Chronodynamics, cosmic space-time bubbles and the entropic 'Dark Matter' force as a galactic stabilizer

E.P.J. de Haas (Paul)

*Nijmegen, The Netherlands**

(Dated: October 4, 2015)

Abstract

In this paper I continue with the elementary particle Dark Matter halo model. The first few sections will shortly repeat the basics of this model. In section II I take a better look at the modified Newtonian potential as a consequence of the changed source mass. In section VI the effect of the modified potential on Einstein lensing is touched briefly. In sections VII and VIII the order stored in the frequency gauge of the de Broglie time devices in the outer galactic disks due to Dark Matter is related to entropy. The study of order stored in frequency synchronized or desynchronized time devices is called chronodynamics and this is added to the thermodynamics part of entropy. We show that in the inner galactic range thermodynamic entropy dominates chronodynamic entropy but that in the outer flat rotation curve part of the galactic disks the chronodynamic entropy dominates by far. We show that the chronodynamic entropy of a galaxy is lowest in its outer fringes and highest in its luminous center. This creates an inward entropic force and that is how the Dark Matter halo, through the intermediate of chronodynamic entropy, stabilizes galaxies. The frequency gauge of the de Broglie elementary time devices in the outer range of galactic disks creates a sort of a gauged time bubble in a cosmic time sea, a gauge regulated by the BTF relation. In the last section we relate this galactic gauged time bubble to GR as a reference frame independent theory of gravity.

* haas2u@gmail.com

CONTENTS

I. THE ELEMENTARY PARTICLE DARK MATTER HALO MODEL

It is common knowledge that a Dark Matter mass function linear in r can explain the flatness of galaxy rotation curves at large r. This is the empirical starting point of our Dark Matter model, as presented in [1], [2] and in [3]. We will shortly repeat the basics of our model. The original part of this paper starts at section VI. The core of this new paper is about chronodynamics and the entropic 'Dark Matter' force.

Given a rest mass m_0 at $r = 0$, it will have an additional spherical Dark Matter halo containing an extra mass, with Dark Matter properties only, in the sphere with radius r as

$$m_{\text{DM}} = \frac{r}{r_{\text{DM}}} m_0. \tag{1}$$

The Dark Matter radius r_{DM} should have a galaxy specific value somewhere in between 10 kpc and 20 kpc, so approximately once or twice the radius of an average luminous galaxy. As everything indicates that Dark Matter only interacts as being a source mass of gravity, this extra mass m_{DM} only comes into play when the rest mass m_0 acts as a source of gravity. So m_{DM} doesn't contribute to the inertial mass of m_0, nor does it contribute to its gravitational charge when acted upon by a force of gravity due to some other mass distribution acting as the source of gravity. In our model the total gravitational source mass m_g of an elementary particle m_0 contained within a sphere with radius r will then be given by

$$m_g = m_0 + m_{\text{DM}} = m_0 + \frac{r}{r_{\text{DM}}} m_0 = m_0 \left(1 + \frac{r}{r_{\text{DM}}}\right). \tag{2}$$

So the total gravitating source mass m_g of an elementary particle at rest inside a galactic sphere of radius r_{DM} wil be twice the original rest mass at $r = 0$.

In our model we identify the Dark Matter halo with the de Broglie matter wave medium. This assures our proposal to be in full accordance with Special Relativity and it gives our theory a direct link with the micro-physics of pre-spin Wave Quantum Mechanics. In our view we connect the de Broglie's later thoughts on the matter wave field as a subquantum thermodynamic medium to Verlinde's ideas of gravity as emergent from quantum information [4], [5]. Disturbances in the elementary Dark Matter halo as changes in probability densities of position and momentum of m_0 at $r = 0$ will travel with matter wave velocity through the halo, with the usual matter wave - particle relation

$$v_{wave} = \frac{c^2}{v_{particle}} \tag{3}$$

If the elementary particle has velocity zero, the disturbances at the source can travel instantaneously through the entire halo, producing a Newtonian instantaneous force field of gravity. Particles that will be kicked out of an original $r = 0, p = 0$ position and momentum and acquire a velocity approaching c from below will have a matter wave velocity approaching c from above and there will be a considerable delay regarding the Dark Matter halo adjustment to the new situation of the source particle and large retardation effects should be expected.

According to the basic hypothesis of de Broglie, every particle is associated with an elementary frequency ν_0 according to $h\nu_0 = m_0c^2$. Particles that move with velocity v and have an associated Lorentzian γ, will have clock frequency $\nu_c = 1/\gamma \cdot \nu_0$. In a previous paper I treated the behavior of such atomic clocks in Newtonian gravitational potentials as this was relevant for the GPS and Galileo like global navigation systems, with an approach based on Special Relativity and the Weak Equivalence Principle [6]. In this paper I will use those results in order to derive for example the bending of light as it passes through a Dark Matter halo.

As for the density function of Dark Matter, we start with the observations by astronomers. From a recent paper by Koopmans et.al. we quote: *In both spiral and elliptical galaxies with prominent baryonic components, there appears to be a conspiracy between dark-matter and baryons, leading to a nearly universal total mass distribution out to the largest measured radii that is very close to isothermal (i.e. $\rho \sim r^{-2}$), with only a small intrinsic scatter between systems [7].* The observation presented in the quote indicates towards some kind of a source like connection between baryons and their Dark Matter halo. The elementary particle Dark Matter halo mass content can been derived from a mass density that is inversely proportional to $4\pi r^2$. We accordingly define a Dark Matter halo mass density as

$$\rho_{\text{DM}} = \frac{m_0}{4\pi r^2 r_{\text{DM}}} \tag{4}$$

and then the spherically symmetric gravitational source mass m_g inside a sphere of radius r is given by

$$m_g = \int_V \rho_{\text{DM}} dV = \int_r \rho_{\text{DM}} 4\pi r^2 dr = \int_r \frac{m_0}{r_{\text{DM}}} dr = \frac{m_0}{r_{\text{DM}}} r + m_0 \tag{5}$$

with the last factor as the obvious constant of integration, given the starting point of our model that we have $m_g = m_0$ at $r = 0$.

II. FROM SOURCE TO POTENTIAL IN AN SRT - WEP APPROACH TO GRAVITY

In the Newtonian approach to gravity one starts with two masses separated by a distance r and then writes down the Newtons force equation, an instantaneous force in absolute space and time. Only afterward are the concepts of energy and gravitational potential introduced. In a relativistic Maxwellian approach to electromagnetism however, one starts with a source charge, calculates the potential as a field in space, connects it to the energy of a charge located in this field and only then the force on the charge in the field is derived. Usually the direction of the procedure doesn't matter, it is reversible. But sometimes it does matter and then the way from the first charge to potential to force on the second charge differs from the method that goes from two charges with a force to the potential of the one charge in the field of the other charge. In GR, the analysis goes from a source mass to the curvature of space-time by this source. Then a second mass, the charge, is placed in this curved space-time and it will follow a path in this metric. In my approach I use the SR analogy of EM and GR by going from source to potential to force and not from source to force and then to the potential. So my approach will by a hybrid of Newton, Maxwell, SR and GR principles. The justification lies in the attempt to understand a bit more of Dark Matter.

Given the definition of the gravitational potential as

$$\phi = -\frac{GM}{r} \tag{6}$$

with gravitatinal source mass M as

$$M = M_0 + \frac{rM_0}{r_{\text{DM}}} \tag{7}$$

we get a gravitational potential at r as

$$\phi = -\frac{GM_0}{r} - \frac{GM_0}{r_{\text{DM}}} = \phi_0 + \phi_{\text{DM}} \tag{8}$$

For the resulting force of gravity on a classical mass m we get the Newtonian result

$$\mathbf{F} = -m\nabla\phi = -m\nabla\phi_0 + -m\nabla\phi_{\text{DM}} = -m\nabla\phi_0 = \frac{GM_0m}{r^2}\hat{r}. \tag{9}$$

This is due to the fact that the new mass factor varies linear over r and thus results in a additional potential term that is constant. Our Dark Matter halo acts as a gauge term in

the source that produces a constant term ϕ_{DM} in the potential and thus has zero effect on the force. This means that our model is not a MOND theory, we do not modify Newtonian Dynamics. Nor do we modify General Relativity. But we do change the traditional approach to gravity because if we go from our source to the force and then to the potential, we would get the potential

$$\phi(r) = -\frac{GM_0}{r} - \frac{GM_0}{r_{\text{DM}}} - \frac{GM_0}{r_{\text{DM}}} \ln\left(\frac{r}{r_{\text{DM}}}\right). \tag{10}$$

This potential doesn't produce the velocity curve over the whole distance range and cannot be used over a wide range on the curve. It also has an unphysical zero potential at $r = r_{\text{DM}}$. So in our model we will only use the potential of Eqn.(8), the one that is derived directly from the source mass.

III. FROM POTENTIAL TO GALACTIC ROTATION CURVE

Although the extra term in m_g doesn't effect Newtons force law of gravity, it is effecting the gravitational energy of a satellite mass m in the field of a source mass M. This gravitational energy is given by

$$U_g = m\phi = m\phi_0 + m\phi_{\text{DM}} = -\frac{GM_0 m}{r} - \frac{GM_0 m}{r_{\text{DM}}}. \tag{11}$$

Now we assume that the virial theorem is still valid, that it is more fundamental than the force analysis from which it was originally derived. Using $2U_k = -U_g$ we get $v^2 = -\phi$ for orbiting satellites and

$$v^2 = -\phi = \frac{GM_0}{r} + \frac{GM_0}{r_{\text{DM}}}. \tag{12}$$

If we let $r \to \infty$ then

$$v_f^2 = \frac{GM_0}{r_{\text{DM}}}, \tag{13}$$

which is a constant, the galaxy rotational velocity curves' final constant value. In Fig.(1) the result is compared to the Newtonian virial expectation for v.

This result also allows us to give an estimate of r_{DM} by applying this to the Milky Way galaxy. We get

$$r_{\text{DM}} = \frac{GM_0}{v_f^2} \approx \frac{6,67.10^{-11} \cdot 1,99 \cdot 10^{30} \cdot 1,4.10^{11}}{(230.10^3)^2} = 3,5.10^{20} m = 11,4 kpc. \tag{14}$$

Actual galaxy velocity rotation curves vary considerably from our model with its point like mass distribution. Real galaxies have disk like or spherical like mass distributions which

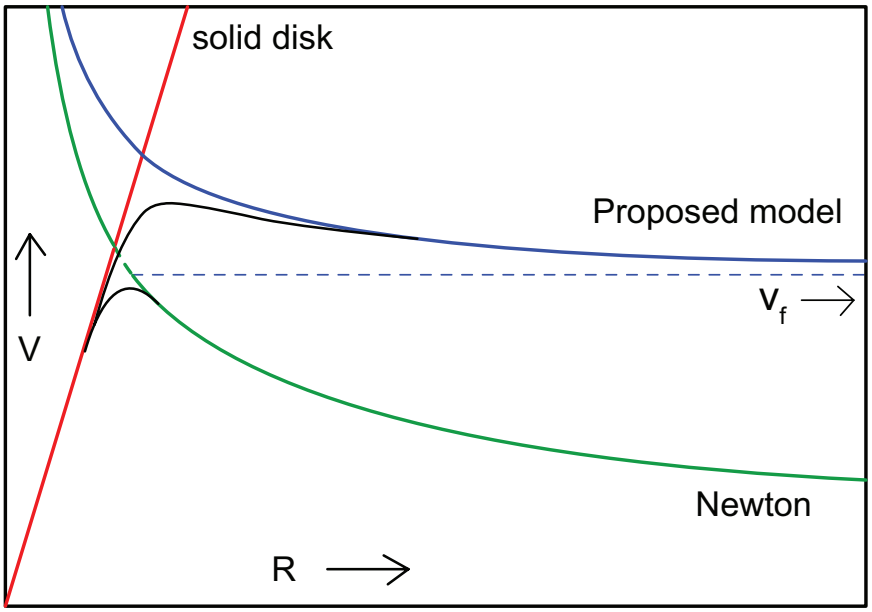

FIG. 1. Rotation velocity versus radius curves with the Newtonian and our new model expectation.

cause deviations from our single particle model. But given the luminous mass distribution, the associated galaxy Dark Matter halo as a summation over all the elementary particle Dark Matter halo's should be computable using Eqn.(4) with the value of r_{DM} as calculated in Eqn.(14).

IV. THE GALACTIC DARK MATTER CONSTANT $r_{\mathbf{dm}}$ AND THE BARYONIC TULLY-FISHER RELATION

The question whether the Dark Matter radius r_{DM} is a galaxy specific constant or that it might even be a universal constant can be answered using the Baryonic Tully-Fisher relation, BTF. The fundamental relation underpinning the Tully-Fisher relation between galaxy luminosity and rotational velocity is one between final rotation velocity v_f and total baryonic disk mass M_d. In the 2005 paper of McGaugh the baryonic version of the LT relation has the form

$$M_d = 50 v_f^4, \tag{15}$$

see [8] and Fig(2). In this form, M_d is expressed in solar mass $M_\odot = 1,99 \cdot 10^{30} kg$ units and the final velocity of the galactic rotation velocity curve v_f is expressed in km/s. If we express the galactic mass in kg and the velocity in m/s we get the total baryonic mass, final

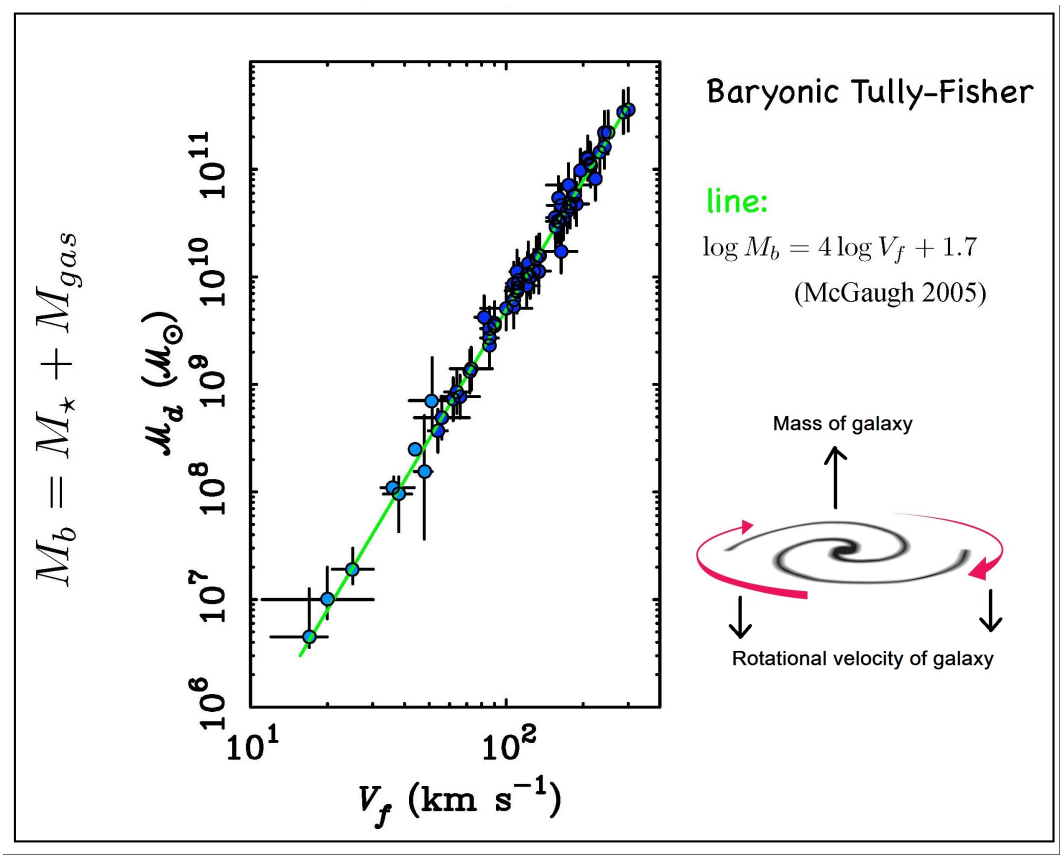

FIG. 2. The graph for the Baryonic Tully-Fisher relation from McGaug.

velocity relations in SI units as

$$M_b = 1,0 \cdot 10^{20} v_f^4. \tag{16}$$

In order to interpret this emperical result in the context of our model we start again with Eqn.(11)

$$U_g = U_b + U_{\text{DM}} = m\phi_b + m\phi_{\text{DM}} = -\frac{GM_b m}{r} - \frac{GM_b m}{r_{\text{DM}}}. \tag{17}$$

With $r \gg r_{\text{DM}}$ this approaches

$$U_g \approx U_{\text{DM}} = m\phi_{\text{DM}} = -\frac{GM_b m}{r_{\text{DM}}}. \tag{18}$$

and with the virial theorem we get for $r \gg r_{\text{DM}}$ the Dark Matter virial theorem

$$v_f^2 = \frac{GM_b}{r_{\text{DM}}} \tag{19}$$

which combines with Eqn.(16) to

$$v_f^2 = 6,64 \cdot 10^9 \frac{v_f^4}{r_{\text{DM}}} \tag{20}$$

and this leads to

$$a_{\text{DM}} = \frac{v_f^2}{r_{\text{DM}}} = 1,5 \cdot 10^{-10} \frac{m}{s^2} \tag{21}$$

This relation with $a_{\text{DM}} \approx 2 \cdot 10^{-10} \frac{m}{s^2}$ was first obtained by Milgrom in 1983 in his second MOND paper [9]. In our model this acceleration is not caused by a modified Newtonian force equation but derived from the energy expression of the virial theorem, in a situation where the derivative of the potential, the real force, should be near zero.

The result allows us to determine the galaxy specific r_{DM} for every galaxy with known v_f without knowledge of the galactic baryonic mass as

$$r_{\text{DM}} = \frac{v_f^2}{a_{\text{DM}}} = \frac{v_f^2}{1,5 \cdot 10^{-10} \frac{m}{s^2}} \tag{22}$$

leading to

$$m_g = m_0 + m_{\text{DM}} = m_0 \left(1 + \frac{a_{\text{DM}}}{v_f^2} r\right). \tag{23}$$

and

$$\rho_{\text{DM}} = \frac{m_0 a_{\text{DM}}}{4\pi r^2 v_f^2} \tag{24}$$

with m_0 as the individual baryonic particles in the specific galaxies.

V. THE GALACTIC ROTATION CURVE EQUATION AND DARK MATTER

The combination of the BTF relationship and our energy equation leads to

$$v(r)^2 = \frac{GM_b(r)}{r} + \frac{GM_b(r)}{r_{\text{DM}}} = GM_b(r)\left(\frac{1}{r} + \frac{1}{r_{\text{DM}}}\right) = GM_b(r)\left(\frac{1}{r} + \frac{a_{\text{DM}}}{v_f^2}\right). \tag{25}$$

With galaxy mass distribution dependent Newtonian rotation velocity v_{N} this leads to a velocity function as

$$v(r) = \sqrt{\frac{GM_b(r)}{r}} \cdot \sqrt{\left(1 + \frac{a_{\text{DM}} r}{v_f^2}\right)} = v_{\text{N}}(r, M_b(r)) \cdot \sqrt{\left(1 + \frac{a_{\text{DM}} r}{v_f^2}\right)} \tag{26}$$

also given as

$$v(r) = v_{\text{N}}(r, M_b(r)) \cdot \sqrt{\left(1 + \frac{r}{r_{\text{DM}}}\right)} \tag{27}$$

A more exact function isn't possible because $M_b(r)$ is an empirical input. This new velocity curve function of Eqn.(27) can be tested, . This is a falsifiable/verifiable prediction of my model.

It might however be that the best way to match the velocity curve will need the density formula and then the calculus will become way more complicated. The formula Eqn.(27) assumes a spherical symmetry. The Milky Way is a disk with a bulge, a bar and spirals, so it isn't spherically symmetric and the density formula might have to be used for a real thorough test. Every good theory usually has a smart way out, towards more complicated mathematics resulting from the confrontation of the principle with reality.

VI. THE RADIAL VELOCITY OF LIGHT AND GALACTIC EINSTEIN LENSING

In our paper [6] we used Newton's gravitational potential ϕ, SR and WEP to derive the radial speed of light in a central field of gravity as

$$c_\phi = \frac{1}{\gamma_\phi^2} c_0 \approx \left(1 + \frac{2\Phi}{c^2}\right) c_0 = \left(1 - \frac{2GM}{rc^2}\right) c_0 < c_0 \tag{28}$$

with an escape velocity defined γ_ϕ as related to the free fall from infinity velocity v_{ff} in a field ϕ

$$U_k = (\gamma_\phi - 1) m_0 c^2 = -m_0 \phi = U_g \tag{29}$$

used in the above equation. This lead to the Shapiro delay and to the gravitational index of refraction. The last is then given by

$$n_\phi = \frac{c_0}{c_\phi} = \gamma_\phi^2 \approx 1 + \frac{2GM}{rc^2} > 1 \tag{30}$$

explaining the bending of light rays that pass by close to the sun.

If we simply apply the same procedure to our Dark Matter halo's potential, we get and extra term ϕ_{DM} in the radial velocity of light in the Dark Matter halo as

$$c_\phi = \frac{1}{\gamma_\phi^2} c_0 \approx \left(1 + \frac{2\Phi}{c^2}\right) c_0 = \left(1 - \frac{2GM}{rc^2} - \frac{2GM}{r_{\text{DM}} c^2}\right) c_0 \tag{31}$$

so now even far away from the gravitating baryonic mass, will there still be Einstein lensing as

$$c_\phi = \left(1 - \frac{2GM}{r_{\text{DM}} c^2}\right) c_0 \tag{32}$$

with a Dark Matter outer halo constant index of refraction as

$$n_{\text{DM}} = 1 + \frac{2GM}{r_{\text{DM}} c^2} = 1 + \frac{2v_f^2}{c^2} \tag{33}$$

where we used the final velocity of the rotation curve v_f.

For a galaxy as the Milky Way, this has the value $n_{\text{DM}} = 1,0000012$. This is a small value, but because the distances are so huge, the effect can still be pronounced. If we use the standard equation for the bending angle we get

$$\theta_{\text{DM}} = \frac{4r_{\text{DM}}}{b} \cdot \frac{2v_f^2}{c^2} \tag{34}$$

which, for our galaxy and a light ray passing at $b = 4r_{\text{DM}} \approx 45kpc$ results in a bending angle of $1,2 \cdot 10^{-6}$ rad.

This approach neglects the complications regarding free fall from infinity in a situation with a rotating galactic disc due to the constant term in the potential. We expect a correction to be necessary. But our approach indicates what can be expected regarding Einstein lensing and Shapiro time delay effects in the outer Dark Matter halo's.

An interesting question arises. How far out does galactic lensing occur? Or, when do outer cosmic influences become more prominent than the constant potential galactic halo? What happens when galaxies cluster? This however goes outside the topic of this paper, which is constrained to galactic issues regarding Dark Matter.

VII. THE FREQUENCY GAUGE AND CONNECTED LOW ENTROPY OF THE GALACTIC OUTER DISK AS A GALACTIC STABILIZER

In the paper we mentioned before, see [6], we used a grid of Einstein Elevators equipped with highly accurate atomic clocks producing a standard proper frequency in its own gravity free rest frame. By means of this grid we looked at the GPS system and its problems regarding time keeping.

We used the Newtonian potential fixed to earth and combined this with the fact that at infinity, the atomic clock in the Einstein Elevator at rest would have proper frequency ν_0. So a free fall Einstein Elevator, starting at rest in infinity, would all the way down remain frequency gauged to a clock that remained at rest in infinity. From this we constructed a frequency gauged free fall grid, which we applied in such a way that the results from GR that are used in the GPS system came out without the need for GR. See Fig.(3).

Now if we look at a galaxy like the Milky Way with a Black Hole at its center and a Dark Matter halo in the outer disk and beyond, this approach will not work because this

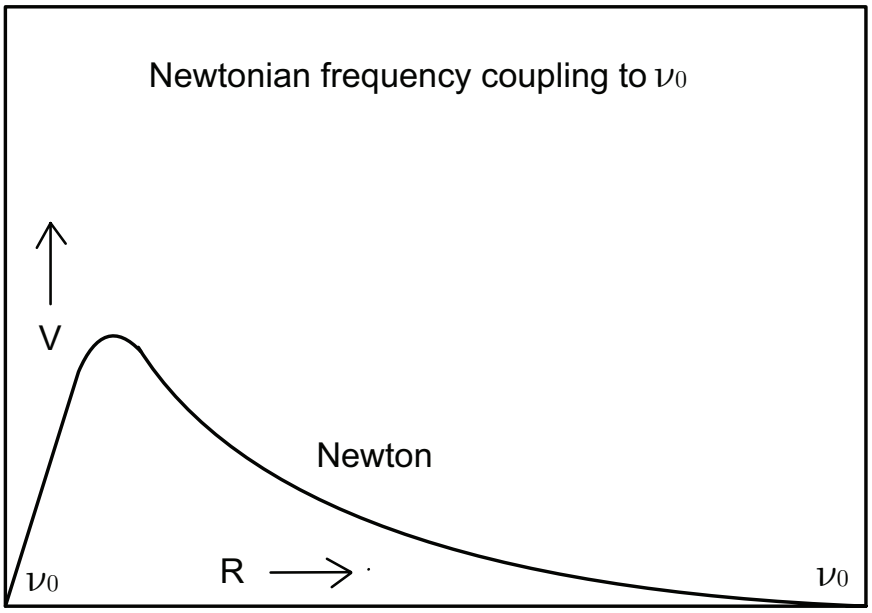

FIG. 3. Newtonian rotation velocity with proper frequency ν_0 at $r = 0$ and $r = \infty$.

galaxy is decoupled from the proper frequency, see Fig.(4). But this same galaxy has a most remarkable property: its outer disk and far beyond is completely frequency gauged without any engineering effort, due to the Dark Matter halo, see Fig.(5). In gravity, only a non-zero constant potential can achieve this kind of situation. If the earth had a Dark Matter halo like our galaxy, life for GPS engineers would be a lot less complicated.

Now we go back to the beginning of this paper where we identified the Dark Matter halo as the matter wave field of de Broglie and as somehow related to his elementary particle frequency ν_0 according to $h\nu_0 = m_0c^2$. Those particles while moving with velocity v have an associated Lorentzian γ and clock frequency $\nu_c = 1/\gamma \cdot \nu_0$. We connected this Dark Matter halo approach to Eric Verlinde's theory of entropic gravity and to de Broglie's later ideas regarding the subquantum thermodynamic turmoil.

Then recall that GPS engineers spend much energy and effort in achieving a frequency gauged network of satellites around the earth. A frequency gauged network of satellites is a highly ordered system, allowing lots and lots of highly coordinated actions on earth. Losing this network would implicate a return to chaos, or even worse because the pre-GPS world wasn't counting on such a system, so the collapse of it would create a peak in chaos with a slow return to a less pre-GPS kind of chaotic, uncoordinated situation. Imagine the amount of order that is represented by an entire outer galactic disk in a frequency gauged mode.

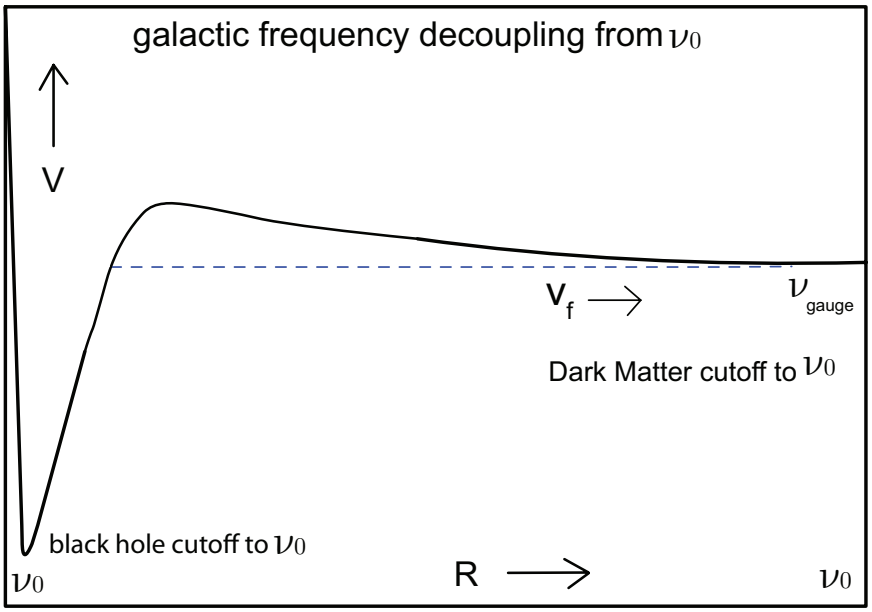

FIG. 4. Galactic rotation velocity with decoupled proper frequency ν_0 at $r = 0$ and at $r = \infty$.

The outer baryonic regions of galaxies are populated with huge gas clouds mainly consisting of neutral hydrogen. Those clouds all rotate with v_f, so with a flat average frequency gauge. By falling inwards, these gas clouds could loose their frequency gauge and thus enter a region with less order and more chaos. All these outer galactic disk atoms have an averaged internal de Broglie clock according to $\nu_c = 1/\gamma_\phi \cdot m_0c^2/h$ and $\gamma_\phi \approx 1 - \phi_{DM}/c^2$. The word 'averaged' is in place because the atoms in these gas clouds also have an internal motion constituting their temperature. A de Broglie wavelength due to this rotation with velocity v_f is added to this clock-time as $\lambda_\phi = h/(\gamma_\phi m_0 v_f)$. This clock frequency and wavelength synchronization has to be perceived as a state function, a thermodynamic property that adds to the entropy of the system.

Imagine a room full of military officers about to engage in battle. Their clocks are still these mechanical devices, that have significantly different frequencies and therefore need to be set 'on time' regularly. In order to have a better coordination of their actions, they all set their clocks to the time of one of them, the master clock. Thermodynamically, nothing has changed in this room. But from a time perspective, entropy has decreased and this decrease in entropy is connected to the real world of better coordination of actions on the battlefield, to a really occurring higher order of events. Now imagine that all these clocks function on the same 'function of state' frequency. Then this action of setting the clocks

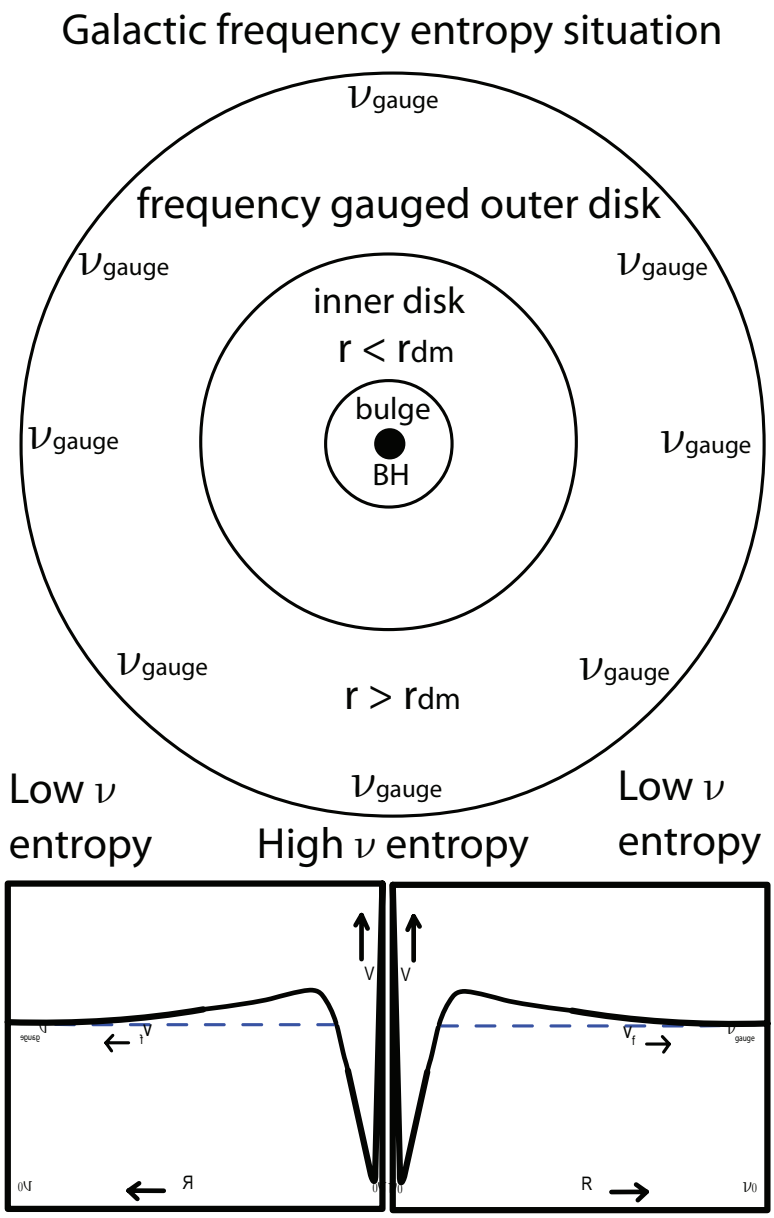

FIG. 5. Galactic disk with frequency gauged halo as a bubble of high frequency entropy freely floating on its, baryonic mass determined, gauge in cosmic space-time.

to a standard clock be much less necessary. Chronodynamic entropy is a real thing in the world of humans. It involves the coordination of actions and in a four dimensional world also the localization of these actions. The entropy of coordination and localization or space-time entropy is what is our global positioning systems like GPS and Galileo are all about. The goal of those systems is to achieve a world with less chronodynamic entropy, so with a higher order regarding the localization and coordination of human actions. Dark Matter has the

same effect on the galactic scale, it is the galactic GPS system-builder.

Through chronodynamic entropy, Dark Matter stabilizes the galaxy. Where from a particles ordinary thermodynamic temperature properties point of view the disorder can be found outwards, from a time-device perspective, the disorder is to be found inwards, towards the center of the galaxy. Temperature devices and time-devices have opposite interests regarding the direction where to find higher entropy. By means of the Dark Matter halo's frequency gauge reaching far outside the baryonic disk, a galaxy creates it's own bubble of chronodynamic entropic inwards stability. So if we want to be the bookkeepers of our galactic entropy we need to add the art of chronodynamics to the known thermodynamics. And in our hypothesis regarding the Dark Matter halo as being equal to or consisting of the de Broglie matter wave subquantum medium, we should add now that in our model it is the medium where galactic bookkeeping regarding chronodynamic entropy is being realized.

VIII. CHRONODYNAMICS, THE ENTROPIC 'DARK MATTER' FORCE AND MOND

It is the constant velocity in the outer regions of a galaxy that creates the frequency gauge and also sets the gauge through the relation between clock and proper frequency as: $\nu_c = 1/\gamma_{\text{DM}} \cdot \nu_0$. The constant Dark Matter halo potential and related virial theorem caused final velocity determine this γ factor. And according to de Broglie, every elementary particle with a rest mass m_0 has such a clock like devise on board and is an ordered time devise in the outer galactic disk.

If we look at the neutral hydrogen one clouds in the outer ranges of galactic disks, they usually preside in the outer constant velocity curve region of their galaxy. The huge cold gas clouds have a highly synchronized velocity and a low temperature of $\approx 100K$. This means that these atoms have a Dark Matter or chronodynamic average velocity of $230km/s$ in the galactic disks plane perpendicular to the axis and a thermodynamic average velocity of $1.6km/s$ in all possible directions added to this. Another way to put the relative importance of chronodynamics and thermodynamics in perspective in the outer galactic disk is by calculating the temperature equivalence of this $v_f = 230km/s$. This turns out to be $T_f = 6,4MK$, resulting in a $T_f/T_H = 64k$. Of course, galactic disk inwards this ratio falls of dramatically and in the bulge chronodynamics plays hardly any role of significance regarding

the total entropy. But by then, the role of the Dark Matter halo has already been fulfilled by getting all that matter in there in the first place.

The further out of the galactic disk the neutral hydrogen gas clouds move, the flatter the potential and the velocity curve and the lower the temperature. This promotes time accuracy and synchronization even further. The entropy decrease connected to this process of frequency synchronization is connected to a temperature velocity distribution around the mean rotational velocity. Moving outwards, the importance of the chronodynamic entropy increases and this entropy continues to decrease, creating an inward entropic force. (According to Wikipedia, *in physics, an entropic force acting in a system is a phenomenological force resulting from the entire system's statistical tendency to increase its entropy, rather than from a particular underlying microscopic force.* [10])

The time-gauge bubble of a galaxy thus creates a stabilizing inward osmotic force. If one would look at the galaxy rotation curves from a force perspective only, a deviation from the Newtonian force law should be detectable representing exactly this entropic force. But no fundamental, principled derivations should be possible to explain this modified Newtonian dynamics or MOND. It should be phenomenological only. If that is the case, then this deviation from Newtonian dynamics is surely entropic. In our perspective, only through the combination of thermodynamic and chronodynamic entropy calculations can MOND be rationalized, explained. And this entropic force should then not be used to derive Einstein lensing and other phenomena related directly to the Dark Matter halo's potential function. MOND is our primary way towards a better understanding of chronodynamic entropy. More accurately, MOND will teach us things about the interplay of thermodynamics and chronodynamics in the new area of galactic entropy. Put in a simple equation, we have

$$F_{MOND} - F_{Newton} = F_{Entropic}, \tag{35}$$

at least as far as our model is used. In our perspective, MOND is a phenomenological theory only, crucial for a better understanding of total galactic entropy. We should put MOND to use to get a better understanding of galactic chronodynamics.

IX. THE FREQUENCY GAUGE, THE BARYONIC TULLY-FISHER RELATION AND GR

In relativistic gravity, mass sets clock-frequencies. So the BTF relation is no exception, it is a recipe of how the baryonic mass of a galaxy sets the frequency gauge of its outer disk, see Fig.(2). And because every galaxy has it's own baryonic mass, all galaxies have different gauges, are decoupled from one another in proper time. Each galaxy has it's own frequency gauged time-device bubble in the cosmos, its own floating device or rescue band in space-time, created by means of the Dark Matter halo, see Fig.(4) and Fig.(5).

The Newtonian potential on the other hand fixes a central mass to an absolute proper time frequency ν_0 at $r = 0$ and $r = \infty$, see Fig.(3). Newton presupposed absolute Time, the Newtonian gravitational potential presupposes the absolute proper frequency ν_0 of the Cosmos to exist at $r = 0$ and $r = \infty$. Our solar system actually floats upon the Milky Way's frequency gauge, or on the beginning of it, so we can safely replace Newtons ν_0 by ν_{gauge} for the solar system in figure (3). At least as long as we realize that we are at approximately $r = 8kpc$ from the center and $r_{\text{DM}} = 11.4kpc$ for our galaxy, which means that we are still in the inner disk where the gauge is not yet strongly established.

If you look at the preferred frame of reference, as regards to frequencies this would be achieved by related our time-keeping-devices' frequencies to objects in the outer disk of our galaxy. Objects in that outer disk are the ideal GPS satellites of our Galactic Positioning System. From the frequency gauge perspective, this frequency gauge should not have an end. If the Milky Way was the only galaxy in the universe, its own frequency gauge would be the cosmic frequency, not the proper frequency. In this way, the baryonic mass inside a galaxy isn't connected to an absolute time frame as a solid ground but to the time-gauge of the outer disk, on which it clings or floats. But galaxies aren't alone, they are with billions. The BTF relation then achieves two things: every galaxy has an outer disk frequency gauge uniquely related to its baryonic mass (no Dark Matter needed); so the frequency gauges of different galaxies are decoupled from each other. But this decoupling-scale is a universal one, the BTF relation, valid for galaxies of all sizes in the entire universe. In this perspective, Dark Matter is just the constant potential added to Newton's, thus creating this BTF frequency gauge system.

I now we look at General Relativity, in this space-time theory of gravity reference frames

are already decoupled from absolute time by axiomatic principle. And the way this was achieved was a long time before the discovery of the missing mass or Dark Matter problem in astronomy. Also way before the phenomenological discovery of the BTF relation. According to my analysis, Dark Matter and the BTF relation are Nature's way to decouple galaxies as reference frames from absolute space-time frequencies or time-devices. The question arises, do GR's axiom's and Nature's DM and BTF match?

Suppose that these two solutions to the same problem do not match, don't translate into another. If that would be the case, we have a problem. Because then GR already solved the problem hundred years ago in it's own unique way and they do not need Nature's solution at all. Then GR theorists do not understand the problem for which Nature uses BTF or for which BTF is Nature's solution, because they already solved that problem a long time ago. This would make them blind to what is going on regarding Dark Matter and the BTF relation. In that case, Einstein's GR was too much too early.

Dark Matter is actually Nature's way to solve this time problem on a cosmic scale, the problem that Einstein solved axiomatically with GR even before it was needed in experimental astronomy: how to decouple gravitational reference frames from Newtonian absolute time. So because GR already solved that problem mathematically, the GR guys don't understand Dark Matter as Nature way to solve that problem in the real world. For them, the problem doesn't exist in GR so there is nothing to solve. In that perspective, for GR theorists, Dark Matter would just be a nuisance.

If we make one extra leap, on a cosmic scale all these frequency gauged halo's meet and mingle. It is on this scale than eventually Dark Energy is needed. If Dark Matter halo's do not have an end because they are just the reflection of a frequency gauge, then the cosmic dance of all these DM halo's might well be the reason of existence for Dark Energy. On that scale, the space-time decoupling problem has been solved and GR should probably be able to do it's thing as a useful part of a cosmology.

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