HARMONIC GRAVITY

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Summary

I. The Hypothesis

The model proposed in this conjecture of harmonic gravity regards the universe as an immense harmonic oscillator, whose movement creates nodal volumes where vibration is canceled. In these nodal volumes, matter is gathered after being guided by the vibrational movement. This is where the density is concentrated. For now, this will apply to gravity at the grandest scales, perhaps at supercluster and galaxy-filament level.

The web-like structure of filaments suggests a phenomenon that resembles a progression to Chladni-esque figures. The large void areas engulfed by these filaments would be the places where vibration manifests in all its power, giving rise to the nodal volumes along which matter is grouped, where harmonic activity causes cancellation of vibration, of course in terms of this large-scale universal wave.

As the medium in which an oscillation is manifested is always one dimension higher than the nodes, it would follow that our universe as a whole is a 4-dimensional topological space.

II. Mathematical Description

II. 1. Defining the harmonic gravity equation

We can start building our harmonic gravity equation by ignoring any overtonal activity for now and describing how an arbitrary location in space is related to the nearest node f_0, in terms of density. This location can be extrapolated to an arbitrarily large region, but the nodal volume to which its relation is defined must generally be sufficiently large for determining relevant quantities. We can write:

$$\rho_r = \rho_{f_0} e^{-2||\alpha_j x^j - \beta_k f_0^k||}$$

This negative exponential makes sure that the density in the nodal volume is overwhelmingly higher than the density in any other place in vibrating regions. The norm of the vector difference in the exponent represents the distance between the referenced location and the center of the nearest nodal volume. However tautological this expression may seem, it sketches the nature of this phenomenon quite nicely and lays the groundwork for further development.

For the moment though, the equation does not include any reference to elements of the wave equation and it excludes the harmonic impact beyond the fundamental. Our next goal is to find ways to integrate these elements into our expression.

We can incorporate overtonal consequences by relating the density of the nearest nodal volume to the specific nature of the respective harmonic, namely by replacing this density term with the inverse of harmonic's frequency:

$$\rho_r = \frac{\Lambda}{\omega} e^{-2||\alpha_j x^j - \beta_k f_0^k|| - \omega} \qquad (1)$$

where Λ is a proportionality parameter. The vectorial notation of the distance is meant to define the measurement as clearly as possible, but moving forward, for the sake of brevity, this distance will be referred to as r, radial distance.

As for the wave equation references, one idea is to treat equation (1) as a solution to a modified wave equation that includes a density gradient and a time derivative of this density:

$$v^2 \nabla^2 \rho_r - \frac{\partial^2 \rho_r}{\partial t^2} l(r^2) = \Psi \qquad (2)$$

where v is the velocity of the wave and $l(r^2)$ is a function of distance that will be helpful while deriving classical gravity from this new theory. Squaring ensures that l will not transform into a constant after the first differentiation. Ψ is the extra-term that will complete our modified wave equation and which we will have to identify by carrying out the differentiation. The time derivatives are done by rewriting the angular frequency as $2\pi n/t$.

$$\Psi = \frac{4\Lambda}{\omega} v^2 e^{-2r-\omega} - l(r^2)\frac{4\pi^2 n^2 \Lambda e^{-2r-\omega}}{\omega t^4}$$

$$\Psi = 4v^2 \rho_r - l(r^2)\rho_r \frac{\omega^2}{t^2}$$

Considering that t is just the unit of time with respect to which the harmonic frequency was measured, we can just consider it as equal to 1 and simplify our expression. Anyway, in the process of deriving Newtonian gravity, t will be absorbed by other quantities, so it will not influence how these developments are carried out.

$$\Psi = \rho_r\left[4v^2 - l(r^2)\omega^2\right]$$

For further brevity, we will denote the expression inside the parantheses with Γ, so we can now replace Ψ in equation (3) and rearrange to arrive at our harmonic gravity equation:

$$v^2 \nabla^2 \rho_r - \rho_r \Gamma = \frac{\partial^2 \rho_r}{\partial t^2} l(r^2) \qquad (3)$$

This expression shows how density in an arbitrary location, as a function of radial distance to the center of the nearest nodal volume, is related to the universal harmonic oscillation.

II. 2. Deriving the classical limit from the new theory

This new theory must be consistent with the classical theory, so we have to derive Newtonian gravity from the new wave equation. Our reference will be Poisson's formulation of Gauss' equivalent law:

$$\nabla^2 \Phi = 4\pi G \rho \qquad (4)$$

To get from equation (3) to equation (4), we begin by examining the right hand side of equation (3). Note that the second derivative with respect to time can be seen as an acceleration and, by Newton's law, we can set the function of r^2 equal to mass, such that the whole right hand side becomes an expression of force. Using the fact that, for a conservative force, $F = -\nabla\Phi$, the left hand side of equation (3) can be equated to the negative gradient of the potential. Changing signs and differentiating again with respect to space, we get:

$$\bigtriangledown\Phi = -v^2\bigtriangledown^2\rho_r + \rho_r\Gamma$$

$$\bigtriangledown^2\Phi = -\frac{\partial}{\partial r}\left(v^2\bigtriangledown^2\rho_r\right) + \frac{\partial}{\partial r}\left[\rho_r\left(4v^2 - l\left(r^2\right)\omega^2\right)\right]$$

$$\bigtriangledown^2\Phi = 8v^2\rho_r - 8v^2\rho_r + 2\rho_r l\left(r^2\right)\omega^2 -$$

$$-\rho_r l'\left(r^2\right)\omega^2$$

$$\bigtriangledown^2\Phi = \rho_r\omega^2\left[2l\left(r^2\right) - l'\left(r^2\right)\right] = \rho_r\omega^2 l^*(r)$$

Rewriting *ω* as *2πn* and dropping the time unit again, as well as expressing the density in the referenced point in terms of nodal density:

$$\bigtriangledown^2\Phi = (2\pi n)(2\pi n)l^*(r)\rho_{f_0}e^{-2r}$$

$$\bigtriangledown^2\Phi = 4\pi n\frac{\omega}{2}l^*(r)\rho_{f_0}e^{-2r}$$

$$\bigtriangledown^2\Phi = 4\pi\rho_{f_0}l^*(r)n\frac{\omega}{2}e^{-2r}$$

The terms following $l^*(r)$ constitute another function of distance, which we will call *g(r)*. These 2 functions form yet a new function of *r*:

$$\bigtriangledown^2\Phi = 4\pi\rho_{f_0}l^*(r)g(r) = 4\pi\rho_{f_0}h(r)$$

By Newton's law of gravity, *h(r)* can be related to the gravitational constant G, which ultimately leads us to Poisson's equation:

$$\bigtriangledown^2\Phi = 4\pi G\rho$$

This potential gradient had to be expressed in terms of nodal density, for keeping consistency with the density reference in the classical theory, namely the density around which the gravitational field is exerted. In this new theory of gravity, this density simply marks a vibration-free location where matter was guided by the universal wave.

The idealized location characterized by complete lack of vibration would be a volume element around and along which vibration would push matter, also depending on how close the harmonic is to the fundamental. So, not the entire density related to a specific node will be concentrated in regions where oscillation-related movement is completely annihilated, but after space is filled up, part of the matter inhabits regions, fundamental or overtonal, where vibration is slightly active.

II. 3. Deriving the harmonic gravity equation from a Lagrangian action principle

For consistency with energy and momentum conservation, this wave equation of gravity must be derivable from an action principle and, for this purpose, we have to ansatz a Lagrangian. Refining this Lagrangian is aided by these fundamental principles that need to be satisfied: least action principle, Lorentz invariance, locality and gauge invariance. Let's address these principles one by one.

The action principle. In our case, the action integral will contain a Lagrangian density, defined as a functional of density and derivatives of this density:

$$S = \int L d^4 x = \int\int L\left(\rho_r, \dot{\rho}_r\right) dr dt \qquad (5)$$

The equation of motion that this action integral leads to is the Euler-Lagrange equation for fields (equation 6 below), that our density term will have to satisfy in order to be consistent with the least action principle. This will be reflected by and will stem from the final form of the Lagrangian that we will develop.

$$\sum_{\mu} \frac{\partial}{\partial X^{\mu}} \frac{\partial L}{\partial\left(\dfrac{\partial \rho_r}{\partial X^{\mu}}\right)} = \frac{\partial L}{\partial \rho_r} \qquad (6)$$

In its simplest formulation, the harmonic gravity Lagrangian should have the form:

$$L = \frac{1}{2}\left[\left(\frac{\partial \rho}{\partial t}\right)^2 - \left(\frac{\partial \rho}{\partial r}\right)^2\right] - \Phi$$

where Φ is the potential. This is a prototype on which we can develop in order to arrive at our Lagrangian. First of all, we can use our expression for potential gradient to determine the potential we need as our last term in this Lagrangian:

$$\Phi = \int\left(\rho_r \Gamma - v^2 \nabla^2 \rho_r\right) dr \qquad (7)$$

$$= \int 4\rho_r v^2 dr - \int \rho_r \omega^2 l(r^2) dr - \int v^2 \nabla^2 \rho_r dr$$

Solving the middle term (without the frequency factor for now) via integration by parts gives:

$$\int \rho_r l(r^2) dr = \rho_r l^{**}(r^2) - \int (-2\rho_r) l^{**}(r^2) dr$$

$$= \rho_r l^{**}(r^2) - l^{\maltese}(r^2) = y(r^2)$$

Putting it all together and absorbing the minus into the new function of distance $y(r^2)$:

$$\Phi = -2\rho_r v^2 - \omega^2 y(r^2) + 2\rho_r v^2$$

$$\Phi = \omega^2 U(r^2) \qquad (8)$$

Let's bring this potential into our Lagrangian prototype, along with other additions and adjustments to the other terms, writing our ansatz:

$$L = \frac{1}{2}\left[v^2\left(\frac{\partial \rho_r}{\partial r}\right)^2 - g(r^2)\left(\frac{\partial \rho_r}{\partial t}\right)^2\right] + \\ + 2v^2\rho_r^2 - \omega^2 U(r^2) \qquad (9)$$

Lorentz invariance. In order to make sure that the Lagrangian does not depend on the reference frame, it has to be a scalar. Looking at equation (9), all the terms are scalars, except for the unspecified functions of distance, which might include multiplication by vectors. So, to ensure that our Lagrangian is Lorentz invariant, we will turn these functions into scalars by squaring them:

$$L = \frac{1}{2}\left[v^2\left(\frac{\partial \rho_r}{\partial r}\right)^2 - g^2(r^2)\left(\frac{\partial \rho_r}{\partial t}\right)^2\right] + \\ + 2v^2\rho_r^2 - \omega^2 U^2(r^2) \qquad (10)$$

This ensures that the laws of physics are the same for all observers, regardless of coordinate transformations.

Locality. As the Lagrangian ultimately depends on density and its derivatives, locality is satisfied. Time and space derivatives guarantee that only neighboring points are immediately affected by an action.

Before getting into gauge invariance, let's work out the equation of motion based on the last form of the Lagrangian (equation 10). We can extract a ρ_r factor out of the potential term, and as ρ_r is also a function of distance in the context of this conjecture, dividing $U^2(r^2)$ by this density will yield a new function of distance $U^*(r^2)$. Thus, the last term of the Lagrangian becomes $\omega^2 U^*(r^2)\rho_r$. After derivation with respect to ρ_r, we can use the same trick, so that the resulting term in the equation of motion will be $\omega^2 U^{**}(r^2)\rho_r$. The entire Euler-Lagrangian equation for fields will yield:

$$v^2 \frac{\partial^2 \rho_r}{\partial r^2} - \frac{\partial^2 \rho_r}{\partial t^2} g^2(r^2) = 4v^2 \rho_r - \omega^2 U^{**}(r^2) \rho_r$$

Setting $\omega^2 U^{**}(r^2)\rho_r$ equal to $g^2(r^2)$ enables us to simply change the notation of the function of distance and write:

$$v^2 \nabla^2 \rho_r - \frac{\partial^2 \rho_r}{\partial t^2} l(r^2) = 4v^2 \rho_r - \omega^2 l(r^2) \rho_r$$

Note that the right hand side is exactly what we named Ψ in equation (2) and we can conclude that the harmonic gravity equation is derivable from a Lagrangian, thus it is consistent with the least action principle, satisfying the conditions of energy and momentum conservation.

Gauge invariance. The last test for our Lagrangian consists in adding a scalar gradient to the potential and checking whether the equation of motion remains unchanged.

By making the transformation

$$U^2(r^2) \rightarrow U^2 + \frac{\partial \lambda}{\partial r}$$

and plugging it into our Lagrangian, we get:

$$L = \frac{1}{2}\left[v^2 \left(\frac{\partial \rho_r}{\partial r}\right)^2 - g^2(r^2)\left(\frac{\partial \rho_r}{\partial t}\right)^2\right] + \\ + 2v^2 \rho_r^2 - \omega^2 U^2(r^2) - \omega^2 \frac{\partial \lambda}{\partial r} \qquad (11)$$

Extracting again ρ_r from U^2 and deriving the Euler-Lagrange equation, we have:

$$L = \frac{1}{2}\left[v^2 \left(\frac{\partial \rho_r}{\partial r}\right)^2 - g^2(r^2)\left(\frac{\partial \rho_r}{\partial t}\right)^2\right] + \\ + 2v^2 \rho_r^2 - \omega^2 \rho_r U^*(r^2) - \omega^2 \frac{\partial \lambda}{\partial r}$$

$$v^2 \nabla^2 \rho_r - \frac{\partial^2 \rho_r}{\partial t^2} l(r^2) = 4v^2 \rho_r - \omega^2 l(r^2) \rho_r$$

We can see that the equation of motion is not changed by this transformation, so the Lagrangian we have developed is gauge invariant.

The four fundamental principles are thus satisfied and they have shaped a Lagrangian formulation of harmonic gravity that reflects how the modified wave equation in this theory is consistent with conservation laws.

II. 4. Consistency with General Relativity

Examining the expression that develops the second order gradient we have used extensively so far, we can get some insight on the curving of space in the proximity of a certain density:

$$\nabla^2 \rho_r = \frac{4\Lambda}{\omega} e^{-2r-\omega}$$

This second order gradient is a second order space differentiation with respect to all directions. If it is not 0, it indicates non-flatness. In our expression, we can see that the closer a body gets to a nodal volume – so to a given density – the greater the value of this gradient will be, therefore the more "curveness" of space the body will experience. As the radial distance from the nodal volume increases, this value tends to 0, meaning flat space. A very small r is basically an identification of the referenced location with the nodal volume and this is where the curving of space is the highest.

Also, the lower the frequency, the higher the curvature, confirming that matter gathered in nodes pertaining to lower and stronger harmonics will generally be denser than matter gathered in nodes of higher and weaker harmonics; thus, adjusting the frequency shows that the curvature is proportional to density. Thus, space curvature seems to be a property that harmonic gravity is consistent with, in agreement with General Relativity.

There is also a way to derive gravitational time dilation from harmonic gravity expressions, though it will be a bit trickier.

As frequency is a perfect time keeper, we should work on writing an equation that isolates frequency and distance. To do that, we begin by using again the fact that $F = -\nabla\Phi$, but this time we will equate it to the right hand side of our harmonic gravity equation (3) and differentiate with respect to space:

$$-\nabla^2 \Phi = \frac{\partial}{\partial r}\left(\frac{\partial^2 \rho_r}{\partial t^2} l(r^2)\right) \qquad (12)$$

Having stated that $l(r^2)$ can be regarded as mass, via Newton's gravitation law, we can write:

$$-\nabla^2\Phi = \frac{\partial}{\partial r}\left(\omega^2\rho_r m\right) = \omega^2\rho_r\left(\frac{\partial m}{\partial r} - 2m\right)$$

$$-\nabla^2\Phi = \omega^2\rho_r\left(\frac{2Fr^2}{GM} - \frac{2Fr}{GM}\right)$$

2Fr/GM is inconsequential here and can be ignored. Developing further and rearranging, we get:

$$-4\pi G\rho_{f_0} = 2\omega^2\rho_r m$$

$$-2\pi G = m\omega^2 e^{-2r}$$

$$-\frac{2\pi G}{m}e^{2r} = \omega^2 \qquad (13)$$

Evaluating *r* and *ω* by ansatz, we find that an increasing distance corresponds to a higher frequency. The interpretation of this finding is that the same frequency is perceived to be higher and higher if measured from locations which are further and further away from the nodal center. Knowing that the frequency of a wave keeps accurate track of time, we can conclude that time flows faster the further away from nodal centers you go, because of the fixed amount of oscillations that define the chosen time unit. In General Relativity, time slows down the closer you get to a gravitational source and the stronger the source is; harmonic gravity theory implies that time slows down in the proximity of nodal elements, which are identified as regions where matter is guided to by the vibrational force; the lower the frequency of the harmonic, the stronger the force will be.

The developments described in this chapter have shown that harmonic gravity is consistent with the tenets of Newtonian gravity and General Relativity, although its ontology is rooted in a different view on the inner-workings of the universe. While being Lorentz invariant, local and gauge invariant, it was shown to be derivable from a Lagrangian action principle. Next we should look for what this theory would infer in terms of consequent phenomena.

III. Implications

III. 1. Dark matter and dark energy

Considering its conjectural openness, this work might have more affinities to natural philosophy rather than physics. From Anaximenes' first principle of air to Anaximander's *apeiron*, the universal wave that this theory proposes seems reminiscent of the type of Presocratic reasoning that regarded matter and absence of matter as condensations and rarefactions of the same primordial element.

Following this hypothesis, the network of overtonal levels that the harmonic activity generates is responsible for the structure of cosmic systems. If this model of harmonic gravity is correct, filaments and galaxy superclusters are brought together as matter is pushed away and arranged by the universal wave, but this might also explain the small level interactions. Planetary orbits, for instance, might be nodes pertaining to higher harmonics, having higher frequency but weaker force, suspended and contoured by reflected waves; the movement would be explained by the all-encompassing inner-activity of the vibration that continues to create harmonics. Thus, what prevents bodies from collapsing altogether into the ideal nodal center is this very overtonal set of consequences of harmonic activity, which creates weaker and weaker "nodal trajectories". In this regard, densities that are accounted for in the harmonic gravity equation are generally related to a sufficiently large region which can infer a relevant comparison.

An important role in keeping galaxies together, according to contemporary science, is played by the so called dark matter, as ordinary matter alone could not account for the stability of cosmic structures. What can our harmonic gravity theory say about dark matter?

Provided that the tenets of this model are correct, the wave's vibrational force saves us from having to imagine an exotic type of matter that could explain how galaxies and clusters are kept together. This force limits matter to occupy certain regions of space, namely the nodal volumes related to the fundamental frequency and its harmonics. The mass needed to keep galaxies and stars from escaping the gravitational pull is much higher than the actual total mass, but in this model, mass becomes just an epiphenomenon of vibrational movement, not the gravitational source *per se*. For this reason, the description of a harmonic gravity theory rules out the need for a dark matter, or, if interpretation allows it, harmonic movement itself plays the role of dark matter[1].

Galaxy rotation curves show a gravitational anomaly for which the proposed solution was the existence of dark matter. The velocity of stars was observed to get higher with distance from the galaxy center, contrary to the descending curve that was expected according to currently accepted views on gravity. This phenomenon can also be extrapolated to galaxy clusters.

The mathematical description of this phenomenon is readily available right in the postulates of harmonic gravity, without the need for introducing dark matter:

Knowing that the centripetal acceleration of a body is $a_c = v^2/r$, where v is instantaneous velocity, we get:

[1] As a side note, for the same reason, the equivalence principle is satisfied, as inertial mass and gravitational mass could not be anything but equivalent to each other; this follows easily from the purely inertial nature of matter as acted upon by vibration, considering that the entire gravitational action is done by the universal wave's vibration.

$$v = \sqrt{a_c r}$$

This *v* represents the velocity of the body in its orbit around the center and must not be confused with the wave velocity we have used so far in our harmonic gravity expressions. Therefore we will denote this instantaneous velocity by v_r , the instantaneous velocity of the body at location *r*. In a harmonic gravity paradigm, the centripetal acceleration is the second order time differentiation we used in the modified wave equation. So we can write:

$$v_r = \sqrt{\frac{\partial^2 \rho_r}{\partial t^2} r}$$

Developing further, we arrive at the equation that describes increasing velocities for stars further and further away from the galaxy center:

$$v_r = \sqrt{\omega^2 \rho_r r} = \sqrt{\omega r \Lambda e^{-2r-\omega}} \qquad (14)$$

As orbits signal potential nodes related to higher harmonics, we can make the observation that frequency increases by multiples of the fundamental as radial distance decreases. The resulting magnitude makes v_r higher and higher with distance, insofar as there is an orbit to be accounted for.

In addition, also the effects of *dark energy* can be attributed to the general oscillatory motion of the wave working to maximize rarefactions between nodes related to various harmonic levels. Matter is accelerated torwards nodal volumes, therefore, from certain frames of reference, some cosmic systems are drifting apart from each other in an accelerated manner, while others are heading towards collision.

In a harmonic gravity ontology, dark matter and dark energy become two facets of the same primordial phenomenon, if we are to keep the mystery of the usual terminology. However, the properties of this model reduce these two mysteries to implied effects of the vibrational force.

Alluding to Pythagorean philosophy and to Kepler's *Harmonices Mundi*, this theory brings the actual concept of gravity into the landscape of harmonic universe. It also replaces the "quintessence" that dark matter has often been related to with universal oscillation and it poses a different view on dark energy, whose effects can be attributed to this force as well.

One note on the problem of permanence when considering this theory. The harmonic gravity equation and its solution cannot describe the configuration of an early universe, unstructured soup of fundamental particles. The mathematics of this theory aims to describe the general tendency of matter arrangement, implied by the activity of this universal vibrational force hypothesized herein. However, this theory claims that the mentioned general tendency was true in the early stages as well, although not expressly manifested in the structure back then.

Since the receding of cosmic structures is accounted for by the vibrational force of the universal wave, expansion itself is not a necessary concept in a harmonic gravity ontology. As some structures are guided towards collision on their way to the nearest nodal volume closer to the fundamental, and others are estranged by the same force helming them on separate ways towards different such nodal clusters, these movements do not infer metric expansion; rather they infer rearranging matter within the same space, until all matter is organized within nodal fasciae, getting denser and denser. This also implies that a universe governed by harmonic gravity does not need Big Bang, since this would be an extra-event which is not necessary in the description of this model.

Tracing back in time, the history of harmonic activity in the universe suggests that densities formed in the nodal volumes were lower in the past and the further we go in the past, the lower the densities were. The extremum of this regression is a landscape where nodes, antinodes and any other location had the same density – a primordial ocean of fundamental particles. Was there a state prior to this primordial ocean, a state in which not even the fundamental particles were formed, a void – or quasi-void – which had been progressively sculpted and shaped by the vibrational force? This question, along with the question of how the wave came into existence in the first place, might be the scope of a future work, but we can examine these ideas in our effort to find other consequences of harmonic gravity.

Insofar as the regression can be done until any density is divided into infinitesimal entities, the coming into existence of the first particles can be regarded as instantiations of the vibrational energy itself, carrying elementary energy to the points where incident waves and reflected waves meet. In this model, the spacetime fabric can be viewed as inherent to this energy, more than a property, but rather an identity. As this energy could have been transported freely between distant nodes without settling, it's actually in the transfinite progression of the harmonic series that we find the infinitesimally neighboring points where the interferences would have constrained energy to be instantiated as mass. Infinite couples of Scylla-incident-waves and Charybdis-reflections clashing in infinite adjacent nodes capture fractions of energy and consolidate them in their matter hypostasis; the web thus formed describes a hypothetical early universe consisting in an indefinite field whose energy ripples created fundamental particles. This is the energy specific to the "highest" harmonic; the energy of the remaining partials is translated to the work done by the oscillatory motion for organizing these particles into bigger and bigger systems.

The cosmogonic implications of this harmonic gravity ontology might inform the development of universal configuration and its direction teleologically. The continuous work done by the vibrational force will eventually push matter closer to the idealized nodal elements, condensing all masses into denser and denser fasciae. This motion could explain the mystery of the Great Attractor, by identifying it with a nodal volume where cosmic structures are heading towards but not all of them have arrived yet. If this is true, then such "places" are not gravitational anomalies; actually we could expect most of Laniakea-sized superclusters to have such Attractors, in the form of nodal spaces, where clusters are being pushed towards, but where few or even none of them has arrived yet.

Could this mean that, in the extreme of this progression, the condensation of matter will result in infinite densities grouped along nodal fasciae? This would imply that the fundamental frequency will overwhelm all the other partials to the point of emptying all harmonic spaces. We incline to doubt that this will be the course of events, having in mind that the early few partials are powerful enough to counteract the force of the fundamental. However, regardless of how many partial spaces will survive, the harmonic gravity equation does describe the general tendency of density distribution.

Using the evolution of densities from the primordial universe up to the current state and the formulation of orbital velocity described in the previous subchapter, we can arrive at an interesting consequence of harmonic gravity theory.

We begin by rewriting the space derivative of the density using the chain rule:

$$\frac{\partial \rho_r}{\partial r} = \frac{\partial \rho_r}{\partial t}\frac{\partial t}{\partial r} \qquad (15)$$

Let's take the terms on the right hand side and examine them one by one. We will describe the time derivative of the density in a different way than we have so far; this alternative approach will be done by taking into consideration the primordial state of the universe (*I*) and an arbitrarily later state (*Ω*), sufficiently evolved as to be able to depict transformations by infinitesimal densities *ε*. We can write:

$$\frac{\partial \rho_r}{\partial t} = \frac{1}{\int \varepsilon dr}\left(\rho_r^{\Omega} - \rho_r^{I}\right)$$

The primordial state inferred by the regression of harmonic evolution describes a universe composed by infinitesimal adjacent densities uniformly spread throughout the entire space, in the moment of mass hypostasiation of energy. The cause of this instantiation was described to be the clashing reflected and incident waves in the transfinite harmonic. So, at this point, the entire universe could be seen as consisting only of a web of nodes, neighboring transfinite nodes covering the entire space. Our time derivative becomes:

$$\frac{\partial \rho_r}{\partial t} = \frac{1}{\int \varepsilon dr}\left(\rho_r^{\Omega} - \frac{\Lambda}{\omega_\infty} e^{-\omega_\infty}\right)$$

For the other term, first we will calculate the time derivative of distance, after solving for *r* in the orbital velocity equation (14), and then we will invert the result:

$$r=\frac{v_r^2}{\omega^2\rho_r}$$

$$\frac{dr}{dt}=v_r^2\frac{\partial}{\partial t}\left(\frac{1}{\omega^2\rho_r}\right)=v_r^2\frac{e^{2r+\omega}}{\Lambda}\left(\frac{1}{\omega}-1\right)$$

$$\frac{dt}{dr}=-\frac{\omega}{v_r^2}\frac{\Lambda e^{-2r-\omega}}{\omega\left(1-\frac{1}{\omega}\right)}=-\frac{\omega\rho_r}{v_r^2}\frac{1}{1-\frac{1}{\omega}}$$

Putting these new derivations together, we get the following equation:

$$\frac{\partial\rho_r}{\partial r}=-\frac{1}{\int\varepsilon dr}\left(\rho_r^{\Omega}-\frac{\Lambda}{\omega_\infty}e^{-\omega_\infty}\right)\frac{\omega_\Omega\rho_r}{v_r^2}\frac{1}{1-\frac{1}{\omega}}$$

Analyzing the terms inside the parantheses, we can use the fact that the primordial density of the transfinite harmonic's node really is equal to the infinitesimal element ε. Replacing and rearranging will give:

$$2\rho_r=\frac{1}{\varepsilon r}\left(\rho_r^{\Omega}-\varepsilon\right)\frac{\omega_\Omega\rho_r}{v_r^2}\frac{1}{1-\frac{1}{\omega}}$$

$$2\frac{v_r^2}{\omega_\Omega}\left(1-\frac{1}{\omega_\Omega}\right)=\frac{\rho_r^{\Omega}}{\varepsilon r}-\frac{1}{r}$$

As $1/\omega$ is basically inconsequential in this context, we can ignore it and further simplify our equation. Also, we can treat ε as the basic unit of density – using its quality of being the smallest density element in the architecture of the universe. This trick enables us to equate the ε element to unity and open up further developments of this equation:

$$2\frac{v_r^2}{\omega_\Omega}=\frac{\rho_r^{\Omega}-1}{r}$$

$$v_r^2=\omega_\Omega\frac{\rho_r^{\Omega}-1}{2r} \qquad (16)$$

A special case of equation (16) is the situation of subunitary densities, in which case we can write the following rough approximation:

$$v_r^2 \backsimeq -\omega \frac{\rho_r}{r}$$

$$v_r \backsimeq i\sqrt{\omega \frac{\rho_r}{r}}$$

The emphasis in this approximation is the imaginary element that we get after square rooting the negative right hand side; the difference in order of magnitude is not so important. Multiplying both sides by mass, we can write an expression for momentum at location *r*:

$$p_r \backsimeq im\sqrt{\omega \frac{\rho_r}{r}} \qquad (17)$$

Imaginary momentum is a property of tachyons, hypothesized particles that travel at faster-than-light speeds, but which have never been observed. According to harmonic gravity equations, subunitary ρ_r corresponds to extremely high radial distances, so locations that are extremely distant from any nodal volume. This suggests that, if they really exist, tachyons might be found somewhere deep in the void areas contoured by nodal fasciae.

This harmonic gravity theory started off from the hypothesis of a universal harmonic oscillation that coordinates all matter and reached conclusions related to supercluster movements, dark matter, dark energy and even tachyons. Their implications from a cosmogonic perspective might be the subject of future work.