The structure of the Pivot Universe

Arieh Sher

email: pivot.universe.theory@gmail.com

Abstract

The Pivot theory describes the structure of the Universe. It postulates that the Universe is composed of a massive spinning Neutron star, the Pivot, located at its center. Orbiting the Pivot is a ring-shaped visible Universe. Two theories can describe The Pivot. From the GR point of view, the Pivot is a Kerr black hole. From the quantum physics point of view, the Pivot is composed of nucleons are packed to the maximum density possible in the Universe, similar to the way nucleons are packed in the nucleon of the atom.

The Pivot theory postulates that the Universe started as a primeval nucleus that was a spinning Neutron star. This primeval nucleus accumulated energy from the vacuum, until its surface velocity reached the speed of light and then it exploded. It exploded into two distinct parts: The Pivot and the visible Universe. Using this assumption, and relying on physical conservation laws I calculate the size of the Universe. The Pivot theory has an answer to the fundamental question in physics: Does the Universe has a reference frame, or everything is relative?
Finally, the verification the structure of the Pivot Universe against known cosmological observations, such as the flat rotation curve in Spiral Galaxies, the Spiral shape of Galaxies, Redshift of Galaxies.

Keywords: Universe structure, frame dragging, Black hole, Neutron star, QM, GR, gravitational constant, gravitational z shift.

Contents

1. The Pivot theory- Overview
2. Known constants and accepted parameters used in this article
3. The Primeval nucleus
4. Dimensions of the Universe
5. The visible Universe is an inertial frame
6. The Origin of spinning and rotation of celestial bodies
7. Rotation curve and spiral shape of a Galaxy
8. The shape of a spiral Galaxy
9. Gravitational z shift
10. Blue shifted Galaxies
11. Andromeda Galaxy
12. Time dilation in the visible Universe
13. Doppler shift Vs. gravitational shift
14. Hubble's observations
15. Cosmic Microwave Background (CMB)
16. Olbers' paradox
17. Handedness of Galaxies
18. Summary
19. Appendix A - The origin of gravity
20. Appendix B - Is a black hole a neutron star?
21. References

1. The Pivot theory- Overview

The Pivot theory postulates that the current Universe is composed of a massive and spinning Neutron star, the Pivot, located at its center. Orbiting the Pivot is a ring-shaped visible Universe. Two theories can describe the Pivot: on the one hand, quantum physics where it is described as a nucleus that is composed of an enormous number of nucleons that are packed in this nucleus to the maximum density possible. In this sense, the Pivot resembles the nucleus of an atom. On the other hand, the Pivot can also be described by GR as a huge Kerr black hole that has an event horizon, and due to its spin, it drags the space around it. The Pivot theory answers three questions:

The first question is: How did it all begin?

This part is speculative and is not adequately addressed; however, it is not out of the blue. The theory is based on quantum physics. I claim that the origin of the matter Universe is the vacuum of the space, that permeates everywhere. Quantum theory describes all elementary particles as vibrational modes in fundamental fields that exist at all points of space and time. In this vacuum, virtual particles are constantly popping in and out of existence. These virtual particles are coming in pairs, e.g., a quark and antiquark, exist for an extremely short time, and then mutually annihilate. Quantum physics teaches that it is possible to boost the pair apart using external energy (e.g., a very strong electric field - This field pushes them in opposite directions because they have opposite electric charges), so that they avoid annihilation and become actual (long-lived) particles.

From QCD it is known that if additional external energy (from the vacuum) was supplied to this primeval hadron, it did not dissolve to its constituents, but instead, caused the number of gluons and quarks inside the hadron grew considerably. It is important to note that although the behavior of the hadron described above is not yet fully explained theoretically by quantum physics, it was verified by a large number of accelerator experiments over the last 50 years. Following that, it happened that quarks and gluons that were boosted by energy from the vacuum attracted each other to form a primeval nucleus. As said above, the energy that was added did not dissolve the nucleus into its constituents, but instead, new nucleons were added. I am making three assumptions: 1) The primeval nucleus started to spin from the beginning and the new nucleons that accumulated continued to spin in the same direction. 2) The spinning of this massive nucleus, according to GR, dragged space around it. 3) An additional assumption relates to the origin of gravity. During the epoch the primeval nucleus, the only sources for holding the nucleus together were the nucleons themselves. Quantum physics teaches that there is a very strong attractive force between nucleons that are located at a sub-atomic distance. This strong force was the one that kept the nucleons together in the primeval nucleus. My claim is that this strong force between nucleons is the origin of gravity between celestial bodies in the Universe. It is true that at cosmological distances the strong force (= gravity) decreases to extremely small values, however, as the number of nucleons in celestial bodies is enormous, there is still considerable gravity force between celestial bodies. The nucleons were added to the primeval nucleus in such a way that they were packed to the maximum density possible in the Universe. I

postulate that the maximum density possible in the Universe is approximately the density of a fermion (proton or neutron) or a Neutron star. At maximum density, the nucleons were so close to each other that they started to repel each other, similar to the structure of a Neutron star or an atom's nucleon. QCD teaches that bringing the nucleons too close requires infinite force.

The second question is: Why did the primeval nucleus stop growing?

I postulate that the size of primeval nucleus grew until the tangential velocity on its physical surface reached the velocity of light and then it exploded. Based on the Big Bang theory, this explosion occurred 13.7 billion years ago. What is not clear to me is how long did it take for the primeval nucleus to reach its maximum size. An additional note is that the explosion raised the temperature of the nucleus to very high temperatures.

The third question is: How has the Universe evolved into the Pivot structure?

The explosion shattered the outer layers of the primeval nucleus causing the nucleons of these layers to flung off tangentially in the equatorial plane of the primeval nucleus and the same direction of the primeval nucleus spin. The result was as follows: The more significant part of the primeval nucleus became the Pivot. The other nucleons that flung off tangentially from the primeval nucleus arranged around the Pivot in a ring-shaped visible Universe. The velocity at which the visible Universe rotates around the Pivot is determined according to Newton's law of universal gravitation. According to this gravitational law, the entire mass of the Pivot is concentrated at its center. The center point of the Pivot is fixed in the space. From GR point of view, the Pivot is a Kerr Black hole. This means that the inner radius of the ring-shaped visible Universe must be slightly bigger than the Schwarzschild radius of the Pivot. The Pivot swallowed all nucleons that were located inside the Schwarzschild radius. As said earlier, the nucleons of the visible Universe orbited the Pivot in the same direction that the Pivot was spinning. Simultaneously, as is known from the Kerr solution, the space around the Pivot was dragged by the Pivot in the same direction. Now, I postulate that the size of the visible Universe is such that the angular speed of the orbiting visible Universe around the Pivot is equal to the angular speed of the dragged space. Therefore, for an observer located anywhere in the visible Universe, there is no relative motion between him and space.

The Pivot structure of the Universe can explain one of the fundamental debates in physics. Does the Universe have a reference frame or everything is relative without any reference frame? This issue is of profound importance in physics. In 1905 Einstein proclaimed that "aether is superfluous," but in 1920 Einstein said: "According to the general theory of relativity space without aether is unthinkable." (Note: In modern physics, the traditional term aether is replaced by the term vacuum space). Newton in 1718 suggested the existence of the aether, but in 1887, Michelson - Morley experiment proved that there is no a relative motion between Earth and the aether. M-M found from the experiment that light was traveling at the same speed no matter in what direction it moved. In other words, there is no aether. Another famous experiment was the Sagnac loop, in 1913, that showed, contrary to the M-M experiment, that there is an aether. The confusion is even greater. So far, SR and GR's predictions are well confirmed by experiments. Newton's gravitational law has also been proven to be precise, although it cannot explain all the

observations. The Pivot structure of the Universe unites the theories of Newton and Einstein. The Pivot theory uses SR and GR so; Einstein is correct with both theories. However, the center of the Pivot is fixed in space, so Newton is also right.

After the explosion of the primeval nucleus, the visible Universe contained only very hot nucleons that were orbiting the Pivot. It took the visible Universe 380,000 years to cool down. When this happened, ordinary atoms were formed, and this was the time that gravity forces between atoms appeared. The local density of the visible Universe was the cause of the variety of celestial bodies. If the density of atoms at a particular region in the visible Universe was too low to enable attraction between them, they remained as a cloud of gas that orbits the Pivot. If the density of atoms was sufficient for interaction between them, stars were created. The variety of celestial body was dependent on the mass of the born star. Some stars that had enough mass to collapse by gravity into Neutron stars, more massive stars collapsed into Black holes. The black hole was powerful enough to attract additional stars that started to orbit it. Thus, stars performed now two simultaneously trajectories. One around the Pivot and the other around the black hole of a Galaxy- this was the way that Galaxies were created.

So far, the description of the Pivot Universe was qualitative. The next paragraphs are quantitative. In these paragraphs, I calculate the size of the primeval nucleus and the sizes of the Pivot and the visible Universe.

In order to test the theory, the Pivot structure is verified against known cosmological observations: Origin of spinning and rotation of all celestial objects, flattened rotation curve in Spiral Galaxies, Spiral shape of Galaxies, Redshift of Galaxies, Blue shift of Galaxies, Cosmic Microwave Background, Handedness of Galaxies, Olbers' paradox, Hubble’s observations.

Finally, there are spin-offs of the Pivot theory. I relate to them in the Appendixes:

Appendix A- The origin of gravity.

Appendix B- Is a black hole a neutron star?

2. Known constants and accepted parameters used in this article

$Gly = 9.454 \cdot 10^{24}$ m …Distance of billion light years.

$Mly = 9.454 \cdot 10^{21}$ m …Distance of million light years.

$Kly = 9.454 \cdot 10^{18}$ m …Distance of thousand light years.

$G = 6.67 \cdot 10^{-11} m^3 / kg / \sec^2$ …Gravitational constant.

$C = 2.99 \cdot 10^{8} m / \sec$ …Light velocity.

$\rho = 10^{-26} kg / m^3$ …Density of ordinary matter in Universe.

$\hbar = 1.054571 \cdot 10^{-34} J \cdot \sec$ …Reduced Planck's constant.

$m_{proton} = 1.6726219 \cdot 10^{-27} kg$ …Mass of proton.

$\omega_{Birtch} = \sim 10^{-13} rad / yr$ …Observed angular velocity of the Universe- Birch [1].

Note: Birch calculated from the study of position angles and polarization of high luminosity classical double radio sources a rotational velocity for the Universe of the order of $\omega_{Birch} = \sim 10^{-13} rad / yr$. Although his work has not been convincingly refuted, it was criticized for using improper statistics.

$M_{vu} = 1.5 \cdot 10^{53} kg$ …Mass of visible Universe, Wikipedia [2].

$R = \dfrac{26.8\%}{4.9\%} = 5.47$ … Ratio of "dark matter" mass to visible Universe mass, Wikipedia [3].

Note: I concur with the theory that claims that adding "dark matter" to the Universe solves the issue of curve flattening of Galaxies. However, I claim that this "dark matter" resides in the Pivot rather than being spread in and around Galaxies as postulated by current cosmology. In the calculations, I am using the mass of the "dark matter" calculated by others, as the mass M_p of the Pivot. The fact that the Pivot is a Kerr Black hole is the reason why "dark matter" cannot be detected.

$M_p = R \cdot M_{vu} = 8.2 \cdot 10^{53} kg$ …Calculated mass of Pivot.

$M_{total} = M_p + M_{vu} = 9.7 \cdot 10^{53} kg$ …Calculated total mass of the Universe.

$M_{bh} = 10^{36} kg$ …Assumed average mass of a black hole in the center of a Galaxy.

$M_{gal} = 10^{39} kg$ …Assumed average mass of a Galaxy.

$\rho_n = 0.85 \cdot 10^{-13} cm$ … Radius of the nucleon

3. The Primeval nucleus

The Pivot theory uses the primeval hadron theory described by Muradian [4] and others suggesting that the Universe began as a super dense primeval hadron. He uses the generalized Regge's law general formula which connects the maximal spin J and the mass m of a celestial object: $J = \hbar \cdot \left[\frac{m}{m_{proton}} \right]^{1+1/n}$ where for Galaxies, clusters of Galaxies and globular Galaxies the two-dimensional disk-like hadron n=2. For stars, planets and asteroids n=3. He showed that the calculated values of J and m of all celestial bodies, namely superclusters, Galaxies, stars, and planets, are in good agreement with observations. I am using this equation for calculating the angular momentum of the primeval Universe.

$$J_{total} = \hbar \cdot \left(\frac{M_{total}}{m_{proton}} \right)^{\frac{3}{2}} = 1.474 \cdot 10^{94} erg \cdot \sec \qquad (3.1)$$

The primeval angular momentum is the sum of the angular momentum of the primeval nucleus plus the angular momentum of space that is dragged by the primeval nucleus. The relation of the angular momentum of the primeval nucleus $J_{nucleus}$ and J_{total} is calculated as follows:

1) Calculating the number of nucleons of the primeval nucleus $N_{nucleons}$ and then calculating the radius of this primeval nucleus $R_{nucleus}$ assuming the nucleons are densely packed.

$$N_{nucleons} = \frac{M_{total}}{m_{proton}} = 5.802 \cdot 10^{80} \qquad (3.2)$$

$$R_{nucleus} = R_{proton} \cdot (N_{nucleons})^{\frac{1}{3}} = 7.089 \cdot 10^{8} km \qquad (3.3)$$

2) Calculating the Schwarzschild radius of the primeval nucleus $R_{s\_nucleus}$.
   Note: The reason for calculating $R_{s\_nucleus}$ is that it is used later in (3.6).

$$R_{s\_nucleus} = \frac{2 \cdot G \cdot M_{total}}{C^2} = 153.16 \cdot Gly \qquad (3.4)$$

3) Finding the angular speed on the primeval nucleus surface $\Omega_{nucleus}$, by assuming that this velocity cannot exceed the speed of light C.

$$\Omega_{nucleus} = \frac{C}{R_{nucleus}} = 1.331 \cdot 10^4 \frac{rad}{yr} \qquad (3.5)$$

So far, the development of the above equations is based only on classical mechanics. The Schwarzschild radius that was found from the solution of GR equations can be derived directly from the classical equation of the escape velocity from a celestial body. (The first who suggested this was John Michell in 1783). However, in Newton's gravitational laws, the spinning of celestial bodies is not taken into considerations. It is known now that all bodies in the Universe spin. Therefore, I have to use GR theory. The solution of GR that takes into consideration the spinning of bodies was suggested in 1963 by Roy Kerr and is called KBH (Kerr Black hole). Analyzing the Kerr solution shows:

1) KBH has a singularity ring at its center. There is no singularity inside this ring.
2) The KBH has two event horizons the outer event horizon, and an inner event horizon.
3) There is a frame dragging of the space around the Black hole nucleus.
4) The Black hole has a photon sphere.

I postulate that:

1) The nucleus of the Black hole resides inside the ring singularity.
2) The density of the nucleus inside the ring singularity is the maximum density possible in the Universe. (See appendix B)
3) A Black hole and a Neutron star have the same structure (See appendix B)
4) $R_{nucleus}$ of the solid nucleus sphere, is equal to the spin parameter $\alpha_{nucleus}$ defined by Kerr.

$\alpha_{nucleus} = R_{nucleus}$ ....Assumption

where:

$a = \frac{J_{nucleus}}{M_{nucleus} \cdot C}$ .... defined by the Kerr solution

$J_{nucleus}$ .... Angular momentum of the primeval nucleus

$M_{nucleus}$ .... Mass of he primeval nucleus

The dragging speed of space in the plane of the equator by the primeval nucleus is calculated for a Kerr spinning Black hole: Wikipedia [5].

$$\Omega_{nucleus} = \frac{R_{s\_nucleus} \cdot \alpha_{nucleus} \cdot C}{R_{nucleus}^{\ 3} + \alpha_{nucleus}^{\ 2} \cdot R_{nucleus} + R_{s\_nucleus} \cdot \alpha_{nucleus}^{\ 2}} = 1.331 \cdot 10^{4} \frac{rad}{yr} \qquad (3.6)$$

By comparing $\Omega_{nucleus}$ from (3.5) to (3.6) the value of $\alpha_{nucleus} = 7.089 \cdot 10^{11} m$ can be found. Then the angular momentum of the primeval nucleus $J_{nucleus}$ is calculated:

$$J_{nucleus} = \alpha_{nucleus} \cdot M_{total} \cdot C = 2.057 \cdot 10^{81} erg \cdot \sec \qquad (3.7)$$

The ratio of $\frac{J_{nucleus}}{J_{total}} = 1.396 \cdot 10^{-13}$ shows that the main contributor to the total angular momentum is the dragged space.

It is also interesting to compare the value of $J_{nucleus}$ from (3.7) to the value that can be derived by considering the primeval nucleus as a solid rotating sphere.

$$J_{sphere} = \frac{2}{5} \cdot M_{total} \cdot R_{nucleus}^{\ 2} \cdot \Omega_{nucleus} = 8.228 \cdot 10^{80} erg \cdot \sec \qquad (3.8)$$

The ratio is: $\frac{J_{nucleus}}{J_{sphere}} = 2.5$. At this stage I cannot explain this discrepancy.

4. The dimensions of the Pivot Universe

Calculating the dimensions of the Pivot Universe is based on conservation laws of angular momentum and mass. Namely, the angular momentum of the Pivot Universe is equal to the total angular momentum that was calculated in (3.1) and is the sum of the angular momentum of the Pivot + the visible Universe + the dragged space. The mass of the Pivot + the mass of the visible Universe is equal to the mass of the primeval nucleus.

The radius of the Pivot is calculated by:

$$R_{pivot} = \rho_n \cdot (N_{pivot})^{\frac{1}{3}} \qquad (4.1)$$

Where:

R_{pivot} … Radius of the Pivot

$\rho_n = 0.85 \cdot 10^{-13} cm$ … Radius of the proton

$N_{pivot} = \frac{M_p}{m_{proton}} = 4.9 \cdot 10^{80}$ … The number of protons in the Pivot

$R_{pivot} = \rho_n \cdot (N_{pivot})^{\frac{1}{3}} = 6.7 \cdot 10^8 km$ … The calculated radius of the Pivot

Schwarzschild radius of the Pivot:

$$R_{s\_pivot} = \frac{2 \cdot G \cdot M_p}{C} = 129.49 Gly \qquad (4.2)$$

In the following equation R_{avg} is the average radius of the visible Universe. The value of $R_{avg} = 131.68 \cdot Gly$ is calculated in (4.10). Using the dragging equation of space, the value of α_{pivot} is found by equating the frame dragging angular speed $\Omega_{pivot}(R_{avg})$ to Birch observation angular speed ω_{Birch}:

$$\Omega_{pivot}(R_{avg}) = \omega_{Birch} = \frac{R_{s\_pivot} \cdot \alpha_{pivot} \cdot C}{{R_{avg}}^3 + {\alpha_{pivot}}^2 \cdot R_{avg} + R_{s\_pivot} \cdot {\alpha_{pivot}}^2} \qquad (4.3)$$

The result of solving this equation is: $\alpha_{pivot} = 1.671 \cdot 10^{25} m$

The angular velocity on the Pivot surface can be found by:

$$\Omega_{pivot}(R_{pivot}) = \frac{R_{s\_pivot} \cdot \alpha_{pivot} \cdot C}{{R_{pivot}}^3 + {\alpha_{pivot}}^2 \cdot R_{pivot} + R_{s\_pivot} \cdot {\alpha_{pivot}}^2} = 5.65 \cdot 10^{-10} \frac{rad}{yr} \qquad (4.4)$$

Thus, the velocity on the Pivot surface:

$$V_{pivot} = \Omega_{pivot}(R_{pivot}) \cdot R_{pivot} = 1.2 \cdot 10^{-5} \frac{m}{\sec} \qquad (4.5)$$

The conclusion is that the Pivot is a Kerr black hole that rotates very slowly.

Finally, I verify the validity two parameters:

1) I compare the angular momentum of the primeval nucleon to the angular momentum of the entire Pivot Universe.

Finding J_{pivot} is done by Kerr definition. It is the sum of the angular momentum of Pivot solid sphere+ space dragged + visible Universe. This angular momentum should be equal to (3.1)

$J_{total} = 1.474 \cdot 10^{94} erg \cdot \sec$

$J_{pivot} = \alpha_{pivot} \cdot M_p \cdot C = 4 \cdot 10^{94} \cdot erg \cdot \sec$

However, $R = \frac{J_{total}}{J_{pivot}} = 2.8$. This is a discrepancy that I cannot explain at this stage.

2) The velocity of a celestial body orbiting the Pivot at a radius of R_{avg} according to Newton's gravitational law is:

$$V_{avg\_Newton} = \left(\frac{G \cdot M_p}{R_{avg}} \right)^{0.5} \cong 0.7C \quad (4.6)$$

The velocity of a celestial body orbiting the Pivot at a radius of R_{avg} can be also calculated by:

$$V_{avg\_\mathrm{Birch}} = \omega_{Birch} \cdot R_{avg} \cong 0.01319C \quad (4.7)$$

There ratio is: $R = \frac{V_{avg\_Newton}}{V_{avg\_Birch}} = 53.1$. This is a discrepancy that I cannot explain at this stage.

In order to find the dimensions of the Pivot Universe, I make several assumptions:

1) The inner radius of Universe ring must satisfy $R_{in} \geq R_{s\_pivot}$. Any matter that was at distance smaller than Schwarzschild radius, has been swallowed by the Pivot.
2) The angular momentum of the visible Universe J_{vu} is equal to the angular momentum of the Pivot + the dragged space by the Pivot J_{pivot} :
   $J_{pivot} = J_{vu} = 0.5 \cdot J_{total} = 7.37 \cdot 10^{93} erg \cdot \sec$
3) The angular speed of the visible Universe was measured by Birch ω_{Birch}

The outer radius of the visible universe R_{out} is found by:

$$\frac{M_{vu}}{2} \cdot (R_{in}^2 + R_{out}^2) \cdot \omega_{Birch} = J_{vu} \Rightarrow R_{out} = 133.87 Gly \quad (4.8)$$

The width of the visible Universe W is found by:

$$M_{vu} = W \cdot \rho \cdot \pi \cdot (R_{out}^2 - R_{in}^2) \Rightarrow W = 4.9 Gly \quad (4.9)$$

The average radius of the visible Universe ring R_{avg} is:

$$R_{avg} = \frac{R_{in} + R_{out}}{2} = 131.68 Gly \qquad (4.10)$$

Notes:

1. The radius of the Pivot is $6.7 \cdot 10^8 km$. It can be compared to the distance of Jupiter from the Sun that is $7.8 \cdot 10^8 km$
2. The size of the Pivot is impressive, but it is dwarfed when compared to the radius of the visible Universe $Ratio = \frac{R_{pivot}}{R_{out}} = 5.2 \cdot 10^{-16}$.
3. An additional parameter I calculate is the surface gravity of the Pivot.

   $$g_{pivot} = \frac{G \cdot M_p}{R_{pivot}^{\ 2}} = 1.2 \cdot 10^{20} \frac{m}{\sec^2} \qquad (4.10).$$

   I claim that this calculated number is the maximal gravity in the Universe. (Note: Inside the Pivot's solid sphere the gravity is smaller than g_{pivot}, and right at the center of the Pivot the gravity is zero because all the forces nullify themselves).
   I compare this result to the maximal gravity in the Universe calculated by Potzel [6]. In his article, he describes a theory and uses experimental data for calculating the maximum acceleration in the Universe. He predicts that the maximal acceleration in the universe is $> 1.5 \cdot 10^{21} \frac{m}{\sec^2}$.

4. The spinning angular momentum of all celestial bodies, i.e., Galaxies, stars, planets, interstellar planets should have been included while calculating the angular moment of the visible Universe. However, it is shown now, that the sum of the spinning angular momentum of all these celestial bodies is negligible in comparison to the orbital angular momentum of the ring-shaped visible Universe. Based on Muradian [4], an estimated total angular momentum of all celestial objects is:
   $J_{objects} = J_{gal} \cdot N_{gal} + J_{star} \cdot N_{star} + J_{planet} \cdot N_{planet} = 2 \cdot 10^{85} erg \cdot \sec$
   Where:
   The average angular momentum of a Galaxy: $J_{gal} = 10^{74} erg \cdot \sec$, Number of Galaxies: $N_{gal} = 2 \cdot 10^{11}$, Angular momentum of an average star: $J_{star} = 10^{49} erg \cdot \sec$, Number solar systems: $N_{star} = 10^{22}$, Angular momentum of an average planet: $J_{star} = 10^{40} erg \cdot \sec$, Number planets: $N_{planet} = 10^{24}$. $J_{objects} = 2 \cdot 10^{85} erg \cdot \sec << J_{vu} = 1.03 \cdot 10^{94} erg \cdot \sec$ and therefore, can be neglected.

5. GR solution gives also rise to a photon sphere. The radius of the photon sphere is $1.5 \cdot R_{s\_pivot}$. This sphere prevents photons to leave our Universe.

6. Based on the description and the calculations above, Figure 4.1 describes the structure of Pivot Universe. The Pivot is a Neutron star that is fixed in space but spins very slowly. Its existence is possible according to the Kerr solution because it is located inside the singularity ring. The visible Universe spins in the same direction of the Pivot. It has a ring-shape and is located outside the event horizon; therefore, the Pivot cannot be observed by an observer from the visible Universe. In the figure, the dragging curves of space by the Pivot are shown. It was calculated that the angular speed of the space dragging is equal to the angular speed of the visible Universe measured by Birch. This fact explains the Michelson-Morley experiment. An observer will not be able to measure his speed relative to the space that surrounds him, but at the same time space is dragged around the Pivot. The Pivot spins around a fixed point in space. One can sum up that Newton was correct by arguing that there is a fixed center of the Universe but in order to explain additional observations Einstein's GR must be taken into consideration.
Also, finally, from the GR solution, the Universe is separated from the infinite outside space by a photon sphere. To sum up, the Universe is an isolated island in the infinite space. The Universe as an entire can exist forever. On the other hand, the visible Universe can change. Stars will consume their energy; galaxies may collide and so on. It can be said: The stage will exist forever, but the players may change.

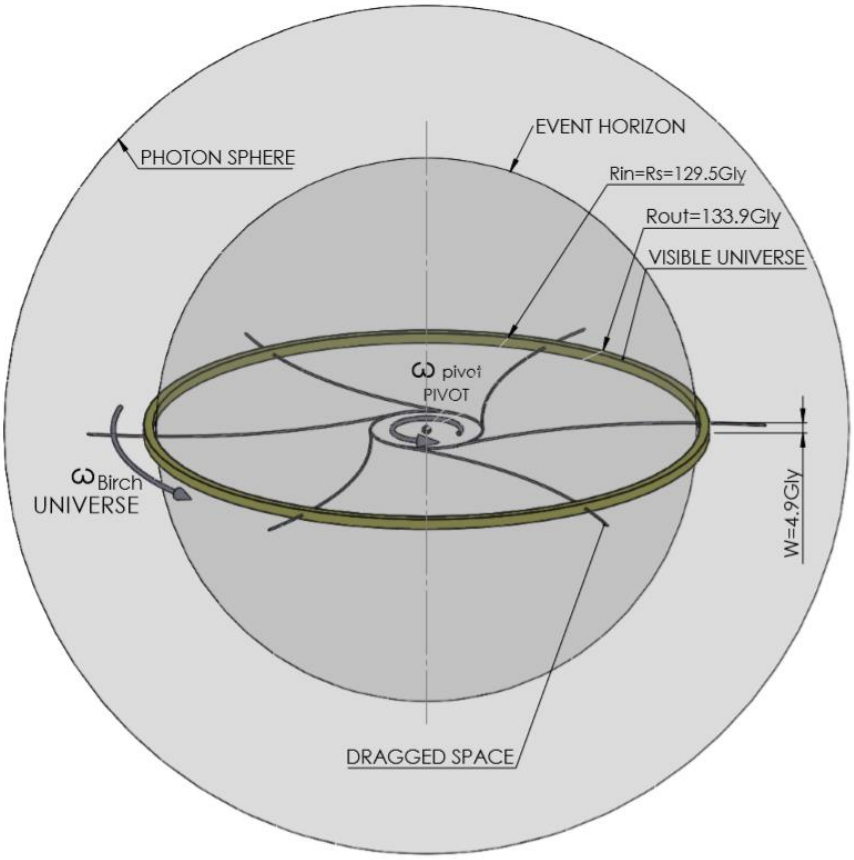

Fig. 4.1- Structure and dimensions of the Pivot Universe

5. The visible Universe is an inertial frame

The reason for including this paragraph is to gives rise for combining Newton's classical law of universal gravitation together with the laws of special relativity (SR). This assumption is used later for other calculations e.g., the flattened rotation curve in spiral Galaxies and the spiral shape of Galaxies. (See paragraphs 7 and 8).

Using Newton's law of universal gravitation, the average velocity V_{avg} of the ring-shaped visible Universe around the Pivot is:

$$V_{avg} = \left(\frac{G \cdot M_p}{R_{avg}} \right)^{0.5} \cong 0.7C \qquad (5.1)$$

It may be claimed that it is not correct to use SR because the celestial bodies are orbiting the Pivot at different orbits, thus having different radial accelerations. I claim that all celestial bodies in the visible Universe may be considered, to a very high degree of accuracy, as inertial frames, and therefore the requirements of SR apply to them. Generally, an inertial frame must fulfill two requirements: 1) There is no acceleration between celestial bodies. 2) The celestial bodies move at a constant velocity in a straight line.

Calculating the radial acceleration of Galaxies gives the following results: The gravity is calculated at R_{in} and at R_{out} :

$$g_{p\_in} = \frac{G \cdot M_p}{R_{in}^{\ 2}} = 3.58 \cdot 10^{-11} \frac{m}{\sec^2} \quad (5.2)$$

$$g_{p\_out} = \frac{G \cdot M_p}{R_{out}^{\ 2}} = 3.27 \cdot 10^{-11} \frac{m}{\sec^2} \quad (5.3)$$

It is demonstrated that the radial acceleration, or the gravity, of the Pivot on the visible Universe is miniscule and is almost the same everywhere in the visible Universe. The second requirement of SR is fulfilled by the fact that the visible Universe radius is so enormous that sections of the visible Universe may be considered as moving at a constant velocity and in parallel straight lines.

6. The Origin of spinning and rotation of celestial bodies

After the explosion of the primeval nucleus, the visible Universe contained only very hot nucleons that were orbiting the Pivot. It took the visible Universe 380,000 years to cool down. When this happened, ordinary atoms were formed, and this was the time that gravity forces between atoms appeared. The local density of the visible Universe was the cause of the variety of celestial bodies. If the density of atoms at a particular region in the visible Universe was too low to enable attraction between them, they remained as a cloud of gas that orbits the Pivot. If the density of atoms was sufficient for interaction between them, stars were created. The variety of celestial body was dependent on the mass of the born star. Some stars that had enough mass to collapse by gravity into neutron stars, even more massive stars collapsed into black holes. The black hole was powerful enough to attract additional stars that started to orbit it. Thus, stars performed now two simultaneously trajectories. One around the Pivot and the other around the black hole - this was the way that Galaxies were created.

Galaxies were formed in the following way: If the mass of the star was big enough it collapsed by gravitation to form a black hole. Once a black hole was created it started to accumulate matter and stars from the surrounding space. Some of the matter/stars were swallowed by the black hole, but other matter/stars started to orbit around the black hole. Fig 6.1 shows trajectories of stars (or any other celestial bodies) around the Galaxy's black hole. Stars that are orbiting the Pivot at a bigger radius than the Galaxy's black hole move slower than the Galaxy's black hole. Stars that are orbiting the Pivot at a smaller radius than the Galaxy's black hole move faster than the Galaxy's black hole. This created a torque on the Galaxy, consequently causing it to simultaneously spin around its black hole and orbiting the Pivot. If the visible Universe orbits the Pivot in a counterclockwise direction, then the spin of the Galaxy is in clockwise direction.

Even though the mass of the supermassive black hole is relatively huge, it can influence only matter/stars that are orbiting near it. For example, the radius of the Milky Way is 100,000 light years Vs. the Schwarzschild radius of its black hole that is $1.3 \cdot 10^{-6}$ light years. But at this stage, additional stars started orbiting around the newborn Galaxy center because the gravitational force exerted on these additional stars the total distributed mass of the Galaxy, rather than the gravity caused by the supermassive black hole. The supermassive black hole played a crucial role in the evolvement of the Galaxy.

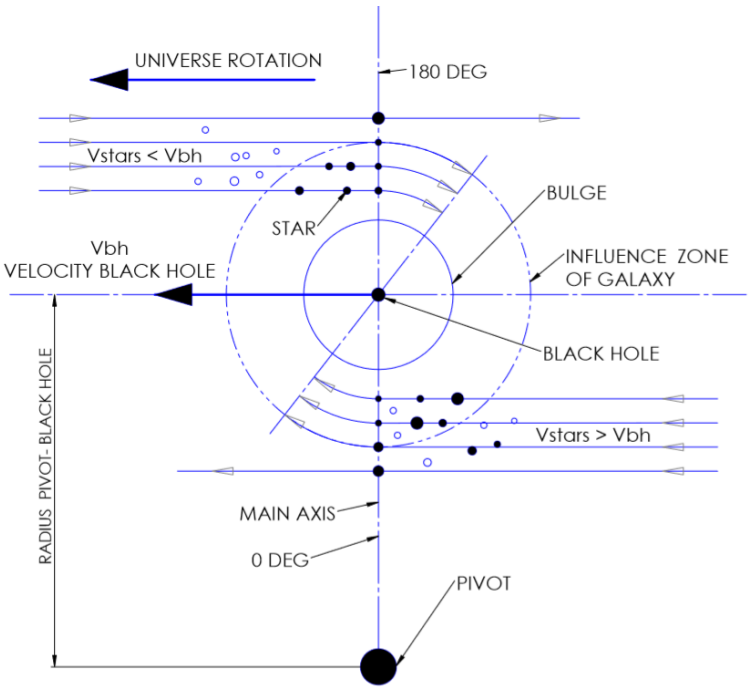

Fig. 6.1 – Trajectories of stars around a Galaxy black hole

7. Rotation curve of a Galaxy

The rotation curve of a Galaxy is a plot of the orbital speeds of stars or gas in that Galaxy versus their radial distance from that Galaxy's center. (See Fig. 7.2). The rotation curves of Galaxies where measured accurately by Vera Rubin and her team. They verified that the rotation curve was flattened, or in other words, that the velocities of stars orbit at roughly the same speed not depending on their distance from the Galaxy's center. This observation is contrary to Newton mechanics that claims that stars that are located further from the Galaxy center will move slower. The Pivot structure can explain the flattening of the rotation curves.

In the previous paragraph, the origin of spinning and rotation of celestial bodies was explained. It has also been calculated in paragraph 6 that any celestial body orbits the Pivot at an average speed of ~0.7C. A celestial body that is part of a Galaxy performs simultaneously two motions. The first is orbiting the Pivot at a speed of ~0.7C. The second is orbiting the center of the Galaxy at a much lower speed of ~ tens to hundreds km/sec. The superposition of the two velocities results in the flattened curve of stars in a Galaxy. The following calculation is done on an arbitrary Galaxy located 150Mly from the Milky Way. It is shown that the exact shape of the curve is dependent on several parameters.

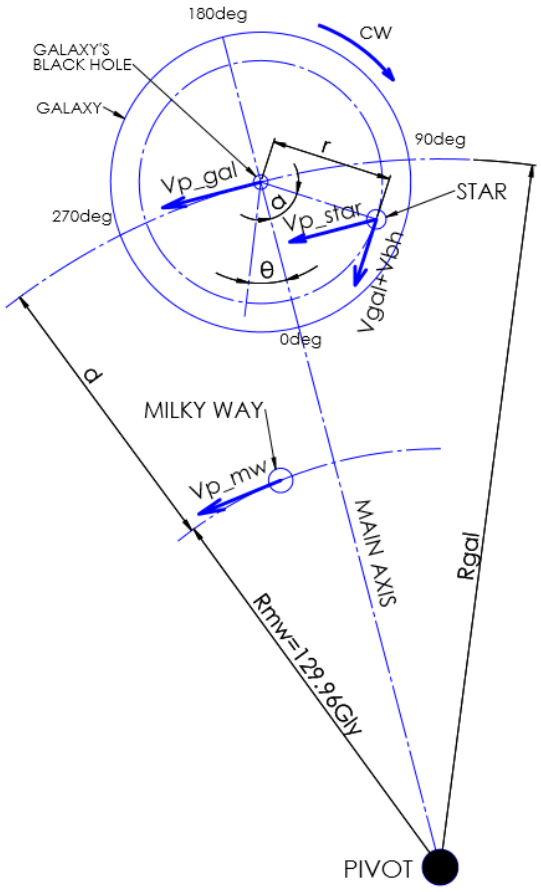

Fig. 7.1 – Velocities of a star

The gravitational forces exerted on a star in a Galaxy are caused by:

a) Distributed mass of the Galaxy.

b) The Black Hole in the center of a Galaxy.

c) The Pivot.

Note: The calculations are done with MathCad software.

a) Velocity of a star due to distributed mass of the Galaxy

$r := 0.0001\,Kly, 0.01\cdot Kly .. 100\cdot Kly$ Distance range of star to its Galaxy center

$r_0 := 30\,Kly$ Assumed characteristic radius.

$$V_{gal}(r) := \begin{cases} \left(\frac{G\cdot M_{gal}}{r_0}\right)^{0.5}\cdot\frac{r}{r_0} & \text{if } 0\cdot Kly \le r < r_0 \\ \left(\frac{G\cdot M_{gal}}{r}\right)^{0.5} & \text{if } r \ge r_0 \end{cases}$$

Rotation velocity due to distributed mass of a Galaxy

(7.1)

b) The velocity of a star around the Galaxy's Black Hole:

$$V_{bh}(r) := \left(\frac{G\cdot M_{bh}}{r}\right)^{0.5} \qquad (7.2)$$

c) The rotation velocity of a star in a Galaxy orbiting the Pivot:

$d := 150\cdot Mly$ Arbitrary assumed distance

$R_{gal} := R_{mw} + d$

$$V_{p\_star}(r,\alpha) := \left(\frac{G\cdot M_P}{R_{gal} - r\cdot\cos(\alpha)}\right)^{0.5} \qquad (7.3)$$

Summation of the three velocities on the star:

$$V_{sum}(r,\alpha) := V_{p\_star}(r,\alpha) + \left(V_{gal}(r) + V_{bh}(r)\right)\cdot\cos(\alpha) \qquad (7.4)$$

Only as a reference, the magnitudes of the three velocities are calculated for a star located 10Kly from the Galaxy's black hole. It is clear that the velocity of a star around the Pivot is dominant.

$V_{p\_star}(10Kly, 0deg) = 210864\,\frac{km}{s}$ $V_{gal}(10Kly) = 5.1\cdot\frac{km}{s}$ $V_{bh}(10Kly) = 0.8\cdot\frac{km}{s}$

Orbital velocity of Milky Way around the Pivot:

$$V_{p\_mw} := \left(\frac{G \cdot M_P}{R_{mw}}\right)^{0.5} \qquad (7.5)$$

The velocities of Galaxies in the Universe, as shown earlier in this paper, are ~0.7C. Therefore, the formulas of SR must be used. The relativistic velocity of a star in a Galaxy as seen by a Milky Way observer is given by:

$$V_{star}(r,\alpha) := \frac{V_{p\_mw} - V_{sum}(r,\alpha)}{1 - \frac{V_{p\_mw} \cdot V_{sum}(r,\alpha)}{C^2}} \qquad (7.6)$$

The rotation curve as observed for Galaxies is somewhat chaotic and is shown is shown in Fig. 7.2. The common characteristic for all observations is that as the distance of a star to the center of its Galaxy increases the curve flattens out.

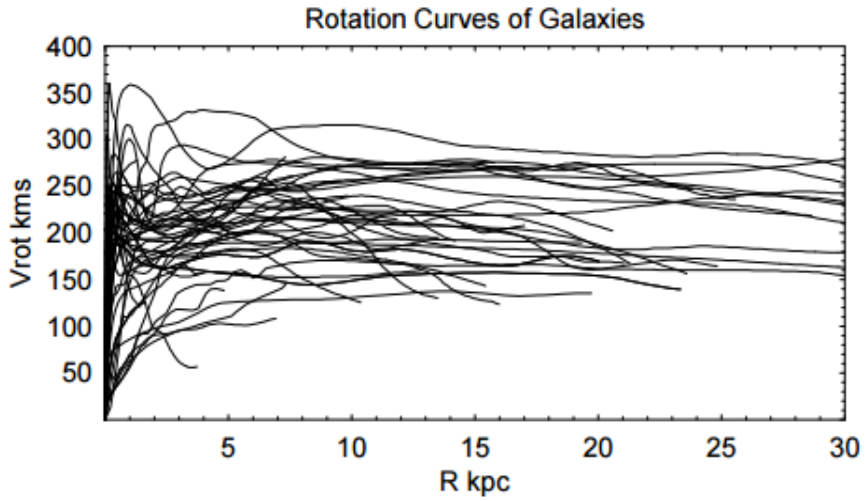

Fig. 7.2 -Rotation curves of Galaxies (from: Sofue [7])

The velocity V_{star} of a star in a Galaxy is given by (7.6) and is shown Fig. 7.3. It is seen that the observed velocities of stars in a Galaxy will be confined between the two extreme curves of the graph (solid red and dashed blue). The exact shape of the graph is dependent mainly on α, d and the mass of Galaxy. It is seen that Fig. 7.3 resembles Fig. 7.2.

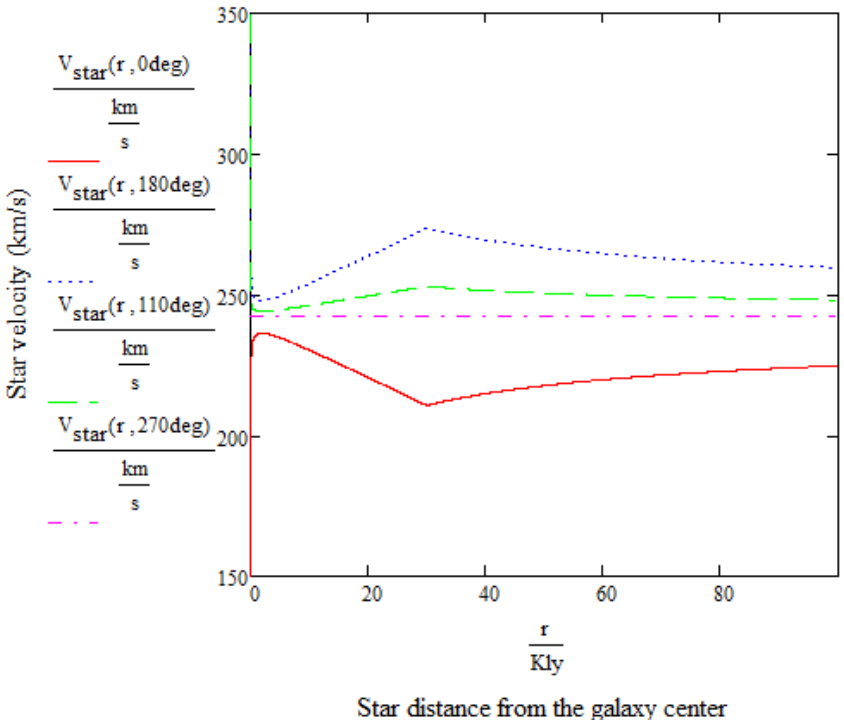

Fig. 7.3 – Rotation curve for a Galaxy at a distance of 150Mly from Milky Way

8. The shape of a spiral Galaxy

The spiral shape of Galaxies is based on the equations used in paragraph 7. Most spiral Galaxies contain a central bulge surrounded by a flat rotating disk of stars. The bulge in the Galaxy center includes a supermassive black hole. The supermassive black hole is created from the cloud of dust and stars that are orbiting the Pivot. This black hole was the kernel of the Galaxy. The size of this black hole varies, and it is also possible that there are Galaxies without black holes at their center. The bulge has an ellipsoidal shape because stars that were attracted by the central black hole in the Galaxy originated not only from stars that were located on the equatorial plane of the Galaxy but also from planes that are "above" or "below" the equatorial plane. Orbiting the bulge, the rotating disk separates itself into arms that that circle the Galaxy center. The spiral arms are the result of the superposition of the velocity of ~0.7C of a star around the Pivot and its velocity around the supermassive black hole at the center of the Galaxy (several hundred km/sec). An additional observation explained by the Pivot theory is why spiral Galaxies may have more than two arms. A Galaxy has more than two arms if during its rotation around the Pivot this Galaxy encountered several dense regions at various times. Each time the Galaxy crosses a dense region a new arm is added to the Galaxy. The width of the arm depends on the size of the dense region. Some Galaxies may encounter so many dense regions, that its arms may appear as an elliptical Galaxy.

The angular displacement, during elapsed time t, of a star orbiting the Galaxy's black hole is designated (θ) (See Fig. 7.1). $\theta(r,\alpha)=\int_0^t \frac{V_{star}(r,\alpha)}{r}dt$, where $V_{star}(r,\alpha)$ is given in (7.6). This integration is done only for stars that are located on the main axis (i.e., the axis that connects the Pivot and the Galaxy's black hole, i.e., angles of 0deg and 180deg – (See Fig. 6.1 and Fig. 7.1). Only at these angles, stars begin to orbit around the Galaxy's center. Fig. 8.1 shows the shape of a spiral shape Galaxy 13 billion years after its creation. It is shown in this figure that the spiral arms have kept their shape even after such a long time.

Note: I am using the MathCad software for calculating (θ). I am adding the "mod" operator to the integral so that the spiral shape is shown only for the last rotation. The "mod" operator - returns the remainder on dividing x by y (x modulo y). In the current case y=360deg. The reason for using this operator is that stars in Galaxies have completed many full rotations around the Galaxy's black hole during 13 billion years. For example, the Milky Way makes a full rotation around the black hole located at its center every ~250 million years. As the Milky Way was formed ~13 billion years ago, it has already completed ~ 52 full turns.

$$\theta_1(r,\alpha) := \mathrm{mod}\left[\left[\int_{0yr}^{13\cdot 10^9 yr} \frac{V_{star}[r,(\alpha)\cdot deg]}{r}\,dt\right]\cdot deg, 360deg\right]$$

$$\theta_2(r,\alpha) := \mathrm{mod}\left[\left[\int_{0yr}^{13\cdot 10^9 yr} \frac{V_{star}[r,(\alpha)\cdot deg]}{r}\,dt\right]\cdot deg, 360deg\right] + 180deg$$

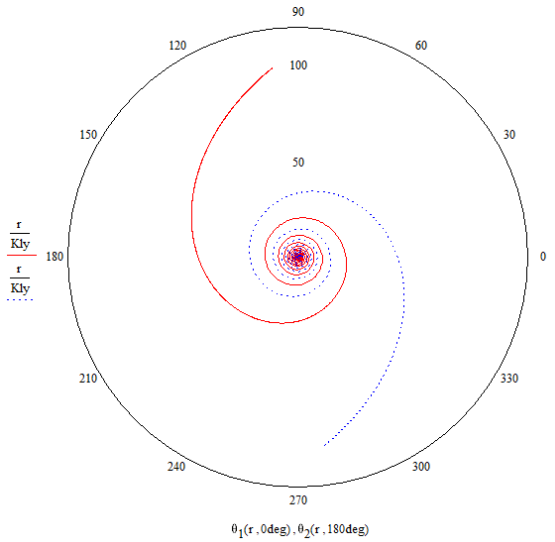

Fig. 8.1 – Shape of a current spiral Galaxy - 13 Billion years after its creation.

It is interesting to show the prediction of the Pivot theory as to what will be the shape of the spiral Galaxy, 26 billion years and 130 billion years after its creation. Fig. 8.2 and Fig. 8.3 show the shape of the spiral after 26 billion years (twice the current Galaxy age) and 130 billion years (10 times the current Galaxy age), respectfully. From the figures, it is shown that the spiral shape is changing at a slow pace over billions of years. However, after 130 billion years the Galaxy will wind up so much that the spiral arms will be hardly recognizable.

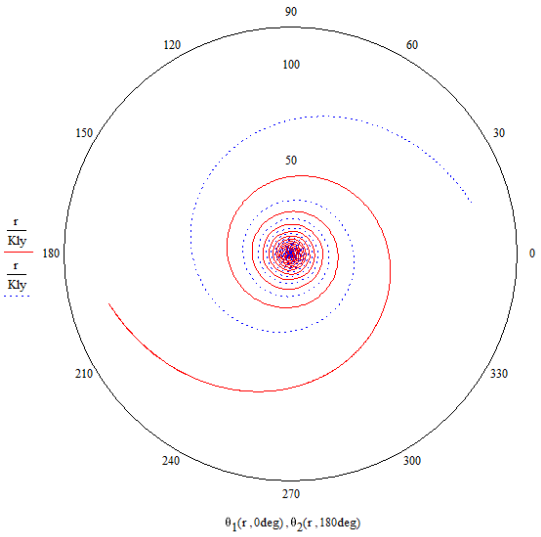

Fig. 8.2 – Shape of spiral Galaxy- 26 billion years after formation

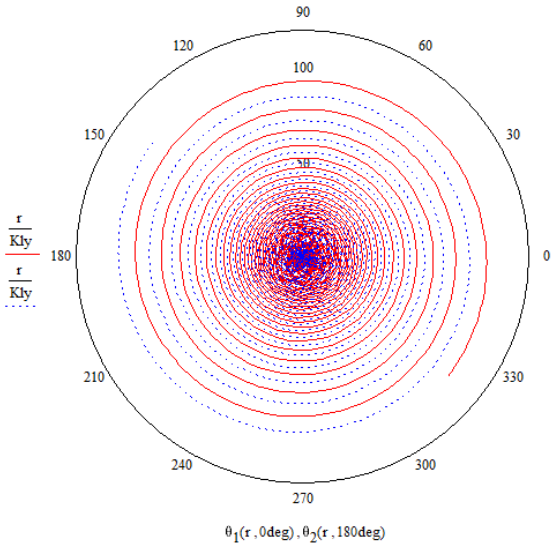

Fig. 8.3 – Shape of spiral Galaxy- 130 billion years after formation

9. Gravitational z shift

The Pivot theory postulates that the gravitational field of the Pivot causes the z shift of Galaxies. It states that electromagnetic radiation originating from a Galaxy orbiting the Pivot is reduced in frequency, or redshifted when observed from a Galaxy that is closer to the Pivot. There is also the Doppler shift that is caused by the difference in the velocities of the observed object and the Milky Way. Since the Pivot theory claims that Galaxies are orbiting the Pivot at different velocities, the Doppler shift cannot be excluded. But, it will be shown later that its contribution to the measured z shift is small.

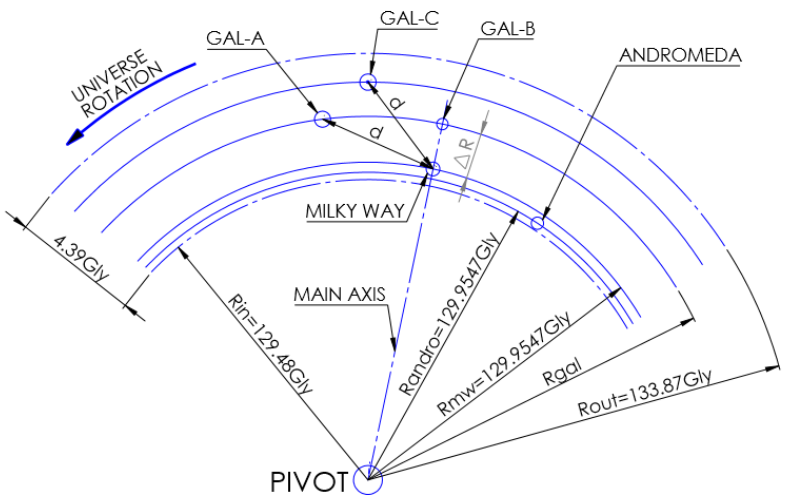

Fig. 9.1 – The Pivot Universe structure shows Galaxies orbiting the Pivot

Fig. 9.1 is a schematic structure of the Pivot Universe. It includes the Pivot, with a ring of the visible Universe orbiting it. Clearly, the inner radius of the ring must be greater than the event horizon of the Pivot. Calculations of the gravitational z shift of a Galaxy Z_{gal_pivot} orbiting the Pivot at a radius R_{gal}, in the gravitational field of the Pivot, is given in equation (9.1) and shown in Fig. 9.2:

$$Z_{gal\_pivot} = \frac{1}{\left(1 - \frac{2 \cdot G \cdot M_p}{R_{gal} \cdot C^2}\right)^{0.5}} - 1 \qquad (9.1)$$

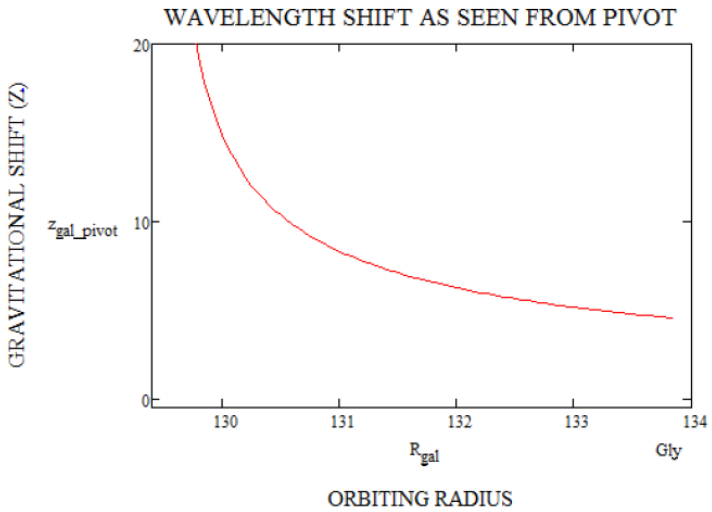

Fig. 9.2 – z shift in the Pivot's gravitational field.

The next step is finding the z shift of Galaxies (Z_{gal}) as seen from the Milky Way. This is done by using the following assumption: Galaxy GN-z11 was found to have the highest z shift ever measured $Z_{gal} = 11.09$. It is **assumed** that GN-z11 is located on the outside radius of the Universe R_{out}. On the other hand, from equation (9.1), the z shift of GN-z11, as seen from the Pivot, is 4.527. Thus, the z shift of the Milky Way Z_{mw}, as seen from the Pivot, can be calculated by equation:

$$Z_{mw} = 11.09 + 4.527 = 15.617 \qquad (9.2)$$

Having Z_{mw} the orbiting radius of the Milky Way R_{mw} is calculated by:

$$R_{mw} = \frac{2 \cdot G \cdot M_p}{\left(1 - \frac{1}{(Z_{mw}+1)^2}\right) \cdot C^2} = 129.954703 Gly \quad (9.3)$$

Now, the z shift of any Galaxy, as seen from the Milky Way Z_{gal} is calculated from:

$$Z_{gal} = Z_{mw} - Z_{gal\_pivot} \qquad (9.4)$$

Having Z_{gal}, the orbiting radius of any Galaxy R_{gal} can be calculated by (9.5) and shown in Fig. 9.3.

$$R_{gal} = \frac{2 \cdot G \cdot M_p}{\left(1 - \frac{1}{(Z_{gal}+1)^2}\right) \cdot C^2} \qquad (9.5)$$

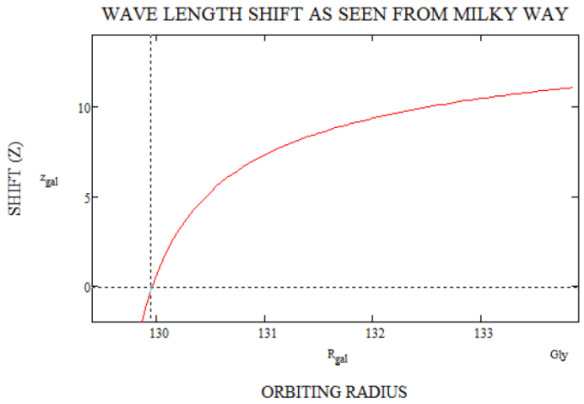

Fig. 9.3 – z shift of Galaxies as seen from Milky Way. The dashed lines relate to the Milky Way: Z_{mw}=0 and $R_{mw} = 129.95 Gly$

10. Blue shifted Galaxies

Fig. 9.1 shows that Galaxies observed from the Milky Way can be either red shifted or blue shifted. For Galaxies that are closer to the Pivot than the Milky Way, $Z_{gal} < 0$. Galaxies that are orbiting the Pivot at a radius larger than the Milky Way radius are red shifted $Z_{gal} > 0$. Had the Milky Way been located on the outer radius of the Universe ring, all Galaxies would have been blue shifted. Referring to Fig. 9.1, GAL-A and GAL-B are shown to have different distances from the Milky Way. Nevertheless, they have the same z shift, because both Galaxies are located on the same orbit. To determine whether the observed Galaxy is approaching or receding the Milky Way, the change in the measured distance should be found.

The Pivot structure explains why there are more observed red-shifted Galaxies than blue-shifted Galaxies. It is clear that the Milky Way orbiting radius is between R_{in} and R_{out}. The distance of the Milky Way from R_{in} is: $R_{mw} - R_{in} = 129.954703\,Gly - 129.4840\,Gly = 0.471Gly = 471Mly$. The distance of the Milky Way from R_{out} is $R_{out} - R_{mw} = 133.868Gly - 129.954703\,Gly = 3.91Gly$.

11. Andromeda Galaxy

Andromeda Galaxy is blue shifted. For Andromeda, it was measured: $Z_{gal} = -0.001001$, distance - 2.5Mly and it is predicted, by others, that the Milky Way and Andromeda will collide in 4Gly. It is interesting to examine the prediction of a collision between Andromeda and the Milky Way, based on the Pivot theory. The orbiting radius of Andromeda R_{andro} is calculated by:

$$R_{andro} = \frac{2 \cdot G \cdot M_p}{\left(1 - \frac{1}{(Z_{mw} + 0.001001 + 1)^2}\right) \cdot C^2} = 129.95465Gly \quad (11.1)$$

The difference in orbiting radiuses of the Milky Way and Andromeda is: $R_{mw} - R_{andro} = 129.954703\,Gly - 129.95465\,Gly = 56.914\,Kly$. The disk diameter of Andromeda is 220Kly, and the disk diameter of the Milky Way is 180Kly. The result is that there is a chance of collision because (220Kly +180Kly)/2 =150Kly > 56.914Kly. A collision will occur if Andromeda and the Milky Way are located on the same plane. However, if the two Galaxies are located on different planes that are separated more than 150Kly, no collision is expected to occur.

To find the time to collision, first the velocity of each Galaxy is found V_{mw} (11.2) and V_{andro} (11.3), then the relativistic velocity between the two Galaxies is calculated (11.4) and finally, the time is calculated (11.5).

$$V_{mw} = (\frac{G \cdot M_p}{R_{mw}})^{0.5} \qquad (11.2\ ) \qquad V_{andro} = (\frac{G \cdot M_p}{R_{andro}})^{0.5} \quad (11.3)$$

$$V = \frac{V_{mw} - V_{andro}}{1 - \frac{V_{andro} \cdot V_{mw}}{C^2}} = 0.092 \frac{km}{\sec} \qquad (11.4) \qquad t = \frac{2.5 Mly}{V} = 8 \cdot 10^{12}\, yr \quad (11.5)$$

The time for a collision between Andromeda and the Milky Way calculated by (11.5)

12. Time dilation in the visible Universe

The Pivot is modeled as a Kerr black hole. The time dilation equation of Kerr metric takes the form of:

$$t_f = \frac{t_0}{\left(1 - \frac{2 \cdot G \cdot M_p \cdot R_{gal}}{C^2 \cdot \rho^2}\right)^{0.5}} \qquad \text{where} \qquad \rho^2 = {R_{gal}}^2 + \frac{J_P}{M_P \cdot C^2} \cdot \cos^2\theta \quad (12.1)$$

The parameters of the Pivot are such that it can be considered as a Schwarzschild black hole. Assuming ($\cos\theta = 1, R_{gal} = R_s$) .

Calculating (13.1) gives: $\frac{J_P}{M_P \cdot C^2} = 9 \cdot 10^{48} m^2 << {R_{gal}}^2 = 1.5 \cdot 10^{54} m^2$ therefore (12.1) becomes:

$\rho^2 = {R_{gal}}^2$

and Schwarzschild time dilation equation (13.2) can be used:

$$t_f = \frac{t_0}{\left(1 - \frac{2 \cdot G \cdot M_p}{C^2 \cdot R_{gal}}\right)^{0.5}} \qquad (12.2)$$

Assuming the time elapsed at the Milky Way is 1 sec, then the time of other Galaxies in the visible Universe is calculated by (12.3) and is shown in Fig. (12.1):

$$t_f = \frac{1\sec}{\left(1 - \frac{2 \cdot G \cdot M_p}{C^2 \cdot R_{mw}}\right)^{0.5}} \cdot \left(1 - \frac{2 \cdot G \cdot M_p}{C^2 \cdot R_{gal}}\right)^{0.5} \qquad (12.3)$$

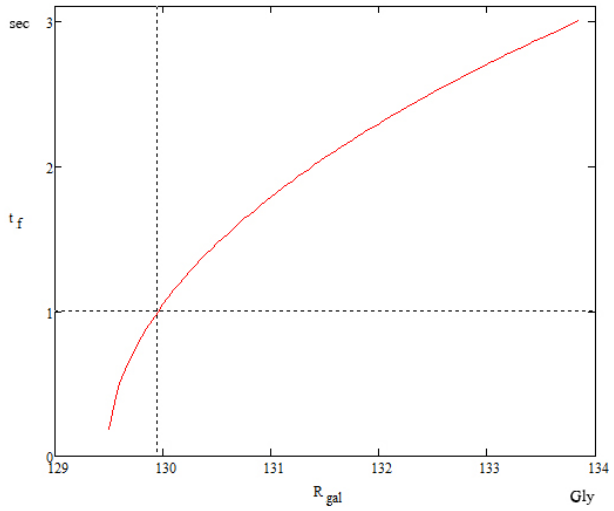

Fig 12.1 – Time dilation in the visible Universe

Assuming the elapsed time in the Milky Way is 1 sec, the elapsed time for a Galaxy located at R_{out} is 3 sec. A Galaxy near R_s the elapsed time approaches 0 sec.

13. Doppler shift Vs. gravitational shift

This paragraph calculates the contribution of the Doppler effect to the observed z shift of a Galaxy. For finding the Doppler shift of an observed Galaxy, first, the orbiting velocities around the Pivot of the Milky Way (13.1) and the observed Galaxy (13.2) should be found. Then, the relativistic velocity of the two Galaxies is calculated (13.3). Subsequently, the Doppler shift is calculated (13.4). Finally, the ratio of the Doppler shift to the total z shift is calculated (13.5) and shown in Fig. 13.1. The Doppler effect contribution to the z shift is less than 0.2%.

$$V_{mw} = \left(\frac{G \cdot M_P}{R_{mw}}\right)^{0.5} = 0.706C \quad (13.1)$$

$$V_{gal} = \left(\frac{G \cdot M_P}{R_{gal}}\right)^{0.5} \quad (13.2)$$

$$V = \frac{V_{mw} - V_{gal}}{1 - \frac{V_{gal} \cdot V_{mw}}{C^2}} \quad (13.3)$$

$$Z_{doppler} = \frac{V}{C} \quad (13.4)$$

$$Ratio = \frac{Z_{doppler}}{Z_{gal} + Z_{doppler}} \quad (13.5)$$

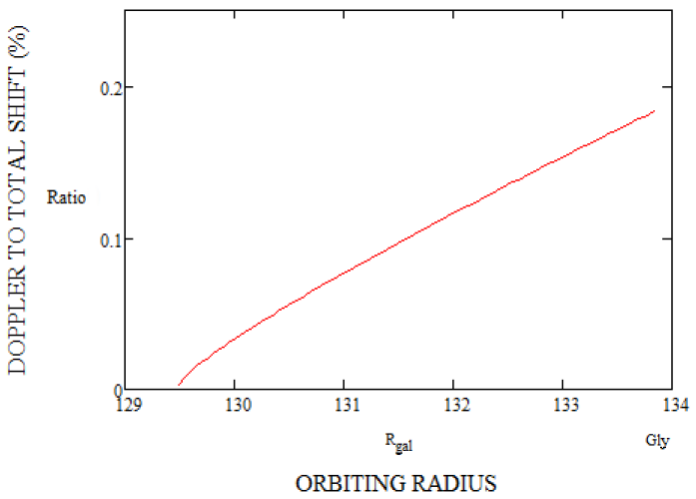

Fig. 13.1 - The ratio of Doppler shift to the total shift

14. Hubble's observations

This paragraph aim is to show that Hubble's law is wrong. I am elaborating on this issue because Hubble's law is in clear contrast to the Pivot theory that claims the Universe has a rotation axis. I am not disputing the correctness of the observations made by Hubble and others. But, I argue that the laws he derived from these observations are wrong.

Hubble's law is a cornerstone in the Big Bang (BB) theory. Hubble's law consists actually of two laws. The first states that Galaxies are receding from each other at a velocity that is linear to their relative distances $V = H_0 \cdot d$. An important conclusion that can be derived from the BB theory is that the Universe "on large-scale" is isotropic and homogenous. The second law claimed by Hubble is $V = z \cdot C$, meaning that there is a linear relationship between the receding velocity and the redshift of a Galaxy. Hubble's laws seemed to be correct at his time when measurements were done on Galaxies near the Milky Way. However, when Hubble's law was used for observations of distant Galaxies with high redshifted the graph curved up. This finding was a basis of an additional paradigm: The Universe is expanding forever in all directions, at an ever-accelerating speed. There are observed Galaxies with z>1.5 that are receding from the Milky Way at speeds greater than the speed of light, Davis & Lineweaver [8]. The accelerated expanding Universe gives rise to yet another theory claiming that to accelerate the Universe expansion at the observed rates, there must be an additional force. This force is dubbed "dark energy". The mass of this dark energy was calculated to be ~70% of all the mass in the Universe.

The confusion, among the scientific community, is great. Kirshner [9] relates to Hubble's diagram (Fig. 14.1): "Staring at his original Hubble diagram, you can see that there is a handful of nearby Galaxies with blue shifts, and a large scatter of velocities at any given distance. Hubble shrewdly used plausible methods to average the data for Galaxies that are at the same distance to

make his result stand out more clearly from the noise. He was fortunate to have data that behaved so well."

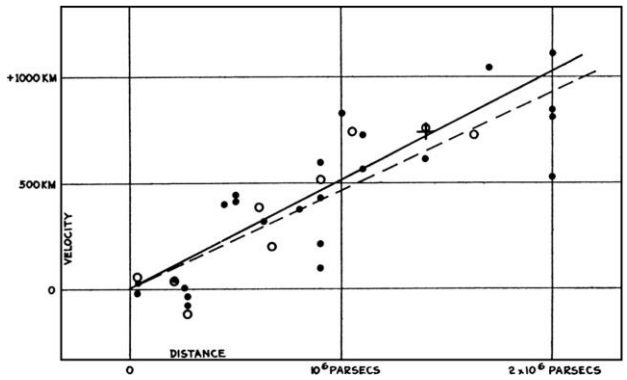

Fig. 14.1 – Hubble's original graph (1929)

Hubble's graph (Fig. 14.1) shows that there is a significant scatter of the measurements. Some Galaxies are located at the same distance from the Milky Way but have different velocities. The Pivot theory can explain Hubble's observations. Fig. 10.1 shows two Galaxies GAL-A and GAL-C having the same distance (d) from the Milky Way, but are located on different radiuses. According to the Pivot theory, they have different z shifts. But according to Hubble, they should have the same redshift and the same velocities. Hubble's law is valid only in a particular case, when the observed Galaxies are located on the main axis (the axis that connects the Milky May and the Pivot), as is shown, e.g., for GAL-B. In this case, $\Delta R=d$ and the relation velocity-distant is linear. To sum up: the linear relation in Hubble's law is velocity-distance, whereas in the Pivot theory the linear relation is between the velocity and the difference in the orbiting radiuses. The relationship between the relativistic velocity of a Galaxy and its radius is calculated by (13.3), and the linear relationship is shown in Fig. 14.2.

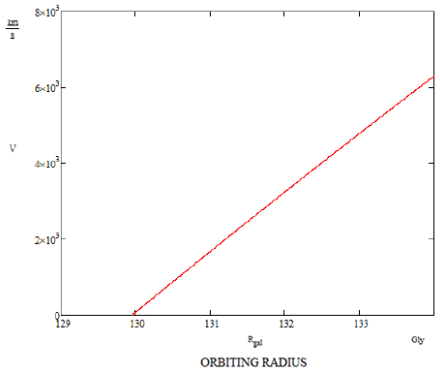

Fig. 14.2 – Linear relation between Galaxy's velocity and its orbiting radius.

From Fig. 14.2 - The maximal and constant recessional velocity of a Galaxy located at R_{out} is ~6200km/s.

From the Pivot model, the relation between the recessional velocity and z can be found by combing (9.4) and (13.3) and the result is shown in Fig. 14.3. Clearly, this is not a linear relation.

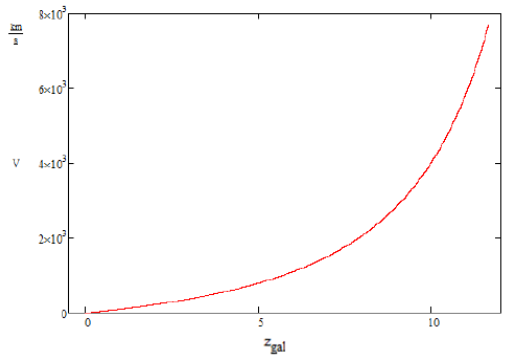

Fig. 14.3 – Velocity of a Galaxy as function of z shift

15. Cosmic Microwave Background (CMB)

A known paradigm in modern cosmology is the cosmological principle. It states that at a "large-scale" (hundreds of million light years), the spatial distribution of matter in the Universe is isotropic and homogeneous. The strongest observational evidence for the cosmological principle is the CMB. Therefore, people may claim that the Pivot Universe, that has a preferred axis, is improbable. I claim that even though the Pivot Universe has a preferred axis, it still agrees with the CMB observation. It is demonstrated in this article, that the Milky Way is located inside a huge observable Universe. According to the calculation based on z shift as shown in paragraph 9, the Milky Way is located 470Mly from R_{in}. This means that the Milky Way is located inside a "large-scale Universe". A Milky Way observer sees a huge number of Galaxies in whatever direction he looks. He may conclude that the entire Universe is isotropic and homogeneous. But for an observer in a Galaxy located on the outer surface of the ring, the Universe is not isotropic and homogenous. In one direction, he will be facing the vacuum which is totally dark and has a temperature of absolute zero. Likewise, an observer that is located on the inner surface of the ring, i.e., facing the Pivot, sees total darkness and measures the temperature of the vacuum. Only an observer that will travel outside the ring of the visible Universe will be able to see that the Universe has an axis of rotation.

16. Olbers' paradox

The paradox is that a static, infinitely old Universe with an infinite number of stars distributed in an infinitely large space would be bright rather than dark. The BB theory explains the paradox by the fact that space is expanding and therefore the emitted light is reduced via redshift. The Pivot Universe, on the other hand, is a finite Universe with a finite number of stars and Galaxies. Outside the ring of the visible Universe, there is the infinite darkness of the vacuum and the darkness of the Pivot. An observer located inside the visible Universe sees a huge number of Galaxies in whatever direction he looks, but eventually, in the background, he sees the total darkness.

17. Handedness of Galaxies

The Pivot theory explains yet an additional observation related to the handedness of the Universe. Longo and others [10] found abundance of left-handed, or counter-clockwise (CCW) Galaxies. The excess is small, about 7 percent, but the chance that it could happen in an isotropic and homogeneous Universe is slim. Fig. 17.1 shows that the observable Universe is contained within a sector of the visible Universe ring. It shows the equatorial plane of the visible Universe and three Galaxies, the Milky Way, and two arbitrary Galaxies: Galaxy A and Galaxy B. The Milky Way is located "above" Galaxy B and "below" Galaxy A. The Pivot theory postulates that all Galaxies rotate in the same direction, opposite to the Universe ring rotation. The location of the Galaxies in relation to the Milky Way will determine the direction of their rotation as seen from the Milky Way. Thus, Galaxy A will be seen as rotating clockwise (CCW), while Galaxy B will be seen as rotating counterclockwise (CW) when observed from the Milky Way. Had the Milky Way been located on the equatorial plane then the number of CCW and CW Galaxies would have been the same. However, if the Milky Way is offset by 7% from the equatorial plane than the number of CCW Galaxies and CW Galaxies will differ by 7%.

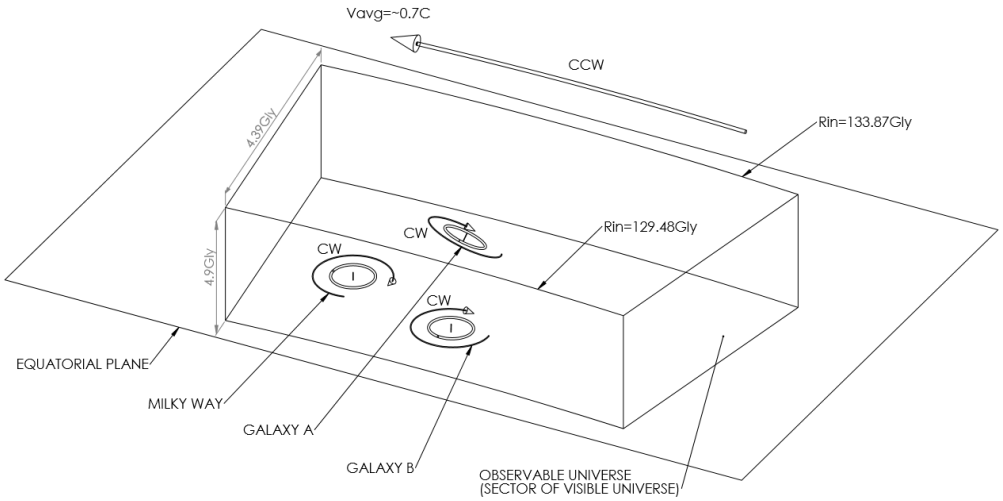

Fig. 17.1- Handedness of Galaxies

18. Summary

The Pivot theory describes a Universe that began as a primeval nucleus. It originated from the vacuum as can be explained by QFT. This primeval nucleon was as a Neutron star that exploded when the velocity on its surface reached the speed of light. Following the explosion, the current Universe was created. The current Universe is composed of a Neutron star the Pivot, that can also be described as Kerr black hole, or and a ring of visible Universe orbiting it in the direction of the Pivot's spin. This structure describes a Universe that is in a state of dynamic equilibrium. Although the Pivot is very massive, it occupies a tiny volume of the Universe. In this sense, the Universe resembles the structure of the atom. The Pivot can be compared to the nucleon of the atom. The Pivot, like the proton, may last forever. On the other hand, the visible Universe may change, stars will consume their energy; Galaxies orbiting in too close orbits will eventually collide, etc. The entire Universe is a finite isolated island in the infinite space, that may last forever.

The Pivot Universe structure explains fundamental questions in physics:

Does the Universe have a reference frame or everything is relative?

What is the origin of gravity?

What is the structure of a black hole?

How are QM and GR connected?

19. Appendix A - The origin of gravity

The gravitational constant G is of profound importance in physics as it is involved in the calculations of gravitational effects in Newton's gravitational law and Einstein's general relativity theory. However, no theory explains its origin. G is an empirical physical constant first measured by Cavendish in 1789 and since then was verified several times.

I claim that the strong force and gravity are the same force. The strongest attractor in the Universe is the Pivot, but it contains only nucleons. Nucleons attract each other by the strong

force. The magnitude of this force changes considerably as a function of the distances between nucleons. In the quantum world, the strong force reigns, but in the Universe, the weak gravity force takes over.

The theory of the origin of gravity is based on the work done by Ma and Wang [11]. They developed formulas based on field theory. The formulas developed relate to the strong force interaction between quarks, nucleons, and atoms. They developed a modified Yukawa potential equation. Yukawa, around 1930, developed a formula for the strong force that indicates that the strong nucleon force between two nucleons is always attractive. However, experimentally, it is now known that the force is attractive and repulsive depending on the distance between nucleons.

The strong force between two nucleons F_n is described by formula 6..12 in [11].

$$F_n = g^2 \cdot \left(\frac{1}{4 \cdot e^2} \cdot \frac{1}{r^2} - \frac{2 \cdot r}{r_1^3} \cdot e^{-\frac{r}{r_1}}\right) \qquad \text{(A.1)}$$

Where:

$g^2 = 10 \cdot \hbar \cdot C$ …Nucleon interaction constant.

Note: Ma and Wang are using the above value of g^2, however this value depends on the energy of the interaction or the distance between particles (TBD).

r …distance between nucleons centers.

$r_1 = 10^{-13} cm$ …Yukawa radius

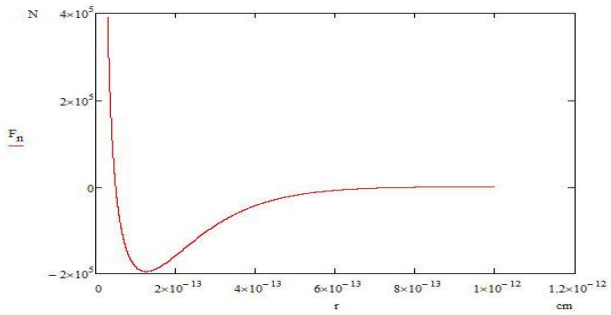

Fig. A.1 – Force between two nucleons as a function of the distance between them.

Figure A.1 is in good agreement with measurements. From the graph, it is also clear that the strong force is reduced substantially as the distance between nucleons grows. For example, at a distance of one hundred centimeters between nucleons, the attractive force is $4.8 \cdot 10^{-26} N$, dropping down from the maximum force of $2 \cdot 10^5 N$ at a distance of $1.3 \cdot 10^{-13} cm$. Here, I postulate that although the force between nucleons in the Universe is extremely small, there is nevertheless, a significant attraction force between celestial bodies in the Universe because each of them contains an enormous number of nucleons. This applies specifically to the Pivot that its

attraction is felt on any celestial body even if the distance between the celestial body and the Pivot is over hundreds of billions light years. In the following paragraph, I will show that the gravitational constant G can be calculated by using other fundamental physical constants.

Examining equation (A.1) shows that $\frac{1}{4\cdot e^{0.5}\cdot r^2} \gg \frac{2\cdot r}{r_1^3}\cdot e^{-\frac{r}{r_1}}$ when the distance between nucleons increases. The meaning of this is that at cosmic distances the second part of the equation (A.1) can be discarded and the attraction force can be written as:

$$F_n = g^2\cdot\frac{1}{4\cdot e^2}\cdot\frac{1}{r^2}$$

Now, consider the force between two celestial bodies one with mass M_1 and the second M_2. The number of the protons in the first body is: $N_1 = \frac{M_1}{m_{proton}}$. The number of protons in the second body is $N_2 = \frac{M_2}{m_{proton}}$

The force between the two bodies each of them containing many nucleons, according to Ma and Wang, is:

$$F_n = 3\cdot g^2\cdot N_1\cdot N_2\cdot(\frac{\rho_0}{\rho_n})^6\cdot\frac{1}{4\cdot e^2}\cdot\frac{1}{r^2} = 3\cdot g^2\frac{1}{m_{proton}{}^2}\cdot(\frac{\rho_0}{\rho_n})^6\cdot\frac{1}{4\cdot e^2}\cdot\frac{M_1\cdot M_2}{r^2} \qquad \text{(A.2)}$$

On the other hand, in Newton's gravitational theory, the force between two bodies is given by:

$$F_G = G\cdot\frac{M_1\cdot M_2}{r^2} \qquad \text{(A.3)}$$

where G - the universal gravitational constant.

By equating F_n (A.2) and F_G (A.3) the value of G can be calculated:

$$G = 3\cdot g^2\cdot\frac{1}{m_{proton}{}^2}\cdot(\frac{\rho_0}{\rho_n})^6\cdot\frac{1}{4\cdot e^2} \qquad \text{(A.4)}$$

Where: $\rho_n = 0.85\cdot 10^{-13}cm$ - the radius of the proton.

Note: In equation (A.4) the effective radius of the quark ρ_0 is not accurately known, therefore, its value is calculated. The result is: $\rho_0 = 0.2809\cdot 10^{-19}cm$. From experiments it is known that its radius is smaller than about $\rho_0 = 20\cdot 10^{-19}cm$.

Equation (A.4) unifies quantum physics, Newton's gravitational law, and GR.

20. Appendix B - Is a black hole a neutron star?

The Pivot was described in this article as a Neutron star from QM point of view, and as a Kerr black hole from GR point of view.

Black holes existence in the visible Universe were predicted by solving GR equations. There is one profound difference between the Pivot and the Black holes in the visible Universe. The Pivot was built by accumulation of nucleons whereas a Black hole in the visible Universe is the result of the gravitational collapse of a massive star. However, the final result is the same. A nucleus in which nucleons that are packed to the maximum allowed density in the Universe.

Karl Schwarzschild in 1915 found an exact solution to Einstein's field equations. This solution predicted that Black holes exist in the Universe. In this solution there is an essential singularity at r = 0, meaning that the density at the center of the Black hole is infinite. This singularity implies that the known laws of physics break down. Einstein rejected this singularity. In a paper from 1939, Einstein concluded that there was no way a Schwarzschild singularity could ever be possible and therefore the Schwarzschild singularity does not exist in physical reality.

This issue can be resolved by postulating that in the physical world all parameters have bounds. There is no mathematical reason why there is a maximum speed in the Universe; however, physics does not allow any speed to exceed the speed of light. The same implies to density. I postulate that the maximum density of matter in the Universe is the density of a proton (or a neutron), i.e., ~6.5*10^17 kg/m^3. This maximum density is found in the nucleus of an atom and a Neutron star. The density of a Neutron star is 3.7x10^17 to 5.9x10^17 kg/m^3, which is comparable to the approximate density of an atomic nucleus of 3x10^17 kg/m^3. Wikipedia [13]

Some theories claim that if the mass of a Neutron star exceeds ~3 sun-masses, it will collapse further to become a Blackhole. One hypothesis assumes that at this point the fermions of the neutron star turn into bosons. Other theories postulate the fermions break to their constituents namely quark gluon plasma. The common denominator to these theories is that the fermions are converted into other elementary particles.

I postulate that also a Black hole, exactly as a Neutron star and a nucleus of an atom, have the same structure. Namely, the nucleons are densely packed to the maximum density possible in the Universe. Specifically, the maximum possible density in the Universe is the density observed in the Universe ~ 6.5*10^17 kg/m^3.

While GR allows theoretically the density to become infinite, quantum theory and quantum experiments show that it is not possible. One of the theoretical reasons is Pauli's exclusion principle which forbids from two identical fermion particles to occupy the same place at the same time. In a Neutron star, the neutrons are packed so densely that they touch each other. To turn into other elementary particles, first the neutrons must be squeezed together so that they overlap, but this is not possible according to Pauli's exclusion principle.

There are QCD experiments that show why squeezing nucleons in a nucleus more than the density of a proton is not possible.

1) Experiments that measure the force between two nucleons as a function of the distance between them show that the force between them can be described by the graph shown in https://en.wikipedia.org/wiki/Nuclear_force . This graph is based on Reid's potential formula. It shows that for a distance smaller than 0.8fm, the force becomes a sizeable repulsive force. Further analyzing Reid's equation shows that at r=0 the potential as well the force between nucleons becomes infinite.
2) Physicists at Jefferson Lab did another experiment https://www.jlab.org/news/releases/quarks-feel-pressure-proton . They measured the distribution of pressure inside the proton. The findings show that the proton's building blocks, the quarks, are subjected to a pressure of 100 decillions Pascal (10^35) near the center of a proton, which is about ten times greater than the pressure in the heart of a Neutron star. The meaning is that the outward-directed pressure from the center of the proton is higher than the inward-directed pressure near the proton's periphery and therefore a Neutron star cannot collapse.

Given the description above, the question now is how come that Black holes are not directly observed in the Universe, while Neutron stars are seen. My answer is: **The visibility depends on the relation between the physical radius of the nucleus and its Schwarzschild radius**. A celestial body will be observed if its physical radius is bigger than its Schwarzschild radius. On the other hand, if a celestial body has a physical radius that is smaller than its Schwarzschild radius, it will be hidden.

The limiting mass and radius between a Neutron star and a Black hole can be found in the following manner:

1. Given a celestial body with mass M.

2. The radius of a densely packed spherical celestial body is:

$$R_n = \rho_n \cdot (\frac{M}{m_{proton}})^{1/3} \qquad (1)$$

where:

Mass of Proton: $m_{proton} = 1.6726 \cdot 10^{-27} kg$

Radius of Proton: $\rho_n = 0.85 \cdot 10^{-13} cm$

3. The Schwarzschild radius of a celestial body is:

$$R_s = \frac{2 \cdot G \cdot M}{C^2} \qquad (2)$$

where:

Gravitational constant: $G = 6.67 \cdot 10^{-11} \frac{m^3}{kg \cdot \sec^2}$

Light velocity: $C = 2.99 \cdot 10^8 \frac{m}{\sec}$

4. Equating Schwarzschild radius of the celestial body to its physical radius; $(R_s = R_n)$:

Gives: $$M_{limit} = (\frac{\rho_n \cdot C^2}{2 \cdot G \cdot m_{proton}^{1/3}})^{3/2} = 1.05 \cdot 10^{31} kg \sim 5.28 Sun - masses. \qquad (3)$$

and $$R_{limit} = 15.69 km$$

From the above calculations, it is shown that the limit between a Neutron star and a Black hole is 5.28 Sun-masses and a radius of 15.69km. A celestial body with a mass higher than 5.28 Sun-masses will become a Black hole because its physical radius is smaller than its Schwarzschild radius.

Observations: This result is in good agreement with observations. The smallest Black hole observed in the Universe is XTE_J1650-500. Its mass is estimated to be ~5 to10 Sun masses. On the other hand, the smallest measured Black hole is GRO 1655-40 with a mass of 6.3 Sun masses. The conclusion is that the limit mass between a Black hole and a Neutron star is between 5 to 6.3 Sun masses. https://en.wikipedia.org/wiki/XTE_J1650-500 Wikipedia [14]

So far, the development of the above equations is based only on classical mechanics. The Schwarzschild radius that was found from the solution of GR equations can be derived directly from the classical equation of the escape velocity from a celestial body. (The first who suggested this was John Michell in 1783). However, in Newton's equations, the spinning of celestial bodies is not taken into considerations. It is known now that all bodies in the Universe spin. A Black hole that is formed by gravitational collapse of a star must retain the angular momentum of the star. In SBH (Schwarzschild Black Hole), the mass collapses to the point that cannot have angular momentum. The conclusion is that SBH is a theoretical solution. But there is an additional solution to GR equations. This solution takes into consideration the spinning of bodies. It was suggested in 1963 by Roy Kerr and is called KBH (Kerr Black hole). Analyzing the Kerr solution shows:

5) KBH has a singularity ring at its center rather than the point singularity of SBH.
6) There is no singularity inside this ring.
7) The KBH has two event horizons the outer event horizon, and an inner event horizon.
8) There is a frame dragging of the space around the Black hole nucleus.

I postulate that:

5) The nucleus of the Black hole resides inside the ring singularity.
6) The density of the nucleus inside the ring singularity is the maximum density possible in the Universe.
7) R_n of the solid nucleus sphere, is equal to the spin parameter a defined by the Kerr solution.

$a = R_n$ ....Assumption

where:

$a = \frac{J}{M \cdot C}$ ...defined by Kerr

J Angular momentum of the Black hole

M Mass of Black hole

$R_{outer} = R_s + \sqrt{R_s^{\,2} - R_n^{\,2}}$ (4) Outer event horizon

Frame dragging around the nucleus is calculated by:

$$\Omega(r) = \frac{R_{outer} \cdot R_n \cdot C}{r^3 + R_n^{\,2} \cdot r + R_{outer} \cdot R_n^{\,2}} \qquad (5)$$

Velocity at r:

$V(r) = \Omega(r) \cdot r$ (6)

In the following examples it is shown that the velocity $V(\mathrm{R}_n)$ is between 0.35C to 1C.

As an example, the biggest supermassive black hole found : $M = 2.1 \cdot 10^{10} \cdot Sunmasses = 4.2 \cdot 10^{40} kg$

$R_n = 2.49 \cdot 10^4 km$ from (1)

$R_s = 6.27 \cdot 10^{10} km$ from (2)

$R_{outer} = 1.25 \cdot 10^{11} km$ from (4)

$\Omega(\mathrm{R}_n) = 12 Hz$ from (5)

$V(R_n) = 1 \cdot C$ from (6)

Another example, the smallest black hole (according to the current article): $M = 5.28 \cdot Sunmasses = 1.06 \cdot 10^{31} kg$

$R_n = 15.71 km$ from (1)

$R_s = 15.76 km$ from (2)

$R_{outer} = 16.98 km$ from (4)

$\Omega(\mathrm{R}_n) = 6.68 \cdot 10^3 Hz$ from (5)

$V(R_n) = 0.351 \cdot C$ from (6)

Note:

Earlier the value of $\mathrm{M}_{\lim it}$ (3) was calculated for a SBH. It seems that this must be changed for KBH because now, $R_n = R_{outer}$ rather than $R_n = R_s$. However solving $R_n = R_s + \sqrt{R_s^2 - R_n^2}$ shows that $R_n = R_s$. Thus the value of $\mathrm{M}_{\lim it}$ applies for SBH as well as for KBH.

21. References

1. P. Birch (1982) – "Is the Universe rotating?". http://buildengineer.com/www.paulbirch.net/IsTheUniverseRotating.pdf
2. Wikipedia. https://en.wikipedia.org/wiki/Observable_Universe#cite_ref-15
3. Wikipedia. https://en.wikipedia.org/wiki/Dark_matter
4. R. M. Muradian (1980). "The primeval hadron: origin of stars, Galaxies and astronomical Universe". http://adsabs.harvard.edu/full/1980Ap%26SS..69..339M
5. Wikipedia https://en.wikipedia.org/wiki/Frame-dragging
6. Potzel (2014) "Clock hypothesis of relativity theory, maximal acceleration, and Mossbauer spectroscopy". https://arxiv.org/abs/1403.2412
7. Y. Sofue (1999). "Central Rotation Curves of Spiral Galaxies". arXiv:astro-ph/9905056
8. T.M. Davis & C.H. Lineweaver (2004) "Expanding Confusion: Common Misconception of Cosmological Horizons and the Superluminal Expansion of the Universe". http://www.publish.csiro.au/AS/pdf/AS03040
9. R.P. Kirshner (2003) "Hubble's diagram and cosmic expansion". http://www.pnas.org/content/101/1/8.long
10. M. J. Longo (2009) - "Evidence for a Preferred Handedness of Spiral Galaxies". https://arxiv.org/abs/0904.2529
11. Ma & Wang "Duality Theory of Strong Interaction". http://www.ejtp.com/articles/ejtpv11i31.pdf#page=113
12. Wikipedia. https://en.wikipedia.org/wiki/Nuclear_force
13. Wikipedia. https://en.wikipedia.org/wiki/Neutron_star
14. Wikipedia. https://en.wikipedia.org/wiki/XTE_J1650-500