GALAXY ROTATION CURVES TRACED OUT BY THE THEORY OF RELATION

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ABSTRACT

Astronomers know since the 1930s that the universe contains more than what meets the eye. Galaxies within clusters of galaxies and stars within galaxies are moving around faster than the gravity of the visible matter would imply, indicating that a huge amount of invisible matter is pulling on them. The theory of Relation asserts that there are two structures going in opposite directions, the expansion and the condensation, and also, by means of the principle of Compensation (CP), that the loss of negative energy of the expanding electromagnetic (EM) wavelength of flat spacetime is transformed into positive matter and gravific spacetime. The universal expansion decelerates, unlike the current single thought, and is counterbalanced by a continual growing global mass; a perpetual creation of ordinary and dark matter within an incessant big bang process. The global deceleration takes the form of a local acceleration of every galaxy towards the internal center, a change of direction from the periphery to the center. It was noted that the order of magnitude − around 10^{-10} m/s^2 − of the abnormal rotation curves observed on the remote galaxies is similar to that of the universal deceleration *Hc* and not far of the anomalous gravitational variations measured for several years on Pioneer probes using Doppler information.

I - INTRODUCTION

The Swiss astronomer Fritz Zwicky had argued since the 1930's for the existence of unseen matter, based on the unusual motion of galaxies. Galactic mass appears concentrated towards the center and diminishes towards the periphery. And yet the stars at the periphery move as if they are embedded in much greater mass; so much, in fact, that this unseen mass must extend far beyond the periphery. If this inference is correct, then galaxies are truly not what they seem; the visible part − the stars we see − must be swamped by cloaks of unseen matter. Such a notion was so far outside conventional theory that it wasn't taken seriously. In 1974, Jeremiah Ostriker, James Peebles, and Amos Yahi at Princeton University predicted that something like dark matter must exist. Their calculations on the gravitational stability of spiral galaxies implied that such structures would fragment as they rotated, because of vibrations triggered by their uneven composition. If, however, the visible disk was embedded in a much larger and unseen mass, then such vibrations would be damped, and the spiral would remain stable. The very existence of our Milky Way implies the reality of unseen matter, they surmised. In 1978, V. Rubin and K. Ford collected data on ten galaxies emerging with this pattern: Stars at the periphery of spiral galaxies move too fast − if one assumes the luminous part of these galaxies represents their entire mass [1].

In 1983, Vera Rubin noted the anomaly is that the rotational velocity v of many galaxies is constant out to the edges of those galaxies. The rotational velocity v of stars appeared the same at all distances *r* from the galactic centers, except for the galactic nuclei themselves.

This means that whatever is r ($r1$, $r2$, $r3$, $r4$, $r5$) out to the edges of many galaxies, the rotational velocity and also the acceleration a of stars appeared the same at all distances from the galactic centers. The rotational velocity versus distance from the galactic centers gave flat rotation curves that precipitated the missing mass scenario. The high quality of Rubin and Ford's data, and the fact that for years there had been scattered suggestions from observation to the effect that spiral galaxies are surrounded by dark halos which are up to thirty times the diameter of each visible galaxy, were important factors in the rapid acceptance of the reality of dark matter. The «dark matter problem» arises because the mass visible (the total of stars, gas and dust detected at all wavelengths) in large scale dynamical systems is up to one hundred times lesser than the mass inferred from their dynamics. This «dynamical discrepancy» remains unresolved today [2]. In principle there are two classes of possible solutions: either there is a huge quantity of unseen matter of unknown type in large scale astrophysical systems, or Newton's law of gravity and Einstein's General Theory of Relativity need to be revised or replaced**.**

M. Milgrom suggested that the theories of gravity were incomplete, that Newton's law of gravitation failed at galactic scales, and advanced a Modified Newtonian Dynamics (MOND) [3] approach where gravity is modified according to a scale of acceleration, without the intervention of dark matter. The value of the critical acceleration is: $a_o = 1{,}2 \times 10^{-10}$ m.s^{-2}. The theory has produced a good agreement with data since its introduction in 1983, but the lack of a physical mechanism has been a major drawback to its general acceptance, so an alternative approach was pursued. It claimed that rotation curves could be accounted for if galaxy mass m increased linearly with distance r from center. The mass distribution indicated by luminous matter gave a vastly different arrangement of matter. It was concluded that there must be a hidden mass existing on larger scales of galaxies in order to match the rotation curves with a suitable matter distribution. However, the search for such «dark» or «missing» matter since the mid 1980's has been largely unsuccessful. In this paper we are considering in part ll the relation between the rotations curves of galaxies, the expansion of the universe and the Pioneer effect. There is also an approach to gravitation using the theory of Relation and the principle of Compensation. In part lll there is an additional term ΔM in the Newtonian equation for gravitational acceleration. In lV we speculate on the nature of dark matter, dark energy and «dark spaces».

ll - RELATION BETWEEN THE ROTATIONS CURVES OF GALAXIES, THE EXPANSION OF THE UNIVERSE AND THE PIONEER EFFECT

The galaxy rotation problem is that the observed velocity of stars and gas beyond a distance of one to three kiloparsecs from the center of spiral galaxies is found to be constant and independent of the distance to the galactic center, contrary to the predictions of Newtonian dynamics. Galaxies are gravitationally bound and their outer members revolve considerably faster than Newton's laws say they should. To make the calculations agree with what is observed, astronomers have been forced to assume that immense amounts of invisible matter surround all galaxies. An approach of the gravitation by using the theory of Relation and the principle of Compensation shows that there is an additional term in the Newtonian equation for the gravitational acceleration. In a previous article [4], we have describe the concepts and the principle of the theory of Relation in order to give a solution to the observed deviation from expectations of the trajectories of various unmanned spacecraft visiting the outer solar system, notably Pioneer 10.

Recall that the theory of Relation gives an interaction between the electromagnetic (EM) spacetime of expansion and the gravitational matter of condensation. We initially assumed that our universe is made of two complementary and interpenetrated structures, one for condensation with a gravific spacetime and EM matter (Einstein), the other for expansion with a flat EM spacetime and ordinary matter (Lorentz-Maxwell). The theory asserts that the energy density of the vacuum is negative and is associated with a positive pressure which drives a decelerated expansion. This universal deceleration is accompanied, in virtue of the principle of Compensation, with a continual growing global mass: it is a continual creation of matter inside an after-big bang process. Both structures run in opposite directions, so the outwards deceleration of the global expansion could be interpreted as a local inwards acceleration of each galaxy towards its center; a change of direction of outer stars and gas towards the bright luminous disc.

The observed anomalous rotation curves of galaxies are about the same order of magnitude than the universal deceleration $Hc \approx 10^{-10}$ m/s^2. Hubble discovered that spectra of distant galaxies are red-shifted proportional to the independently estimated distance to the galaxies. A plausible model of this effect is that the universe is expanding uniformly. Freedman et al. [5] estimated the expansion rate (Hubble constant) H as 72 ± 8 km per second per megaparsec, or $2.33 \pm 0.26 \times 10^{-18}$ sec^{-1} ($Hc = \sim 7 \times 10^{-10}$ m/s^2). In virtue of the principle of Compensation, the deceleration of the expansion would cause the anomalous acceleration towards the center of the galaxy (change of direction of the curves swept by distant stars) [6]. Notice that it is also the order of magnitude measured by the gravimeters during the solar eclipses (Allais effect) [7, 8] and that of the spacecrafts anomaly [9].

The Pioneer anomaly is seen in radio Doppler and ranging data, yielding information on the velocity and distance of the spacecraft. The Pioneer 10 spacecraft, at a distance from the Sun of about 67 astronomical units (AU) or 1.0×10^{13} m, experiences a measured acceleration towards the Sun of 1.32×10^{-6} m/s^2, which is $8.74 \pm 1.33 \times 10^{-10}$ m/s^2 less than the Newtonian model [10]. So when all known forces acting on the spacecraft are taken into consideration, a very small but unexplained force remains, causing a constant sunward acceleration of $(8.74 \pm 1.33) \times 10^{-10}$ m/s^2 [11]. The magnitude of Pioneer effect is numerically quite close to the product of the speed of light and the Hubble constant.

Let us be more specific about the galaxies:
Firstly, galaxies, globally, follow the structure of the decelerated expansion. Their recessional velocity is decreasing. They are loosing ground compared to the current theory of an accelerating universe. The redshift seems to be higher not because of Hubble effect (speed is slower) or Doppler shift, but due to tired-light effect [12].

Secondly, what is important to say is that the mass of the galaxies increases with the cosmological time and the expansion. The mass of the universe is growing with the cosmological time. This is equivalent to a continuous creation of matter in a dynamics of big bang. To corroborate this augmentation, let us say that recently, researchers using a NASA ultraviolet space telescope named GALEX (Galaxy Evolution Explorer) have discovered stars in extreme galactic environments where star formation is not supposed to happen. The observatory, launched in 2003 on a mission to study how galaxies change and evolve as new stars coalesce inside them, is super-sensitive to the kind of UV rays emitted by the youngest stars. It found not only stars forming far outside the gassy disk of distant spiral galaxies, but also stars being born in elliptical and irregular galaxies thought to be gas-poor, in the gaseous debris of colliding galaxies, in vast «comet-like» tails that trail behind some fast-moving galaxies, in cold primordial gas clouds, which are small and barely massive enough to hang together [13]. Our interpretation is that the negative EM wave of expansion decelerates inducing gravity and acceleration towards the galactic center. Around the galaxy there is a dark negative energy halo constituted either of black «void space» or of gravitational dark matter. The level of this negative energy diminishes and induces gravity towards the center of galaxy; the abnormal acceleration in the outskirts of the galaxy results from a change of direction around the galactic center caused by this dark peripheral substance.

Thirdly, the principle of Compensation asserts that the permanent loss of negative energy of the expanding EM wavelength of spacetime induces the positive matter and the gravific spacetime:

$$\mathrm{t}c_{\mathrm{em}} = \mathrm{h} / mc = \mathrm{GM} / c^2 \qquad (1)$$

[*m* decreases on the structure of expansion; M increases on the structure of condensation].

In virtue of the principle, the energy lost by m on the structure of expansion is recuperated by M of GM / c^2 on the structure of condensation. Here, $\mathrm{t}c_{\mathrm{em}} = \mathrm{h} / mc$ represents the cosmological constant, *m* represents as much the baryons than the bosons. The operation represents a negative energy which is converted into a positive energy. The speed of light is constant; t, *m* and M are variables.

Note: a) In a *general* sense, the EM wavelength of spacetime is assimilated with the cosmological constant construed as dark energy. It corresponds, in our theory, to the negative mass-energy containing the baryons at a speed less than that of light and the bosons at the speed of light. In a *special* sense, the EM wavelength of spacetime is associated with the energy of the bosons. Here we use the general sense.

The theory of Relation has given an explanation for the Pioneer effect [4] and pointed out that for members of galaxies orbiting consistently faster than expected from the estimated baryonic matter inside their paths [2], a similar adjustment to gravity, oriented to the center of the individual galaxy, can explain their speed. But this time, more than a transformation of EM negative bosons into positive gravitational bosons (Pioneer effect), it is a matter of conversion of negative baryons into a kind of gravitational exotic dark matter, which is on its way to become positive ordinary matter [14].

b) Strictly in terms of energy with speed *c*, we consider that the universe in expansion is like a white hole. But as the speed of the expansion is below the speed of light, v, *r* and *a* become variables and M is constant: $\mathrm{v} = (\mathrm{GM} / r)^{1/2}$; $\mathrm{t}c_{\mathrm{em}} = \mathrm{t}c_{\mathrm{gr}} = r = \mathrm{GMt}^2 / r^2 = \mathrm{GM} / \mathrm{v}^2$; $a = \mathrm{GM} / r^2$. Similarly, the EM wavelength becomes a stationary matter wave with a velocity under *c*: $\lambda = \mathrm{h} / \mathrm{p} = \mathrm{h} / m\mathrm{v}$.

III - FORMULA

Kepler's law says that the rotation velocity beyond the limits of a finite body of mass must fall off with distance, but the path of the peripheral stars around galaxies are not reproduced completely accurately by Newtonian mechanics; there seems an excess acceleration towards the center. The rotational velocity of stars in every galaxy appeared the same at all distances from the galactic centers, as if gravity from a hidden mass in or around the galaxy were yanking them along, boosting their speed [15].

If acceleration ($a = \mathrm{GM} / r^2$) and velocity ($\mathrm{v} = (\mathrm{GM} / r)^{1/2}$) stay the same even when distance increases, the mass must also increases. The theory of Relation adds a term ΔM to the Newtonian formula ($\mathrm{GMm} / r^2 = \mathrm{mv}^2 / r$), which increases the ordinary visible mass. This added term implicates a kind of induction of gravity in a continual dynamical creation. It corresponds to the anomalous acceleration of the peripheral rotation curves of galaxies resulting from the deceleration of the expansion. The cosmological constant on the structure of the expansion loses negative energy which is recovered locally by the structure of the condensation as a transient gravitational dark matter in waiting to be transformed into positive mass-energy. The formula becomes

$$\mathrm{G}(\mathrm{M}\Delta M)\mathrm{m} / r^2 = \mathrm{m}(\mathrm{v}^2) / r, \qquad (2)$$

$$\mathrm{GM}\Delta M = \mathrm{v}^2 r,$$

[M is the visible mass, ΔM is the missing mass; $a = \mathrm{G}\,(\mathrm{M}\Delta M) / r^2$, $\mathrm{v} = (\mathrm{G}\,(\mathrm{M}\Delta M) / r)^{/2}$,
$\mathrm{F} = \mathrm{G}\,(\mathrm{M}\Delta M)\,\mathrm{m} / r^2$].

When distances increase, the rotational velocity of outer stars appeared the same and the term's effect ΔM, proportional with distance, increases abnormally from the center of a galaxy. This said, even if the rotational velocity of outer stars appeared the same with distance (it takes longer to complete the orbits farther out because the orbits are bigger), the speed of the stars is higher ($\mathrm{m}(\mathrm{v}^2\Delta v^2) / r$) than the rotational velocity expected by Newtonian theory (mv^2 / r).

At the periphery of a system, both structures are overlapping and the local structure of condensation starts to obey to laws of the structure of expansion. In the Newtonian formula $\mathrm{GMm} / r^2 = \mathrm{mv}^2 / r$; $r = \mathrm{GM} / \mathrm{v}^2$, v stops to be a variable an M becomes a variable obeying to the expression $r_\mathrm{u} = \mathrm{t}c = \mathrm{GM} / c^2 = \mathrm{h} / mc$ of the expansion structure, in which when the universal radius of expansion is growing with cosmological time M increases while m decreases. The rotational velocity of many galaxies appears constant out to the edges of those galaxies.

The meaning of this is that the local structures of condensation are overlapping the global structure of compensation at the periphery of a system and galactic rotations tends to level off at some hundred of kilometres per second, and to stay there, with a hidden mass called dark matter as compensation. We can put the formula like this:

$$\mathrm{F} = \mathrm{G}\,[(\mathrm{M_N}\Delta M_\mathrm{DM})\mathrm{m}] / (r_\mathrm{N}\Delta r_\mathrm{DM})^2 \qquad (3)$$

[$\mathrm{M_N}$ and r_N are Newtonian mass and radius; ΔM_DM and Δr_DM are for dark matter].

An extra mass well beyond the point at which no light is seen from the galaxy is the best evidence for dark matter in the universe, but for all galaxies it adds up to substantially less mass than would constitute a critical cosmological density; whether there is enough dark matter to fill it up is another issue [16]. As said before, the global deceleration of the expansion could be interpreted as a local inwards acceleration of each galaxy towards their center. *This acceleration takes the form of a change of direction of the rotation of the peripheral galaxies towards their centers.* The case is similar to the induction of gravity undergoes by the Pioneer probe which seems to accelerate towards the sun. The accelerations have roughly the same order of magnitude in all three cases.

IV - DISCUSSION ABOUT THE NATURE OF DARK MATTER

a) ROTATION CURVES

Science learns about the universe by the electromagnetic radiation seen from it and understands a great deal in terms of baryonic matter − the «normal» matter which makes up the stars, planets and people − but is struggling to comprehend the main material from which the cosmos is constructed. This strange material that dominates the universe but which is invisible to current telescope technology is one of the great enigmas of modern science. Even if astronomers cannot detect dark matter directly because it emits no light, its presence, though, can be inferred from the way galaxies rotate.

The matter in spiral galaxies rotates about the center at high speed, up to hundreds of kilometres per second. This speed is measured using the Doppler effect. If a rotating disk galaxy oriented in a way that its plane is presented to the observer edge-on., matter on one side will be approaching giving a spectrum that is shifted towards blue colours, while the matter on the other side will be receding and shifted to the red. A «rotation curve» is the curve obtained when spectroscopy is used to plot a graph of the velocity of stars in disc galaxies as a function of their distance from the center of rotation.

In this respect, a spiral galaxy is similar to our Solar System, in which the planets are in orbit around the Sun. The difference is that the speeds of the planets in their orbits decrease with increasing distance from the Sun, and most of the mass of the Solar System resides in the Sun, but the matter in spiral galaxies has a roughly constant velocity out to tens of thousands of light years from the center and most of the mass of a galaxy does not lie near the center of its rotation.

All rotation curves for disc galaxies show the same characteristic shape. The orbital speed of the stars increases rapidly over the first few kiloparsecs out from the center, then levels off and stays largely flat to the edge of the visible disc. There must be matter distributed throughout the galaxy to generate this constant velocity, while in the System there is no such matter and the rotation curve therefore drops off with distance. Moreover, it is known that the amount of starlight coming from a galaxy falls off very rapidly with distance from the center. This pattern of behaviour of flat rotation curve together with the falling light curve can be explained only if the entire visible disc of stars is being held in the gravitational grip of a much larger halo of unseen matter, not associated with the galactic stars. Such observations provide one of the most direct and straight-forward indications of the presence of a mysterious substance that neither emits nor absorbs light and reveals itself solely by its gravitational influence.

The detailed shape of rotation curves can be fitted by adding a dark-matter halo to the disk component. The usual way of quantifying this dark matter is to calculate the *mass-to-light ratio*, which is the ratio of the total mass (inferred from dynamics) to the total luminosity (obtained by adding up all the starlight). It is convenient to give the result in terms of the mass and luminosity of the Sun, which therefore has a mass-to-light ratio of 1. A typical galaxy has a mass-to-light ratio in the range 10 to 30, implying that it contains at least 10 times as much matter as is present in the form of stars like the Sun.

The observations of the rotational velocities of galaxies have established that dark matter makes up about 80-85% of the matter of the universe. Gravitational lens (gravitational lensing falls out of the principle of equivalence) indirectly detect it in region on the scale of galaxies where dark matter bends light. From the effects of «extra» gravity that astronomers detect, they infer how much mass must be present [17]. These astronomical constraints do not directly distinguish between non-baryonic models for dark matter (WIMPs) and other possible ideas involving more massive objects (MACHOs) such as Jupiter-sized planets and mini-black holes. However experiments in the 1990s established that MACHOs do not make an appreciable contribution to the dark matter content of our galaxy. So far, measurements with the WMAP probe confirm that dark matter accounts for five times as much mass as ordinary matter (protons, neutrons, electrons, and so on). It looks like there is both, a kind of baryonic and non-baryonic dark matter, and it appears to be that the universe is composed of both kinds. In fact, it is likely that most of the matter in the universe is a dark stuff which remains as elusive as ever [18, 19].

On their side, physicists have realized that extensions to the Standard Model may provide the identification of this stuff. The most popular of these extensions involves a hypothetical aspect of nature known as supersymmetry. Supersymmetric theories predict the existence of many new particles which may be observable at the *Large Hadron Collider* (LHC). It is now widely believed that it is composed of weakly interacting massive particles (WIMPs) drifting slowly through the galaxy. The Earth, Sun and planets pass through this wimp wind and there is hope that experimental initiative will observe dark matter in the coming years. These theories also suggest that the supersymmetric dark particle is not strictly dark. Although it may not interact with ordinary matter and light very much, it is thought that if it encounters another particle of its kind, both annihilate, which could produce a gamma ray of a huge energy directly or might produce other particles, which in turn decay into gamma rays with a range of energies. *The Gamma-ray Large Area Space Telescope* (GLAST) satellite monitors a wide part of the electromagnetic spectrum and if it sees these gamma rays, it would confirm that particle dark matter indeed exists and would reveal some of the particle's properties, such as its mass and interactivity. Working together, LHC and GLAST could be able to probe some of the same microscopic phenomena and identify the dark matter that accounts for the bulk of the material content of the universe [20].

b) FROM DARK ENERGY TO DARK MATTER

Although it seems that supersymmetry excludes alternative theories, we would like to use the theory of Relation to express our views, from a macroscopic point of view, on the nature of the dark matter. We put forward that it is an intermediate state between the potential mass-negative energy and the ordinary mass-positive energy. The theory of Relation assumes that our present universe comes from a big crunch (the metric of the expansion of space, from a previous universe, was reversed, collapsed, ended as a black hole «singularity» which was our big bang) which was not that punctual, but which continues through the expansion by disintegrating its negative energy (with regard to our energy) in positive energy which is the ordinary matter. Our universe is dual, with a negative structure, said structure of expansion, which extends the big bang and transforms its energy into positive structure of condensation (a global positive mass-energy divided up in local sub-structures) intended to attain a summit where, by inversion of polarity, it will head for a future big crunch.

The current cosmology distinguishes two kinds of matter in the universe, visible matter and dark matter, as if they were intrinsically of different essence and their role in gravitational formation of structure was fundamentally different. The theory of Relation considers the ordinary matter (visible positive matter) as resulting from the dark negative energy, and looks at dark matter as being ordinary matter not yet completely formed, and also resulting from negative energy.

Dark energy, which is assimilated with the negative energy of our negative wave EM of spacetime, or with the decelerating cosmological constant of the structure of expansion, is transformed throughout its expansion into positive mass-energy [1]. At the beginning of the universe, the transformation was almost instantaneous because of the enormous heat and of the speed of the chemical reactions touching the speed of light. The intermediary «state of dark matter» was not necessary. The ordinary matter being created almost at once by the extremely powerful radiation reacted to the gravitation (classic gravitation which, as space-time, built up itself and strengthened at the rate of the expansion), began to condense as the stream of photons of high energy transformed the negative energy into positive energy.

Moulded by the deformations of spacetime that originated as quantum fluctuations in the «negative energy» universe, ordinary matter could have begun to aggregate, under the influence of gravity, as early as ten thousand years after the big bang. Further to the cooling of the expansion and to the progressive slowness of the chemical reactions in the cosmological scale, the radiation of dark energy lost its power to transform instantaneously its negative energy into positive energy, the energetic flux of negative fermions and bosons was slowed down, bogged down in an intermediate state between negative energy and positive energy, a dark incubation of invisible matter emerging into visible matter.

So, at the beginning there was there was very little dark matter, contrary to the interpretation of data from *COBE-WMAP*. Note in this respect that scientists of the *Fermi's Large Area Telescope (LAT)* announced in November 2010 the discovery of two huge bubbles of gamma-ray emitting gas which appear to come from the center of the Milky Way Galaxy [21]. The origin of these huge structures, which cover half the visible sky is not known, but speculation is considering that they might be «burps» from the massive black hole at the center of the galaxy, or perhaps, they are left-overs from a period of intense star-formation. Cosmological theories suggest that dark matter would be concentrated at the center of the galaxy. Collisions of dark matter particles could produce showers of gamma rays which are the highest-energy form of light. Scientists noticed that the more dense groupings of gamma ray light were like «fog» with «edges», which gave them the shape of bubbles. They speculated that the haze was produced by dark matter, but the haze turned out to have sharp boundaries. Dark matter, according to the prevailing theory of inflation, should be more diffuse. If dark matter has been there billions of years you would expect a diffuse edge. If, on the other hand, there is relatively little time the edge would be sharp. The theory of Relation, which says that the universe had little dark matter at the beginning and that lot of dark matter came after, would be the more acceptable theory.

After three hundred thousand years, what the standard theory of big bang called recombination and decoupling was the sudden lightening of ordinary matter. The decoupling of matter and radiation freed the recently formed dark matter which was attracted by the structures shaped by ordinary matter. Stars and galaxies constituted in proportion as the visible and the dark matter aggregated [14].

The passage from dark matter to ordinary visible matter was easier and faster in the early universe because it was hot, dense, and the rate of chemical reactions was very rapid. The process is still going on today but with a very slow rate, because the universe became cold and diluted. So the dark matter accumulates and the transformation from dark matter to visible matter could be as slow as is the acceleration of the cosmological constant.

Dark matter is a gravitational non baryonic matter coming from conversion of negative pairs of baryons into a kind of gravitational exotic dark matter, which is on its way to become positive ordinary matter (baryonic matter). This may correspond to a state of «unmatter» with «unparticle»: a new form of matter formed by matter and antimatter that bind together [22, 23]. On a way, we can say that all the visible baryonic matter would come from this dark matter since the early universe.

Dark matter includes all which is not visible in the universe. It does not emit − or little − visible, infrared, ultraviolet, X or gamma radiation. On the other hand, it interacts gravitationally with the visible matter. Its mass is therefore necessary to report the anomalous movement of members of galaxies orbiting consistently faster than expected from the estimated ordinary baryonic matter inside their paths [14, 15].

c) DARK MATTER ASSOCIATED WITH «DARK SPACE»

Dark matter is inevitably associated with «dark spaces» or «dark voids» [17, 24, 25]. Each time there is a conversion of negative matter-energy into positive matter-energy, there is a creation of wrinkles (hot spots), which is ordinary matter (instantaneous conversion or via dark matter), destined to become visible matter and there is voids of negative matter-energy (cold spots). Voids and wrinkles are opposite and complementary. Void can be like Dirac's holes when a positive particle is created. It goes in opposite direction of the particle and plays an inverse role. They have contrary spatial signs: we can say that empty space is full of decreasing negative EM energy going in an expansionist direction opposite to the positive gravitational direction of condensation. These voids constitute our «empty space-cosmological time». The more there is voids the more there will be positive matter. And «dark space» beyond the standard empty space infers gravity. That's what principle of compensation is all about to constitute matter and cosmological space-time.

We can also imagine a «dark space» born in the outskirts of a galaxy when a flow of negative matter-energy was converted in a flow of positive matter-energy of inverse direction. It can be illustrated by a macroscopic Casimir effect: the dark space invades and pervades the last bright arms in the far-off low density halo around the rotating disk, exerts gravitational forces which tighten the spiral arms and accelerates the whirlwind of stars towards the central attractor. The outside part of the galaxy becomes more curved, accentuating the spiral curl.

This said, dark matter observed in our present universe can take the form of big dark empty spaces, kinds of «black void holes» filled with gravitational plasma in incubation waiting to be definitively transformed into a visible baryonic matter. The rate of reaction of these particles is very slow and feeble, giving the impression that only the virtual reactions are possible. But these reactions are real, giving sometime cosmic rays and the apparition of stars which seems created from nothing. The theory of Relation alleges that the global mass of the universe is not static, nor its density. The global mass grows because the negative energy matter of the pre big bang universe continue, throughout disintegration (or creation of matter by a process of annihilation-creation), to create positive particles, accordingly with the decrease of the cosmological constant. When there will be no more fuel in the expansionist constant, there will be a reverse process towards a future big crunch, all that inside a frame of cyclic universe. Until experiments gives us more clues to conclude one way or another, we like to think that these black empty spaces are filled with neutrinos giving birth to neutrinos and also to baryons of negative energy, like those we know, which metamorphose themselves into positive baryons.

V - CONCLUSION

Members of galaxies orbit consistently faster than expected from the estimated baryonic matter inside their paths. The theory of Relation modelled these deviations with the principle of Compensation and gives an interaction between the EM spacetime of expansion and the gravitational matter of condensation. We assumed that our universe is made of these two complementary and interpenetrated structures. A term is added which increases the ordinary visible mass and implicates a missing mass in continual dynamical creation. This paradigm of the theory of Relation would be consistent with the anomalous acceleration of the peripheral rotation curves of galaxies resulting from the deceleration of the expansion. We attribute this anomaly to the cosmological constant that is losing negative energy on the structure of the expansion; energy recovered by the local structure of the condensation, under the shape of a gravitational dark matter in wait to be definitively transformed into positive mass-energy. This constant inward acceleration for the outer parts of galaxies is numerically close to the product of the speed of light and the Hubble constant. It also corresponds to the Pioneer effect which is the observed deviation from expectations of the trajectories of spacecrafts visiting the outer solar system and their slowing down under the influence of the Sun's gravity. The anomaly perceived by the radio Doppler is modeled as a constant additional sunward acceleration of $(8.74 \pm 1.33) \times 10^{-10}$ m/s^2. The theory of Relation ascribes the significance of this discrepancy to the conversion of negative energy of the EM wavelenght of the expansion into a gravitational energy. The cosmological photon of the tired-light induced gravity.

Contrary to the strong theoretical prejudice driven by inflationary cosmologies that nonbaryonic dark matter need not have been coupled to radiation before the epoch of recombination, and could therefore have clumped gravitationally, the theory of Relation suggests that at the beginning the negative energy from a pre big crunch was transformed instantaneously into ordinary positive energy which have clumped gravitationally before the recombination. In this scheme, ordinary matter fluctuations seeded galaxy formation to occur faster than might been the case with «dark matter» which appears after when expansion cool off and the rate of chemical reactions were longer. Dark matter is a kind of «transitory state» with «tired-matter» issues from the negative electronic matter wave, waiting to be transformed into positive ordinary matter forming the galaxies. We can also see it like some empty space or «dark void». With the theory of Relation there is a decreasing negative dark energy which increases, or «creates», the positive matter. So if there is actually not enough «dark matter» (fermionic or «non fermionic») material to give closure density (q_o = ½), this density will be obtained by this sort of «perpetual creation» until the cycle will be reversed.

REFERENCES

[1] George Smooth, Keay Davidson, *Wrinkles in Time*, Harper Perennial, 155-6, 286 (2007).
[2] William L. Vanderburgh, *The Methodological Value of Coincidences: Further Remarks on Dark Matter and the Astrophysical Warrant for General Relativity*, Wichita State University
[3] Milgrom, M., *A modification of the Newtonian dynamics - Implications for galaxies*, ApJ, 270, 371 (1983).
[4] Russell Bagdoo, *The Pioneer Effect: a new Theory with a new Principle*, Scisprint, Gravitationalanomalies (2008), Issuu, Scribd (2010), General Science Journal (2011).
[5] W. L. Freedman et al., *Final Results from the Hubble Space Telescope Key Project to Measure the Hubble Constant*, Astrophys.J. 553 (2001) 47-72.
[6] Georges Gamow, *Gravitation*, P-B Payot, 115-6 (1962).
[7] Russell Bagdoo, *Link between Allais effect and General Relativity's residual Arc during solar Eclipse*, Internet Archive, Scribd, Issuu (2009).
[8] Russell Bagdoo, *Is the Growth of the Astronomical Unit Caused by the Allais Eclipse Effect?* Internet Archive, Issuu, Scribd (2010).
[9] Xavier E. Amador, *Review on possible Gravitational Anomalies*, arXiv: gr-qc/0604069 v1 (2006).
[10] James F. Carter, *Anomalous Acceleration of Pioneer 10 and 11*, www. Math.ucla. edu/~jimc**/documents/mond.html**, 2003-09-12
[11] J.D. Anderson, P.A. Laing, E.L. Lau, A.S. Liu, M. M. Nieto, S.G. Turyshev, *Study of the anomalous acceleration of Pioneer 10 and 11*, arXiv:gr-qc/0104064 v5, p.1, 2, 8, 18-20, 43- 46, 50, 126, Phys.Rev. D65 (2002) 082004.
[12] Russell Bagdoo, *Cosmological Inconstant, Supernovœ 1a and Decelerating Expansion* The General Science Journal, Issuu, Scribd (2011).
[13] Dr. Tony Phillips, Science@ NASA Headline, 2011, Stellar Extremophiles.
[14] Russell Bagdoo, *Arcade 2 extragalactic emission and dark matter as seen by the theory of Relation*, Gravitationalanomalies, Scribd, Issuu (2009), The General Science Journal.
[15] John Gribbin, Martin Rees, *Cosmic Coincidences*, Bantam Book, 133 (1989).
[16] David Lindley, *Messing around with gravity*, NATURE, Vol. 359, 583, 15 Oct (1992).
[17] Stéphane Fay, *Matière noire*, Ciel & Espace, N° 449, 39, 16, Octobre (2007).
[18] Stéphane Fay, *La matière noire hors des sentiers battus*, Ciel & Espace, N° 446, 26, Juillet (2007).
[19] David Fossé, *Matière noire* : *la piste des particules cosmiques*, Ciel & Espace, N° 469, 28, Juin (2009).
[20] William B. Atwood, Peter F Michelson, Steven Ritz, *Window on the Extreme Universe,* Scientific American, 54, Dec (2007).
[21] NASA - *NASA's Fermi Telescope Finds Giant Structure in our Galaxy*, www.nasa.gov/ *…/ GLAST/news/new-structure.htm*
[22] Ervin Goldfain, Florentin Smarandache, *On Emergent Physics,* "*Unparticle*" *and Exotic "Unmatter" States*, Progress in Physics, Vol 4, Oct (2008).
[23] Howard Georgi, *Unparticle Physics*, ArXiv:hep-ph/0703260v3, 20 May (2007).
[24] C. J. Conselice, *The Universe's invisible hand*, Scientific American, 35, Feb. (2007).
[25] Timothy Clifton, Pedro B. Ferreira, *Does dark energy really exist?* Scientific American, 48, April (2009).