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# Detection and Measurement of Quantum Gravity by a Curvature Energy Sensor: H-States of Curvature Energy

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Additional information is available at the end of the chapter

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## Abstract

The curvature energy as spectra of a field observable that is resulted of the variation of energy due to the speed of direction change in the space, is measured and detected by a sensor designed and developed through H-fields of energy that are superposes, obtaining strong variations in the fermion state to the H-torsion (second curvature energy) of the space-time via the gravitational covariant derivative having that the actions can be consigned to these H-fields as Majorana states with a corresponding action of gauge field. Likewise, in this chapter, some geometrical models of these H-states and their spectra of curvature are generated and discussed, which are extrapolated to the design of curvature energy sensors to quantum gravity.

**Keywords:** curvature energy, curvature energy sensor H-states, H-torsion, quantum gravity, spectral curvature, torsion

## 1. Introduction

The study of the field theory in physics establishes that the field actions can be measurable through their observables such as curvature or torsion of the space, which represent forms in how the field affects the space giving it a geometrical shape that depends directly on the field sources and their localization in the space. From the viewpoint of the topological field theory (TFT), these relations between the sources localizing in the space, where born the actions of the field, are born and the proper geometry engendered in the space by the actions of field to deform the space establish to the curvature and their second version; the torsion, as the geometrical invariant most important to characterize to a space and their geometry as implicit part of the field acting in the space through their energy. Physically, the detection of the field presence, without causing its extension in the space, is realized through its energy. This makes us think that curvature measurements can be realized using the energy concept that considers the curvature as an energy perturbation in the space, which can be measured through its spectra.

Likewise, a new concept developed above through new measurement methods and new technology prototypes to measure curvature as field observable [1, 2], or as microscopic deforming of the space-time associated to the gauge fields that enter in action with the quantum gluing of the matter and the constructing of the electric charge of the particles, is the curvature energy [1, 2], which is determined as a variation of energy perceived by a change in speed rate of direction in the space detected by the energy condition or censorship condition designed by certain integrals of energy born of the curvature integral transforms [3, 4] applied on certain cycles of the signal space acting on the space, to obtain certain energy co-cycles that are curvature data of the space and which represent in an energy space the curvature energy (see **Figure 1**).

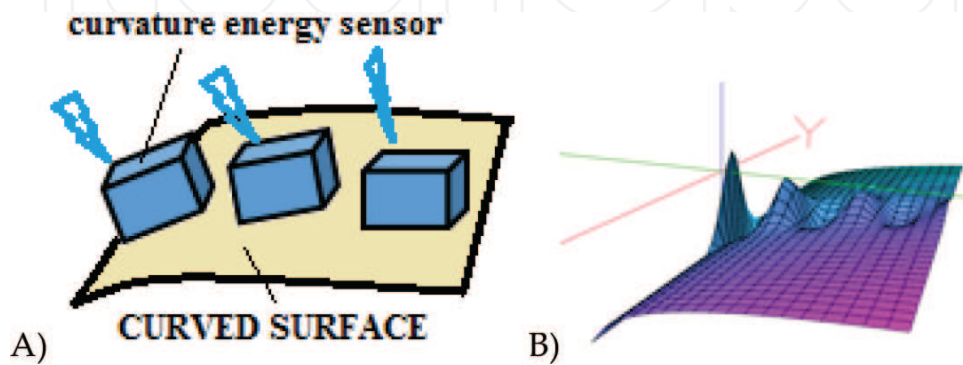
This raises the need to design a sensor and also the space perception of a device (censorship condition), which must use a modulation space with a domineering energy condition given by [2, 3] as follows:

$$[V]^2 \int_C h k^2 ds \geq \left( \int_C h^2 - k \right)^2 ds \geq \frac{1}{2} A V^2 \int_0^{2\pi} k d\theta \quad (1)$$

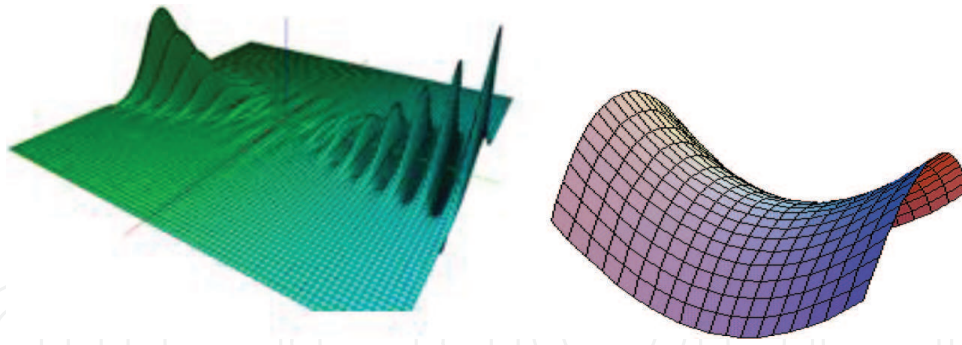
Here voltages  $V$  are factored by mean and principal curvatures along the curved part of curved surface, having an inequality of Hilbert type, which establishes the energy range in which the curvature energy exists.

Then the measure of curvature can be obtained as an extrinsic curvature from a space classes (cycles) with a curvature measure well defined and which represent the interacting of the rate of direction changes of the space with pulses of energy (Fourier analysis) that go sensing these direction variations and consigned in their energy spectrum through of their co-cycles. Some measurements realized have been the obtained applying energy Gaussian pulses  $\pi(x, y)$ , [2] that determine, in the infinitum the measure of curvature through of this spectra (see the **Figure 2**).

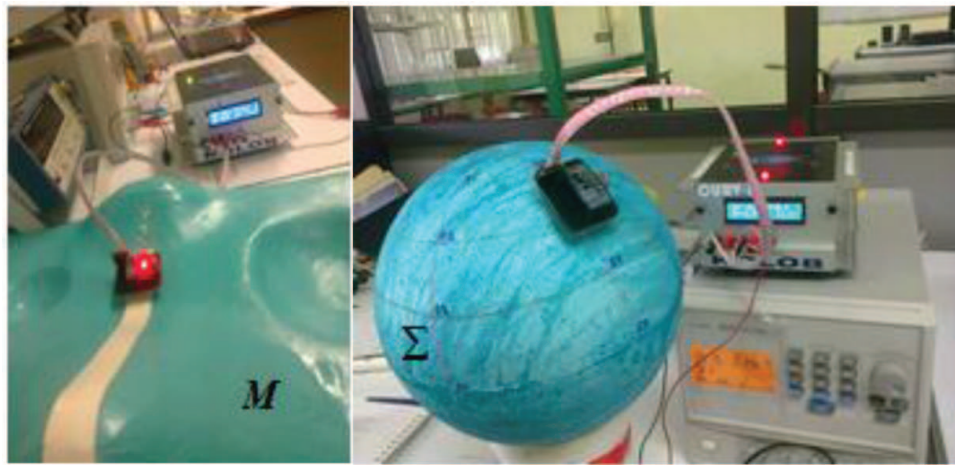
Thus from the perturbation theory viewpoint, the curvature energy can be defined as the energy perturbing product of the interaction of the electrical field of the curvature sensor (with their censorship) with the surface curvature in accordance with the metrology study realized in [5], where the curvature energy is given by the units as Voltage  $m^{-3}$  and is proved with the experiments (see **Figure 3**) introducing the curvature integral transform as follows:



**Figure 1.** (A) Curvature energy sensor advancing on curved surface. (B) Curvature energy perturbation due to the surface curvature.



**Figure 2.** Curvature energy spectra of hyperbolic paraboloid  $z = xy$ .



**Figure 3.** Curvature gauged in curvature energy on an arbitrary surface  $M$ , using a spherical surface  $\Sigma$ , [5].

$$O_E = d_Y \text{Hom}_K(M, S^2) \int \Omega, \quad (2)$$

But this obeys to the field condition given by gravity in their more fine aspects, since gravity acts as subjacent energy in the geometrical aspect of any space (all the objects in the space are always affected by gravity) using the universal gravitation in the modality of field theory given by Einstein equations.<sup>1</sup> Likewise, the scaled gravitational energy is used in the process of gauging of sensor device whose advances correspond to that measured and gauged by the proper universal gravitation and considered by the spherizer operator  $O_E$ , [2, 6, 7]. Then using the result enounced in [8], and considering the scaled gravitational constant  $\chi = \frac{8\pi}{c^4}G = 2.071 \times 10^{-43} \text{ sec}^2\text{meter}^{-1}\text{kg}^{-1}$ , which is the proportionality between space-time curvature and energy (as shown in **Figure 3** in [8]), and using Eq. (2) and the field Einstein equations, we have the following:

$$O_E = d_Y \text{Hom}_K(M, S^2) \int_M e(-1)^n d\Sigma(f(x)) = 8\pi^2, \quad (3)$$

<sup>1</sup> $R_{\mu\nu} - \frac{1}{2}Rg_{\mu\nu} = \chi T_{\mu\nu}$ .

which is the energy quantity measured per determined curvature. Similarly, using this measure of net energy, gravitational waves can be detected by the device that involves this energy to measure curvature energy through electromagnetic fields as gauge fields. This idea is and will be fundamental to determine conditions of energy [Hilbert inequations as given in Eq. (1)] to any censorship required to design a curvature sensor in field theory, including the microscopic theory to QFT. Similarly, in this respect arises the possibility of using the torsion field as the second curvature to measure curvature in field theory considering certain modifications that can be used in field quantum equations as Dirac equation. But far of want the unification of the gravitational and electromagnetic forces to construct a unique field (which is failed reheresal considering only the Einstein equations) is necessary involves the Dirac equation and their solutions in their first integral given by the field actions to curvature in a homogeneous space [3, 7] as described in [7] and using the field theory on the homogeneous space  $G[[z]]/X$ , [9] whose curvature energy measures can be constructed by co-cycles in this space.

Other studies followed in the search of curvature measure through light waves were realized in [6] under the same philosophy of the energy integral value on curved spaces (more specific Riemannian manifolds), considering integral transforms defined in homogeneous spaces or cycle spaces (whose cycles are invariant under translations and rotations on the proper manifold). Similarly, the curvature was obtained initially (using the units of volts on cubic meter, mentioned before) as measure through the corresponding co-cycles as integral transform [2, 10]:

$$\kappa(\omega_1, \omega_2) = \int_M \kappa(p, \phi) e^{-j(\omega_1 t_1 + \omega_2 t_2)} dp d\phi, \quad (4)$$

which are our spectra of curvature to a measure realized by our curvature device in an instant  $t$ . In the case of light waves, the censorship condition is given in [6] as follows:

**Theorem (F. Bulnes) 1. 1.** [6, 11]. The Radon transform of the Gaussian curvature whose detection condition is the inequality (*censorship*<sup>2</sup>) is as follows:

$$[\log \varphi(\xi(t))]^2 \left[ \int \log \sigma(t) \right]^2 \geq \left( \int \Omega(1 - \nabla^2 \log \Omega) \right)^2 \geq 4\pi \int \Omega, \quad (5)$$

and using the signals, the curvature measured by light beam is

$$\iint |K\varphi, L_{\zeta} \bullet|_{L^1} = \frac{2}{R} \iint_{D^2} |K_h(\sigma(t))| dx dy, \quad (6)$$

*Proof.* [6, 11].

Likewise, considering the representation of curvature in a Hilbert space (energy space) that is to say, given by  $\Lambda_{\tilde{g}}(f)$ ,  $\forall v \in V_{\zeta}$ ,  $\forall \zeta \in K^{\wedge}$ , and  $f \in C_c^{\infty}(G/K)$ ,<sup>3</sup> (theorem (F. Bulnes) [12, 13]), we have the following:

<sup>2</sup>Theoretical sensor of curvature by a wave of light [6, 10, 11]

<sup>3</sup> $\tilde{g}$ , is the pseudo-Riemannian metric in  $G/K$ , induced by the pseudo-Riemannian metric of the manifold  $M$ .



$$\langle \Lambda_{\tilde{g}}(V), f \rangle \geq \langle \Lambda_{\tilde{g}}(V(\zeta)), f \rangle, \quad (7)$$

which is an “energy” representation of curvature. This permit generalizes the idea of the curvature as field observable to a level of its energy, having the concept of *curvature energy to quantum level*, that is to say, the domineering energy in the action of a quantum field on a curved space [14] to displace a particle on said space (see **Figure 2**). The next step is that it can interpret these energy observables as field observables, which are born of the deformations obtained on space-time background. Remember that the representations of curvature determined in Eq. (7) obey a fine structure with weak topological conditions from a point of view of global analysis. Each isotopic component is a co-cycle in the spectral space or spectrum of curvature.

But how to design a field gauge to measure the gravity observables through curvature energy to a quantum level?

Re-writing the symmetric tensor of the metric, it stays as  $o^{\mu\nu(S)}$ . This tensor is analogue to the usual metric tensor “g” but refers to lengths (as is usual) where the distance is symmetric as functional. The super fix that is represented as “S” refers to symmetric state [15]. The asymmetric tensor that could be the case of more general metric tensor (*which could consider electromagnetic fields as field gauges to measurements of other fields as gravitational field*) is defined through the external product between tetrads as follows [9, 15]:

$$o_{\mu\nu}^{ab} = o_{\mu}^a o_{\nu}^b = o_{\mu\nu}^{ab(S)} + o_{\mu\nu}^{ab(A)}, \quad (8)$$

The anti-symmetric form involves the symmetry and anti-symmetry parts. The anti-symmetric component from Eq. (8) is  $o_{\mu\nu}^{ab(A)}$ . The anti-symmetric tensor of the metric is defined through the wedge product of two tetrads [9, 15]:

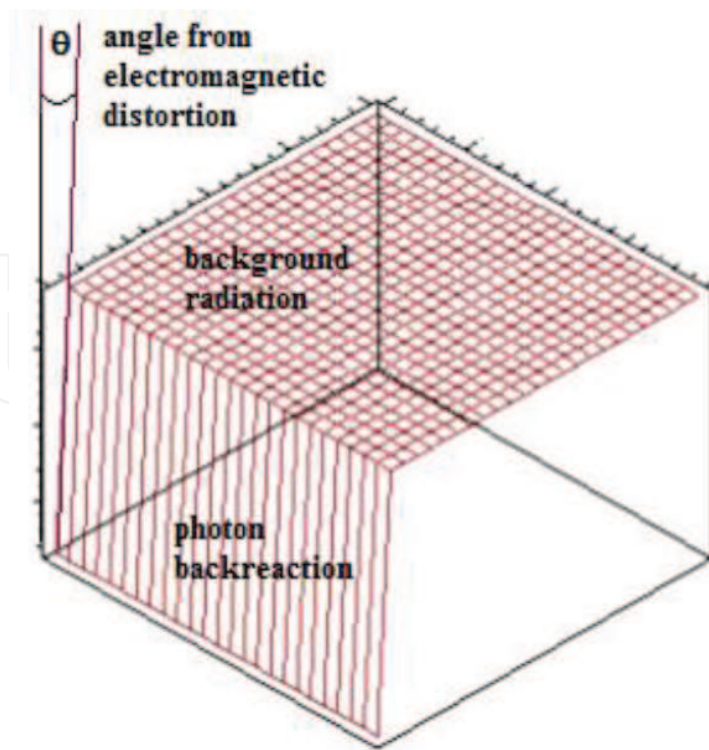
$$o_{\mu\nu}^{ab(A)} = o_{\mu}^a \wedge o_{\nu}^b, \quad (9)$$

The action of the product of the tensors of curvatures  $R^{\alpha\beta}$  and  $o_{\mu}^{\alpha}$  will establish “torsion effect on the action of gravity”, which is measurable and representable as *distortions produced from the gravity*, in the presenece of a gauge field (see (**Figure 4**)). In this point, the spectrum of the searched curvature can be constructed. Then with the application of the quantum mechanics, more specifically, the QFT, and their interrelation with the gravitation is searched and the cause of the field through the quantum interactions that generate this is established. Then in this new “exhibition of gravity”, the Einstein field equations can be re-written as follows:

$$R_{\mu}^a - \frac{1}{2} R o_{\mu}^a = \chi T_{\mu}^a, \quad (10)$$

and using this fact, the new metric tensor can be expressed as<sup>4</sup>:

<sup>4</sup>The new metric tensor is anti-symmetric.



**Figure 4.** Flat- $\mathbb{R}^4$ -Worksheet of distortion angle obtained for the electromagnetic backreaction with the background radiation (gravity). The photon is the gauge field to measure quantum gravity action.

$$g_{\mu\nu}^{ab(A)} = o_\mu^a \wedge o_\nu^b, \quad (11)$$

we arrive at the new field equation to electrodynamics that is generally covariant:

$$o_\mu^a \wedge (R_\nu^b - \frac{1}{2} R o_\nu^b) = \chi o_\mu^a \wedge T_\nu^b, \quad (12)$$

which gives us the spin or torsion of the field. However, this must be accompanied with the Dirac equation to a designed boson to the start of the second curvature, which must have inherence in the microstructure of the space-time to perceive the gravity to microscopic scale. In the asymmetric space-time model are obtained field models that reflect the torsion as the central part (this is due to the field polarization to particle level) that defines field perturbations whose origins are quantum and whose operators are non-commutative [9]; for example, the asymmetric field theory given by Yang-Mills where this theory provides an extension of Maxwell theory to the case of non-Abelian fields. In these dimensions raise the wrappings and the loop contributions that will contribute to the energy micro-states used to define electromagnetic signal effects of power that can be consigned in a harmonic analyzer with polynomial enters in a non-harmonic interphase of Legendre polynomials.

## 2. Curvature from quantum gravity: a curvature sensor in field theory

How measure curvature of the space-time from the concept of quantum gravity interpreting their observables as light-field deformations obtained on space-time background with the action of a gauge field?

To this measurement, we use a hypothetical particle graviton that is modelled as dilaton, being a gauge graviton (gauge boson) [1, 15]. According to our curvature, studies come from a theoretical sensor of curvature in the presence of the incurve and detected by a wave of light [1, 6]. This was mentioned in the previous section. The curvature quantum perception in the space is associated as a little distortion of the fine micro-local structure of the space-time due to the interaction of particles of the matter and energy with diverse field manifestations [1]. The matter is shaped by hypothetical particles that take as base the background radiation of the space, which in last studies due to QFT [16] and brane theory are organized and tacked to shape spaces of major dimensions. These spaces are represented by diverse particles of the matter, such as gravitons, barions, fermions of three generations, etc. [1, 9]. These particles are shaping gravity to quantum level, obtaining representations of the same for classes of cohomology of the QFT, for example, the FRW-cohomology (which is a Floer Wrapped Cohomology [16]), which brings exact solutions to the Einstein field equations. This last affirmation considers diverse symmetries of cylindrical and spherical type for the gravity modelled like a wave of gravitational energy “quasi-locally” (see **Figure 5**) [1, 9].

We can determine action integrals of the gravitational energy density (Hamiltonian) given for [1, 9, 18] as follows:

$$H_{\text{TOTAL}} = \frac{1}{G8\pi} \int_M \Gamma + \frac{1}{2} L^\alpha T_{\alpha\beta} X^\beta, \quad (13)$$

where  $L^\alpha$  is the Lagrangian,  $T_{\alpha\beta}$  is the corresponding tensor of matter and energy,  $\Gamma$  is a Hamiltonian density and  $X^\beta$  is the corresponding field of displacement of the particles in the space moving for action of  $L^\alpha$  influenced by the matter and energy tensor  $T_{\alpha\beta}$  [1, 9].

In the study of the microscopic space-time exist the group representations of  $SU(2)$ , where one of these considers that the super-symmetry is given for  $S^3$  (sphere of dimension 3) [15]. In it, the topological invariant of their 2-form  $\omega_3$ , and given in the cohomology group  $H^3(SU(2), \mathbb{R}) \neq 0$ , [9, 17, 19] will show clearly the gravity presence.

This registry, at least, is realized on the surface of this ball  $S^3$ , which is a mini-twister surface in the presence of gravity [9], having as ambitwistor space the set of field couples  $(Z^\alpha, W_\alpha)$ , to the microscopic space-time. Here,  $Z^\alpha$  is the field of gauge nature (in this case electromagnetic fields) and  $W^\alpha$ , the field of particles of the gravity (gravitons, that in this case is the background) [1, 9].

Similarly, it was mentioned and considered that the curvature value can be understood as the deformation contour on a surface (initial idea created and developed relative to the understanding of curvature in a space-time [10, 15]).

Also the curvature can be understood to the field distortion as undulating in the space-time for the back-reaction due to the photon propagation in the presence of gravity [see **Figure 5 (a)** and **(b)** (using string theory)].



We can extrapolate this idea to design a type of accelerometer that can be connected to the devices of navigation of a travelling satellite by space. In said accelerometer, a sensor of ultra-sensitive gravity based on a solid sphere  $S^3$ , whose material can be similar to a colloid, could be involved in their interior, capturing the changes of the weight of a liquid that is also of colloid type (perhaps of major density that of the ball  $S^3$ ) due to the universal factor  $G$  [1, 17].

A censorship<sup>5</sup> device in the earth's gravity can be designed to construct a fine curvature sensor to detect energy for the matter inflow in the space occupied by matter. This brings to collation the perception of the matter-energy tensor  $T_{\alpha\beta}$ , which influences the movement of the sensor device.<sup>6</sup>

The measured curvature will be a Gaussian curvature expressed through spherical harmonics given by Legendre polynomials.

<sup>5</sup>This censorship can be understood as electromagnetic detectors of curvature, which can design the cosmic sensors of curvature with the Penrose censor [1].

<sup>6</sup>Considering  $M$ , a four – dimensional space is necessary to consider the spherical map  $\partial M \rightarrow S^3$ , where for this case the electromagnetic fields can be used as gauges, remembering that  $SU(2) \cong S^3$ . Then the cohomology group of the Cartan forms  $\omega_1$ , and  $\omega_2$  are annulled [17], that is to say  $H^1(SU(2), \mathbb{R}) = 0$ , that is the case of the integrals  $\oint \omega_1 = 0$  ( $\oint \delta A^i = \delta(\oint A^i) = 0$ ). To the non-null case, as was mentioned earlier, the unique 2-form to the determination of curvature is  $\omega_3$ . Thus, the value of the integral of this group of cohomology is [1, 9] as follows:

$$\frac{1}{8\pi^2} \int_{SU(2) \cong S^3} \omega_3 = 2 \langle F, \bar{F} \rangle ,$$

But by the background radiation of a Minkowski space  $M$  (as four-dimensional model of the space-time), where the energy of the matter is given by the tensor  $T^{\alpha\beta}$ , is that  $J^\alpha = k^\alpha T^{\alpha\beta}$ , where  $k^\alpha$ , is the density of background radiation that establishes for the curved part of the space (*that in this case has spherical symmetry*) the variation of energy together with the energy and matter tensor that comes given as [1, 17] follows:

$$\frac{1}{4G\pi} \int_{S^2} T_{\alpha\beta} k^\alpha d\sigma^\beta \geq \int_{S^2} J^\alpha d\sigma^\beta \geq 2\pi\chi,$$

But conserved current in whole space is

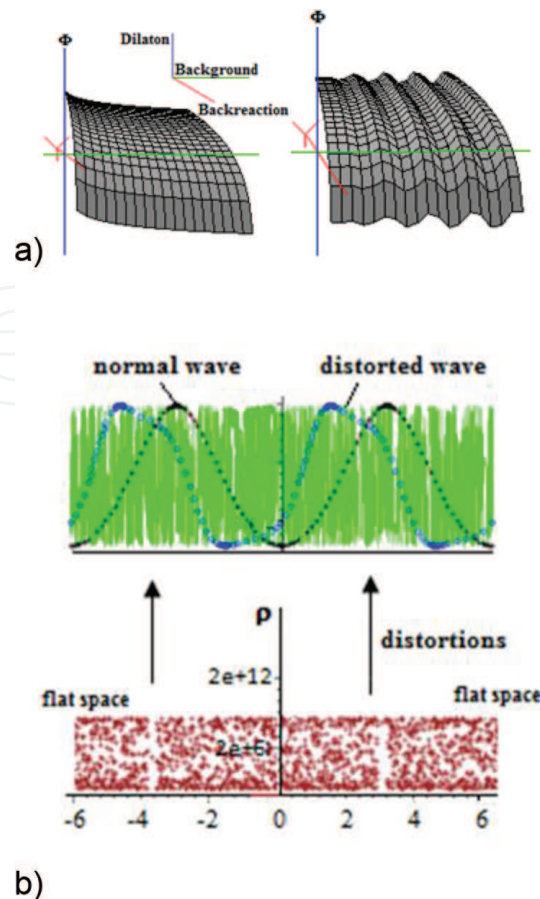
$$J^\alpha = E^{\alpha\beta} k_\beta + \frac{1}{2} S^{\alpha\beta\gamma} \nabla_\beta k_\gamma,$$

Then the energy inside the sphere satisfies [7, 27]

$$\frac{1}{16\pi^2} \frac{1}{(2-2g)} \int_{SU(2) \cong S^3} \omega_3 \leq 1,$$

since the electromagnetic energy with respect to the energy of background radiation can fulfill that

$$4\pi \int \Omega^2 \geq 8\pi \int \langle F_{ij}, F^{ij} \rangle .$$



**Figure 5.** (a) Dilaton measuring distortion due to quantum gravity, according to the model computational magnetic. (b) The case is when there is not photon back-reaction [1, 14].

These Legendre polynomials can be measured by harmonics that can be consigned in a wave with an algebraic frequency. The device is a sensor of free fall that can register different force  $G$ , according to its position in the Cosmos [1]. The difference is consigned by the Hall Effect obtained by the scattering difference of fermions detected in each case by particles/anti-particles [1, 17].

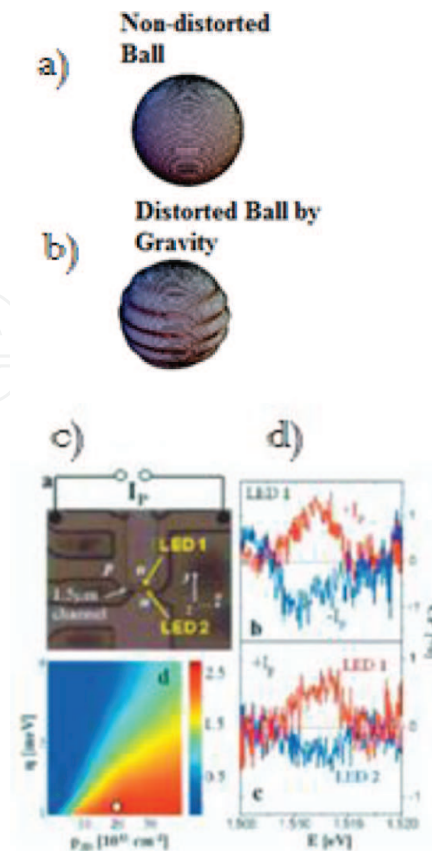
Inside the device, considering the Lagrangian action given for [1], the actions of change registered by the free little falls can be reprogrammed. The distortions detected on the 3-sphere can be identified with these harmonics and thereafter consigned as spectral curvature (**Figure 6**) [17].

With our ideas and precise goal, we can consider some useful concepts and create other.

**Def. 3. 1 (F. Bulnes, M. Ramírez, L. Ramírez, O. Ramírez).** *broson* is a hypothetical particle that is a fermion that comes from D – Branes, being the hypothetical particle wrapped by gauge bosons in the space-time [15].

Being a field solution, the *broson* will be our solution of the Dirac equation to distortions of field [1, 9, 15] that are perturbations in the space-time created by reaction of this particle with background. Likewise the *broson* will be solution of the field equation:

$$(\square + \chi T)\phi_\mu^a = 0, \quad (14)$$



**Figure 6.** (a) Sensor device to consigne the little variations in free fall for gravity of the sensitive material ball in the space-time. (b) Deformed ball due gravity sensing. (c) The device is designed to be used in a traveler satellite. (d) Gravity spectra.

If we have the term  $\chi T$ , this must be imagined as spherical density. The term  $R$  is the curvature of the space-time, which is a deformation of the spatial scenery due to the presence of matter in space. The exact values are not important in this last description, but their implications in the geometrical scenery and their invariants [15] hold significance because these describe the shape of the space-time, at least, locally.

The torsion is produced by the gauge bosons in the microscopic space due to the electromagnetic characteristics of these bosons that are photons [15], realizing back-reaction [1, 17] with the space covered or affected by gravity.

Indeed, in the non-Abelian electromagnetic theory “ghosts” are produced that are states of negative norm or fields with the wrong sign of the kinetic term linked to every particle whose effect is predicted by Faddeev-Popov [19, 20, 21].

Every ghost is associated to a gauge field where the gauge field acquires a mass via a Higgs mechanism (mechanism that creates matter and charge, although each one takes its proper way in the particle decomposition).

The associated ghost field acquires the same mass (in the *Feynman-t Hooft gauge* only, not true for other gauges) where the gauge must be designed or proposed in accordance to the Feynman-t’Hooft theory) [1, 9].

In the QFT, and particle physics frame, the existence of a weak field has been established that helps to define the unification to the neutron. The weak field, whose nature is electromagnetic, is associated with the gauge boson as of the type W boson. Similarly, when the neutron exists outside the atomic nucleus, it is transformed after 10 minutes into an electron, anti-neutrino and one proton. This establishes the condition to create matter and anti-matter in the required proportion that is needed in the Universe [14].

We consider the algebraic object assigned as a set of rules of a chain complex (as a graded module equipped with degree  $d$ , such that  $d^2 = 0$ ) that permits to understand the movement as a continuous transformation whose image in a quantum space is a deformation of the space-time to microscopic level given by little changes in energy. Their macroscopic image of such quantization can be consigned inside a Poisson manifolds family that under certain quasi-equivalence [9, 15, 20, 21] and through homotopies can be carried to a macroscopic reality [9, 15]. Through the duality of Koszul complexes on microstate spaces can be demonstrated that the entropy is an aspect of the evolution of the energy that can be considered as an inverted image in a mirror space of the equivalences. Gravity in this case is consigned under torsion (and defined as pressure on a body or particles) in a *Drinfeld space* with *twisted loops*, where these loops and strings could be our "brosons" according to definition 3. 1., given [1, 15].

Taking into consideration the optimal design of the censorship condition, using the microscopic torsion theory and involving the field solution to Eqs. (10) and (14) from the QFT (considering that the artificial particle is defined before, because remember that *the broson must be a fermion to be consistent with the different helicities of strings*), we have the movement ramification as macroscopic effect of the following field action<sup>7</sup> [15]:

$$\mathcal{I}_{\text{Total}} = \mathcal{I}_G + \mathcal{I}_{\text{QED-fermions}}, \quad (15)$$

### 3. H-fields in a generalized curvature tensor and some boson-fermion measurements

Through the integration formalism applied to the total action integral of  $g_{\mu\nu}^{ab(A)}$ , which comes from the actions of two tensors, the partial action due to the curvature tensor and the electromagnetic tensor, including in this last, along with the fermion self-interactions induced by the quantum second curvature, we can establish the following total action as second integral of Eq. (12):

$$\begin{aligned} \mathcal{I}_{\text{TOTAL}} = & \frac{1}{2\kappa} \int d^4x o o_{\mu}^a o_{\nu}^b R(\omega) + \frac{i}{2} \int d^4x o \times \\ & \times (o_{\mu}^a (\bar{\psi} \bar{\gamma}^a D_{\mu}(\omega, A) \psi - \overline{D_{\mu}(\omega, A) \psi} \gamma^a \psi)) - \\ & - \int d^4x o \frac{3}{10} \kappa J_{(A)}^{\mu} J_{(A)\mu}, \end{aligned} \quad (16)$$

where  $\{\gamma^{\mu}, \gamma^{\nu}\} = 2g^{\mu\nu}$ , is Dirac matrix and  $R^{\mu\nu} = d\omega^{\mu\nu} + \omega_{\sigma}^{\mu} \wedge \omega^{\nu\sigma}$ , is the 2-form of curvature.

<sup>7</sup>This is viewed as energy curvature stated using the perturbative method.

Here,  $\chi = 8\pi G_N$ , is the gravitational constant mentioned in the introduction section, which we know, is intimately related with the production of matter by the tensor of matter-energy-momentum in the Universe estimated inside the Einstein field equations.

However, the studies in [15, 22, 23] need to explain the mechanism of the gravitational energy with the torsion. Similarly, through the QED and QFT, (see **Figure 7**) using perhaps the *spinor frame* (because it is a wave superposing many trajectories taken by the dilaton interacting with the space-time), we have within the Dirac equation as was given in Eq. (14) the fermion interactions [14] that give the different matter particle, which is a space-time torsion, where finally is a second curvature.

Finally, this global action defined in Eq. (16) can be re-written to fermions in gravity with torsion [23, 24], with a specific scalar field of torsion (*Kalb-Ramond field strength* [25]) inspired from the string theory [26] (UV- complete) and that can do the job of providing a constant, axial background in a local frame of FRW-cosmology. The additional fermion-piece of the form is stated as follows:

$$\mathcal{J} = \frac{\alpha}{2} \int d^4x o(\bar{\Psi} \gamma^a D_\mu(\omega, A) \Psi - \overline{D_\mu(\omega, A) \Psi} \gamma^a \Psi), \alpha = \text{cte}, \quad (17)$$

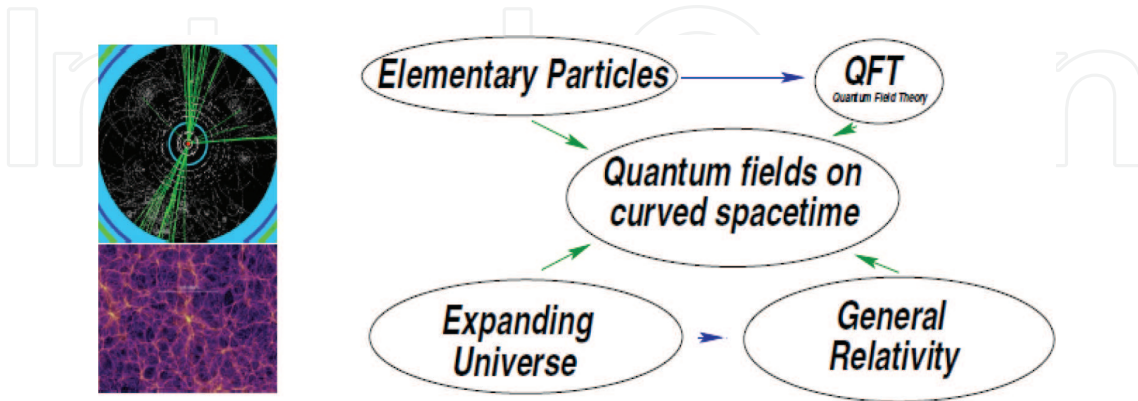
Using the Dirac kinetic terms, the fermion action reads:

$$\mathcal{J}_{\text{Dirac-Holst-Fermi}} = \frac{\alpha}{2} \int d^4x o(\bar{\Psi} \gamma^a (1 - i\alpha \gamma_5) D_\mu \Psi - \overline{D_\mu \Psi} \gamma^a (1 - i\alpha \gamma_5) \Psi), \quad (18)$$

where inside the integrand the Dirac equations to the differentiating fermions are involved in the non-Harmonic analysis that appears in the anti-symmetric behaviour of the curvature field measured for quantum interactions (see **Figure 8**).

This establishes the conjecture in [15], which we enounce.

**Conjecture (F. Bulnes) 3. 1.** The curvature from the quantum gravity is the measure through the link-wave or perturbation wave (see **Figure 9a**) between a hypothetical graviton particle



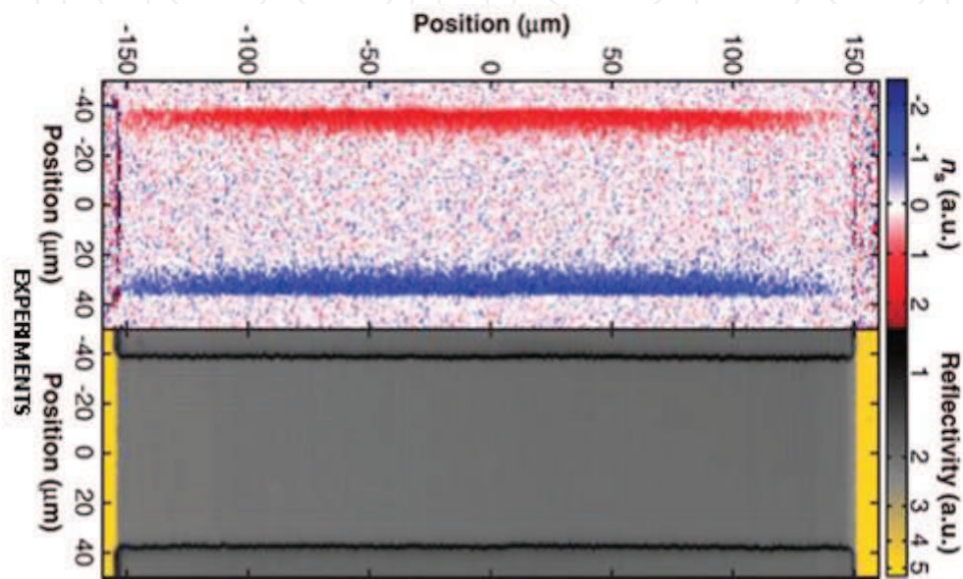
**Figure 7.** Construction of string energy curvature through the study areas to quantum fields on curved space. To obtain the curvature energy, we consider QFT and general relativity on expanding Universe, and to initial conditions we consider elemental particle behaviour in the early Universe. The curvature energy model in quantum level is necessary to consider fields that are solutions of the Cartan-Einstein equations and Dirac equation. This has been mentioned in the Introduction section I.



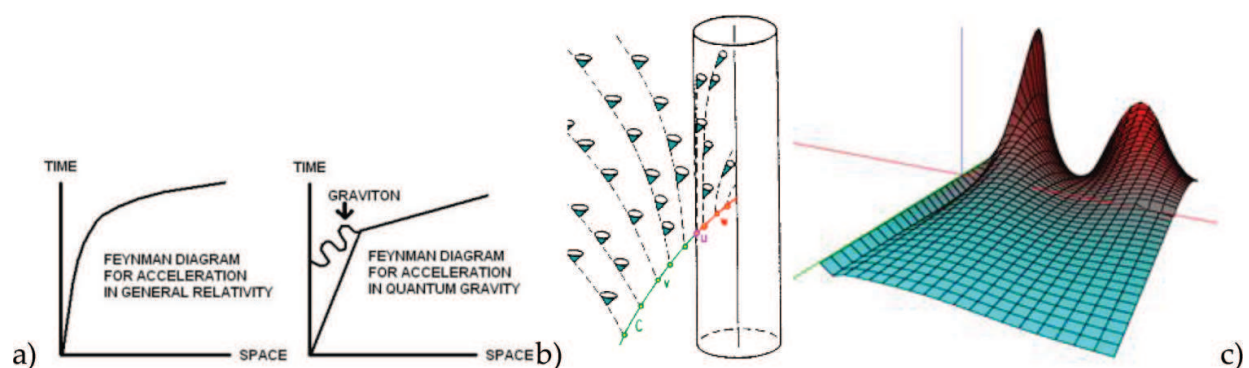
modelled as dilaton (gauge graviton) and the trace of any particle in the space-time, whose relativistic Feynman diagram followed to a quantum field [15].

**Theorem (F. Bulnes).** *The quantum curvature is the set of curvature energy states from the perturbative method of their Hamiltonian [15].*

The perturbation method consider a Hamiltonian  $H = H_1 + \varepsilon H_2$ , which determines first, energy spectra and after on the base of an action as the given through a field broson action [15], obtain curvature as torsion or second curvature. Similarly, the electro-gravitational energy



**Figure 8.** Refs. [14, 26] Separation of fermions due to their spin  $\frac{1}{2}$  in the non-Harmonic analysis that appear in the anti-symmetric behaviour of the curvature in a gravitational field measured for quantum interactions. This is realized in a spintronic simulation.



**Figure 9.** (a) Curvature measured to quantum level as the little quantum distortion given by the link-wave between a hypothetical particle as graviton modelled as dilaton (gauged graviton) and the trace on relativistic Feynman diagram followed in quantum gravity [15]. (b) The quantum curvature can be considered as different times in the causality and conformal structure of the the space-time [15]. The different deviations to the world lines in each case show the curvature. (c) The microscopic perturbation on a cylindrical surface is retaken [15]. Also it is considered the causal structure given by light cones. The red segment in Figure 9b corresponds to the surface model given in Figure 9c.

produced can be consigned to torsion energy and its detection can be obtained by back-reaction on background space-time as energy perturbation expressed as perturbation wave.

In microscopic UV-radiation frame, the underlying theory of quantum gravity takes different tensors with a corresponding particle spin involved in the interaction. Likewise, we consider the Kalb-Ramond field  $B_{\mu\nu} = -B_{\nu\mu}$  [27] with the massless gravitational multiplets of “closed” strings such as scalar or *dilaton* (spin 0), traceless symmetric rank (spin 2), 2-tensor or the *graviton* (spin 1), anti-symmetric rank 2-tensor or *electromagnetic tensor*.

A gauge invariant to effective field theories (in low-energy scale  $E \ll M_s$ ) given for  $B_{\mu\nu} \rightarrow B_{\mu\nu} + \partial_{[\mu}\theta(x)_{\nu]}$ , is feasible, which depends only on the field strength  $H_{\mu\nu\rho} = \partial_{[\mu}B_{\nu\rho]}$  [27]. Then we give the Bianchi identity as follows:

$$\partial_{[\sigma}H_{\mu\nu\rho]} = 0, \quad (19)$$

However, the detected anomalies by gravitational field interacting with gauge field cancellations of strings (*necessary to the perceiving of the gravitational waves letting only the gravitational strings*) require a re-definition of the H-fields given in Eq. (19) considering the extension due to the Majorana neutrinos masses from (three loop) anomalous terms with axion-neutrino couplings [27]. The corresponding extended Bianchi identity to these anomalous terms is stated as follows:

$$H_{\mu\nu\rho} = \partial_{[\mu}B_{\nu\rho]} + \frac{\alpha'}{2\kappa}(\Omega_L - \Omega_V), \quad (20)$$

Thus interesting results from the study of the phase-space density are derived from the difference between the Chern-Simons 3-forms [28]  $\Omega_L$  and  $\Omega_V$ , where Lorentz-Chern-Simons 3-form  $\Omega_L$  defined to neutrinos is considered and the electro-gravitational formalism in gauge theory is considered in the case of the gauge Chern-Simons 3-form [27].

In quantum gravity, a theoretical study related to the propagation of photons shows that a region of space-time with a singularity is supported by an energy that decreases asymptotically to the infinite. This hypothetical energy can be constructed with the expression of a Lagrangian-type given in **Table 1** [1, 29], with cylindrical gravitational wave given by the *dilaton* (gauge particle) [27] as follows:

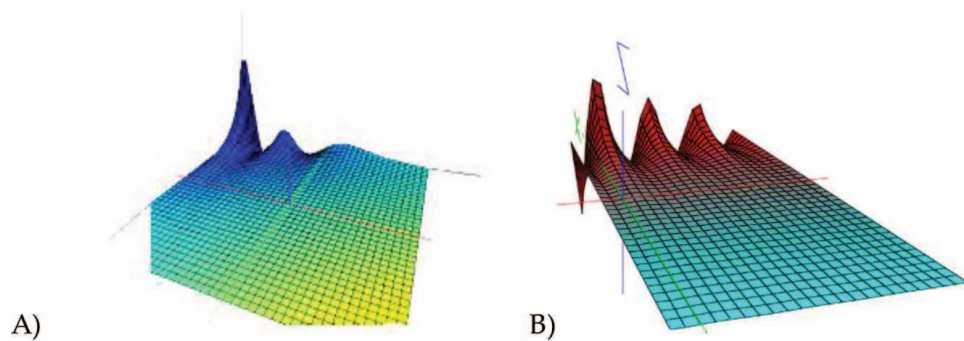
$$\Phi = (1/10000)(\exp(-4\xi)J_{\nu,x}(3\xi, 1) + \exp(-4\xi)Y_{\nu,x}(2\xi, 1)) \quad (21)$$

where the equation expresses a wave model for energy of gravitational waves (see Eqs. (1), (9), (17)) [1]. Also see **Figure 10a** [1, 9].

Now, considering the effective gravitational action (that is to say, the action whose Lagrangian is effective) in string low-energy and in terms of a generalized curvature Riemannian tensor (where the Christoffel connection includes the H-fields, that is to say,  $\bar{\Gamma}_{\nu\rho}^{\mu} = \Gamma_{\nu\rho}^{\mu} + \frac{\kappa}{\sqrt{3}}H_{\nu\rho}^{\mu} \neq \bar{\Gamma}_{\rho\nu}^{\mu}$  defined in Eq. (20)), we can give the four-dimensional action as follows:

Electromagnetic Lagrangian action	Electromagnetic interaction
$\mathcal{I}(x(s)) = \int_M L_{MAX}(x(s))d(x(s)),$	Classic electromagnetism
$\mathring{\mathcal{I}} = \int R_{ij} \wedge \Sigma^{ij} - \frac{1}{2} \langle F_{ij}, F^{ij} \rangle_{\tilde{M}} \text{Vol}(g),$	Quantized electromagnetism
$\mathcal{I} = \frac{1}{2\pi} \int d^2z (G_{\mu\nu} + B_{\gamma\nu}) \partial x^\mu \bar{\partial} x^\mu + \frac{1}{4\pi} \int \sqrt{g} R \Phi(x^L),$	Electromagnetic string photons (Bosons)
$\mathcal{I} = \frac{k}{4} I_{SO(3)}(\lambda, \theta, \omega) + \frac{1}{2\pi} \int d^2z [\partial x^0 \bar{\partial} x^0 + \psi^0 \partial \psi^0 + \sum_{l=1}^3 \psi^l \partial \psi^l] + \frac{Q}{4\pi} \int \sqrt{g} R x^L,$	Gravitational heterotic string (gravitons)
$\mathcal{I} = \int d^4x \sqrt{G} e^{-2\Phi} [R + 4(\nabla\Phi)^2 - \frac{1}{12} H^2 - \frac{1}{4g^2} F_{\alpha\beta}^\mu F^{\mu, \alpha\beta} + \frac{C}{3}],$	Electro-gravitational heterotic string dilaton-graviton
$\delta\mathcal{I} = \frac{\sqrt{kk_g H}}{2\pi} \int d^2z [\partial\omega + \cos\theta\partial\lambda],$	Magnetic distortion (back-reaction)

**Table 1.** Lagrangian actions to electromagnetic interactions [1, 9, 17].



**Figure 10.** (A) Gravitational alteration perceived by the censor is designed by Eq. (20) when it is obtained as a great alteration of energy near the singularity of the space-time. (B) Spinor waves superposing due to the curvature energy due to singularity. These are created as small quantum field fluctuations in the post-limit of Newtonian gravity. The singularity is not combing thus the unique admissible representation is through spinor waves which can be superposed to shape a perturbing measurable in energy space.

$$\begin{aligned}
 S^{(4)} &= \int d^4x \sqrt{-g} \left( \frac{1}{2\kappa^2} R - \frac{1}{6} H_{\mu\nu\rho} H^{\mu\nu\rho} \right) \\
 &= \int d^4x \sqrt{-g} \left( \frac{1}{2\kappa^2} \bar{R} - \frac{1}{3} \kappa^2 H_{\mu\nu\rho} H^{\mu\nu\rho} \right),
 \end{aligned} \tag{22}$$

where the dual of  $H$ , in four dimensions, is given by the differential equation:

$$-3\sqrt{2}\partial_\sigma b = \sqrt{-g} \epsilon_{\mu\nu\rho\sigma} H^{\mu\nu\rho}, \tag{23}$$

where  $b(x)$  is a pseudo-scalar that defines the Kalb-Ramond axion. Then to a dilaton  $\Phi$ , that satisfies Eq. (23) has the properties described in Eq. (14) as gravitational wave, the field equation is as follows:

$$H^{\mu\nu\rho} = o^{2\Phi} \in_{\mu\nu\rho\sigma} \partial^\sigma b(x), \quad (24)$$

The linear dilaton solution in string frame (or logarithmic in FRW-time in Einstein frame) with conformally flat Einstein-frame target space-time [see **Figure 11a**] is exact in all orders of a parameter that appears in Eq. (17) [27].

Then considering the principles dictated in Eqs. (18)–(20) and the differentiated fermions in the non-Harmonic analysis that appears in the anti-symmetric behaviour of the curvature field measured by quantum interactions (**Figure 8**), we can give the following action that comes from the Majorana states in fermionic field theories with H-torsion [9, 27]:

$$S_\psi = -\frac{3}{4} \int d^4 \sqrt{-g} S_\mu \bar{\psi} \gamma^\mu \gamma^5 \psi, \quad (25)$$

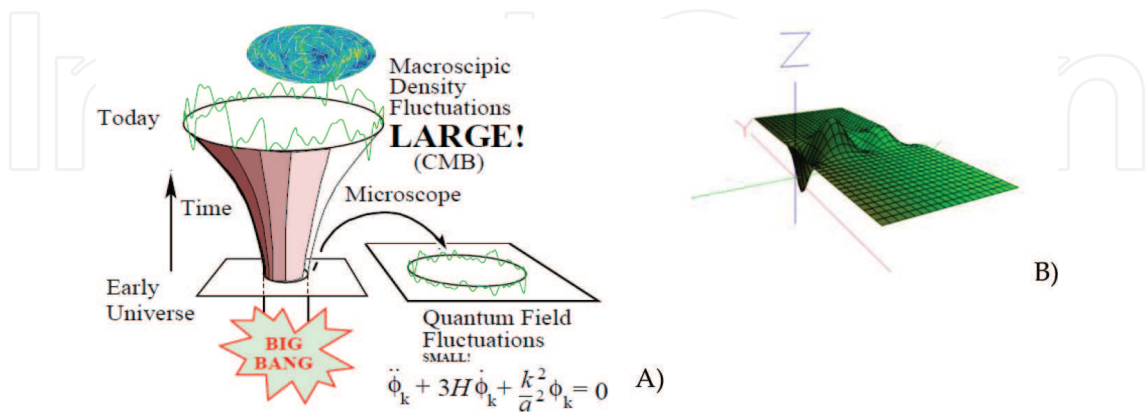
Then considering the extra-charge created by the fermion interaction (central charge underlying in the world-sheet conformal field theory [16]), we can define the scalar field:

$$b(x) = \sqrt{2} e^{-\phi_0} \sqrt{Q^2 \frac{M_s}{\sqrt{n}}} t, \forall n \in \mathbb{Z}, \quad (26)$$

which is a field model with fine electromagnetic terms, where this can be used to create a basic charge in a component of g-cell [27].

Also we use the theorem on curvature given in [3], which must consider an isotopic component of Gaussian *factor* to lectures of curvature, then we can define a sensor whose 3-ball of non-Newtonian fluid can receive these signals and re-interpret through voltage-curvature energy, such as said by *theorem III. 1* [1, 14, 17].

These data as little electrical voltages that come from the surface of the 3-ball can be censored (and sensed) as little changes in the background (that are perturbations) due to the dilaton interaction with this [14, 27].



**Figure 11.** (A) Macroscopic Fluctuations density detected by CMB in the Newtonian limit, which can be consigned in microwave map realized by the SWAP Universe. The quantum field fluctuations that generate the macroscopic fluctuations can be modelled by a dilaton  $\phi$ , that enters in back-reaction with the background radiation. (B) Perturbation surface in the Newtonian limit (in beginning of the flatness of the space-time supported by the neutrinos/anti-neutrinos totality).



Likewise, realizing some experiments with little accelerometers in curvature sensor performance, we can include a charged ball whose charge variation in time is given by the energy spectra [1, 27]. Then the position variation of the accelerometer in respect to their horizontal frame (Ecuador) registered in their g-cell change (see **Figure 8**) will measure the falls by gravity, these being consigned in curvature energy. We can use two leads to determine the polarization effect created in natural way by the fermionic behaviour [27] (see **Figures 6** and **8**).

Then we can define an accelerometer in a classic sense in the earth's gravity. The curvature will be expressed as a Gaussian curvature according to spherical harmonics given by Legendre polynomials [14, 27]. These polynomials carry the information of ball variations. Likewise, the sensor is a sensor of free fall that can register different force factors  $G$ . This difference is consigned by the Hall Effect obtained by the scattering difference of fermions detected in each case, particles/anti-particles. The proper device considering these as a Lagrangian action given can reprogram the actions of the changes [1, 9, 27].

Then extrapolating this experiment in the ambit of the photonics, the folds or "creases" in a deformable sphere (**Figure 6**) are oscillations in the Universe, which are given by the mixture of neutrinos/anti-neutrinos for the eco of the Early Universe [27], which will arrive until our days.

The Universe will maintain its basic non-spherical symmetry until our days, which can be expressed through its Lagrangian as follows:

$$\mathcal{L} = \mathcal{L}_f + \mathcal{L}_I = \sqrt{-g}\bar{\psi}[i\gamma^a\partial_a - m) + \gamma^a\gamma^5 B_a]\psi, \quad (27)$$

where  $\bar{\psi}$ , and  $\psi$ , are component of the field spinor  $\Psi$ . The oscillations are received as spherical auto-modes of the alteration of central charge  $Q$ , obtained by the differentiated fermionic process (see **Figure 9**) (extension of the model the axion  $b(x)$ , using total derivatives of the gravitational  $cR^{\mu\nu\rho\sigma}\tilde{R}_{\mu\nu\rho\sigma}$ , and electromagnetic  $cF^{\mu\nu}\tilde{F}_{\mu\nu}$ , terms [18] of the fields  $o_\mu^a$ , translated to H-fields).

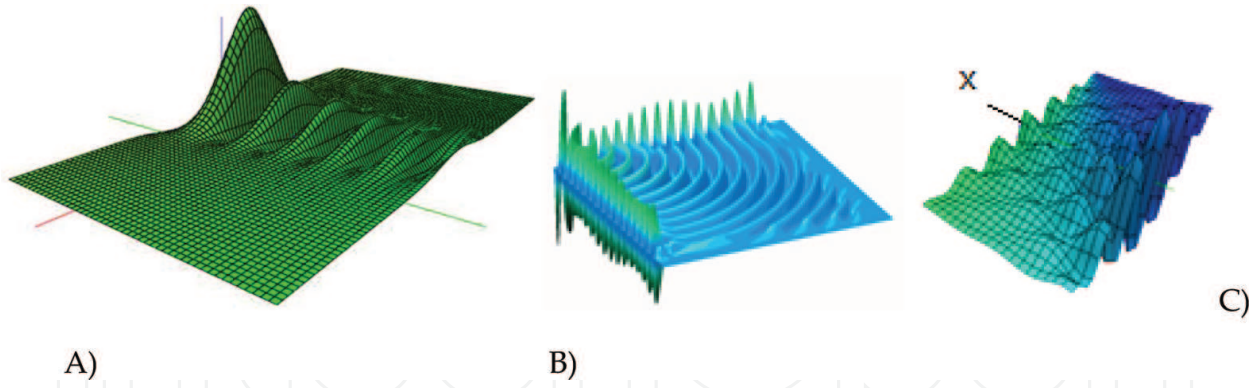
In the Universe, the neutrinos and anti-neutrinos conform to the asymmetry around the black holes or space-time singularities [25]. Inside singularities, the gravitational field is dementia. Then their particles and anti-particles (by the same polarization process) can be generated from the torsion. Likewise, using a plane wave approximation, different dispersion relations between particles and anti-particles to finite densities assuming constant background torsion can be obtained (see Ref. [27]).

Finally, through a magnetic dilaton  $\Phi$ , we can give a model of magnetic distortion, that is to say, the energy curvature in the gravitational media can be translated as magnetic deformation of the four-dimensional part of the string of background radiation (see **Figure 11**) [9, 27].

The gravitational energy is the curvature energy obtained through components of Bessel functions or harmonic polynomials (see **Figure 12**).

Finally, we can conclude that the curvature energy expressed through the H-states can be written using the superposing principle to each connection  $\omega_C^{\otimes j}$ , (with  $C$ , a curve) that





**Figure 12.** (A) Direct sum of H-states to establish the curvature measure by field ramification. (B) The waves that are *spinor waves* can be consigned in oscillations in the *space-time* in the presence of *curvature* to the change of particles spin. (C) Gravitational waves produced by quantum gravity due to H-states on cylindrical surface. Their propagation is realized on axis X. These gravitational waves are originated for the oscillations in the space-time-curvature/spin (that is to say using causal fermions systems).

describes the corresponding dilaton. Likewise, in a Hamiltonian densities space [9], we have **Figure 12(a)** considering a Hitchin base that is stated as follows:

$$H^0(\omega_C) \oplus H^0(\omega_C^{\otimes 2}) \oplus \dots \oplus H^0(\omega_C^{\otimes n}), \quad (28)$$

In the case of spinor representation, the corresponding H-states can be given as spinor waves [see **Figure 12b**], which can be consigned in oscillations in the space-time-curvature/spin, to a microscopic deformation measured in  $\mathcal{H}$ .

## 4. Conclusions

The curvature as field observable can be detected by back-reaction of a gauge field considering that the quantum gravity is the quantum effect produced by interaction of particles that conform to the matter (that is to say, particles of matter) with gauge particles, which in most cases are of boson type. However, we can consider an underlying causal fermion system or fundamental causal fermion system from which effects (from their energy states) as geometrical invariants to the space-time can be observed, which can be described to the space-time as discretized by H-states of Majorana states (as given in 28 to a space-time modelled initially as complex Riemannian manifold and transformed later to be a discrete manifold).

Then we can establish quantum geometry of the space-time, and using the concept of curvature energy associated to the particle/wave, we can give a representation as perturbation  $H = H_1 + \varepsilon H_0$ , generated by the interaction of particles mentioned. Likewise, geometrical models of quantum gravity can be given to show the quantum behaviour of observables obtained for photons that act on the background radiation (or microwave radiation) such that a second curvature as torsion can be induced for fields as dilatons or gauge bosons, which can exhibit observable of gravitational field that is curvature in all cases. As this process is realized in quantum level, results remain curvature to quantum gravity, which is curvature energy or gravitational energy (as defined in the introduction of this chapter from the energy-matter

tensor  $T_{\alpha\beta}$ ) that will exist until our days as an echo of the times of the creation of the gravity in the transit of the Early Universe. Then a censorship condition can be used to sensing and gauging of curvature, which can give characteristics to construct and design a sensor device, using the curvature energy to measure and detect quantum gravity as such [29].

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