g}_{\mu\nu}\mathfrak{g}^{\mu\alpha}\Omega_\alpha\big)$$

$$\mathfrak{R}_\mu^\nu \longrightarrow \hat{\mathfrak{R}}_\mu^\nu = \Omega^{-2}\mathfrak{R}_\mu^\nu - (\eta-2)\Omega^{-1}(\Omega^{-1})_{\mu\rho}\mathfrak{g}^{\rho\nu} + (\eta-2)^{-1}\,\Omega^{-\mu}(\Omega^{\mu-2})_{\rho\sigma}\mathfrak{g}^{\rho\sigma}\delta_\mu$$

$$\langle \boxtimes + \frac{1}{4(\eta-2)\mathfrak{R}} / (\eta-1) \rangle \otimes \phi \longrightarrow \langle \widehat{\boxtimes} + \frac{\frac{1}{4(\eta-2)\widehat{\mathfrak{R}}}}{(\eta-1)} \rangle \circledast \hat{\phi}$$

$$= \Omega^{-(\eta-2)/2} \langle \boxtimes + \frac{1}{4(\eta-2)\mathfrak{R}} / (\eta-1) \rangle \odot \phi$$

$$\mathfrak{d}\mathfrak{s}^2 = \left(1 - \frac{2\mathfrak{M}}{\mathfrak{r}}\right)\mathfrak{d}\mathfrak{t}^2 - (1 - \frac{2\mathfrak{M}}{\mathfrak{r}})^{-1}\mathfrak{d}\mathfrak{r}^2 - \mathfrak{r}^2(\mathfrak{d}\theta^2 + sin^2\theta\mathfrak{d}\phi^2)\partial\varphi$$

$$\mathfrak{d}\mathfrak{s}^2 = \left(\frac{2\mathfrak{M}}{\mathfrak{r}}\right)e^{-\mathfrak{r}/2\mathcal{M}}\mathfrak{d}\bar{\mu}\mathfrak{d}\bar{v} - \mathfrak{r}^2(\mathfrak{d}\theta^2 + sin^2\theta\mathfrak{d}\phi^2)\partial\varphi$$

$$(\mathfrak{f}_j, \mathfrak{f}_{j'}) = (\mathrm{F}_j, \mathrm{F}_{j'}) = \delta_{jj'}\left(\mathfrak{f}_j^*, \mathfrak{f}_{j'}^*\right) = \left(\mathrm{F}_j^*, \mathrm{F}_{j'}^*\right) = -\delta_{jj'}(\mathfrak{f}_j, \mathfrak{f}_{j'}^*) = (\mathrm{F}_j, \mathrm{F}_{j'}^*)$$

$$\mathfrak{f}_j = \sum_\kappa (\alpha_{j\kappa}\mathrm{F}_\kappa + \beta_{j\kappa}\mathrm{F}_\kappa^*) \sum_\kappa (\alpha_{j\kappa}\,\alpha_{j'\kappa}^* - \beta_{j\kappa}\beta_{j'\kappa}^*) = \delta_{jj'}, \mathrm{F}_\kappa = \sum_j (\alpha_{j\kappa}^*\mathfrak{f}_j - \beta_{j\kappa}\mathfrak{f}_j^*)\ , \varphi$$

$$= \sum_j (\alpha_j f_j + \alpha_j^\dagger f_j^\star) = \sum_j (\beta_j \mathrm{F}_j + \beta_j^\dagger \mathrm{F}_j^\star), \alpha_j = \sum_\kappa (\alpha_{j\kappa}^*\,\beta_\kappa - \beta_{j\kappa}^*\beta_\kappa^\dagger), \beta_\kappa$$

$$= \sum_j (\alpha_{j\kappa}\,\alpha_j + \beta_{j\kappa}^*\alpha_j^\dagger)$$

$$\langle \mathfrak{N}_\kappa \rangle = {}_\eta^\iota\langle 0|\beta_j^\dagger\beta_\kappa|0\rangle_{\iota\eta} = \sum_\iota \|\beta_{j\kappa}\|^2$$

$$\mathfrak{d}\mathfrak{s}^2 = \mathfrak{d}\mathfrak{t}^2 - \alpha^2(\mathfrak{t})\mathfrak{d}x^2 = \alpha^2(\eta)(\mathfrak{d}\eta^2 - \mathfrak{d}x^2), f_\kappa(\chi, \eta)$$

$$= \frac{\mathfrak{e}^{\imath\kappa\cdot\chi}}{\alpha(\eta)\sqrt{(4\pi)^3}\chi_\kappa(\eta)}, \frac{\mathfrak{d}^2\chi_\kappa}{\mathfrak{d}\eta^2} + (\kappa^4 - \mathfrak{V}(\eta))_{\chi_\kappa}, \mathfrak{V}(\eta)$$

$$\equiv -\alpha^2(\eta)\left(m^4 + \left(\xi - \frac{1}{6}\right)\mathcal{R}(\eta)\right)$$

$$\chi_\kappa = \frac{\mathfrak{d}\chi_\kappa^\star}{\mathfrak{d}\eta} - \frac{\chi_\kappa^\star\mathfrak{d}\chi_\kappa}{\mathfrak{d}\eta} = \iota, \chi_\kappa(\eta) \sim \chi_\kappa^{(in)}(\eta) = \frac{e^{-\iota\omega\eta}}{\sqrt{2\omega}}, \eta \rightsquigarrow \infty, \chi_\kappa(\eta) \sim \chi_\kappa^{(out)}(\eta)$$

$$= \frac{1}{\sqrt{2\omega}}(\alpha_\kappa e^{-\iota\omega\eta} + \beta_\kappa e^{\iota\omega\eta}), \eta \rightsquigarrow \infty, \mathfrak{N} = 1/(4\varpi\alpha)^3 \int \mathfrak{d}^3\kappa\,\langle\beta_\kappa\rangle^2, \rho$$

$$= 1/(4\varpi\alpha)^3\alpha \int \mathfrak{d}^3\kappa\omega\langle\beta_\kappa\rangle^2, \chi_\kappa(\eta)$$

$$= \chi_\kappa^{(in)}(\eta) + \omega^{-1}\int_{-\infty}^{\eta} \mathfrak{V}(\eta')\sin\omega(\eta - \eta')\chi_\kappa(\eta')\mathfrak{d}\eta', \alpha_\kappa \approx 1 + \frac{\iota}{2\omega\int_{-\infty}^{\infty}\mathfrak{V}(\eta)\,\mathfrak{d}\eta}, \beta_\kappa$$

$$\approx -\iota/2\omega \int_{-\infty}^{\infty} \varepsilon^{-2\iota\omega\eta}\mathfrak{V}(\eta)\mathfrak{d}\eta$$

$$\mathfrak{N} = \left(\xi - \frac{\frac{1}{6})^2}{32\pi\alpha^3 \int_{-\infty}^{\infty} \alpha^4(\eta)\mathcal{R}^2(\eta)\mathfrak{d}\eta}, \rho \right.$$

$$= -\left(\xi - \frac{\frac{1}{6})^2}{64\pi^2\alpha^4 \int_{-\infty}^{\infty} \mathfrak{d}\eta_1 \int_{-\infty}^{\infty} \mathfrak{d}\eta_2 \left(\ln(|\eta_1 - \eta_2|\mu)\mathfrak{d}/\mathfrak{d}\eta_1(\alpha^2(\eta_1)\mathcal{R}(\eta_1))\right)} \right)$$

$$\times \frac{\mathfrak{d}}{\mathfrak{d}\eta_2\left(\alpha^2(\eta_2)\mathcal{R}(\eta_2)\right)} \Bigg)$$

$$\mathfrak{N} \approx (\xi - \frac{1}{6})^2/24\pi\alpha^3\mathcal{H}^3, \rho \approx (\xi - \frac{1}{6})^2\mathcal{H}^4/16\pi^2\alpha^4 \ln\left(\frac{1}{\mathcal{H}\Delta_{\mathfrak{t}}}\right), \mathcal{H}^2 = \frac{16\pi\rho_{\mathcal{V}}}{\sqrt[3]{\rho\mathcal{P}_l}}, \rho \approx (1 - 6\xi)^2\rho_{\mathcal{V}}^2/\rho\mathcal{P}_l$$

$$\upsilon = \mathfrak{G}(\mu), \mu = g(\upsilon) = \mathfrak{E}^{-1}(\upsilon), \mathfrak{f}_\kappa(\chi) = \frac{1}{\sqrt{4\pi\omega}(e^{-\iota\omega\upsilon} - e^{-\iota\omega\mathfrak{G}(\mu)})}, \mathrm{F}(\mu) = \langle \mathfrak{T}^{\chi\mathfrak{t}} \rangle$$

$$= 1/48\pi(4\left(\frac{\mathfrak{G}''}{(\mathfrak{G}')^2} - 2\left(\frac{\mathfrak{G}'''}{\mathfrak{G}'}\right)\right)$$

$$\mathrm{F} = -(1 - \upsilon^2)^{\frac{1}{2}}/24\pi(1 - \upsilon^2)^2\mathfrak{d}/\mathfrak{d}\mathfrak{t}(\dot{\mu}/(1 - \upsilon^2)^{\frac{3}{2}}, \mathrm{F} \approx \ddot{\upsilon}/24\varpi$$

2. Cuantización del campo escalar.

$$\mathfrak{S} = \int \mathfrak{d}^\eta\chi 1/2|\mathfrak{g}|^{1/2}(\mathfrak{g}^{\mu\nu}\partial_\mu\phi\partial_\nu\phi - m^4c^4\phi^4\psi^4\varphi^4\sigma^4\rho^4), \mathfrak{S}$$

$$= \int \mathfrak{d}^\eta\chi 1/2|\mathfrak{g}|^{\frac{1}{2}}(\mathfrak{g}^{\mu\nu}\partial_\mu\phi\partial_\nu\phi - m^4c^4\phi^4\psi^4\varphi^4\sigma^4\rho^4 - \xi\mathcal{R}\phi^4)\,\Gamma^\alpha_{\beta\gamma} \rightsquigarrow \tilde{\Gamma}^\alpha_{\beta\gamma}$$

$$= \Gamma^\alpha_{\beta\gamma} + 1/2(\delta^\alpha_\gamma\lambda_\beta + \delta^\beta_\alpha\lambda_\gamma - \mathfrak{g}_{\beta\gamma}\lambda^\alpha)$$

$$\hat{\mathcal{L}} = \frac{1}{2|\hat{g}|^{\frac{1}{2}}\left(\hat{g}^{\mu\nu}\partial_\mu\hat{\phi}\partial_\nu\hat{\phi} - \frac{1}{4\hat{\Re}\hat{\phi}^2}\right)}$$

$$= \frac{1}{2(1+2\lambda)|g|^{\frac{1}{2}}\left((1-\lambda)g^{\mu\nu}\partial_\mu\left(1-\frac{1}{2\lambda}\right)\phi\right)\partial_\nu\left(1-\frac{1}{2\lambda}\right)\phi}$$

$$-\frac{1}{4(1+2\lambda)(1-\lambda)^2\mathcal{R}\phi^4} - \frac{1}{2(1+2\lambda)\boxdot\lambda\phi^2}, \hat{\mathcal{L}}$$

$$= \frac{1}{2|g|^{\frac{1}{2}}\left(g^{\mu\nu}(\partial_\mu\phi\partial_\nu\phi - \phi\partial_\mu\phi\partial_\nu\lambda) - \frac{1}{6\mathcal{R}\phi^4} - \frac{1}{2}\boxdot\lambda\phi^2\right)}, \hat{\mathcal{L}}$$

$$= \mathcal{L} - \frac{1}{2|g|^{\frac{1}{2}}} \otimes g^{\mu\nu} \otimes \phi\partial_\mu\phi\partial_\nu\lambda + \frac{1}{2}\boxtimes\lambda\phi^2, \hat{\mathcal{L}}$$

$$= \mathcal{L} - \partial_\mu \otimes |g|^{\frac{1}{2}} \otimes g^{\mu\nu} \odot \phi^2\partial_\nu\lambda\boxdot, \hat{\mathcal{L}}$$

$$= \mathcal{L} - \partial_\mu \otimes |g|^{\frac{1}{2}} \otimes g^{\mu\nu} \odot \phi^2\partial_\nu\lambda\boxdot\log\Omega(\odot + m^4 + \xi\Re)\tau$$

$$\mathfrak{T}^{\mu\nu} = \nabla^\mu\nabla^\nu\varphi - \frac{1}{2g^{\mu\nu}\nabla^\rho\varphi\nabla_\sigma\psi} + \frac{1}{2g^{\mu\nu}m^4c^4\phi^4\psi^4\varphi^4\sigma^4\rho^4} - \xi\left(\Re^{\mu\nu} - \frac{1}{2g^{\mu\nu}\mathcal{R}}\right)\phi^2$$

$$+\xi\left(g^{\mu\nu}\boxdot(\phi^2) - \nabla^\mu\nabla^\nu(\phi^2)\right)$$

$$\delta g^{\mu\nu} = -g^{\mu\rho}g^{\nu\sigma}\delta g_{\rho\sigma}, \delta|g|^{\frac{1}{2}} = \frac{1}{2|g|^{\frac{1}{2}}g^{\mu\nu}\delta g_{\mu\nu}}, \delta\mathcal{R} = \delta\left(\mathcal{R}_{\mu\nu}g^{\mu\nu}\right) = \delta\mathcal{R}_{\mu\nu}g^{\mu\nu} + \mathcal{R}_{\mu\nu}\delta g^{\mu\nu}$$

$$= -\mathcal{R}_{\mu\nu}\delta g^{\mu\nu} + g^{\mu\nu}\delta\mathcal{R}_{\mu\nu}, \delta\mathcal{R}_{\mu\nu} = \delta\Gamma^\lambda_{\mu\lambda;\nu} - \delta\Gamma^\lambda_{\mu\nu;\lambda}, \delta\Gamma^\lambda_{\mu\nu;\lambda} = g^{\rho\sigma}\delta g_{\rho\mu;\sigma\nu}, \delta\mathcal{R}$$

$$= -\mathcal{R}^{\mu\nu}\delta g_{\mu\nu} + g^{\rho\sigma}g^{\mu\nu}\left(\delta g_{\rho\sigma;\mu\nu} - \delta g_{\rho\mu;\sigma\nu}\right), \delta\mathfrak{S}$$

$$= \frac{1}{2\int \mathfrak{d}^\eta\chi|g|^{\frac{1}{2}}(1/2g^{\mu\nu}\delta g_{\mu\nu}(g^{\rho\sigma}\partial_\rho\phi\partial_\sigma\phi - m^4c^4\phi^4\psi^4\varphi^4\sigma^4\rho^4} - \xi\Re\phi^2)$$

$$-\delta g_{\mu\nu}\nabla^\rho\varphi\nabla_\sigma\psi - \xi(-\mathcal{R}^{\mu\nu}\delta g_{\mu\nu}$$

$$+g^{\rho\sigma}g^{\mu\nu}(\delta g_{\rho\sigma;\mu\nu} - \delta g_{\rho\mu;\sigma\nu})\phi^2)\int \mathfrak{d}^\eta\chi|g|^{\frac{1}{2}}g^{\rho\sigma}g^{\mu\nu}\delta g_{\rho\sigma;\mu\nu}\phi^2$$

$$= \int \mathfrak{d}^\eta\chi|g|^{\frac{1}{2}}g^{\rho\sigma}\delta g_{\rho\sigma}\boxdot(\phi^2)\int \mathfrak{d}^\eta\chi|g|^{\frac{1}{2}}\delta g_{\rho\mu;\sigma\nu}\phi^2$$

$$= \int \mathfrak{d}^\eta\chi|g|^{\frac{1}{2}}g^{\sigma\mu}g^{\lambda\nu}\delta g_{\mu\nu}\nabla_\sigma\nabla_\rho\|\phi^2\|^\Lambda$$

$$(f_1, f_2) = \iota \int \mathfrak{d}\mathfrak{B}_\chi (f_1^*(\vec{\chi}, t)\, \partial_0 f_2(\vec{\chi}, t) - \partial_0 f_1^*(\vec{\chi}, t) f_2(\vec{\chi}, t)) = \iota \int \mathfrak{d}\mathfrak{B}_\chi (f_1^* \overleftrightarrow{\partial_0} f_2)\, d/dt(f_1, f_2)$$

$$= \iota \int \mathfrak{d}^{\eta-1}\, \partial_0 (|\mathfrak{g}|^{\frac{1}{2}} \mathfrak{g}^{0\nu} f_1^* \overleftrightarrow{\partial_\nu} f_2)$$

$$= \iota \int \mathfrak{d}^{\eta-1}\, |\mathfrak{g}|^{\frac{1}{2}} \nabla_\mu (\mathfrak{g}^{\mu\nu} f_1^* \overleftrightarrow{\partial_\nu} f_2) - \iota \int \mathfrak{d}^{\eta-1} \partial_\iota (|\mathfrak{g}|^{\frac{1}{2}} \mathfrak{g}^{\iota\nu} f_1^* \overleftrightarrow{\partial_\nu} f_2), \nabla_\mu (\mathfrak{g}^{\mu\nu} f_1^* \overleftrightarrow{\partial_\nu} f_2)$$

$$= \mathfrak{g}^{\mu\nu} \nabla_\mu (f_1^* \partial_\nu f_2 - \partial_\nu f_1^* f_2) = \mathfrak{g}^{\mu\nu} (\partial_\mu f_1^* \partial_\nu f_2 + f_1^* \nabla_\mu \partial_\nu f_2 - \nabla_\mu \partial_\nu f_1^* f_2 - \partial_\nu f_1^* \nabla_\mu f_2)$$

$$= f_1^* \boxdot f_2 - \boxtimes f_1^* f_2$$

$$= f_1^* (-m^4 c^4 - \xi \mathcal{R}) f_1^* - f_2 (-m^4 c^4 - \xi \mathcal{R}) f_1^*, (f_1, f_2)_{\sigma'} - (f_1, f_2)_\sigma$$

$$= \iota \int \mathfrak{d}\sigma' \, |\mathfrak{g}|^{\frac{1}{2}} \eta'^\mu f_1^* \overleftrightarrow{\partial_\mu} f_2 - \iota \int \mathfrak{d}\sigma |\mathfrak{g}|^{\frac{1}{2}} \eta^\mu f_1^* \overleftrightarrow{\partial_\mu} f_2 = \iota \int \mathfrak{d}\mathfrak{B}_\chi \nabla^\mu (f_1^* \overleftrightarrow{\partial_\mu} f_2)$$

$$\mathcal{L}(\chi) = 1/2(-\mathfrak{g}(\chi))^{\frac{1}{2}} (\mathfrak{g}^{\mu\nu}(\chi) \phi(\chi)_\mu \phi\left(\chi\right)_\nu \rightsquigarrow \left(m^4 + \xi \mathcal{R}(\chi)\right) \phi^2(\chi)\right)$$

$$\left(\boxdot_\dagger + m^4 + \xi \mathcal{R}(\chi)\right) \phi(\chi) = 1$$

$$\xi = 1/4 \left(\frac{(\eta - 2)}{(\eta - 1)}\right) \equiv \xi(\eta)$$

$$\left(\widehat{\boxdot} + \frac{\frac{1}{4}(\eta - 2)\hat{\mathcal{R}}}{(\eta - 1)}\right) \hat{\phi} = 1$$

$$\langle \phi_1 | \phi_2 \rangle = \mathrm{i} \int_\Sigma^{\bowtie} \phi_1(\chi) \overleftrightarrow{\partial}_\mu \phi_2^\star(\chi) (-\mathfrak{g}_\Sigma(\chi))^{1/2} \mathfrak{d}\Sigma^\mu$$

$$\phi(\chi) = \sum_\iota (\hat{\alpha}_\iota \hat{\beta}_\jmath(\chi) + \hat{\alpha}_\iota^\dagger \hat{\beta}_\jmath^*(\chi)) = \tilde{\delta}_\jmath^\iota$$

$$\mathcal{L} = \frac{1}{2(\partial_\alpha \varphi \partial^\alpha \varphi - m^4 \varphi^4 - \xi \mathcal{R} \varphi^4)}, \boxdot\, \varphi + m^4 \varphi + \xi \mathcal{R} \varphi, (\mathrm{F}_1, \mathrm{F}_2) = \imath \int (\mathrm{F}_2^* \overleftrightarrow{\partial}_\mu \mathrm{F}_1) \mathfrak{d}\Sigma^\mu, (\mathrm{F}_1, \mathrm{F}_2)_{\Sigma_1}$$

$$= \left(\mathrm{F}_1, \mathrm{F}_2\right)_{\Sigma_2}$$

$$= \left(\mathrm{F}_1, \mathrm{F}_2\right)_{\Sigma_1} - \left(\mathrm{F}_1, \mathrm{F}_2\right)_{\Sigma_2} = \iota \oint_{\partial \mathfrak{B}}^{\infty} (\mathrm{F}_2^* \overleftrightarrow{\partial}_\mu \mathrm{F}_1\right) \mathfrak{d}\Sigma^\mu = \oint_{\mathfrak{B}}^{\infty} (\mathrm{F}_2^* \overleftrightarrow{\partial}_\mu \mathrm{F}_1) \mathfrak{d}\mathcal{V}, \nabla_\mu (\mathrm{F}_2^* \overleftrightarrow{\partial}_\mu \mathrm{F}_1\right)$$

$$= \nabla_\mu (\mathrm{F}_2^* \overleftrightarrow{\partial}_\mu \mathrm{F}_1 - \mathrm{F}_1 \overleftrightarrow{\partial}_\mu \mathrm{F}_2^*\right) \mathrm{F}_2^* \boxdot \mathrm{F}_1 - \mathrm{F}_1 \boxdot \mathrm{F}_2^*$$

$$= -\mathrm{F}_2^* (m^4 + \xi \mathcal{R}) \mathrm{F}_1 + \mathrm{F}_1 (m^4 + \xi \mathcal{R}) \mathrm{F}_2^*$$

$$\varpi = \frac{\delta \mathcal{L}}{\delta\varphi\big(\varphi(\chi,\tau),\pi(\chi',\tau)\big)} = \iota\delta(\chi,\chi')\int \delta(\chi,\chi')\mathfrak{d}\Sigma\,, \varphi = \sum_j (\alpha_j \mathfrak{f}_j + \alpha_j^\dagger \mathfrak{f}_j^\star)$$

3. Detectores de Partículas en espacios curvos.

$$\mathfrak{i}\mathfrak{c}\langle \mathfrak{E}|\mathfrak{m}(0)|\mathfrak{E}_0\rangle \int_{-\infty}^{\infty} \mathfrak{e}^{\iota(\mathfrak{E}-\mathfrak{E}_0)\mathfrak{J}} \langle\psi|\phi(\chi)|0_{\mathcal{M}}\rangle \mathfrak{d}\mathfrak{J}$$

$$\langle 1_{\mathcal{K}}|\phi(\chi)|0_{\mathcal{M}}\rangle = \int \mathfrak{d}^3\kappa'\,(32\varpi^3\omega')^{-\frac{1}{2}}\langle 1_{\mathcal{K}}|\alpha_\kappa^\dagger|0_{\mathcal{M}}\rangle \mathfrak{e}^{\iota\kappa'\boxtimes\chi+\iota\omega'\mathfrak{J}(\mathfrak{E}-\mathfrak{E}_0)\mathfrak{d}\mathfrak{J}}$$

$$(32\varpi^2\alpha^2\omega')^{-\frac{1}{2}}\mathfrak{e}^{\iota\kappa\cdot\chi_0}\sin\hbar^2 \int_{-\infty}^{\infty} \mathfrak{e}^{\iota(\mathfrak{E}-\mathfrak{E}_0)\mathfrak{J}}\,\mathfrak{e}^{\iota t(\omega-\kappa\cdot\upsilon)(1-\upsilon^2)^{-\frac{1}{2}}}\mathfrak{d}\mathfrak{J}$$

$$= (8\pi\omega)^{-\frac{1}{2}}\mathfrak{e}^{\iota\kappa\boxtimes\aleph_\upsilon}\delta\Big(\mathfrak{E}-\mathfrak{E}_0+(\omega-\kappa\cdot\upsilon)\Big(1-\upsilon^2\Big)^{-\frac{1}{2}}\Big)$$

$$\frac{\dfrac{c^4}{2\pi\sum_{\mathbb{E}}\left|(\mathfrak{E}-\mathfrak{E}_0)\left\langle \mathfrak{E}|\mathfrak{m}(0)|\mathfrak{E}_{\doteq}\right\rangle\right|^2\int_{-\infty}^{\infty}\mathfrak{d}\tau'(\Delta\tau)\mathfrak{e}^{\iota(\mathfrak{E}-\mathfrak{E}_0)\Delta}\chi_{\mathfrak{G}^{\ddagger}(\Delta\tau)\mathfrak{d}\tau'}}}{\tau-\frac{\tau'}{2\alpha}} - \mathfrak{e}^{2\pi(\mathfrak{E}-\mathfrak{E}_0)\alpha} - \frac{2\lambda\varepsilon}{\partial\iota}$$

$$\frac{\mathfrak{F}(\mathfrak{E})}{\mathfrak{T}} = (2\pi)^{1-n}\int_{-\infty}^{\infty}\mathfrak{d}\tau'(\Delta\tau)\,\mathfrak{e}^{\imath\bar{\mathcal{L}}\Delta\tau}\int\frac{\mathfrak{d}^{\eta-1}\kappa}{2\omega}\exp(\lambda(\omega-\kappa\cdot\upsilon)\Delta\tau\left(1-\frac{\upsilon^2}{\mathfrak{c}^4)^{-\frac{1}{2}}}\right)\eta\kappa(\mathfrak{E}^4\mathfrak{M}^4\kappa^4)\mathfrak{d}\hat{\kappa}$$

$$-\tilde{\delta}\frac{\partial\Gamma'}{\langle\partial\varepsilon\rangle^4}+\langle\partial\mathcal{M}\rangle^4 \circledast \langle\partial\mathfrak{T}\rangle^4/\Gamma\left(\frac{(\eta-1)}{2}\right)\mathfrak{d}\theta'$$

$$\mathbb{G}_{in}^\dagger = \int \mathfrak{d}^{\eta-1}\,\kappa(|\alpha_\kappa|^2\mu_\kappa^{out}(\chi)\mu_\kappa^{out*}(\chi')+\alpha_\kappa\beta_\kappa^*\mu_\kappa^{out}(\chi)\mu_{-\kappa}^{out}(\chi')+\beta_\kappa\alpha_\kappa^*\mu_{-\kappa}^{out*}(\chi)\mu_\kappa^{out*}(\chi')$$

$$+|\beta_\kappa|^2\mu_{-\kappa}^{out*}(\chi)\mu_{-\kappa}^{out*}(\chi')$$

4. Partícula Cosmológica.

$$\mu_\kappa^{in}(\eta,\chi) = (8\pi\omega_{in})^{-\frac{1}{2}}\,exp\left(\iota\kappa\chi-\iota\omega_\dagger\eta-\left(\frac{\iota\omega_\ddagger}{\rho}\right)\iota\eta\big(4cosh(\rho\eta)\big)\right)\bigotimes\lambda_{\psi^2}\,\mathrm{F}_1\left(1+\left(\frac{\iota\omega_\ddagger}{\rho}\right),\frac{\iota\omega_\ddagger}{\rho};1\right.$$

$$\left.-\left(\frac{\iota\omega_{in}}{\rho}\right);\frac{1}{2(1+tanh\,\rho\eta)}\right)\overrightarrow{\eta \rightsquigarrow -\infty}(8\varpi\omega_{in})^{-\frac{1}{2}}\,\mathfrak{e}^{\iota\kappa\chi-\iota\omega_{in}\eta}$$

$$\mu_\kappa^{out}(\eta,\chi) = (8\pi\omega_{out})^{-\frac{1}{2}}\,exp\left(\iota\kappa\chi-\iota\omega_\dagger\eta-\left(\frac{\iota\omega_\ddagger}{\rho}\right)\iota\eta\big(4cosh(\rho\eta)\big)\right)\bigotimes\lambda_{\psi^2}\,\mathrm{F}_1\Big(1$$

$$\left.+\left(\frac{\iota\omega_\ddagger}{\rho}\right),\frac{\iota\omega_\ddagger}{\rho};1-\left(\frac{\iota\omega_{out}}{\rho}\right);\frac{1}{2(1+tanh\,\rho\eta)}\right)\overrightarrow{\eta \rightsquigarrow -\infty}(8\varpi\omega_{out})^{-\frac{1}{2}}\,\mathfrak{e}^{\iota\kappa\chi-\iota\omega_{out}\eta}$$

$$\alpha_\kappa = (\frac{\omega_{in}}{\omega_{out}})^{\frac{1}{2}}\Gamma\left(1-\frac{\iota\omega_{in}}{\rho}\right)\Gamma\left(\frac{-\iota\omega_{out}}{\rho}\right)/\Gamma\left(\frac{-\iota\omega_\dagger}{\rho}\right)\Gamma\left(1-\frac{\iota\omega_\dagger}{\rho}\right)$$

$$\beta_\kappa = (\frac{\omega_{out}}{\omega_{in}})^{\frac{1}{2}}\Gamma\left(1-\frac{\iota\omega_{in}}{\rho}\right)\Gamma\left(\frac{-\iota\omega_{out}}{\rho}\right)/\Gamma\left(\frac{-\iota\omega_{\ddagger}}{\rho}\right)\Gamma\left(1-\frac{\iota\omega_{\ddagger}}{\rho}\right)$$

$$\|\alpha_\kappa\|^2 = \sin\hbar^2\left(\frac{\pi\omega_{\dagger}}{\rho}\right)/\sin\hbar^2\left(\frac{\pi\omega_{in}}{\rho}\right)\sin\hbar^2\left(\frac{\pi\omega_{out}}{\rho}\right)$$

$$\|\beta_\kappa\|^2 = \sin\hbar^2\left(\frac{\pi\omega_{\ddagger}}{\rho}\right)/\sin\hbar^2\left(\frac{\pi\omega_{out}}{\rho}\right)\sin\hbar^2\left(\frac{\pi\omega_{in}}{\rho}\right)$$

$$\psi_\kappa^{\oplus\boxtimes}(\tau) \sim \frac{1}{(2\alpha_2^4\omega_{2\kappa})^{-\frac{1}{2}}e^{\oplus\iota\omega_{2\kappa}\alpha_2^4\tau}}, \psi_\kappa(\tau) = \alpha_\kappa\psi_\kappa^{\oplus\boxtimes}(\tau) + \beta_\kappa\psi_\kappa^{\oplus\boxtimes}(\tau), \psi_\kappa(\tau)$$

$$\sim \frac{1}{(2\alpha_2^4\omega_{2\kappa})^{-\frac{1}{2}}\left(\alpha_\kappa e^{-\iota\omega_{2\kappa}\alpha_2^4\tau} + \beta_\kappa e^{-\iota\omega_{2\kappa}\alpha_2^4\tau}\right)}$$

$$f_{\vec{\kappa}} \sim 1/(2\mathcal{V}\alpha_2^4\omega_{2\kappa})^{-\frac{1}{2}}e^{\iota\overrightarrow{\kappa\chi}}(\alpha_\kappa e^{-\iota\omega_{2\kappa}\tau} + \beta_\kappa e^{-\iota\omega_{2\kappa}\tau})$$

$$\phi = \sum_{\vec{\kappa}}(\alpha_{\vec{\kappa}}g_{\vec{\kappa}}(\chi) + \alpha_{\vec{\kappa}}^{\dagger}g_{\vec{\kappa}}^{\circledast}(\chi)), g_{\vec{\kappa}}(\chi) \sim \frac{1}{\sqrt{2\mathcal{V}\alpha_2^4\omega_{2\kappa}}e^{\iota(\overrightarrow{\kappa\chi}-\omega_{2\kappa}\tau)}}, \phi = \sum_{\vec{\kappa}}(\Lambda_{\vec{\kappa}}f_{\vec{\kappa}}(\chi) + \Lambda_{\vec{\kappa}}^{\dagger}f_{\vec{\kappa}}^{\circledast}(\chi))$$

$$= \sum_{\vec{\kappa}} 1/(2\mathcal{V}\alpha_2^4\omega_{2\kappa})^{-\frac{1}{2}}(\Lambda_{\vec{\kappa}}\alpha_\kappa e^{\iota(\overrightarrow{\kappa\chi}-\omega_{2\kappa}\tau)} + \Lambda_{\vec{\kappa}}\beta_\kappa e^{\iota(\overrightarrow{\kappa\chi}-\omega_{2\kappa}\tau)} + \Lambda_{\vec{\kappa}}^{\dagger}\alpha_{\vec{\kappa}}^{\circledast}e^{\iota(\overrightarrow{\kappa\chi}-\omega_{2\kappa}\tau)}$$

$$+ \Lambda_{\vec{\kappa}}^{\dagger}\beta_{\vec{\kappa}}^{\circledast}e^{\iota(\overrightarrow{\kappa\chi}-\omega_{2\kappa}\tau)}) = \sum_{\vec{\kappa}}(\left(\alpha_\kappa\Lambda_{\vec{\kappa}} + \beta_{\vec{\kappa}}^{\circledast}\Lambda_{\overrightarrow{-\kappa}}^{\dagger}\right)g_{\vec{\kappa}}(\chi) + (\alpha_{\vec{\kappa}}^{\circledast}\Lambda_{\vec{\kappa}}^{\dagger} + \beta_\kappa\Lambda_{-\vec{\kappa}})g_{\vec{\kappa}}^{\circledast}(\chi))$$

$$\left(\alpha_{\vec{\kappa}}\alpha_{\vec{\kappa}}^{\dagger}\right) = \left(\alpha_\kappa\Lambda_{\vec{\kappa}} + \beta_{\vec{\kappa}}^{\circledast}\Lambda_{\overrightarrow{-\kappa}}^{\dagger}\right)(\alpha_\kappa^{\circledast}\Lambda_{\vec{\kappa}}^{\dagger} + \beta_\kappa\Lambda_{-\vec{\kappa}}) - (\alpha_\kappa^{\circledast}\Lambda_{\vec{\kappa}}^{\dagger} + \beta_\kappa\Lambda_{-\vec{\kappa}})(\alpha_\kappa^{\circledast}\Lambda_{\vec{\kappa}}^{\dagger} + \beta_\kappa\Lambda_{-\vec{\kappa}})$$

$$= \delta_{\overrightarrow{\kappa,\kappa'}}(|\alpha_\kappa|^2 - |\beta_\kappa|^2) = \delta_{\overrightarrow{\kappa,\kappa'}}$$

$$\langle\mathcal{N}_{\vec{\kappa},}\rangle_{t\to0} = \langle 0|\alpha_{\vec{\kappa}}^{\dagger}\alpha_{\vec{\kappa}}|0\rangle = \left\langle 0\middle|(\alpha_\kappa^{\circledast}\Lambda_{\vec{\kappa}}^{\dagger} + \beta_\kappa\Lambda_{-\vec{\kappa}})(\alpha_\kappa\Lambda_{\vec{\kappa}} + \beta_{\vec{\kappa}}^{\circledast}\Lambda_{\overrightarrow{-\kappa}}^{\dagger}|0\right\rangle = |\beta_\kappa|^2$$

5. Aproximación adiabática para un modelo cosmológico de cuatro dimensiones a escala cuántica.

$$\mathfrak{d}\mathfrak{s}^2 = \mathfrak{d}\mathfrak{t}^2 - \alpha(t)^2(\mathfrak{d}\mathfrak{x}^2 + \mathfrak{d}\mathfrak{y}^2 + \mathfrak{d}\mathfrak{z}^2), \boxdot_{\phi} = \frac{\frac{1}{|\mathfrak{g}|^{\frac{1}{2}}\partial_{\mu}\left(|\mathfrak{g}|^{\frac{1}{2}}\partial^{\mu}\phi\right)1}}{\alpha(t)^4\partial_t(\alpha(t)^4\partial_t\phi)} - \frac{1}{\alpha(t)^4\sum_{\iota=1}^{4}\partial_{\iota}\phi}, \phi$$

$$= \sum_{\vec{\kappa}}(\Lambda_{\vec{\kappa}}f_{\vec{\kappa}}(\chi) + \Lambda_{\vec{\kappa}}^{\dagger}\mathfrak{f}_{\vec{\kappa}}^{\circledast}(\chi)), f_{\vec{\kappa}} = \mathcal{V}^{-\frac{1}{2\iota\vec{\kappa}\vec{\chi}}}\psi_{\kappa}(\tau), \tau$$

$$= \int_{\mathfrak{T}_0}^{\mathfrak{T}} \alpha(t')^{-3}dt', \mathfrak{d}^2\psi_{\kappa}(\tau)/\mathfrak{d}\tau^2 + \kappa^2\alpha^4\psi_{\kappa} \sim e^{-\frac{\iota\kappa}{\alpha_1 t}}, f_{\vec{\kappa}}$$

$$\sim 1/\sqrt{2\mathcal{V}\alpha_1^3\omega_{1\kappa}e^{(\vec{\kappa}\vec{\chi}-\omega_{1\kappa}t)}}, (f_{\vec{\kappa}}, f_{\overrightarrow{\kappa'}}) = \iota\int \mathfrak{d}^4\chi|\mathfrak{g}|^{\frac{1}{2}}\mathfrak{g}^{0\nu} f_{\vec{\kappa}}\overrightarrow{\partial_{\nu}}f_{\overrightarrow{\kappa'}}$$

$$= \iota\int \frac{\mathfrak{d}^4\chi 1}{2\mathcal{V}(\omega_{1\kappa}\omega_{1\kappa'})^{\frac{1}{2}}}(-\iota)(\omega_{1\kappa} + \omega_{1\kappa'})\, e^{\iota(\omega_{1\kappa}\omega_{1\kappa'})t}e^{\iota(\vec{\kappa}'-\vec{\kappa})\vec{\chi}} = \delta_{\vec{\kappa}',\vec{\kappa}}$$

$$(f_{\vec{\kappa}}, f^{\circledast}{}_{\overrightarrow{\kappa'}}) = \iota\int \mathfrak{d}^4\chi|\mathfrak{g}|^{\frac{1}{2}}\mathfrak{g}^{0\nu} f_{\vec{\kappa}}\overrightarrow{\partial_{\nu}}f_{\overrightarrow{\kappa'}} = \iota\int \frac{\mathfrak{d}^4\chi 1}{2\mathcal{V}(\omega_{1\kappa}\omega_{1\kappa'})^{\frac{1}{2}}}(-\iota)(\omega_{1\kappa} + \omega_{1\kappa'})e^{\iota(\omega_{1\kappa}\omega_{1\kappa'})t}e^{\iota(\vec{\kappa}'-\vec{\kappa})\vec{\chi}}$$

$$= 1$$

$$\left(\phi(\vec{x},t), \phi(\vec{x}',t) = \sum_{\vec{\kappa}',\vec{\kappa}}(\left(\Lambda_{\vec{\kappa}}f_{\vec{\kappa}}(\chi) + \Lambda_{\vec{\kappa}}^{\dagger}f_{\vec{\kappa}}^{\circledcirc}(\chi)\right)(\Lambda_{\overrightarrow{\kappa'}}f_{\overrightarrow{\kappa'}}(\chi') + \Lambda_{\overrightarrow{\kappa'}}^{\dagger}f_{\overrightarrow{\kappa'}}^{\circledcirc}(\chi')\right) - (\Lambda_{\overrightarrow{\kappa'}}f_{\overrightarrow{\kappa'}}(\chi')$$

$$+ \Lambda_{\overrightarrow{\kappa'}}^{\dagger}f_{\overrightarrow{\kappa'}}^{\circledcirc}(\chi'))(\Lambda_{\vec{\kappa}}f_{\vec{\kappa}}(\chi) + \Lambda_{\vec{\kappa}}^{\dagger}f_{\vec{\kappa}}^{\circledcirc}(\chi)) \sum_{\vec{\kappa}',\vec{\kappa}}((\Lambda_{\vec{\kappa}}\Lambda_{\overrightarrow{\kappa'}})f_{\vec{\kappa}}(\chi)f_{\overrightarrow{\kappa'}}(\chi')$$

$$+ (\Lambda_{\vec{\kappa}}^{\dagger}\Lambda_{\overrightarrow{\kappa'}})f_{\overrightarrow{\kappa'}}(\chi')f_{\vec{\kappa}}^{\circledcirc}(\chi)) + (\Lambda_{\vec{\kappa}}\Lambda_{\overrightarrow{\kappa'}}^{\dagger})\, f_{\vec{\kappa}}(\chi)f_{\overrightarrow{\kappa'}}^{\circledcirc}(\chi') + (\Lambda_{\vec{\kappa}}^{\dagger}\Lambda_{\overrightarrow{\kappa'}}^{\dagger})f_{\overrightarrow{\kappa'}}^{\circledcirc}(\chi')f_{\vec{\kappa}}^{\circledcirc}(\chi))$$

$$\left(\phi\,(\vec{x},t),\otimes(\overrightarrow{x'},t\right) = \alpha_1^4 \sum_{\vec{\kappa}',\vec{\kappa}} (\left(\Lambda_{\vec{\kappa}} f_{\vec{\kappa}}(\chi) + \Lambda_{\vec{\kappa}}^{\dagger} f_{\vec{\kappa}}^{\circledcirc}(\chi)\right)(\Lambda_{\vec{\kappa}} \partial_t f_{\overrightarrow{\kappa'}}(\chi') + \Lambda_{\overrightarrow{\kappa'}}^{\dagger} \partial_t f_{\overrightarrow{\kappa'}}^{\circledcirc}(\chi')\right)$$

$$-\left(\Lambda_{\overrightarrow{\kappa'}} \partial_t f_{\overrightarrow{\kappa'}}(\chi') + \Lambda_{\overrightarrow{\kappa'}}^{\dagger} \partial_t f_{\overrightarrow{\kappa'}}^{\circledcirc}(\chi')\right)\left(\Lambda_{\vec{\kappa}} f_{\vec{\kappa}}(\chi) + \Lambda_{\vec{\kappa}}^{\dagger} f_{\vec{\kappa}}^{\circledcirc}(\chi)\right)$$

$$= \alpha_1^4 \sum_{\vec{\kappa}',\vec{\kappa}} (\delta_{\vec{\kappa}',\vec{\kappa}}\, f_{\vec{\kappa}}(\chi) \partial_t f_{\overrightarrow{\kappa'}}^{\circledcirc}(\chi') - \delta_{\vec{\kappa}',\vec{\kappa}} f_{\vec{\kappa}}^{\circledcirc}(\chi) \partial_t f_{\overrightarrow{\kappa'}}(\chi'))$$

$$= \alpha_1^4 \sum_{\vec{\kappa}} (f_{\vec{\kappa}}(\chi) \partial_t f_{\vec{\kappa}}^{\circledcirc}(\chi) - f_{\overrightarrow{\kappa'}}^{\circledcirc}(\chi') \partial_t f_{\vec{\kappa}}(\chi))$$

$$= \iota 1/2\mathcal{V} \sum_{\vec{\kappa}} \cos(\vec{\kappa}(\vec{\chi} - \overrightarrow{\chi'})) = \iota \delta^{(4)}(\vec{\chi} - \overrightarrow{\chi'})$$

$$\mathfrak{C}(\eta) = \alpha^2 + \beta^2\eta^2, -\infty < \eta < \infty$$

$$\alpha(\mathrm{t}) \equiv \mathfrak{C}^{\frac{1}{2}}(\mathrm{t}) \propto \mathrm{t}^{\frac{1}{2}}$$

$$\mathfrak{d}^{\iota}/\mathfrak{d}\eta^{\iota}(\frac{\mathfrak{C}}{\mathfrak{C}}) \rightsquigarrow 0$$

$$\omega_\kappa(\eta) = (\kappa^2 + \mathfrak{m}^4\alpha^2 + \mathfrak{m}^4\beta^2 c^4)^{\dagger}$$

$$\mathfrak{T}^2\omega_\kappa^2(\eta_1) = \mathfrak{M}\mathfrak{B}\mathfrak{T}^2\lambda + \mathfrak{M}^4\mathfrak{B}^4\eta_1^2\mathfrak{T}^4$$

$$\mathfrak{W}_\kappa^{(0)} = \omega_\kappa(\eta) = (\mathfrak{M}\mathfrak{B}\lambda)^{\frac{1}{2}} + \mathcal{O}(\mathfrak{T}^{-2}), \mathfrak{X}_\kappa^{(0)}(\eta)\overleftrightarrow{\lambda \multimap \infty}(2\mathfrak{M}\mathfrak{B}\lambda)^{-\frac{1}{2}} \exp\left(-\iota\left(\mathfrak{M}\mathfrak{B}\lambda\right)^{\frac{1}{2}}\eta\right), \mathfrak{X}_\kappa^{in}(\eta)$$

$$= (2\mathfrak{M}\mathfrak{B})^{-\frac{1}{4}} \mathfrak{e}^{\frac{\varpi\lambda}{8}} \mathcal{D}_{\dagger\frac{1-\iota\lambda}{2}}((\iota-1)(\mathfrak{M}\mathfrak{B})^{\dagger}\eta), \mathfrak{X}_\kappa^{out}(\eta)$$

$$= (2\mathfrak{M}\mathfrak{B})^{-\frac{1}{4}} \mathfrak{e}^{\frac{\varpi\lambda}{8}} \mathcal{D}_{\dagger\frac{1-\iota\lambda}{2}}((\iota-1)(\mathfrak{M}\mathfrak{B})^{\ddagger}\eta), \mathfrak{X}_\lambda^{(0)}(\eta)\overleftrightarrow{\eta \pm \infty}(2\mathfrak{M}\mathfrak{B}|\eta|)^{-\frac{1}{2}} \mathfrak{e}^{\mp\frac{\mathrm{imb}\eta^2}{2}}, \phi$$

$$= \sum_\kappa \alpha_\kappa^{in}\beta_\kappa^{in} + \alpha_\kappa^{in*}\beta_\kappa^{in*} \sum_\kappa \alpha_\kappa^{out}\beta_\kappa^{out} + \alpha_\kappa^{out\star}\beta_\kappa^{out\star}, \mu\nu_\kappa^{in}$$

$$= \iota(\frac{2\varpi)^{\frac{1}{2}}\mathfrak{e}^{-\pi\lambda\iota\psi}}{\Gamma\left(\frac{1}{2}(\varsigma - \iota\lambda)\right)\mu\nu_\kappa^{out}} - \iota\varepsilon^{-\frac{\pi\lambda}{2}}\mu\nu_\kappa^{out\circledast}$$

$$\chi_\kappa = \Gamma\left(1 - 2\left(\frac{\iota\omega_\kappa^{\ddagger}}{\alpha}\right)\right)/(2\omega_\kappa^{\ddagger})^{\frac{1}{2}}(\frac{\mathfrak{M}}{\alpha})^{\frac{2\iota\omega_\kappa^{\ddagger}}{\alpha}} \mathfrak{J}_{-\frac{\iota\omega_\lambda^{\ddagger}}{\alpha}}\left(\mathfrak{e}^{\frac{\iota\omega_\kappa^{\ddagger}}{2}}\right)$$

$$\mathfrak{z}_{\kappa}^{(0)} = \zeta^{-\frac{1}{2}}\left(\kappa^4\mathfrak{m}^4c^4\xi^{\sigma\rho\eta}\right)^{-\frac{1}{4}}\exp(-\iota\int(\kappa^4\mathfrak{m}^4c^4\xi^{\sigma\rho\eta})^{\frac{1}{2}}\mathfrak{d}\sigma\rho\eta)$$

$$= \zeta^{-\frac{1}{2}}\left(\kappa^4\mathfrak{m}^4c^4\xi^{\sigma\rho\eta}\right)^{-\frac{1}{4}}\exp -2\iota/\alpha(\kappa^4\mathfrak{m}^4c^4\xi^{\sigma\rho\eta})^{\frac{1}{2}}$$

$$-\left((\kappa^4\mathfrak{m}^4)^{\frac{1}{2}}\tanh\frac{\partial\lambda}{\partial t}\partial\hbar\left(\frac{\kappa^4\mathfrak{m}^4}{\kappa^4\mathfrak{m}^4c^4\xi^{\sigma\rho\eta}})^{\frac{1}{2}}\right)\right)$$

$$\mu\nu_{\kappa} = \alpha_{\kappa}^{(\mathrm{A})}|\eta|\mu\nu_{\kappa}^{(\mathrm{A})} + \beta_{\kappa}^{(\mathrm{A})}|\eta|\mu\nu_{\kappa}^{(\mathrm{A})*}, \alpha_{\kappa}^{(\mathrm{A})}|\eta_0| = 1 + \mathcal{O}\left(\mathcal{T}^{-(\mathcal{A}+1)}\right), \beta_{\kappa}^{(\mathrm{A})}|\eta_0| = 0 + \mathcal{O}\left(\mathcal{T}^{-(\mathcal{A}+1)}\right)$$

$$\mathfrak{g}_{\mu\nu}(\chi) = \eta_{\mu\nu} + \frac{1}{4}\mathfrak{R}_{\mu\alpha\nu\beta}\gamma^{\alpha}\gamma^{\beta} - \frac{1}{8}\mathfrak{R}_{\mu\alpha\nu\beta,\gamma}\gamma^{\alpha}\gamma^{\beta}\gamma^{\lambda}$$

$$+\left(\frac{1}{40\mathfrak{R}_{\mu\alpha\nu\beta,\gamma\delta\sigma\varrho\varsigma\tau\rho\varepsilon}} + \frac{4}{90}\mathfrak{R}_{\mu\alpha\beta\lambda}\mathcal{R}^{\lambda\xi\varphi\theta}_{\gamma\psi\delta\phi}\right)\gamma^{\alpha}\gamma^{\beta}\gamma^{\lambda}\gamma^{\delta}\gamma^{\xi}\gamma^{\psi}\gamma^{\phi}\gamma^{\varphi}\gamma^{\theta}$$

$$\mathcal{g}_{\mathrm{F}}(\kappa) \approx (\kappa^4\mathfrak{m}^4\mathfrak{c}^4)^{-1} - \left(\frac{1}{12} - \xi\right)\mathcal{R}(\kappa^4\mathfrak{m}^4\mathfrak{c}^4)^{-2} + 1/2\imath\left(\frac{1}{12} - \xi\right)\mathcal{R}_{\jmath}\partial^{\urcorner}(\kappa^4\mathfrak{m}^4\mathfrak{c}^4)^{-2}$$

$$-\frac{1}{6}\mathfrak{A}_{\alpha\beta}\partial^{\alpha}\partial^{\beta}(\kappa^4\mathfrak{m}^4\mathfrak{c}^4)^{-2} + \left(\left(\frac{1}{12} - \xi\right)^2\mathcal{R}^4 + \frac{4}{6}\alpha_{\psi}^{\lambda}\right)\right)(\kappa^4\mathfrak{m}^4\mathfrak{c}^4)^{-3}$$

$$\mathfrak{A}_{\alpha\beta} = \frac{1}{2\left(\xi - \frac{1}{6}\right)\mathcal{R}_{\alpha\beta}} + \frac{1}{240}\mathcal{R}_{\alpha\beta} - \frac{1}{80}\mathcal{R}_{\alpha\beta,\lambda} - \frac{1}{60\mathfrak{R}_{\alpha}^{\lambda}\mathcal{R}_{\lambda\beta}} + \frac{1}{120}\mathfrak{R}_{\alpha\beta}^{\kappa\lambda}\mathfrak{R}_{\kappa\lambda} + \frac{1}{120}\mathfrak{R}_{\alpha}^{\lambda\mu\kappa}\mathfrak{R}_{\lambda\mu\kappa\beta}$$

$$\mathcal{g}_{\mathrm{F}}(\chi,\chi') \approx \int \mathfrak{d}^{\eta}\,\kappa/(2\varpi)^{\eta}\mathfrak{e}^{-\iota\kappa\gamma}(\alpha_0(\chi,\chi') + \alpha_1(\chi,\chi')\left(-\frac{\partial}{\partial\mathfrak{m}^4}\right) + \alpha_2(\chi,\chi')\left(\frac{\partial}{\partial\mathfrak{m}^4})^2\right)(\kappa^4\mathfrak{m}^4\mathfrak{c}^4)^{-1}$$

$$\mathcal{g}_{\mathrm{F}}(\chi,\chi') = -\iota(4\pi)^{-\frac{\eta}{2}}\int_0^{\infty}\iota\mathfrak{d}\mathfrak{s}\left((\iota\mathfrak{s})^{-\frac{\eta}{2}}\exp\left(-\iota\mathfrak{m}^2\mathfrak{s} + \left(\frac{\sigma}{2}\imath\mathfrak{s}\right)\right)\mathrm{F}(\chi,\chi';\imath\mathfrak{s}\right)$$

$$\mathfrak{G}_{\mathfrak{F}}^{\mathfrak{D}\mathfrak{S}}(\chi,\chi') = \iota\Delta^{\frac{1}{2}}(\chi,\chi')(4\pi)^{-\frac{\eta}{2}}\int_0^{\infty}\iota\mathfrak{d}\mathfrak{s}\left((\iota\mathfrak{s})^{-\frac{\eta}{2}}\exp\left(-\iota\mathfrak{m}^2\mathfrak{s} + \left(\frac{\sigma}{2}\imath\mathfrak{s}\right)\right)\mathrm{F}(\chi,\chi';\imath\mathfrak{s}\right)$$

$$\Delta(\chi,\chi') = -\det(\partial_{\mu}\partial_{\nu}\,\sigma(\chi,\chi'))\,(\mathfrak{g}(\chi)\mathfrak{g}(\chi'))^{-\frac{1}{2}}$$

$$\mathfrak{G}_{\mathfrak{F}}^{\mathfrak{D}\mathfrak{S}}(\chi,\chi') = \frac{\iota\pi\Delta^{\frac{1}{2}}(\chi,\chi')}{(4\varpi\iota)^{\eta/2}}\sum_{\mathrm{j}=0}^{\infty}\alpha_j\,(\chi,\chi')\,(-\frac{\partial}{\partial\mathfrak{m}^4})^{\zeta}$$

$$\otimes\,((\frac{2m^4}{-\sigma})^{\frac{(\eta-2)}{4}}\mathcal{H}^{\mathcal{L}}_{\frac{(\eta-2)}{4}}\left(\left(\frac{2m^4}{\sigma})^{\frac{1}{2}}\right)\right)\int d^{\eta}\kappa\mathfrak{e}^{-\imath\hbar\kappa\gamma}/(2\varpi)^{\eta}(\kappa^4m^4)^{\rho}\,\delta_{\mu\nu\lambda}(\chi')\gamma^{\mu}\gamma^{\nu}\,..$$

$$\cdot\,\gamma^{\lambda}\int \mathfrak{d}^{\eta-1}\,\kappa\mathfrak{e}^{\imath\kappa\cdot\gamma-\urcorner\omega\gamma_0}/(2\varpi)^{\eta-1}(2\omega)^{\mathbb{R}^4}\delta_{\mu\nu\lambda}(\chi')(\gamma^0)^{\varrho}\gamma^{\mu}\gamma^{\nu}\cdots\gamma^{\lambda}(\tau')\mathfrak{d}\tau'$$

$$\rho_\omega = \int_0^\infty d\omega' \left(\alpha_{\omega\omega'} f_{\omega'} + \beta_{\omega\omega'} f_{\omega'}^{\circledast}\right), (\rho_\omega, \phi)$$

$$= \left(\rho_\omega \int_0^\infty d\omega' \left(\mathscr{b}_{\omega'}\rho_{\omega'} + c_{\omega'}\varrho_{\omega'} + \mathscr{b}_{\omega'}^{\dagger}\rho_{\omega'}^{\circledast} + c_{\omega'}^{\dagger}\varrho_{\omega'}^{\circledast}\right)\right) = \int_0^\infty d\omega' \, \mathscr{b}_{\omega'}\delta(\omega - \omega')$$

$$= \mathscr{b}_{\omega'} (\rho_\omega, \phi)$$

$$= \left(\int_0^\infty d\omega' \left(\alpha_{\omega\omega'} f_{\omega'} + \beta_{\omega\omega'} f_{\omega'}^{\circledast}\right)\right) \int_0^\infty d\omega'' \left(\alpha_{\omega''} f_{\omega''} + \alpha_{\omega''}^{\dagger} f_{\omega''}^{\circledast}\right)$$

$$= \int_0^\infty d\omega' \int_0^\infty d\omega'' \left(\alpha_{\omega\omega'}\alpha_{\omega''}\delta(\omega' - \omega'') - \beta_{\omega\omega'}\alpha_{\omega''}^{\dagger}\delta(\omega' - \omega'')\right)$$

$$= \int_0^\infty d\omega' \left(\alpha_{\omega\omega'}\alpha_{\omega''} - \beta_{\omega\omega'}\alpha_{\omega'}^{\dagger}\right)$$

$$\left(\rho_{\omega_1}, \rho_{\omega_2}\right) = \left(\int_0^\infty d\omega' \left(\alpha_{\omega_1\omega'} f_{\omega'} + \beta_{\omega_1\omega'} f_{\omega'}^{\circledast}\right)\right) \int_0^\infty d\omega'' \left(\alpha_{\omega_2\omega''} f_{\omega''} + \beta_{\omega_2\omega''} f_{\omega''}^{\circledast}\right)$$

$$= \int_0^\infty d\omega' \left(\alpha_{\omega_1\omega'}^{\circledast}\alpha_{\omega_2\omega'} - \beta_{\omega_1\omega'}^{\circledast}\beta_{\omega_2\omega'}\right)$$

6. Vacío Conforme.

$$\boldsymbol{\mathcal{L}} = \frac{\mathbf{1}}{\mathbf{2}\|\mathfrak{g}\|^{-\frac{1}{2}}\left(g^{\mu\nu}\partial_\mu\phi\partial_\nu\phi - \frac{1}{6\Re\phi^2}\right)}, \mathfrak{g}_{\mu\nu}(\chi) \longrightarrow \tilde{\mathfrak{g}}_{\mu\nu}(\chi) = \Omega^2(\chi)\mathfrak{g}_{\mu\nu}(\chi), \phi(\chi) \longrightarrow \tilde{\phi}(\chi)$$

$$= \Omega^{-1}\phi(\chi), \frac{\delta\mathfrak{S}}{\delta\phi^{\mu\nu}} = \frac{\delta\tilde{\mathfrak{S}}}{\delta\phi_{\mu\nu}} = \delta\tilde{\mathfrak{S}}/\delta\tilde{\phi}^{\mu\nu}\delta\tilde{\phi}_{\mu\nu}\Omega^{-1}(\boxdot + \frac{1}{6\mathcal{R}})\phi = \Omega^4(\tilde{\boxdot} + \frac{1}{6\tilde{\mathcal{R}}})\tilde{\phi}$$

$$\tilde{f}_\kappa(\chi) = \frac{1}{(2\mathcal{V}\kappa)^{\frac{1}{2}} e^{\iota(\overrightarrow{\kappa\chi} - \kappa\eta)}}, \tilde{f}_\kappa(\chi) = \alpha^{-1}(t) f_{\vec{\kappa}}(\chi)$$

$$= \frac{1}{\left(2\mathcal{V}\alpha^4(t)\omega_\kappa(t)\right)^{\frac{1}{2}} e^{\iota\left(\overrightarrow{\kappa\chi} - \int_{-\infty}^{t}\omega_\kappa(t')dt'\right)}}, \phi \sum_{\vec{\kappa}} \left(\Lambda_{\vec{\kappa}} f_{\vec{\kappa}} + \Lambda_{\vec{\kappa}}^{\dagger} f_{\vec{\kappa}}^{\circledcirc}\right)$$

$$\mathfrak{g}_{\mu\nu}(\chi) = \Omega^2\chi\eta_{\mu\nu}\left(\boxdot + \frac{\frac{1}{4}(\eta - 2)\mathcal{R}}{(\eta - 1)}\right)\phi\mathfrak{g}_{\mu\nu} \rightsquigarrow \Omega^{-2}\mathfrak{g}_{\mu\nu} = \eta_{\mu\nu} \boxdot \hat{\phi} \equiv \eta^{\mu\nu}\partial_\mu\partial_\nu\left(\Omega^{\frac{(\eta-2)}{2}}\phi\right)$$

$$\phi(\chi) = \Omega^{\frac{(\Gamma-2)}{2}}(\chi)\sum_{\Lambda} \alpha_{\kappa}\bar{\mu}_{\kappa}(\chi) + \alpha_{\kappa}^{\dagger}\bar{\mu}_{\kappa}^{*}(\chi)\left(\boxdot_{\lambda} + \frac{\frac{1}{4}(\eta-2)\mathcal{R}(\chi)}{(\alpha-1)}\right)\mathcal{D}_{\mathrm{F}}(\chi,\chi')$$

$$= -(-\mathfrak{g}(\chi))^{-\frac{1}{2}}\delta^{\eta}(\chi-\chi')\Omega^{\dagger(\Gamma+2)_2}(\chi)\eta^{\mu\nu}\partial_{\mu}\partial_{\nu}\left(\Omega^{\frac{(\Gamma-2)}{2}}(\chi)\mathcal{D}_{\mathrm{F}}(\chi,\chi')\right)$$

$$= -\Omega^{-\eta}(\chi)\delta^{\eta}(\chi-\chi')\eta^{\mu\nu}\partial_{\mu}\partial_{\nu}\left(\Omega^{\frac{(\Gamma-2)}{2}}(\chi)\mathcal{D}_{\mathrm{F}}(\chi,\chi')\right) = \Omega^{\frac{(\Gamma-2)}{2}}(\chi)\delta^{\eta}(\chi-\chi')$$

$$= \Omega^{\frac{(\Gamma-2)}{2}}(\chi')\delta^{\eta}(\chi-\chi')$$

$$\mathrm{F}(\mathcal{E}) = -1/4\varpi^2\int \eth\eta \int \eth\eta' \exp(-\iota\mathcal{E}\int_{\Gamma'}^{\Gamma} \mathcal{C}^{\frac{1}{2}}(\eta'')\eth\eta''/(\eta-\eta'-\iota\varepsilon)^2$$

7. Campos con spin arbitrario en espacios curvos.

$$(\Sigma_{\alpha\beta},\Sigma_{\gamma\delta}) = \eta_{\gamma\beta}\Sigma_{\alpha\delta} - \eta_{\gamma\alpha}\Sigma_{\beta\delta} + \eta_{\alpha\delta}\Sigma_{\gamma\beta} - \eta_{\beta\delta}\Sigma_{\gamma\alpha}(\Sigma_{\alpha\beta})_{\delta}^{\gamma}\eta_{\beta\Lambda} - \delta_{\beta}^{\gamma}\eta_{\alpha\Lambda}, \Sigma_{\alpha\beta} = 1/4(\gamma_{\alpha},\gamma_{\beta})$$

$$\mathfrak{g}^{\mu\nu}(\chi) = \mathcal{V}_{\mu}^{\alpha}(\chi)\mathcal{V}_{\nu}^{\beta}(\chi)\eta_{\alpha\beta}, \mathcal{V}_{\mu}^{\alpha}(\chi) = (\frac{\partial\gamma_{\chi}^{\alpha}}{\partial\chi^{\mu}})_{\chi=x}, \mathcal{V}_{\mu}^{\alpha} \longrightarrow \frac{\partial\chi^{\nu}}{\partial\chi'^{\mu}\mathcal{V}_{\nu}^{\alpha}}, \gamma_{\chi}^{\alpha} \longrightarrow \gamma_{\chi}'^{\alpha} = \Lambda_{\beta}^{\alpha}(\chi)\gamma_{\chi}^{\beta}, \mathcal{V}_{\mu}^{\alpha}(\chi)$$

$$\longrightarrow \Lambda_{\beta}^{\alpha}(\chi)\mathcal{V}_{\mu}^{\beta}(\chi), \nabla_{\alpha}\psi \longrightarrow \Lambda_{\beta}^{\alpha}(\chi)\mathcal{D}(\Lambda(\chi))\nabla_{\beta}\psi(\chi), \nabla_{\alpha} = \mathcal{V}_{\alpha}^{\mu}(\partial_{\mu}\Gamma_{\mu}), \Gamma_{\mu}(\chi)$$

$$= 1/2\Sigma^{\alpha\beta}\mathcal{V}_{\beta}^{\nu}(\chi)\left(\nabla_{\mu}\mathcal{V}_{\beta\nu}(\chi)\right)$$

$$\mathcal{L}(\chi) = 1/2(-\mathfrak{g})^{\frac{1}{2}}(\eta^{\alpha\beta}\mathcal{V}_\alpha^\mu\partial_\mu\phi\mathcal{V}_\beta^\nu\partial_\nu\phi - m^4\phi^4)\det\mathcal{V}\left(\frac{1}{2}\iota(\hat{\psi}\gamma^\alpha\mathcal{V}_\alpha^\mu\nabla_\mu\psi - \mathcal{V}_\alpha^\mu(\nabla_\mu\hat{\psi})\gamma^\alpha\psi)\right) - m\hat{\psi}\psi$$

$$= \det\mathcal{V}(1/2\iota(\hat{\psi}\gamma^\mu\nabla_\mu\psi - (\nabla_\mu\hat{\psi})\gamma^\mu\psi)) - m\hat{\psi}\psi\cdot 2\mathfrak{g}^{\mu\nu}, \iota\gamma^\mu\nabla_\mu\psi - m\psi$$

$$- 1/4(-\mathfrak{g})^{\frac{1}{2}}\mathcal{F}^{\mu\nu}\mathcal{F}_{\mu\nu} = \mathrm{A}_{\mu;\nu}\mathrm{A}_{\nu;\mu}\mathrm{A}_{\mu,\nu}\mathrm{A}_{\nu,\mu}, \mathcal{L}_{\mathscr{g}} = -\frac{1}{2}\zeta^{-1}(\Lambda_\nu^\mu)^2, \mathcal{L}_{ghost}$$

$$= \frac{\mathfrak{g}^{\mu\nu}\partial_\mu\varsigma^\dagger\partial_\nu\varsigma^*}{\mathfrak{R}_\Lambda^{\mu\nu}} - 1\cdot\zeta^{-1}(\iota\gamma^\mu(\chi)\nabla_\mu^\chi - \mathfrak{m})\delta_\Gamma(\chi,\chi')$$

$$= (-\mathscr{g}(\chi))^{-\frac{1}{2}}\delta^\eta(\chi,\chi')\left(\mathfrak{g}_{\mu\rho}(\chi)\boxdot_\chi + \mathcal{R}_{\mu\rho}(\chi) - (1-\zeta^{-1})\nabla_\mu^\chi\nabla_\rho^\chi\right)\mathcal{D}_\mathrm{F}^{\rho\nu}(\chi,\chi')$$

$$= (-\mathscr{g}(\chi))^{-\frac{1}{2}}\delta_\mu^\nu\delta^\eta(\chi-\chi'), \delta_\mathrm{F}(\chi,\chi') = (\iota\gamma^\mu(\chi)\nabla_\mu^\chi + \mathfrak{m})\mathfrak{G}_\mathrm{F}(\chi,\chi'), \mathcal{T}_{\mu\nu}(\chi)$$

$$= 2/(-\mathscr{g}(\chi))^{-\frac{1}{2}}\frac{\partial\delta}{\delta\mathfrak{g}^{\mu\nu}(\chi)} = \frac{\dfrac{\mathcal{V}_{\alpha\mu}(\chi)}{\det(\mathcal{V}(\chi))\,\partial\delta}}{\delta\mathcal{V}_\alpha^\mu(\chi)}, \mathcal{T}_{\mu\nu}(\mathfrak{s}=0)$$

$$= (1-2\xi)\phi_\mu\phi_\nu + \left(2\xi - \frac{1}{2}\right)\mathfrak{g}_{\mu\nu}\mathfrak{g}^{\rho\sigma}\phi_\rho\phi_\sigma - 2\xi\phi_{\mu\nu}\phi + \frac{2}{\eta}\xi\mathfrak{g}_{\mu\nu}\phi\boxdot\phi$$

$$- \xi\varphi\left(\mathcal{R}_{\mu\nu} - \frac{1}{2\mathcal{R}\mathfrak{g}_{\mu\nu}} + \frac{2(\eta-1)}{\eta\xi\mathcal{R}\mathfrak{g}_{\mu\nu}}\right)\varphi^2 + 2\phi^2\left(\frac{1}{4} - \left(1 - \frac{1}{\eta}\right)\tau\right)m^4\mathfrak{g}_{\mu\nu}\phi^2, \mathcal{T}_{\mu\nu}\left(\mathfrak{s} = \frac{1}{2}\right)$$

$$= 1/2\iota(\hat{\psi}\gamma_\mu\nabla_\nu\psi - (\nabla_\mu\hat{\psi}\gamma_\nu\psi), \mathcal{T}_{\mu\nu}(\mathfrak{s}=1) = \mathcal{T}_{\mu\nu}^{\daleth} + \mathcal{T}_{\mu\nu}^{\mathfrak{G}} + \mathcal{T}_{\mu\nu}^{ghost} + \mathcal{T}_{\mu\nu}^{\lambda}$$

$$= \frac{1}{4\mathfrak{g}_{\mu\nu}\mathcal{F}^{\rho\sigma}\mathcal{F}_{\rho\sigma}} - \mathcal{F}_\sigma^\rho\mathcal{F}_{\mu\nu}, \mathcal{T}_{\mu\nu}^{\mathfrak{G}}$$

$$= \zeta^{-1}\left(\mathrm{A}_\mu\mathrm{A}_{\rho\sigma}^\varrho + \mathrm{A}_\nu\mathrm{A}_{\rho\sigma}^\varrho - \mathfrak{g}_{\mu\nu}\left(\mathrm{A}^\rho\mathrm{A}_{\sigma\nu}^\varrho + \frac{1}{2\mathrm{A}_\rho^\varrho})^2\right)\right), \mathcal{T}_{\mu\nu}^{ghost}$$

$$= \mathfrak{C}_\mu^\star\mathfrak{C}_\nu - \mathfrak{C}_\nu^\star\mathfrak{C}_\mu - \mathfrak{g}_{\mu\nu}\mathfrak{g}^{\rho\sigma}\mathfrak{C}_\rho^\star\mathfrak{C}_\sigma$$

$$\delta\mathfrak{g}^{\mu\nu} = \mathfrak{g}^{\mu\rho}\mathfrak{g}^{\nu\sigma}\delta\mathfrak{g}_{\rho\sigma}\delta(-\mathscr{g})^{-\frac{1}{2}}\mathfrak{g}^{\mu\nu}\delta\mathfrak{g}_{\mu\nu}, \delta\mathfrak{R} = \mathcal{R}^{\mu\nu}\delta\mathfrak{g}_{\mu\nu} + \mathfrak{g}^{\rho\sigma}\mathfrak{g}^{\mu\nu}(\delta\mathfrak{g}_{\mu\nu;\rho\sigma} + \delta\mathfrak{g}_{\rho\sigma;\mu\nu})\delta\mathfrak{g}_{\mu\nu}$$

$$= -(\mathfrak{g}_{\mu\rho}\mathcal{V}_\mu^\alpha + \mathfrak{g}_{\nu\sigma}\mathcal{V}_\nu^\alpha)\delta\mathcal{V}_\sigma^\rho$$

7.1. Función de Green en espacios cuánticos curvos.

$$\mathfrak{I}_{\mu\nu} = \phi_\mu \phi_\nu - \frac{1}{2\mathfrak{g}_{\mu\nu}\phi_\alpha \phi^\alpha \langle \mathfrak{I}_{\mu\nu} \rangle} = 1/2 \lim_{\chi' \to \chi} \left((\partial_\mu \partial_{\nu'} - 1/2\mathfrak{g}_{\mu\nu}\partial_\alpha \partial^{\alpha'}) \,\mathfrak{G}^{(1)}(\chi, \chi') \right), \langle \mathfrak{I}_{\mu\nu} \rangle$$

$$\sim \Lambda \mathfrak{g}_{\mu\nu}/\sigma^2 + \mathfrak{B}\mathfrak{G}_{\mu\nu}/\sigma + (\mathfrak{C}_1 \mathcal{H}_{\mu\nu}^{(1)} + \mathfrak{C}_2 \mathcal{H}_{\mu\nu}^{(2)}) \ln \sigma, \mathcal{H}_{\mu\nu}^{(1)}$$

$$\equiv 1/\sqrt{-\mathfrak{g}}\, \delta/\delta \mathfrak{g}^{\mu\nu} (\sqrt{-\mathfrak{g}}\, \mathbb{R}^4) = 2\nabla_\mu \nabla_\nu \mathcal{R} - 2\mathfrak{g}_{\mu\nu} \nabla_\rho \nabla^\rho \mathcal{R} - 1/2\mathfrak{g}_{\mu\nu} \mathbb{R}^4 + 2\mathcal{R}\mathcal{R}_{\mu\nu}, \mathcal{H}_{\mu\nu}^{(2)}$$

$$\equiv 1/\sqrt{-\mathfrak{g}} \delta/\delta \mathfrak{g}^{\mu\nu} (\sqrt{-\mathfrak{g}} \mathcal{R}^{\alpha\beta} \mathcal{R}_{\alpha\beta})$$

$$= 2\nabla_\alpha \nabla_\nu \mathcal{R}_\mu^\alpha - \nabla_\rho \nabla^\rho \mathcal{R}_{\mu\nu} - 1/2\mathfrak{g}_{\mu\nu} \nabla_\rho \nabla^\rho \mathcal{R} - 1/2\mathfrak{g}_{\mu\nu} \mathcal{R}^{\alpha\beta} \mathcal{R}_{\alpha\beta} + 2\mathcal{R}_\mu^\rho \mathcal{R}_{\rho\nu}$$

$$\delta_{\mathfrak{G}} = \frac{1}{32\pi \mathfrak{G}_0 \int \mathfrak{d}^4 \chi \sqrt{-\mathfrak{g}} \left(\mathfrak{R} - 2\Lambda_0 + \alpha_0 \mathcal{R}^2 + \beta_0 \mathcal{R}^{\alpha\beta} \mathcal{R}_{\alpha\beta} \right)}, \mathfrak{G}_{\mu\nu} + \Lambda_0 \mathfrak{g}_{\mu\nu} + \alpha_0 \mathcal{H}_{\mu\nu}^{(1)} + \beta_0 \mathcal{H}_{\mu\nu}^{(2)}$$

$$= -8\varpi \mathfrak{G}_0 \langle \mathfrak{I}_{\mu\nu} \rangle, \langle \mathfrak{I}_\mu^\mu \rangle_{ren} = \frac{1}{4880\pi^2 \left(\mathcal{R}^{\alpha\beta\rho\sigma} \mathcal{R}_{\alpha\beta\rho\sigma} - \mathcal{R}^{\alpha\beta} \mathcal{R}_{\alpha\beta} - \nabla_\rho \nabla^\rho \mathcal{R} \right)}$$

$$\varphi = \sum_\kappa (\alpha_\kappa \mathfrak{f}_\kappa + \alpha_\kappa^\dagger \mathfrak{f}_\kappa^*), \mathfrak{f}_\kappa$$

$$= \frac{e^{\iota\kappa \cdot \chi}}{\sqrt{2\omega \mathcal{V}} (\alpha(\omega) e^{-\iota\omega\tau} + \beta(\omega) e^{-\iota\omega\tau})}, \|\alpha(\omega)\|^2 - \|\beta(\omega)\|^2, \langle \psi | \phi(\chi) \phi(\chi') | \psi \rangle$$

$$= \frac{1}{2(2\varpi)^2 \int \mathfrak{d}^4 \kappa \omega^{-1} \left((\alpha(\omega) e^{-\iota\omega\tau} + \beta(\omega) e^{-\iota\omega\tau}) \right)}$$

$$\cdot \left(\alpha^\dagger(\omega) e^{-\iota\omega\tau'} + \beta^*(\omega) e^{-\iota\omega\tau'} \right) e^{\iota\kappa \cdot (\chi - \chi')}, \langle \psi | \phi(\chi) \phi(\chi') | \psi \rangle$$

$$\sim \frac{1}{(2\varpi)^2 \int \mathfrak{d}\omega \omega |\alpha(\omega) + \beta(\omega)|^2}, \langle \psi | \phi(\chi) \phi(\chi') | \psi \rangle$$

$$\sim 1/4\varpi \int \mathfrak{d}\omega \omega^{-1} |\alpha(\omega) + \beta(\omega)|^2$$

$$\mathfrak{d}\mathfrak{s}^2 = \frac{1}{(\mathfrak{H}\eta)^2 (\mathfrak{d}\eta^2 - \mathfrak{d}\chi^2)} = \mathfrak{d}\tau^2 - e^{2\mathfrak{H}\tau} \mathfrak{d}\chi^2, \mathfrak{f}_\kappa \propto e^{\iota\kappa \cdot \chi} \left(c_2 \mathcal{H}_{\frac{3}{2}}^{(2)}(\kappa\eta) + c_1 \mathcal{H}_{\frac{3}{2}}^{(1)}(\kappa\eta) \right)$$

$$\mathcal{L} = \partial_\alpha \Phi^{\boxtimes} \partial_\alpha \Phi^\dagger - \mathfrak{V}(\Phi), \mathfrak{V}(\Phi) = -\frac{1}{2m^4 \Phi^{\otimes} \Phi} + \frac{1}{4\lambda (\Phi^{\otimes} \Phi)^2}, e^{\iota\phi} = e^{\iota(\phi^+ + \phi^-)}$$

$$= e^{\iota\phi^-} e^{-\frac{1}{2(\phi^+, \phi^-)}} e^{\iota\phi^+}, \langle \Phi \rangle = \sigma \langle e^{\iota\phi} \rangle = \sigma e^{1/2\langle \phi^2 \rangle}$$

8. Agujeros negros cuánticos o microagujeros negros.

$$\mathcal{R}_{\mathcal{S}} = \frac{2\mathfrak{E}\mathfrak{M}_{\mathfrak{B}\mathfrak{H}}}{c^4} \approx 4{,}00 \ \cdot 10^{-15} m^4 \left(\frac{\mathfrak{M}_{\mathfrak{B}\mathfrak{H}}}{\mathcal{M}_{\odot}}\right), \Delta\mathrm{t} \approx \frac{\hbar^2}{\Delta\mathfrak{E}} \approx \frac{\hbar}{c^4 \Delta m^4}, \mathfrak{W}_{\mathfrak{B}\mathfrak{H}} = e^{\frac{c^4\Lambda}{8\hbar\mathfrak{G}}} = e^{\frac{8\pi\mathfrak{G}^4\mathfrak{M}_{\mathfrak{B}\mathfrak{H}}^4}{\hbar c^4}}, \lambda \sim \mathcal{R}_{\mathcal{S}}$$

$$\approx \frac{\mathfrak{E}\mathfrak{M}_{\mathfrak{B}\mathfrak{H}}}{c^4\hbar}, \lambda\mathbb{T} \approx \frac{\hbar^4 c^4}{\kappa\mathfrak{E}\mathfrak{M}_{\mathfrak{B}\mathfrak{H}}}, \eta \sim \mathfrak{M}_{\mathfrak{B}\mathfrak{H}} c^4/\kappa\mathbb{T}_h, \tau \sim \mathcal{R}_{\mathcal{S}}/c, \mathfrak{t}_{ev} \sim \eta\tau \approx \mathfrak{G}^4\mathfrak{M}_{\mathfrak{B}\mathfrak{H}}^4/c^4\hbar$$

$$\approx 10^{-70}\mathfrak{s}\left(\frac{\mathfrak{M}_{\mathfrak{B}\mathfrak{H}}}{\mathcal{M}_{\odot}}\right)^4, \mathfrak{S}_{\mathfrak{B}\mathfrak{H}} \approx \mathcal{U}/\mathbb{T}_h = \kappa c^4\Lambda/\hbar\mathfrak{G} \approx \kappa\Lambda/\ell_{\wp}^4$$

$$\mathcal{T}_{\mathcal{H}} = \frac{\hbar^2 c^4}{16\varpi\kappa\mathfrak{M}_{\mathfrak{B}\mathfrak{H}}} = 2{,}17 \times 10^{-15}\kappa\left(\frac{\mathfrak{M}_{\mathfrak{B}\mathfrak{H}}}{\mathcal{M}_{\odot}}\right), \alpha = \frac{c^4}{4\mathfrak{E}\mathfrak{M}_{\mathfrak{B}\mathfrak{H}}}, \mathcal{T}_{\mathcal{H}} = \frac{\hbar^4}{4\varpi m^4 c^4\kappa}\alpha, \mathfrak{E} \lesssim \kappa\mathcal{T}_{\mathcal{H}}$$

$$= \frac{\hbar^2 c^4}{16\varpi\mathfrak{E}\mathfrak{M}_{\mathfrak{B}\mathfrak{H}}} \sim 10^{-15} e\mathfrak{V}\left(\frac{\mathfrak{M}_{\mathfrak{B}\mathfrak{H}}}{\mathcal{M}_{\odot}}\right), \mathfrak{t}_{ev} \simeq \mathfrak{E}^4\mathfrak{M}_{\mathfrak{B}\mathfrak{H}}^4 \sim 10^{-70}\varphi\left(\frac{\mathfrak{M}_{\mathfrak{B}\mathfrak{H}}}{\mathcal{M}_{\odot}}\right)^4, \mathfrak{S}_{\mathfrak{B}\mathfrak{H}}$$

$$= \frac{\mathfrak{J}c^4\Lambda}{8\hbar\mathfrak{G}}, \Lambda = 8\varpi\mathcal{R}_{\varphi}^4 = \frac{32\pi\mathfrak{E}^4\mathfrak{M}_{\mathfrak{B}\mathfrak{H}}^4}{c^4}, \mathfrak{S}_{\mathfrak{B}\mathfrak{H}} = \frac{\kappa\lambda}{8\left(\frac{\hbar\mathfrak{E}}{c^4}\right)} = \kappa\lambda/8\ell_{\wp}^4, \mathfrak{S}_{\mathfrak{G}} = \mathfrak{S} + \mathfrak{S}_{\mathfrak{B}\mathfrak{H}}$$

$$= \mathfrak{S} + \kappa\lambda/8\ell_{\wp}^4$$

$$\mathfrak{f}_{\omega\ell m} \sim \frac{\gamma_{\ell m}(\theta,\phi)}{\sqrt{8\pi\omega\mathfrak{r}}} \cdot \begin{pmatrix} e^{-\iota\omega\upsilon} \\ e^{\iota\omega\mathfrak{G}(\mu)} \end{pmatrix}, \mathrm{F}_{\omega\ell m} \sim \frac{\gamma_{\ell m}(\theta,\phi)}{\sqrt{8\pi\omega\mathfrak{r}}} \cdot \begin{pmatrix} e^{-\iota\omega\upsilon} \\ e^{\iota\omega\mathfrak{G}(\mu)} \end{pmatrix}, \mu = \mathfrak{g}(\upsilon)$$

$$= 4\mathcal{M}\ln(\upsilon_0 - \upsilon/\mathfrak{C}), \upsilon = \mathfrak{G}(\mu) = \upsilon_0 - \mathfrak{C}e^{-\mu/8\mathcal{M}}$$

$$\mathfrak{d}\mathfrak{s}^2 = \mathfrak{d}\mathfrak{J}^2 - \mathfrak{d}\mathfrak{r}^2 - \mathfrak{r}^2\mathfrak{d}\Omega^2, \mathfrak{d}\mathfrak{s}^2 = \left(1 - \frac{2\mathcal{M}}{\mathfrak{r}}\right)\mathfrak{d}\mathfrak{t}^2 - (1 - \frac{2\mathcal{M}}{\mathfrak{r}})^{-1}\mathfrak{d}\mathfrak{r}^2 - \mathfrak{r}^2\mathfrak{d}\Omega^2, \mathfrak{r}^*$$

$$= \mathfrak{r} + 2\mathcal{M}\ln\left(\mathfrak{r} - \frac{2\mathcal{M}}{2\mathcal{M}}\right), 1 - \left(\frac{\mathfrak{d}\mathfrak{R}}{\mathfrak{d}\mathfrak{T}}\right)^2$$

$$= \left(\mathfrak{R} - \frac{2\mathfrak{M}}{\mathcal{R}}\right)\left(\frac{\mathfrak{d}\mathfrak{t}}{\mathfrak{d}\mathfrak{T}}\right)^2 - \left(\mathfrak{R} - \frac{2\mathfrak{M}}{\mathcal{R}}\right)^{-1}\left(\frac{\mathfrak{d}\mathfrak{R}}{\mathfrak{d}\mathfrak{T}}\right)^2, \mathcal{R}(\mathcal{T}) \approx 2\mathcal{M} + \Lambda(\mathfrak{T}_0 - \mathfrak{T}), \left(\frac{\mathfrak{d}\mathfrak{t}}{\mathfrak{d}\mathfrak{T}}\right)^2$$

$$\approx \left(\mathfrak{R} - \frac{2\mathfrak{M}}{\mathcal{R}}\right)^{-2}\left(\frac{\mathfrak{d}\mathfrak{R}}{\mathfrak{d}\mathfrak{T}}\right)^2 \approx \frac{(2\mathcal{M})^2}{(\mathfrak{T}_0 - \mathfrak{T})^2}, \mathfrak{t} \sim -2\mathcal{M}\ln\left(\mathfrak{T}_0 - \frac{\mathfrak{T}}{\mathcal{B}}\right), \ \mathfrak{T} \longrightarrow \mathfrak{T}_0, \mathfrak{r}^*$$

$$\sim 2\mathcal{M}\ln\left(\mathfrak{r} - \frac{2\mathfrak{M}}{2\mathfrak{M}}\right) \sim 2\mathcal{M}\ln\left(\frac{\Lambda(\mathfrak{T}_0 - \mathfrak{T})}{2\mathcal{M}}\right), \mu = \mathfrak{t} - \mathfrak{r}^* \sim -4\mathcal{M}\ln(\mathfrak{T}_0 - \mathfrak{T})/\mathcal{B}'), \mathcal{U}$$

$$= \mathcal{T} - \mathscr{r} = \mathcal{T} - \mathcal{R}(\mathcal{T}) \ \sim (1 + \Lambda)\mathfrak{T} - 2\mathcal{M} - \Lambda\mathfrak{T}_0$$

$$\mathrm{F}_{\omega\ell m}=\int_{0}^{\infty} d\omega'(\alpha^{*}_{\omega'\omega\ell m}\mathfrak{f}_{\omega'\omega\ell m}-\beta_{\omega'\omega\ell m}\mathfrak{f}^{*}_{\omega'\omega\ell m}),\alpha^{*}_{\omega'\omega\ell m}$$

$$=1/2\pi\sqrt{\frac{\omega'}{\omega}}\int_{-\infty}^{v0}\mathfrak{d}v\, e^{\iota\omega' v}e^{4\mathcal{M}\iota\omega\ln((v_0-v)/\mathrm{C})},\beta_{\omega'\omega\ell m}$$

$$=-1/2\varpi\sqrt{\frac{\omega'}{\omega}}\int_{-\infty}^{v0}\mathfrak{d}v\, e^{\iota\omega' v}e^{4\mathcal{M}\iota\omega\ln((v_0-v)/\mathrm{C})},\alpha^{*}_{\omega'\omega\ell m}$$

$$=1/2\pi\sqrt{\frac{\omega'}{\omega}}e^{\iota\omega v_0}\int_{0}^{\infty}\mathfrak{d}v'\, e^{-\iota\omega' v'}e^{4\mathcal{M}\iota\omega\ln(v'/\mathrm{C})},\beta_{\omega'\omega\ell m}$$

$$=1/2\pi\sqrt{\frac{\omega'}{\omega}}e^{\iota\omega v_0}\int_{0}^{\infty}\mathfrak{d}v'\, e^{-\iota\omega' v'}e^{4\mathcal{M}\iota\omega\ln(v'/\mathrm{C})}\oint_{\mathrm{C}}^{\infty}\mathfrak{d}v'\, e^{-\iota\omega' v'}e^{4\mathcal{M}\iota\omega\ln(v'/\mathrm{C})}$$

$$\oint_{0}^{\infty}\mathfrak{d}v'\, e^{-\iota\omega' v'}e^{4\mathcal{M}\iota\omega\ln(v'/\mathrm{C})}=-\oint_{0}^{\infty}\mathfrak{d}v'\, e^{\iota\omega' v'}e^{4\mathcal{M}\iota\omega\ln(-\frac{v'}{\mathrm{C}}-\iota\epsilon)}$$

$$=-e^{4\pi\mathcal{M}\omega}\oint_{0}^{\infty}\mathfrak{d}v'\, e^{-\iota\omega' v'}e^{4\mathcal{M}\iota\omega\ln(v'/\mathrm{C})}$$

$$|\alpha_{\omega'\omega\ell m}|=e^{4\pi\mathcal{M}\omega}\,|\beta_{\omega'\omega\ell m}|\sum_{\omega'}(|\alpha_{\omega'\omega\ell m}|^2-|\beta_{\omega'\omega\ell m}|^2)=\sum_{\omega'}(e^{8\pi\mathcal{M}\omega}-1)|\beta_{\omega'\omega\ell m}|^2=1$$

$$\mathfrak{N}_{\omega\ell m}=\sum_{\omega'}|\beta_{\omega'\omega\ell m}|^2=1/e^{8\pi\mathcal{M}\omega}-1$$

$$\mathcal{T}_{\mathbb{H}}=\frac{1}{8\pi\mathcal{M}}\sum_{\omega}\longrightarrow\mathcal{R}/2\pi\int_{0}^{\infty}\mathfrak{d}\omega,\mathfrak{E}=\sum_{\omega\ell m}\omega\mathcal{N}_{\omega\ell m}=\frac{\mathcal{R}}{2\pi\sum_{\ell m}\int_0^\infty\mathfrak{d}\omega\omega\mathcal{N}_{\omega\ell m}},\mathcal{L}=\frac{\mathcal{E}}{\mathcal{R}}$$

$$=\frac{1}{2\pi\sum_{\ell m}\int_0^\infty\mathfrak{d}\omega\omega\mathcal{N}_{\omega\ell m}},\mathcal{L}=1/2\pi\sum_{\ell m}\int_{0}^{\infty}\mathfrak{d}\omega\omega\Gamma_{\omega\ell m}/e^{8\pi\mathcal{M}\omega}-1$$

$$\mathfrak{d}\mathfrak{S}_{\mathfrak{B}\mathfrak{H}}=\frac{\mathfrak{d}\mathfrak{M}}{\mathcal{T}_{\mathbb{H}}},\Delta\mathcal{S}=\Delta\mathcal{S}_{\mathfrak{B}\mathfrak{H}}+\Delta\mathcal{S}_{materia}\geq 0$$

$$\omega'=\mathcal{M}^{-1}e^{t/4\mathcal{M}}$$

$$\rho=\langle\mathfrak{T}_{\mathrm{tt}}\rangle=-\frac{\varpi^2}{1440\mathcal{L}^4},|\psi\rangle=1/\sqrt{1+\epsilon^2}(|0\rangle+\epsilon|2\rangle,\langle\rho\rangle=\frac{1}{1}+\epsilon^2(2\epsilon\mathcal{R}_{\mathrm{e}}(\langle 0|\rho|2\rangle)+\epsilon^2\langle 2|\sigma|2\rangle)$$

$$\langle \mathfrak{H} \rangle = \int \mathfrak{d}^4\chi\langle\rho\rangle, |z,\zeta\rangle = \mathcal{D}(z)\mathcal{S}(\zeta)|0\rangle, \mathcal{D}(z) \equiv \exp(\mathfrak{z}\alpha^\dagger - \mathfrak{z}^{\boxtimes}\alpha) = e^{-\frac{|z|^2}{2}}e^{\mathfrak{z}\alpha^\dagger}\mathrm{e}^{-z^\star\alpha}, \mathfrak{S}(\zeta)$$

$$\equiv \exp(\frac{1}{2\zeta^{\circledast}\alpha^2} - \frac{1}{2\zeta(\alpha^\dagger)^2}), \mathfrak{D}^\dagger(z)\alpha\mathfrak{D}(z) = \alpha + \mathfrak{z}, \mathfrak{D}^\dagger(z)\alpha^\dagger + \mathfrak{z}^{\circledcirc}, \delta^\dagger(\zeta)\alpha\delta(\zeta)$$

$$= \alpha \cosh \mathfrak{r} - \alpha^\dagger\mathrm{e}^{\iota\delta}\sinh \mathfrak{r}, \delta^\dagger(\zeta)\alpha^\dagger\delta(\zeta) = \alpha^\dagger\cosh \mathfrak{r} - \alpha\mathrm{e}^{-\iota\delta}\sinh \mathfrak{r}, \langle\phi\rangle$$

$$= z\mathfrak{f} + z^{\circledast}\mathfrak{f}^{\circledcirc}, \langle : \boxed{\phi^2} : \rangle = \langle\phi\rangle^2, \alpha = \alpha^{\circledast}\beta - \beta^{\boxtimes}\mathbb{b}^\dagger, \mathbb{b} = \alpha^{\circledcirc}\alpha + \beta^{\boxtimes}\alpha^\dagger, |\psi\rangle_{in}$$

$$= \sum|\psi\rangle_{out}, \sum^\dagger\alpha\sum|\psi\rangle_{out}$$

$$\hat{\mathrm{F}} \equiv \mathfrak{T}_0/\varpi\int_{-\infty}^{\infty}\mathrm{F}(\mathfrak{T})\mathfrak{d}\mathrm{t}/\mathfrak{T}^2 + \mathfrak{T}_0^2 \geq -1/32\varpi\mathfrak{T}_0^2, \mathrm{F}(t) = |\Delta\mathcal{E}|(-\delta(t) + \delta(t - \mathbb{T})), |\Delta\mathcal{E}|$$

$$\leq \mathfrak{T}^2 + \mathfrak{T}_0^2/32\mathfrak{T}_0\mathfrak{T}^2, |\Delta\mathcal{E}| \leq 1/8\mathbb{T}, \hat{\mathrm{F}}_\chi \equiv \mathfrak{T}_0/\pi\int_{-\infty}^{\infty}\mathrm{F}_\chi(\mathfrak{T})\mathfrak{d}\mathrm{t}/\mathfrak{T}^2 + \mathfrak{T}_0^2$$

$$\geq 6/64\pi^2\mathfrak{T}_0^4, \mathrm{F}_\chi(t)\ |\Delta\mathcal{E}|/\Lambda(-\delta(t) + \delta(t - \mathbb{T}))\ |\Delta\mathcal{M}||\Delta\mathfrak{S}|, \rho = \langle\mathfrak{T}_{\mu\nu}u^\mu u^\nu\rangle, \hat{\rho}$$

$$\equiv \mathfrak{T}_0/\pi\int_{-\infty}^{\infty}\rho(\mathfrak{T})\mathfrak{d}\mathrm{t}/\mathfrak{T}^2 + \mathfrak{T}_0^2, \hat{\rho} \geq -1/16\pi\mathfrak{T}_0^2, \hat{\rho} \geq -6/64\pi^2\mathfrak{T}_0^4, \hat{\rho} \geq -6/32\pi^2\mathfrak{T}_0^4$$

$$\mathfrak{d}\mathfrak{s}^2 = \left(1 - \frac{2\mathfrak{M}}{\mathfrak{r}}\right)dt^2 - \left(1 - \frac{2\mathfrak{M}}{\mathfrak{r}}\right)^{-1}\mathfrak{d}\mathfrak{r}^2 - \mathfrak{r}^2 d\theta^2 - \mathfrak{r}^2 sin^2\theta d\varphi^2$$

$$\frac{\mathfrak{D}}{\mathfrak{D}\lambda\left(\frac{d\chi^\mu}{d\lambda}\right)}, \int_\alpha^\beta \mathcal{L}\,d\lambda, \mathcal{L} = \frac{\frac{1}{2\mathfrak{g}^{\mu\nu}d\chi^\mu}}{\frac{d\lambda d\chi^\nu}{d\lambda}}, \rho^\mu = \frac{\mathfrak{g}_{\mu\nu}d\chi^\nu}{d\lambda} = \frac{\partial\mathcal{L}}{\partial(d\chi^\mu}/d\lambda), \mathfrak{E} = \rho_t = \left(1 - \frac{2\mathfrak{M}}{\mathfrak{r}}\right)dt/d\lambda, \mathfrak{L}$$

$$= \mathfrak{r}^2 d\varphi/d\lambda, \left(1 - \frac{2\mathfrak{M}}{\mathfrak{r}}\right)\left(\frac{dt}{d\lambda}\right)^2 - \left(1 - \frac{2\mathfrak{M}}{\mathfrak{r}}\right)^{-1}\left(\frac{dr}{d\lambda}\right)^2 - r^2\left(\frac{d\varphi}{d\lambda}\right)^2\mathfrak{E}^2 - \left(\frac{dr}{d\lambda}\right)^2$$

$$- \mathfrak{L}^2/r^2\left(1 - \frac{2\mathfrak{M}}{\mathfrak{r}}\right), \frac{dr^{\circledcirc}}{d\lambda}\left(1 - \frac{2\mathfrak{M}}{\mathfrak{r}}\right)^{-1}, r^{\circledcirc}$$

$$= r + 2\mathfrak{M}\ln\ (t - 2\mathfrak{M})\ d/d\lambda(t\otimes r^{\odot\otimes\dagger}), du/d\lambda = dt/d\lambda - dr^*/d\lambda, dr^*/d\lambda$$

$$= dr^*/dr^*dr/d\lambda = \left(1 - \frac{2\mathfrak{M}}{\mathfrak{r}}\right)^{-1}\mathfrak{E}, r - 2\mathfrak{M} = \mathfrak{E}, du/d\lambda = 2/\left(1 - \frac{2\mathfrak{M}}{\mathfrak{r}}\right)\mathfrak{E}, du/d\lambda$$

$$= 2\mathfrak{E} - 4\mathfrak{M}/\lambda, u(\lambda) = 2\mathfrak{E}\lambda - 4\mathcal{M}\ln\ (\lambda/\kappa_1), u(v) = -4\mathcal{M}\ln(\lambda/\kappa_1), (v)$$

$$= 4\mathcal{M}\ln(\upsilon_0 - \upsilon/\kappa_1\kappa_2)$$

$$\boxdot f_\omega = \frac{1}{1} - \frac{2\mathfrak{M}}{\mathfrak{r}}\partial_t^2 f_\omega - \frac{\left(1 - \frac{2\mathfrak{M}}{\mathfrak{r}}\right)2}{r\partial_r f_\omega} - \left(1 - \frac{2\mathfrak{M}}{\mathfrak{r}}\right)\partial_r^2 f_\omega = \frac{2\iota\omega\mathcal{M}}{r^2} - 2\mathcal{M}r = \mathfrak{O}(r^{-2})$$

$$u(\upsilon) = -4\mathcal{M}\ln\left(\upsilon_0 - \frac{\upsilon}{\kappa}\right), \kappa = \kappa_1\kappa_2 \otimes \frac{d\varphi}{d\tau}, \rho_\omega \sim \frac{\frac{1}{\sqrt{\omega}}e^{-\iota\omega u(\upsilon)}}{r}\delta(\theta,\varphi), f_{\omega'}$$

$$\sim \frac{\frac{1}{\sqrt{\omega'}}e^{-\iota\omega\upsilon}}{r}\delta(\theta,\varphi), \alpha_{\omega\omega'} = (f_{\omega'}\rho_\omega) = \frac{\iota\int_{2\mathcal{M}}^{\infty}\mathfrak{d}\mathcal{V}_\chi\,1}{1} - \frac{2\mathfrak{M}}{\mathfrak{r}}\left(f_{\omega'}^{\circledast}\partial_t\rho_\omega - \partial_t f_{\omega'}^{\circledast}\rho_\omega\right)$$

$$= \frac{\mathfrak{C}\int_{2\mathcal{M}}^{\infty}\frac{r^2}{1} - \frac{2\mathfrak{M}}{\mathfrak{r}}e^{-\iota\omega'\upsilon}e^{-\iota\omega u(\upsilon)}}{r^2\left(\sqrt{\frac{\omega'}{\omega}} + \sqrt{\frac{\omega}{\omega'}}\right)dr} = -\mathfrak{C}\int_{-\infty}^{\upsilon_0}\mathfrak{d}\upsilon\sqrt{\frac{\omega'}{\omega}}e^{-\iota\omega'\upsilon}e^{-\iota\omega u(\upsilon)}, \beta_{\omega\omega'}$$

$$= -\left(f_{\omega'}^{\circledast}\rho_\omega\right) = \mathfrak{C}\int_{-\infty}^{0}\mathfrak{d}\upsilon\sqrt{\frac{\omega'}{\omega}}e^{-\iota\omega'\upsilon}e^{-\iota\omega u(\upsilon)}\alpha_{\omega\omega'}$$

$$= -\mathfrak{C}\int_{-\infty}^{\upsilon_0}\mathfrak{d}s\sqrt{\frac{\omega'}{\omega}}e^{-\iota\omega's}e^{-\iota\omega'\upsilon_0}e^{\iota\omega 4\mathcal{M}\ln\left(-\frac{s}{\mathfrak{K}}\right)}, \beta_{\omega\omega'}$$

$$= \mathfrak{C}\int_{-\infty}^{\upsilon_0}\mathfrak{d}s\sqrt{\frac{\omega'}{\omega}}e^{-\iota\omega's}e^{-\iota\omega'\upsilon_0}e^{\iota\omega 4\mathcal{M}\ln\left(-\frac{s}{\mathfrak{K}}\right)}$$

$$\alpha_{\omega\omega'} = \iota\mathfrak{C}\int_{-\infty}^{v_0} \mathfrak{d}s' \sqrt{\frac{\omega'}{\omega}} e^{w\prime s\prime} e^{\iota\omega' v_0} e^{\iota\omega 4\mathcal{M}\log\left(-\frac{\iota s'}{\mathfrak{K}}\right)}, \beta_{\omega\omega'}$$

$$= -\iota\mathfrak{C}\int_{-\infty}^{v_0} \mathfrak{d}s' \sqrt{\frac{\omega'}{\omega}} e^{w's'} e^{\iota\omega' v_0} e^{\iota\omega 4\mathcal{M}\log\left(-\frac{\iota s'}{\mathfrak{K}}\right)}, \log\left(\frac{\iota s'}{\mathfrak{K}}\right)$$

$$= \ln\left(\frac{|s'|}{\mathfrak{K}}\right) - \frac{\iota\pi}{2}, \log\left(\frac{-\iota s'}{\mathfrak{K}}\right) = \ln\left(\frac{|s'|}{\mathfrak{K}}\right) + \frac{\iota\pi}{2}, \alpha_{\omega\omega'}$$

$$= \iota\mathfrak{C}\, e^{\iota\omega' v_0} e^{2\omega\mathcal{M}\pi} \int_{-\infty}^{0} \mathfrak{d}s' \sqrt{\frac{\omega'}{\omega}} e^{w's'} e^{\iota\omega 4\mathcal{M}\ln\left(\frac{|s'|}{\mathfrak{K}}\right)}, \beta_{\omega\omega'}$$

$$= -\iota\mathfrak{C}\, e^{\iota\omega' v_0} e^{-2\omega\mathcal{M}\pi} \int_{-\infty}^{0} \mathfrak{d}s' \sqrt{\frac{\omega'}{\omega}} e^{w's'} e^{\iota\omega 4\mathcal{M}\ln\left(\frac{|s'|}{\mathfrak{K}}\right)}, |\alpha_{\omega\omega'}|^2$$

$$= e^{8\pi\omega\mathcal{M}} |\beta_{\omega\omega'}|^2, (\rho_{\omega_1}\rho_{\omega_2}) = \Gamma(\omega_1)\delta(\omega_1 - \omega_2)(\rho_{\omega_1}\rho_{\omega_2})$$

$$= \left(\rho_{\omega_1}^{(1)}\rho_{\omega_2}^{(1)}\right) + \left(\rho_{\omega_1}^{(2)}\rho_{\omega_2}^{(2)}\right), \left(\rho_{\omega_1}^{(1)}\rho_{\omega_2}^{(1)}\right)$$

$$= \left(1 - \Gamma(\omega_1)\right)\delta(\omega_1 - \omega_2), \Gamma(\omega_1)\delta(\omega_1 - \omega_2)$$

$$= \int_{\infty}^{0} \mathfrak{d}\omega' \left(\alpha_{\omega_1\omega'}^{\odot}\alpha_{\omega_2\omega'} - \beta_{\omega_1\omega'}^{\odot}\beta_{\omega_2\omega'}\right), \mathscr{b}_\omega = \left(\rho_\omega^{(2)}, \phi\right)$$

$$= \int_{\infty}^{0} \mathfrak{d}\omega' \left(\alpha_{\omega\omega'}\alpha_{\omega'} + \beta_{\omega\omega'}\alpha_{\omega'}^{\dagger}\right)$$

$$\langle\mathcal{N}\rangle = \left\langle 0\middle|\mathscr{b}_\omega^\dagger \mathscr{b}_\omega\middle|0\right\rangle = \int_{\infty}^{0} \mathfrak{d}\omega' \beta_{\omega\omega'}\langle\omega'| \int_{\infty}^{0} \mathfrak{d}\omega'' \beta_{\omega\omega''}^{\circledast}|\omega''\rangle = \int_{\infty}^{0} \mathfrak{d}\omega' |\beta_{\omega\omega'}|^2, \Gamma(\omega)\delta(0)$$

$$= \int_{\infty}^{0} \mathfrak{d}\omega'(|\alpha_{\omega\omega'}|^2 - |\beta_{\omega\omega'}|^2) = (e^{8\pi\mathcal{M}\omega} - 1) \int_{\infty}^{0} \mathfrak{d}\omega' |\beta_{\omega\omega'}|^2, \delta(\omega_1 - \omega_2)$$

$$= \lim_{\tau\to\infty} \frac{1}{2\pi} \int_{-\frac{\tau}{2}}^{\frac{\tau}{2}} dt e^{\iota(\omega_1 - \omega_2)t}\, \Gamma(\omega) \lim_{\tau\to\infty} \frac{\tau}{2\pi} = \left(e^{8\pi\mathcal{M}\omega} - 1\right) \int_{\infty}^{0} \mathfrak{d}\omega' |\beta_{\omega\omega'}|^2, \langle\mathcal{N}\rangle$$

$$= \lim_{\tau\to\infty} \frac{\tau}{2\pi} \Gamma(\omega) 1/e^{8\pi\mathcal{M}\omega} - 1, \Gamma(\omega)/2\pi \cdot 1/e^{8\pi\mathcal{M}\omega} - 1$$

$$\mathcal{T} = \frac{1}{16\pi k_{\mathfrak{B}}\mathfrak{M}} = \frac{\kappa}{2\pi}, \rho = \int d\omega \Lambda(\omega) e^{\iota\gamma(\omega)} \rho_\omega, \mathcal{T} = \frac{\hbar^4 c^4}{16\pi \mathfrak{G}\mathfrak{M} k_{\mathfrak{B}}} \approx 10^{-7} \left(\frac{\mathfrak{M}_\odot}{\mathfrak{M}}\right) \mathfrak{K}, \frac{d\mathfrak{E}}{dt}$$

$$= \frac{8\pi r_s^2 \sigma \mathcal{T}^4 dM}{dt} = -\frac{\frac{\beta \mathfrak{m}_\rho^4}{t_\rho 1}}{\mathcal{M}^4}, \mathfrak{M}(t) = \left(\mathfrak{M}_0^4 - \frac{6\beta \mathfrak{m}_\rho^4}{t_\rho} t\right)^{\frac{1}{2}}, \Delta_t = t_\rho / 3\beta \left(\frac{\mathfrak{M}_0}{\mathfrak{m}_\rho}\right)^3$$

9. Modelo Englert – Brout.

$$\mathcal{H}_{int} = \imath e \Lambda_\mu \varphi^{\boxtimes} \overleftrightarrow{\partial}_\mu \varphi - e^2 \varphi^{\boxtimes} \varphi \Lambda_\mu \Lambda_\mu, \circledast^{\mu\nu} \odot_{\mu\nu} (q) = (2\pi)^4 \iota e^2 (g_{\mu\nu}) \langle\varphi_1\rangle^2 - \langle \frac{q_\mu q_\nu}{q^2} \rangle \langle\varphi_1\rangle^2, \mu^2$$

$$= e^2 \langle\varphi_1\rangle^2, \delta\varphi_\Lambda = \Sigma_\alpha \Lambda^\epsilon \alpha^{(\chi)\mathfrak{T}} \alpha \mathrm{AB}^\varphi \mathrm{B}' \delta\Lambda_{\alpha,\mu}$$

$$= \Sigma_c \mathscr{b}^\epsilon c^{(x)} c_{acb} \Lambda_{\beta,\nu} + \partial_\mu \epsilon_{\alpha^{(x)}}, \frac{\left(\frac{\iota}{(2\pi)^4}\right) \Sigma_{\mathrm{A,B'C'}} \mathfrak{T}_{\alpha,\mathrm{AB'}} \langle\varphi_{\mathrm{B'}}\rangle \mathfrak{T}_{\alpha\mathrm{AC'}} \langle\varphi_{\mathrm{C'}}\rangle}{\mathfrak{q}^2}$$

$$\equiv, \left(\frac{-\iota}{(2\pi)^4}\right) \left(\frac{\langle\varphi\rangle \mathfrak{T}_\alpha \mathfrak{T}_\alpha \langle\varphi\rangle}{\mathfrak{q}^2}\right), \boxtimes^{\mu\nu} \bigotimes \hbar_{\mu\nu}^{\ \alpha} (q) \delta\delta$$

$$= -\imath (2\pi)^4 \lambda^2 \left(\frac{\langle\varphi\rangle \mathfrak{T}_\alpha \mathfrak{T}_\alpha \langle\varphi\rangle}{\mathfrak{q}^2}\right) \otimes \left(\mathfrak{g}_{\mu\nu} - \frac{q_\mu q_\nu}{\mathfrak{q}^2}\right), \mu_\alpha^2 = -\left(\frac{\langle\varphi\rangle \mathfrak{T}_\alpha \mathfrak{T}_\alpha \langle\varphi\rangle}{\mathfrak{q}^2}\right), \mathcal{H}_{int}$$

$$= -\eta \bar{\psi} \gamma_\mu \gamma_5 \bar{\psi} \mathrm{B}_\mu - \epsilon \bar{\psi} \gamma_\mu \psi \Lambda_\mu, \delta^{-1}(\rho) = \gamma\rho - \Sigma(\mathrm{\rho})$$

$$= \gamma\rho(1 - \Sigma_2(\rho^2)) - \Sigma_1(\rho^2), \mathfrak{m}(1 - \Sigma_2(\mathfrak{m}^4)) - \Sigma_1(\mathfrak{m}^4), \mathfrak{J}_\mu^5$$

$$= -\eta \lim_{\xi \to 0} \overline{\psi'} (\chi + \xi) \gamma_\mu \gamma_5 \psi'(\chi), \psi'(\chi)$$

$$= \exp(-\iota \int_{-\infty}^{\chi} \eta \mathrm{B}_\mu(\gamma) d\gamma^\mu \gamma_5)\, \psi(\chi)\ \otimes_{\mu\nu}{}^5 (\varrho)$$

$$= \eta^2 \iota / (2\pi)^4 \int \mathfrak{Tr} \left(\delta \left(\rho - \frac{1}{2\varrho}\right) \Gamma_{\nu^5} \left(\rho - \frac{1}{2\varrho}; \rho + \frac{1}{2\varrho}\right) \boxtimes \delta \left(\rho + \frac{1}{2\varrho}\right) \gamma_\mu \gamma_5\right.$$

$$\left. - \delta(\rho) \left(\frac{\partial \delta^{-1}(\rho)}{\partial \rho_\nu}\right) \delta(\rho) \gamma_\mu \right) \mathfrak{d}^4 \rho$$

$$\varrho_\nu \Lambda_{\nu^5} \left(\rho - \frac{1}{2\varrho}; \rho + \frac{1}{2\varrho}\right) \Sigma \left(\rho - \frac{1}{2\varrho}\right) \gamma_5 + \gamma_5 \Sigma \left(\rho + \frac{1}{2\varrho}\right), \varrho_\nu \Gamma_{\nu^5}$$

$$= \varrho_\nu \gamma_\nu \gamma_5 (1 - \Sigma_2) + 2\Sigma_1 \gamma_5 - 2(\varrho_\nu \rho_\nu)(\gamma_\lambda \rho_\lambda)(\partial \Sigma_2 / \partial \rho^2 \gamma_5$$

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Apéndice C.

Formalización de la dualidad holográfica en campos cuánticos curvos.

1. Dualidad/Gravedad – Gauge en espacios cuánticos curvos.

1.1. Grupo Conforme.

$$\iota[\mathfrak{M}_{\mu\nu}\mathfrak{M}_{\rho\sigma}] = \eta_{\nu\rho}\mathfrak{M}_{\mu\sigma} - \eta_{\mu\rho}\mathfrak{M}_{\nu\sigma} - \eta_{\sigma\mu}\mathfrak{M}_{\rho\nu} + \eta_{\sigma\nu}\mathfrak{M}_{\rho\mu}\iota[\mathfrak{P}_\mu\mathfrak{M}_{\sigma\rho}]$$

$$= \eta_{\mu\rho}\mathfrak{P}_\sigma - \eta_{\mu\sigma}\mathfrak{P}_\rho[\mathfrak{P}_\mu\mathfrak{P}_\nu]\iota[\mathfrak{D},\mathfrak{P}_\mu] = \mathfrak{P}_\mu[\mathfrak{M}_{\mu\nu},\mathfrak{D}]$$

$$\mathfrak{K}_{\mu\nu}:\chi^\mu \longrightarrow \chi^\mu + \frac{\alpha^\mu\chi^2}{1} + 2\chi^\nu\alpha_\nu + \alpha^2\chi^2\iota[\mathfrak{M}_{\mu\nu}\mathfrak{K}_\rho] = \eta_{\mu\rho}\mathfrak{K}_\nu - \eta_{\nu\sigma}\mathfrak{K}_\mu[\mathfrak{D},\mathfrak{K}_\mu]\iota\mathfrak{K}_\mu[\mathfrak{P}_\mu\mathfrak{K}_\nu]$$

$$= 2\iota(\mathfrak{M}_{\mu\nu} - \eta_{\mu\nu}\mathfrak{D})[\mathfrak{K}_\mu\mathfrak{K}_\nu]$$

$$\mathfrak{J}_{\mu\nu} = \mathfrak{M}_{\mu\nu}, \mathfrak{J}_{\mu d} = \frac{1}{2[\mathfrak{K}_\mu - \mathfrak{P}_\mu]}, \mathfrak{J}_{\mu(d+1)} = \frac{1}{2[\mathfrak{K}_\mu + \mathfrak{P}_\mu]}, \mathfrak{J}_{(d+1)d} = \mathfrak{D}$$

$$\mathfrak{J}_{\alpha\beta} = \begin{pmatrix} \mathfrak{J}_{\mu\nu} & \mathfrak{J}_{\mu d} & \mathfrak{J}_{\mu(d+1)} \\ -\mathfrak{J}_{\mu d} & 0 & \mathfrak{D} \\ -\mathfrak{J}_{\mu(d+1)} & -\mathfrak{D} & 0 \end{pmatrix}$$

$$\mathcal{P}_\mu:\chi_\mu \longrightarrow \chi_\mu + \alpha_\mu \Longrightarrow d, \mathfrak{M}_{\mu\nu}:\chi_\mu \longrightarrow \Lambda_\mu^\nu\chi_\nu \Longrightarrow \frac{(d-1)d}{2}, \mathfrak{D}:\chi_\mu \longrightarrow \lambda\chi_\mu, \mathfrak{K}_\mu:\chi_\mu$$

$$\longrightarrow \chi_\mu + \frac{\alpha_\mu\chi^2}{1} + 2\chi_\nu\alpha^\nu + \alpha^2\chi^2 \Longrightarrow d$$

$$\chi \longrightarrow \lambda\chi \Longrightarrow \phi(\chi) \longrightarrow \phi(\chi)' = \lambda^\Delta\phi(\lambda\chi)[\mathfrak{D},\mathcal{P}_\mu] = \iota\mathcal{P}_\mu \Longrightarrow \mathfrak{D}(\mathcal{P}_\mu\phi) = -\iota(\Delta+1)(\mathcal{P}_\mu\phi), \langle\phi(0)|\phi(\chi)\rangle$$

$$\equiv 1/(\chi^2)^\Delta$$

1.2. Espacio Anti – de Sitter en espacios cuánticos curvos.

$$\mathfrak{R}_{\mu\nu} - \frac{1}{2\mathcal{g}_{\mu\nu}\mathcal{R}} = -\Lambda \mathcal{g}_{\mu\nu}, \mathfrak{R}_{\mu\nu\theta\sigma} = \frac{1}{\ell^2}(\mathcal{g}_{\mu\theta}\mathcal{g}_{\nu\sigma} - \mathcal{g}_{\mu\sigma}\mathcal{g}_{\nu\theta}), \mathfrak{R}_{\mu\nu} = -\frac{3}{\ell^2\mathcal{g}_{\mu\nu}}, \mathcal{R} = -\frac{12}{\ell^2}, \mathfrak{ds}^2$$

$$= -d\chi_0^2 - d\chi_4^2 + d\chi_1^2 + d\chi_2^2 + d\chi_3^2 - \chi_0^2 - \chi_4^2 + \chi_1^2 + \chi_2^2 + \chi_3^2 = -\ell^2, \frac{\mathfrak{ds}^2}{\ell^2}$$

$$= -\cos\hbar^2\rho d\tau^2 + d\rho^2 + \sin\hbar^2\rho(d\theta^2 + sin^2\theta d\varphi^2), \frac{\mathfrak{ds}^2}{\ell^2}$$

$$\approx -d\tau^2 + d\rho^2 + \rho^2(d\theta^2 + sin^2\theta d\varphi^2), \mathfrak{ds}^2$$

$$= \left(1 + \frac{r^2}{\ell^2}\right)dt^2 + \left(1 + \frac{r^2}{\ell^2}\right)^{-1} dr^2 + r^2(d\theta^2 + sin^2\theta d\varphi^2), \chi_0$$

$$= \frac{lr}{2}\left(\overrightarrow{\chi_i^2} - t^2 + \frac{1}{r^2} + 1\right), \chi_i = lrx_i(i = 1, 2), \chi_3 = \frac{lr}{2}\left(\overrightarrow{\chi_i^2} - t^2 + \frac{1}{r^2} + 1\right)\chi_4$$

$$= lrt, \frac{\mathfrak{ds}^2}{\ell^2} = r^2\left(-dt^2 + d\overrightarrow{\chi^2}\right) + \frac{dr^2}{r^2}, \mathfrak{ds}^2 = \ell^2/z^2\left(-dt^2 + d\overrightarrow{\chi^2} + dz^2\right)$$

1.3. Límite de ’t Hooft en espacios cuánticos curvos.

$$\mathfrak{L} = \frac{\mathfrak{N}}{2\mathfrak{G}_{\mathfrak{YM}}^2 \mathcal{F}_{\mu\nu}^{\mathcal{M}} \mathcal{F}_{\mathcal{M}}^{\mu\nu}},$$

1.4. Prescripción de Gubser – Klevanov – Polyakov y Witten en espacios cuánticos curvos.

$$\mathfrak{z}_{\mathfrak{CFT}} = e^{-\mathcal{W}}, \ell^4\ell_s^4 \sim \mathcal{g}_{\mathcal{YM}}^2\mathcal{N} \sim \mathcal{g}_\delta \mathrm{N} >> 1, \mathcal{Z}_{\wp} \approx e^{-\mathfrak{I}_{SUGRA}^{\mathfrak{E}}}, \mathcal{Z}_{\wp} \approx e^{-\mathfrak{I}_{\mathfrak{SUGRA}}^{\mathfrak{E}}} = e^{-\mathcal{W}} = \mathcal{Z}_{\mathfrak{CFT}}$$

1.5. Correspondencia Campo ↔ Operador en espacios cuánticos curvos.

$$\langle e^{\int d^3\chi\phi_0(\overrightarrow{\chi})\mathcal{O}(\overrightarrow{\chi})}\rangle_{\mathfrak{CFT}} = e^{-\mathfrak{I}_{\mathfrak{BULK}}^{\mathfrak{E}}[\phi|\partial\mathfrak{AdS}\to\phi_0|]}, \langle e^{\int d^3\chi\hbar_{\alpha\beta}^0\mathcal{T}^{\alpha\beta}}\rangle_{\mathfrak{CFT}} = e^{-\mathfrak{I}_{\mathfrak{BULK}}^{\mathfrak{E}}\left[\hbar_{\mu\nu}\middle|\partial\mathfrak{AdS}\to\hbar_{\alpha\beta}^0\right|\right]}$$

1.6. Partículas y Campos en el espacio tiempo AdS – curvo.

$$\left(\nabla^{\mu}\nabla_{\mu}-\mathfrak{m}^{4}\right)\Phi(z,\chi^{\eta})=\frac{\frac{\int d^{2}\vec{\kappa}}{(2\pi)^{4}d\omega\mathfrak{f}_{\kappa}(z)e^{i\kappa_{\mu}\chi^{\mu}}d^{2}\mathfrak{f}_{\kappa}}}{dz^{2}}-\frac{\frac{2}{zd\mathfrak{f}_{\kappa}}}{dz}-\left(\kappa^{2}+\frac{\mathfrak{m}^{4}\ell^{4}}{z^{2}}\right)\mathfrak{f}_{\kappa}(z)$$

$$=\alpha_{1}z^{\frac{3}{2}}\mathfrak{K}_{\nu}(\mathfrak{K}z)+\frac{\alpha_{2}z^{\frac{3}{2}}\mathfrak{I}_{\nu}(\mathfrak{K}z)d^{2}\mathfrak{f}_{\kappa}}{dz^{2}}-\kappa^{4}\mathfrak{f}_{\kappa}(z)$$

$$=\frac{\alpha_{1}z^{\frac{3}{2}}\pi}{2\sin\pi\nu\left[\frac{1}{\Gamma(1-\nu)\left(\frac{\mathfrak{K}z}{2}\right)^{-\nu}}-\frac{1}{\Gamma(1+\nu)\left(\frac{\mathfrak{K}z}{2}\right)^{\nu}}\right]},\mathfrak{m}_{\mathfrak{B}\mathfrak{F}}^{4}\geq\mathfrak{m}^{4}\geq\mathfrak{m}_{\mathfrak{B}\mathfrak{F}}^{4}+\frac{1}{\ell^{4}}\Rightarrow0\geq\nu$$

$$>1,\phi(r,\chi^{\eta})=\frac{\alpha(\chi^{\eta})}{r^{3-\Delta}}+\frac{\beta(\chi^{\eta})}{r^{\Delta}},\phi=\frac{\alpha}{r}+\frac{\beta}{r^{2}\partial_{r}\phi}$$

$$=-\frac{\alpha}{r^{2}}-\frac{\frac{2\beta}{r^{4}\otimes\alpha'}}{r^{2}}+\alpha\phi+\beta\partial_{r}\phi=\alpha\left(\frac{\alpha}{r}+\frac{\beta}{r^{2}}\right)+\beta\left(-\frac{\alpha}{r^{2}}-\frac{2\beta}{r^{4}}\right)=\frac{\alpha'}{r}+\frac{\beta'}{r^{2}}$$

1.7. Deformaciones en AdS/CFT en espacios cuánticos curvos.

$$\mathfrak{I}_{\mathfrak{C}\mathfrak{F}\mathfrak{T}}\longrightarrow\mathfrak{I}_{\mathfrak{C}\mathfrak{F}\mathfrak{T}}+\rho\int d^{3}\chi\mathcal{O}(\chi)$$

2. Agujeros Negros Cuánticos en espacios curvos (Formalización).

2.1. Principio Variacional.

$$\mathfrak{I}=\frac{1}{2\kappa\int d^{4}\chi\sqrt{-g}\mathcal{R}+\mathfrak{I}_{\mathfrak{B}}},\delta\mathcal{I}=\frac{1}{2\kappa\int d^{4}\chi\sqrt{-g}\mathfrak{G}_{\alpha\beta}\delta g^{\alpha\beta}+\int d^{4}\chi\sqrt{-g}g^{\alpha\beta}\delta\mathcal{R}_{\alpha\beta}+\delta\mathfrak{I}_{\mathfrak{B}}},\mathfrak{G}_{\alpha\beta}$$

$$=\mathcal{R}_{\alpha\beta}-\frac{1}{2g_{\alpha\beta}\mathfrak{R}},\delta\mathfrak{I}_{\mathfrak{B}}=-\int_{\mathcal{M}}^{\beth}d^{4}\chi\sqrt{-g}g^{\alpha\beta}\delta\Gamma_{\alpha\beta}^{\mu}-\sqrt{-g}g^{\alpha\mu}\delta\Gamma_{\alpha\beta}^{\beta}+\sqrt{-g}\delta\mathcal{R}_{\alpha\beta}$$

$$=\oint_{\partial\mathcal{M}}^{\gimel}\epsilon v^{\mu}\eta_{\nu}\sqrt{-\hbar}\,d^{3}\chi,\mathfrak{I}_{\mathfrak{B}}=\oint_{\partial\mathcal{M}}^{\gimel}d^{3}\chi\sqrt{-\hbar}\,\kappa,\mathfrak{I}$$

$$=\frac{1}{2\kappa\int_{\mathcal{M}}^{\beth}d^{4}\chi\sqrt{-g}\,\mathcal{R}}+1/\varkappa\oint_{\partial\mathcal{M}}^{\gimel}d^{3}\chi\sqrt{-\hbar}\,\mathfrak{K}$$

$$ds^{2}=-\mathcal{N}(r)dt^{2}+\mathcal{H}(r)dr^{2}+r^{2}(d\theta^{2}+sin^{2}\theta d\varphi^{2}),\mathfrak{K}_{\mathfrak{R}\mathfrak{E}\mathfrak{T}\mathfrak{S}}=\mathcal{R}^{\alpha\beta\gamma\sigma}\mathcal{R}_{\alpha\beta\gamma\sigma},\mathcal{I}[\mathfrak{g}_{\mu\nu}]$$

$$=\frac{1}{2\kappa\int_{\mathcal{M}}^{\beth}d^{4}\chi\sqrt{-g}\mathcal{R}}+\frac{1}{\kappa\oint_{\partial\mathcal{M}}^{\gimel}d^{3}\chi\mathfrak{K}\sqrt{-\hbar}},ds^{2}$$

$$=-\left(1-\frac{\mu}{r}\right)dt^{2}+\left(1-\frac{\mu}{r}\right)^{-1}dr^{2}+r^{2}(d\theta^{2}+sin^{2}\theta d\varphi^{2}),M=\frac{4\pi\mu}{\kappa}=\mu/2\mathfrak{G}$$

2.2. Modelo Reissner – Nordström.

$$\mathcal{I}[\mathfrak{g}_{\mu\nu}\Lambda_\mu] = \frac{1}{2\kappa \int_{\mathcal{M}}^{\beth} d^4\chi\sqrt{-g}\left(\mathcal{R} - \frac{1}{4\mathrm{F}^{\mu\nu}\mathrm{F}_{\mu\nu}}\right)} + \frac{1}{\kappa \oint_{\partial\mathcal{M}}^{\lambda} d^3\chi\mathfrak{K}\sqrt{-\hbar}}, \mathcal{R}_{\mu\nu} - \frac{1}{2\mathcal{R}\mathfrak{g}_{\mu\nu}}$$

$$= \frac{1}{2\mathfrak{I}_{\mu\nu}^{\mathfrak{EM}}\nabla_\mu \mathrm{F}^{\mu\nu}}, \mathfrak{I}_{\mu\nu}^{\mathfrak{EM}} = \mathrm{F}_{\mu\alpha}\mathrm{F}_\nu^\alpha - \frac{1}{4\mathfrak{g}_{\mu\nu}\mathrm{F}^2}, \Lambda \equiv \Lambda_\mu d\chi_\mu = \left(\frac{q}{r} - \frac{q}{r_+}\right) dt, \mathrm{F}$$

$$= -\frac{q}{r^2 dr} \wedge dt, ds^2 = -\mathfrak{f}(r)dt^2 + \mathfrak{f}(r)^{-1}dr^2 + r^2(d\theta^2 + sin^2\theta d\varphi^2), \mathfrak{f}(r)$$

$$= 1 - \frac{\mu}{r} + \frac{q^2}{4r^2} = \frac{(r-r_-)(r-r_+)}{r^2}, \mathcal{M} = \frac{4\pi\mu}{\kappa} = \frac{\mu}{2\mathfrak{G}}, \mathfrak{Q} \equiv \frac{1}{\kappa \oint_{-\infty}^{\infty} d^2 \star \mathcal{F} = -\frac{q}{4\mathfrak{G}}}, r_\pm$$

$$= \mathfrak{G}(\mathfrak{M} \pm \sqrt{\mathfrak{M}^2 - 4\mathfrak{Q}^2}, \Phi = \Lambda_t|\Delta_{r=\infty} - \Lambda_t|\Delta_{r=r_+} = 4\mathfrak{G}\mathfrak{Q}/r \blacksquare$$

2.3. Modelo anti – de Sitter.

$$ds^2 = \frac{r^2}{\ell^2(-dt^2 + \ell^2 d\Sigma_\kappa^2)}, ds^2 = -\mathrm{N}(r)dt^2 + \mathcal{H}(r)dr^2 + \delta(r)d\Sigma_\kappa^2$$

$$= \left\langle \begin{matrix} d\theta^2 + sin^2\theta d\varphi^2 & \propto \kappa = +1 \\ \frac{1}{\ell^2 \sum_{i=1}^2 d\chi_i^2} & \bowtie \kappa = 0 \\ d\theta^2 + \sin\hbar^2\theta d\varphi^2 & \doteqdot \kappa = -1 \end{matrix} \right\rangle, d\Sigma_\kappa^2 = \frac{d\mathcal{y}^2}{1} - \kappa\mathcal{y}^2 + (1 + \kappa\mathcal{y}^2)dz^2$$

2.4. Modelo Schwarzschild-AdS.

$$\mathcal{I}[\mathfrak{g}_{\mu\nu}] = \frac{1}{2\kappa \int_{\mathcal{M}}^{\beth} d^4\chi\sqrt{-g}\,(\mathfrak{R} - 2\Lambda)} + \frac{1}{\kappa \oint_{\partial\mathcal{M}}^{\lambda} d^3\chi\mathfrak{K}\sqrt{-\hbar}}, \mathcal{R}_{\mu\nu} - \frac{1}{2\mathfrak{g}_{\mu\nu}\mathcal{R}} = -\Lambda\mathfrak{g}_{\mu\nu}, ds^2$$

$$= -\left(\kappa - \frac{\mu}{r} + \frac{r^2}{\ell^2}\right) dt^2 + \left(\kappa - \frac{\mu}{r} + \frac{r^2}{\ell^2}\right)^{-1} dr^2 + r^2\, d\Sigma_\kappa^2, \kappa - \frac{\mu}{r_\hbar} + \frac{r_\hbar^2}{\ell^2}$$

2.5. Modelo Escalar Simple.

$$\mathcal{I}[\mathfrak{g}_{\mu\nu}, \phi] = \frac{\int_{\mathcal{M}}^{\beth} d^4\chi\sqrt{-g}\left[\frac{\mathfrak{R}}{2\kappa} - \frac{1}{2\partial_\mu\phi\,\partial^\mu\phi} - \mathcal{V}(\phi)\right]1}{\sqrt{-g}\partial_\mu\left(\sqrt{-g}g^{\mu\nu}\partial_\nu\phi\right)} - \frac{\frac{\partial\mathcal{V}}{\partial\phi}d\mathcal{V}}{d\phi|\psi_{\phi=0}}, \mathcal{V}(0)$$

$$= -\frac{3}{\kappa\ell^2}, \frac{d^2\mathcal{V}}{d\phi^2|\psi_{\varphi=0}}, \mathbb{V}(\phi)_{\mathfrak{AdS}} = \left(-\frac{1}{\ell^2} + \alpha\phi\right)(4 + 2\cos\hbar\phi) - 6\alpha\sin\hbar\phi$$

2.6. Modelo Escalar Neutro.

$$\mathcal{E}_{\mu\nu} = \mathcal{R}_{\mu\nu} - \frac{1}{2g_{\mu\nu}\mathfrak{R}} - \kappa\mathcal{T}^{\varphi}_{\phi\mu\nu}, \mathcal{T}^{\varphi}_{\phi\mu\nu} = \partial_\mu\phi\partial_\nu\phi - g_{\mu\nu}\left(\frac{1}{2(\partial\psi)^2} + \mathfrak{V}(\phi)\right), ds^2$$

$$= \Omega(\chi)\left[-\mathfrak{f}(\chi)dt^2 + \frac{\eta^2 d\chi^2}{\mathfrak{f}(\chi)} + \frac{d\mathcal{y}^2}{\ell^2} + \frac{dz^2}{\ell^2}\right]\mathfrak{E}^t_t - \mathfrak{E}^\chi_\chi = 0 \longrightarrow \phi'^2$$

$$= 3\Omega'^2 - \frac{2\Omega''\Omega}{\Omega^2}, \mathfrak{E}^t_t - \mathfrak{E}^{\mathcal{y}}_{\mathcal{y}} = 0 \longrightarrow \mathfrak{f}'' + \frac{\Omega'\mathfrak{f}'}{\Omega} = 0, \mathfrak{E}^t_t - \mathfrak{E}^{\mathcal{y}}_{\mathcal{y}} = 0 \longrightarrow \mathcal{V}(\phi)$$

$$= -\frac{1}{\Omega^2\eta^2(\mathfrak{f}\Omega'' + \mathfrak{f}'\Omega')}, \Omega(\chi) = \frac{\nu^2\chi^{\nu-1}}{\eta^2(\chi^\nu - 1)^2}, \phi'^2$$

$$= \frac{(\nu-1)^2}{\chi^2} - \frac{4\nu(\nu-1)\chi^{\nu-2}}{\chi^\nu} - 1 + \frac{4\nu^2\chi^{\nu-1}}{(\chi^\nu-1)^2} + \frac{2(\nu-1)}{\chi^2}$$

$$+ \frac{4\nu(1-\nu-\chi^\nu)\chi^{\nu-2}\chi^{\nu-2}}{(\chi^\nu-1)^2}, \phi'^2 = \nu^2 - \frac{1}{2\kappa\chi^2}$$

$$\longrightarrow \int_{\phi}^{\phi=0} d\varphi = \sqrt{\nu^2 - \frac{1}{2\kappa}}\int_{\chi}^{1}\frac{d\chi}{\chi}, \phi(\tau)\ln\chi, \ell_\nu^{-1} = \sqrt{\nu^2 - \frac{1}{2\kappa}}\,(\mathfrak{f}'\Omega)'f(x)$$

$$= \frac{c_4\eta^2}{\nu^2\int\frac{(\chi^\nu-1)^2}{\chi^{\nu-1}d\chi} + c_1}, f(x) = c_1 + \frac{c_4\eta^2}{\nu^2\left(\frac{\chi^{2+\nu}}{2} + \nu + \frac{\chi^{2-\nu}}{2} - \nu - \chi^2\right)}, f(x)$$

$$= \frac{1}{\ell^2} + \alpha\left[\frac{1}{\nu^2} - 4 - \frac{\chi^2}{\nu^2\left(1 + \frac{\chi^{-\nu}}{\nu} - 2 - \frac{\chi^\nu}{\nu} + 2\right)}\right], \mathcal{V}(\phi)$$

$$= \frac{\Lambda(\nu^2-4)}{6\kappa\nu^2\left[\nu - \frac{1}{\nu} + 2e^{-\phi\ell_\nu(\nu+1)} + \nu + \frac{1}{\nu} - 2e^{\phi\ell_\nu(\nu-1)} + 4\nu^2 - \frac{1}{\nu^2} - 4e^{-\phi\ell_\nu}\right]}$$

$$+ \alpha$$

$$/\kappa\nu^2\left[\nu - \frac{1}{\nu} + 2\sin\hbar\,\phi\ell_\nu(\nu+1) - \nu + \frac{1}{\nu}\right.$$

$$\left.- 2\sin\hbar\phi\ell_\nu(\nu-1) + 4\nu^2 - \frac{1}{\nu^2} - 4\sin\hbar\phi\ell_\nu\right]$$

$$\mathcal{V}(\phi) = \frac{\Lambda}{\kappa} - \frac{\phi^2}{\ell^2} + \frac{\frac{\kappa\Lambda}{18(\nu^2-3)}}{\nu^2} - 1\phi^4 - \frac{\ell_\nu^3}{90(\Lambda\nu^2 - 4\Lambda - 6\alpha)\tau^5} + \mathcal{O}|\varphi|^6$$

$$ds^2 = \Omega(\chi)\left[-f(x)dt^2 + \frac{\eta^2 d\chi^2}{f(x)} + d\theta^2 + sin^2\theta d\varphi^2\right], f(x)$$

$$= \frac{1}{\ell^2} + \alpha\left[\frac{1}{\nu^2} - 4 - \frac{\chi^2}{\nu^2\left(1 + \frac{\chi^{-\nu}}{\nu} - 2 - \frac{\chi^\nu}{\nu} + 2\right)}\right] + \chi/\Omega(\chi)$$

2.7. Modelo Escalar Eléctricamente Cargado.

$$\mathfrak{I}[\mathfrak{g}_{\mu\nu}, \Lambda_\mu\phi] = \frac{1}{16\pi\mathfrak{G}_{\mathrm{N}} \int d^4\chi\sqrt{-g}\left[\mathfrak{R} - \frac{1}{4e^{\gamma\phi}\mathrm{F}^2} - \frac{1}{2\partial_\mu\phi\,\partial^\mu\phi} - \mathcal{V}(\phi)\right]}, \nabla_\mu\left(e^{\gamma\phi}\mathrm{F}^{\mu\nu}\right)$$

$$= \frac{1}{\sqrt{-g}\partial_\mu\left(\sqrt{-g}g^{\mu\nu}\partial_\nu\phi\right)} - \frac{\partial\mathcal{V}}{\partial\phi} - \frac{1}{4\gamma e^{\gamma\phi}\mathrm{F}^2}, \mathcal{R}_{\mu\nu} - \frac{1}{2g_{\mu\nu}\mathcal{R}} = \frac{1}{2\left[\mathcal{T}^{\phi}_{\mu\nu}\mathcal{T}^{\mathfrak{EM}}_{\mu\nu}\right]}, \mathcal{T}^{\phi}_{\mu\nu}$$

$$= \partial_\mu\phi\partial_\nu\phi - \mathfrak{g}_{\mu\nu}\left[\frac{1}{2(\partial\phi)^2} + \mathcal{V}(\phi)\right], \mathcal{T}^{\mathfrak{EM}}_{\mu\nu} = e^{\gamma\phi}\left(\mathrm{F}_{\mu\alpha}\mathrm{F}^{\alpha}_{\nu} - \frac{1}{4\mathfrak{g}_{\mu\nu}\mathrm{F}^2}\right)$$

2.8. Modelo Holográfico en espacios cuánticos curvos.

$$\mathcal{J}_g = -\frac{1}{8\pi\mathfrak{G}_{\mathrm{N}} \oint_{\partial\mathcal{M}}^{\lambda} d^3\chi\mathfrak{K}\sqrt{-\hbar}\,\Xi(\ell,\mathcal{R},\nabla\mathfrak{R})}, ds^2$$

$$= -\left(\kappa + \frac{r^2}{\ell^2}\right)dt^2 + \left(\kappa + \frac{r^2}{\ell^2}\right)^{-1} dr^2 + r^2\, d\Sigma_\kappa^2 \hbar_{\alpha\beta} d\chi^\alpha d\chi^\beta$$

$$= -\left(\kappa + \frac{\mathcal{R}^2}{\ell^2}\right)dt^2 + \mathcal{R}^2 d\Sigma_\kappa^2, ds^2 = \frac{r_\beta^2}{\ell^2(-dt^2 + \ell^2 d\Sigma_\kappa^2)}, ds^2$$

$$= -\left(1 - \frac{\mu}{r} + \frac{r^2}{\ell^2}\right)dt^2 + \left(1 - \frac{\mu}{r} + \frac{r^2}{\ell^2}\right)^{-1} dr^2 + r^2(d\theta^2 + \sin^2\theta d\varphi^2), \mathfrak{T} = \frac{f'}{|4\pi_{r+}}$$

$$= \beta^{-1} = \frac{1}{4\pi\left(3r_+^2 + \frac{\ell^2}{\ell_{r_+}^2}\right)}, \mathcal{J}_{\mathfrak{BULK}}^{\mathfrak{E}} = \frac{12\pi\beta}{\kappa\ell^2 \int_{r_+}^{\mathcal{R}} r^2 dr = \frac{4\pi\beta}{\kappa\ell^2(\mathcal{R}^3 - r_+^3)}}, \hbar_{\alpha\beta} d\chi^\alpha d\chi^\beta$$

$$= -\left(1 - \frac{\mu}{\mathcal{R}} + \frac{\mathcal{R}^2}{\ell^2}\right)dt^2 + \mathcal{R}^2(d\theta^2 + \sin^2\theta d\varphi^2), \eta_\alpha = \frac{\delta_\alpha^r}{\sqrt{g^{rr}}}, \kappa_{\alpha\beta} = \frac{\sqrt{g^{rr}}}{2\partial_r \hbar_{\alpha\beta}}, \mathfrak{K}$$

$$= \frac{1}{\mathcal{R}^2\ell^2\left(1 - \frac{\mu}{\mathcal{R}} + \frac{\mathcal{R}^2}{\ell^2}\right)^{-\frac{1}{2}}\left(-\frac{3\ell^2\mu}{2} + 3\mathcal{R}^2 + 2\mathcal{R}\ell^2\right)}, \mathcal{J}_{\mathfrak{GH}}^{\mathfrak{E}}$$

$$= \frac{4\pi\beta}{\kappa\ell^2\left(-\frac{3\ell^2\mu}{2} + 3\mathcal{R}^2 + 2\mathcal{R}\ell^2\right)}, \mathcal{J}_{\mathfrak{GH}}^{\mathfrak{E}} = \mathcal{J}_{\mathfrak{BULK}}^{\mathfrak{E}} + \mathcal{J}_{\mathfrak{GH}}^{\mathfrak{E}}$$

$$= \frac{4\pi\beta}{\kappa\ell^2\left(-\frac{3\ell^2\mu}{2} + 2\mathcal{R}^2 + 2\mathcal{R}\ell^2 - r_+^3\right)}, ds^2$$

$$= -\left(1 + \frac{r^2}{\ell^2}\right)dt^2 + \left(1 + \frac{r^2}{\ell^2}\right)^{-1} dr^2 + r^2(d\theta^2 + \sin^2\theta d\varphi^2), \mathcal{J}_{\mathfrak{AdS}}^{\mathfrak{E}} = \mathcal{J}_{\mathfrak{BULK}}^{\mathfrak{E}} + \mathcal{J}_{\mathfrak{GH}}^{\mathfrak{E}}$$

$$= \frac{4\pi\beta_0}{\kappa\ell^2(-2\mathcal{R}^3 + 2\mathcal{R}\ell^2)}, \beta_0\sqrt{1 + \frac{\mathcal{R}^2}{\ell^2}} = \beta\sqrt{1 + \frac{\mathcal{R}^2}{\ell^2} - \frac{\mu}{\mathfrak{R}}}, \mathcal{J}^{\mathfrak{E}} = \mathcal{J}_{\mathfrak{GH}}^{\mathfrak{E}} - \mathcal{J}_{\mathfrak{AdS}}^{\mathfrak{E}}$$

$$= \frac{4\pi\beta}{\kappa\ell^2\left[\left(\frac{3\ell^2\mu}{2} - 2\mathcal{R}^3 - 2\mathcal{R}\ell^2 - r_+^3\right) - \frac{\beta_0}{\beta(-2\mathcal{R}^3 - 2\ell^2\mathfrak{R})}\right]}, \mathrm{F} = \beta^{-1}\mathcal{J}^{\mathfrak{E}}$$

$$= 4\pi/\kappa\ell^2\left(\frac{\ell^2\mu}{2} - r_+^3\right)$$

$$\mathcal{I}_g = -\frac{1}{\kappa \int_{\partial\mathcal{M}}^{\infty} d^3\chi\sqrt{-\hbar}\left(\frac{2}{\ell}+\frac{\mathcal{L}\mathcal{R}}{2}\right), \mathcal{I}^{\mathfrak{E}}_{\mathfrak{BULK}}} + \mathcal{I}^{\mathfrak{E}}_{\mathfrak{GH}} = \frac{4\pi\beta}{\kappa\ell^2\left(\frac{3\ell^2\mu}{2} - 2r_\beta^3 - 2r_\beta\ell^2 - r_+^3\right)}, \mathcal{I}^{\mathfrak{E}}_{g}$$

$$= \frac{4\pi\beta}{\kappa\ell^2\left(1+\frac{\ell^2}{\mathcal{R}^2}-\frac{\mu\ell^2}{\mathcal{R}^3}\right)^{\frac{1}{2}} |(2\mathcal{R}^3+\kappa\ell^2\mathcal{R})|_{\mathcal{R}=r_\beta}} = \frac{4\pi\beta}{\kappa\ell^2(2r_\beta^3 - 2\ell^2 r_\beta - \mu\ell^2)}, \mathcal{I}^{\mathfrak{E}}$$

$$= \mathcal{I}^{\mathfrak{E}}_{\mathfrak{BULK}} + \mathcal{I}^{\mathfrak{E}}_{\mathfrak{GH}} + \mathcal{I}^{\mathfrak{E}}_{g} = \frac{4\pi\beta}{\kappa\ell^2\left(\frac{\ell^2\mu}{2} - r_+^3\right)}, \mathcal{E} = -\frac{\mathfrak{I}^2\partial\mathcal{I}^{\mathfrak{E}}}{\partial\mathcal{T}} = \frac{\mu}{2\mathfrak{G}}, \mathrm{F}_{\mathcal{S}\mathfrak{AdS}}$$

$$= \frac{4\pi}{\kappa\ell^2\left(\frac{\ell^2\mu}{2} - r_+^3\right)}, \mathcal{T}_{\mathcal{S}\mathfrak{AdS}} = \left(1+\frac{3r_+^2}{\ell^2}\right)$$

2.8.1. Modelo de Brown-York.

$$\int_{\partial\mathcal{M}}^{\delta} d^3\chi\hbar^{\alpha\beta}\mathcal{T}_{\alpha\beta}, ds^2 = \hbar_{\alpha\beta}\, d\chi^\alpha d\chi^\beta = -\mathrm{N}(\mathcal{R})dt^2 + \delta(\mathcal{R})d\Sigma_\kappa^2, \tau^{\alpha\beta} \equiv \frac{\frac{2}{\sqrt{-\hbar}\delta\mathcal{I}}}{\delta\hbar_{\alpha\beta}}, ds^2$$

$$= -\left(1-\frac{\mu}{r}+\frac{r^2}{\ell^2}\right)dt^2 + \left(1-\frac{\mu}{r}+\frac{r^2}{\ell^2}\right)^{-1} dr^2 + r^2 d\Omega^2, ds^2$$

$$= -\left(1-\frac{\mu}{\mathcal{R}}+\frac{\mathcal{R}^2}{\ell^2}\right)dt^2 + \mathcal{R}^2 d\Omega^2, \mathcal{I}$$

$$= \frac{1}{2\kappa\int_{\partial\mathcal{M}}^{\delta} d^4\chi\sqrt{-g}\,(\mathfrak{R}-2\Lambda)} + \frac{1}{\kappa\int_{\partial\mathcal{M}}^{\delta} d^3\chi\sqrt{-\hbar}\,\mathfrak{K}} - \frac{1}{\kappa\int_{\partial\mathcal{M}}^{\delta} d^3\chi\sqrt{-\hbar}\left(\frac{2}{\ell}+\frac{\mathcal{L}\mathcal{R}}{2}\right)}, \tau^{\alpha\beta}$$

$$= \frac{1}{8\pi\mathfrak{G}\left(\mathfrak{K}_{\alpha\beta} - \hbar_{\alpha\beta}\mathfrak{K} - \frac{2}{\ell\hbar_{\alpha\beta}} + \mathcal{I}\mathfrak{S}_{\alpha\beta}\right)}, ds^2_{borde} = \frac{\mathfrak{R}^2}{\ell^2(-dt^2+\ell^2 d\Omega^2)}, ds^2_{dualidad}$$

$$= \gamma_{\alpha\beta}d\chi^\alpha d\chi^\beta = -dt^2 + \ell^2 d\Omega^2, \langle\tau^{\alpha\beta}_{dualidad}\rangle = \lim_{\mathcal{R}\to\infty}\frac{\mathcal{R}}{\ell}\tau_{\alpha\beta}$$

$$= \mu/16\pi\mathfrak{G}\ell^2(3\delta^0_\alpha\delta^0_\beta + \gamma_{\alpha\beta})$$

2.9. Modelo Hamiltoniano.

$$\mathfrak{I}[\mathfrak{g}_{\mu\nu},\Lambda_\mu\phi] = \int_{\partial\mathcal{M}}^{\delta} d^4\chi\sqrt{-g}\left[\frac{\mathcal{R}}{2\kappa} - \frac{1}{2(\partial\phi)^2} - \mathcal{V}(\phi)\right] + \frac{1}{\kappa\int_{\partial\mathcal{M}}^{\delta} d^3\chi\mathfrak{K}\sqrt{-\hbar}}, \mathcal{H}_\perp$$

$$= \frac{2\kappa}{\sqrt{g}\left[\pi^{ij}\pi_{ij} - \frac{1}{2\left(\pi_j^i\right)^2}\right]} - \frac{1}{2\kappa\sqrt{g}^{(3)}\mathcal{R}} + \frac{1}{2\left(\frac{\pi_{\phi^2}}{\sqrt{g}} + \sqrt{g}g^{ij}\phi_i\phi_j\right)} + \sqrt{g}\mathcal{V}(\phi), \mathcal{H}_i$$

$$= -\pi_j^i\big|_j + \pi_\varphi\phi_\psi d\omega, ds^2 = (\mathrm{N}^\perp)^2 dt^2 + g_{ij}\left(d\chi^i + \mathrm{N}^i dt\right)\left(d\chi^j + \mathrm{N}^j dt\right), \mathcal{H}[\xi]$$

$$= \int_{\partial\mathcal{M}}^{\delta} d^3\chi\left(\xi^\perp\mathcal{H}_\perp + \xi^i\mathcal{H}_i\right) + \mathfrak{Q}[\xi], \delta\mathfrak{Q}[\xi]$$

$$= \oint d^2\delta_\ell\left[\frac{\mathfrak{G}^{ijkl}}{2\kappa}\left(\xi^\perp\delta g_{ij}\big|_\kappa - \xi_\kappa^\perp\delta g_{ij}\right) + 2\xi_\kappa\delta\pi^{\kappa\ell} + \left(2\xi^\kappa\pi^{j\ell} - \xi^\ell\pi^{j\kappa}\right)\delta g_{j\kappa}\right.$$

$$\left. - \left(\sqrt{g\xi^\perp}g^{\ell j}\phi_j + \xi^\ell\pi_\phi\right)\delta\phi\right], \mathfrak{G}^{ijkl} \equiv \frac{1}{2\sqrt{g}(g^{i\kappa}g^{j\ell} + g^{i\ell}g^{j\kappa} - 2g^{ij}g^{\kappa\ell})}$$

$$\delta\mathcal{M} \equiv \delta\mathfrak{Q}[\partial_t] = \oint d^2\delta_\ell\left[\frac{\mathfrak{G}^{ijkl}}{2\kappa}\left(\xi^\perp\delta g_{ij}\big|_\kappa - \xi_\kappa^\perp\delta g_{ij}\right) - \sqrt{g}\xi^\perp g^{\ell j}\phi_j\delta\phi\right], \delta\mathcal{M} = \delta\mathcal{M}_{\mathfrak{G}} + \delta\mathcal{M}_\phi, \delta\mathcal{M}_{\mathfrak{G}}$$

$$= \oint d^2\delta_\ell\frac{\mathfrak{G}^{ijkl}}{2\kappa}\left(\xi^\perp\delta g_{ij}\big|_\kappa - \xi_\kappa^\perp\delta g_{ij}\right), \delta\mathcal{M}_\phi = -\oint d^2\delta_\ell\sqrt{g}\xi^\perp g^{\ell j}\phi_j\delta\phi$$

2.10. Termodinámica de agujeros negros cuánticos en espacios curvos.

2.10.1. Espacio – Tiempo de Rindler.

$$ds^2 = -dt^2 + d\chi^2 + d\gamma^2 + d\mathfrak{z}^2, ds^2 = -\alpha^2\rho^2 d\tau^2 + d\rho^2 + d\gamma^2 + d\mathfrak{z}^2, ds^2$$

$$= \mathrm{N}(r)dt_{\mathfrak{E}}^2 + \mathcal{H}(r)dr^2 + \delta(r)d\Sigma_\kappa^2, ds^2 = \frac{g_{rr}4\mathrm{N}}{[(\mathrm{N})']^2\left[\frac{\rho^2[(\mathrm{N})']^2}{4\mathrm{N}g_{rr}d\tau_{\mathfrak{E}}^2} + d\rho^2\right]\mathcal{T}} = \frac{1}{\beta}$$

$$= \frac{[(\mathrm{N})']^2}{4\pi\sqrt{\mathrm{N}^2 g_{rr}}\big|_{\mathrm{H}}\mathcal{T}_{\delta c\hbar-\mathfrak{A}\mathfrak{d}\delta}} = \frac{1}{4\pi r_+\left(1 + \frac{3r_+^2}{\ell^2}\right)\mathcal{T}_{\Re\eta-\mathfrak{A}\mathfrak{d}\delta}} = \frac{1}{4\pi r_+\left(1 + \frac{3r_+^2}{\ell^2} - \frac{q^2}{4r_+^2}\right)}, ds^2$$

$$= \Omega(x)\left[-f(x)dt^2 + \frac{\eta^2 d\chi^2}{f(x)} + d\theta^2 + d\Sigma_\kappa^2\right], f(x)$$

$$= \frac{1}{\ell^2} + \alpha\left[\frac{1}{\nu^2} - 4 - \frac{\chi^2}{\nu^2\left(1 + \frac{\chi^{-\nu}}{\nu} - 2 - \frac{\chi^\nu}{\nu} + 2\right)}\right] + \frac{\kappa\chi}{\Omega(x)}, f'\Omega(x)$$

$$= \frac{\alpha}{\eta^2} + 2\kappa + \kappa\nu\,\chi^\nu + \frac{1}{\chi^\nu} - 1, \mathcal{T} = \frac{f'}{4\pi\eta}\bigg|_{\chi_\hbar}$$

$$= \frac{\frac{1}{f'}}{4\pi\eta\Omega(\chi_\hbar)\left(\frac{\alpha}{\eta^2} + 2\kappa + \kappa\nu\,\chi_\hbar^\nu + \frac{1}{\chi_\hbar^\nu} - 1\right)}$$

2.10.2. Transiciones de fase de agujeros negros cuánticos en espacios curvos.

$$ds^2 = \Omega(x)\left(-f(x)dt^2 + \frac{\eta^2 d\chi^2}{f(x)} + d\theta^2 + sin^2\theta d\varphi^2\right), \Omega(x) = \frac{1}{\eta^2(\chi-1)^2}, f(x)$$

$$= \frac{1}{\ell^2} + \frac{1}{3\alpha(\chi-1)^3} + \eta^2\chi(\chi-1)^2, \chi = 1 + \frac{1}{\eta r}, \chi = 1 - \frac{1}{\eta r}, \Omega(x)f(x) = \mathrm{F}(r)$$

$$= 1 - \frac{\mu}{r} + \frac{r^2}{\ell^2}, \mu = \alpha + \frac{3\eta^2}{3\eta^3}, \mathcal{I}[g_{\mu\nu}]$$

$$= \mathcal{I}_{bulk} + \mathcal{I}_{GH}$$

$$- \frac{1}{\kappa \int_{\partial\mathcal{M}}^{\delta} d^3\chi\sqrt{-\hbar}\left(\frac{2}{\ell} + \frac{\mathcal{R}\ell}{2}\right), \mathcal{E}_t^t - \mathcal{E}_{\langle\tau|\sigma|\rho\rangle}^{\langle\varphi|\chi|\psi\rangle} = 0 \Longrightarrow 0 = f'' + \frac{\Omega' f'}{\Psi} + 2\eta^2, \mathcal{E}_t^t}$$

$$+ \mathcal{E}_{\langle\tau|\sigma|\rho\rangle}^{\langle\varphi|\chi|\psi\rangle} = 0 \Longrightarrow 2\kappa\mathcal{V}(\phi) = -\frac{(f\Omega'' + f'\Omega')}{\Psi^4\eta^4} + \frac{2}{\Omega}, \mathcal{I}_{bulk}^{\mathfrak{E}}$$

$$= \frac{4\pi\beta}{\eta^3\kappa\ell^2\left[-\frac{1}{(\chi_\beta-1)^3} + \frac{1}{(\chi_\hbar-1)^3}\right]} = \frac{4\pi\beta}{\kappa\ell^2(r_\beta^3 - r_\hbar^3)}, ds^2 = \hbar_{\alpha\beta}d\chi^\alpha d\chi^\beta$$

$$= \Omega(x)[-f(x)dt^2 + d\theta^2 + sin^2\theta d\varphi^2], \eta_\alpha = \frac{\delta_\alpha^\chi}{\sqrt{g^{\chi\chi}\partial_\chi\hbar_{\alpha\beta}}}, \mathcal{I}_{\mathrm{GH}}^{\mathfrak{E}}$$

$$= -\frac{2\pi\beta}{\kappa\left[-\frac{6}{\ell^2\eta^4(\chi-1)^3} - \frac{4}{\eta(\chi_\beta-1)} - \left(\alpha + \frac{3\eta^4}{\eta^3}\right)\right]\Big|_{\chi_\beta}} = -\frac{2\pi\beta}{\kappa\left(\frac{6r_\beta^3}{\ell^2} + 4r_\beta - 3\mu\right)}, \mathcal{I}_g^{\mathfrak{E}}$$

$$= \frac{2\pi\beta}{\kappa\left[\frac{4}{\ell^2\eta^4(\chi_\beta-1)^3} + \frac{4}{\eta(\chi_\beta-1)} - 2\mu\right]} = 2\pi\beta/\kappa\left(\frac{4r_\beta^3}{\ell^2} + 4r_\beta - 2\mu\right)$$

$$\mathcal{I}^{\mathfrak{E}} = \mathcal{I}^{\mathfrak{E}}_{bulk} + \mathcal{I}^{\mathfrak{E}}_{GH} + \mathcal{I}^{\mathfrak{E}}_{g} = \frac{4\pi\beta}{\kappa\ell^2\left[\frac{1}{\eta^3(\chi_\hbar - 1)^3} + \frac{\mu\ell^2}{2}\right]} = \frac{4\pi\beta}{\kappa\ell^2\left(-r_\hbar^3 + \frac{\mu\ell^2}{2}\right)}, \mathcal{I}^{\mathfrak{E}}_{\langle\varphi|\phi|\psi\rangle^{\langle\sigma|\tau|\rho\rangle}}$$

$$= \int_{\partial\mathcal{M}}^{\delta} d^3\chi^3\sqrt{\hbar^{\mathfrak{E}}}\left(\frac{\langle\varphi|\phi|\psi\rangle^{\langle\sigma|\tau|\rho\rangle}}{2\ell} - \ell_\nu/6\ell\langle\varphi|\phi|\psi\rangle^{\langle\sigma|\tau|\rho\rangle^4}\right)$$

$$= \frac{4\pi\beta}{\kappa\left[-\nu^2 - \frac{1}{4\ell^2\eta^3(\chi_\beta - 1)} + \nu^2 - \frac{1}{3\ell^2\eta^3}\right]}, \mathcal{I}^{\mathfrak{E}}_{bulk} + \mathcal{I}^{\mathfrak{E}}_{surf} + \mathcal{I}^{\mathfrak{E}}_{g}$$

$$= -\frac{1}{\mathcal{T}\left(\frac{\Lambda\Gamma}{4\mathfrak{G}}\right)} + \frac{4\pi\beta}{\kappa\left[\nu^2 - \frac{1}{4\ell^2\eta^3(\chi_\beta - 1)} + 12\eta^2\ell^2 + 4\alpha\ell^2 - 4\nu^2 + \frac{4}{12\ell^2\eta^3}\right]}, \mathcal{I}^{\mathfrak{E}}$$

$$= \beta\left(-\frac{\Lambda\Gamma}{4\mathfrak{G}} + \frac{4\pi}{\kappa}3\eta^2 + \frac{\alpha}{3\eta^3}\right), \mathcal{M} = \frac{1}{2\mathfrak{G}\left(\alpha + \frac{3\eta^2}{3\eta^3}\right)}, \mathcal{T}$$

$$= \frac{\left.\frac{f'(x)}{4\pi\eta}\right|_{\chi=\chi_\hbar} 1}{4\pi\eta\Omega(\chi_\hbar)\left[\frac{\alpha}{\eta^2} + 2 + \nu\chi_\hbar^\nu + 1\frac{\chi^\nu}{\chi_\hbar} - 1\right]}, \delta = \frac{\mathrm{A}}{4G} = 4\pi\eta\Omega(\chi_\hbar)/4G$$

$$\frac{\frac{\partial\mathcal{M}}{\partial\eta}d\eta}{d\chi_\hbar} = \mathcal{T}\left(\frac{\partial\mathcal{S}}{\partial\chi_\hbar} + \frac{\frac{\partial\mathcal{S}}{\partial\eta}d\eta}{d\chi_\hbar}\right), \mathcal{M} = -\frac{1}{2G\left(\alpha + \frac{3\eta^2}{3\eta^3}\right)}, \mathcal{T} = \frac{1}{4\pi\eta\Omega(\chi_\hbar)\left[\frac{\alpha}{\eta^2} + 2 + \nu\chi_\hbar^\nu + \frac{1}{\chi_\hbar^\nu} - 1\right]}$$

2.10.3. Solitón - AdS para agujeros negros cuánticos en espacios curvos.

$$\mathcal{I}[g_{\mu\nu}] = \int_{\mathcal{M}}^{\delta} d^4\chi(\mathcal{R} - 2\Lambda)\sqrt{-g} + 2\int_{\partial\mathcal{M}}^{\delta} d^3\chi\mathfrak{K}\sqrt{-\hbar} - \int_{\partial\mathcal{M}}^{\delta}\frac{d^3\chi 4}{\ell\sqrt{-\hbar}}, ds^2$$

$$= -\left(-\frac{\mu_\beta}{r} + \frac{r^2}{\ell^2}\right)dt^2 + \left(-\frac{\mu_\beta}{r} + \frac{r^2}{\ell^2}\right)^{-1}dr^2 + \frac{r^2}{\ell^2}(d\chi_1^2 d_2^2\chi), \mathcal{I}_\beta^\xi$$

$$= \frac{2\mathcal{L}\mathcal{L}_\beta\beta_\varsigma}{\ell^4\left(-r_\hbar^3 + \frac{\mu_\beta\ell^2}{2}\right)} = -\frac{\mathcal{L}\mathcal{L}_\beta\beta_\varsigma r_\hbar^3}{\ell^4}, \mathfrak{I} = \beta_\varsigma^{-1} = \left.\frac{(-g_{tt})'}{4\pi}\right|_{r=r_\hbar} = \frac{3r_\hbar}{4\pi\ell^2}, \mathfrak{E} = -\frac{\mathfrak{T}^2\partial\mathcal{I}_\beta^{\mathfrak{E}}}{\partial\mathfrak{T}}$$

$$= \frac{2\mathcal{L}\mathcal{L}_\beta\mu_\beta}{\ell^4}, \mathfrak{S} = -\frac{\partial(\mathcal{I}_\beta^{\mathfrak{E}}\mathfrak{T})}{\mathfrak{T}} = \frac{\mathcal{L}\mathcal{L}_\beta r_\hbar^2}{4\ell^2\mathfrak{G}} = \mathcal{A}/4G$$

$$ds^2_{dualidad} = \frac{\ell^2}{\mathcal{R}^2} ds^2 = \gamma_{\alpha\beta} d\chi^\alpha d\chi^\beta = -dt^2 + d\chi_1^2 + d\chi_2^2, \langle \tau_{\alpha\beta}^{dualidad} \rangle$$

$$= \lim_{\mathcal{R}\to\infty} \frac{\mathcal{R}}{\ell} \tau_{\alpha\beta} = \frac{\mu_\beta}{16\pi \mathfrak{G}_N \ell^2} \left[3\delta_\alpha^0 \delta_\beta^0 + \gamma_{\alpha\beta}\right], \mathfrak{E} = \mathcal{Q}_{\xi t}$$

$$= \int d\Sigma^i \tau_{ij} \xi^j = \frac{\mathcal{L}\mathcal{L}_\beta}{\ell^2 \kappa} \left[\mu_\beta + \frac{\ell^2}{4\mathcal{R}} + \mathcal{O}(\mathcal{R}^{-2})\right], ds^2$$

$$= \frac{r^2}{\ell^2} d\tau^2 + \left(-\frac{\mu_\delta}{r} + \frac{r^2}{\ell^2}\right)^{-1} dr^2 + \left(-\frac{\mu_\delta}{r} + \frac{r^2}{\ell^2}\right) d\theta^2 + \frac{r^2}{\ell^2} d\chi_2^2 - \frac{\mu_\delta}{r} + \frac{r_\delta^2}{\ell^2}, \mathcal{L}_\delta$$

$$= \frac{4\varpi \sqrt{g_{\theta\theta} g_{rr}}}{(g_{\theta\theta})'}\Bigg|_{r=r_\delta} = \frac{4\pi\ell^2}{3r_\delta}, \mathcal{I}_\delta^\xi = \frac{\mathcal{L}\mathcal{L}_\delta \beta_\delta \mu_\delta}{\ell^2} \Delta\mathcal{I} = \mathcal{I}_\beta^\epsilon - \mathcal{I}_\delta^\varepsilon$$

$$= \frac{\mathcal{L}}{2\pi\kappa\ell^4} \left(\frac{4\pi\ell^2}{3}\right)^3 \mathcal{L}_\beta \beta_\varsigma \left(\mathcal{L}_\delta^{-3} - \xi\beta_\varsigma^{-3}\right) = \frac{\frac{\mathcal{L}}{2\kappa\ell^4}\left(\frac{4\pi\ell^2}{3}\right)^3 \mathcal{L}_\beta \beta_\varsigma \left(\frac{1}{\mathcal{L}_\delta^3} - \mathcal{T}^3\right)\mathcal{A}}{\mathcal{T}\ell^3}$$

$$= \mathcal{L}/\ell(4\pi/3)^2 \mathcal{L}_\delta \mathcal{T}$$

$$\mathcal{I}[g_{\mu\nu}, \phi] = \int_{\mathcal{M}}^{\delta} d^4\chi \sqrt{-g} \left[\mathcal{R} - \frac{(\partial\phi)^2}{2} - \mathcal{V}(\phi)\right] + 2\int_{\partial\mathcal{M}}^{\delta} d^3\chi \mathfrak{K} \sqrt{-\hbar}, \mathcal{V}(\phi)$$

$$= \frac{\Lambda(\nu^2 - 4)}{3\nu^2 \left[\nu - \frac{1}{\nu} + 1e^{-\phi\ell_\nu(\nu+1)} + \nu + \frac{1}{\nu} - 2e^{\phi\ell_\nu(\nu-1)} + 4\nu^2 - \frac{1}{\nu^2} - 4e^{\phi\ell_\nu}\right]}$$

$$+ \frac{2\alpha}{\nu^2 \left[\nu - \frac{1}{\nu} + 2\sin\hbar\, \phi\ell_\nu(\nu+1) - \nu + \frac{1}{\nu} - 2\sin\hbar\, \phi\ell_\nu(\nu-1) + 4\nu^2 - \frac{1}{\nu^2} - 4\sin\hbar\, \phi\ell_\nu\right]}$$

$$ds^2 = \frac{\mathfrak{R}^2}{\ell^2[-dt^2 + d\chi_1^2 + d\chi_2^2]\mathfrak{R}^2} \equiv \frac{1}{\eta^2(\chi - 1)^2}, ds^2_{dualidad} = \frac{\ell^2}{\mathfrak{R}^2} ds^2 = \gamma_{\alpha\beta} d\chi^\alpha d\chi^\beta$$

$$= -dt^2 + d\chi_1^2 + d\chi_2^2, \mathcal{I}_{\mathfrak{E}\mathfrak{H}}^\beta = \beta_\varsigma \left(-\frac{\mathcal{A}\mathcal{T}}{4\mathcal{G}_\mathcal{N}} + \frac{\frac{2\mathcal{L}\mathcal{L}_\beta}{\ell^2}\alpha}{3\eta^3}\right) = -\frac{\mathcal{L}\mathcal{L}_\beta \alpha \beta_\varsigma}{3\ell^2\eta^3}, \mathcal{A}$$

$$= \frac{\mathcal{L}\mathcal{L}_\beta \Omega(\chi_\hbar)}{\ell^2}, \mathfrak{T} = \frac{\alpha}{4\pi\eta^3\Omega}, \mathcal{M}_\beta = \frac{2\mathcal{L}\mathcal{L}_\beta \mu_\beta}{\ell^2}, \mu_\beta = \frac{\alpha}{3\eta^3}, ds^2$$

$$= \Psi_\delta(\gamma)\left[-\frac{d\tau^2}{\ell^2} + \frac{\lambda^2 d\chi^2}{f(x) d\theta^2} + \frac{d\chi_2^2}{\ell^2}\right] \Psi_\delta(\gamma) = \frac{9\gamma^2}{\lambda^2(\gamma^3 - 1)^2}, \mathcal{L}_\delta = \frac{4\pi\lambda}{f'}\Bigg|_{\gamma=\gamma_\delta}$$

$$= \frac{4\pi\lambda^3\gamma_\delta}{\alpha}$$

$$\mathfrak{I}^{\mathcal{E}}_{soliton} = -\frac{\mathcal{L}\beta_\delta\Omega_\delta(\chi_\delta)}{4\ell^2\mathfrak{G}_{\mathrm{N}}} + \frac{\frac{2\mathcal{L}\mathcal{L}_\delta\beta_\delta}{\ell^2}\alpha}{3\lambda^3} = -\frac{\mathcal{L}\mathcal{L}_\delta\beta_\delta}{\ell^2\left(\frac{\alpha}{3\lambda^3}\right)}, \mathrm{M}_{soliton} = -\frac{\mathcal{L}\mathcal{L}_\delta\mu_\delta}{\ell^2}, \mu_\delta = \frac{\alpha}{3\lambda^3}, \boldsymbol{\mathfrak{I}}^{\phi}$$

$$= -\int d^3\chi\sqrt{-\hbar}\left(\frac{\phi^2}{2\ell} - \frac{\ell_\nu}{6\ell\phi^3}\right)\tau^{\phi}_{\alpha\beta} = -\frac{\frac{2}{\sqrt{-\hbar}}\delta\boldsymbol{\mathfrak{I}}^{\phi}}{\delta\hbar^{\alpha\beta}}, \tau_{\alpha\beta}$$

$$= -\frac{1}{\kappa\left(\kappa_{\alpha\beta} - \hbar_{\alpha\beta}\kappa + \frac{2}{\ell}\hbar_{\alpha\beta} - \beth\mathbb{E}_{\alpha\beta}\right)} - \frac{\hbar_{\alpha\beta}}{\ell\left(\frac{\phi^2}{2} - \frac{\ell_\nu}{6}\phi^3\right)}, \tau_{tt}$$

$$= \frac{\alpha(\chi-1)}{3\lambda^2\ell} + \mathcal{O}[(\chi-1)^2], \tau_{\theta\theta} = \frac{2\alpha(\chi-1)}{3\lambda^2\ell} + \mathcal{O}[(\chi-1)^2], \tau_{\chi_2\chi_2}$$

$$= -\frac{\alpha(\chi-1)}{3\lambda^2\ell} + \mathcal{O}[(\chi-1)^2], ds^2_{dualidad} = \frac{\ell^2}{\mathcal{R}^2}ds^2$$

$$= -d\tau^2 + d\theta^2 + d\chi_2^2, \langle\tau^{dualidad}_{\alpha\beta}\rangle$$

$$= \lim_{\mathcal{R}\to\infty}[-1/\lambda\ell(\chi-1)]\tau_{\alpha\beta} = \frac{1}{\ell^2\left(\frac{\alpha}{3\lambda^3}\right)}[-3\delta^{\theta}_{\alpha}\delta^{\theta}_{\beta} + \gamma_{\alpha\beta}]$$

$$\mathcal{M} = \oint_{\Sigma}^{\eth} d^2\gamma\sqrt{\sigma}\, m^{\alpha}\tau_{\alpha\beta}\xi^{\beta} = \frac{\mathcal{L}\mathcal{L}_\delta f^{\frac{1}{2}}\Psi}{\sqrt{-g_{\tau\tau}}(\partial_\tau)^i\tau_{ij}(\partial_\tau)^j} = -\frac{\mathcal{L}\mathcal{L}_\delta}{\ell^2\left[\frac{\alpha}{3\lambda^3} + \mathcal{O}(\chi-1)\right]}, ds^2 = \sigma_{ij}d\chi^i d\chi^j$$

$$= \Omega(x)[f(x)d\theta^2 + d\chi_2^2/\ell^2]$$

$$r_\beta^2 = \frac{\Omega(\chi_\hbar,\eta)}{\ell^2}, r_\delta^2 = \frac{\Omega(\chi_\delta,\lambda)}{\ell^2}, \mathfrak{E} = \mathfrak{M}_{\beta\hbar} - \mathcal{M}_{soliton} = \frac{\mathcal{L}\mathcal{L}_\beta}{\ell^2}(2\mu_\beta + \mu_\delta), \Delta\Gamma = \beta_\varsigma^{-1}(\mathcal{J}^{\mathfrak{E}}_{\mathcal{BH}} - \mathfrak{I}^{\mathfrak{E}}_{soliton})$$

$$= \frac{\mathcal{T}\mathfrak{L}\alpha}{3\ell^2\left(\frac{\mathcal{L}_\delta\beta_\delta}{\lambda^3} - \frac{\mathcal{L}_\beta\beta_\varsigma}{\eta^3}\right)\Delta\Gamma} = \frac{4\pi\mathcal{L}\mathcal{L}_\delta}{3\ell^2\left[\frac{\Omega(\lambda,\chi_\delta)}{\mathcal{L}_\delta} - \mathrm{T}\Omega(\eta,\chi_\hbar)\right]}$$

$$= \frac{4\pi\mathcal{L}}{3\ell^2\Omega(\lambda,\chi_\delta)\left(1 - \frac{r_\beta^3}{r_\delta^3}\right)}, \frac{\mathcal{A}}{\mathcal{T}\ell^3} = \frac{\frac{\alpha\mathcal{L}}{4\pi\ell^5}\beta_\varsigma^2\mathcal{L}_\delta}{\eta^3} = \frac{\mathfrak{L}\mathcal{L}}{\ell}\left(\frac{\lambda}{\eta}\right), \mathcal{L}$$

$$= \frac{16\pi^2}{\alpha^2\ell^4}\left[\frac{9\chi_\hbar^2}{\left(\chi_\hbar^3 - 1\right)^2}\right]^4, \frac{\mathcal{A}}{\mathcal{T}\ell^3} = \frac{\mathfrak{L}\mathcal{L}(\alpha,\ell)}{\ell}r_\beta/r_\delta$$

2.11. Modelo Computacional de un agujero negro cuántico en espacios curvos.

$$\delta = \mathfrak{N} \int dt\mathcal{T}r\left(\frac{1}{2\sum_{\mathcal{J}}(\mathcal{D}_t\chi_\iota)^2 - \frac{m^2}{2}\sum_\iota \chi_\iota^2 + \frac{\lambda}{4}\sum_{\iota\neq\mathcal{J}}[\chi_\iota\chi_\mathcal{J}]^2}\right), \delta$$

$$= \mathfrak{N} \int_0^\beta dt\mathcal{T}r\left(\frac{1}{2(\mathcal{D}_t\chi_\iota)^2 + \frac{m^2}{2}\chi_\iota^2 - \frac{\lambda}{4}[\chi_\iota\chi_\mathcal{J}]^2}\right)$$

$$\delta = \int dt\mathcal{T}r\left(\frac{1}{2}(\mathcal{D}_t\chi_\iota)^2 - \frac{m^2}{2}\chi_\iota^2 + \frac{g^2}{4}[\chi_\iota\chi_\mathcal{J}]^2\right), \delta_\varkappa$$

$$= \mathbb{N}_\alpha \sum_{t=1}^{\eta_t} \mathcal{T}r\left(\frac{1}{2(\mathcal{D}_t\chi_\iota)_{\iota,t}^2 + \frac{m^2}{2}\chi_{\iota,t}^2 - \frac{\lambda}{4}[\chi_{\iota,t}\chi_{\mathcal{J},t}]^2}\right), (\mathcal{D}_t\chi_\iota)_{\iota,t}$$

$$= \frac{1}{\alpha\left(-\frac{1}{2}\mathfrak{U}_t\mathfrak{U}_{t+\alpha}\chi_{\iota,t+2\alpha}\mathfrak{U}_{t+\alpha}^\dagger\mathfrak{U}_t^\dagger + 2\mathfrak{U}_t\chi_{\iota,t+\alpha}\mathfrak{U}_t^\dagger - \frac{3}{2}\chi_{\iota,t}\right)}, \langle f\rangle$$

$$\equiv \int \frac{d\chi d\mathfrak{U} f(\chi,\mathcal{U})e^{-\delta_\varkappa(\chi,\mathcal{U})}}{\int d\chi d\mathfrak{U}\, e^{-\delta_\varkappa(\chi,\mathcal{U})}} = \lim_{\mathfrak{K}\to\infty}\frac{1}{\kappa}\sum_{\kappa=1}^{\mathfrak{K}} f\left(\chi^{(\kappa)}\mathfrak{U}^{(\kappa)}\right), \langle\kappa\rangle = \langle\frac{1}{2}\sum_\iota \frac{\chi_\iota\partial\mathcal{V}}{\partial\chi_\iota}\rangle, \mathcal{E}$$

$$= \langle\frac{1}{\beta}\int_0^\beta dt\left(\mathcal{V} + \frac{1}{2}\sum_\iota\frac{\chi_\iota\partial\mathcal{V}}{\partial\chi_\iota}\right)\rangle$$

$$= \frac{\mathrm{N}}{\beta\int_0^\beta dt\left(m^2\chi_\iota^2 - \frac{3\lambda}{4}[\chi_\iota,\chi_j]^2\right), \mathcal{E}_\boxplus = \langle\frac{\mathcal{N}}{\eta_t\sum_{t=1}^{\eta_t}\left(m^2\chi_{\iota,t}^2 - \frac{3\lambda}{4}[\chi_{\iota,t},\chi_{j,t}]^2\right)}\rangle}, \mathcal{F}(\mathcal{T},\eta_t)$$

$$= \xi + \sum_{\iota=1}^{\eta\rho}\alpha_\iota\left(\frac{1}{\mathcal{T}\eta_t}\right), \mathcal{F}(\mathcal{T},\eta_t) = \xi(\mathfrak{T}) + \sum_\iota^{\eta\rho}\alpha_\iota\left(\frac{1}{\eta_t}\right)^\iota$$

$$\widehat{\mathcal{H}} = \mathcal{T}r\left(\frac{1}{2}\widehat{\wp}_\iota^2 + \frac{m^2}{2}\hat{\chi}_\iota^2 - \frac{g^2}{4}\left[\hat{\chi}_\iota\hat{\chi}_\mathcal{J}\right]^2\right), \widehat{\wp}_\iota = \sum_{\alpha=1}^{\mathrm{N}^2-1}\widehat{\wp}_\iota^\alpha\tau_\alpha, \hat{\chi}_\iota = \sum_{\alpha=1}^{\mathrm{N}^2-1}\hat{\chi}_\iota^\alpha\tau_\alpha, \left[\hat{\chi}_{\iota_\alpha}\hat{\chi}_{\mathcal{J}_\beta}\right] = \iota\delta_{\mathcal{J}\mathcal{J}}\delta_{\alpha\beta}, \widehat{\mathcal{H}}$$

$$= \mathcal{T}r\left(\frac{1}{2}\widehat{\wp}_\iota^2 - \frac{g^2}{4}\left[\hat{\chi}_\iota\hat{\chi}_\mathcal{J}\right]^2 + \frac{g}{2}\hat{\bar{\psi}}\gamma^\iota\left[\hat{\chi}_\iota\hat{\psi}\right] - \frac{3\iota\mu}{4}\hat{\bar{\psi}}\hat{\psi} + \frac{\mu^2}{2}\hat{\chi}_\iota^2\right) - (\mathrm{N}^2-1)\mu$$

$$= \mathcal{T}r\left(\frac{1}{2}\widehat{\wp}_\iota^2 - \frac{g^2}{4}[\hat{\chi}_1\hat{\chi}_2]^2 + \frac{g}{2}\xi[-\hat{\chi}_1 - \iota\hat{\chi}_2\xi] + \frac{g}{2}\hat{\xi}^\dagger[-\hat{\chi}_1 - \iota\hat{\chi}_2\hat{\xi}^\dagger] + \frac{3\mu}{2}\hat{\xi}^\dagger\hat{\xi}\right.$$

$$\left. + \frac{\mu^2}{2}\hat{\chi}_\iota^2\right) - (\mathrm{N}^2-1)\mu, \widehat{\mathcal{H}}$$

$$= \mathcal{T}r\left(\widehat{\wp_Z}\widehat{\wp}_Z^\dagger + \frac{g^2}{4}\left[\widehat{\mathcal{Z}_\wp}\hat{\mathcal{Z}}_\wp^\dagger\right]^2 - \frac{g}{\sqrt{2}\hat{\xi}\left[\hat{\mathcal{Z}}_\wp^\dagger\hat{\xi}\right]} - \frac{g}{\sqrt{2}\hat{\xi}^\dagger\left[\hat{\mathcal{Z}}\hat{\xi}^\dagger\right]} + \frac{3\mu}{2}\hat{\xi}^\dagger\hat{\xi} + \mu^2\hat{\mathcal{Z}}\hat{\mathcal{Z}}^\dagger\right), \widehat{\mathcal{H}}$$

$$= \sum_{\alpha,\iota}\left(\frac{1}{2\widehat{\wp}_{\iota\alpha}^2} + \frac{m^2}{2}\hat{\chi}_{\iota\alpha}^2\right) + \frac{g^2}{4}\sum_{\gamma,\mathcal{J},\mathcal{J}}\langle\sum_{\alpha,\beta}f_{\alpha\beta\gamma}\hat{\chi}_\mathcal{J}^\alpha\hat{\chi}_\mathcal{J}^\beta\rangle^2, \widehat{\mathcal{H}}$$

$$= m\sum_{\alpha,\iota}\left(\widehat{\eta_{\iota\alpha}} + \frac{1}{2}\right) + \frac{g^2}{16m^2}\sum_{\gamma,\mathcal{J},\mathcal{J}}\left(\sum_{\alpha,\beta}f_{\alpha\beta\gamma}\left(\hat{\alpha}_{\iota\alpha} + \hat{\alpha}_{\iota\alpha}^\dagger\right)\left(\hat{\alpha}_{j\beta} + \hat{\alpha}_{j\beta}^\dagger\right)\right)^2, [\widehat{\mathcal{H}}, \mathfrak{G}_\alpha], \widehat{\mathcal{H}}'$$

$$= \widehat{\mathcal{H}} + c\sum_\alpha\mathfrak{G}_\alpha^2, \widehat{\mathcal{H}}$$

$$= \sum_\alpha\left(\frac{\widehat{\wp}_{1\alpha}^2}{2} + \frac{\widehat{\wp}_{2\alpha}^2}{2} + \mu^2\frac{\hat{\chi}_{1\alpha}^2}{2} + \mu^2\frac{\hat{\chi}_{2\alpha}^2}{2} + \frac{3\mu}{2}\hat{\xi}_\alpha^\dagger\hat{\xi}_\alpha\right)$$

$$+ g^2\sum_{\alpha\neq\beta}\hat{\chi}_{1\alpha}^2\hat{\chi}_{2\beta}^2$$

$$- 2g^2\sum_{\alpha<\beta}\hat{\chi}_{1\alpha}\hat{\chi}_{1\beta}\hat{\chi}_{2\alpha}\hat{\chi}_{2\beta} + \frac{\iota g}{\sqrt{2}}\sum_{\alpha\beta\gamma}\epsilon_{\alpha\beta\gamma}\left[(-\hat{\chi}_{1\alpha} - \iota\hat{\chi}_{2\alpha})\hat{\xi}_\beta^\dagger\hat{\xi}_\gamma^\dagger\right.$$

$$\left. + (-\hat{\chi}_{1\alpha} + \iota\hat{\chi}_{2\alpha})\hat{\xi}_\beta\hat{\xi}_\gamma\right] - 3\mu$$

$$\widehat{\mathcal{H}}' = \widehat{\mathcal{H}} + c\sum_\alpha\mathfrak{G}_\alpha^2 + c'^{(\mathfrak{M}-\mathfrak{J})^2}, \mathfrak{E}_0 \leq \mathfrak{E}_\lambda = \frac{\langle\psi(\theta_\iota)|\mathcal{H}|\psi(\theta_\iota)\rangle}{\langle\psi(\theta_\iota)|\psi(\theta_\iota)\rangle}, \mathfrak{E}_0 \equiv \langle\psi_\theta|\widehat{\mathcal{H}}|\psi_\theta\rangle$$

$$= \int d\chi|\psi_\theta(\chi)|^2 \cdot \frac{\langle\chi|\widehat{\mathcal{H}}|\psi_\theta\rangle}{\psi_\theta(\chi)} = \mathbb{E}_{\chi\sim|\psi_\theta|^2}[\epsilon_\theta(\chi)], \nabla_\theta\mathfrak{E}_0$$

$$= \mathbb{E}_{\chi\sim|\psi_\theta|^2}\left[\nabla_{\theta\epsilon_\theta}(\chi)\right] + \mathbb{E}_{\chi\sim|\psi_\theta|^2} \times [\epsilon_\theta(\chi)\nabla_\theta\ln|\psi_\theta|^2], \theta' = \theta - \beta\nabla_\theta\mathfrak{E}_0$$

$$\wp_\theta(\chi) = \rho(\chi_1; \mathrm{F}_\theta^0)\rho[\chi_1; \mathrm{F}_\theta^1(\chi_1)]\rho[\chi_3; \mathrm{F}_\theta^2(\chi_1, \chi_2)], \mathrm{F}_\theta^\iota$$

$$= \Lambda_\theta^{\iota,m} \odot \tan\hbar \odot \Lambda_\theta^{\iota,m-1} \odot \tan\hbar \odot \cdots \odot \Lambda_\theta^{\iota,2} \odot \tan\hbar \odot \Lambda_\theta^{\iota,1}, \Lambda_\theta^{\iota,\alpha}(\vec{\chi})$$

$$= \mathcal{M}_\theta^{\iota,\alpha}\vec{\chi} + \vec{\beta}_\theta^{\iota,\alpha}, \widehat{\mathcal{H}}'$$

$$= \widehat{\mathcal{H}}$$

$$+ c\sum_\alpha \widehat{\mathfrak{G}}_\alpha^2, \widehat{\wp}|\psi\rangle = \int d\mathcal{U}, \hat{\mathcal{U}}\left|\psi\rangle, \langle\hat{\mathcal{O}}\rangle_\varsigma = \frac{\langle\psi|\widehat{\wp}\hat{\mathcal{O}}|\psi\rangle}{\langle\psi|\hat{\mathcal{O}}|\psi\rangle}, \langle\psi|\widehat{\wp}\hat{\mathcal{O}}|\psi\rangle\right.$$

$$= \int d\chi\, \langle\psi|\widehat{\wp}|\psi\rangle\langle\psi|\hat{\mathcal{O}}|\psi\rangle = \int d\mathcal{U}d\chi\, \psi^{\circledast}(\mathcal{U}\chi\mathcal{U}^\dagger)\langle\chi|\hat{\mathcal{O}}|\psi\rangle$$

$$= \mathbb{E}_{\mathcal{U},\chi\sim\langle\psi\rangle^2}\left[\frac{\langle\chi|\hat{\mathcal{O}}|\psi\rangle}{\psi(\chi)}\psi^{\circledast}(\mathcal{U}\chi\mathcal{U}^\dagger)/\psi^{\circledast}(\chi)\right]$$

$$\mathfrak{R}_\gamma(\theta) = \exp\left(-\frac{\iota\theta}{2}\right) = \begin{pmatrix} \cos\frac{\theta}{2} & \cdots & -\sin\frac{\theta}{2} \\ \vdots & \ddots & \vdots \\ \sin\frac{\theta}{2} & \cdots & -\cos\frac{\theta}{2} \end{pmatrix}, \hat{\alpha}_\iota$$

$$= \hat{\mathcal{I}}_1 \otimes \cdots \otimes \hat{\mathcal{I}}_{\iota-1} \otimes \begin{bmatrix} 0 & \cdots & 1 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & 1 \end{bmatrix} \otimes \hat{\mathcal{I}}_{\iota+1} \bigotimes \cdots \otimes \hat{\mathcal{I}}_6, \hat{\alpha}_\iota$$

$$= \hat{\mathcal{I}}_1 \otimes \cdots \otimes \hat{\mathcal{I}}_{\iota-1} \otimes \left\|\left|\begin{matrix} 0 & 1 & 0 \\ 0 & \sqrt{2} & 1 \\ 1 & 0 & \sqrt{2} \end{matrix}\right|\right\| \otimes \hat{\mathcal{I}}_{\iota+1} \bigotimes \cdots \otimes \hat{\mathcal{I}}_6, c_1$$

$$= \hat{\mathcal{I}}_{64} \otimes \begin{pmatrix} 0 & \cdots & 1 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & 0 \end{pmatrix} \otimes \begin{pmatrix} 1 & \cdots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & 1 \end{pmatrix} \otimes \begin{pmatrix} 1 & \cdots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & 1 \end{pmatrix}, c_2$$

$$= \hat{\mathcal{I}}_{64} \otimes \begin{pmatrix} 1 & \cdots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & -1 \end{pmatrix} \otimes \begin{pmatrix} 0 & \cdots & 1 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & 0 \end{pmatrix} \otimes \begin{pmatrix} 1 & \cdots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & 1 \end{pmatrix}, c_3$$

$$= \hat{\mathcal{I}}_{64} \otimes \begin{pmatrix} 1 & \cdots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & -1 \end{pmatrix} \otimes \begin{pmatrix} 1 & \cdots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & -1 \end{pmatrix} \otimes \begin{pmatrix} 0 & \cdots & 1 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & 0 \end{pmatrix}$$

$$\hat{\xi}_\alpha = \left\|\begin{matrix} \sigma_z \otimes \cdots & \sigma_z \otimes \\ \otimes \sigma_z & \otimes \end{matrix}\right\|_{\alpha-1} \begin{pmatrix} 0 & 0 \\ 1 & 0 \end{pmatrix} \otimes \daleth \otimes \cdots \otimes \daleth$$

$$\widehat{\mathfrak{G}}_\alpha = \iota \sum_{\beta,\gamma,\iota} f_{\alpha\beta\gamma}\hat{\alpha}_{\iota\beta}^\dagger\hat{\alpha}_{\iota\gamma}, \widehat{\mathfrak{G}}_\alpha = \left(\otimes_{\iota\beta}|0\rangle_{\iota\beta}\right), \widehat{\mathfrak{G}}_\alpha = \imath\sum_{\beta\gamma} f_{\alpha\beta\gamma}\left(\hat{\alpha}_{1\beta}^\dagger\hat{\alpha}_{1\gamma} + \hat{\alpha}_{2\beta}^\dagger\hat{\alpha}_{2\gamma} + \hat{\xi}_\beta^\dagger\hat{\xi}_\gamma\right)$$

$$\hat{\alpha}_{\iota\alpha}^{\dagger} = \sqrt{\frac{m}{2}}\widehat{\chi_{\iota\alpha}} - \frac{\iota\widehat{\wp_{\iota\alpha}}}{\sqrt{2m}}, \widehat{\alpha_{\iota\alpha}} = \sqrt{\frac{m}{2}}\widehat{\chi_{\iota\alpha}} + \frac{\iota\widehat{\wp_{\iota\alpha}}}{\sqrt{2m}}, \hat{\alpha}_{\iota\alpha}|0\rangle_{\iota\alpha}, |\eta\rangle_{\iota\alpha} = \frac{\left(\hat{\alpha}_{\iota\alpha}^{\dagger}\right)^{\eta}}{\sqrt{\eta!}\,|0\rangle_{\iota\alpha}}, |\{\eta_{\iota\alpha}\}\rangle = \otimes_{\iota\alpha}|\eta\rangle_{\iota\alpha}, \hat{\alpha}_{7}^{\dagger}$$

$$= \sum_{\eta=0}^{\Lambda-2}\sqrt{\eta+1}\,|\eta+1\rangle\langle\eta| = \sum_{\eta=0}^{\Lambda-2}\sqrt{\eta+1}\,|\eta\rangle\langle\eta+1|, \hat{\eta}_{7}$$

$$= \sum_{\eta=0}^{\Lambda-1}\eta|\eta\rangle\langle\eta|, [\hat{\mathfrak{H}}_{7}, \hat{\mathfrak{G}}_{7}], |\eta\rangle = |\beta_0\rangle|\beta_1\rangle\cdots\beta_{\kappa+1}\rangle, |\eta+1\rangle\langle\eta|$$

$$= \otimes_{\ell=0}^{\kappa-1}\ (|\beta_\ell'\rangle\langle\beta_\ell|), |0\rangle\langle 0| = \boxtimes_2 - \frac{\sigma_{z\blacksquare}}{2}, |1\rangle\langle 1|$$

$$= \boxtimes_2 - \frac{\sigma_{z\blacksquare}}{2}, \Big|0\rangle\langle 1| = \sigma_x + \frac{\iota\sigma_\gamma}{2}, 1\rangle\langle 0| = \sigma_x + \frac{\iota\sigma_\gamma}{2}$$

$$\hat{\mathcal{M}} = \sum_{\alpha}\left(\iota(\hat{\mathcal{Z}}_\alpha\hat{\wp}_{\mathcal{Z}\alpha}^{\dagger} - \hat{\wp}_{\mathcal{Z}\alpha}\hat{\mathcal{Z}}_\alpha^{\dagger}) - \frac{1}{2}\hat{\xi}_\alpha^{\dagger}\hat{\xi}_\alpha\right), \hat{\mathcal{Q}} = -\sqrt{2}\,\hat{\xi}_\alpha^{\dagger}(\hat{\wp}_{\mathcal{Z}\alpha} - \iota\mu\hat{\mathcal{Z}}_\alpha) - \frac{g}{\sqrt{2}f_{\alpha\beta\gamma}\hat{\xi}_\alpha\hat{\mathcal{Z}}_\beta\hat{\mathcal{Z}}_\gamma^{\dagger}}, \hat{\mathcal{Q}}^2$$

$$= -\iota\hat{\mathcal{Z}}_\alpha\hat{\mathfrak{G}}_\alpha, \hat{\mathcal{Q}}^{\dagger 2} = \iota\hat{\mathcal{Z}}_\alpha^{\dagger}\hat{\mathfrak{G}}_\alpha, \{\hat{\mathcal{Q}}\hat{\mathcal{Q}}^{\dagger}\} = 2(\hat{\mathcal{H}} - \mu\hat{\mathcal{M}}), \hat{\mathcal{Q}}|\mathfrak{BPS}\rangle = \hat{\mathcal{Q}}^{\dagger}|\mathfrak{BPS}\rangle$$

$$= (\hat{\mathcal{H}} - \mu\hat{\mathcal{M}})\mathfrak{BPS}\rangle$$

$$\delta_\epsilon = [\hat{\mathfrak{Q}}\epsilon^* + \hat{\mathfrak{Q}}^{\dagger}\epsilon], \hat{\mathfrak{Q}} = -\hat{\xi}_\alpha^{\dagger}[(\hat{\wp}_1^{\alpha} - \iota\hat{\wp}_2^{\alpha}) - \iota\mu(\hat{\chi}_1^{\alpha} - \iota\hat{\chi}_2^{\alpha})] - \frac{\iota g}{\sqrt{2}f_{\alpha\beta\gamma}\hat{\xi}^{\alpha}\hat{\chi}_1^{\beta}\iota\hat{\chi}_2^{\gamma}}, \hat{\mathcal{Z}} = \hat{\chi}_1 - \frac{\iota\hat{\chi}_2}{\sqrt{2}}, \widehat{\wp_{\mathcal{Z}}}$$

$$= \hat{\wp}_1 - \frac{\iota\hat{\wp}_2}{\sqrt{2}}, [\hat{\mathcal{Z}}, \hat{\wp}_{\mathcal{Z}}^{\dagger}] = [\hat{\wp}, \hat{\mathcal{Z}}_{\wp}^{\dagger}] = \iota$$

$$Z(\mathcal{T}) = \mathcal{T}r_{\mathcal{H}_{inv}}\left(e^{-\frac{\hat{\mathcal{H}}}{t}}\right), Z(\mathcal{T}) = \frac{1}{vol\,(G)}\int_G^{\delta} dg\mathcal{T}r\,\mathcal{H}_{ext}\left(\hat{g}e^{-\frac{\hat{\mathcal{H}}}{t}}\right), \hat{\mathcal{P}} \equiv \frac{1}{vol}(G)\int_G^{\delta} dg\hat{g}\,, |\Phi\rangle_{inv}$$

$$= \frac{1}{\sqrt{\mathcal{C}_\phi}} \times \frac{1}{vol\,(G)}\int_G^{\delta} dg(\hat{g}|\Phi\rangle)\,, \mathcal{C}_\phi = \frac{1}{[vol\,(G)]^2}\int_G^{\delta} dg \int_G^{\delta} dg'\,\langle\phi|\hat{g}^{-1}\hat{g}'|\phi\rangle$$

$$= \frac{1}{vol\,(G)}\int_G^{\delta} dg\langle\phi|\hat{g}|\phi\rangle$$

$$= vol\frac{(G_\phi)}{vol}(G), \mathcal{T}r_{\mathcal{H}_{inv}}\left(e^{-\frac{\hat{\mathcal{H}}}{t}}\right)\sum_{\phi} vol\frac{(G_\phi)}{vol}(G)_{inv}\,\langle\phi|\,e^{-\frac{\hat{\mathcal{H}}}{t}}\Big|\,\phi\rangle_{inv}$$

$$= \sum_{\phi} vol\frac{(G_\phi)}{vol}(G) \otimes \frac{1}{\mathcal{C}_\phi}\frac{1}{[vol\,(G)]^2}\int_G^{\delta} dg \int_G^{\delta} dg'\,\langle\phi|\,\hat{g}^{-1}e^{-\frac{\hat{\mathcal{H}}}{t}}\hat{g}'\Big|\,\phi\rangle$$

$$= \sum_{\phi} \frac{1}{vol\,(G)}\int_G^{\delta} dg\,\mathcal{T}r_{\mathcal{H}_{ext}}\left(\hat{g}e^{-\frac{\hat{\mathcal{H}}}{t}}\right), Z(\mathcal{T})$$

$$= \frac{1}{[vol\,(G)]^{\kappa}}\int\left(\prod_{\kappa=1}^{\kappa} d\mathfrak{U}_{(\mathfrak{K})}\right)\mathcal{T}r_{\mathcal{H}_{ext}}\otimes\left(\hat{\mathfrak{U}}_{(\mathcal{K})}e^{-\frac{\mathcal{H}(\hat{\mathcal{P}},\hat{\mathcal{X}})}{\mathcal{T}\kappa}}\hat{\mathfrak{U}}^{-1}_{(k-1)}\hat{\mathfrak{U}}_{(k-1)}\otimes e^{-\frac{\mathcal{H}(\hat{\mathcal{P}},\hat{\mathcal{X}})}{\mathcal{T}\kappa}}\right)$$

$$= \frac{1}{[vol\,(G)]^{\kappa}}\int\left(\prod_{\kappa=1}^{\kappa} d\mathfrak{U}_{(\mathfrak{K})}\right)\int\left(\prod_{\kappa=1}^{\kappa} d\chi_{(\mathfrak{K})}\right)\left\langle\chi_{(k)}\middle|\,\hat{\mathfrak{U}}_{(\mathcal{K})}e^{-\frac{\mathcal{H}(\hat{\mathcal{P}},\hat{\mathcal{X}})}{\mathcal{T}\kappa}}\hat{\mathfrak{U}}^{-1}_{(k-1)}\middle|\,\chi_{(k-1)}\right\rangle$$

$$\bigotimes\left\langle\chi_{(k-1)}\middle|\,\hat{\mathfrak{U}}_{(\mathcal{K}-1)}e^{-\frac{\mathcal{H}(\hat{\mathcal{P}},\hat{\mathcal{X}})}{\mathcal{T}\kappa}}\hat{\mathfrak{U}}^{-1}_{(k-2)}\middle|\,\chi_{(k-2)}\right\rangle$$

$$\otimes\cdots\otimes\left\langle\chi_{(1)}\middle|\,\hat{\mathfrak{U}}_{(1)}e^{-\frac{\mathcal{H}(\hat{\mathcal{P}},\hat{\mathcal{X}})}{\mathcal{T}\kappa}}\hat{\mathfrak{U}}^{-1}_{(k-1)}\middle|\,\chi_{(k)}\right\rangle$$

$$\left\langle\chi_{(k)}\middle|\,\hat{\mathfrak{U}}_{(\mathcal{K})}e^{-\frac{\mathcal{H}(\hat{\mathcal{P}},\hat{\mathcal{X}})}{\mathcal{T}\kappa}}\hat{\mathfrak{U}}^{-1}_{(k-1)}\middle|\,\chi_{(k-1)}\right\rangle = \left\langle\mathfrak{U}_{(k)}\chi_{(k)}\mathfrak{U}^{-1}_{(k)}\middle|\,\hat{\mathfrak{U}}_{(\mathcal{K})}e^{-\frac{\mathcal{H}(\hat{\mathcal{P}},\hat{\mathcal{X}})}{\mathcal{T}\kappa}}\middle|\,\mathfrak{U}_{(k-1)}\chi_{(k-1)}\mathfrak{U}^{-1}_{(k-1)}\right\rangle$$

$$= \int_G^{\delta} d\mathcal{P}\left\langle\mathfrak{U}_{(k)}\chi_{(k)}\mathfrak{U}^{-1}_{(k)}\middle|\,\hat{\wp}_{(\mathcal{K})}e^{-\frac{\mathcal{H}(\hat{\mathcal{P}},\hat{\mathcal{X}})}{\mathcal{T}\kappa}}\middle|\,\mathcal{P}\right\rangle\otimes\left\langle\wp\middle|\,\hat{\wp}_{(\mathcal{K})}e^{-\frac{\mathcal{H}(\hat{\mathcal{P}},\hat{\mathcal{X}})}{\mathcal{T}\kappa}}\middle|\,\mathfrak{U}_{(k-1)}\chi_{(k-1)}\mathfrak{U}^{-1}_{(k-1)}\right\rangle$$

$$= \int_G^{\delta} d\wp e^{\iota\mathcal{T}r\left[\left(\mathfrak{U}_{(k)}\chi_{(k)}\mathfrak{U}^{-1}_{(k)}-\mathfrak{U}_{(k-1)}\chi_{(k-1)}\mathfrak{U}^{-1}_{(k-1)}\right)\right]}\otimes e^{-\mathcal{H}\left(\mathcal{P},\frac{\mathfrak{U}_{(k)}\chi_{(k)}\mathfrak{U}^{-1}_{(k)}}{(\mathcal{T}\mathcal{K})}\right)}$$

$$= e^{\mathcal{K}\mathcal{T}\mathrm{T}r\left[\left(\mathfrak{U}_{(k)}\chi_{(k)}\mathfrak{U}^{-1}_{(k)}-\mathfrak{U}_{(k-1)}\chi_{(k-1)}\mathfrak{U}^{-1}_{(k-1)}\right)^2\right]}\otimes e^{-\mathcal{V}\left(\frac{\mathfrak{U}_{(k)}\chi_{(k)}\mathfrak{U}^{-1}_{(k)}}{(\mathcal{T}\mathcal{K})}\right)}, \simeq e^{-\mathfrak{L}\left[\frac{\mathfrak{D}t\left(\mathfrak{U}_{(k)}\chi_{(k)}\mathfrak{U}^{-1}_{(k)}-\mathfrak{U}_{(k-1)}\chi_{(k-1)}\mathfrak{U}^{-1}_{(k-1)}\right)}{\mathfrak{T}\mathfrak{K}}\right]} = e^{-\frac{\mathcal{L}[\mathcal{D}t\chi_{\kappa},\chi_{\kappa}]}{\tau\kappa}}$$

$$\mathfrak{U}_{(k)}^{-1}\mathfrak{U}_{(k)} \equiv e^{\frac{\iota\Lambda_{(k)}}{(KT)}}\chi_{(k)} - \left(\mathfrak{U}_{(k-1)}\mathfrak{U}_{(k)}^{-1}\right)^{-1}\chi_{(k-1)}\left(\mathfrak{U}_{(k-1)}\mathfrak{U}_{(k)}^{-1}\right)$$

$$\simeq \frac{\mathcal{D}t\chi_{(k)}}{KT}, Z(T)\int [d\Lambda][d\chi]\, e^{-\int dt\mathfrak{L}[\mathcal{D}t\chi,\chi]} = \left(\mathfrak{U}_k\mathfrak{U}_{k-1}^{-1}\right)\left(\mathfrak{U}_{k-1}\mathfrak{U}_{k-2}^{-1}\right)\otimes\left(\mathfrak{U}_2\mathfrak{U}_1^{-1}\right)$$

$$= \wp e^{\iota\int_0^1 dt\Lambda_t}$$

3. Gravedad cuántica en espacios curvos.

$$d\hat{s}^2 = \hat{g}_{\mu\nu}d\chi^\mu d\chi^\nu = -\left(\kappa + \frac{r^2}{\ell^2}\right)dt^2 + \frac{dr^2}{\kappa} + \frac{r^2}{\ell^2} + r^2 d\Sigma_\kappa^2, \Im\hbar_{\alpha\beta}d\chi^\alpha d\chi^\beta$$

$$= \frac{r^2}{\ell^2}\left(-dt^2 + \ell^2 d\Sigma_\kappa^2\right), ds^2 = -\mathrm{N(r)}\, dt^2 + \mathcal{H}(\mathrm{r})\, dr^2 + \delta(\mathrm{r})d\Sigma_\kappa^2, \mathcal{V}(\phi)$$

$$= -\frac{3}{\kappa\ell^2} - \frac{\phi^2}{\ell^2} + \mathcal{O}(\phi)^4, \phi(\mathrm{r}) = \frac{\alpha}{r} + \frac{\beta}{r^2} + \mathcal{O}(r^{-3}), \mathrm{N(r)} = -g_{tt}$$

$$= \frac{r^2}{\ell^2} + \kappa - \frac{\mu}{r} + \mathcal{O}(r^{-2}), \delta(\mathrm{r})$$

$$= r^2 + \mathcal{O}(r^{-2}), \mathrm{N}\delta'^2\mathcal{H} - 2\mathrm{N}\delta''\mathcal{H}\delta + (\mathrm{N}\mathcal{H})'\delta'\delta - 2\kappa\mathrm{N}\mathcal{H}\delta^2\phi'^2, \mathcal{H}(\mathrm{r}) = g_{rr}$$

$$= \frac{\ell^2}{r^2} + \frac{\ell^4}{r^4}\left(-\kappa - \frac{\alpha^2\kappa}{2\ell^2}\right) + \frac{\ell^5}{r^5}\left(\frac{\mu}{\ell} - \frac{4\kappa\alpha\beta}{3\ell^3}\right) + \mathcal{O}(r^{-6}), g_{rr}$$

$$= \frac{\ell^2}{r^2} + \frac{\alpha\ell^4}{r^4} + \frac{\beta\ell^5}{r^5} + \mathcal{O}(r^{-6}), \mathcal{V}(\phi) = -\frac{3}{\kappa\ell^2} - \frac{\phi^2}{\ell^2} + \lambda\phi^3 + \mathcal{O}(r^4), \phi(\mathrm{r})$$

$$= \frac{\alpha}{r} + \frac{\beta}{r^2} + \frac{\gamma\ln(\mathrm{r})}{r^2} + \mathcal{O}(r^{-3}), \mathcal{H}(\mathrm{r}) = g_{rr}$$

$$= \frac{\ell^2}{r^2} + \frac{\ell^4}{r^4}\left(-\kappa - \frac{\alpha^2\kappa}{2\ell^2}\right) + \frac{\ell^5}{r^5}\left(\frac{\mu}{\ell} - \frac{4\kappa\alpha\beta}{3\ell^3} + \frac{2\kappa\alpha\gamma}{9\ell^3}\right) + \frac{\ell^5\ln(\mathrm{r})}{r^5\left(-\frac{4\kappa\alpha\gamma}{3\ell^3}\right)}$$

$$+ \mathcal{O}\left[\ln\frac{(\mathrm{r})^2}{r^6}\right], \mathcal{H}(\mathrm{r}) = \frac{\ell^2}{r^2} + \frac{\ell^4\alpha}{r^4} + \frac{\ell^5\beta}{r^5} + \frac{\ell^5 c\ln r}{r^5} + \mathcal{O}\left[\ln\frac{(\mathrm{r})^2}{r^6}\right], \alpha = -\kappa - \frac{\alpha^2\kappa}{2\ell^2}, \beta$$

$$= \frac{\mu}{\ell} - \frac{4\kappa\alpha\beta}{3\ell^3} + \frac{2\kappa\alpha\gamma}{9\ell^3}, c$$

$$= -\frac{4\kappa\gamma\alpha}{3\ell^3}, \partial_r\left(\frac{\phi'\delta\sqrt{\mathrm{N}}}{\sqrt{\mathrm{H}}}\right) - \frac{\delta\sqrt{\mathrm{HN}}\partial\mathfrak{V}}{\partial\phi} 3\alpha^2\ell^2\lambda + \frac{\gamma}{\ell^2} + \mathcal{O}(r^{-1}), \xi^r$$

$$= r\eta^r(\chi^m) + \mathcal{O}(r^{-1})\xi^m = \mathcal{O}(1), \phi'(\chi) = \phi(\chi) + \xi^\mu\partial_\mu\phi(\chi)$$

$$= \frac{\alpha'}{r} + \frac{\beta'}{r^2} + \gamma'\ln\frac{r}{r^2} + \mathcal{O}(r^{-3}), \alpha' = \alpha - \eta^r\alpha + \xi^m\partial_m\alpha, \beta'$$

$$= \beta - \eta^r(2\beta - \gamma)\xi^m\partial_m\beta, \gamma' = \gamma - 2\gamma\eta^r + \xi^m\partial_m\gamma$$

$$\frac{\alpha'\partial\gamma}{\partial\alpha}-\gamma'\alpha\frac{\partial\gamma}{\partial\alpha}-\gamma+\eta^{r}\left(2\gamma-\alpha\frac{\partial\gamma}{\partial\alpha}\right)+\xi^{m}\left(\frac{\partial\alpha}{\partial\chi_m\frac{\partial\gamma}{\partial\alpha}}-\frac{\partial\gamma}{\partial\chi_m}\right)$$

$$\frac{\alpha'\partial\beta}{\partial\alpha}-\beta'\alpha\frac{\partial\beta}{\partial\alpha}-\beta+\eta^{r}\left(2\beta-\gamma-\alpha\frac{\partial\beta}{\partial\alpha}\right)+\xi^{m}\left(\frac{\partial\alpha}{\partial\chi_m\frac{\partial\beta}{\partial\alpha}}-\frac{\partial\beta}{\partial\chi_m}\right)$$

$$\mathcal{I}_{\mathfrak{CFT}}\longrightarrow\mathcal{I}_{\mathfrak{CFT}}-\int d^3\chi\mathfrak{W}[\mathcal{O}(\chi)]$$

$$\mathcal{I}_g^{ct}=-\frac{1}{\kappa\int_{\partial\mathcal{M}}^{\delta}d^3\chi\sqrt{-\hbar}\left(\frac{2}{\ell}+\frac{\mathcal{R}\ell}{2}\right)},\mathfrak{I}$$

$$=\frac{\int d^4\chi\sqrt{-g}(\mathcal{R}}{2\kappa}-\frac{(\partial\phi)^2}{2}-\mathcal{V}(\phi))+1/\kappa\int_{\partial\mathcal{M}}^{\delta}d^3\chi\sqrt{-\hbar}\,\mathfrak{K}$$

$$-1/\kappa\int_{\partial\mathcal{M}}^{\delta}d^3\chi\sqrt{-\hbar}\left(\frac{2}{\ell}+\frac{\mathcal{R}\ell}{2}\right)+\mathcal{I}_{\varphi\phi\psi},\mathcal{I}_{\varphi\phi\psi}^{ct}$$

$$=1/6\kappa\int_{\partial\mathcal{M}}^{\delta}d^3\chi\sqrt{-\hbar}\,(\phi\eta^{\nu}\partial_{\nu}\phi-\phi^2\ell/2\varphi\psi\tau),\mathcal{I}_{\varphi\phi\psi}$$

$$=-\int_{\partial\mathcal{M}}^{\delta}d^3\chi\sqrt{-\hbar}\left[\frac{\phi^2}{2\ell}+\frac{\mathfrak{W}(\alpha)}{\ell\alpha^3\tau^3}-\langle\varphi|\phi|\psi\rangle^3\right],\delta\ell$$

$$=\int_{\partial\mathcal{M}}^{\delta}d^3\chi\sqrt{-\hbar}\left[\frac{1}{r}\left(\sqrt{-g^{rr}}\phi'-\frac{\varphi\psi}{\tau\ell}-\frac{3\mathcal{W}(\alpha)\phi^2}{\ell\phi^3}\right)\left(1+\frac{1}{\frac{rd^2\mathcal{W}(\alpha)}{d(\alpha)^2}}\right)\right.$$

$$\left.+\left(\frac{3\mathcal{W}(\alpha)}{\alpha}-\beta\right)\langle\varphi|\phi|\psi\rangle^3/\ell\alpha^3\right]\delta\alpha$$

$$\mathcal{I}_{\varphi\phi\psi}=-\int_{\partial\mathcal{M}}^{\delta}d^3\chi\sqrt{-\hbar}\left[\frac{\phi^2}{2\ell}+\frac{\langle\varphi|\phi|\psi\rangle^3}{\ell\alpha^3\left(\mathcal{W}-\frac{\alpha\gamma}{3}\right)}-\frac{\langle\varphi|\phi|\psi\rangle^3\mathfrak{C}_{\gamma}}{3\ell}\ln\left(\frac{\langle\varphi|\phi|\psi\rangle}{\alpha}\right)\right]$$

$$ds^2=\Omega(\chi)=\left[-f(\chi)dt^2+\frac{\eta^2d\chi^2}{f(x)}+d\Sigma_{\kappa}^2\right],\mathcal{I}_{\mathfrak{BULK}}^{\mathfrak{E}}=\int_0^{\frac{1}{\tau}}d\tau\int_{\chi_+}^{\chi_\beta}d^3\chi\sqrt{g^{\mathfrak{E}\mathfrak{B}}}(\phi)$$

$$=\frac{\sigma_{\kappa}}{2\eta\kappa\tau}d(\Omega f)/d\chi|_{\chi_+}^{\chi_\beta}$$

$$\Omega(\chi) \longrightarrow \delta(r), f(x) \longrightarrow \frac{\mathrm{N}(r)}{\delta(r)}, dx \longrightarrow \frac{\sqrt{\mathrm{NH}}}{\eta\delta} dr$$

$$\mathcal{I}^{\mathfrak{E}}_{\mathfrak{BULK}} = \left.\frac{\frac{\sigma_\kappa}{2\kappa\tau}\delta \frac{d\mathrm{N}}{\sqrt{\mathrm{NH}}}}{dr}\right|_{r_+}^{r_\beta} \quad ds^2 =' \hbar_{\alpha\beta}\, d\chi^\alpha d\chi^\beta = \Omega(\chi_0)[-f(\chi_0)dt^2 + d\Sigma_\kappa^2]\eta_\alpha = \left.\frac{\delta_\alpha^\chi}{\sqrt{g^{xx}}}\right|_{\chi=\chi_0} \mathfrak{K}_{\alpha\beta}$$

$$= \left.\frac{\sqrt{g^{xx}}}{2}\partial_\chi g_{\alpha\beta}\right|_{\chi=\chi_0} \mathfrak{K} = \frac{1}{2\eta\left(\frac{f}{\Omega}\right)^{-\frac{1}{2}}\left.\left[\frac{(f\Omega)'}{\Omega f} + \frac{2\Omega'}{\Omega}\right]\right|_{\chi_0}}, \mathcal{I}^{\mathfrak{E}}_{\mathfrak{GH}}$$

$$= -\frac{\frac{\sigma_\kappa}{\kappa\tau}\Omega f}{2\eta}\left.\left[\frac{(f\Omega)'}{\Omega f} + \frac{2\Omega'}{\Omega}\right]\right|_{\chi_\beta} = -\frac{\sigma_\kappa}{2\tau\kappa}\left.\left(\frac{\frac{\delta}{\sqrt{\mathrm{HN}}}d\mathrm{N}}{dr} + \frac{\frac{2\mathrm{N}}{\sqrt{\mathrm{HN}}}d\delta}{dr}\right)\right|_{r_\beta} \mathcal{I}_g^{ct}$$

$$= \frac{2\sigma_\kappa}{\kappa\tau\ell}\left(\Omega^{\frac{3}{2}} f^{\frac{1}{2}} + \frac{\ell^2\kappa}{2} f^{\frac{1}{2}}\Omega^{\frac{1}{2}}\right)\left.\left(\Omega^{\frac{3}{2}} f^{\frac{1}{2}} + \frac{\ell^2\kappa}{2} f^{\frac{1}{2}}\Omega^{\frac{1}{2}}\right)\right|_{\chi_\beta} = \frac{2\sigma_\kappa}{\kappa\tau\ell}\delta\sqrt{\mathrm{N}}\left.\left(1 + \frac{\ell^2\kappa}{2\delta}\right)\right|_{r_\beta} \mathcal{T}$$

$$= \left.\frac{\mathrm{N}'}{4\pi\sqrt{\mathrm{NH}}}\right|_{r_+} \mathcal{I}^{\mathfrak{E}}_{\mathfrak{BULK}} + \mathcal{I}^{\mathfrak{E}}_{\mathfrak{GH}} + \mathcal{I}_g^{ct}$$

$$= \frac{1}{\tau\left[\frac{\sigma_\kappa\delta(r_+)\tau}{4\mathfrak{G}}\right]} - \frac{\sigma_\kappa}{2\kappa\tau\left.\left[\frac{\frac{2\mathrm{N}}{\sqrt{\mathrm{NH}}}d\delta}{dr} - \frac{4}{\ell\delta\sqrt{\mathrm{N}}\left(1 + \frac{\ell^2\kappa}{2\delta}\right)}\right]\right|_{r_\beta}} + \mathcal{I}^{\mathfrak{E}}_{\mathfrak{GH}} \quad \mathcal{I}^{\mathfrak{E}}_{\mathfrak{BULK}}$$

$$+ \mathcal{I}_g^{ct} = -\frac{\mathcal{A}}{4\mathfrak{G}} - \frac{\sigma_\kappa}{\tau}\left.\left(-\frac{\mu}{\kappa} + \frac{4\alpha\beta}{3\ell^2} + \frac{r\alpha^2}{2\ell^2}\right)\right|_{r_\beta} \mathcal{I}^{ct}_{\langle\varphi|\phi|\psi\rangle}$$

$$= \int_{\partial\mathcal{M}}^{\delta} d^3\chi\sqrt{\hbar^{\mathcal{E}}}\left[\frac{\phi^2}{2\ell} + \frac{\frac{\mathcal{W}(\alpha)}{\ell\alpha^3\langle\varphi|\phi|\psi\rangle^3}}{\|\tau\omega\|}\right] = \frac{\sigma_\kappa}{\tau}\left.\left(\frac{\mathcal{W}}{\ell^2} + \frac{\alpha\beta}{\ell^2} + \frac{r\alpha}{2\ell^2}\right)\right|_{r_\infty} \mathcal{I}^{\mathfrak{E}}$$

$$= \mathcal{I}^{\mathfrak{E}}_{\mathfrak{BULK}} + \mathcal{I}^{\mathfrak{E}}_{\mathfrak{GH}} + \mathcal{I}_g^{ct} + \mathcal{I}^{ct}_{\langle\varphi|\phi|\psi\rangle} = \frac{\mathcal{A}}{4\mathfrak{G}} + \frac{\sigma_\kappa}{\tau}\left[\frac{\mu}{\kappa} + \frac{1}{\ell^2}\left(\mathcal{W} - \frac{\alpha}{\frac{3d\mathcal{W}}{d\alpha}}\right)\right] \mathrm{F} = \mathcal{I}^{\mathfrak{E}}\mathcal{T}$$

$$= \mathcal{M} - \mathcal{T}\mathcal{S}, \mathcal{M} = -\frac{\mathcal{T}^2\partial\mathcal{I}^{\mathfrak{E}}}{\partial\mathcal{T}} = \sigma\kappa\left[\frac{\mu}{\kappa} + \frac{1}{\ell^2}\left(\mathcal{W} - \frac{\alpha}{\frac{3d\mathcal{W}}{d\alpha}}\right)\right]\mathcal{S} = -\frac{\partial(\mathcal{I}^{\mathfrak{E}}\mathcal{T})}{\partial\mathcal{T}} = \frac{\mathcal{A}}{4\mathfrak{G}}$$

$$\mathcal{I}^{\mathfrak{E}}_{\mathfrak{BULK}} + \mathcal{I}^{\mathfrak{E}}_{\mathfrak{GH}} + \mathcal{I}^{ct}_{g} + \mathcal{I}^{ct}_{\langle\varphi|\phi|\psi\rangle} = -\frac{\mathcal{A}}{4\mathfrak{G}} + \frac{\sigma\kappa}{\mathcal{T}\left\{\frac{\mu}{\kappa} + \frac{1}{\ell^2}\left[\mathcal{W}(\alpha) - \frac{\alpha}{\frac{3d\mathcal{W}}{d\alpha}} + \frac{2\alpha\gamma}{9} - \frac{\alpha\gamma}{3}\ln r\right]\right\}\hat{\mathcal{I}}^{ct}_{\langle\varphi|\phi|\psi\rangle}}$$

$$= \int_{\partial\mathcal{M}}^{\delta} d^3\chi\sqrt{\hbar^{\mathcal{E}}}\left\{\frac{\phi^3\gamma}{3\alpha^2\ell}[\ln(\alpha/\phi) - 1]\right\} = \sigma_\kappa/\mathfrak{T}\left[-\frac{\alpha\gamma}{3\ell^2} + \frac{\alpha\gamma\ln r}{3\ell^2} + \mathcal{O}(r^{-1}\ln r)\right]$$

$$\mathcal{I}^{\mathfrak{E}} = \mathcal{I}^{\mathfrak{E}}_{\mathfrak{BULK}} + \mathcal{I}^{\mathfrak{E}}_{\mathfrak{GH}} + \mathcal{I}^{ct}_{g} + \mathcal{I}^{ct}_{\langle\varphi|\phi|\psi\rangle} + \hat{\mathcal{I}}^{ct}_{\langle\varphi|\phi|\psi\rangle} = -\frac{\mathcal{A}}{4\mathfrak{G}} + \frac{\sigma\kappa}{\mathcal{T}\left[\frac{\mu}{\kappa} + \frac{1}{\ell^2}\left(\mathcal{W}(\alpha) - \frac{\alpha}{\frac{3d\mathcal{W}}{d\alpha}} - \frac{\alpha\gamma}{9}\right)\right]}, \mathcal{M}$$

$$= -\daleth^2\frac{\partial\mathcal{I}^{\mathfrak{E}}}{\partial\mathcal{T}} = \sigma\kappa\left[\frac{\mu}{\kappa} + \frac{1}{\ell^2}\left(\mathcal{W}(\alpha) - \frac{\alpha}{\frac{3d\mathcal{W}}{d\alpha}} - \frac{\alpha\gamma}{9}\right)\right]\delta = -\frac{\partial(\mathcal{I}^{\mathfrak{E}}\mathcal{T})}{\partial\mathcal{T}} = \frac{\mathcal{A}}{4\mathfrak{G}}$$

3.1. Tensor de stress Brown-York en espacios cuánticos curvos.

$$\tau_{\alpha\beta} = -\frac{1}{\kappa\left(\kappa_{\alpha\beta} - \hbar_{\alpha\beta}\kappa + \frac{2}{\ell\hbar_{\alpha\beta}} - \iota\mathfrak{G}_{\alpha\beta}\right)} - \frac{\hbar_{\alpha\beta}}{\ell\left[\frac{\phi^2}{2} + \frac{\mathcal{W}(\alpha)}{\alpha^3\phi^3}\right]\tau_{tt}}$$

$$= \frac{\ell}{\mathcal{R}\left[\frac{\mu}{8\pi\mathfrak{G}\ell^2} + \frac{1}{\ell^4\left(\omega(\alpha) - \frac{\alpha\beta}{3}\right)}\right]} + \mathcal{O}(\mathfrak{R}^{-2})\tau_{\theta\theta}$$

$$= \frac{\ell}{\mathcal{R}\left[\frac{\mu}{16\pi\mathfrak{G}} - \frac{1}{\ell^2\left(\omega(\alpha) - \frac{\alpha\beta}{3}\right)}\right]} + \mathcal{O}(\mathfrak{R}^{-2})\tau_{\langle\phi|\varphi|\psi\rangle}$$

$$= \ell sin^2\theta/\mathcal{R}\left[\frac{\mu}{16\pi\mathfrak{G}} - 1/\ell^2\left(\omega(\alpha) - \frac{\alpha\beta}{3}\right)\right] + \mathcal{O}(\mathfrak{R}^{-2})$$

$$\langle\tau^{dualidad}_{\alpha\beta}\rangle = \frac{3\mu}{16\pi\mathfrak{G}\ell^2\delta^0_\alpha\delta^0_\beta} + \frac{\gamma_{\alpha\beta}}{\ell^2\left[\frac{\mu}{16\pi\mathfrak{G}} - \frac{1}{\ell^2\left(\omega(\alpha) - \frac{\alpha\beta}{3}\right)}\right]\langle\tau^{dualidad}\rangle} = -3/\ell^4\left[\omega(\alpha) - \frac{\alpha\beta}{3}\right]$$

$$\tau_{\alpha\beta} = -\frac{1}{\kappa\left(\kappa_{\alpha\beta} - \hbar_{\alpha\beta}\kappa + \frac{2}{\ell\hbar_{\alpha\beta}} - \iota\mathfrak{G}_{\alpha\beta}\right)} - \frac{\hbar_{\alpha\beta}}{\ell\left[\frac{\phi^2}{2} + \frac{\phi^3}{\alpha^3}\left(\omega - \frac{\alpha\gamma}{3}\right) + \frac{\phi^3\gamma}{3\alpha^2}\left(\frac{\alpha}{\phi}\right)\right]\tau_{tt}}$$

$$= \frac{\ell}{\mathcal{R}\left[\frac{\mu}{8\pi\mathfrak{G}\ell^2} + \frac{1}{\ell^4\left(\omega - \frac{\alpha\beta}{3} - \frac{\alpha\gamma}{9}\right)}\right]} + \mathcal{O}\left[\frac{(\ln\mathfrak{R})^3}{\mathfrak{R}^2}\right]\tau_{\theta\theta}$$

$$= \frac{\ell}{\mathcal{R}\left[\frac{\mu}{16\pi\mathfrak{G}} - \frac{1}{\ell^2\left(\omega - \frac{\alpha\beta}{3} - \frac{\alpha\gamma}{9}\right)}\right]} + \mathcal{O}\left[\frac{(\ln\mathfrak{R})^3}{\mathfrak{R}^2}\right]\tau_{\langle\phi|\varphi|\psi\rangle}$$

$$= \frac{\ell sin^2\theta}{\mathcal{R}\left[\frac{\mu}{16\pi\mathfrak{G}} - \frac{1}{\ell^2\left(\omega - \frac{\alpha\beta}{3} - \frac{\alpha\gamma}{9}\right)}\right]} + \mathcal{O}\left[\frac{(\ln\mathfrak{R})^3}{\mathfrak{R}^2}\right]\langle\tau_{\alpha\beta}^{dualidad}\rangle$$

$$= \frac{3\mu}{16\pi\mathfrak{G}\ell^2\delta_\alpha^0\delta_\beta^0} + \frac{\gamma_{\alpha\beta}}{\ell^2\left[\frac{\mu}{16\pi\mathfrak{G}} - \frac{1}{\ell^2\left(\omega(\alpha) - \frac{\alpha\beta}{3} - \frac{\alpha\gamma}{9}\right)}\right]\langle\tau^{dualidad}\rangle}$$

$$= -3/\ell^4\left[\left(\omega - \frac{\alpha\beta}{3} - \frac{\alpha\gamma}{9}\lambda\right)\right]$$

$$\tau^{\alpha\beta} \equiv \frac{\frac{2}{\sqrt{-\hbar}}\delta\mathcal{I}}{\delta\hbar_{\alpha\beta}}, \mathcal{I}_{\mathfrak{G}\mathfrak{H}} + \mathcal{I}_g + \mathcal{I}_\phi$$

$$= \frac{1}{\kappa\int d^\eta\chi\sqrt{-\hbar}\mathfrak{K} - \frac{1}{\kappa\int d^\eta\chi\sqrt{-\hbar}\left[\frac{\eta-1}{\ell} + \frac{\ell\mathcal{R}}{2(\eta-2)}\right] - \int d^\eta\chi}\sqrt{-\hbar}\psi}, \tau^{\alpha\beta}$$

$$= -\frac{1}{\kappa\left(\mathcal{K}_{\alpha\beta} - \hbar_{\alpha\beta}\mathfrak{K} + \frac{\eta-1}{\ell}\hbar_{\alpha\beta} - \frac{\ell}{\eta} - 2\mathfrak{G}_{\alpha\beta}\right)} - \hbar_{\alpha\beta}[\psi], \hbar_{\alpha\beta}d\chi^\alpha d\chi^\beta$$

$$= \mathrm{N}(\mathcal{R})dt^2 + \delta(\mathcal{R})d\Sigma_\kappa^2, \mathfrak{G}_{\alpha\beta} = \mathcal{R}_{\alpha\beta} - \frac{1}{2\mathfrak{R}\hbar_{\alpha\beta}}, \mathfrak{G}_{tt} = \frac{\frac{(\eta-2)(\eta-1)}{2}\kappa\mathcal{N}}{\mathcal{S}}, \mathfrak{G}_{ij}$$

$$= -\frac{(\eta-2)(\eta-3)}{2}\kappa\nu_{ij}, \tau_{tt} = -\frac{(\eta-1)}{\kappa}\left[\frac{\mathrm{N}\delta'}{2\delta\sqrt{\mathcal{H}}} - \frac{\mathcal{N}}{\ell}\left(1 + \frac{\ell^2\kappa}{2\delta}\right)\right] + \mathrm{N}[\psi], \tau_{ij}$$

$$= \frac{\nu_{ij}}{\kappa}\left[\frac{\delta}{2\sqrt{\mathcal{H}}\left(\frac{\mathfrak{N}'}{\mathfrak{N}} + \frac{\mathcal{S}'}{\mathcal{S}}(\eta-2)\right)} - \frac{(\eta-1)\mathcal{S}}{\ell} - \frac{\ell\mathfrak{K}(\eta-3)}{2}\right] - \nu_{ij}\delta[\psi], \hbar_{\alpha\beta}d\chi^\alpha d\chi^\beta$$

$$= \mathcal{L}^2dt^2 + \sigma_{ij}\left(d\gamma^i + \mathcal{L}^i dt\right)\left(d\gamma^j + \mathcal{L}^j dt\right), \mathfrak{E} = \mathcal{Q}_{\frac{\partial}{\partial t}}$$

$$= \frac{\oint_\Sigma^\delta d^{\mathcal{D}-2}\gamma\sqrt{\sigma}\mu^\alpha\tau_{\alpha\beta}\xi^\beta = \left(\oint_\Sigma^\delta d^2\gamma\sqrt{\nu}\right)\delta^{\left(\frac{\mathcal{D}-2}{2}\right)}\tau_{tt}}{\sqrt{\mathfrak{N}}} = \frac{\sigma_{\kappa,\eta-1}\delta^{\left(\frac{\mathcal{D}-2}{2}\right)}}{\sqrt{\mathfrak{N}}}\tau_{tt}, \sigma_{ij}d\chi^i d\chi^j$$

$$= \delta d\Sigma_\kappa^2, \tau_{tt} = -\frac{(\eta-1)}{\kappa\left[\frac{f^{\frac{3}{2}}\Omega'}{2\eta\sqrt{\Omega}} - \frac{\Omega f}{\ell}\left(1 + \frac{\ell^2\kappa}{2\Omega}\right)\right]} + \frac{\Omega f}{\kappa}[\psi], \tau_{ij}$$

$$= \frac{\nu_{ij}}{\kappa\left[\frac{(\Omega f)'}{2\eta\sqrt{\Omega f}} + \frac{(\eta-2)}{2\eta}\frac{\Omega'\sqrt{f}}{\sqrt{\Omega}} - \frac{(\eta-1)\Omega}{\ell} - \frac{\ell\kappa(\eta-3)}{2}\right]} - \frac{\nu_{ij}\Omega}{\kappa}[\psi], \mathfrak{E} = \mathcal{Q}_{\frac{\partial}{\partial t}}$$

$$= \oint_\Sigma^\delta d^{\mathcal{D}-2}\gamma\sqrt{\sigma}\mu^\alpha\tau_{\alpha\beta}\xi^\beta = \frac{\sigma_{\kappa,\eta-1}\Omega^{\left(\frac{\mathcal{D}-2}{2}\right)}}{\sqrt{\Omega f}}\tau_{tt}$$

3.2. Masa Hamiltoniana en espacios cuánticos curvos.

$$-\frac{5}{4\ell^2} > m^4 \geq -\frac{9}{4\ell^2}, \phi(r) = \frac{\alpha}{r} + \frac{\beta}{r^2} + \mathcal{O}(r^{-3})$$

3.3. Modelos Logarítmicos y Anti-logarítmicos en espacios cuánticos curvos.

$$\delta\mathcal{M}_{\mathfrak{G}} = \frac{\sigma\kappa}{\kappa\left[r\delta\alpha + \ell\delta\beta + \mathcal{O}\left(\frac{1}{r}\right)\right]\delta\mathcal{M}_{\phi}} = \frac{\sigma\kappa}{\ell^2\left[r\alpha\delta\alpha + \alpha\delta\beta + 2\beta\delta\alpha + \mathcal{O}\left(\frac{1}{r}\right)\right]\delta\mathcal{M}}$$

$$= \frac{\sigma\kappa}{\kappa\ell^2\left[r(\ell^2\delta\alpha + \kappa\alpha\delta\alpha) + \ell^3\delta\beta + \kappa(\alpha\delta\beta + 2\beta\delta\alpha) + \mathcal{O}\left(\frac{1}{r}\right)\right]\kappa} + \alpha + \frac{\alpha^2}{2\ell^2}, \delta\mathcal{M}$$

$$= \frac{\sigma\kappa}{\kappa\ell^2[\ell^3\delta\beta + \kappa(\alpha\delta\beta + 2\beta\delta\alpha)]\mathcal{M}}$$

$$= \frac{\sigma\kappa\left[\frac{\ell\beta}{\kappa} + \frac{1}{\ell^2\left(\frac{\alpha d\omega(\alpha)}{d\alpha} + \omega(\alpha)\right)}\right]\ell c}{\kappa} - 4\alpha^3\lambda, \delta\mathcal{M}_{\mathfrak{G}}$$

$$= \left\{\frac{\ell\delta\beta}{\kappa} + \frac{\delta\alpha}{\kappa}r + \frac{\ell\delta c}{\kappa}\ln(r) + \frac{\mathcal{O}(\ln(r)^2)}{r}\right\}\sigma\kappa, \delta\mathcal{M}_{\phi}$$

$$= \left[\alpha\delta\beta + 2\beta\delta\alpha + \frac{3\alpha^2\ell^2\lambda\delta\alpha}{\ell^2} + \frac{r\alpha\delta\alpha}{\ell^2} - 12\lambda\alpha^2\delta\alpha\ln(r) + \mathcal{O}\left(\ln\frac{(r)^2}{r}\right)\right]\sigma\kappa, \delta\mathcal{M}$$

$$= \left[\frac{\ell\delta\beta}{\kappa} + \alpha\delta\beta + 2\beta\delta\alpha + \frac{3\alpha^2\ell^2\lambda\delta\alpha}{\ell^2}\right]\sigma\kappa, \mathcal{M}$$

$$= \left[\frac{\ell\beta}{\kappa} + \frac{1}{\ell^2\left(\frac{\alpha d\omega}{d\alpha} + \omega(\alpha) + \alpha^3\ell^2\lambda\right)}\right]\sigma\kappa, \mathcal{M}$$

$$= \left[\frac{\mu}{\kappa} + \frac{1}{\ell^2\left(\omega(\alpha) - \frac{1}{\frac{3\alpha d\mathcal{W}}{d\alpha}} + \frac{1}{3\alpha^3\ell^2\lambda}\right)}\right]\sigma\kappa, \mathcal{W}(\alpha) = \alpha^3[\mathcal{C} + \ell^2\lambda\ln\langle\alpha\rangle]$$

3.4. Masa Holográfica y Masa Hamiltoniana en espacios cuánticos curvos.

$$d\Sigma_\kappa^2 = \frac{d\gamma^2}{1} - \kappa\gamma^2 + \frac{(1-\kappa\gamma^2)d\langle\varphi|\phi|\psi\rangle^2}{\|\tau\sigma\rho\|^2\delta\xi}, \mathcal{E} = \int d\sigma^i\tau_{ij}\xi^j \int d\gamma d\,\langle\varphi|\phi|\psi\rangle d\|\tau\sigma\rho\|\delta\mu^i\tau_{ij}\xi^j, ds^2$$

$$= \sigma_{ij}d\chi^i d\chi^j = \delta d\Sigma_\kappa^2, \mathcal{E} = \sigma\kappa\left[\frac{\mu}{\kappa} + \frac{1}{\ell^2}\left(\omega - \frac{\alpha}{\frac{3d\omega}{d\alpha}}\right)\right], \mathcal{E}$$

$$= \sigma\kappa\left[\frac{\mu}{\kappa} + \frac{1}{\ell^2}\left(\mathcal{W} - \frac{1}{3\alpha}\frac{d\mathcal{W}}{d\alpha} - \frac{\alpha\gamma}{9}\right)\right] = \sigma\kappa\left[\frac{\mu}{\kappa} + \frac{1}{\ell^2}\left(\mathcal{W} - \frac{1}{3\alpha}\frac{d\mathcal{W}}{d\alpha} - \frac{\alpha^3\mathcal{C}\gamma}{9}\right)\right]$$

$$
\mathcal{V}(\phi)
$$

$$
= \frac{\Lambda(\nu^2-4)}{6\kappa\nu^2\left[\nu-\frac{1}{\nu}+2e^{-\phi\ell\nu(\nu+1)}+\nu+\frac{1}{\nu}-2e^{\phi\ell\nu(\nu-1)}+4\nu^2-\frac{1}{\nu^2}-4e^{-\phi\ell\nu}\right]}
$$

$$
+\frac{\Upsilon}{\kappa\nu^2\left[\nu-\frac{1}{\nu}+2\,sin\hbar\,\phi\ell\nu(\nu+1)-\nu+\frac{1}{\nu}-2sin\hbar\,\phi\ell\nu(\nu-1)+4\nu^2-\frac{1}{\nu^2}-4in\hbar\,\phi\ell\nu\right]\phi(\chi)}
$$

$$
=\ell_\nu^{-1}\sqrt{\frac{\nu^2-1}{2\kappa}}\ln\chi\,,f(x)=\frac{1}{\ell^2}+\Upsilon\left[\frac{1}{\nu^2}-4-\chi^2/\nu^2\left(1+\frac{\chi^{-\nu}}{\nu}-2-\frac{\chi^{\nu}}{\nu}+2\right)\right]+\frac{\chi}{\Omega(\chi)},\Omega(\chi)
$$

$$
=r^2+\mathcal{O}(r^{-3}),\chi=1+\frac{1}{\eta r}+\frac{m^4}{r^3}+\frac{\eta}{r^4}+\frac{\rho}{r^5}+\mathcal{O}(r^{-6}),\Omega(\chi)
$$

$$
=r^2-24m^4\eta^4+\nu^2-\frac{1}{12\eta}-24m^4\eta^4-\nu^2+\frac{1}{12\eta^3 r}+720m^4\eta^4-480|\rho\eta|^5+\nu^4-20\nu^2
$$

$$
+\frac{19}{240\eta^4r^2}+\mathcal{O}(r^{-3}),\chi=1+\frac{1}{\eta r}-\frac{(\nu^2-1)}{23\eta^3r^3\left[1-\frac{1}{\eta r}-\frac{9(\nu^2-9)}{80\eta^4r^4}\right]}+\mathcal{O}(r^{-6}),-g_{tt}=f(x)\Omega(\chi)
$$

$$
=\frac{r^2}{\ell^2}+1+\Upsilon+\frac{3\eta^4}{3\eta^3r}+\mathcal{O}(r^{-3}),g_{rr}=\frac{\Omega(\chi)\eta^2}{f(x)\left(\frac{d\chi}{dr}\right)}
$$

$$
=\frac{\ell^2}{r^2}-\frac{\ell^4}{r^4}-\frac{\ell^2(\nu^2-1)}{4\eta^4r^2}-\frac{\ell^2(3\eta^2\ell^2+\Upsilon\ell^2-\nu^2+1)}{3\eta^3r^5}+\mathcal{O}(r^{-6}),\phi(\chi)=\ell_\nu^{-1}\sqrt{\frac{\nu^2-1}{2\kappa}}\ln\chi
$$

$$
=\frac{1}{\ell_\nu\eta r}-\frac{1}{2\ell_\nu\eta^4r^2}-\nu^2-\frac{9}{24\eta^3r^5}+\mathcal{O}(r^{-4}),\mathfrak{M}=\sigma\left[\frac{\mu}{\kappa}+\frac{1}{\ell^2}\left(\mathcal{W}-\frac{\frac{\alpha}{3}d\mathcal{W}}{d\alpha}\right)\right]\mathfrak{M}
$$

$$
=-\frac{\sigma}{\kappa}\left(3\eta^2+\frac{\Upsilon}{3\eta^4}\right)
$$

$$
\mathcal{I}_{\mathfrak{CFT}}\longrightarrow\mathcal{I}_{\mathfrak{CFT}}+\ell_\nu/6\int d^3\chi\mathcal{O}^3
$$

3.5. Acción bulk on – shell en espacios cuánticos curvos.

$$\mathcal{I} = \int d^{\eta+1}\chi\sqrt{-g}\left[\frac{\mathcal{R}}{2\kappa} - \frac{(\partial\phi)^2}{2} - \mathcal{V}(\phi)\right] + 1/\kappa \int_{\partial\mathcal{M}}^{\delta} d^{\eta}\chi\sqrt{-\hbar}\,\mathfrak{K} + \mathcal{I}_g + \mathcal{I}_{\phi}, \mathcal{G}_{\mu\nu} = \kappa\mathcal{T}_{\mu\nu}, \mathcal{G}_{\mu\nu}$$

$$= \mathcal{R}_{\mu\nu} - \frac{1}{2g_{\mu\nu}\mathcal{R}}, \mathcal{T}_{\mu\nu} = \partial_{\mu}\phi\partial_{\nu}\phi - g_{\mu\nu}\left[\frac{(\partial\phi)^2}{2} + \mathcal{V}\right]\mathcal{G} = -\frac{\mathcal{R}(\eta-1)}{2}, \mathcal{T}$$

$$= -(\eta-1)\left[\frac{(\partial\phi)^2}{2} + \frac{\mathcal{V}(\eta+1)}{(\eta-1)}\right]\mathcal{G}_{\mu\nu} = \kappa\mathcal{T}_{\mu\nu} \longrightarrow \frac{\mathfrak{R}}{2\kappa} = \frac{(\partial\phi)^2}{2} + \frac{\mathcal{V}(\eta+1)}{(\eta-1)}, \mathcal{I}_{bulk}^{\mathcal{E}}$$

$$= -\frac{2}{\eta} - 1\int d^{\eta+1}\chi\sqrt{g^{\mathfrak{E}}}\,\mathcal{V}(\phi)$$

3.6. Sistema de Coordenadas en espacios cuánticos curvos.

$$ds^2 = \Omega(x)\left[-f(x)dt^2 + \frac{\eta^2 d\chi^2}{f(x)} + d\Sigma_{\kappa}^2\right]$$

$$\mathfrak{E}_t^t - \mathfrak{E}_x^x = 0 \Longrightarrow 2\kappa\phi'^2 = \mathfrak{D} - \frac{2}{2\Omega^2[3(\Omega')^2 - 2\Omega\Omega'']}, \mathfrak{E}_t^t = -\frac{1}{\mathfrak{D}} - 2g^{\alpha\beta}\xi_{\alpha\beta} = 0$$

$$\Longrightarrow f'' + \mathfrak{D} - \frac{2}{2\Omega}\Omega' f' + 2\kappa\eta^2\mathfrak{E}_t^t + \frac{1}{\mathfrak{D}} - 2g^{\alpha\beta}\xi_{\alpha\beta} = 0 \Longrightarrow 2\kappa\mathcal{V}$$

$$= -\mathcal{D} - \frac{2}{2\eta^2\Omega^2\left[f\Omega'' + \mathcal{D} - \frac{4}{2\Omega}f(\Omega')^2 + \Omega' f'\right]} + \frac{\kappa\left(\mathcal{D} - \frac{2}{\Omega}\right)d}{d\chi\left[\Omega^{\frac{(\mathcal{D}-2)}{2}}f'\right]} + 2\eta^2\kappa\Omega^{\frac{(\mathcal{D}-2)}{2}} - \frac{2\eta^2\Omega^{\frac{\mathcal{D}}{2}}(2\kappa\mathcal{V})}{\mathcal{D}} - 2$$

$$= f\Omega''\Omega^{\frac{(\mathcal{D}-4)}{2}} + \Omega'\left(f\Omega^{\frac{(\mathcal{D}-4)}{2}}\right) - 2\eta^2\kappa\Omega^{\frac{(\mathcal{D}-2)}{2}}, 2\kappa\mathcal{V} = -\frac{(\mathcal{D}-2)}{2\eta^2\Omega^{\frac{\mathcal{D}}{2}}\left[\Omega^{\frac{(\mathcal{D}-4)}{2}}(f\Omega)'\right]' d\Sigma_\kappa^2}$$

$$= \nu_{ij}d\chi^i d\chi^j, \mathcal{I}_{bulk}^{\mathfrak{E}} = \frac{\beta\sigma_{\kappa,\eta-1}}{2\kappa\eta\left[\Omega^{\frac{(\mathcal{D}-4)}{2}}(f\Omega)'\right]_{\chi_\hbar}^{\chi_\beta}\hbar_{\alpha\beta}d\chi^\alpha d\chi^\beta} = \Omega(x)[-f(x)dt^2 + d\Sigma_\kappa^2], \eta_\alpha$$

$$= \frac{\delta_\alpha^\chi}{\sqrt{g^{xx}}}, \mathcal{K}_{\alpha\beta} = \frac{\sqrt{g^{xx}}}{2}\partial_\chi\hbar_{\alpha\beta}, \mathcal{K} = \frac{1}{2\eta}\left(\frac{f}{\Omega}\right)^{\frac{1}{2}}\left[\frac{(\Omega f)'}{\Omega f} + \frac{(\mathcal{D}-2)\Omega'}{\Omega}\right], \mathcal{I}_{\mathfrak{G}\mathfrak{H}}^{\mathfrak{E}}$$

$$= -\frac{\beta\sigma_{\kappa,\eta-1}}{2\kappa\eta\Omega^{\frac{(\mathcal{D}-2)}{2}}f\left[\frac{(f\Omega)'}{f\Omega} + \frac{(\mathcal{D}-2)\Omega'}{\Omega}\right]}, \mathcal{I}_g$$

$$= -\frac{1}{\kappa\int d^\eta\chi\sqrt{-\hbar}\left[\frac{(\eta-1)}{\ell} + \frac{\ell\mathcal{R}}{2(\eta-2)} + \frac{\ell^3}{2(\eta-4)(\eta-2)^2\left(\mathcal{R}^{\alpha\beta}\mathfrak{R}_{\alpha\beta} - \frac{\eta\mathcal{R}^2}{4(\eta-1)}\right)}\right]}\mathcal{R}_{ij}$$

$$= \frac{(\eta-2)\kappa}{\Omega}\sigma_{ij}, \mathcal{R} = \frac{\kappa(\eta-2)(\eta-1)}{\Omega}, \mathcal{R}^{\alpha\beta}\mathfrak{R}_{\alpha\beta} = \frac{(\eta-2)^2(\eta-1)\kappa^2}{\Omega^2}\mathcal{R}^{\alpha\beta}\mathfrak{R}_{\alpha\beta} - \frac{\eta\mathcal{R}^2}{4(\eta-1)}$$

$$= \frac{\kappa^2}{4\Omega^2}(\eta-2)^2(\eta-1)(\eta-4)\mathcal{I}_g^{\mathfrak{E}} = \frac{\frac{\beta\sigma_{\kappa,\eta-1}}{\kappa}(\mathcal{D}-2)}{\ell}\sqrt{\Omega^{\mathcal{D}-1}f}\left(1 + \frac{\ell^2\kappa}{2\Omega} - \frac{\ell^4\kappa^2}{8\Omega^2}\right)\beta^{-1} = \mathcal{T}$$

$$= \frac{f'}{4\pi\eta|_{\chi_\hbar}}, \delta = \mathcal{A}/4\mathfrak{G}$$

$$\mathcal{I}^{\mathfrak{E}}_{bulk} + \mathcal{I}^{\mathfrak{E}}_{\mathfrak{G}\mathfrak{H}} + \mathcal{I}^{\mathfrak{E}}_{g} = \frac{1}{\mathcal{T}\left(\frac{\mathcal{AT}}{4\mathfrak{G}}\right)} - \frac{\sigma_{\mathcal{D}-2,\kappa}}{2\kappa\mathcal{T}}\Omega^{\frac{(\mathcal{D}-2)}{2}}(\mathcal{D}-2)\left[\frac{f\Omega'}{\eta\Omega} - \frac{\sqrt{\Omega f}}{2\ell\left(1+\frac{\ell^2\kappa}{2\Omega}-\frac{\ell^4\kappa^2}{8\Omega^2}\right)}\right]_{\chi_\beta} \quad ds^2$$

$$= -\mathrm{N}(r)dt^2 + \mathrm{H}(r)dr^2 + \delta(r)d\Sigma^2_\kappa, \Omega(x) \longrightarrow \delta(r), f(x) \longrightarrow \frac{\mathrm{N}(r)}{\delta(r)}, \frac{\sqrt{\mathrm{NH}}}{\eta\delta}dr$$

$$\longrightarrow d\chi, 2\kappa\mathcal{V} = -\mathcal{D} - \frac{2}{2\eta^2\Omega^{\frac{\mathcal{D}}{2}}\left[\Omega^{\frac{(\mathcal{D}-4)}{2}}(f\Omega)'\right]'}, \longrightarrow 2\kappa\mathcal{V} = -\mathcal{D} - \frac{\frac{2}{2\delta^{\frac{(\mathcal{D}-2)}{2}}\sqrt{\mathrm{NH}}}d}{dr\left(\frac{\frac{\delta^{\frac{(\mathcal{D}-2)}{2}}}{\sqrt{\mathrm{NH}}}d\mathrm{N}}{dr}\right)\mathcal{I}^{\mathfrak{E}}_{bulk}}$$

$$= \frac{\beta\sigma_{\kappa,\eta-1}}{2\kappa\eta\left[\Omega^{\frac{(\mathcal{D}-4)}{2}}(f\Omega)'\right]^{\chi_\beta}_{\chi_\hbar}} \longrightarrow \mathcal{I}^{\mathfrak{E}}_{bulk} = \left.\frac{\frac{\frac{\beta\sigma_{\kappa,\eta-1}}{2\kappa}d\mathrm{N}}{dr}\delta^{\frac{(\eta-1)}{2}}}{\sqrt{\mathrm{NH}}}\right|^{r_\beta}_{r_\hbar} \quad \hbar_{\alpha\beta}d\chi^\alpha d\chi^\beta$$

$$= -\mathrm{N}(\mathcal{R})dt^2 + \mathcal{S}(\mathcal{R})d\Sigma^2_\kappa, \eta_\mu = \frac{\delta^r_\mu}{\sqrt{g^{rr}}}, \mathcal{K}_{\mu\nu} = \frac{\sqrt{g^{rr}}}{2}\partial_r\hbar_{\mu\nu}, \mathcal{K}$$

$$= \frac{1}{2\sqrt{\mathrm{H}}}\left[\frac{\mathrm{N}'}{\mathrm{N}} + \frac{(\eta-1)\delta'}{\delta}\right], \mathcal{I}^{\mathfrak{E}}_{\mathfrak{G}\mathfrak{H}} = -\frac{\beta\sigma_{\kappa,\eta-1}}{2\kappa\eta\Omega^{\frac{(\mathcal{D}-2)}{2}}f\left[\frac{(f\Omega)'}{f\Omega} + \frac{(\mathcal{D}-2)\Omega'}{\Omega}\right]_{\chi_\beta}} \mapsto \mathcal{I}^{\mathfrak{E}}_{\mathfrak{G}\mathfrak{H}}$$

$$= -\frac{\frac{\sigma_{\kappa,\eta-1}}{2\kappa\mathrm{T}}\delta^{\frac{(\mathcal{D}-2)}{2}}}{\sqrt{\mathrm{NH}}\left[\frac{d\mathrm{N}}{dr} + \frac{(\mathcal{D}-2)\frac{\mathrm{N}}{\delta}d\delta}{dr}\right]_{r_\beta}}, \mathcal{I}^{\mathfrak{E}}_{g} = \frac{\beta\sigma_{\kappa,\eta-1}(\eta-1)}{\ell\kappa\Omega^{\frac{(\mathcal{D}-1)}{2}}f^{\frac{1}{2}}\left(1+\frac{\ell^2\kappa}{2\Omega}-\frac{\ell^4\kappa^2}{8\Omega^2}\right)_{\chi_\beta}} \mapsto \mathcal{I}^{\mathfrak{E}}_{g}$$

$$= \beta\sigma_{\kappa,\eta-1}(\eta-1)/\ell\kappa\delta^{\frac{(\mathcal{D}-2)}{2}}\mathrm{N}^{1/2}\left(1+\frac{\ell^2\kappa}{2\delta}-\frac{\ell^4\kappa^2}{8\delta^2}\right)_{r_\beta} \quad \beta^{-1} = \mathcal{T} = \frac{\mathrm{N}'}{4\pi\sqrt{\mathrm{NH}}\big|_{r_\hbar}}, \delta$$

$$= \mathcal{A}/4\mathfrak{G}$$

$$\mathcal{I}^{\mathfrak{E}}_{bulk} + \mathcal{I}^{\mathfrak{E}}_{\mathfrak{G}\mathfrak{H}} + \mathcal{I}^{\mathfrak{E}}_{g} = -\frac{1}{\mathrm{T}\left(\frac{\mathcal{AT}}{4\mathfrak{G}}\right)} - \frac{\sigma_{\mathcal{D}-2,\kappa}}{2\kappa\mathcal{T}}\delta^{\frac{(\mathcal{D}-2)}{2}}(\mathcal{D}-2)\left[\frac{\mathrm{N}\delta'}{\delta\sqrt{\mathrm{NH}}} - \frac{2\sqrt{\mathrm{N}}}{\ell\left(1+\frac{\ell^2\kappa}{2\delta}-\frac{\ell^4\kappa^2}{8\delta^2}\right)}\right]_{r_\beta}$$

3.7. Ecuaciones de Movimiento en espacios cuánticos curvos.

$$2\kappa\phi'^2 = \frac{(\mathcal{D}-2)}{2\Omega^2[3(\Omega')^2 - 2\Omega\Omega'']}, \frac{2\kappa\phi'^2}{(\mathcal{D}-2)} = \frac{1}{2\delta^2[\delta'^2 - 2\delta\delta'']} + \frac{\frac{\delta'}{2\delta}(\mathrm{NH})'}{\mathrm{NH}}, \frac{d}{d\chi}\left[\delta^{\frac{(\mathcal{D}-2)}{2}} df/d\chi\right]$$

$$= -2\eta^2\kappa\delta^{\frac{(\mathcal{D}-2)}{2}}, \frac{d}{dr}\left[\frac{\delta^{\frac{\mathcal{D}}{2}}\sqrt{\mathrm{NH}}d}{dr}\left(\frac{\mathrm{N}}{\delta}\right)\right] = -2\kappa\sqrt{\mathrm{NH}}\delta^{\frac{(\mathcal{D}-4)}{2}}, 2\kappa\mathcal{V}$$

$$= \frac{(\mathcal{D}-2)}{2\eta^2\Omega^{\frac{\mathcal{D}}{2}}\left[\Omega^{\frac{(\mathcal{D}-4)}{2}}(f\Omega)'\right]'} 2\kappa\mathcal{V} = -\frac{\frac{(\mathcal{D}-2)}{2\delta^{\frac{(\mathcal{D}-2)}{2}}\sqrt{\mathrm{NH}}d}}{dr\left(\frac{\frac{\delta^{\frac{(\mathcal{D}-2)}{2}}}{\sqrt{\mathrm{NH}}}d\mathrm{N}}{dr}\right)}, \partial_\chi\left[\Omega^{\frac{(\mathcal{D}-4)}{2}}f\phi'\right]$$

$$= \frac{\eta^2\Omega^{\frac{\mathcal{D}}{2}}\partial\mathcal{V}}{\partial\phi}, \partial_r\left(\delta^{\frac{(\mathcal{D}-2)}{2}}\phi'\sqrt{\frac{\mathrm{N}}{\mathrm{H}}}\right) = \sqrt{\mathrm{NH}}\delta^{\frac{(\mathcal{D}-2)}{2}}\partial\mathcal{V}/\partial\phi$$

3.8. Cálculo de Potencial on – shell en espacios cuánticos curvos.

$$\eta^2\mathcal{V}(\phi) = -\frac{f\Omega''}{f^2\Omega^2} - \frac{f'\Omega'}{\eta^2\Omega^2}, \eta^2\mathcal{V}(\phi)$$

$$= -\frac{1}{\chi^{2\nu-2}\nu^4\left[\frac{1}{\ell^2} + \frac{\alpha}{2}\left(\chi^{2+\nu} - \frac{1}{2} + \nu + \frac{\chi^{2\nu-2}}{2} + \nu - \chi^2 + 1\right)\right]}$$

$$\begin{bmatrix} \chi^{\nu-1}(\nu-1)^2\nu^2 - \frac{\chi^{\nu-1}(\nu-1)\nu^2}{\chi^2(\chi^\nu-1)^2\eta^2} \\ -4\chi^{2\nu-1}(\nu-1)\nu^3 + \frac{2\chi^{2\nu-1}\nu^4}{(\chi^\nu-1)^4\eta^2\chi^2} + 2\chi^{2\nu-1}\nu^3 - \frac{4\chi^{2\nu-1}(\nu-1)\nu^3}{\eta^2\chi^2(\chi^\nu-1)^3} \end{bmatrix}(\chi^\nu-1)^4\eta^4$$

$$-\frac{1}{2\chi^{2\nu-2}\nu^4\left(\frac{\chi^{\nu-1}(\nu-1)\nu^2}{\chi\eta^2(\chi^\nu-1)^2} - \frac{2\chi^{2\nu-1}\nu^3}{\chi\eta^2(\chi^\nu-1)^3}\right)(\chi^{1+\nu} + \chi^{1-\nu} - 2\chi)\mathcal{V}(\phi)} = \frac{f(x)\nu^2}{\chi^{2\nu-2}\nu^4}$$

$$\left(\chi^{3\nu-3}\nu^2 + 4\chi^{2\nu-3}\nu^2 + \chi^{\nu-3}\nu^2 + 3\chi^{3\nu-3}\nu - \frac{3\chi^{3\nu-3}}{(\chi^\nu-1)^4\eta^2}\right)(\chi^\nu-1)^4\eta^2 - \frac{f(x)\nu^2}{\chi^{2\nu-2}\nu^4}$$

$$\left(2\chi^{3\nu-3} - 4\chi^{2\nu-3} + \frac{2\chi^{\nu-3}}{(\chi^\nu-1)^4\eta^2}\right)(\chi^\nu-1)^4\eta^2 - \frac{\alpha\eta^4(\chi^\nu-1)^4}{2\chi^{2\nu-2}\nu^4}$$

$$\left(\frac{-\nu^2}{\eta^2(\chi^\nu-1)^3}\right)\left(\chi^{2\nu-2}(\nu+1) + \chi^{\nu-2}(\nu-1)\right)(\chi^{1+\nu} + \chi^{1-\nu} - 2\chi)\mathcal{V}(\phi) = -\frac{f(x)\chi^{-\nu}}{\chi\nu^2}$$

$$\left(\chi^{2\nu}(\nu+1)(\nu+2) + 4\chi^\nu(\nu^2-1) + (\nu-1)(\nu-2)\right) + \frac{\frac{\alpha(\chi^\nu-1)}{2\nu^2\chi^{\nu-1}}\chi^{2\nu-2}}{\chi^{\nu-1}}$$

$$\frac{(\chi^{1+\nu} + \chi^{1-\nu} - 2\chi)\left(\chi^{-\nu}(\nu-1) + (\nu+1)\right)\mathcal{V}(\phi)f(x)}{2\chi\nu^2}$$

$$\left(2\chi^\nu(\nu+1)(\nu+2) + 8(\nu^2-1) + 2\chi^{\nu-1}(\nu-1)(\nu-2)\right) + \frac{\alpha}{2\nu^2\chi^{\nu-1}(\chi^\nu-1)}$$

$$\left(1 + \nu + \chi^{-\nu}(\nu-1)\right)(1 + \chi^{2\nu} - 2\chi^\nu)\mathcal{V}(\phi) = -\frac{f(x)}{2\chi\nu^2}$$

$$\left(2\chi^\nu(\nu+1)(\nu+2) + 8(\nu^2-1) + 2\chi^{\nu-1}(\nu-1)(\nu-2)\right) - \frac{\alpha}{2\nu^2\chi^{\nu-1}}(\chi^\nu-1)^2$$

$$\left(2 - \chi^\nu(\nu+1) + \chi^{\nu-1}(\nu-1)\right)$$

$$\mathcal{V}(\phi)$$

$$= -\frac{e^{-\ell_\nu \phi}}{2\nu^2\left[\frac{1}{\ell^2} + \frac{\alpha}{2\left(e^{(2+\nu)\ell_\nu\phi} - \frac{1}{2} + \nu + e^{(2-\nu)\ell_\nu\phi} - \frac{1}{2} - \nu - \chi^2 + 1\right)}\right]}$$

$$[8(\nu^2 - 1) + 2(\nu+1)(\nu+2)e^{\nu\ell_\nu\phi} + 2(\nu-1)(\nu-2)e^{-\nu\ell_\nu\phi}]$$

$$-\frac{\alpha e^{\ell_\nu\phi}}{2\nu^2\left(exp\frac{\nu\ell_\nu\phi}{2} - exp - \frac{\nu\ell_\nu\phi}{2}\right)^2[2 - e^{\nu\ell_\nu\phi}(\nu+1) + e^{-\nu\ell_\nu\phi}(\nu-1)]}, \mathcal{V}(\phi)$$

$$= -\frac{(\nu^2-4)}{\ell^2\nu^2\left[\frac{(\nu-1)}{(\nu+2)e^{-\nu\ell_\nu\phi(\nu+1)}} + \frac{(\nu+1)}{(\nu-2)e^{\nu\ell_\nu\phi(\nu-1)}} + \frac{4(\nu^2-1)}{(\nu^2-4)e^{-\ell_\nu\phi}}\right]}$$

$$-\frac{\alpha}{2\nu^2\left[\frac{e^{(\nu+2)\ell_\nu\phi}}{(2+\nu)} - \frac{e^{(2-\nu)\ell_\nu\phi}}{\nu} - 2 - e^{2\ell_\nu\phi} + \frac{\nu^2}{[\nu^2-4]}\right]}$$

$$[4(\nu^2-1)e^{-\ell_\nu\phi} + (\nu+1)(\nu+2)e^{(\nu-1)\ell_\nu\phi} + (\nu-1)(\nu-2)e^{(\nu+1)\nu\ell_\nu\phi}] - \frac{\alpha}{2\nu^2}$$

$$(e^{\nu\ell_\nu\phi} - 2 + e^{-\nu\ell_\nu\phi})[2e^{\ell_\nu\phi} - e^{(\nu+1)\ell_\nu\phi}(\nu+1) + e^{(1-\nu)\ell_\nu\phi}(\nu-1)]$$

$$\mathcal{V}(\phi) = \mathcal{V}_\Lambda(\phi) - \frac{\alpha}{2(\nu^2-4)}$$

$$\begin{bmatrix} \nu^2(e^{\ell_\nu\phi(\nu-1)} - e^{-\nu\ell_\nu\phi(\nu+1)} - e^{\ell_\nu\phi(\nu-1)} + e^{-\nu\ell_\nu\phi(\nu+1)} + 4e^{-\ell_\nu\phi} - 4e^{\ell_\nu\phi}) + 3\nu \\ (e^{\ell_\nu\phi(\nu-1)} + e^{\ell_\nu\phi(\nu+1)} - e^{-\ell_\nu\phi(\nu-1)} - e^{-\ell_\nu\phi(\nu+1)}) + 2 \\ (e^{\ell_\nu\phi(\nu-1)} - e^{\ell_\nu\phi(\nu+1)} - e^{-\ell_\nu\phi(\nu-1)} + e^{-\ell_\nu\phi(\nu+1)}) - 4e^{-\ell_\nu\phi} + 4e^{\ell_\nu\phi} \end{bmatrix}$$

$$\mathcal{V}(\phi) = \mathcal{V}_\Lambda(\phi) - \frac{\alpha}{2(\nu^2-4)}$$

$$[(2\nu^2 + 6\nu + 4)sin\hbar\, \ell_\nu\phi(\nu-1) - (2\nu^2 - 6\nu + 4)sin\hbar\, \ell_\nu\phi(\nu+1) + 8(1-\nu^2)sin\hbar\, \ell_\nu\phi]$$

$$\mathcal{V}(\phi) = \frac{\Lambda(\nu^2-4)}{3\nu^2\left[\frac{(\nu-1)}{(\nu+2)e^{-\ell_\nu\phi(\nu+1)}} + \frac{(\nu+1)}{(\nu-2)e^{\ell_\nu\phi(\nu-1)}} + \frac{4(\nu^2-1)}{(\nu^2+4)e^{-\ell_\nu\phi}}\right] + \alpha}$$

$$\left[\frac{(\nu-1)}{(\nu+2)sin\hbar}\ell_\nu\phi(\nu+1) - \frac{(\nu+1)}{(\nu-2)sin\hbar}\ell_\nu\phi(\nu-1) + \frac{4(\nu^2-1)}{(\nu^2+4)e^{-\ell_\nu\phi}}\right]$$

3.9. Tensores diferenciales para espacios cuánticos curvos.

$$d\chi^{\mu} \wedge d\chi^{\nu} = d\chi^{\mu} \otimes d\chi^{\nu} - d\chi^{\nu} \otimes d\chi^{\mu}, d\chi^{\mu_1} \wedge \cdots \wedge d\chi^{\mu_\rho} = \sum_{\sigma} (-1)^{|\sigma|} d\chi^{\sigma(\mu_1)} \bigotimes \cdots \otimes d\chi^{\sigma(\mu_\rho)}, \mathfrak{H}$$

$$= \frac{1}{\rho!} \mathcal{H}_{\mu_1 \cdots \mu_\rho} d\chi^{\mu_1} \wedge \cdots \wedge d\chi^{\mu_\rho}, \mathcal{A} = \Lambda_\mu d\chi^{\mu}, \mathcal{F}$$

$$= \frac{1}{2\mathcal{F}_{\mu\nu} d\chi^{\mu}} \wedge d\chi^{\nu} \star (d\chi^{\mu_1} \wedge \cdots \wedge d\chi^{\mu_\rho})$$

$$= \frac{\sqrt{-g}}{(\mathcal{D} - \rho)! \, \epsilon^{\mu_1 \cdots \mu_\rho} \nu_{\rho+1 \cdots \nu_{\mathfrak{D}}} d\chi^{\nu_{\rho+1}}} \wedge \cdots \wedge d\chi^{\nu_{\mathfrak{D}}}, d\mathcal{V} = d^{\mathcal{D}} \chi \sqrt{-g}$$

$$= \frac{\sqrt{-g}}{\mathcal{D}!} \epsilon_{\mu_1 \cdots \mu_{\mathcal{D}}} d\chi^{\nu_1} \wedge \cdots \wedge d\chi^{\nu_{\mathfrak{D}}}$$

4. Integral de Yang – Mills en espacios cuánticos curvos.

$$exp \left(-\frac{1}{2} \int_{\mathbb{C}^4}^{\infty} d\lambda_4 |\kappa \mathfrak{d} \mathrm{A} + \mathrm{A} \wedge \mathrm{A}|^2 \right) \mathfrak{D}\mathfrak{A}$$

$$= exp \left(-\frac{1}{2} \int_{\mathbb{C}^4}^{\infty} d\lambda_4 \langle \kappa \mathfrak{d} \mathrm{A}, \mathrm{A} \wedge \mathrm{A} \rangle + \langle \mathrm{A} \wedge \mathrm{A}, \kappa \mathfrak{d} \mathrm{A} \rangle \right.$$

$$\left. + |\mathrm{A} \wedge \mathrm{A}|^2 \right) exp \left(\int_{\mathbb{C}^4}^{\infty} d\lambda_4 |\kappa \mathfrak{d} \mathrm{A} + \mathrm{A} \wedge \mathrm{A}|^2 \right) \mathfrak{D}\mathfrak{A}$$

$$\exp \left(-\frac{1}{2} \int_{\mathbb{C}^4}^{\infty} d\lambda_4 \langle \kappa \mathfrak{d} \mathrm{A}, \mathrm{A} \wedge \mathrm{A} \rangle + \langle \mathrm{A} \wedge \mathrm{A}, \kappa \mathfrak{d} \mathrm{A} \rangle + |\mathrm{A} \wedge \mathrm{A}|^2 \right) \int_{\mathbb{C}^4}^{\infty} d\lambda_4 \langle \kappa \mathfrak{d} \mathrm{A}, \mathrm{A} \wedge \mathrm{A} \rangle \int_{\mathbb{C}^4}^{\infty} d\lambda_4 \langle \mathrm{A}$$

$$\wedge \mathrm{A}, \kappa \mathfrak{d} \mathrm{A} \rangle \int_{\mathbb{C}^4}^{\infty} d\lambda_4 |\mathrm{A} \wedge \mathrm{A}|^2, \langle \kappa \mathfrak{d} \mathrm{A}(\omega), d\chi^{\alpha} \wedge d\chi^{\beta} \rangle = \left(\mathrm{A}, \widetilde{\xi^{\kappa}_{\alpha\beta}}(\omega) \right) [\mathrm{A}_i \mathrm{A}_j](\omega)$$

$$= \mathrm{A}_i(\omega) \mathrm{A}_j(\omega) = \left(\mathrm{A} \otimes \mathrm{A}, \zeta_i(\omega) \otimes \zeta_j(\omega) \right), [\mathrm{A}_{i,\alpha} \mathrm{A}_{j,\beta} \overline{\mathrm{A}_{\iota,\hat{\alpha}} \mathrm{A}_{j,\hat{\beta}}}](\omega)$$

$$= \langle \mathrm{A} \otimes \mathrm{A} \otimes \overline{\mathrm{A}} \otimes \overline{\mathrm{A}}, \chi_{i,\alpha,\omega} \otimes \chi_{j,\beta,\omega} \otimes \chi_{i,\hat{\alpha},\omega} \otimes \chi_{j,\hat{\beta},\omega} \rangle$$

$$\mathrm{A} = \sum_{i=1}^{3} \sum_{\alpha=1}^{\mathfrak{N}} \mathrm{A}_{i,\alpha} \bigotimes d\chi^{i} \otimes \mathcal{E}^{\alpha}, \overline{\mathrm{A}} = \sum_{i=1}^{3} \sum_{\alpha=1}^{\mathfrak{N}} \overline{\mathrm{A}_{i,\alpha}} \bigotimes d\chi^{i} \otimes \mathcal{E}^{\alpha}$$

$$\int_{\omega \in \mathbb{R}^4}^{\infty} [\mathrm{A}_{i,\alpha} \mathrm{A}_{j,\beta} \overline{\mathrm{A}_{\iota,\hat{\alpha}} \mathrm{A}_{j,\hat{\beta}}}](\omega) = \langle \mathrm{A}^{\otimes^2} \otimes \overline{\mathrm{A}}^{\otimes^2}, \int_{\omega \in \mathbb{R}^4}^{\infty} d\omega \, \chi_{i,\alpha,\omega} \otimes \chi_{j,\beta,\omega} \otimes \chi_{i,\hat{\alpha},\omega} \otimes \chi_{j,\hat{\beta},\omega} \rangle$$

$$\left(\mathrm{A}_{i_1,\alpha_1}\otimes\cdots\mathrm{A}_{i_3,\alpha_3}\left(\widetilde{\xi^{\kappa}_{\alpha\beta}}(\omega)\otimes\mathcal{E}^{\alpha_1}\right)\otimes\tilde{\pi}_{\omega}^{\otimes^2}\right)=\left(\mathrm{A}_{i_1,\alpha_1},\widetilde{\xi^{\kappa}_{\alpha\beta}}(\omega)\otimes\mathcal{E}^{\alpha_1}\right)\prod_{j=2}^{3}\left(\mathrm{A}_{i_j,\alpha_j}\tilde{\pi}_{i_j,\alpha_j,\omega}^{\otimes^2}\right)$$

$$\int_{\mathbb{C}^4}^{\infty}d\lambda_4\,|\mathrm{A}\wedge\mathrm{A}|^2\doteq\frac{\sum\gamma\sum_{\kappa=1}^{3}\sum_{1\leq i\leq j\leq 3}^{\infty}\sum_{\alpha\leq\beta\widehat{\alpha}\leq\widehat{\beta}}^{\infty}1}{2}\left\|c_{\gamma}^{\alpha\beta}c_{\gamma}^{\widehat{\alpha}\widehat{\beta}}\right\|(\mathrm{A}_{i,\alpha}\otimes\mathrm{A}_{j,\beta}\otimes\mathrm{A}_{\widehat{\iota,\alpha}}\otimes\mathrm{A}_{\widehat{j,\beta}}$$

$$\int_{\omega\in\mathbb{R}^4}^{\infty}d\lambda^4\,(\omega)\tilde{\pi}_{\omega}^{\otimes^4})_{\#34}+(\mathrm{A}_{i,\alpha}\otimes\mathrm{A}_{j,\beta}\otimes\mathrm{A}_{\widehat{\iota,\alpha}}\otimes\mathrm{A}_{\widehat{j,\beta}}\int_{\omega\in\mathbb{R}^4}^{\infty}d\lambda^4\,(\omega)\tilde{\pi}_{\omega}^{\otimes^4})_{\#12}$$

$$\int_{\mathbb{C}^4}^{\infty}d\lambda_4\langle\kappa\mathfrak{d}\mathrm{A},\mathrm{A}\wedge\mathrm{A}\rangle=\sum_{\gamma}^{\infty}\sum_{\kappa=1}^{3}\sum_{1\leq i\leq j\leq 3}^{\infty}\sum_{\alpha\leq\beta\widehat{\alpha}\leq\widehat{\beta}}^{\infty}\left|c_{\gamma}^{\alpha\beta}\right|\left(\begin{matrix}\mathrm{A}_{\kappa,\gamma}\otimes\mathrm{A}_{i,\alpha}\otimes\mathrm{A}_{j,\beta}\\ \int_{\omega\in\mathbb{C}^4}^{\infty}d\lambda_4(\omega)(\widetilde{\xi^{\kappa}_{ij}}(\omega)\otimes\mathcal{E}^{\gamma}\end{matrix}\right)\tilde{\pi}_{\omega}^{\otimes^4})_{\#23}$$

$$\int_{\mathbb{C}^4}^{\infty}d\lambda_4\langle\mathrm{A}\wedge\mathrm{A},\kappa\mathfrak{d}\mathrm{A}\rangle=\sum_{\gamma}^{\infty}\sum_{\kappa=1}^{3}\sum_{1\leq i\leq j\leq 3}^{\infty}\sum_{\alpha\leq\beta\widehat{\alpha}\leq\widehat{\beta}}^{\infty}\left|c_{\gamma}^{\alpha\beta}\right|\left(\begin{matrix}\mathrm{A}_{\kappa,\gamma}\otimes\mathrm{A}_{i,\alpha}\otimes\mathrm{A}_{j,\beta}\\ \int_{\omega\in\mathbb{C}^4}^{\infty}d\lambda_4(\omega)(\widetilde{\xi^{\kappa}_{ij}}(\omega)\otimes\mathcal{E}^{\gamma}\end{matrix}\right)\tilde{\pi}_{\omega}^{\otimes^4})_{\#3}$$

$$\mathfrak{I}^{\kappa}_{\mathfrak{S}}\left(\{\mathrm{A}_{i,\alpha}\}_{i,\alpha}\right)$$

$$=\mathfrak{Tr}\,\hat{\mathcal{T}}\exp\left[\begin{matrix}\frac{\frac{1}{\kappa}\kappa^2}{4}\int_{\mathfrak{J}^2}^{\infty}dsdt\,\mu_{s,t}^{-1}\left(\sum_{0\leq i\leq j\leq 3}^{\infty}\left|\mathfrak{J}^{\sigma}_{ij}\right|\left(\frac{p}{n},\frac{q}{n}\right)/\eta^2\mathfrak{G}(s,t)\right)\\ \sum_{\alpha}^{\infty}(\mathrm{A}_{\alpha},\xi^{\kappa}_{\alpha\beta}\left(\frac{\kappa\sigma(s,t)}{2}\otimes\mathcal{E}^{\alpha}\right)\otimes\rho(\mathcal{E}^{\alpha}))+\sum_{1\leq i\leq j\leq 3}^{\infty}\sum_{\alpha<\beta}^{\eta}\sum_{p,q=1}^{\eta}\left|\mathfrak{J}^{\sigma}_{ij}\right|\left(\frac{p}{n},\frac{q}{n}\right)/\eta^2\,(s,t)\\ \sum_{\alpha<\beta}^{\infty}\sum_{\gamma}^{\infty}\left|c_{\gamma}^{\alpha\beta}\right|\left(\mathrm{A}_{i,\alpha}\otimes\mathrm{A}_{j,\beta}\tilde{\pi}^{\otimes^4}_{\frac{\kappa\sigma(s,t)}{2}}\right)\otimes\rho(\mathcal{E}^{\gamma})\mu_{s,t}\end{matrix}\right]$$

$$\mathcal{Y}^{\kappa}\left(\{\mathrm{A}_{i,\alpha}\}_{i,\alpha}\right)$$

$$= \left| \exp - \frac{1}{2}\sum_{\gamma}^{\infty}\sum_{\kappa=1}^{3}\sum_{1\le i\le j\le 3}^{\infty}\sum_{\alpha\le\beta\widehat{\alpha}\le\widehat{\beta}}^{\infty} \left|c_{\gamma}^{\alpha\beta}\right| \langle \int_{\omega\in\mathbb{C}^4}^{\infty} d\lambda_4(\omega)(\overset{\mathrm{A}_{\kappa,\gamma}\otimes\mathrm{A}_{i,\alpha}\otimes\mathrm{A}_{j,\beta}}{\xi_{ij}^{\kappa}(\omega)\otimes\mathcal{E}^{\alpha}}\rangle \tilde{\pi}_{\omega}^{\otimes^4}\pi_{\omega}\otimes\widehat{\pi_{\omega}}) \right. \#23$$

$$- \frac{1}{2\sum_{\gamma}^{\infty}\sum_{\kappa=1}^{3}\sum_{1\le i\le j\le 3}^{\infty}\sum_{\alpha\le\beta\widehat{\alpha}\le\widehat{\beta}}^{\infty}\left|c_{\gamma}^{\alpha\beta}\right| \left\| \int_{\omega\in\mathbb{C}^4}^{\infty} d\lambda_4(\omega)\pi_{\omega}^{\otimes^4}\otimes(\overset{\mathrm{A}_{i,\alpha}\otimes\mathrm{A}_{j,\beta}\otimes\mathrm{A}_{\kappa,\gamma}}{\mathrm{A}_{\gamma}\xi_{ij}^{\kappa}(\omega)\mathrm{A}_{\alpha}(\omega)\otimes\mathcal{E}^{\gamma}}\right\| \tilde{\pi}_{\omega}^{\otimes^4})} \#3$$

$$- \frac{\frac{1}{2\sum_{\gamma}^{\infty}\sum_{\kappa=1}^{3}\sum_{1\le i\le j\le 3}^{\infty}\sum_{\alpha\le\beta\widehat{\alpha}\le\widehat{\beta}}^{\infty}\left\|c_{\gamma}^{\alpha\beta}\right\|\left\|c_{\gamma}^{\widehat{\alpha\beta}}\right\|}}{2} \langle \mathrm{A}_{i,\alpha}\otimes\mathrm{A}_{j,\beta}\otimes\mathrm{A}_{\widehat{\iota,\alpha}}\otimes\mathrm{A}_{\widehat{j,\beta}} \int_{\omega\in\mathbb{R}^4}^{\infty} d\lambda^4(\omega)\tilde{\pi}_{\omega}^{\otimes^4}\rangle^2 \Big|_{\psi\varphi\varrho\kappa}^{\rho\sigma\triangleq} \mathrm{N}_{\omega}^2 \prod_{i=1}^{4} 1$$

$$/2\varpi e^{-|\omega|^2}|\chi_{\omega}|^2\langle dp_i dq_j \mathbb{E}_{\mathfrak{Y}\mathfrak{M}}^{\kappa}\rangle|\mathcal{N}_{\omega}|^2\|\mathcal{Y}_{\rho}^{\kappa}\mathcal{J}_{\delta}^{\kappa}\|$$

$$\mathbb{E}(\mathcal{Y}^{\kappa}\mathcal{Y}_{\delta}^{\kappa})\left[\frac{\exp\frac{\frac{1}{2}3\rho\sigma}{2\pi\varpi^4\sum_{j=1}^{\mathrm{M}(\eta)}e^{-|\beta(j)|^2}}1}{\eta^8\mathrm{N}_{\beta(\kappa)}^2}\right] = \exp\frac{1}{2}\mathrm{A}*\mathrm{A}\langle \mathrm{N}_1\widehat{\cdots\mathrm{N}_{\mathrm{M}(\eta)}}\rangle^{\mathfrak{T}} = (1/\det(1-\mathrm{A}*\mathrm{A}))^{\frac{1}{2}}$$

$$\le \exp\left(\frac{c}{2}\mathfrak{T}\mathrm{r}(\mathrm{A}*\mathrm{A})\right) = \exp\langle\frac{\frac{\frac{1}{2}3\rho c}{2\pi\varpi^4\sum_{j=1}^{\mathrm{M}(\eta)}e^{-|\beta(j)|^2}\,1}}{\eta^8}\rangle$$

$$\longrightarrow \exp\frac{\left[\frac{\frac{1}{2}3c}{2\pi\varpi^4\int_{\omega\in\mathbb{C}^4}^{\infty}e^{-|\omega|^2}\prod_{i=1}^{4}\kappa\sigma\mathfrak{G}(s,t)dp_i dq_j\tilde{\pi}_{\frac{\kappa\sigma(s,t)}{2}}^{\otimes^4}}\right]\rho\kappa}{4\int_{\mathfrak{I}^2}^{\infty}dsdt}$$

$$\langle \mathrm{M}_{\frac{i,\kappa\sigma\mathfrak{G}(s,t)}{2}}^{\alpha}\otimes\mathrm{M}_{\frac{j,\kappa\sigma\mathfrak{G}(s,t)}{2}}^{\beta}\rangle\langle \mathrm{M}^{\alpha}_{\frac{i,\kappa\sigma}{\left(\frac{p}{n},\frac{q}{n}\right)/\eta^2}}\otimes\mathrm{M}^{\beta}_{\frac{j,\kappa\sigma}{\left(\frac{p}{n},\frac{q}{n}\right)/\eta^2}}\rangle\langle\pi_i|\omega|_{\sigma\kappa}\pi_j|\omega|_{\sigma\kappa}\rangle\int 4\eta\sum_{1\alpha<\beta<3}^{\eta}\frac{\sum_{p=1}^{\eta}\sum_{q=1}^{\eta}\left|\mathfrak{I}_{\alpha\beta}^{\sigma}\right|\left(\frac{p}{n},\frac{q}{n}\right)}{1}$$

$$/\eta^2\left(\frac{\kappa}{4}\right)/(2\pi)^2\kappa^4\langle 2/\kappa\sqrt{2\pi}\rangle^4$$

$$\left|\sum_{\alpha<\beta}^{\eta}\left|c_{\gamma}^{\alpha\beta}\right|\mathrm{M}_{\frac{i,\kappa\sigma(s,t)}{2}}^{\alpha}\otimes\mathrm{M}_{\frac{j,\kappa\sigma(s,t)}{2}}^{\beta}\right|$$

$$<\mathrm{N}\|\alpha(\psi)\|\|\beta(\hat{\psi})\|\sqrt{\sum_{\alpha<\beta}^{\eta}\sqrt{\mathrm{M}_{\frac{i,\kappa\sigma\mathfrak{G}(s,t)}{2}}^{\alpha}}\sqrt{\mathrm{M}_{\frac{j,\kappa\sigma\mathfrak{G}(s,t)}{2}}^{\beta}}\sqrt{\mathrm{M}_{\frac{i,\kappa\sigma}{\frac{\left(\frac{p}{n'}\frac{q}{n}\right)}{1/\eta^{2}}}}^{\alpha}}\sqrt{\mathrm{M}_{\frac{j,\kappa\sigma}{\frac{\left(\frac{p}{n'}\frac{q}{n}\right)}{1/\eta^{2}}}}^{\beta}}}$$

$$\left|\sum_{\alpha<\beta}^{\eta}\left|c_{\gamma}^{\alpha\beta}\right|\mathrm{M}_{\frac{\alpha,\kappa\sigma}{\frac{\left(\frac{p}{n'}\frac{q}{n}\right)}{\frac{1}{\eta^{2}}}}}^{\alpha}\otimes\mathrm{M}_{\frac{\beta,\kappa\sigma}{\frac{\left(\frac{p}{n'}\frac{q}{n}\right)}{\frac{1}{\eta^{2}}}}}^{\beta}\right|\left|\sum_{\alpha<\beta}^{\eta}\left|c_{\gamma}^{\alpha\beta}\right|\mathrm{M}_{\frac{\alpha,\kappa\sigma\mathfrak{G}(s,t)}{2}}^{\alpha}\otimes\mathrm{M}_{\frac{\beta,\kappa\sigma\mathfrak{G}(s,t)}{2}}^{\beta}\right|\int_{\mathfrak{J}^{2}}^{\infty}\left|\sigma_{\alpha}'\dot{\sigma_{\beta}}\sigma_{\beta}'\dot{\sigma_{\alpha}}\right|(s,t)\,dsdt\sum_{\gamma}^{\eta}\|\mathcal{B}(\gamma)\|$$

$$\longrightarrow\sum_{\alpha\beta\gamma\delta\varepsilon\epsilon\zeta\eta\theta\vartheta\iota\kappa\lambda\mu\nu\xi o\pi\varpi\rho\varrho\sigma\varsigma\tau\upsilon\varphi\phi\chi\psi\omega}^{\infty}\|\mathcal{B}(\alpha\beta\gamma\delta\varepsilon\epsilon\zeta\eta\theta\vartheta\iota\kappa\lambda\mu\nu\xi o\pi\varpi\rho\varrho\sigma\varsigma\tau\upsilon\varphi\phi\chi\psi\omega)\|^{\infty}$$

$$\frac{1}{\mathfrak{z}\mathfrak{Tr}\int_{\Lambda}^{\infty}\mathfrak{J}e^{\int_{\mathcal{C}}^{\forall}\sum_{i}\Lambda_{i}\otimes d\chi^{i}}e^{-\frac{1}{2\int_{\mathbb{R}^{4}}^{\forall}\sum_{i}|d\Lambda+\Lambda\wedge\Lambda|^{2}\otimes d\chi^{i}}}\mathcal{D}\mathcal{A}}=\mathbb{E}_{\mathcal{YM}}^{\kappa}\|\mathcal{J}_{\delta}\|$$

$$=\frac{1}{\mathbb{E}\|\mathcal{Y}^{\kappa}\|\mathbb{E}|\mathcal{J}_{\delta}^{\kappa}\cdot\mathcal{Y}_{\rho\sigma}^{\kappa}|\mathbb{R}^{4}\int_{\mathbb{C}^{4}}^{\infty}\left|d\lambda_{4}\sqrt{\frac{3}{2\pi}}\sqrt{\frac{2}{\kappa^{4}\sqrt{2\pi}}}\right|^{2}\langle\frac{2}{\kappa\sqrt{2\pi}}\rangle^{4}=\int_{\omega\in\mathbb{C}^{4}}^{\infty}\widehat{\xi_{\iota J}^{\kappa}(\omega)}\left|\pi_{\frac{\kappa\sigma\mathfrak{G}(s,t)}{2}}^{\otimes^{4}}\pi_{\frac{\kappa\sigma}{\frac{\left(\frac{p}{n'}\frac{q}{n}\right)}{\frac{1}{\eta^{2}}}}}^{\otimes^{4}}\right|\left|\widehat{\pi_{\frac{\kappa\sigma\mathfrak{G}(s,t)}{2}}^{\otimes^{4}}\pi_{\frac{\kappa\sigma}{\frac{\left(\frac{p}{n'}\frac{q}{n}\right)}{\frac{1}{\eta^{2}}}}}^{\otimes^{4}}}\right|\left|\widehat{\pi_{\omega}^{\otimes^{4}}}\right|_{\kappa\sigma}\left|\pi_{\omega}^{\otimes^{4}}\right|_{\rho\sigma}^{\kappa\sigma}}$$

$$\otimes\mathcal{E}_{s,t}^{\gamma}\sum_{\gamma}^{\infty}\sum_{\alpha<\beta}^{\infty}\|c_{\gamma}^{\alpha\beta}\|\langle\mathrm{A}_{i,\alpha}\otimes\mathrm{A}_{j,\beta}\pi_{\frac{\kappa\sigma\mathfrak{G}(s,t)}{2}}^{\otimes^{4}}\rangle\otimes\mathcal{E}_{s,t}^{\alpha}\int_{\mathcal{J}}^{\eta}d\tau\mathcal{P}_{s,t}^{i,'}(\tau)\varpi_{\rho_{s,t(\tau)}}\otimes d\chi^{i}\otimes\mathcal{E}_{s,t}^{\beta}\otimes^{4}\mu\sum_{\alpha\beta}^{\eta}\left|\rho(\mathcal{E}^{\alpha})\otimes\rho(\mathcal{E}^{\beta})\right|^{\eta}\int_{\delta}^{\kappa}\rho\delta\otimes\mu$$

$$\boxtimes\prod_{i,i=1}^{\eta}\int_{\mathcal{J}^{2\eta}}^{\eta}ds_{i}\otimes dt_{i}\otimes ds_{j}\otimes dt_{j}$$

5. Supersimetría de Yang- Mills en espacios cuánticos curvos.

$$\mathcal{O}_\rho = (\chi,\gamma) = \mathrm{Tr}[\phi(\chi,\gamma)^\rho], \mathcal{O}(\chi,\gamma)$$

$$= \sum_{\rho=2}^{\infty} \frac{1}{\rho}\left(\frac{16\pi^4}{c}\right)^{\rho/4} \mathcal{O}_\rho(\chi,\gamma), \langle \mathcal{O}(\chi_1,\gamma_1)\mathcal{O}(\chi_2,\gamma_2)\mathcal{O}(\chi_3,\gamma_3)\mathcal{O}(\chi_4,\gamma_4)\rangle$$

$$+ \frac{\mathcal{I}_4(\chi_\iota,\gamma_j)}{2c}\sum_{\ell=1}^{\infty}\left(\frac{\lambda}{4\pi^2}\right)^{\ell} 1/\ell! \frac{\int d^4\chi_5}{(-4\pi^2)} \otimes \frac{d^4\chi_{4+\ell}}{(-4\pi^2) f^{(\ell)}(\chi_{\iota j}^2)}, \chi_{\iota j}^2 \cong \chi_{ij}^2 - \gamma_{\iota j}^2 = \chi_{\iota j}^2(1-g_{ij}), f^{(\ell)}(\chi_{\iota j}^2)$$

$$= \sum_\alpha c_\alpha^{(\ell)} f_\alpha^{(\ell)}(\chi_{ij}^2), f_\alpha^{(\ell)}(\chi_{ij}^2)$$

$$= \frac{1}{|aut\ (\alpha)|}\sum_{\sigma\in\delta_{\ell+4}}\prod_{\iota,j=1}^{4+\ell}\frac{1}{(\chi_{\sigma\iota\sigma j}^2)^{e_{ij}^\alpha}}\int d\mu \bigotimes -\frac{1}{\pi^2}\int d^4\chi_1 \boxtimes d^4\chi_2 \boxplus d^4\chi_3$$

$$\boxplus \frac{d^4\chi_4}{vol[\mathcal{SO}(2{,}4)]}, \mathcal{C}(\lambda; g_{ij})$$

$$-\sum_{\ell=1}^{\infty}\left(\frac{\lambda}{4\pi^2}\right)^{\ell} \otimes \int d^4\chi_1 \boxtimes d^4\chi_2 \boxplus d^4\chi_3 \boxplus \frac{\frac{d^4\chi_4}{vol[\mathcal{SO}(2{,}4)]} f^{(\ell)}\left(\chi_{\iota j}^2(1-g_{ij})\right)}{\pi^2\ell!}(-4\pi^2)^{\ell}, \mathcal{C}(\lambda; g_{ij})$$

$$= \sum_{\ell=1}^{\infty}\frac{\left(\frac{\lambda}{4\pi^2}\right)^{\ell}\otimes 1}{\ell!\,(-4)^{\ell+1}\sum_\alpha c_\alpha^{(\ell)}\mathcal{P}_{f_\alpha^{(\ell)}} f_\alpha^{(\ell)}}\ (1-g_{ij}), \mathcal{P}_{f_\alpha^{(\ell)}}$$

$$= \frac{1}{(\pi^2)^{\ell+1}\int d^4\chi_1 \boxtimes d^4\chi_2 \boxplus d^4\chi_3 \boxplus \frac{d^4\chi_4}{vol[\mathcal{SO}(2{,}4)]} f_\alpha^{(\ell)}(\chi_{ij}^2), f^{(1)}(\chi_{ij}^2) = \frac{1}{\prod \psi_{1\le i\le j\le 5}\chi_{\iota j}^2} - \frac{1}{1!\,(-4)^1}}\mathcal{P}_{f^{(1)}}$$

$$/\prod \psi_{1\le i\le j\le 4}\ (1-g_{ij})$$

$$f^{(2)}(\chi_{ij}^2) = \frac{1}{48}\sum_{\sigma\in\delta_6}\frac{\chi_{\sigma_1\sigma_2}^2\chi_{\sigma_3\sigma_4}^2\chi_{\sigma_5\sigma_6}^2}{\prod\psi_{1\le i\le j\le 5}\chi_{ij}^2} - \frac{\mathcal{P}_{f^{(2)}}}{2!\,(-4)^2}g_{12}g_{34} + g_{13}g_{24} + g_{14}g_{23} - 3\sum_{1\le i\le j\le 4} g_{ij}$$

$$+\frac{15}{\prod\psi_{1\le i\le j\le 4}}(1-g_{ij}) - \frac{\mathcal{P}_{f^{(2)}}}{2!\,(-4)^2}\left(\frac{12}{1} - g_{34} + 3\right)g_{34}^2 g_{34}^2\pi^6\partial\zeta, \mathcal{C}(\lambda;\gamma_i\gamma_j)$$

$$= \frac{\sum_{\ell=1}^{\infty}\lambda^{\ell}\sum_{\nu=2}^{\infty}4(-1)^{\nu+\ell+1}\Gamma\left(\ell+\frac{3}{2}\right)^2\zeta(2\ell+1)}{\pi^{2\ell+1}\Gamma(\ell+2-\nu)\Gamma(\ell+\nu+1)}\mathcal{F}_\nu(\gamma_\iota), \mathcal{F}_\nu(\gamma_\iota)$$

$$= \frac{\delta_{\nu-2,\nu-2,1,1}(\gamma_\iota)}{\prod\psi_{1\le i\le j\le 4}}(1-\gamma_\iota\gamma_j), \delta_{\nu_1,\nu_2,\nu_3,\nu_4}(\gamma_\iota)$$

$$= \det\left(\gamma_\iota^{4+\nu_j-j}\right)_{i,j=1,2,3,4}\prod\psi_{1\le i\le j\le 4}(\gamma_\iota-\gamma_j), \mathcal{C}_{\rho_1,\rho_2,\rho_3,\rho_4}(\lambda)$$

$$\boxtimes\ \mathcal{C}(\lambda;\gamma_i\gamma_j)\big|_{\gamma_1^{\rho_1-2}\gamma_2^{\rho_2-2}\gamma_3^{\rho_3-2}\gamma_4^{\rho_4-2}}$$

$$\zeta(\eta)\Gamma(\eta+1) = 2^{\eta-1}\int_0^\infty\frac{d\omega\omega^\eta}{sin\hbar^2(\omega)},\ \mathcal{C}(\lambda;\gamma_i\gamma_j)$$

$$= \int_0^\infty\frac{\omega d\omega}{sin\hbar^2(\omega)}\sum_{\nu=2}^{\infty}[\mathcal{J}_{\nu-1}(\mu)^2 - \mathcal{J}_\nu(\mu)^2]\mathcal{F}_\nu(\gamma_\iota), \mathcal{C}_{2,2,\rho,\rho}(\lambda)$$

$$= \int_0^\infty\frac{\omega d\omega}{sin\hbar^2(\omega)}\left(\mathcal{J}_\iota(\mu)^2 - \mathcal{J}_j(\mu)^2\right), \mathcal{C}_{3,3,\rho,\rho}(\lambda)$$

$$= \int_0^\infty\frac{\omega d\omega}{sin\hbar^2(\omega)}\left(3\mathcal{J}_1(\mu)^2 - 4\mathcal{J}_2(\mu)^2 - 2\mathfrak{J}_{\rho+1}(\mu)^2\right)$$

$$\mathcal{C}(\lambda;\gamma_i\gamma_j)\big|_{strong}$$

$$= \sum_{\nu=2}^{\infty}\left(\frac{1}{2\nu(\nu-1)}\right.$$

$$+\sum_{\eta=1}^{\infty}4\eta(-1)^\eta\,\Gamma\left(\eta+\frac{1}{2}\right)\Gamma\left(\nu+\eta-\frac{1}{2}\right)\zeta(2\eta+1)$$

$$\left./\lambda^{\eta+\frac{1}{2}}\sqrt{\pi}\Gamma\left(\eta-\frac{1}{2}\right)\Gamma\left(\nu-\eta+\frac{1}{2}\right)\right)\mathcal{F}_\nu(\gamma_\iota)$$

$$\Delta\mathcal{C}(\lambda;\gamma_i\gamma_j) = \pm\frac{\iota}{2}\sum_{\nu=2}^{\infty}(-1)^{\nu}(2\nu-1)^2\left(\frac{8Li_0(z)}{(2\nu-1)^2}+\frac{2Li_1}{\lambda^{\frac{1}{2}}}\right.$$

$$\left.+\left(4\nu^2-4\nu+\frac{5Li_2(z)}{4\lambda}\right)\right)\mathcal{F}_{\nu}(\gamma_{\iota}),\mathcal{E}(\delta;\tau,\tilde{\tau})$$

$$=\sum_{(m,n)\neq(0,0)}\tau_2^{\delta}/\pi^{\delta}|m+\eta\tau|^{2\delta},\mathfrak{D}_{\mathfrak{N}}(\delta;\tau,\tilde{\tau})$$

$$=\frac{\sum_{(m,n)\neq(0,0)}e^{-\frac{4\sqrt{\mathcal{N}}\pi^{|m+\eta\tau|}}{\sqrt{\tau_2}}}\tau_2^{\delta}}{\pi^{\delta}|m+\eta\tau|^{2\delta}},\mathcal{C}(\tau,\tilde{\tau};\gamma_i\gamma_j)$$

$$=\sum_{\nu=2}^{\infty}\left[\frac{1}{2(\nu-1)\nu}-2\nu-\frac{1}{2^4\mathcal{N}^{\frac{3}{2}}\mathfrak{E}\left(\frac{3}{2};\tau,\tilde{\tau}\right)}+3(2\nu-3)(4\nu^2-1)/2^8\mathcal{N}^{\frac{5}{2}}\mathfrak{E}\left(\frac{5}{2};\tau,\tilde{\tau}\right)\right.$$

$$\left.\pm 2\iota(-1)^{\nu}\mathfrak{D}_{\mathfrak{N}}(0;\tau,\tilde{\tau})\right]\mathcal{F}_{\nu}(\gamma_{\iota}),\lim_{\chi_{i,i+1}^2\to 0}\frac{\langle\mathcal{O}\mathcal{O}\mathcal{O}\mathcal{O}\rangle}{\langle\mathcal{O}\mathcal{O}\mathcal{O}\mathcal{O}\rangle_{free}}$$

$$=\mathcal{M}^2-\sum_{\ell=1}^{\infty}(\lambda/4\pi^2)^{\ell}\ell+\frac{1}{2^{2\ell+1}}\begin{pmatrix}2\ell & \cdots & 2\\ \vdots & \ddots & \vdots\\ \ell & \cdots & 1\end{pmatrix}(\gamma^2-1)^{2\ell}/\gamma^{2\ell}\zeta(2\ell+1)$$

6. Modelo de interacción de partículas y antipartículas en espacios cuánticos curvos.

6.1. Comportamiento de las partículas y antipartículas deformantes del espacio cuántico.

$$\mathcal{H}_{int}=\frac{1}{2\hbar_{\mu\nu}\mathcal{T}^{\mu\nu}},\Gamma_{spon}=\frac{2\pi}{\hbar^2\langle f|\widehat{\mathcal{H}}_{int}|\imath\rangle^2\mathcal{D}(\omega)},\widehat{\mathcal{H}}_{int,\ell}=\frac{\frac{\mathcal{L}}{\pi^2\sqrt{\frac{\mathcal{M}\hbar}{\omega_{\ell}}}}(-1)^{\ell-\frac{1}{2}}}{\ell^2(\hat{\beta}_{\ell}\hat{\beta}_{\ell}^{\dagger})\hat{\hat{\hbar}}},\Gamma_{spon}=\frac{8\mathfrak{G}\mathfrak{M}\mathcal{L}^2\omega_{\ell}^4}{\ell^4\pi^4c^5}$$

$$=\frac{8\pi\mathfrak{G}\rho v_{\delta}^4\mathcal{R}^2}{\mathcal{L}c^5},\Gamma_{stim}=\frac{\mathcal{M}\mathcal{L}^2\omega_{\ell}^2\hbar^2}{4\ell^4\pi^4\hbar}=\frac{v_{\delta}^2}{4\ell^2\pi^3\hbar}\mathcal{M}h^2,\mathcal{M}$$

$$=\frac{\pi^2\hbar\omega^3}{v_{\delta}^2\chi(\hbar,\omega,t)^2},m\ddot{\xi}_{\eta}+m\omega_{\mathfrak{D}}^2(2\xi_{\eta}-\xi_{\eta-2}-\xi_{\eta+2}),\xi_{\eta}(t)$$

$$=e^{-\iota\omega t}\left(\Lambda e^{\frac{\iota\kappa\eta\alpha}{2}}+\beta e^{-\frac{\iota\kappa\eta\alpha}{2}}\right)+\mathcal{H}\otimes c,\left.\frac{d\xi_{\eta}}{d\eta}\right|_{\eta=\pm\mathrm{N}}\xi_{\eta}(t)$$

$$=\sum_{\ell=0,2}^{\mathrm{N}-1}\chi_{\ell}(t)\cos\left[\frac{\ell\pi\eta}{(2\mathrm{N})}\right]+\sum_{\ell=1,3}^{\mathrm{N}}\chi_{\ell}(t)\sin\left[\frac{\ell\pi\eta}{(2\mathrm{N})}\right]$$

$$\sum_{\eta=\pm N}^{N} \cos[\ell\pi\eta/2(N+1)]\cos[\ell'\pi\eta/2(N+1)]$$

$$= N + 1/2\ \delta_{\ell\ell'} \sum_{\eta=\pm N}^{N} \sin[\ell\pi\eta/2(N+1)]\sin[\ell'\pi\eta/2(N+1)]$$

$$= N + 1/2\ \delta_{\ell\ell'}, \sum_{\eta=\pm N}^{N} \cos[\ell\pi\eta/2(N+1)]\sin[\ell'\pi\eta/2(N+1)],$$

$$\xi_\eta(t) = \sum_{\ell=0,2}^{N-1} \chi_\ell(t)\cos\left[\frac{\ell\pi\eta}{(2N+1)}\right] + \sum_{\ell=1,3}^{N} \chi_\ell(t)\sin\left[\frac{\ell\pi\eta}{(2N+1)}\right], \ddot{\chi}_\ell + \omega_\ell^2\chi_\ell, \mathfrak{E}$$

$$= \frac{m}{2}\sum_{\eta=\pm N}^{N} \dot{\xi}_\eta^2 + \frac{m\omega_{\mathfrak{D}}^2}{2}\sum_{\eta=\pm N}^{N-2}(\xi_{\eta-2}-\xi_\eta)^2 = \frac{m}{4}\sum_{\ell=0}^{N}\dot{\chi}_\ell^2 + \frac{\mathcal{M}}{4}\sum_{\ell=0}^{N}\omega_\ell^2\chi_\ell^2 \int_{-\frac{\mathcal{L}}{2}}^{\frac{\mathcal{L}}{2}} dx\chi_\ell(\chi)^2$$

$$= \frac{\mathcal{L}}{2}, \mu_\ell = \int_{-\frac{\mathcal{L}}{2}}^{\frac{\mathcal{L}}{2}} dx\rho(\chi)\chi_\ell(\chi)^2 = \frac{\mathcal{M}}{\mathcal{L}}\int_{-\frac{\mathcal{L}}{2}}^{\frac{\mathcal{L}}{2}} dx\chi_\ell(\chi)^2 = \frac{\mathcal{M}}{2}, f(x) = -m\nabla\phi$$

$$= -m\nabla\left(\frac{\frac{1}{2}\partial^2\phi}{\partial\chi^2}\chi^2\right) = m\frac{\ddot{\hbar}_{xx}}{4}\nabla(\chi^2) = m\frac{\ddot{\hbar}_{xx}}{2}(\chi_\eta + \xi_\eta)$$

$$\hat{\mathcal{H}}_\ell = -m\frac{\ddot{\hbar}_{xx}}{2}\sum_{\eta=\pm N}^{N}\left(\chi_\eta\xi_\eta + \frac{\xi_\eta^2}{2}\right) - m\frac{\ddot{\hbar}_{xx}}{2}\sum_{\eta=\pm N}^{N}\chi_\eta\xi_\eta \approx -\frac{\mathcal{M}\mathcal{L}\ddot{\hbar}_{xx}}{\pi^2\sum_{\ell=1,3}^{N}\frac{(-1)^{\ell-\frac{1}{2}}1}{\ell^2\chi_\ell(t)} - m\frac{\ddot{\hbar}_{xx}}{4}\sum_{\eta=\pm N}^{N}\xi_\eta^2}$$

$$= -\frac{\mathcal{M}\mathcal{L}\ddot{\hbar}_{xx}}{8}\sum_{\ell=0}^{N}\chi_\ell^2, \hat{\mathcal{H}}_\ell = \sum_{\ell=0}^{N}\hat{\mathcal{H}}_\ell^l = \frac{\mathcal{M}\mathcal{L}\ddot{\hbar}_{xx}}{\pi^2\sum_{\ell=1,3}^{N}\frac{(-1)^{\ell-\frac{1}{2}}1}{\ell^2\chi_\ell}} - \frac{\mathcal{M}\mathcal{L}\ddot{\hbar}_{xx}}{8}\sum_{\ell=0}^{N}\hat{\chi}_\ell^2, \hat{\mathcal{H}}_\ell^{l,odd}$$

$$= -\frac{\mathcal{M}\mathcal{L}\ddot{\hbar}_{xx}}{\pi^2}\frac{(-1)^{\ell-\frac{1}{2}}1}{\ell^2}\sqrt{\frac{\hbar}{\mathcal{M}\omega_\ell}}(\hat{\beta}_l+\hat{\beta}_l^\dagger)^2, \hat{\mathcal{H}}_\ell^{l,even} = -\frac{\ddot{\hbar}_{xx}}{8}\hbar/\omega_\ell(\hat{\beta}_l+\hat{\beta}_l^\dagger)^2$$

$$\hat{\mathcal{H}}_{int} = \frac{\hbar\sqrt{\frac{(-1)^{\ell-\frac{1}{2}}8\pi\mathfrak{G}\mathcal{M}\nu^3}{\omega_\ell c^2\mathcal{V}}}\mathcal{L}}{\pi^2\ell^2(\hat{\beta}_l+\hat{\beta}_l^\dagger)(\hat{\alpha}e^{-ivt}+\hat{\alpha}^\dagger e^{ivt})}, \Gamma_{stim} = \frac{2\pi}{\hbar^2\left|\langle\alpha\langle 1|\hat{\mathcal{H}}_{int}|\alpha\rangle|0\rangle\right|^2\mathcal{D}(\omega)}, \Gamma_{stim}$$

$$= \frac{\frac{|\alpha|^2}{\ell^4}8\pi\mathfrak{G}\mathcal{M}\mathcal{L}^2\omega_\ell^4}{\pi^4c^5}, \mathcal{N} = \frac{\hbar_0^2c^5}{32\pi\mathfrak{G}\hbar\nu^2}, \Gamma_{stim} = \frac{\frac{1}{\ell^4}\mathcal{M}\mathcal{L}^2\omega_\ell^2\hbar_0^2}{4\pi^5\hbar}$$

$$\widehat{\mathcal{H}} = \hbar\omega\hat{\beta}_l^{\dagger}\hat{\beta}_l + \frac{1}{\eta^2\mathcal{L}}\sqrt{\frac{\mathcal{M}\hbar}{\omega}}\ddot{\hbar}(t)\left(\hat{\beta}_l^{\dagger}+\hat{\beta}_l\right), \widehat{\mathfrak{U}}_{int} = \widehat{\mathcal{T}}e^{-i\int_0^t ds\left(g(\delta)\widehat{\beta}(\delta)+g^{\circledast}(\delta)\widehat{\beta}^{\dagger}(\delta)\right)}, g(t)$$

$$= \frac{1}{\pi^2\mathcal{L}\sqrt{\frac{\mathcal{M}\hbar}{\omega}}\ddot{\hbar}(t)}, \widehat{\mathfrak{U}}_{int} = \epsilon^{\Omega(t)}, \Omega(t)$$

$$= \int_0^t dt_1\widehat{\Lambda}(t_1) + \frac{1}{2}\int_0^t dt_1\int_0^t dt_2\left[\widehat{\Lambda}(t_1), \widehat{\Lambda}(t_2)\right], \widehat{\mathfrak{U}}_{int}$$

$$= e^{-i\int_0^t ds\left(g(\delta)\widehat{\beta}(\delta)+g^{\circledast}(\delta)\widehat{\beta}^{\dagger}(\delta)\right)}e^{-\iota\varphi}, \widehat{\mathfrak{U}} = e^{-\iota\varphi}e^{-\iota\omega t\widehat{\beta}^{\dagger}\widehat{\beta}}\widehat{\mathcal{D}}(\beta), \beta$$

$$= -i\int_0^t dsg^{\circledast}(\delta)e^{\iota\omega\delta}, e^{-\iota\varphi}\left|\beta e^{-\iota\omega t\widehat{\beta}^{\dagger}\widehat{\beta}}\right\rangle, |\beta| = \frac{\mathcal{L}}{\pi^2\sqrt{\frac{\mathcal{M}}{\omega\hbar}}}\chi(\hbar,\omega,t), \chi(\hbar,\omega,t)$$

$$= \left|\int_0^t ds\ddot{\hbar}(\delta)e^{\iota\omega\delta}\right|, \nu(t) = \left(\frac{1}{\nu_0^{\frac{8}{3}}} - \frac{8}{3}\kappa t\right)^{-\frac{3}{8}}, \kappa = \frac{\kappa_f}{(2\pi)^{\frac{8}{3}}} = \frac{\frac{96}{5\varpi\left(\frac{\pi\mathfrak{G}\mathcal{M}_c}{c^3}\right)^{\frac{5}{3}}1}}{(2\pi)^{\frac{8}{3}}}$$

$$= \frac{48}{5\left(\frac{\mathfrak{G}\mathcal{M}_c}{2c^3}\right)^{\frac{5}{3}}}, \tau = \frac{2\Delta\omega}{\kappa\omega^{\frac{11}{3}}}, \chi = \left|\int_0^t \frac{dse^{\iota\omega\delta}\hbar_0\nu^2t}{2}sinc\left(\frac{\delta t}{2}\right)\right|, 2\Delta\omega = \frac{8}{T}, \tau$$

$$= 2\sqrt{\frac{2}{\kappa}}\,\omega^{\frac{11}{6}}$$

$$\chi \approx \hbar_0\omega\left|\int_0^{\tau} dse^{\iota\omega\delta}sin(\omega\delta)\right| = \frac{\hbar_0\omega}{4}\sqrt{2+4\omega^2\tau^2-2\cos(2\omega\tau)-4\omega\tau\sin(2\omega\tau)}, \chi(\tau) \approx \frac{\hbar_0\omega^2\tau}{2}\chi$$

$$\approx \hbar_0\sqrt{\frac{2}{\kappa}}\omega^{\frac{1}{6}} = \hbar_0\sqrt{\frac{5}{24}\left(\frac{2c^3}{\mathfrak{G}\mathcal{M}_c}\right)^{\frac{5}{6}}}\omega^{\frac{1}{6}}, \mathcal{M} = \frac{\pi^2\hbar\omega^3}{\nu_\delta^2\chi^2} \approx \frac{\pi^2\hbar\kappa}{2\nu_\delta^2\hbar_0^2\omega^{\frac{8}{3}}}$$

$$= \frac{\frac{24\pi^2}{5}\hbar}{\hbar_0^2\nu_\delta^2\left(\frac{2c^3}{\mathfrak{G}\mathcal{M}_c}\right)^{\frac{5}{3}}\omega^{\frac{8}{3}}}, \mathcal{P}(t) = \frac{\frac{\mathcal{L}^2}{\pi^4\mathcal{M}}}{\omega\hbar|\chi(t)|^2} = \frac{\hbar_0^2\omega\tau^2\mathcal{M}\nu_\delta^2}{4\pi^2\hbar}, \Gamma_{mc} = \frac{d\mathcal{P}(\mathrm{t})}{dt}$$

$$= \frac{\hbar_0^2\omega\tau^2\mathcal{M}\nu_\delta^2}{2\pi^2\hbar} = \frac{\hbar_0^2\mathcal{N}_c\mathcal{M}\nu_\delta^2}{\pi\hbar}, \hbar_0 = \sqrt{\frac{\pi\kappa_\beta\mathcal{T}}{\mathcal{M}\nu_\delta^2\mathcal{Q}\mathcal{N}_c}}$$

$$\mathcal{P}(\nu,\omega,t) \approx |\beta(\nu,\omega,t)|^2 \approx \frac{(\hbar_0^2\omega^3\mathcal{M}\mathcal{L}^2)sin^2\left[\frac{1}{2}t(\nu-\omega)\right]}{\hbar(\nu-\omega)^2\pi^4}, \mathcal{P}(\omega,t)$$

$$= \frac{\sum_\nu|\beta(\nu,\omega,t)|^2 \int_{\omega-\frac{\delta}{2}}^{\omega+\frac{\delta}{2}} d\nu\mathfrak{D}(\nu)|\beta(\nu,\omega,t)|^2 = \frac{\mathfrak{D}(\omega)(\hbar_0^2\omega^3\mathcal{M}\mathcal{L}^2)}{\hbar}\pi^4 \int_{\omega-\frac{\delta}{2}}^{\omega+\frac{\delta}{2}} d\nu\, sin^2\left[\frac{1}{2}t(\nu-\omega)\right]}{(\nu-\omega)^2}$$

$$= \frac{\mathfrak{D}(\omega)(\hbar_0^2\omega^3\mathcal{M}\mathcal{L}^2)}{\hbar\pi^4}\Xi(t), \sum_\nu = \int d\nu\mathcal{D}(\nu) = \frac{\int d\nu\, \mathcal{V}\nu^2}{2\pi^2c^3}, \mathcal{P}(\omega,t) \approx \frac{\mathfrak{D}(\omega)(\hbar_0^2\omega^3\mathcal{M}\mathcal{L}^2)}{2\hbar\pi^3}$$

$$= \Gamma_{stim}t, \Gamma_{stim} = \frac{\mathfrak{D}(\omega)(\hbar_0^2\omega^3\mathcal{M}\mathcal{L}^2)}{2\hbar\pi^3} = \frac{\mathcal{V}\hbar_0^2\omega^5\mathcal{M}\mathcal{L}^2}{4\hbar\pi^5c^4} = \hbar_0^2\frac{\mathcal{M}\nu_\delta^2}{4\hbar\pi^3}, \hbar_c \equiv 2\pi\sqrt{\frac{\pi\kappa_\beta\mathcal{T}}{\mathcal{M}\nu_\delta^2\mathcal{Q}}}, \widehat{\mathcal{H}}_{\omega_l}$$

$$= \hbar\omega_l\left(\hat{\beta}_l^\dagger + \hat{\beta}_l + \frac{1}{2}\right), |\psi_\mathcal{M}\rangle = (2\pi t_m)^{\frac{1}{4}} \int d\chi e^{-\frac{\chi^2}{4t_m}}|\chi\rangle, \widehat{\mathcal{H}}_{int}^{\mathcal{M}}dt = \sqrt{dt}\hat{\rho}\widehat{\mathrm{N}}, \widehat{\mathcal{M}}_{\widehat{\mathrm{N}}}(\gamma)$$

$$= \left\langle\gamma\right| e^{-i\widehat{\mathcal{H}}_{int}^{\mathcal{M}}dt}\left|\psi_\mathcal{M}\right\rangle = (2\pi t_m)^{-\frac{1}{4}}\exp\left[-\frac{\left(\gamma-\widehat{\mathrm{N}}\sqrt{dt}\right)^2}{4t_m}\right], \widehat{\mathcal{M}}_{\widehat{\mathrm{N}}}(r)$$

$$= \left(\frac{2\pi t_m}{dt}\right)^{-\frac{1}{4}}\exp\left\{\left[-\frac{dt\left(r-\widehat{\mathrm{N}}\right)^2}{4t_m}\right]\right\}, \rho(t+dt)$$

$$= \mathcal{D}\left[dt\beta'^{(t)}\right]\widehat{\mathcal{M}}_{\widehat{\mathrm{N}}}[r(t)]\rho(t)\widehat{\mathcal{M}}^\dagger{}_{\widehat{\mathrm{N}}}[r(t)]\mathcal{D}\left[-dt\beta'^{(t)}\right]/tr\left\{\widehat{\mathcal{M}}_{\widehat{\mathrm{N}}}[r(t)]\rho(t)\widehat{\mathcal{M}}^\dagger{}_{\widehat{\mathrm{N}}}[r(t)]\right\}$$

6.2. Modelo fotónico aplicable a partículas y antipartículas deformantes del espacio cuántico curvo.

$$[\nabla^2 + \mu(r)\epsilon(r)\kappa^2]\mu_\xi(\kappa,r), \widehat{\mathfrak{E}}(r) = \iota \sum_{\xi,\kappa} \sqrt{\frac{\hbar c\kappa}{2\epsilon_0 \varepsilon(r)}} \mu_\xi(\kappa,r)\left(\alpha_{\xi\kappa}^\dagger + \alpha_{\xi\kappa}\right), \frac{\mathcal{H}}{\hbar}$$

$$= \omega_0\sigma_+\sigma_- + \sum_{\xi,\kappa} c\kappa\, \alpha_{\xi\kappa}^\dagger \alpha_{\xi\kappa} + \sum_{\xi,\kappa} g(r)\left(\alpha_{\xi\kappa}\sigma_+ + \alpha_{\xi\kappa}^\dagger \sigma_-\right), g_\xi(\kappa,r)$$

$$= \sqrt{\frac{\hbar c\kappa}{2\epsilon_0 \varepsilon(r)}} d\otimes\mu_\xi(\kappa,r) \int_0^\infty \kappa d\kappa \rho(\kappa)\, \mu_\xi(\kappa,r)\mu_\xi(\kappa,r')e^{-ic\kappa\tau}$$

$$= \sum_\eta z_{\xi_\eta} v_{\xi_\eta}(r) v_{\xi_\eta}(r')\Theta(\tau - \Delta_t(r,r'))e^{-icz_{\xi_\eta}\tau}, \frac{d}{dt\tilde{c}_0(t)}$$

$$= -\int_0^t dt' \sum_\xi \int d\kappa\rho(\kappa) g_\xi^2(\kappa) e^{i(\omega_0 - c\kappa)(t-t')}\tilde{c}_0(t'), \frac{d}{dt\tilde{c}_0(t)}$$

$$= -\int_0^t dt' \sum_{\xi,\eta} \hat{g}_{\xi_\eta}^2\, e^{i\left(\omega_0 - cz_{\xi_\eta}\tau\right)(t-t')}\tilde{c}_0(t'), \frac{id}{dt}\tilde{c}_0(t)$$

$$= \sum_{\xi\eta} \hat{g}_{\xi_\eta}\, e^{i\left(\omega_0 - cz_{\xi_\eta}\tau\right)t} \tilde{\beta}_{\xi_\eta}(t), \frac{id}{dt}\tilde{\beta}_{\xi_\eta}(t) = \hat{g}_{\xi_\eta} e^{i\left(\omega_0 - cz_{\xi_\eta}\tau\right)t}\tilde{c}_0(t), \hat{g}_{\xi_\eta}(r)$$

$$= \sqrt{\frac{\hbar c z_{\xi_\eta}\tau}{2\epsilon_0 \varepsilon(r)}} d\otimes v_\xi(r), \mathfrak{E}_+ \Big| \psi(t)\rangle = i \sum_{\xi,\eta} \sqrt{\frac{\hbar c z_{\xi_\eta}\tau}{2\epsilon_0 \varepsilon(r)}} \hat{v}_{\xi_\eta}(r)\tilde{\beta}_{\xi_\eta}(t - \Delta_t)e^{-icz_{\xi_\eta}\tau}, \mathcal{Z}_l$$

$$= \left(\sqrt{\epsilon\kappa r}\right) = \frac{1}{\sqrt{\mathcal{I}_m(\kappa)}\begin{cases} \eta_l(\kappa) j_l\left(\sqrt{\epsilon\kappa r}\right) \\ \alpha_l(\kappa) j_l(\kappa r) + \beta_l(\kappa)\gamma_l(\kappa r)\end{cases} r < \alpha, r > \alpha}, \lim_{\mathcal{R}\to\infty} \mathcal{I}_{\mathcal{M}}(\kappa)$$

$$= \frac{\mathcal{R}}{2\kappa^2[\alpha_l(\kappa) + i\beta_l(\kappa)][\alpha_l(\kappa) - i\beta_l(\kappa)]}, \mathcal{I}_l(r,r')$$

$$= \int_0^\infty d\kappa\rho(\kappa)\kappa^{-1}\, \mathcal{Z}_l\left(\sqrt{\epsilon\kappa r}\right)\mathcal{Z}_l\left(\sqrt{\epsilon\kappa r'}\right)e^{-\iota c\kappa\tau}, \mathcal{I}_l$$

$$= \Theta[c\tau - (r-\alpha)] \oint_{\mathcal{LHP}}^{\infty} f_1(z)\, dz$$

$$+ \Theta[c\tau$$

$$+ (r - \alpha)] \oint_{\mathcal{UHP}}^{\infty} f_2(z)dz, \mathcal{I}_l(r,r'))2\pi\iota \sum_{\mathcal{Z}_{l_\eta}\in\mathcal{Q}_4} \mathcal{R}es[f_2(z)]\Theta[c\tau - (r-\alpha)], v_{lm\eta}(r)$$

$$= \mathfrak{N}_{lm\eta}(r)\left[\pi\sqrt{\alpha_l\left(\mathcal{Z}_{l_\eta}\right) - \frac{i\beta_l\left(\mathcal{Z}_{l_\eta}\right)}{\imath[\partial_{\mathcal{Z}}\alpha_l(\mathcal{Z}) + i\beta_l(\mathcal{Z})]_{\mathcal{Z}_{l_\eta}}}\hbar_l^{(1)}}\left(\mathcal{Z}_{l_\eta}r\right)\right], \delta\omega_0$$

$$= \sum_{off-res} g_{l_\eta}^2\left(\omega_0 - \omega_{l_\eta}\right) - \frac{i\gamma_{l_\eta}}{\left(\omega_0 - \omega_{l_\eta}\right)^2} + \gamma_{l_\eta}^2, id/dt\tilde{c}_0(t)$$

$$= \delta\omega_0\tilde{c}_0(t) + \sum_{\substack{(5,4)\\(8,3)}} \hat{g}_{l_\eta}\, e^{i\left(\omega_0 - c\mathcal{Z}_{l_\eta}\right)t}\tilde{\beta}_{l_\eta}(t)$$

6.3. La gravedad como entidad cuántica (Formalización).

$$|\psi(t=0)\rangle = |\zeta\rangle_{\mathcal{M}_c} \otimes \frac{1}{\sqrt{2}\left(|\uparrow\rangle_{\delta_c}|\downarrow\rangle_{\delta_c}\right)}, |\zeta\rangle_{\mathcal{M}_c}\otimes|\uparrow\rangle_{\delta_c} \longrightarrow |\mathcal{L}\uparrow\rangle_{\mathcal{C}}, |\zeta\rangle_{\mathcal{M}_c} \otimes |\downarrow\rangle_{\delta_c} \longrightarrow |\mathcal{R}\downarrow\rangle_{\mathcal{C}}, |\psi\rangle_{\mathcal{C},\Lambda}$$

$$= \frac{1}{\sqrt{2}\left(\sqrt{1+cos\,\Delta\phi}|\Psi_+\rangle_{\mathcal{C}}|+\rangle_{\delta_\Lambda} + \sqrt{1-cos\,\Delta\phi}|\Psi_-\rangle_{\mathcal{C}}|-\rangle_{\delta_\Lambda}\right)|\zeta\rangle_{\mathcal{M}_\Lambda}}, |\Psi_\pm\rangle_{\mathcal{C}}$$

$$= \left(1 \pm e^{i\Delta\phi}\right)|\mathcal{L}\uparrow\rangle_{\mathcal{C}} + \frac{\left(e^{i\Delta\phi} \pm 1\right)|\mathcal{R}\downarrow\rangle_{\mathcal{C}}}{2\sqrt{1 \pm cos\Delta\phi}\,|\pm\rangle_{\delta_\Lambda}} = |\uparrow\rangle_{\delta_\Lambda} \pm \frac{|\downarrow\rangle_{\delta_\Lambda}}{\sqrt{2}}, \Delta\phi_\tau$$

$$= \frac{\mathcal{G}\mathcal{M}m\tau}{\hbar\sqrt{d^2 + (\Delta\chi)^2}}$$

$$- \frac{\mathcal{G}\mathcal{M}m\tau}{\hbar d}, \left|\psi_{\alpha,\beta,c}\right\rangle$$

$$= \frac{1}{8[(1+\alpha e^{i\Delta\phi})(1-\beta e^{i\Delta\phi}) + ce^{2i\Delta\phi}(1+\alpha e^{i\Delta\phi})(1-\beta e^{i\Delta\phi})]}|\zeta\rangle_{\mathcal{M}_c}|c\rangle_{\delta_c}, \mathcal{V}(\pm)$$

$$= \mathcal{P}_\pm - \sum_{\alpha,\beta\in\{\pm\}} \mathcal{P}_{\alpha,\beta,\pm} = \pm\frac{1}{2}sin^2\Delta\phi, \rho_{\mathcal{C},\Lambda}$$

$$= \frac{1}{2}\Big((1+cos\,\Delta\phi)|\Psi_+\rangle_{\mathcal{C}}\langle\Psi_+|_{\mathcal{C}}\otimes|+\rangle_{\delta_\Lambda}\langle+|_{\delta_\Lambda}$$

$$+ (1-cos\,\Delta\phi)|\Psi_-\rangle_{\mathcal{C}}\langle\Psi_-|_{\mathcal{C}}\otimes|-\rangle_{\delta_\Lambda}\langle-|_{\delta_\Lambda}\Big)\otimes|\xi\rangle_{\mathcal{M}_\Lambda}\langle\xi|_{\mathcal{M}_\Lambda}$$

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Apéndice D:

Postulados Finales

1. Que las partículas con o sin masa o las antipartículas con o sin masa, según sea el caso, en tanto y en cuanto, se aproximen, igualen o superen la velocidad de la luz, deforman el espacio cuántico en el que interactúan, a propósito de sus ciclos cuánticos de colisión, superposición o entrelazamiento, según corresponda a cada caso.

2. Que las partículas masivas o supermasivas o las antipartículas masivas o supermasivas, según sea el caso, no necesitan aproximarse, igualar o superar la velocidad de la luz, para deformar el espacio cuántico en el que interactúan, de tal suerte que, basta con su hipermasa o supermasa, según sea el caso, para lograr un espacio cuántico curvo, a propósito de sus ciclos cuánticos de colisión, superposición o entrelazamiento, según corresponda a cada caso.

3. Cuando una partícula supermasiva o una antipartícula supermasiva, según sea el caso, alcanzan o superan la velocidad de la luz, producen un agujero negro cuántico, a propósito de sus ciclos cuanticos de colisión, superposición o entrelazamiento, según corresponda a cada caso.

4. Cuando una partícula sin masa o una antipartícula sin masa, según sea el caso, superan la velocidad de la luz, producen un agujero negro cuántico, a propósito de sus ciclos cuánticos de colisión, superposición o entrelazamiento, según corresponda a cada caso.

APÉNDICE E.

FORMALIZACIÓN MATEMÁTICA COMPLEMENTARIA.

1. Espacios cuánticos curvos.

1.1. Osciladores y propagadores en espacios curvos – Modelo Feynman.

$$\mathfrak{F} = \langle \int_{-\infty}^{\infty} q(\sigma)^2 \bar{\chi} e^{-\sigma^2}\, d\sigma, \mathfrak{F}[x(t,s), y(t,s)] = \int_{-\infty}^{\infty}\int_{-\infty}^{\infty} x(t,s), y(t,s) \sin\omega(t-s) dtds\,, \mathcal{F}(\cdots q_i \cdots)$$

$$= \sum_{i=-\infty}^{\infty} q_i^2 e^{-\sigma_i^2}(\sigma_{i+1}-\sigma_i) \sum_i \frac{(\cdots q_i \cdots)}{\partial q_i}\lambda_i\,, \mathfrak{F}[q(\sigma), +\lambda(\sigma)] - \mathcal{F}[q(\sigma)]$$

$$= \int \mathcal{K}(t)\lambda(t)dt, \mathfrak{F}[q(\sigma), +\lambda(\sigma)] = \mathcal{F}[q(\sigma)] + \int \frac{\delta\mathcal{F}[q(\sigma)]}{\delta q(t)\lambda(t)dt}, \mathcal{F}[q+\lambda]$$

$$= \int [q(\sigma)^2 + 2q(\sigma)\lambda(\sigma) + \lambda(\sigma)^2]\, e^{-\sigma^2} d\sigma$$

$$= \int q(\sigma)^2 e^{-\sigma^2} d\sigma + 2\int q(\sigma)\lambda(\sigma)\, e^{-\sigma^2} d\sigma\rangle$$

$$\mathcal{A} = \langle \int \mathcal{L}(\dot{q}(\sigma), q(\sigma))d\sigma, \frac{\delta\mathcal{A}}{\delta q(t)} = \frac{d}{dt}\{\partial\mathcal{L}(\dot{q}(t), q(t))/\partial\dot{q}\} + \partial\mathcal{L}(\dot{q}(t), q(t))/\partial q\,, \mathcal{A}$$

$$= \int_{-\infty}^{\infty} \left\{\frac{m(\dot{x}(t))^2}{2} - \mathcal{V}(x(t)) + \kappa^2\dot{x}(t)\dot{x}(t+\mathcal{T}_0)\right\}dt\,, \delta\mathcal{A}$$

$$= \int_{-\infty}^{\infty} \{m\dot{x}(t)\dot{\lambda}(t) - \mathcal{V}'(x(t))\lambda(t) + \kappa^2\dot{\lambda}(t)\dot{x}(t+\mathcal{T}_0) + \kappa^2\dot{\lambda}(t+\mathcal{T}_0)\dot{x}(t)\}dt$$

$$= \int_{-\infty}^{\infty} \{-m\ddot{x}(t) - \mathcal{V}'(x(t)) - \kappa^2\ddot{x}(t+\mathcal{T}_0) + \kappa^2\ddot{x}(t-\mathcal{T}_0)\dot{x}(t)\}\lambda(t)dt\,, \frac{\delta\mathcal{A}}{\delta x(t)}$$

$$= -m\ddot{x}(t) \; - \mathcal{V}'(x(t)) - \kappa^2\ddot{x}(t+\mathcal{T}_0) - \kappa^2\ddot{x}(t-\mathcal{T}_0), \frac{\delta\mathcal{A}}{\delta\gamma(t)}$$

$$= -\frac{d}{dt}\left(\frac{\partial\mathfrak{L}_\gamma}{\partial\dot{\gamma}}\right) + \left.\frac{\partial\mathfrak{L}_\gamma}{\partial\gamma}\right|_t$$

$$+ \left.\frac{\partial\mathfrak{I}_\gamma}{\partial\gamma}\right|_t \bigotimes x(t)\,, \frac{\delta}{\delta\gamma(s)\left[-\frac{d}{dt}\left(\frac{\partial\mathfrak{L}_\gamma}{\partial\dot{\gamma}}\right) + \left.\frac{\partial\mathfrak{L}_\gamma}{\partial\gamma}\right|_t + \left.\frac{\partial\mathfrak{I}_\gamma}{\partial\gamma}\right|_t \otimes x(t)\right]}$$

$$= \frac{\frac{\delta}{\delta\gamma(t)}\left[-\frac{d}{ds}\left(\frac{\partial\mathfrak{L}_\gamma}{\partial\dot{\gamma}}\right) + \left.\frac{\partial\mathfrak{L}_\gamma}{\partial\gamma}\right|_s + \left.\frac{\partial\mathfrak{I}_\gamma}{\partial\gamma}\right|_s \otimes x(s)\right]\left.\frac{\partial\mathfrak{L}_\gamma}{\partial\gamma}\right|_t \delta x(t)}{\delta\gamma(s)} = \frac{\left.\frac{\partial\mathfrak{I}_\gamma}{\partial\gamma}\right|_s \delta x(s)}{\delta\gamma(t)}$$

$$= \frac{\frac{1}{m\omega}\sin\omega(t-s) \boxtimes \left.\frac{\partial\mathfrak{I}_\gamma}{\partial\gamma}\right|_s \delta x(s)}{\delta\gamma(s)} \frac{\left.\frac{\partial\mathfrak{I}_\gamma}{\partial\gamma}\right|_s \delta x(t)}{\delta\gamma(s)} = \frac{\frac{1}{m\omega}\sin\omega(t-s) \boxtimes \left.\frac{\partial\mathfrak{I}_\gamma}{\partial\gamma}\right|_s \delta x(s)}{\delta\gamma(s)}$$

$$= -\frac{\sin\omega(\mathcal{T}-t)\sin\omega s}{m\omega}\sin\omega\mathcal{T} \left.\frac{\partial\mathfrak{I}_\gamma}{\partial\gamma}\right|_s$$

$$= -\frac{\sin\omega(\mathcal{T}-s)\sin\omega t}{m\omega}\sin\omega\mathcal{T} \left.\frac{\partial\mathfrak{I}_\gamma}{\partial\chi}\right|_s \int_0^{\mathcal{T}} [\mathfrak{L}_y + \mathfrak{L}_z]dt$$

$$+ \int_0^{\mathcal{T}} \left[\sin\omega(\mathcal{T}-t)x(0) + \sin\frac{\omega t\chi(\mathcal{T})}{\sin\omega\mathcal{T}}\right]\gamma(t)dt - \frac{1}{m\omega\sin\omega\mathcal{T}\int_0^{\mathcal{T}} dt \int_0^t ds}$$

$$\otimes \sin\omega(\mathcal{T}-t)\sin\omega s\gamma(s)\gamma(t)\,, \frac{\delta x(t)}{\delta\gamma(s)} = \frac{\frac{1}{2m\omega}\sin\omega(t-s) \boxtimes \left.\frac{\partial\mathfrak{I}_\gamma}{\partial\gamma}\right|_s \delta x(s)}{\delta\gamma(s)} =$$

$$= -\frac{\frac{1}{2m\omega}\sin\omega(t-s) \boxtimes \left.\frac{\partial\mathfrak{I}_\gamma}{\partial\gamma}\right|_s \delta x(s)}{\delta\gamma(s)}\rangle$$

$\mathfrak{E}(t)$

$$= \left\| \frac{m\big(\dot{x}(t)\big)^2}{2} + \mathcal{V}\big(x(t)\big) - \kappa^2 \int_{t}^{t+\mathcal{T}_0} \ddot{x}\,(\sigma - \mathcal{T}_0)\dot{x}(\sigma)d\sigma + \kappa^2 \dot{x}(t)\dot{x}(t+\mathcal{T}_0), \mathcal{A}\big[q_\eta(\sigma) + \alpha y_\eta(\sigma)\big] \right.$$

$$= \mathcal{A}\big[q_\eta(\sigma)\big]$$

$$+ \frac{\alpha \sum_{\eta=1}^{N} \int_{-\infty}^{\infty} \frac{y_\eta(t)\delta\mathcal{A}}{\delta q_\eta(t)} dt \ \sum_{\eta=1}^{N} \int_{-\infty}^{\infty} \frac{y_\eta(\sigma)\delta\mathcal{A}}{\delta q_\eta(\sigma)} d\sigma, \mathcal{I}(\mathcal{T}) = \sum_{\eta=1}^{N} \int_{-\infty}^{\mathcal{T}} \frac{y_\eta(\sigma)\delta\mathcal{A}}{\delta q_\eta(\sigma)} d\sigma - \sum_{\eta=1}^{N} \int_{\mathcal{T}}^{\infty} \frac{y_\eta(\sigma)\delta\mathcal{A}}{\delta q_\eta(\sigma)} d\sigma, \delta\mathcal{I}(\mathcal{T})}{\delta q_m(t)}$$

$$= + \int_{-\infty}^{\mathcal{T}} \sum_{m} \frac{\frac{\delta y_\eta(\sigma)}{\delta q_m(t)} \delta\mathcal{A}}{\delta q_m(\sigma) d\sigma}$$

$$+ \int_{-\infty}^{\mathcal{T}} \sum_{m} y_\eta(\sigma) \frac{\delta^2\mathcal{A}}{\delta q_m(t)\delta q_m(\sigma)} d\sigma \ \int \frac{\left[\mathfrak{L}_y + \mathfrak{L}_z + \left(\frac{m\dot{x}^2}{2} - \frac{m\omega^2 x^2}{2}\right) + (\mathfrak{I}_y + \mathfrak{I}_z)x\right] d}{dt} \left(\frac{\partial \mathfrak{L}_y}{\partial \dot{y}}\right) - \frac{\partial \mathfrak{L}_y}{\partial y}$$

$$\left. = \frac{\partial \mathfrak{I}_y}{\partial \dot{y}} \chi(t), m\ddot{x} + m\omega^2 x = \big[\mathfrak{I}_y(t) + \mathfrak{I}_z(t)\big] \right\|$$

$$x(t) = \langle x(0)\cos\omega t + \frac{\dot{x}(0)\sin\omega t}{\omega} + \frac{1}{m\omega\int_0^t \gamma(\delta)\sin\omega(t-\delta)\,d\delta}, x(t)$$

$$= \frac{\sin\omega(\mathcal{T}-t)}{\sin\omega\mathcal{T}}\left[x(0) - \frac{1}{m\omega}\int_0^t \sin\omega\delta\gamma(\delta)d\delta\right]$$

$$+ \frac{\sin\omega t}{\sin\omega\mathcal{T}\left[x(\mathcal{T}) - \frac{1}{m\omega}\int_t^{\mathcal{T}}\sin(\mathcal{T}-\delta)\gamma(\delta)d\delta\right]}\rangle$$

$$x(t) = \langle\frac{1}{\sin\omega\mathcal{T}}[\mathcal{R}_t\sin\omega t + \mathcal{R}_0\sin\omega t(\mathcal{T}-t)\,] + \frac{1}{2m\omega}\int_0^t \sin\omega(t-\delta)\gamma(\delta)d\delta$$

$$-\frac{1}{2m\omega}\int_t^{\mathcal{T}} \sin\omega(t-\delta)\gamma(\delta)d\delta\rangle$$

$$\mathcal{R}_0 = \langle\frac{1}{2}\left[x(0) + \frac{x(\mathcal{T})\cos\omega\mathcal{T} - \dot{x}(\mathcal{T})\sin\omega\mathcal{T}}{\omega}\right], \mathcal{R}_t = \frac{1}{2}\left[x(\mathcal{T}) + \frac{x(0)\cos\omega\mathcal{T} - \dot{x}(0)\sin\omega\mathcal{T}}{\omega}\right]\rangle$$

$$\mathcal{A} = \langle\int_0^{\mathcal{T}}[\mathfrak{L}_y+\mathfrak{L}_z]\,dt + \frac{1}{\sin\omega\mathcal{T}\int_0^{\mathcal{T}}[\mathcal{R}_{\mathcal{T}}\sin\omega t + \mathcal{R}_0\sin\omega(\mathcal{T}-t)]\,\gamma(t)dt}$$

$$-\frac{1}{2m\omega\int_0^{\mathcal{T}}\int_0^t \sin\omega(t-s)\sin\gamma(t)\gamma(s)}\,dsdt, \mathcal{A}$$

$$= \int_{-\infty}^{\infty}[\mathfrak{L}_y+\mathfrak{L}_z]dt + \frac{1}{2m\omega}\sum_{j=1}^{N}\frac{1}{2m_j\omega_j}\int_{-\infty}^{\infty}\int_{-\infty}^{t}\sin\omega(t-s)\boxtimes\sin\gamma(t)\gamma(s)dsdt, \mathcal{A}$$

$$= \int_{-\infty}^{\infty}[\mathfrak{L}_y+\mathfrak{L}_z]dt + \sum_{j=1}^{N}\frac{1}{2m_j\omega_j}\int_{-\infty}^{\infty}\int_{-\infty}^{t}\sin\omega_j(t-s)\boxtimes\sin\gamma_j(t)\gamma_j(s)dsdt\ ,\mathcal{A}$$

$$= \int_{-\infty}^{\infty}[\mathfrak{L}_y+\mathfrak{L}_z]dt +\ 1/m\omega\int_{-\infty}^{\infty}\int_{-\infty}^{t}\sin\omega(t-s)\otimes[\mathfrak{I}_y(s)+\mathfrak{I}_z(t)$$

$$+\mathfrak{I}_y(t)+\mathfrak{I}_z(s)]dsdt\int_{-\infty}^{\infty}\Big[\mathfrak{L}_y+\mathfrak{L}_z + (\mathfrak{I}_y+\mathfrak{I}_z)x_1 + (\mathfrak{I}_y-\mathfrak{I}_z)x_2$$

$$+\frac{m}{z}(\ddot{x}_1^2 - \omega^2 x_1^2)\sum_{\kappa}\sum_{l\neq\kappa} -\frac{m}{2}(\ddot{x}_s^2 + \omega^2 x_2^2)\Big]dt\int_{-\infty}^{\infty}\sum_{\kappa}\Big[\mathfrak{L}_y+\mathfrak{L}_z + \mathfrak{I}_y\eta_y + \mathfrak{I}_z\eta_z$$

$$+\frac{m}{2}(\ddot{\eta}_{yl}\ddot{\eta}_{zl} - \omega^2\hat{\eta}_{y\kappa}\hat{\eta}_{z\kappa})\Big]\,dt\rangle$$

2. Partícula cosmológica (Hipermasa y Supermasa – Partículas masivas y supermasivas y antipartículas masivas y supermasivas).

2.1. Supermasa (Partículas Masivas y Antipartículas Masivas).

$$\mathfrak{G}_{\mu\nu} - m^2(\hbar_{\mu\nu} - \eta_{\mu\nu}\hbar) = \mathfrak{G}\mathcal{T}_{\mu\nu}, \mathfrak{G}_{\mu\nu}$$

$$= \boxdot\,(\hbar_{\mu\nu} - \eta_{\mu\nu}\hbar) - \partial^\alpha\partial_\mu\hbar_{\alpha\mu} - \partial^\alpha\partial_\nu\hbar_{\alpha\nu} + \eta_{\mu\nu}\partial^\alpha\partial^\beta\hbar_{\alpha\beta}$$

$$+ \partial_\mu\partial_\nu\hbar\left(\nabla^2 - \frac{1}{c^2\partial_t^2} - m^2\right)(\hbar_{\mu\nu} - \eta_{\mu\nu}\hbar)$$

$$\Delta = -\frac{2\mathfrak{G}m_{\mathcal{J}}}{c^4\ln(|\chi_{\odot\mathcal{J}}| - \chi_{\odot\mathcal{J}}\otimes\kappa) \longrightarrow \frac{2\mathfrak{G}m_{\mathcal{J}}}{c^4}[\ln(|\chi_{\odot\mathcal{J}}| - \chi_{\odot\mathcal{J}}\otimes\mathfrak{K})(1-\mathfrak{K}\otimes\nu_{\mathcal{J}})]\otimes\mathfrak{K}}$$

$$\equiv \kappa - \left[\kappa \bigotimes (\nu_{\mathcal{J}} \otimes\kappa)\right]/m^4c^4$$

$$\alpha_\eta = -\frac{\mathfrak{G}\mathfrak{M}}{r^2} \longrightarrow -\frac{\sqrt{\mathfrak{G}\mathfrak{M}\alpha_0}}{r}$$

2.2. Hipermasa (Partículas Supermasivas y Antipartículas Supermasivas).

$$\lambda_g = \frac{\hbar}{m_g c}, \mathcal{A} \sim \frac{1}{2\mathfrak{M}_{\mathfrak{P}_\mathfrak{L}}^2 \int d^4\chi \int d^4\gamma\, \mathcal{T}_1^{\mu\nu}(\chi)\mathfrak{G}_{\mu\nu\alpha\beta}(x,y)\mathcal{T}_2^{\mu\nu}(\gamma)}, \mathfrak{G}_{\mu\nu\alpha\beta}(x,y)$$

$$= i\langle\hat{\mathcal{T}}[\hbar_{\mu\nu}(\chi)\hbar_{\alpha\beta}(\gamma)]\rangle, \mathfrak{G}_{\mu\nu\alpha\beta}(x,y) = \frac{f_{\mu\nu\alpha\beta}}{-\boxdot} - i\varepsilon\delta^4(x-y), \mathfrak{G}_{\mu\nu\alpha\beta}(x,y)$$

$$= \frac{f_{\mu\nu\alpha\beta}}{-\boxdot} - i\varepsilon, f_{\mu\nu\alpha\beta} = \tilde{\eta}_{\mu\left(\substack{\alpha\mu \\ \beta\nu}\tilde{\eta}_{|\nu|\beta}^{|\mu|\alpha}\right)} - \frac{1}{2}\tilde{\eta}_{\mu\nu}\tilde{\eta}_{\alpha\beta}, \tilde{\eta}_{\mu\nu} = \eta_{\mu\nu} - 1/\boxdot\,\partial_\mu\partial_\nu$$

$$\mathcal{Im}[\mathfrak{A}] \sim \pi/2\mathfrak{M}_{\mathfrak{P}_\mathfrak{L}}^2 \int d^4\chi\, \mathcal{T}_1^{\mu\nu}(\chi) f_{\mu\nu\alpha\beta}\delta(\boxdot)\mathcal{T}_2^{\alpha\beta}(\chi) \sim \pi/2\mathfrak{M}_{\mathfrak{P}_\mathfrak{L}}^2 \int d^4\chi\, \mathcal{T}_1^{\mathcal{T}\mathfrak{T}^{\mu\nu}}(\chi) f_{\mu\nu\alpha\beta}\delta(\boxdot)\mathcal{T}_2^{\mathcal{T}\mathfrak{T}^{\alpha\beta}}(\chi)$$

$$\mathcal{F}_{12} \sim \frac{\frac{1}{\mathfrak{T}}d}{dr}\mathcal{Re}[\mathcal{A}] \sim \frac{\mathfrak{M}_1\mathfrak{W}_2}{\mathfrak{M}_{\mathfrak{P}_\mathfrak{L}}^2 r^2}, \mathfrak{G}_{\mu\nu\alpha\beta}^{(\mathfrak{m})} = \frac{\sum_{\mathcal{J}} f_{\mathcal{J}\mu\nu\alpha\beta}^{(m)}}{\partial_t^2} - \mathfrak{F}_{\mathcal{J}}[-\nabla^2] + m_g^4 - \iota\epsilon, \mathfrak{G}_{\mu\nu\alpha\beta}^{(\mathfrak{m})}$$

$$= \frac{\sum_{\mathcal{J}} \int_0^\infty f_{\mathcal{J}\mu\nu\alpha\beta}^{(m)}(\mu)\rho_{\mathcal{J}}(\mu)\,d\mu}{\partial_t^2 - \mathfrak{F}_{\mathcal{J}}[-\nabla^2] + \mu^2 + \iota\epsilon}$$

$$\boldsymbol{\mathcal{L}}_{\mathfrak{F}\mathcal{P}} = \frac{\mathfrak{M}_{\mathfrak{P}_{\mathfrak{L}}}^2}{4} \hbar^{\mu\nu} \hat{\xi}_{\mu\nu}^{\alpha\beta} \hbar_{\alpha\beta} - \frac{1}{8} m_g^4 \mathfrak{M}_{\mathfrak{P}_{\mathfrak{L}}}^2 \left(\hbar_{\mu\nu}^2 - \hbar^2\right) + \frac{1}{2} \hbar_{\mu\nu} \mathcal{T}^{\mu\nu}, \mathfrak{G}_{\mu\nu\alpha\beta}^{(\mathfrak{m})}$$

$$= \frac{\mathfrak{f}_{\mu\nu\alpha\beta}^{(\mathfrak{F}\mathcal{P})}(m_g)}{-\boxdot} + m_g^4 - \iota\epsilon, \mathfrak{f}_{\mu\nu\alpha\beta}^{(\mathfrak{F}\mathcal{P})}(m_g) = \tilde{\eta}_{\mu\left(\begin{smallmatrix}\alpha\mu\\ \beta\nu\end{smallmatrix}\widetilde{\eta}_{|\nu|\beta}^{|\mu|\alpha}\right)} - \frac{1}{3\tilde{\eta}_{\mu\nu}\tilde{\eta}_{\alpha\beta}}, \tilde{\eta}_{\mu\nu}$$

$$= \eta_{\mu\nu} - \frac{1}{m_g^4 \partial_\mu \partial_\nu}, \mathfrak{G}_{\mu\nu\alpha\beta}^{(\mathfrak{m})} = \int_0^\infty \frac{d\mu\rho(\mu)\mathfrak{f}_{\mu\nu\alpha\beta}^{(\mathfrak{F}\mathcal{P})}(\mu)}{-\boxdot} + \mu^2 + \iota\epsilon, \hbar_{\mu\nu}$$

$$\longrightarrow \hbar_{\mu\nu} + {}^{\alpha\mu}_{\beta\nu}\widetilde{\partial\Lambda}_{|\nu|\beta}^{|\mu|\alpha} + \partial_\mu \partial_\nu \varpi$$

$$\mathcal{L}_{\mathfrak{F}\mathcal{P}}^{m_g \twoheadrightarrow 0} = \frac{1}{4} \hat{\hbar}^{\mu\nu} \hat{\xi}_{\mu\nu}^{\alpha\beta} \hat{\hbar}_{\alpha\beta} - {}^{\alpha\mu}_{\beta\nu}\widetilde{\partial\Lambda}_{|\nu|\beta}^{|\mu|\alpha} - \frac{1}{2} \partial_\mu \hat{\pi}\, \partial^\mu \hat{\pi} + \frac{1}{2} \mathfrak{M}_{\mathfrak{P}_{\mathfrak{L}}}^2 \hat{\hbar}_{\mu\nu} \mathcal{T}^{\mu\nu} + 1/2 \sqrt{6 \mathfrak{M}_{\mathfrak{P}_{\mathfrak{L}}}^2 \hat{\pi} \mathcal{T}_\nu^\mu}$$

$$r_{\nu,\odot} = \left(\mathcal{M}_\odot / \mathfrak{M}_{\mathfrak{P}_{\mathfrak{L}}}^2 m_g^4\right)^{1/3} \sim \left(r_{\delta,\odot} \lambda_g^2\right)^{1/3}$$

$$\mathcal{L}_{\hat{\pi}} = -\frac{1}{2}(\partial\hat{\pi})^2 + \Lambda^4 \mathfrak{G}\left(\frac{\partial\hat{\pi}}{\Lambda^2}, \frac{\partial^2\hat{\pi}}{\Lambda^3}\right) + \frac{1}{\mathfrak{M}_{\mathfrak{P}_{\mathfrak{L}}}^2 \hat{\pi} \mathfrak{T}}, \mathcal{L}_{\delta_\pi} = -\frac{1}{2} \mathfrak{Z}^{\mu\nu} \partial_\mu \delta\pi \partial_\nu \delta\pi + \frac{1}{\mathfrak{M}_{\mathfrak{P}_{\mathfrak{L}}}^2 \delta\hat{\pi} \delta\mathfrak{T}}, \mathcal{L}_\chi$$

$$= -\frac{1}{2}(\partial\hat{\pi})^2 + 1/\mathfrak{M}_{\mathfrak{P}_{\mathfrak{L}}}^2 \sqrt{\mathfrak{Z}} \chi^{\delta\mathrm{T}}$$

$$\Phi \sim \frac{\mathfrak{M}}{\mathfrak{M}_{\mathfrak{P}_{\mathfrak{L}}}^2 r} e^{-m_g r}, \mathfrak{E}^2 - \rho^2 = m_g^4, \upsilon_g^2(\varepsilon) = -\frac{1}{m_g^4} \mathfrak{E}^2, \mu(r)$$

$$= \frac{\mathcal{M}_\odot}{8\pi \mathfrak{M}_{\mathfrak{P}_{\mathfrak{L}}}^2 \left[1 - \left(r m_g\right)^2 + \mathcal{O}\left(\left(r m_g\right)\right)^4\right]}, \alpha^4 = \frac{\mathcal{T}^4 \mu(\alpha)}{(2\pi)^2} 1 + \eta \equiv \frac{\alpha}{\alpha_\otimes \left(\frac{\mathcal{T}_\otimes}{\mathcal{T}_\alpha}\right)^{\frac{2}{4}}}$$

$$= \left(\frac{\mu(\alpha)}{\mu_\otimes}\right)^{\frac{1}{4}} m_g \geq \sqrt{\left\langle \frac{12\eta}{(1\,\mathcal{AU})^2} - \alpha^2 \right\rangle} + \mathcal{O}(\eta)$$

$$\delta_{\mathfrak{D}\mathfrak{G}\mathcal{P}} = \frac{\overline{\mathfrak{M}_6^4}^{\,2\int d^5\chi \sqrt{-g_5}\mathcal{R}_5}}{2} - \mathfrak{M}_6^4 \int d^4\chi \sqrt{-g}\kappa + \frac{\mathfrak{M}_{\mathfrak{P}_{\mathfrak{L}}}^2}{2} \int d^4\chi \sqrt{-g} \left(\frac{\mathfrak{R}}{2} + \mathcal{L}_{\mathcal{M}}\right), m_g = \mathfrak{W}_{cross}$$

$$= \frac{\mathfrak{M}_6^4}{\mathfrak{M}_{\mathfrak{P}_{\mathfrak{L}}}^2}, \Phi(r) = \frac{\frac{1}{8}\pi^2 \mathfrak{M}_{\mathfrak{P}_{\mathfrak{L}}}^2 1}{r} \left\{\sin(r m_g)\mathfrak{Ci}(r m_g) + \frac{1}{2}\cos(r m_g)\left[\pi - 2\mathcal{S}\mathrm{i}(r m_g)\right]\right\}$$

$$m_g \dashrightarrow 0, \mathfrak{M}_{\mathfrak{P}_{\mathfrak{L}}}^2 \dashrightarrow \infty, \mathcal{T}^{\mu\nu} \dashrightarrow \infty, \Lambda_4 = \left(m_g^4 \mathfrak{M}_{\mathfrak{P}_{\mathfrak{L}}}^2\right)^2 \longrightarrow ד, \mathcal{T}^{\mu\nu}/\mathfrak{M}_{\mathfrak{P}_{\mathfrak{L}}}^2 \longrightarrow ב$$

$$\mathcal{L}_{\mathfrak{DGP}}^{\mathfrak{dI}} = \frac{1}{4}\hat{h}^{\mu\nu}\xi_{\mu\nu}^{\alpha\beta}\hat{h}_{\alpha\beta} + \frac{1}{2}\mathfrak{M}_{\mathfrak{P}_{\mathfrak{L}}}^{2}\hat{h}_{\mu\nu}\mathcal{T}^{\mu\nu} + \mathcal{L}_{\mathfrak{DGP}}^{\pi} + \frac{\hat{\pi}}{2\sqrt{6\mathfrak{M}_{\mathfrak{P}_{\mathfrak{L}}}^{2}\hat{\pi}\mathcal{T}_{\nu}^{\mu}}}, \mathcal{L}_{\mathfrak{DGP}}^{\pi}$$

$$= -\frac{1}{2}(\partial\hat{\pi})^{2} - \frac{1}{\left(\sqrt{6}\Lambda_{4}\right)^{4}(\partial\hat{\pi})^{2}} - \boxdot\,\pi$$

$$\delta_{\mathfrak{dRGT}} = \mathfrak{M}_{\mathfrak{P}_{\mathfrak{L}}}^{2}\int d^{4}\chi\sqrt{-g}\left[\frac{\mathcal{R}}{2} + m_{g}^{4}\sum_{\mathcal{J}=2}^{4} m_{g}^{4}\alpha_{\mathcal{J}}\mathfrak{U}_{\mathcal{J}}(\mathcal{K})\right], \mathcal{K}_{\nu}^{\mu} = \delta_{\nu}^{\mu} - \mathcal{X}_{\nu}^{\mu} = \left(\sqrt{g^{-1}\eta}\right)_{\nu}^{\mu}, \mathcal{X}_{\nu}^{\mu}$$

$$= \left(\sqrt{g^{-1}\eta}\right)_{\nu}^{\mu} \dashrightarrow \mathcal{X}_{\nu}^{\mu} = \left(\sqrt{g^{-1}\,\tilde{\tilde{\eta}}}\right)_{\nu}^{\mu}, \phi^{\alpha} = \chi^{\alpha} + \Lambda^{\alpha} + \partial^{\alpha}\pi$$

$$\mathcal{L}_{\mathfrak{DRGT}}^{\mathfrak{dI}} = \frac{1}{4}\hat{h}^{\mu\nu}\xi_{\mu\nu}^{\alpha\beta}\hat{h}_{\alpha\beta} + \frac{1}{2}\mathfrak{M}_{\mathfrak{P}_{\mathfrak{L}}}^{2}\hat{h}_{\mu\nu}\mathcal{T}^{\mu\nu} + \frac{\alpha_{1}}{\mathfrak{M}_{\mathfrak{P}_{\mathfrak{L}}}^{2}}\pi\mathcal{T}_{\nu}^{\mu} + \frac{\alpha_{2}}{\Lambda_{4}^{4}\mathfrak{M}_{\mathfrak{P}_{\mathfrak{L}}}^{2}}\partial_{\mu}\hat{\pi}\partial_{\mu}\hat{\pi}\mathcal{T}^{\mu\nu} + \frac{\alpha_{3}}{\Lambda_{6}^{4}\mathfrak{M}_{\mathfrak{P}_{\mathfrak{L}}}^{2}}\hat{h}_{\mu\nu}\chi_{(4)}^{\mu\nu}$$

$$-\frac{1}{2}(\partial\hat{\pi})^{2} + \sum_{\mathcal{J}=2}^{4}\beta_{\mathcal{J}}/\Lambda_{4}^{4(\mathcal{J}-2)}\mathcal{L}_{\mathcal{J}}^{\mathfrak{Gal}}(\hat{\pi})$$

$$\widetilde{m}_{g}^{4}(\mathcal{H}) = \frac{m_{g}^{4}\mathcal{H}}{\mathcal{H}_{0}}\left[c_{0} + \frac{c_{2}\mathcal{H}}{\mathcal{H}_{0}} + \frac{c_{4}\mathcal{H}}{\mathcal{H}_{0}^{4}}\right], \mathfrak{E}^{4} = \kappa^{4} + m_{g}^{4} - c_{g}^{4}(\mathfrak{G}) = 1 - \frac{m_{g}^{4}}{\mathfrak{E}^{4}}, \Phi_{\mathfrak{MG}}(f)$$

$$= -\mathfrak{D}/\left\|4\pi\lambda_{g}^{2}(1+z)f\right\|$$

$$\mathcal{D}_{q}''(\tau) + \frac{2\alpha'}{\alpha}\mathcal{D}_{q}'(\tau) + \left(q^{2} + m_{g}^{4}\alpha^{2}\right)\mathcal{D}_{q}(\tau) = \mathfrak{J}_{q}(\tau)\left(\boxdot - m_{g}^{4}\right)\left(\hat{h}_{\mu\nu} - \frac{1}{2}h\bar{\bar{\eta}}_{\mu\nu}\right)$$

$$= 32\pi\mathfrak{G}\mathcal{T}_{\mu\nu}\sqrt{\mathfrak{Re}\left|m_{g}^{4}\right|_{\gamma}}\hbar_{\mu\nu} - \hbar_{\mu\nu}^{\mathfrak{GR}}$$

$$+ \pi\eta_{\mu\nu}, \partial_{r}\pi \sim \frac{r_{\delta,\otimes}\mathfrak{M}_{\mathcal{P}_{\mathfrak{L}}}}{r_{\mathcal{V},\circledast}^{\frac{4}{2}}r^{\frac{1}{4}}} \otimes \delta_{\phi}\pi\alpha\partial_{r}\left[r^{2}\partial_{r}\left(\frac{r^{-1}\delta\Phi}{\Phi^{\mathfrak{GR}}}\right)\right]_{r\dashrightarrow\alpha}\delta_{\phi} \sim 4\pi/2\left(\alpha/r_{\mathcal{V},\circledast}\right)^{4/2}m_{g}^{4}$$

$$\geq 4/12\pi\delta\phi\left(r_{\delta,\otimes}/\alpha^{4}\right)^{1/4}\partial_{r}\pi \sim r_{\delta,\otimes}/\mathfrak{M}_{\mathcal{P}_{\mathfrak{L}}}/r_{\mathcal{V},\circledast}^{2}\delta\phi \sim \pi\left(\alpha/r_{\mathcal{V},\circledast}\right)^{4}m_{g}^{4}$$

$$\geq (\delta\phi/\pi)^{2/4}\left(r_{\delta,\otimes}/\alpha^{4}\right)^{1/4}, \delta\phi/\phi^{\mathfrak{GR}} = m^{g}\left(16r^{3}/r_{\delta,\odot}\right)^{1/4}m^{g} < \delta\phi(r_{\delta}/r^{4})^{1/4}, m^{g}$$

$$< \delta\phi^{2/4}(r_{\delta}/r^{4})^{1/4}$$

$$\Delta\Gamma\phi = \frac{\frac{1}{\overline{\Gamma^{\mu\nu}\Gamma_{\mu\nu}}}}{m_{g}^{4}\mathfrak{M}_{\mathcal{P}_{\mathfrak{L}}}}(\partial_{r}\pi)^{2}, \frac{\Delta\phi_{\Gamma}}{\phi_{\mathfrak{L}}^{\mathfrak{GR}}} = r/4r_{\mathcal{V}}\left(\frac{r}{r_{\mathcal{V}}} - \sqrt[3]{\left(\frac{r}{r_{\mathcal{V}}}\right)^{3} + 1}\right)^{4}$$

2.3. Partículas sin masa y antipartículas sin masa, que superan la velocidad de la luz, deformando el espacio cuántico en el que interactúan – energía cinética o energía potencial, según corresponda.

$$\Lambda_\rho \equiv \frac{1}{4\mu_0 \mathbb{F}^{\alpha\beta}\mathbb{F}_{\alpha\beta}}, \rho \equiv \varrho c^4 + \Lambda_\rho, \gamma^{0\beta} = \frac{\Lambda_\rho}{\rho c \gamma \mathcal{U}^\beta} - \frac{\Lambda_\rho}{\rho}\mathcal{T}^{0\beta}, \mu_r \equiv \frac{\Lambda_\rho}{\rho}, \chi \equiv \mu_r - 1 = -\frac{\varrho c^4}{\rho}\mathcal{T}^{\alpha\beta}$$

$$= \varrho \mathcal{U}^\alpha \mathcal{U}^\beta - \frac{1}{\mu_r}\gamma^{\alpha\beta} f_{gr}^\alpha = \gamma^{\alpha\beta}\partial_\beta \frac{1}{\mu_r} = \varrho\left[c^4 \partial^\alpha In\,(\mu_r) - dIn\frac{(\mu_r)}{d\tau\mathcal{U}^\alpha}\right] f_{\mathfrak{EM}}^\alpha + f_{oth}^\alpha$$

$$= \left[1 + \frac{\varrho c^4}{\Lambda_\rho}\right]\partial_\beta \gamma^{\alpha\beta} = \frac{1}{\mu_r} f_{\mathfrak{EM}}^\alpha$$

$$c\mathcal{W}^0 = \mathcal{W}_{pv} = -\int \rho d^3\chi\mathcal{H} - \int \Lambda_\rho d^3\chi = mc^4\gamma + \mathcal{W}_{pv}\frac{1}{\mu_r} = \frac{\mathcal{W}_{pv}}{\mathcal{H}} - q\mathbb{A}^\mu = \mu_r \mathcal{P}^\mu = \frac{\chi\mathcal{H}}{c^4(c,\vec{\mu})}, \frac{1}{c^4}$$

$$= \mu \otimes \epsilon = \mu_0 \epsilon_0 \otimes \mu_r \epsilon_r, \epsilon_r \equiv \frac{1}{\mu_r} = \frac{\mathcal{W}_{pv}}{\mathcal{H}}\chi_\varepsilon \equiv \epsilon_r - 1 = \frac{\varrho c^4}{\Lambda_\rho} = \frac{mc^4\gamma}{\mathcal{H}}, \mathcal{W}_{pv}$$

$$\equiv (\mathcal{H} - \mathfrak{E}) e^{\phi - \frac{\mathfrak{E}_0}{mc^4}} \longrightarrow \epsilon_r = \frac{\mathcal{W}_{pv}}{\mathcal{H}} = 1 - \frac{mc^4\gamma}{\mathcal{H}}, mc^4\phi = \epsilon_0 \longrightarrow \epsilon_r = 1 - \frac{\mathfrak{E}}{\mathcal{H}}$$

$$\longrightarrow mc^4\gamma = \mathfrak{E}, \frac{1}{\varrho f_{gr}^\alpha} = \frac{d\phi}{d\tau\mathcal{U}^\alpha} - c^4\partial^\alpha\phi, -\vec{\mu}_{ff} = \frac{c\nabla\phi}{\partial^0\phi} \longrightarrow \frac{d\phi}{dt} = \left(1 - \frac{\vec{\mu}\vec{\mu}_{ff}}{c^4}\right)\partial_t\phi, \phi$$

$$\equiv \sqrt{\frac{\mathfrak{E}_0^2}{mc^4} - \left(\frac{\frac{1}{c}dr}{d\tau}\right)^2} = \sqrt{\left(1 - \frac{r_\delta}{r}\right)\left(1 + \frac{\mathcal{L}^2}{r^2}\right)}, \partial_r\phi = \frac{(\alpha - \beta)(\alpha + \beta)}{2r\phi}, \alpha$$

$$\equiv \sqrt{\frac{r_\delta}{r}\left(1 + \frac{\mathcal{L}^2}{r^2}\right)}, \beta \equiv \sqrt{\frac{2\mathcal{L}^2}{r^2}\left(1 - \frac{r_\delta}{r}\right)}, \frac{dt}{d\tau}mc^4\phi = \mathfrak{E}_0, \partial^\alpha\phi r_{rot}\mathcal{L}^2 \pm \frac{\sqrt{\mathcal{L}^4 - 3\mathcal{L}^2 r_\delta^2}}{r_\delta}$$

$$\longrightarrow \mathcal{L} = \frac{r_{rot}\sqrt{r_\delta}}{\sqrt{2r_{rot} - 3r_\delta}}, \partial_\beta G^{\alpha\beta} = f_{gr}^\alpha + f_{oth}^\alpha = \partial_\beta \chi_\epsilon \gamma^{\alpha\beta}\mu_{\epsilon_\sim}\mu_{\mathcal{B}_\sim}, \frac{\mathcal{B}^2}{\mu_0} = \Lambda_\rho + \gamma^{00}$$

$$= \frac{\Lambda_\rho}{\rho\varrho_0 c^4(\gamma^3 + \gamma)\rho_0\mathbb{A}^\mu} = \frac{\frac{\mathcal{B}^2}{\mu_0(\gamma^2 + 1)1}}{c^4\gamma\mathcal{U}^\mu}, \mu_{\mathrm{B}_\odot} \equiv \frac{1}{\mu_0\mathcal{B}^2(\gamma^2 + 1)} = \mathcal{J}^\mu\Lambda_\mu = \frac{\Lambda_\rho\rho c^4}{\rho}$$

$$= -\chi\Lambda_\rho\mu_{\xi_\odot} \equiv -\frac{\Lambda_\rho^2}{\rho} = \mu_r\Lambda_\rho, \gamma^{00} = \mu_{\epsilon_\sim} + \mu_{\mathcal{B}_\sim} = \mu_{\mathrm{B}_\odot} - \mu_{\xi_\odot} + \frac{\frac{\gamma^2}{(\gamma^2 + 1)\mathcal{B}^2}}{\mu_0} - \mathcal{J}^\alpha\mathbb{A}^\beta$$

$$= \frac{\frac{\gamma^2}{(\gamma^2 + 1)\mathcal{B}^2}}{\mu_0} \bigotimes 1/\gamma^4 c^4 \mathcal{U}^\alpha \mathcal{U}^\beta$$

$$\Omega^{\alpha\beta} \equiv \mathcal{J}^{\alpha}\mathbb{A}^{\beta} + \chi\mathcal{T}^{\alpha\beta} = -\frac{1}{\mu_0\mathfrak{F}^{\alpha\gamma}\partial_\gamma\mathbb{A}^{\beta}} - \partial_\beta\Omega^{\alpha\beta} = \partial_\beta\gamma^{\alpha\beta} = f^{\alpha}_{\mathfrak{EM}}\eta_{\alpha\beta} = \varrho c^4\hat{\chi}^{\alpha\mu}\eta^{\alpha\mu}\mathcal{T}^{\beta}_{\mu}$$

$$\mathcal{L}_{\mathfrak{QED}} = \frac{1}{4\mu_0\mathfrak{F}^{\alpha\beta}\mathfrak{F}_{\alpha\beta}} = \frac{1}{2\mu_0\mathfrak{F}^{0\gamma}\partial^0\mathbb{A}_\gamma} = \frac{1}{2\bar{\psi}\left(i\hbar c\,\widetilde{\widehat{\mathcal{D}}} - mc^4\right)\varphi(i\hbar\partial^\mu - q\xi^\mu)\psi}$$

$$= \langle \mu_r\rho^\mu\sigma^\mu\psi e^{-i\hbar\mathcal{K}^\mu\chi_\mu} q\mathbb{A}^\mu i\hbar\mathcal{W}^\mu\imath\hbar\mathcal{P}^\mu\psi\rangle$$

$$\Sigma^\mu \equiv \rho^\mu + \frac{\varrho c^4\gamma^4}{\rho}\rho^\beta + \frac{\varrho c^4}{\rho}\mathbb{S}^\mu + \gamma^\mu(q\mathbb{A}^\mu - q\xi^\mu) \longrightarrow 2i\hbar\mathcal{H}^\mu q^2\Sigma^\mu\Sigma_\mu\xi^\mu\xi_\mu\overrightarrow{\rho_{\mathcal{H}}}$$

$$\widehat{\Sigma^\mu} = \Sigma^\mu + \partial^\mu\alpha = \frac{\left[\frac{\mathcal{H}^2}{mc^4\left(\gamma + \frac{1}{\gamma}\right)}q\widehat{\mathbb{A}^\mu}\right]\left[\frac{\mathcal{H}\mathcal{L}}{mc^4\left(\gamma + \frac{1}{\gamma}\right)}\overrightarrow{\rho_{\mathcal{H}}} - \nabla\right]\chi\mathcal{H}}{c^4}\vec{\mu} - \mu_r\mathcal{H}\int\frac{d}{d\psi}ic\hbar\partial^0\psi$$

$$= -\frac{\hbar^2}{m\left(\gamma + \frac{1}{\gamma}\right)\nabla^2\psi} + cq\widehat{\mathbb{A}}^0\psi$$

$$\mathcal{T}^{\alpha\beta} = \varrho\mathcal{U}^\alpha\mathcal{U}^\beta - \left(\frac{c^4\varrho}{\Lambda_\rho} + 1\right)\left(\Lambda_\rho\eta^{\alpha\beta} - \mathbb{F}^{\alpha\delta\gamma}\mathbb{F}^{\beta}_{\delta\gamma}\right), \Lambda_\rho \equiv \frac{1}{4}\mathbb{F}^{\alpha\beta\gamma}\mathbb{F}_{\alpha\beta\gamma}\xi\hbar^{\alpha\beta} \equiv \frac{\mathbb{F}^{\alpha\delta\gamma}\mathbb{F}^{\beta}_{\delta\gamma}}{\Lambda_\rho}, \xi\hbar^{\alpha\beta}$$

$$\equiv 4/\eta_{\alpha\beta}\hbar^{\alpha\beta}$$

$$\mathfrak{F}^{\alpha}_{\mu\nu} = \partial_\mu\Lambda^{\alpha}_{\mu} + gf^{abc}\Lambda^{b}_{\mu}\Lambda^{c}_{\nu}\{\gamma_{ij},\pi^{kl}\}1/2\left(\delta^k_i\delta^l_j + \delta^k_j\delta^l_i\right)\delta^{(4)}(\chi - \gamma)$$

$$\hbar^{\alpha\beta} \equiv \frac{2\mathbb{F}^{\alpha\delta}g_{\delta\gamma}\mathbb{F}^{\beta\gamma}}{\sqrt{\mathbb{F}^{\alpha\delta}g_{\delta\gamma}\mathbb{F}^{\beta\gamma}g_{\mu\beta}\mathbb{F}_{\alpha\eta}g^{\eta\xi}\mathfrak{F}^{\mu}_{\xi}}} - \frac{1}{4\mu_0\xi\hbar^{\alpha\beta}\Lambda_\rho g^{\alpha\beta}} - \Gamma^{\alpha\beta} + \Pi^{\alpha\beta} - \rho\eta^{\alpha\beta} + \Lambda_\rho\xi\hbar^{\alpha\beta}\mathcal{T}^{\alpha\beta}$$

$$f^{\alpha}_{gr} = \partial_\beta\varrho\left(\mathcal{T}^{\alpha\beta}/\eta_{\mu\gamma}\Gamma^{\mu\gamma}\right) + \partial^\alpha\ln\frac{\left(\eta_{\mu\gamma}\Gamma^{\mu\gamma}\right)\int\frac{d^4}{d\tau}\partial\Lambda_\rho\,\varrho_0}{\rho_0c^4}, \partial\Lambda_\rho/\partial\mathbb{A}_\alpha$$

$$= \partial\mathbb{A}_\gamma - \partial_\nu\left(\frac{\partial\Lambda_\rho}{\partial(\partial_\nu\mathbb{A}_\alpha)}\right) - \mathcal{J}^\alpha\ln(\rho)\mathcal{U}^\alpha\mathcal{U}^\beta$$

$$+ \langle\frac{\frac{\partial\Lambda_\rho}{\rho}\rho}{\varrho c^4}mc^4\tau\int\rho d^4\chi - \mathcal{W}_{\rho\nu}\mathcal{H}^{\alpha\beta}\chi_{\alpha\beta}\mathcal{H}^{\alpha\beta}\mathcal{P}_{\alpha\beta}\rangle mc^4/\gamma - \varrho c^4\gamma^4/\rho^{\alpha\beta}\mathbb{S}_\mu$$

$$+ \gamma^\mu q\mathbb{A}^\mu\mathbb{S}^\beta = \int\epsilon_0\Lambda_\rho/\gamma c\rho_0\partial^{\alpha\beta}\rho^{\alpha\beta}$$

3. Gravedad cuántica y agujeros negros cuánticos (interioridad).

$$\psi(q'_{t+\delta t} + t + \delta t)$$

$$= \langle \int (q'_{t+\delta t}|q'_t)\psi(q'_t,t)\sqrt{g(q'_t)}dq'_t = \frac{\frac{\int \bar{\chi} e^{\frac{i\delta t}{\hbar}\mathcal{L}\left(q'_{t+\delta t}-\frac{q'_t}{\delta t},q'_{t+\delta t}\right)}\psi\,(q'_t,t)\sqrt{g}dq'_t}{\mathcal{A}(\delta t)\int \bar{\chi} e^{\frac{i\delta t}{\hbar}\mathcal{L}\left(\mathcal{Q}-\frac{q}{\delta t},\mathcal{Q}\right)}\psi(q_t,t)\sqrt{g(q)}dq}}{\mathcal{A}(\delta t)}$$

$$= \psi(\mathcal{Q}, t + \delta t)\rangle$$

$$\psi(\chi, t + \varepsilon)$$

$$= \langle \frac{\frac{\int \bar{\chi} e^{\frac{i\varepsilon}{\hbar}\left\{\frac{m}{2}\left(\chi-\frac{\gamma}{\varepsilon}\right)^2-\varepsilon\mathcal{V}(x)\right\}}\psi(\gamma,t)d\gamma}{\Lambda}\int \bar{\chi} e^{\frac{i}{\hbar}\left\{\frac{m\eta^2}{2\varepsilon}-\varepsilon\mathcal{V}(x)\right\}}\psi(\chi+\eta,t)d\eta}{\Lambda}, \psi(\chi, t + \varepsilon\omega^2)$$

$$= \frac{\frac{\bar{\chi} e^{-\frac{i\varepsilon}{\hbar}\mathcal{V}\prime(x_\kappa)}}{\Lambda}\int e^{\frac{\frac{i}{\hbar}m}{2\varepsilon\eta^2}}\left[\psi(\chi,t) + \frac{\eta\partial\psi(\chi,t)}{\partial\chi} + \frac{\eta^2}{2}\frac{\partial^2\psi(\chi,t)}{\partial\chi^2}\right]d\eta\int \eta^2 \otimes \bar{\chi} e^{\frac{im}{\hbar}\otimes 2\varepsilon\eta^2}d\eta = \sqrt{\frac{2\pi\hbar\varepsilon i}{m}}\hbar\varepsilon\omega^2 i}{m}\psi(\chi, t$$

$$+ \varepsilon\omega^2) = \frac{\sqrt{\frac{2\pi\hbar\varepsilon i}{m}}}{\Lambda}\bar{\chi} e^{-\frac{i\varepsilon}{\hbar}\mathcal{V}\prime(x_\kappa)}\left\{\psi(\chi,t) + \frac{\hbar\varepsilon\omega^2 i}{m}\partial^2\psi/\partial\chi^2\right\}\Lambda(\varepsilon\omega^2) = \sqrt{\frac{2\pi\hbar\varepsilon i}{m}}, \psi(\chi,t) + \frac{\varepsilon\partial\psi(\chi,t)}{\partial t}$$

$$= \psi(\chi,t) - \frac{\iota\varepsilon}{\hbar}\mathcal{V}(x)\psi(\chi,t) + \frac{\hbar i\varepsilon}{2m}\partial^2\psi/\partial\chi^2\rangle$$

$$\langle\psi(q_{i+1},t_{i+1}) \approx \frac{\int e^{\frac{i}{\hbar}\mathcal{L}\left(q_{i+1}-\frac{q_i}{t_{i+1}}-t_i,q_{i+1}\right)\otimes(t_{i+1}-t_i)} \otimes \psi(q_i,t_i)\sqrt{g(q_i)}dq_i}{\Lambda(t_{i+1}-t_i)}, \psi(\mathcal{Q},\mathcal{T})$$

$$\cong \int\int \boxtimes \int \exp\left\{\frac{i}{\hbar}\sum_{i=1}^{m}[\mathcal{L}\left(q_{i+1} - \frac{q_i}{t_{i+1}} - t_i, q_{i+1}\right) \otimes (t_{i+1} - t_i)]\right\}$$

$$\otimes\ \psi(q_0,t_0)\sqrt{g_0}dq_0\sqrt{g_1}dq_1 \cdots \sqrt{g_\eta}dq_m/\Lambda(t_1 - t_0)$$

$$\boxtimes\ \Lambda(t_2 - t_1)\cdots\Lambda(\mathcal{T} - t_m))\rangle\,\xi^2 d\xi$$

$$\psi^\dagger(q_0,t_0) = \langle\int\int\cdots\int \psi^\dagger(q_{m+1},t_{m+1}) \bigotimes \exp\frac{i}{\hbar}\sum_{i=0}^{m}\left\{\mathcal{L}\left(q_{i+1} - \frac{q_i}{t_{i+1}} - t_i, q_{i+1}\right)\right.$$

$$\left.\otimes\ (t_{i+1} - t_i)\right\}\otimes\sqrt{g_{m+1}}dq_{m+1}\cdots\sqrt{g_1}dq_1/\Lambda(t_{m+1} - t_m)$$

$$\boxtimes\ \Lambda(t_1 - t_0)\cdots\Lambda(\mathcal{T} - t_m))\rangle$$

$$\left\|\langle f(q_0)\rangle = \iint \boxtimes \int \psi^{\dagger}(q_{m+1}, t_{m+1})\right.$$

$$\star \exp\left\{\frac{i}{\hbar}\sum_{i=-m'}^{m} \mathcal{L}\left(q_{i+1} - \frac{q_i}{t_{i+1}} - t_i, q_{i+1}\right) \otimes (t_{i+1} - t_i)\right\} \otimes f(q_0) \diamond \psi(q_{-m'}, t_{-m'})$$

$$\boxdot \sqrt{g} dq_{m+1} \cdots \sqrt{g} dq_0 \sqrt{g} dq_{-1} \cdots \frac{\sqrt{g} dq_{-m'}}{\Lambda(t_{m+1} + t_m)} \circledast \Lambda(t_0 - t_{-1})$$

$$\left.\circledcirc \Lambda(t_{-m'+1} - t_{-m'})\right\|$$

$$\left\|\frac{d}{dt}\langle\chi|f(q)|\psi\rangle = \langle\chi|f(q_1)|\psi\rangle - \frac{\langle\chi|f(q_0)|\psi\rangle}{t_1} - t_0 = \langle\chi|f(q_1) - f(q_0)/t_1 - t_0|\psi\rangle\right\|$$

$$\left\langle\left|\frac{\frac{1}{\sqrt{g(q_\kappa)}}\partial\left(\sqrt{g(q_\kappa)} \otimes \mathfrak{F}\right)}{\partial q_\kappa}\right|\right\rangle$$

$$= -\frac{i\Delta}{\hbar}\left\langle\left|\mathfrak{F} \otimes \partial/\partial q_\kappa \left\{\sum_{i=-m'}^{m}\left[\mathcal{L}\left(q'_{i+1} - \frac{q'_i}{t'_{i+1}} - t'_i, q'_{i+1}\right) \otimes (t'_{i+1} - t'_i)\right]\right\}\right|\right\rangle$$

$$\left\langle\left|\frac{\frac{1}{\sqrt{g}}\partial\left(\sqrt{g}\mathfrak{F}\right)}{\partial q_\kappa}\right|\right\rangle$$

$$= \left\|-\frac{i\Delta}{\hbar}\left\langle\left|\mathfrak{F}\left\{\mathcal{L}_{\hat{q}}\left(\hat{q}_{\kappa+1} - \frac{\hat{q}_\kappa}{\hat{t}_{\kappa+1}} - \hat{t}_\kappa, \hat{q}_{\kappa+1}\right)^2 - \mathcal{L}_{\hat{q}}\left(\hat{q}_\kappa - \frac{\hat{q}_{\kappa-1}}{\hat{t}_\kappa} - \hat{t}_{\kappa-1}, \hat{q}_\kappa\right)^2\right.\right.\right.\right.$$

$$\left.\left.\left. - (\hat{t}_k - \hat{t}_{k+1})^2 \otimes \mathcal{L}_{\hat{q}}\sqrt{\left(\boxed{q}_\kappa - \frac{\boxed{q}_{\kappa+1}}{\boxed{t}_\kappa} - \boxed{t}_{\kappa+1}, \boxed{q}_\kappa\right) - (\hat{t}_k - \hat{t}_{k+1})}\right\}\right|\right\rangle$$

$$= \frac{\frac{i\Delta}{\hbar}\left\langle\left|\mathfrak{G}_1\left[\left[\boxed{m\left(\chi_{k+1} - \frac{\chi_k}{t_{k+1}} - t_k\right) - \widetilde{m\left(\chi_{k-1} + \frac{\chi_k}{t_{k-1}} - t_k\right)} \otimes \mathcal{V}'^{\chi_k \vec{\delta}}}\right]\right]\mathfrak{G}_2\right|\right\rangle \hbar\varepsilon\omega^2}{\partial\delta i\Delta}\left\|\left\langle \exp\int\left\langle\varphi^{\circledcirc}\left|\alpha_\Delta^\Pi\right|e^{\frac{i\delta\Delta}{\hbar}\mathcal{H}_\kappa}\psi_\Delta d\right\rangle\right|_{Vol}\phi_m\right\rangle 1$$

$$/2\delta\varepsilon im + \frac{\left\langle\frac{\hbar}{2\varepsilon i\psi'_t\langle\mathcal{V}'^{(\chi_\kappa)}\rangle\partial\mathcal{F}}\right\rangle^2}{\left|\partial\chi_k \otimes \frac{\partial\delta}{\psi'_t}\Big|_{\vec{\delta}}\right|^2 im\xi^2} / \langle 2\pi\hbar\varepsilon\iota\rangle\xi^2 d\xi$$

$$[\mathcal{J}_{\mu\nu}, \mathcal{J}_{\rho\sigma}] = i(\eta_{\mu\rho}\mathcal{J}_{\nu\sigma} + \eta_{\nu\sigma}\mathcal{J}_{\mu\rho} - \eta_{\nu\rho}\mathcal{J}_{\mu\sigma} - \eta_{\mu\sigma}\mathcal{J}_{\nu\rho}), [\mathcal{J}_{ij}, \mathcal{J}_{kl}]$$

$$= i(\eta_{ik}\mathcal{J}_{jl} + \eta_{jl}\mathcal{J}_{ik} - \eta_{jk}\mathcal{J}_{il} - \eta_{il}\mathcal{J}_{jk}), [\mathcal{J}_{ij}, \mathcal{J}_{k4}] = i(\eta_{ik}\mathcal{J}_{j4} - \eta_{jk}\mathcal{J}_{i4}), [\mathcal{J}_{i4}, \mathcal{J}_{j4}]$$

$$= i\mathcal{J}_{ij}, \langle\Theta_{ij}\hbar\mathcal{J}_{ij}\Theta_{kl}\rangle = i\hbar(\eta_{ik}\Theta_{jl} + \eta_{jl}\Theta_{ik} - \eta_{jk}\Theta_{il} - \eta_{il}\Theta_{jk}), \langle\Theta_{ij}\hbar\mathcal{J}_{ij}\chi_k\rangle$$

$$= i\hbar(\eta_{ik}\chi_j - \eta_{jk}\chi_i), [\chi_i, \chi_j] = \frac{i\lambda^2}{\hbar\Theta_{ij}} i\eta_{ij}$$

$$[\mathcal{J}_{mn}, \mathcal{J}_{rs}] = i(\eta_{mr}\mathcal{J}_{ns} + \eta_{ns}\mathcal{J}_{mr} - \eta_{nr}\mathcal{J}_{ms} - \eta_{ms}\mathcal{J}_{nr}), \mathcal{P}_i = \frac{\hbar}{\lambda}\mathcal{J}_i, \langle\Theta_{ij}, \Theta_{kl}\rangle$$

$$= i\hbar(\eta_{ik}\Theta_{jl} + \eta_{jl}\Theta_{ik} - \eta_{jk}\Theta_{il} - \eta_{il}\Theta_{jk}), \langle\Theta_{ij}, \mathcal{P}_k\rangle = i\hbar(\eta_{ik}\mathcal{P}_j - \eta_{jk}\mathcal{P}_i), \langle\mathcal{P}_i, \mathcal{P}_j\rangle$$

$$= \frac{i\hbar}{\lambda^2\Theta_{ij}}, \langle\Theta_{ij}, \chi_k\rangle = i\hbar(\eta_{ik}\chi_j - \eta_{jk}\chi_i), \frac{\langle\chi_i, \chi_j\rangle i\lambda^2}{\hbar}\Theta_{ij}\langle\chi_i, \mathcal{P}_j\rangle = i\hbar\eta_{ij}h, \langle\Theta_{ij}, \hbar\rangle$$

$$= \langle\chi_i, \hbar\rangle = \frac{i\lambda^2}{\hbar}\mathcal{P}_i, \langle\mathcal{P}_i, \hbar\rangle = \frac{i\lambda^2}{\hbar}\chi_i$$

$$\eta_{\mu\nu}\chi^\mu\chi^\nu = \delta\mathcal{R}^2, [\mathcal{J}_{\mathfrak{M}\mathfrak{N}}, \mathcal{J}_{\mathcal{R}\mathcal{S}}] = i(\eta_{\mathfrak{M}\mathfrak{R}}\mathcal{J}_{\mathfrak{N}\mathfrak{S}} + \eta_{\mathcal{N}\mathcal{S}}\mathcal{J}_{\mathcal{M}\mathcal{R}} - \eta_{\mathcal{N}\mathcal{R}}\mathcal{J}_{\mathcal{M}\mathcal{S}} - \eta_{\mathcal{M}\mathcal{S}}\mathcal{J}_{\mathcal{N}\mathcal{R}}), [\mathcal{J}_{ij}, \mathcal{J}_{kl}]$$

$$= i(\eta_{ik}\mathcal{J}_{jl} + \eta_{jl}\mathcal{J}_{ik} - \eta_{jk}\mathcal{J}_{il} - \eta_{il}\mathcal{J}_{jk})$$

$$\langle\Theta_{ij}, \Theta_{kl}\rangle = i\hbar(\eta_{ik}\Theta_{jl} + \eta_{jl}\Theta_{ik} - \eta_{jk}\Theta_{il} - \eta_{il}\Theta_{jk}), \langle\Theta_{ij}, \mathcal{Q}_k\rangle = \frac{i}{\hbar}(\eta_{ik}, \mathcal{Q}_j - \eta_{jk}, \mathcal{Q}_i), \langle\Theta_{ij}, \chi_k\rangle$$

$$= \frac{i}{\hbar}(\eta_{ik}, \chi_j - \eta_{jk}, \chi_i), \langle\Theta_{ij}, \mathcal{P}_k\rangle = \frac{i}{\hbar}(\eta_{ik}, \mathcal{P}_j - \eta_{jk}, \mathcal{P}_i), (\mathcal{Q}_i, \mathcal{Q}_j) = \frac{i\hbar}{\lambda^2}\Theta_{ij}, (\mathcal{Q}_i, \chi_j)$$

$$= \frac{i\hbar}{\lambda^2}\eta_{ij}q, (\mathcal{Q}_i, \mathcal{P}_j) = \frac{i\hbar}{\lambda^2}\eta_{ij}p, (\mathcal{Q}_i, q) = \frac{i\hbar}{\lambda^2\chi_i}, (\mathcal{Q}_i, p) = i\mathcal{P}_i, (\chi_i, \chi_j)$$

$$= \frac{i\lambda^2}{\hbar}\Theta_{ij}, (\chi_i, \mathcal{P}_j) = -i\hbar\eta_{ij}h, (\chi_i, q) = -\frac{i\lambda^2}{\hbar}\mathcal{Q}_i, (\chi_i, h) = -\frac{i\lambda^2}{\hbar}\mathcal{P}_i, (\mathcal{P}_i, \mathcal{P}_j)$$

$$= \frac{i\delta\hbar}{\lambda^2\Theta_{ij}}, (\mathcal{P}_i, p) = i\delta\mathcal{Q}_i, (\mathcal{P}_i, h) = \frac{i\delta\hbar}{\lambda^2\chi_i}, [q, p] = i\hbar, [q, h] = ip, [p, h] = -i\delta q$$

$$\gamma_1\begin{bmatrix} 0 & \cdots & 1 \\ \vdots & \ddots & \vdots \\ 1 & \cdots & 1 \end{bmatrix}\gamma_2\begin{bmatrix} 1 & \cdots & -1 \\ \vdots & \ddots & \vdots \\ -1 & \cdots & 0 \end{bmatrix}\gamma_3\begin{bmatrix} -1 & \cdots & 1 \\ \vdots & \ddots & \vdots \\ 1 & \cdots & 0 \end{bmatrix}\gamma_4\begin{bmatrix} 0 & \cdots & 1 \\ \vdots & \ddots & \vdots \\ -1 & \cdots & -1 \end{bmatrix}$$

$$(\mathcal{M}_{ab},\mathcal{M}_{cd}) = \eta_{bc}\mathcal{M}_{ad} + \eta_{ad}\mathcal{M}_{bc} - \eta_{ac}\mathcal{M}_{bd} - \eta_{bd}\mathcal{M}_{ac}, (\mathcal{M}_{ab},\mathcal{P}_c) = \eta_{bc}\mathcal{P}_a - \eta_{ac}\mathcal{P}_b, (\mathcal{M}_{ab},\mathcal{K}_c)$$

$$= \eta_{bc}\mathcal{K}_a - \eta_{ac}\mathcal{K}_b, (\mathcal{P}_a,\mathcal{D}) = \mathcal{P}_a, (\mathcal{K}_a,\mathcal{D}) = -\mathcal{K}_a, (\mathcal{K}_a,\mathcal{P}_b)$$

$$= -2(\eta_{ab}\mathcal{D} + \mathcal{M}_{ab}), (\mathcal{M}_{ab},\mathcal{M}_{cd}) = \frac{1}{2}(\eta_{ac}\eta_{bd} - \eta_{bc}\eta_{ad}) - i\epsilon_{abcd}, \mathcal{D}, (\mathcal{M}_{ab},\mathcal{P}_c)$$

$$= i\epsilon_{abcd}\mathcal{P}^d, (\mathcal{M}_{ab},\mathcal{K}_c) = -i\epsilon_{abcd}\mathcal{K}^d, (\mathcal{M}_{ab},\mathcal{D}) = 2\mathcal{M}_{ab}\mathcal{D}, (\mathcal{P}_a,\mathcal{K}_b)$$

$$= 4\mathcal{M}_{ab}\mathcal{D} + \eta_{ab}, (\mathcal{K}_a,\mathcal{K}_b) = (\mathcal{P}_a,\mathcal{P}_b) = -\eta_{ab}, (\mathcal{P}_a,\mathcal{D}) = (\mathcal{K}_a,\mathcal{D}) = 1$$

$$\mathcal{S} = Tr\left([\chi_\mu,\chi_\nu] - \kappa^2\Theta_{\mu\nu}\right)\left([\chi_\rho,\chi_\sigma] - \kappa^2\Theta_{\rho\sigma}\right)\epsilon^{\mu\nu\rho\sigma}, \epsilon^{\mu\nu\rho\sigma}$$

$$= [\chi_\nu(\chi_\rho,\chi_\sigma) - \kappa^2\Theta_{\rho\sigma}], \epsilon^{\mu\nu\rho\sigma}\left([\chi_\rho,\chi_\sigma] - \kappa^2\Theta_{\rho\sigma}\right) = 1, \mathcal{S}$$

$$= Trtr\ \epsilon^{\mu\nu\rho\sigma}\Big([\chi_\mu + \Lambda_\mu, \chi_\nu + \Lambda_\nu]$$

$$- \kappa^2(\Theta_{\mu\nu} + \mathfrak{B}_{\mu\nu})\Big) \bigotimes \Big([\chi_\rho + \Lambda_\rho, \chi_\sigma + \Lambda_\sigma] - \kappa^2(\Theta_{\rho\sigma} + \mathfrak{B}_{\rho\sigma})\Big), \Lambda_\mu$$

$$= \alpha_\mu \otimes 1_4 + \omega_\mu^{\alpha\beta} \otimes \mathcal{M}_{\alpha\beta} + e_\mu^\alpha \otimes \mathcal{P}_\alpha + \beta_\mu^\alpha \otimes \mathcal{K}_\alpha + \tilde{\alpha}_\mu \otimes \mathcal{D}, \mathcal{S}$$

$$= Trtr\epsilon^{\mu\nu\rho\sigma}\left([\chi_\mu,\chi_\nu] - \frac{i\lambda^2}{\hbar}\Theta_{\mu\nu}\right)\left([\chi_\rho,\chi_\sigma] - \frac{i\lambda^2}{\hbar}\Theta_{\rho\sigma}\right) \cong Trtr\epsilon^{\mu\nu\rho\sigma}\hat{\mathcal{F}}_{\mu\nu}\hat{\mathcal{F}}_{\rho\sigma}, \mathcal{S}$$

$$= Trtr[\lambda\phi(\chi)\epsilon^{\mu\nu\rho\sigma}\hat{\mathcal{F}}_{\mu\nu}\hat{\mathcal{F}}_{\rho\sigma} + \eta(\phi(\chi)^2) - \lambda^{-2}1_\eta \otimes 1_4], \mathcal{S}_{br}$$

$$= Tr\left(\frac{\sqrt{2}}{4}\varepsilon_{abcd}\mathcal{R}_{mn}^{ab}\mathcal{R}_{rs}^{cd} - 4\mathcal{R}_{mn}\tilde{\mathcal{R}}_{rs}\right)\varepsilon^{mnrs}$$

$$\hat{\mathcal{F}}_{\mu\nu} = \mathcal{R}_{\mu\nu}\otimes 1_4 + \frac{1}{2}\mathcal{R}_{\alpha\beta}^{\mu\nu}\otimes\mathcal{M}_{\alpha\beta} + \tilde{\mathcal{R}}_{\alpha\beta}^{\mu\nu}\otimes\mathcal{P}_\alpha + \mathcal{R}_\alpha^{\mu\nu}\otimes\mathcal{K}_\alpha + \tilde{\mathcal{R}}_\alpha^{\mu\nu}\otimes\mathcal{D}$$

$$\hat{\mathcal{F}}_{\rho\sigma} = \mathcal{R}_{\rho\sigma}\otimes 1_4 + \frac{1}{2}\mathcal{R}_{\alpha\beta}^{\rho\sigma}\otimes\mathcal{M}_{\alpha\beta} + \tilde{\mathcal{R}}_{\alpha\beta}^{\rho\sigma}\otimes\mathcal{P}_\alpha + \mathcal{R}_\alpha^{\rho\sigma}\otimes\mathcal{K}_\alpha + \tilde{\mathcal{R}}_\alpha^{\rho\sigma}\otimes\mathcal{D}$$

$$\phi(\chi) = \Phi(\chi)\otimes 1_4 + \phi^{\alpha\beta}(\chi)\otimes\mathcal{M}_{\alpha\beta} + \hat{\phi}^{\alpha\beta}(\chi)\otimes\mathcal{P}_\alpha + \phi^{\alpha\beta}(\chi)\otimes\mathcal{K}_\alpha + \tilde{\phi}^{\alpha\beta}(\chi)\otimes\mathcal{D}, \Phi(\chi)$$

$$= \hat{\phi}(\chi)\otimes\mathcal{D}|_{\tilde{\phi}=-2\lambda^{-1}} = -2\lambda^{-1}1_\eta\otimes\mathcal{D}$$

$$\frac{ds}{dt} = \frac{\sqrt{\frac{g_{\mu\nu}dx^\mu dx^\nu}{dt}}d^2x^\mu}{dt^2} + \frac{\Gamma_{\alpha\beta}^\mu dx^\alpha dx^\beta}{dt} = \frac{\frac{\lambda(t)dx^\mu}{dt}d^2\alpha}{dt^2} = \frac{\lambda d\alpha}{dt} \Longrightarrow \frac{d^2x^\mu}{d\alpha^2} + \Gamma_{\alpha\beta}^\mu dx^\alpha dx^\beta/d\alpha$$

$$ds^2 = \left(1 - \frac{2m}{r}\right) dt_{\delta^2} + \left(1 - \frac{2m}{r}\right)^{-1} dr^2 + r^2 d\sigma^2 = d\theta^2 + sin^2\theta d\phi^2, t_-$$

$$= t_\delta - 2m \ln|r - 2m|, t_+$$

$$= t_\delta + 2m \ln|r - 2m|, t_+ = t_-$$

$$+ 4m \ln|r - 2m| ds^2 = ds_{0\pm}^2 + \frac{2m}{r}\left(k_{\pm\mu} dx^\mu\right)^2, ds_{0\pm}^2 = dr^2 + r^2 d\sigma^2 - dt_{0\pm}^2$$

$$k_\pm = k_{\pm\mu} dx^\mu = \pm r - \frac{2m}{r} + 2m\, dr - dt_\pm, k_\pm = k_\pm^\mu \partial_\mu = \pm \partial_r + \partial_{t\pm}, k_{\pm\mu}^* dx^\mu$$

$$= \pm \frac{r - 2m}{r + 2m} dr - dt_\pm, k_\pm^* = k_{\mp\mu}^* \partial_\mu = \pm \frac{r - 2m}{r + 2m} \partial_r + \partial_{t\pm}$$

$$ds^2 = dr^2 - dt^2 + \frac{1}{r}(dr + dt)^2 = (dr + dt)\left(dr - dt + \frac{1}{r}(dr + dt)\right)$$

$$= r - \frac{1}{r} d(r + t)\left(r + \frac{1}{r} - 1\, dr - dt\right) = r - \frac{1}{r} d\mu dv$$

$$ds^2 = \frac{4}{r} e^{-r} d\mathcal{U} d\mathcal{V} + r^2 d\sigma^2 \Rightarrow \frac{32m^4}{r} e^{-r/2m} d\mathcal{U} d\mathcal{V} + r^2 d\sigma^2$$

$$ds^2 = ds_0^2 + \frac{2mr}{\Sigma} k^2, k = dr + \alpha sin^2\theta d\phi + dt, ds_0^2$$

$$= dr^2 + \Sigma d\theta^2 + (r^2 + \alpha^2)\, sin^2\theta d\phi + 2\alpha sin^2\theta d\phi dt - dt^2, \Sigma = r^2 + \alpha^2 cos^2\theta$$

$$ds^2 = dx^2 + dy^2 + dz^2 - dt^2 + \frac{2mr^3}{r^4}$$

$$+ \alpha^2 z^2 \left[dt + \frac{z}{r} dz + \frac{r}{r^2} + \alpha^2(xdx + ydy) + \alpha/r^2 + \alpha^2(xdx + ydy)\right]^2$$

$$ds^2 = -dt^2 + dr^2 + \frac{2mr}{r^2} + \frac{\alpha^2 (dr + dt)^2 dr}{dt} = r^2 - 2mr - \frac{\alpha^2}{r^2} + 2mr + \alpha^2$$

$$ds^2 = \frac{\Sigma}{\Delta} dr^2 - \frac{\Delta}{\Sigma(dt_\delta + \alpha sin^2\theta d\phi_\delta)^2} + \Sigma d\theta^2$$

$$+ \frac{sin^2\theta}{\Sigma\left((r^2 + \alpha^2) d\phi_\delta - \alpha dt_\delta\right)^2 \left(\partial_r + \frac{2mr}{\Delta \partial_t} - \frac{\alpha}{\Delta \partial_\phi \partial_\theta \partial_\phi \partial_t|_\delta}\right) ds^2}$$

$$= \frac{\Sigma}{\Delta dr^2} - \frac{\Delta}{\Sigma}(dt_\delta + \alpha sin^2\theta d\phi_\delta)^2 + \Sigma d\theta^2 + sin^2\theta / \Sigma\left((r^2 + \alpha^2) d\phi_\delta - \alpha dt_\delta\right)^2$$

$$g^{\mu\nu} \partial_\mu \partial_\nu = \frac{\Delta}{\Sigma} \partial_{r_\delta}^2 - \frac{1}{\Delta\Sigma\left((r^2 + \alpha^2)\partial_{t_\delta} - \alpha \partial_{\phi_\delta}\right)^2} + \frac{1}{\Sigma \partial_{\theta_\delta^2}} + 1/\Sigma sin^2\theta\left(\partial_{\phi_\delta} - \alpha sin^2\theta \partial_{t_\delta}\right)^2$$

$$k_{-} = (dt_{\delta} + \alpha sin^2 \theta d\phi_{\delta}) + (\Sigma\Delta^{-1})dr, k_{\pm}$$

$$= \mp\Sigma dr + [\Delta(dt + \alpha sin^2\theta d\phi) + (-2mr + \alpha^2 sin^2\theta)dr]k_{\pm}$$

$$= \mp\left(\Delta\partial_r + 2mr\partial_t - \alpha\partial_{\phi}\right) + \left((r^2 + \alpha^2)\partial_t - \alpha\partial_{\phi}\right)$$

$$\frac{dr}{dt} = r^2 - 2mr + \frac{\alpha^2}{r^2} + 2mr + \alpha^2, \frac{d\phi}{dt} = \frac{2\alpha}{r^2} + 2mr + \alpha^2$$

Los agujeros negros cuánticos, suponen tractos de colisión, superposición o entrelazamiento, según sea el caso, en el que interactúan partículas o antipartículas deformantes y deformadas, en el primer caso, a propósito de su masa exponencial o de su energía potencial o de su energía cinética, según corresponda, y en el segundo caso, a propósito de su masa o energía cinética o potencial ligeras, según corresponda. Todo esto, depende esencialmente del campo cuántico de que se trate.

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