Connecting de Broglie's inner frequency to the Hubble constant: a new road to quantum cosmology?

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Abstract

While working on the concept of space volume absorption, as underlying classical Newtonian gravity, I got the idea to connect de Broglie's idea of an inner frequency to the Hubble constant. The space absorption concept brings gravity conceptually in line with Hubble's space expansion and allows balancing Hubble space volume expansion with space volume absorption. This reproduced Friedmann's critical density formula. The introduction of the concept of the rate of space volume absorption, a Lorentz scalar, leads to an expression for a quantized bubble of space absorption of the size of the largest nucleus. The mass independent formula for the volume of this quantized bubble of space absorption combines Friedmann's formula and de Broglie's formula and thus integrates the universal constants of Newton, Hubble, Planck and Einstein. I noticed a conceptual similarity between thus quantized space and the sub-quantum medium of the Bohm-Vigier-de Broglie theory.

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I. 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 defined as

$$\nu_C = \frac{m_0 c^2}{h}. \tag{1}$$

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

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

Further considerations led de Broglie to attaching 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].

II. GRAVITY AS AN ANTI-'HUBBLE EXPANSION' PHENOMENON

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 constance 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. Within a Newtonian, pre-Einstein conception of gravity, that makes no sense, because Newtonian space is a static background and gravity acts between any two masses within inert space. Hubble space expansion should be a universal property of space, wherever that space is located. Newtonian gravity, originally understood, acts at a distance between any two masses, having no effect at all on space, thus leaving space as it is in the process. If we want to solve this riddle without the help of General Relativity but within the framework of Special Relativity, then a radical conceptual change of either Hubble's or Newton's theories are needed.

In this paper, I propose a radical conceptual change of the latter. The choice is to redefine gravity as space contraction with every mass as a local sinkhole of space, thus re-interpreting gravity as an anti-'Hubble-expansion' influence. In this conceptual change approach, mass affects space, not by curving it but by annihilating it. We then conceptualize Hubble space expansion as space creating space and Newtonian gravity as a secondary effect of mass destroying space. We then have the opposites of space creation and space destruction.

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 then have to conceptualize 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

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

and leads to

$$r_c^3 = \frac{2GM}{H_0^2}, \tag{4}$$

so we get

$$r_c = \left(\frac{2GM}{H_0^2}\right)^{\frac{1}{3}}, \tag{5}$$

and

$$V_c = \frac{8\pi GM}{3H_0^2}. \tag{6}$$

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

$$\rho_c = \frac{3H_0^2}{8\pi G}. \tag{7}$$

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 as the distance a 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.

III. SPACE VOLUME ABSORPTION AS A 'PHÉNOMENÈ PÉRIODIQUE SIMPLE'

We define the space volume doubling time τ_H as

$$\tau_H = \frac{ln(2)}{3} T_H = \frac{ln(2)}{3H_0} = 0.231 \cdot T_H, \tag{8}$$

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 $T_H = 14.0Gy$ and $\tau_H = 3,25Gy$.

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 [**?**] 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, 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

$$V_B = \frac{8\pi G h}{ln(2) H_0 c^2}. \tag{11}$$

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.

IV. POSSIBLE IMPLICATION

In this paper I propose that the de Broglie inner frequency reflects the *phénomenè périodique simple* of quantized space absorption, producing Newtonian gravity as a secondary effect. I do not suggest that space itself is similarly quantized, nor do I suggest that space expansion proceeds with equal space volume quanta.

But if Hubble space expansion can be speculatively imagined as produced by these quantized space-volume bubbles acting like living cells, with every bubble doubling at a random moment such that an overall space volume doubling time τ_H is realized on a cosmic scale, then a first hypothesis might be that these Hubble quanta have the same volume as the de Broglie space absorption quanta, V_B, so of the size of a large nucleus. If that would be the case, then an interesting dynamics between absorbing proton and to be absorbed quantized space bubbles should develop. The proton should first absorb the bubble it is in, thus destroying the space it occupies. Does it then temporarily vanish? Does it immediately reappear inside another bubble? If so, which other bubble? If not immediately, with what delay?

The ensuing dynamics between quantized metric and metric absorbing elementary particle has strong similarities with the Bohm-Vigier-deBroglie concept of the hidden sub-quantum medium [5]. The de Broglie's thermodynamics of the hidden sub-quantum medium could then be, or become, part of a theory of quantum gravity.

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[2] L. de Broglie, *Recherches sur la théorie des quanta*, these, Paris, 25 novembre 1924; Annales de Physique **10**, Tombe III, 22-128, (1925).

[3] E. P. J. de Haas, Ann. Fond. Louis Broglie **29** 707-725 (2004).

[4] G. Lochak, Ann. Fond. Louis Broglie **30** 115-117 (2005).

[5] L. de Broglie, Ann. Inst. Poincare (A). Physique theorique **1** 1-19 (1964).