Space Quantum Gravity

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In this paper I propose that the 'Hubble expansion' phenomenon is universal and isotropic and countered by space absorption as an activity of central massess. With mass sucking in space on the one hand and space expanding isotropically with the Hubble rate on the other hand, we get a continuous drift of space towards the central mass. We can define a critical distance from the central mass as the distance where the two effects are balanced. The cosmic density parameter is given a different, more local, interpretation because it now devides space into regions where absorption of space is dominant and regions where space creation is dominant. I add to this that at elementary particle level, the space absorption process is quantized and periodic, with the de Broglie internal frequency as the quantized space volume absorption frequency. This then leads to a mass independend quantized volume of space of approximately the size of the largest nuclei. De Broglie's subquantum gas is identified with space that is thus quantized. Nuclei occupy at most one single quantum bubble of space. Inside these quantized space bubbles, we have the physics of the weak and strong nuclear forces. In between quantizes space bubbles we have the physics of wave mechanics and gravity. The same process of quantized space cell absorption by elementary particles lies at the basis of both gravity on the macro level and wave mechanics on the meso level. It also produces inertia in a way that is, conceptually at least, somewhat similar to the Higgs mechanism by which elementary particles of the weak and strong interactions acquire mass. The concept of stochastic drift of quantized bubbles of space is a refined version of earlier 'velocity of space' approaches towards gravity.

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I. THE CONSEQUENCE OF TAKING THE HUBBLE EXPANSION OF SPACE SERIOUSLY: INTRODUCING SPACE ABSORPTION.

A. The 'Hubble expansion' phenomenon as universal and isotropic.

Hubble's Law of space expansion reads $v_H = H_0 d$, with v_H as the apparent Hubble redshift-velocity, d as the distance of the redshifted galaxy and H_0 as Hubble's constant at present time. The interpretation of the Hubble velocity of galaxies is that space between galaxies is expanding and thus pushing those galaxies apart. The galaxies themselves can be motionless relative to their local space. Hubble's space expansion is supposed to be effective on cosmological distances only because on smaller scales gravity dominates the much weaker effect of space expansion.

Conceptually, the division of space into patches that are Hubble expanding and patches that aren't Hubble expanding, depending on the amount of mass in those patches, makes little sense. Hubble space expansion should be a universal and isotropic property of space, wherever that space is located and independent of the amount of mass in it. This is how we will interpret Hubble space expansion, as a universal and isotropic property of space, independent of location and mass density.

The easiest way to imagine such a universal and isotropic Hubble effect would be with a quantized space, a space consisting of quantized space bubbles of a certain small size. I hypothesize these quantized space bubbles to behave like living cells, doubling themselves every now and then in a random, stochastic way but with a certain overall Hubble related doubling time τ_H. At present, τ_H can be connected to the Hubble rate of doubling the volume of the universe and has been calculated to be

$$\tau_H = \frac{ln(2)}{3} T_H = \frac{ln(2)}{3H_0} = 0.231 \cdot T_H, \tag{1}$$

with the Hubble time $T_H = \frac{1}{H_0}$ and for the ease of things assume this doubling time to be constant after the initial inflation period of the Universe. Choosing $H_0 = 2.22 \cdot 10^{-18} Hz$, we get $T_H = 14.0 Gy$ and $\tau_H = 3,25 Gy$ as the present doubling time of the universe as a whole.

Because we connect this to Hubble space expansion as universal and isotropic, every patch of volume in the universe is doubling its size in τ_H in a probabilistic manner. That means that it will be impossible to determine the moment a certain space bubble quantum will duplicate itself. But on average, given a huge quantity of such bubbles, the overall doubling time will be τ_H.

B. Gravity on test masses as a secondary effect of a counter-'Hubble expansion' phenomenon

Given the Hubble space volume doubling time of $3,25Gy$ and the age of our solar system of about $4,6Gy$ with a stable distance between sun and Earth, something is obviously counter-effecting the Hubble expansion in our solar system and this 'something' is somehow connected to mass and gravity. A similar calculation applies to our galaxy, the Milky Way.

So from these two observations we conclude that a high enough mass density counteracts Hubble space expansion, but, in our hypothesis, without interfering with the phenomenon of space creating space, without stopping quantized space bubbles doubling themselves randomly, universally and isotropically. The counter-effect, understood as mass annihilating space by absorption, is hypothesized to have its own cause without interfering with Hubble space expansion as a universal property of space. Mass then causes space contraction with every central mass as a local sinkhole of space. This by itself doesn't directly produce the effects attributed to gravity on a test mass in the vicinity of the central mass. But because central masses suck in space, secondary test masses are, by there own inertia, dragged along with the space that's being sucked in.

We already know that local Hubble space creation pushes masses from each other as a global cumulative effect. The more local space creating additional local space in between two masses, the stronger the global effect on the distance between those masses. We conceptualize the origin of gravity in the opposite way as local masses sucking up local space, creating a sinkhole that then sucks in space from the surrounding. A second test-mass located in that surrounding is inertially connected to its local space and will get sucked in too, in a free fall. Newtonian gravity then is a secondary effect, as the inertial reaction of a secondary mass on local space being drawn in by a space-sinkhole created by a primary mass.

With mass sucking in space on the one hand and space expanding with the Hubble rate on the other hand, we can define a critical distance as the distance where the two effects cancel each other out. That should be the distance at which a central mass M sucks in space with a rate equal to the Hubble expansion over that distance. That is the critical distance r_c at which the Newtonian free fall crash-velocity equals the Hubble velocity, $v_H = v_{crash}$. This gives

$$H_0 r_c = \sqrt{\frac{2GM}{r_c}} \tag{2}$$

and leads to

$$r_c^3 = \frac{2GM}{H_0^2}, \tag{3}$$

so we get

$$r_c = \left(\frac{2GM}{H_0^2}\right)^{\frac{1}{3}}, \tag{4}$$

and

$$V_c = \frac{8\pi GM}{3H_0^2}. \tag{5}$$

Defining a critical density as $\rho_c = \frac{M}{V_c}$, we get the Friedmann expression for the critical density of the Universe as

$$\rho_c = \frac{3H_0^2}{8\pi G}. \tag{6}$$

If two masses are at a distance of $2r_c$ from each other, they each occupy a static bubble of space, a bubble that is neither contracting nor expanding, so they will remain at the distance of $2r_c$ forever. Put them closer together, then the space in between them contracts, something we interpret as gravity pulling the masses towards each other. Put them further apart, then the space between them will expand faster than it is contracted and they eventually become Hubble receding masses. If an infinitely small test mass m_0 is placed at r_c it will remain at rest because the relative velocity of space at that location will be zero.

C. Cosmic density parameter and critical distances

Our model implies a new interpretation of the cosmic density parameter. At the present interpretation, we have one single parameter for the entire universe during its entire existence that determines the fate of the cosmos as either expanding, being stable or contracting, also named open, flat or closed. This parameter has to be fixed in advance and with it one of three scenarios for the fate of the universe. In our model, we do not have a cosmic parameter with three scenarios for the fate of the universe, dependent on the density of matter in the universe. Instead, Friedmanns expression for the critical density divides the universe in three domain types: one in which the density is bigger than the critical density where space is contracting; one in which the density is identical to the critical density and where space is in equilibrium; finally one in which the density is smaller than the critical density where space is expanding.

Every mass has its own critical distance and critical volume, depending on its mass.

object	mass	r_c	$r_{measured}$	space type
electron	$9,1 \cdot 10^{-31} kg$	$2,9 \cdot 10^{-2} m$	-	-
proton	$1,7 \cdot 10^{-27} kg$	$0,356m$	-	-
Pb-208	$3,45 \cdot 10^{-25} kg$	$2,1m$	-	-
Earth	$5,97 \cdot 10^{24} kg$	$5,4ly$	-	-
Sun	$1,99 \cdot 10^{30} kg$	$402ly$	-	-
SM Black Hole	$(10^5 - 10^9) \cdot M_{sun}$	$(18,5 - 400)kly$	-	-
Milky Way SMBH	$4,3 \cdot 10^6 \cdot M_{sun}$	$64,7kly$	-	-
Milky Way	$1,5 \cdot 10^{12} \cdot M_{sun}$	$4,6Mly$	$50kly$	contracting
local cluster	$15 \cdot 10^{12} \cdot M_{sun}$	$9,6Mly$	$5Mly$	contracting
Virgo supercluster	$1,5 \cdot 10^{15} \cdot M_{sun}$	$46Mly$	$55Mly$	balanced ?
Laniacen supercluster	$10^{17} \cdot M_{sun}$	$184Mly$	$260Mly$	expanding

Conceptually, the creation of space is happening isotropic throughout the critical volume while the destruction of space is a central mass, local sinkhole, occurrence. So it might be that during τ_h as much space is created as is absorbed inside V_c, the overall effect will be a continuous stochastic drift of quantized bubbles of space from the isotropic distribution of creation to centralized absorption. And because $\tau_H = 3,25Gy$, at any moment in time, a minute portion of the quantized space bubbles inside V_c will take part in this stochastic drift towards the central mass M. It is this minute portion of quantized space bubbles drifting towards the central mass that produce the effect of gravity on test masses inside V_c. In previous papers, I have worked on the hypothesis of moving space, but as a general concept without the ideas of space quantization with minute stochastic drift of those quantized space bubbles.

Cosmologically, our conception of the division of space around a central mass M into a contracting space inside V_c and an expanding space outside of V_c produces interesting dynamic considerations. For example, the SMBH at the centre of our Milky Way has a critical volume compassing the entire visible mass of the Milky Way. Thus, on its own, this SMBH already shields our galaxy against Hubble expansion and thus stabilizes it. One wonders if there is a general correlate between the size of a SMBH and the galaxy it centres.

II. CONNECTING DE BROGLIE'S ORIGINAL IDEA TO SPACE ABSORPTION

A. The de Broglie inner frequency as the forgotten starting point of wave mechanics

The Compton frequency ν_C of an elementary particle with rest-mass m_0 is a derivative of the Compton wavelength λ_C and has been defined as

$$\nu_C = \frac{m_0 c^2}{h}. \tag{7}$$

This definition has its root in the original idea of de Broglie (1; 2), that every proper mass m_0 represented a quantum of energy $E_0 = m_0 c^2$ and should thus, due to Planck's law $E_0 = h\nu_0$, be connected to an internal frequency ν_0 according to

$$h\nu_0 = m_0 c^2. \tag{8}$$

Further considerations led de Broglie to attach a wavelength $\lambda = \frac{h}{p}$ to such quanta of mass/energy when they were moving (3). For an electron orbiting a proton in the Hydrogen-atom, this should lead to standing waves and thus to a discrete frequency spectrum. This lead to the formulation of wave mechanics, but, due to the absence of associable observables to this *phénomenè périodique simple* (1), the idea of an inner frequency attributed to any elementary particle disappeared from the scene. In all college physics textbooks, wave mechanics starts with de Broglie's wavelength formula $\lambda = h/p$, not with the inner frequency idea. Nevertheless, *de Broglie était persuadé que cette fréquence existe* (4).

B. Quantized space volume absorption as a 'phénomenè périodique simple'

We can combine this with the previous section by concluding that a mass M has to absorb a volume V_c in τ_H time in order to achieve stability, or equilibrium, at r_c. We then have a space absorption rate [1] of

$$\frac{V_c}{\tau_H} = \frac{\frac{8\pi GM}{3H_0^2}}{\frac{ln(2)}{3H_0}} = \frac{8\pi GM}{ln(2)H_0}. \tag{9}$$

We now assume that at elementary particle level, this process is quantized and periodic, with the de Broglie internal frequency as the quantized space volume absorption frequency. Of course,

[1] The space volume absorption rate dV/dt is a Lorentz scalar because both dV and dt Lorentz transform with the factor $1/\gamma$. So the velocity of the source mass M doesn't affect the space volume absorption rate, and thus the secondary Newtonian effect on other far away masses.

the average absorption rate has to be the same at the local as at the global level. Defining the de Broglie time as $T_B = \frac{1}{\nu_0}$ and the quantized space volume as V_B, we get

$$\frac{V_B}{T_B} = \frac{V_c}{\tau_H} = \frac{8\pi GM}{ln(2)H_0} = \nu_0 V_B \tag{10}$$

and by using $\nu_0 = Mc^2/h$ we get

$$V_B = \frac{8\pi Gh}{ln(2)H_0c^2}. \tag{11}$$

Because the volume V_B is mass independent, it is the same for every elementary particle with a de Broglie frequency ν_0. This expression for V_B combines Friedmann's formula and de Broglie's formula and thus integrates the universal constants of Newton, Hubble, Planck and Einstein.

We can calculate the volume to be $V_B = 8.025 \cdot 10^{-42} m^3$ with the connected radius $r_B = 12,4fm$. This is approximately the size of the largest nuclei. So nuclei occupy at most one single quantum bubble of space, a single cell of space so to speak. Inside these quantized space bubbles, we have the physics of the weak and strong nuclear forces. In between quantizes space bubbles we have the physics of QED, QM, EM and gravity.

C. Some numbers regarding the proton as quantized space bubble absorber

For the proton, the critical volume is $V_c = 0,198m^3$. If we compared this to V_B we get

$$N = \frac{V_c}{V_B} = \frac{0,198}{8.025 \cdot 10^{-42}} = 2,358 \cdot 10^{40} \tag{12}$$

as the amount of quantized space bubbles inside V_c of the proton. This amount is being created by the Hubble expansion during τ_H of $3,25Gy$ and then also absorbed in the same time by the proton.

The absorption frequency is given by the de Broglie internal frequency of $\nu_0 = \frac{m_0c^2}{h} = 2,268 \cdot 10^{23} Hz$. This gives us an absorption rate of

$$\frac{\partial V_{abs}}{\partial t} = V_B \cdot \nu_0 = 8.025 \cdot 10^{-42} \cdot 2,268 \cdot 10^{23} = 1,820 \cdot 10^{-18} \frac{m^3}{s}. \tag{13}$$

At this rate it will take the proton $3,25Gy$ to absorb an amount of space volume equal to its critical volume.

The difference between Hubble space creation and mass space absorption is that the first happens isotropically in space and that the second is a central affair. As a result, a stochastic space drift from within all of V_c towards the proton is continuously taking place. On a cosmic scale, this stochastic drift of quantized space bubbles towards the proton produces gravity as a secondary effect of space absorption.

D. A cocktail-party effect with elementary particles in de Broglie's subquantum gas

De Broglie speculated that a subquantum gas piloted elementary particles through space in a thermodynamic way, thus producing a pilot wave. I assume that the quantized space bubbles can be identified as de Broglie's subquantum gas. But the piloting process is more complicated, because in my conception the elementary particle is at least as active at the quantized space bubbles are. The elementary particle absorbs quantized space bubbles in a stochastic manner, thus causing a drift of other bubbles towards the vacated spots. But the absorption process doesn't happen instantaneous. The absorption process causes the elementary particle to be slowed down in its movement. Together with the drift of space bubbles towards the elementary particle, this produces inertia.

Inertia thus can be imagined as the cocktail-party effect which is known from the Higgs field. The interaction between Higgs field and leptons or bosons gives them inertia, measured as mass. But the de Broglie cocktail-party effect I imagine here is a more active one, because the elementary particle is consuming the cocktail-party members flocking around it. The cocktail-party members flock around the elementary particle because they are being eaten. It is like a cocktail party of normal people with Dracula. All want to be loved by Dracula, who in term loves them all, one by one. In such a situation, one can ask, who is piloting who? The subquantum gas is in turmoil due to the particle eating them and the particle's motion is influenced by the turmoil.

A particle without mass will not interact with the quantized space bubbles through absorption and then not acquire intertia, like the photon and the neutrino. A test-particle with mass in an external field of gravity, understood as a stochastic drift of quantized space bubbles towards a central mass, will interact through this cocktailparty with dracula effect with some of those drifting space bubbles and thus be coerced to move towards the central mass. From the outside, this looks like a free-fall.

E. How space bubble absorption leads to wave mechanics

In my conceptual quantum gravity approach, space bubble absorption with the de Broglie internal angular frequency ω_0 leads to wave mechanics once the central mass is moving while periodically absorbing space cells. It is a wave forced upon the stochastic drift of space cells caused by the the particle's evenly stochastic absorbtion of those space cells, while moving through the

space where this absorbtion takes place. How does this semi-chaotic drift process leads to wave mechanics on elementary particle level?

As de Broglie observed, a moving elementary particle had two frequencies instead of one for the same particle at rest: an inertial angular frequency ω_i and a clock angular frequency ω_i. De Broglie, who used frequencies instead of angular frequencies, arrived at this conclusion based upon Einstein's theory of special relativity. In order to understand the appearance of those two frequencies, we first look at the Hamiltonian and Lagrangian energies of such an elementary particle with velocity v and momentum p, see fig.(1).

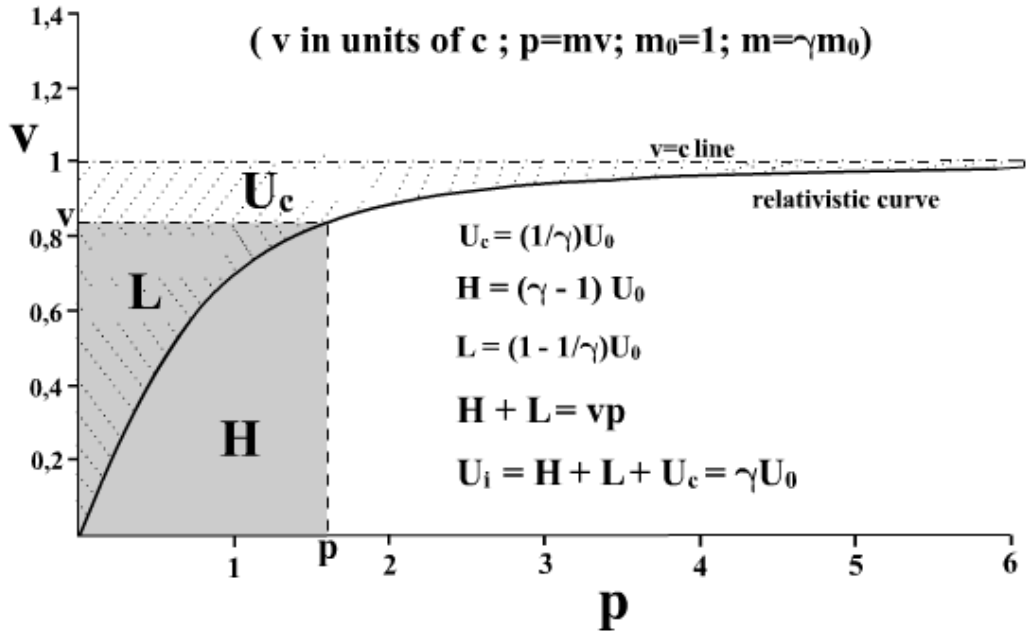

FIG. 1. Elementary particle's energies on the one degree of freedom relativistic velocity curve

Compared to the standard definition of the Lagrangian and the Hamiltonian, we use a slightly different one by adding a constant rest energy U_0 to the usual Lagrangian and distracting it from the standard Hamiltonian. This ensures graphical continuity of the definitions when transitioning from a classical Newtonian regime to a relativistic regime without changing the differential equations involving the Hamiltonian and the Lagrangian. The Lagrangian and Hamiltonian, represented by surfaces in the graph, are connected through a Legendre transformation. The energies de Broglie was working with were the inertial energy $U_i = \gamma U_0$ and the clock related energy $U_c = \frac{1}{\gamma}U_0$, which

are also depicted as surfaces in the same graph. By relating U_i and U_c to the Lagrangian and Hamiltonian energies, they become less detached from standard physics. According to de Broglie, every energy attributed to an elementary particle should have a connected internal frequency, as a generalization of Planck's relation $U = h\nu$. The clock energy is an integral part of the Lagrangian energy and the inertial energy is part of the Hamiltonian energy of the elementary particle. The different energies aren't independent, but fixed graphically by one and the same relativistic curve.

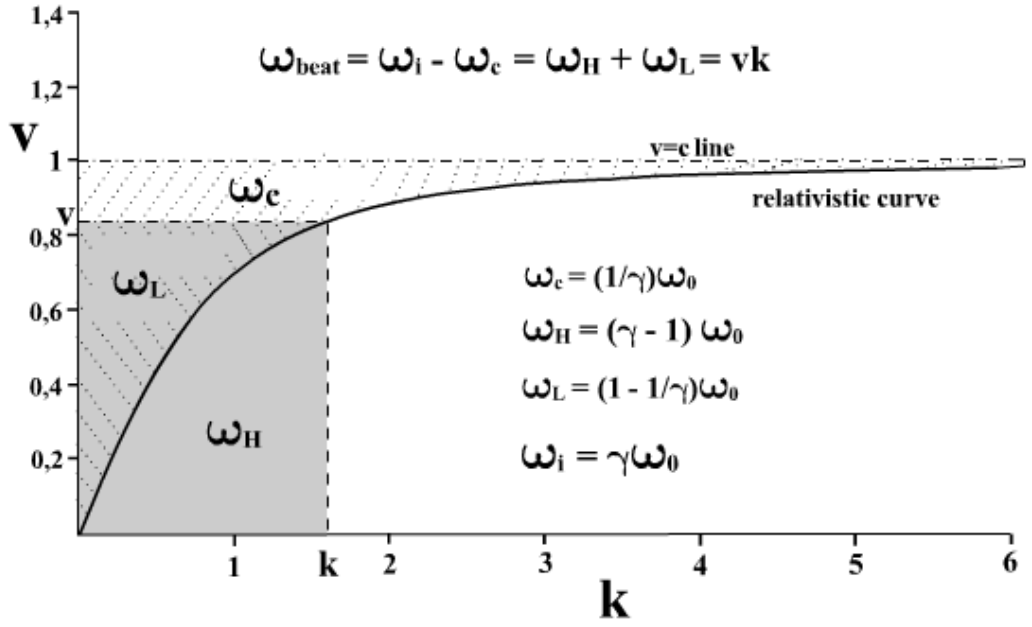

FIG. 2. Elementary particle's internal frequencies when on relativistic curve

If we divide p by $\hbar$ we get k and the surfaces then represent the angular frequencies ω, see fig. (2). According to de Broglie, instead of one internal frequency, a moving partiicle has two, its clock frequency and its inertial frequency. Those two produce a beat angular frequency as $\omega_{beat} = \omega_i - \omega_c$ and this beat angular frequency also has a wavelenght and thus a wavenumber k, with $\omega_{beat} = vk$. These last two expression contain my version of de Broglie's 'Harmony of the Phases'. Once this particle is confined in a box, the particle can only be in a state where the beat forms a stable standing wave of drifting space cells in the confinement, thus producing discrete states only, as depicted in fig. (3). In my approach, this is a standing wave in the de Broglie's subquantum gas identified as the quantized space cells with individual cell-volume V_B

and caused by the interaction between the stochastic drift of those space cells towards the emptied spots and the space cell absorbing elementary particle randomly creating new empty spots. In their mutual dance, a quantum wave is created on the beat of the two internal frequencies of the moving elementary particle.

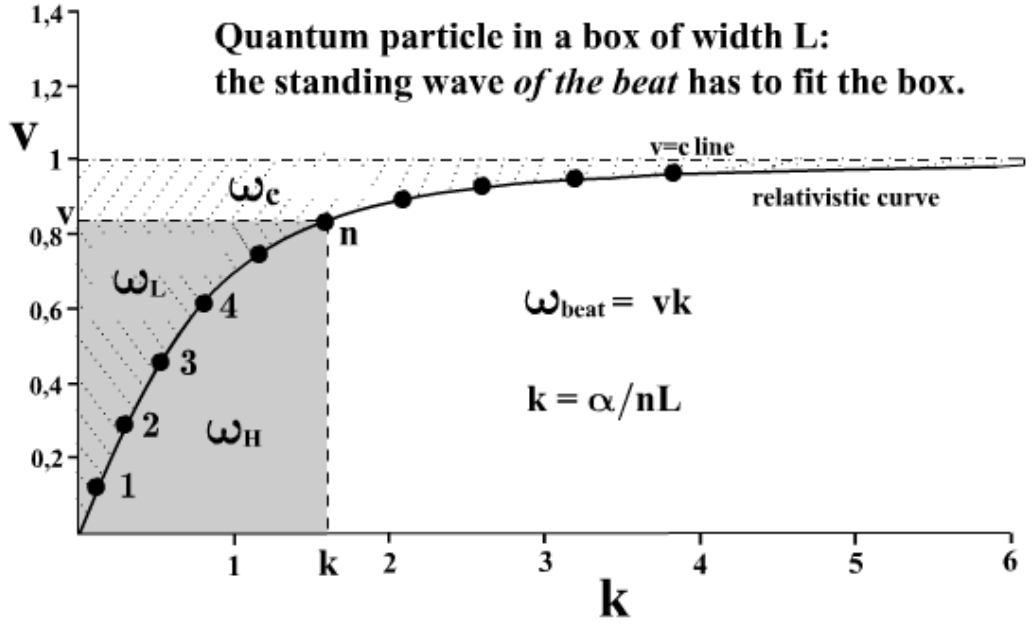

FIG. 3. Elementary particle's quantized frequencies when on relativistic curve

In the graph of fig. (2), we also have Hamiltonian and Lagrangian angular frequencies. These are also beats themselves, but theoritical ones: $\omega_H = \omega_i - \omega_0$ and $\omega_L = \omega_0 - \omega_c$. The beat of quantum mechanics is the summation of these two theoretical beats: $\omega_{beat} = \omega_H + \omega_L$. So we have a lot of frequencies attached to a single elementary particle once it moves, but because they are fixed by one single relativistic curve, there is only one degree of freedom for the particle and all those frequencies are tied by that one single degree of freedom. History lead wave mechanics to take the wavelength as its degree of freedom. If we put the particle in a box, the one degree of freedom reduces even more to discreet jumps on the curve, see fig. (3).

De Broglie assumed ω_0 to be fundamental for the static particle and ω_i and ω_c for the moving particle, as the two possible ways for the Lorentz transformation of ω_0 and connected by the wavelength λ throught the four vector multiplication of $R_\nu K^\nu$ (3). For the proton, these

frequencies are in the order of $\nu_0 = \frac{m_0 c^2}{h} = 2,3 \cdot 10^{23} Hz$. At a velocity of $v = 0,001c$ we get $\nu_{beat} = \nu_0 \cdot 10^{-6} = 2,3 \cdot 10^{17} Hz$ which gives a wavelength of $\lambda = 1,3 \cdot 10^{-12} m$ for this proton. With the same velocity, the electron would have a wavelength of $\lambda = 2,4nm$. which is in the Röntgen range.

So it is the frequency of the beat that leads to the wavelenghts of quantum mechanics. Both ω_H and ω_L are defined as beats in the same order of magnitude, in constrast to the original angular frequencies of ω_0, ω_i and ω_c. The last three relate to the physical cause, the absorption frequency of quantum bubbles of space by the elementary particle. The beat frequency is a secondary effect and the wavelength a tertiary effect. It is the tertiary effect that can be measured in QM, but because all the quantities are bound by the graph with only one degree of freedom, this is the maximum of information that can be extracted from such a system.

But in quantum gravity or quantum cosmology, it is the fundamental frequency that matters and that allows me to connect de Broglie to Hubble through my hypothesis of space absorption as an anti-Hubble process. On a cosmic scale the wavelength does not matter but the internal de Brogle frequency does. That frequency quantizes space absorption.

III. BEYOND SPACE QUANTUM GRAVITY

According to my approach, the same process of quantized space cell absorption by elementary particles lies at the basis of both gravity on the macro level and wave mechanics on the meso level. It also produces inertia in a way that is, conceptually at least, somewhat similar to the Higgs mechanism by which elementary particles of the weak and strong interactions acquire mass. The concept of stochastic drift of quantized bubbles of space is a more refined version of the 'moving space' approach I deployed in previous papers. (5; 6)

My approach doesn't include the weak and strong nuclear forces, which, in my opinion, are space cell internal processes at the micro level. That touches on the question where the elementary particle goes to when it absorps the space cell it is in. From the outside it might seem as it is being absorbed by space itself, after which it reappears again in the next space bubble to be absorbed. That space bubble, in which the elementary particle reappears, might be a random space bubble inside its wave, leading to Born's stochastic interpretation the wave function of quantum mechanics.

Inertia, gravity and wave mechanics are, in my approach, processes involving interaction be-

tween large amounts of quantized space bubbles and particles with rest mass. This interaction is independent of the internal physics of these space bubbles. The weak and strong forces are present inside a single space bubble of size V_B and I assume the Higgs field to exist inside every quantized space bubble or space cell, in an isolationist way. The Hubble expansion of space is interpreted as a stochastic doubling process of these space cells. Electromagnetism somehow seems to connect the macro-world outside these space cells with the micro-world inside them, through the intermediate of electric charge and magnetic spin. In the Large Hadron Collider, it could be that the experiments at those large energies and small scale somehow manage a certain breakdown of the isolation of the Higgs field and the strong and weak processes inside those space bubbles.

From a point of view of the metric I think that a Kantian apriori structure exists through which space bubbles and elementary particles interact, for example in the form of a non-commutative algebra (7) like a Clifford algebra. If a particle absorbs the space cell it is in, after which both case to exist in our world and only for the particle to reappear inside another space cell, without the world falling apart, then something has to keep things together. This could the metric as a pure Clifford-like structure, existing independent of space and particles, as a Kantian apriori.

Because V_B is dependent on the Hubble parameter, and the Hubble parameter is time dependent on a Big Bang scale, it can be assumed that at the beginning of our universe, right after the Big Bang, the neat separation presented above didn't exist yet. That neat separation of weak and strong nuclear forces from gravity and wave mechanics still had to be produced as its outcome. That is the field of cosmogenesis. At CERN, through the LHC, some of those early conditions seem to be recreated.

I don't think gravity is a fundamental force. I think quantized space bubble absorption is a fundamental phenomenon. Gravity is one of its secondary effects, as is wave mechanics. I think the strong and weak forces are space bubble internal processes on their own. In our present universe, gravity on the one hand and the strong and weak nuclear forces on the other hand are not unifiable because the realm of the one ends where the realm of the other begins, at the quantized bubbles of space.

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