The structure of the Pivot Universe

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Abstract

The Pivot theory postulates that our Universe is an isolated island located somewhere in the infinite vacuum space. It is composed of two parts: a massive spinning nucleus designated the Pivot and a ring-shaped visible Universe that orbits this Pivot. The Pivot, from the quantum physics point of view, is composed of neutrons and antineutron packed at the highest possible density in the Universe. From the GR point of view, the Pivot is described as a Kerr black hole. Therefore, the ring-shaped visible Universe must reside outside the event horizon of the Pivot. The Pivot theory postulates that our Universe started as a spinning primeval nucleus. This primeval nucleus accumulated mass from the vacuum space energy. The growth of this nucleus stopped when the velocity on its equator surface reached the speed of light and then exploded into two distinct parts: The Pivot and a ring of the visible Universe.

The theory is verified against known cosmological observations. For example, the flat rotation curve in Spiral Galaxies, the Spiral shape of Galaxies, the high redshift of Galaxies, Michelson-Morley experiment, Sagnac effect, CMB, Nucleosynthesis, and other observations.

Finally, the theory explains two profound issues in physics: the origin of gravity and the conundrum of matter-antimatter.

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

Contents

1. The Pivot theory – Overview

The Pivot theory postulates that our Universe is an isolated island located somewhere in the infinite vacuum space. It is composed of two parts: a massive and slowly spinning nucleus, designated the Pivot, and a thin ring-shaped visible Universe that orbits the Pivot. The Pivot, from the quantum physics point of view, is composed of neutrons and antineutron packed at the highest possible density in the Universe. From the GR point of view, the Pivot can be described as a Kerr black hole. Therefore, the visible Universe must be located outside the event horizon of the Pivot.

The Pivot theory answers profound questions:

How did it all begin?

I accept Newton's hypothesis that the vacuum space (or aether as known at his time) is absolute, eternal, infinite, and permeates everywhere. This vacuum space, according to Quantum Field Theory (QFT), is not empty but is rather endowed with fluctuating fields of energy. Any point in this vacuum space contains energy that has a minimum value designated the vacuum energy. Its behavior is codified in Heisenberg's energy-time uncertainty principle. QFT also teaches that from this vacuum energy, pairs of matter and antimatter particles are perpetually generated, e.g., up quark and its up antiquark, a down quark, and its down antiquark. These pairs pop out in the vacuum, exist for a short time, and then annihilate each other. I postulate that somewhere in the infinite vacuum space, it so happened that two down quarks and one up quark joined together to create a neutron. At the same time, the antimatter particles, namely two down antiquarks and one up antiquark, also joined together to create an antineutron. The neutron and the antineutron cannot annihilate each other because they have the same electrical charge (0). But they attract each other by the strong force. It is also important to note that a neutron and an antineutron have the same spin (1/2), i.e., they spin in the same direction. This event was the beginning of the creation of a primeval nucleus. The vacuum energy in the space is an infinite source of neutrons and antineutron; thus, the process went on. Additional neutrons and antineutrons that were created did not mutually annihilate but were attracted by the strong force to the first pair of neutron and antineutron. In the nucleus, the neutrons and antineutrons are stable, and therefore, they did not decay into protons and antiprotons. The neutrons and antineutrons were packed in the primeval nucleus to the maximum density possible in the Universe. The question that arises now is what stopped the growth of the primeval nucleus? The answer is given in the next paragraph.
The above description is given from the quantum physics point of view. However, the primeval nucleus can also be described by general relativity. As the primeval nucleus grew, its mass was big enough to become a rotating Kerr black hole. GR teaches that a rotating black hole dragged vacuum space around it.

Gravity- During the epoch of the primeval Universe, only the primeval nucleus existed in the infinite vacuum space. The only force holding the nucleus together was the nucleons themselves. Quantum physics teaches that there is an attractive force between nucleons that are located at a sub-atomic distance. This force is designated the strong force. **My claim is that this strong force between nucleons is the origin of gravity between celestial bodies.** At cosmological

distances, the strong force (= gravity) decreases to extremely small values, but, as the number of nucleons in celestial bodies is enormous, there is still considerable gravity force between celestial bodies. Appendix A elaborates on this topic.

Why did the primeval nucleus stop growing?

I postulate that the growth of the nucleus stopped when it reached maximum values possible in the Universe. In addition to the accepted maximum velocity in the Universe, there is also a maximal acceleration possible. The radius of the primeval nucleus grew until the gravity on its surface reached the maximum acceleration possible in the Universe. At this stage, the tangential velocity on the equatorial surface of the primeval nucleus reached the speed of light, and it exploded. Based on cosmological observations, the explosion occurred 13.7 billion years ago. The open question is, how long did it take for the primeval nucleus to reach its maximum size?

How has the Universe evolved into the Pivot structure?

The explosion shattered the outer layers of the primeval nucleus, specifically those regions near its equatorial plane. It caused 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 final result was as follows: A 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. From the GR point of view, the Pivot can be described as a rotating black hole. A black hole has an event horizon; therefore, the visible Universe must reside outside this event horizon. The force that holds the visible Universe in orbit around the Pivot is gravity, which, as pointed earlier, is the manifestation of the strong force at a cosmological distance.

The above description of the primeval nucleus answers the arguably greatest conundrums in physics, namely the question of why there is more matter than its antimatter. Or, in other words, why anything exists at all. As mentioned earlier, the primeval nucleus contained equal numbers of neutrons and antineutron, or in other words, there was symmetry between matter and antimatter. At the moment of the explosion, there was a breaking of the symmetry between matter and antimatter. It so happened that the Pivot remained with more antineutrons than the neutron, whereas the visible Universe contained more neutrons than antineutrons. Neutrons and antineutron are stable when confined in the nucleus. However, free neutrons and free antineutrons outside the nucleus, including the visible Universe, are not stable. Within ~15 minutes after the explosion, the free neutrons decayed into protons, electrons, and antineutrinos. At the same time, the free antineutron decayed into antiprotons, positrons, and neutrinos. In this soup of matter and antimatter in the visible Universe, a mutual annihilation occurred, i.e., protons and antiproton, electron and positron and neutrino and antineutrino. The annihilation of the matter and antimatter particles into energy released a considerable amount of energy that reached high temperatures. The result was that only matter, i.e., protons and electrons, remained in the visible Universe. The Pivot includes more antineutrons than neutrons; nevertheless, it is stable because its constituents, the neutrons, and antineutrons are stable when confined in the nucleus. However, the visible Universe contains 85% protons (with an equal number of electrons) and just 15% neutrons. A question arises what is the source of neutrons in the atom’s

nucleus? This is due to a Beta (+) decay process. In this process, that generally occurs in a proton-rich nucleus, a proton inside the nucleus can converts to stable a neutron, while emitting a positron and an electron neutrino

After the explosion of the ancient nucleus, the visible Universe contained a hot soup of protons and electrons. It took the visible Universe 380,000 years to cool down to 3000K. When this happened, the nucleosynthesis began - electrons began to combine with hydrogen and helium nuclei. The local density of matter in 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 bodies 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. This black hole was powerful enough to attract new stars that started to orbit it. Thus, stars performed two simultaneously trajectories. One around the Pivot and the other around the black hole - 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 ring.
The Pivot structure is verified against known cosmological observations. For example, Origin of spinning and rotation of all celestial objects, flattened rotation curve in Spiral Galaxies, Spiral shape of Galaxies, Redshift of Galaxies, the Blueshift of Galaxies, Cosmic Microwave Background, Handedness of Galaxies, Olbers' paradox, Hubble's observations, CBM, Nucleosynthesis.

Speculative note: It is possible that an additional primeval nucleus could be created, in the same manner, at other places in the infinite space. This gives rise to the existence of additional Universes.

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

Appendix A- The origin of gravity.
It is shown how quantum physics, Newton's gravitational law, and GR can be unified.

Appendix B- Is a black hole a neutron star?
The primeval nucleus was created from the accumulation of matter and antimatter particles from the vacuum space. In contrast, black holes in the visible Universe are the result of the gravitational collapse of massive stars. From the GR point of view, the final result is the same. In both cases, the nucleus contains nucleons that are packed to the maximum density in the Universe. But, from quantum physics, there is a difference. The Pivot is made of neutrons and antineutrons, whereas the black holes in the visible Universe contain only neutrons.

Appendix C- Can Stokes flow describe space?
The GR frame dragging describes the behavior of the vacuum space. I claim that this behavior resembles the behavior of Stokes flow.

2. **Known constants and estimated parameters**

Definitions:

$Gly = 9.46 \cdot 10^{24}\,\mathrm{m}$ …is the distance of billion light years.

$Mly = 9.46 \cdot 10^{21}\,\mathrm{m}$ …is the distance of million light years.

$Kly = 9.46 \cdot 10^{18}\,\mathrm{m}$ …is the distance of thousand light years.

Accepted parameters:

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

$C = 2.9979 \cdot 10^{8} m / \sec$ …is light velocity.

$\rho_{ring} = 10^{-26} kg / m^3$ …is the density of matter in the visible Universe

$\hbar = 1.0545716 \cdot 10^{-34} J \cdot \sec$ …is the reduced Planck's constant.

$m_{neutron} = 1.674927471 \cdot 10^{-27} kg$ …is the mass of neutron.

$R_{neutron} = 0.8 \cdot 10^{-13} cm$ … is the radius of the neutron

2.1 Evaluated and estimated parameters:

Each of the following parameters are my best estimation.

What is the maximum density in the Universe?

One of the central claims of the Pivot theory is that there is a maximum density of matter in the Universe. This maximum density occurs when nucleons of matter are packed so densely that they cannot be squeezed anymore. It is known that neutron stars, atom nucleus, and neutrons have approximately the same maximum density. (See Appendix B).

$$\rho_{\max} \cong \rho_{neutron} = \frac{m_{neutron}}{\frac{4}{3} \cdot \pi \cdot R_{neutron}{}^3} = 7.81 \cdot 10^{17} \cdot kg / \mathrm{m}^3$$

The maximum acceleration in the Universe.

There is a maximum acceleration possible in the Universe. Recent experiments were conducted to find this acceleration. Potzel [1] did such an experiment. He calculated that the maximal acceleration possible in the Universe is $>1.5\cdot 10^{21}\cdot m/\sec^2$. In his paper, he mentions another experiment done by Friedman, who found an acceleration of $1\cdot 10^{19}\cdot m/\sec^2$. The experiments are quite sensitive and more refined experiments are needed.

In this paper, I estimate: $a_{\max}=1.58\cdot 10^{20}\cdot\frac{m}{\sec^2}$. This value was fitted so that the sizes of the Pivot Universe are in accord with observations. Having an accurate measurement of the maximum acceleration in the Universe will enable calculating the exact primeval nucleus mass and radius.

Brich's observation of the spinning Universe.

Birch [2] calculated from the study of position angles and polarization of high luminosity classical double radio sources an angular velocity of the Universe. Although his work has not been convincingly refuted, it was criticized for using improper statistics. He found an approximate value of:

$$\omega_{Birtch}=\sim 10^{-13}\,rad/yr$$

In this paper, I choose $\omega_{Birtch}=0.3905\cdot 10^{-13}\,rad/yr$. This is the angular velocity of the Milky Way around the Pivot. This value was fitted so that the Milky Way radius is within the ring of the visible Universe, but closer to the Pivot than most of the galaxies. This explains the observations that only a few galaxies are blue shifted whereas of most galaxies are red shifted. (See paragraph 5). Having an accurate measurement of this parameter will enable exact calculations of the orbiting radius of the Milky Way.

3. The Primeval Universe

The calculation of the of the primeval nucleus mass $M_{nucleus}$ and its radius $R_{nucleus}$, at the moment it exploded can be derived by using the following assumptions:

1) My claim is that the maximal acceleration in the Universe $a_{\max}$ was reached on the equator surface of the primeval nucleus. From Newton's theory of gravity:

$$a_{\max} = \frac{G \cdot M_{nucleus}}{R_{nucleus}^{\ 2}} \qquad (3.1)$$

Where:

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

$R_{nucleus}$ ...Radius of primval nucleus

2) The following formula is based on the model used for calculating the radius of the atom's nucleus.

$$R_{nucleus} = R_{neutron} \cdot (\frac{M_{nucleus}}{m_{neutron}})^{\frac{1}{3}} \qquad (3.2)$$

This equation resembles the way the radius of atom's nucleus is calculated. The reasoning of using this equation is that the structure of primeval nucleus is similar to the structure of the atom nucleus. The radius of atom's nucleus is calculated by $R = r_0 \cdot A^{1/3}$ where R – radius of the atom's nucleus and A number of nucleons. The value of r_0 varies depending on the atom and is 1.25+/-0.2fm. For the primeval nucleus I assume $r_0 = R_{neutron} = 0.8\,fm$.

3) Mass of primeval nucleus sphere:

$$M_{nucleus} = \frac{4}{3} \cdot \pi \cdot R_{nucleus}^{\ 3} \cdot \rho_{\max} \quad .... \quad (3.3)$$

From equations (3.1), (3.2) and (3.3) the primeval nucleus mass and its radius can be calculated:

$$M_{nucleus} = (\frac{a_{\max} \cdot R_{neutron}^{\ 2}}{G \cdot m_{neutron}^{\ \frac{2}{3}}})^3 = 1.24 \cdot 10^{54} \cdot kg \qquad (3.4)$$

The radius of the primeval nucleus is calculated by:

$$R_{nucleus} = R_{neutron} \cdot (\frac{M_{nucleus}}{m_{neutron}})^{\frac{1}{3}} = 7.24 \cdot 10^{8} \cdot km \qquad (3.5)$$

The angular momentum of the primeval nucleus is calculated based on the primeval hadron theory described by Muradian [3]. He uses the generalized Regge's law general formula which connects the maximal spin J and the mass m of a celestial object. He showed that the calculated values of J and m of celestial bodies are in good agreement with observations. Therefore, the angular momentum of the primeval nucleus $J_{nucleus}$ is:

$$J_{nucleus} = \hbar \cdot \left(\frac{M_{nucleus}}{m_{neutron}} \right)^{\frac{3}{2}} = 2.13 \cdot 10^{87} J \cdot \sec \quad (3.7)$$

The explosion of the primeval nucleus occurred when the tangential velocity at the equator of the primeval nucleus was equal to the speed of light C. The angular velocity of the nucleus $\Omega_{nucleus}$ was at that moment:

$$\Omega_{nucleus} = \frac{C}{R_{nucleus}} = 4.14 \cdot 10^{-4} \cdot rad / \sec \quad (3.8)$$

4. The structure of the Pivot Universe

In this paragraph, the sizes of the Pivot and the ring-shaped visible Universe are calculated. Angular momentum and mass conservation laws are used to calculate the mass and dimensions of the Pivot Universe. Namely, the angular momentum of the Pivot Universe must be equal to the angular momentum of the primeval Universe $J_{nucleus}$ (3.7). The angular momentum of the Pivot Universe is the sum of the angular momentum of the Pivot + the ring visible Universe. In addition, the mass of the Pivot + the mass of the ring visible Universe + the mass of annihilated matter must be equal to the mass of the primeval nucleus.

The calculation is done in the following steps:

4.1 Based on general relativity equations relating to a system composed of a slowly rotating black hole and a axisymmetric ring of matter around it, the angular momentum of the Pivot J_{pivot} and the angular momentum of the ring J_{ring} are equal: See S. Hod [4]

$$J_{pivot} = J_{ring} = \frac{J_{nucleus}}{2} = 1.06 \cdot 10^{87} J \cdot \sec \qquad (4.1)$$

4.2 The mass of the Pivot is found by using (3.7):

$$M_{pivot} = (\frac{J_{pivot}}{\hbar})^{\frac{2}{3}} \cdot m_{neutron} = 7.82 \cdot 10^{53} kg \quad (4.2)$$

4.3 The Schwarzschild radius of the Pivot is:

$$R_H = \frac{2 \cdot G \cdot M_{pivot}}{C^2} = 122.76 \cdot Gly \qquad (4.3)$$

4.4 The Pivot Universe structure is similar to the known GR structure of the composed black-hole-ring system. GR teaches that there is an Innermost stable circular orbit (ISCO) which marks the inner radius of a particle orbiting the black hole. According to GR, a particle can stably stay in orbit around a massive object if its orbiting radius is greater than ISCO. The ISCO of a ring orbiting the black hole differs from the ISCO of a particle. Clearly, the inner radius must be greater than the Schwarzschild radius. I assume a ratio of 1.001 between the inner radius of the visible Universe ring and the Schwarzschild radius of the Pivot.

$$R_{in} = R_{isco} = 1.001 \cdot R_H = 122.88 \cdot Gly \quad (4.4)$$

4.5 In order to find the outer radius and the width of the visible Universe ring more assumptions must be done. Cosmological observations show that the majority of galaxies have a red z shift and only a few galaxies have blue z shift. The meaning is that the radius of the Milky Way R_{mw} is slightly bigger than R_{in} thus, most of galaxies have an orbital radius that is bigger than the Milky Way radius. A detailed explanation is in paragraph 5- Gravitational z shift.

The mass of the ring is found based on mass conservation law. During the explosion free neutrons and antineutrons annihilated. The mass that was annihilated is estimated to be $M_{anihilation} = 3 \cdot 10^{52} kg$, and therefore the mass of the ring-shaped visible Universe is:

$$M_{ring} = M_{nucleus} - M_{pivot} - M_{anihilation} = 4.3 \cdot 10^{53} kg \qquad (4.5)$$

To find the total angular momentum of the Pivot universe the angular momentum addition law is used:

$$M_{total} = M_{pivot} + M_{ring} = 1.21 \cdot 10^{54} kg \qquad (4.6)$$

$$J_{total} = \hbar \cdot \left(\frac{M_{total}}{m_{neutron}} \right)^{\frac{3}{2}} = 2.05 \cdot 10^{87} J \cdot \sec \qquad (4.7)$$

In order to find the outer radius of the ring-shaped visible universe R_{out} I use the frame dragging of space by the Pivot predicted by GR. The angular velocity of dragged space in the plane of the Pivot's equator is not constant but rather dependent on the radius r according to: See Wikipedia [5].

$$\Omega(r) = \frac{R_H \cdot \alpha \cdot C}{r^3 + \alpha^2 \cdot r + R_H \cdot \alpha^2} \qquad (4.8)$$

Where: $$\alpha = \frac{J_{total}}{M_{total} \cdot C} = 0.6 Gly$$

The outer radius of the ring R_{out} is found by equating the angular momentum of a disk about its central axis to J_{ring} from Eq. (4.1).

$$J_{ring} = \frac{1}{2} \cdot M_{ring} \cdot (R_{in}{}^2 + R_{out}{}^2) \cdot \frac{\Omega(R_{in}) + \Omega(R_{out})}{2} ..... \Rightarrow R_{out} = 253.67 Gly \qquad (4.9)$$

The width of the visible Universe W is found by:

$$W = \frac{M_{ring}}{\rho_{ring} \cdot \pi \cdot (R_{out}^2 - R_{in}^2)} = 0.33 \cdot Gly \qquad (4.10)$$

4.6 This paragraph relates to the Pivot. The radius of the Pivot R_{pivot} :

$$R_{pivot} = R_{neutron} \cdot (\frac{M_{pivot}}{m_{neutron}})^{\frac{1}{3}} = 6.21 \cdot 10^8 km \qquad (4.11)$$

The angular velocity of the Pivot is $\Omega(R_{pivot}) = 5.31 \cdot 10^{-17} rad / \sec$ (4.12)

The tangential velocity on the surface of the Pivot is:

$$V_{pivot} = \Omega(R_{pivot}) \cdot R_{pivot} = 0.03 \cdot mm / \sec \quad (4.13)$$

Conclusion: In GR terms the Pivot is a slow spinning Kerr black hole.

4.7 Finding the orbiting radius of the Milky Way.

From the frame dragging equation (4.8), the angular velocity of a galaxy is dependent on its orbital radius around the Pivot. The orbiting radius of the Milky Way (R_{mw}) can be found by equating Birch's measured angular velocity $\omega_{Birch} = 0.3905 \cdot 10^{-13} rad / yr$ to the angular velocity $\Omega(r)$ of Eq (4.8).

$$\omega_{Birch} = \frac{R_H \cdot \alpha \cdot C}{{R_{mw}}^3 + \alpha^2 \cdot R_{mw} + R_H \cdot \alpha^2} ..... \Rightarrow R_{mw} = 123.36 Gly \qquad (4.14)$$

Additional Notes on the Pivot Universe:

1. *Size of the Pivot relative to Universe* - The calculated radius of the Pivot is $6.21 \cdot 10^8 km$. For comparison only, the distance of Jupiter from the Sun is $7.8 \cdot 10^8 km$. This size of the Pivot is impressive, but it is dwarfed when compared to the radius of the visible Universe ring. This ratio is: $Ratio = \frac{R_{pivot}}{R_{out}} = 2.59 \cdot 10^{-16}$.
2. *Angular momentum of celestial bodies.* - The calculations of the angular momentum of the visible Universe ring, should include the spinning angular momentum of all celestial bodies, i.e., Galaxies, stars, planets, interstellar planets. 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, 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: $N_{planet} = 10^{24}$. $J_{objects} = 2 \cdot 10^{85} erg \cdot \sec << J_{ring} = 1.06 \cdot 10^{94} erg \cdot \sec$ and therefore, can be neglected.

3. *Velocity of a celestial body - Newton Vs. Birch*
   The velocity of the Milky Way galaxy around the Pivot can be calculated by:

$$V_{Birch} = \omega_{Birch} \cdot R_{mw} = 0.0048c\,.$$

   However, when the velocity of the Milky Way is calculated according Newton's gravity law of gravity the velocity is:

$$V_{Newton} = (\frac{G \cdot M_{pivot}}{R_{mw}})^{0.5} = 0.71c$$

   This is a discrepancy of 146 times. The explanation is that in Newton's law the distance between two celestial bodies is not the straight line connecting the centers of the two bodies but rather the geodesic between their centers. Newton's law is approximately correct for bodies that do not drag significantly the space around them. However, the Pivot drags significantly space around it and the length of the geodesic between the Pivot and the Milky Way is much higher than R_{mw}.

4. *Velocity of Space around the Pivot* - Fig. 4.1 shows the velocity of the dragged space around the Pivot. $\Omega(r)$ according to (4.8)

$$V(r) = \Omega(r) \cdot r \quad (4.15)$$

In the range of $r = 0.6Gly \leftrightarrow 8.21Gly$ the velocity of the dragged space is higher than the speed of light, reaching a peak of 3.1C. This range can be considered as a singularity ring. (Note: the singularity ring was predicted by Kerr, except that in Kerr's solution it has no width). I claim that material crossing the event horizon of the Pivot (@ $R_H = 122.76 \cdot Gly$), plunges towards the Pivot but will not reach the Pivot because it will be annihilated at the singularity ring. The annihilated energy is ejected via two opposing jets along the axis of rotation.

Fig. 4.1 – Velocity of dragged space around the Pivot

5. *The structure of the Pivot Universe-*

Figure 4.2 depicts the structure of the Pivot Universe schematically. The Pivot is a nucleus whose center is fixed in space, but it spins around an axis through this fixed point. The thin ring-shaped visible Universe is located outside the event horizon and rotates in the same direction of the Pivot. The thin ring-shaped visible Universe shape is confirmed by experimental data that shows that the visible Universe is flat with only a 0.4%. The Pivot cannot be observed by an observer located at the visible Universe ring because he is located outside the event horizon. In the figure, it is also shown schematically - the dragging geodesics of space around the Pivot: on the equator plane and about the axis. The ring-shaped Universe is located in space at such a distance from the Pivot that the velocity of the dragged space is equal to the tangential velocity of celestial bodies in the visible Universe. Thus, there is no relative motion between dragged space and the celestial bodies in the visible Universe. The figure also shows schematically the trajectory of a celestial body rotating the Pivot. The center of this celestial body orbits the Pivot at a velocity V, precisely as the speed of the dragged space. However, there is a difference in the velocities of regions on the body. The region that is closer to the Pivot moves at $V+\Delta V$. The region that is further from the Pivot moves at $V-\Delta V$. As a result, the body must spin around its center in the direction opposite the spin of the Pivot. This configuration explains both the Michelson-Morley experiment (M-M) and the Sagnac effect.

M-M experiment: If "V" is precisely in the direction of the trajectory than there, the result from M-M is null. However, the situation is more complicated because a celestial body may also rotate around its star, and the star rotates around the center of its galaxy. Indeed, the results from various tests of M-M show that the velocity of Earth relative to space is varying and not precisely null.

The Sagnac effect is explained by the fact that all bodies, no matter their size, spin naturally in a direction opposite to the Pivot's spin. The magnitude of this natural spin is constant along the trajectory. Now, if the spin of the celestial body is changed artificially, for example, in Sagnac gyro, then there is a difference between the natural spin and the artificial spin that can be measured by the Sagnac effect.

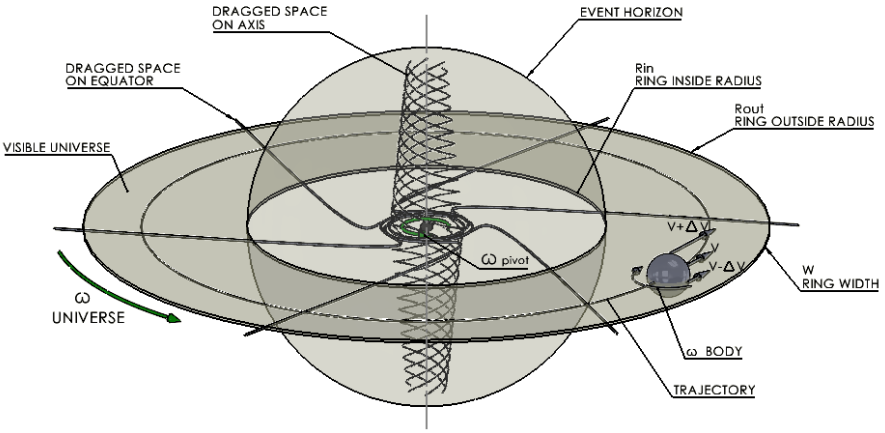


Fig. 4.2 - Structure and dimensions of the Pivot Universe

5. Gravitational z shift

The Pivot theory postulates that the main contributor to the z shift of galaxies is the gravitational field of the Pivot, rather than the Doppler shift. In Fig. 5.1 the colors of z shift are shown schematically. The frequency is blue shifted when a galaxy is closer to the Pivot. Galaxies further from the Pivot are red shifted. It was demonstrated earlier that the Milky Way is closer to R_{in} than most of the galaxies. Therefore, only few galaxies are blue shifted $Z_{gal} < 0$ (e.g., Andromeda). The majority of galaxies 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.

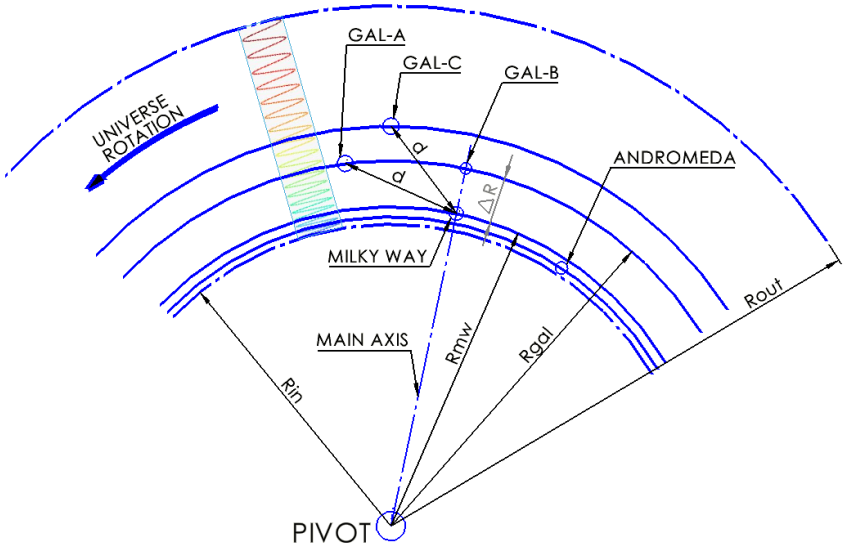


Fig. 5.1 – The Pivot Universe structure shows galaxies orbiting the Pivot

Referring to Fig. 5.1, 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. On the other hand, it is possible that GAL-A and GAL-C have the same distance from the Milky Way but have different z shift. Since the Pivot theory claims that galaxies are orbiting the Pivot at different velocities, the Doppler shift cannot be excluded. However, it will be shown later (see paragraph 8) that the Doppler redshift contribution to the measured z shift is small.

The gravitational z shift of a galaxy Z_{gal} orbiting the Pivot at a radius R_{gal}, is calculated by GR Eq. (5.1):

$$Z_{gal}(R_{gal}) = \frac{1}{\left(1 - \frac{2 \cdot G \cdot M_{pivot}}{R_{gal} \cdot C^2}\right)^{0.5}} - 1 \qquad (5.1)$$

The z shift of the Milky Way can be calculated because the radius of the Milky Way R_{mw} is known

$$z_{mw} = \frac{1}{\left(1 - \frac{2 \cdot G \cdot M_{pivot}}{R_{mw} \cdot C^2}\right)^{0.5}} - 1 = 12.75 \quad (5.2)$$

Now, the orbiting radius R_{gal} of any galaxy can be found by the measurement of z shift as seen the Milky Way z_{gal}.

$$R_{gal} = \frac{2 \cdot G \cdot M_{pivot}}{\left(1 - \frac{1}{(z_{mw} - z_{gal} + 1)^2}\right) C^2} \quad (5.3)$$

Two examples of finding the orbiting radius of Galaxies using Eq. (5.3):

1) The measured blue shift of Andromeda galaxy is: -0.001001. This gives (from 5.3) that radius of Andromeda around the Pivot is: $R_{andromeda} = 123.3597 Gly$. The Milky Way radius $R_{mw} = 123.3597 Gly$ differs from Andromeda by only $84 Kly$. The sum of the radius of the Milky Way + the radius of Andromeda is greater than the difference in the radiuses $60 Kly + 110 Kly > 84 Kly$. This means that both galaxies will collide in the future.
2) The currently measured highest redshift is of galaxy GN-z11: 11.09. The calculated radius of GN-z11 is $R_{GN\_z11} = 135.66 Gly$, i.e., $12.3 Gly$ further away from the Pivot than the Milky Way.

6. The Origin of spinning and rotation of celestial bodies

After the explosion of the primeval nucleus, the ring-shaped visible Universe contained very hot soup of nucleons and electrons that orbited the Pivot. It took the visible Universe 380,000 years to cool down. When this happened, ordinary atoms were formed.
The celestial bodies were created as a result of atoms attracting each other by gravity. The local density of the visible Universe was the cause of the variety of celestial bodies, i.e., dust, stars, neutron stars, and galaxies. If the density of atoms at a particular region in the visible Universe ring was too low to enable significant 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 bodies was dependent on the mass of the born star. Some stars that had enough mass to collapse into neutron stars. 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. The black hole swallowed some of the matter/stars, but other matter/stars began to orbit around it. Fig 6.1 shows trajectories of stars 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 torque on the galaxy, consequently causing it to simultaneously spin around its black hole and orbiting the Pivot in a counter direction of the Pivot's spin. The black hole in the galaxy's center played a crucial role in the first stages of the Galaxy evolvement. Even though the mass of the black hole in the center of the galaxy is relatively huge, it can influence only stars that are orbiting near it. But at this stage, new stars were attracted to the galaxy by the distributed mass of the new galaxy, rather than the gravity caused by the supermassive black hole.
Note: An alternative explanation of the spinning and rotation of celestial bodies is Stokes flow- see Appendix C

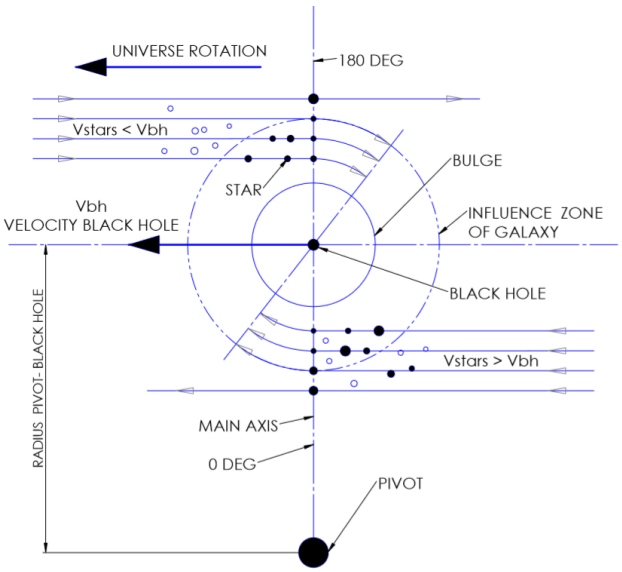


Fig. 6.1 – Trajectories of stars around a galaxy's black hole

7. Rotation curve and spiral shape 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.

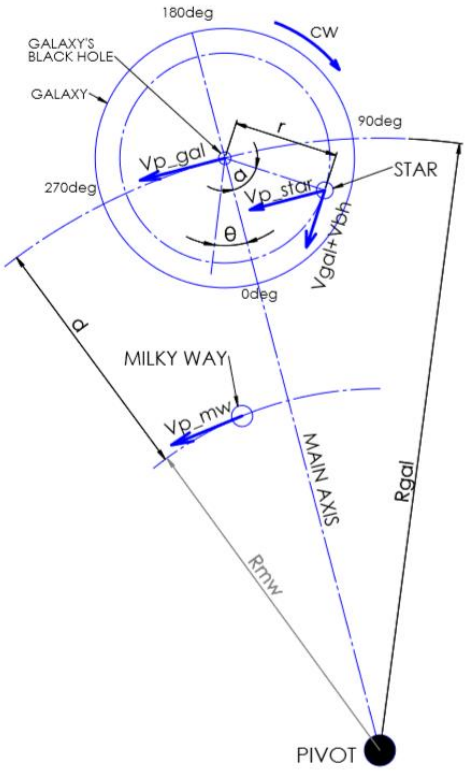


Fig. 7.1 – Velocities of a star in a galaxy

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.

Data:

$M_{gal} = 10^{39}\,kg$ … is an average mass of a galaxy.

$M_{bh} = 10^{36}\,kg$ … is the average mass of a black hole in the center of a galaxy.

$d = 50\,Mly$ … distance between the Milky Way to a center of a galaxy

$R_{gal} = R_{mw} + d$ … is the distance between a galaxy and the Pivot.

$r = 0...140\,\mathrm{Kly}$ …is the distance from the star to the black hole of the galaxy

$r_0 = 30\,\mathrm{Kly}$ ... is an estimated characteristic radius of distributed mass of the galaxy. (see (7.1)

$V_{sun\_bh} = 213 \cdot km/s$ …is the velocity of the Sun around Milky Way black hole

$V_{\mathrm{earth\_sun}} = 30 \cdot km/s$ …is the velocity of Earth around the Sun

$\alpha = 0 \cdot Deg..360 \cdot Deg$ …Angle, see Fig. 7.1

a) Velocity of a star due to distributed mass of the galaxy according to Newtonian dynamics: (Note: this is an approximation because Newton related to a sphere and a galaxy has a thin-disk shape)

$$V_{gal}(r) := \begin{cases} \left(\dfrac{G \cdot M_{gal}}{r_0}\right)^{0.5} \cdot \dfrac{r}{r_0} & \text{if } 0 \cdot Kly < r \le r_0 \\ \left(\dfrac{G \cdot M_{gal}}{r}\right)^{0.5} & \text{else} \end{cases} \qquad (7.1)$$

b) The velocity of a star around the galaxy's Black hole:

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

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

$$V_{p\_star} = \Omega\ (R_{gal}) \cdot (R_{gal} - r \cdot \cos(\alpha)) \qquad (7.3)$$

Summation of the three velocities on the star gives:

$$V_{sum} = V_{p\_star} + (V_{gal} + V_{bh}) \cdot \cos(\alpha) \qquad (7.4)$$

Orbital velocity of Milky Way around the Pivot:

$$V_{p\_mw} = \omega_{Birch} \cdot R_{mw} = 0.013C \qquad (7.5)$$

The velocity of a star in a galaxy as seen by an Earth observer is given by:

$$V_{star} = V_{p\_mw} - V_{sum} + (V_{sun\_bh} + V_{earth\_sun}) \qquad (7.6)$$

Figure 7.2 shows the velocities of stars in an arbitrary galaxy as seen from Earth. The red curve is a star velocity in a galaxy and it is flattened out as r becomes bigger. Some of the curve velocities of stars will be flattened, similar to the red curve. In any case, all the curves are confined between the two extreme curves of the graph (the black and the blue). The exact shape of the graph is dependent on α, d, r, and the mass of the galaxy's black hole.

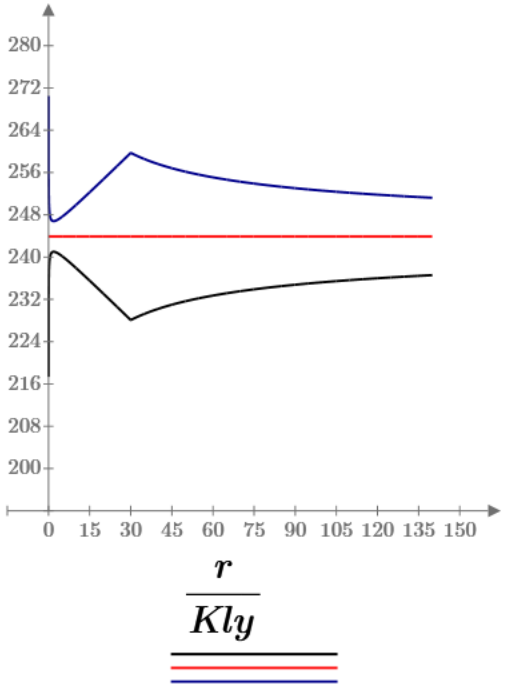


Fig. 7.2 – Rotation curve for a galaxy at as seen by Earth observer

The shape of a spiral galaxy

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 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. The spiral arms of a galaxy are the result of the superposition of the motion of a star around the Pivot and its motion around the supermassive black hole at the center of the galaxy. Spiral Galaxies may have more than two arms if the 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.

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. 7.3 shows the shape of a spiral shape galaxy 10 billion years after its creation. The reason for using the modulo operator in the following equations is that stars in Galaxies have completed by now many full rotations around the galaxy's black hole. For example, the Milky Way makes a full rotation around the black hole located at its center every ~250 million years. Thus, the Milky Way has completed during its life ~54 full revolutions.

It is interesting to show the prediction of the Pivot theory as to what will be the shape of the spiral galaxy 50 Billion years after its creation. From Fig. 7.4 it can be concluded that the spiral shape of a spiral galaxy is changing at a slow pace over billions of years.

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

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

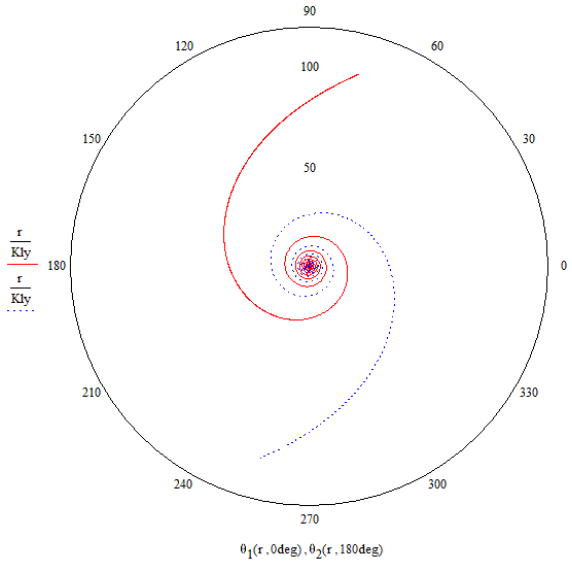


Fig. 7.3 – Shape of a spiral galaxy at t =10 Billion years after its creation.

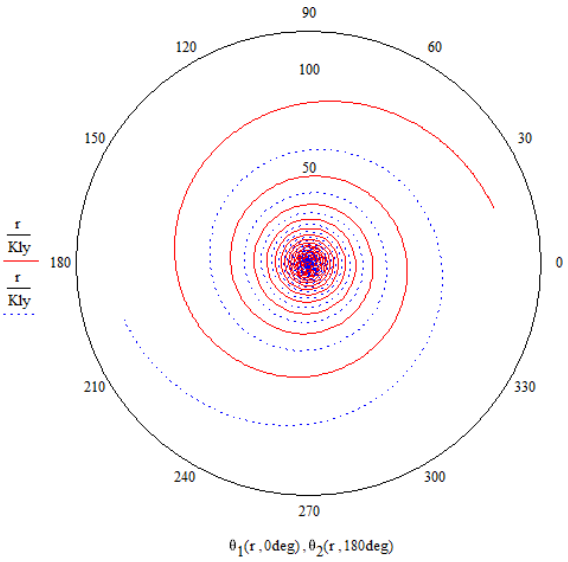


Fig. 7.4 – Shape of a spiral galaxy at t =50 Billion years after its creation.

8. Hubble's law

This paragraph aims to show that Hubble's law is wrong. I am elaborating on this issue because Hubble's law is one of the pillars of the Big Bang (BB) theory. The BB claims that the Universe on a large scale is isotropic. The Pivot theory claims the Universe is not isotropic as it 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 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 $V = H_0 \cdot d$. 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 the paradigm that the Universe is expanding forever in all directions, at an ever-accelerating speed. According to Hubble's laws, there are Galaxies with z>1.5 that are receding from the Milky Way at speeds greater than the speed of light. 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 [6] relates to Hubble's diagram (Fig. 8.1): "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."

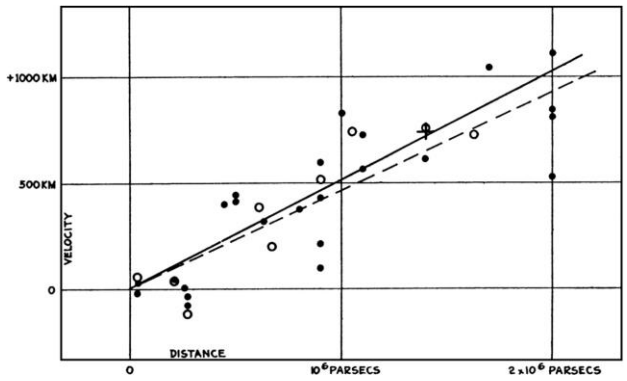


Fig. 8.1 – Hubble's original graph (1929)

Hubble's diagram 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. 5.1 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.

Doppler shift Vs. gravitational shift

Hubble claims that the redshift of Galaxies is due only to the Doppler effect. The Pivot theory claim that there is a Doppler effect, but it is small in comparison to the gravitational shift that is calculated in paragraph 5. For finding the Doppler shift of an observed galaxy, first, the orbiting velocities around the Pivot of the Milky Way (8.1) and the observed galaxy (8.2) should be found. Then, the velocity difference between the two Galaxies is calculated (8.3). Subsequently, the Doppler shift is calculated (8.4). Finally, the ratio of the Doppler shift to the total z shift is calculated (8.5) and shown in Fig. 8.2. From this graph, the maximal Doppler effect contribution to the total z shift can reach 1% at R_{out} .

$$V_{mw} = \omega_{Birch} \cdot R_{mw} = 0.0048C \quad (8.1) \qquad V_{gal} = \Omega(R_{gal}) \cdot R_{gal} \quad (8.2)$$

$$\Delta V = V_{mw} - V_{gal} \quad (8.3)$$

$$Z_{doppler} = \frac{\Delta V}{C} \quad (8.4) \qquad R_{percent} = \frac{Z_{doppler}}{Z_{gal} + Z_{doppler}} \cdot 100 \quad (8.5)$$

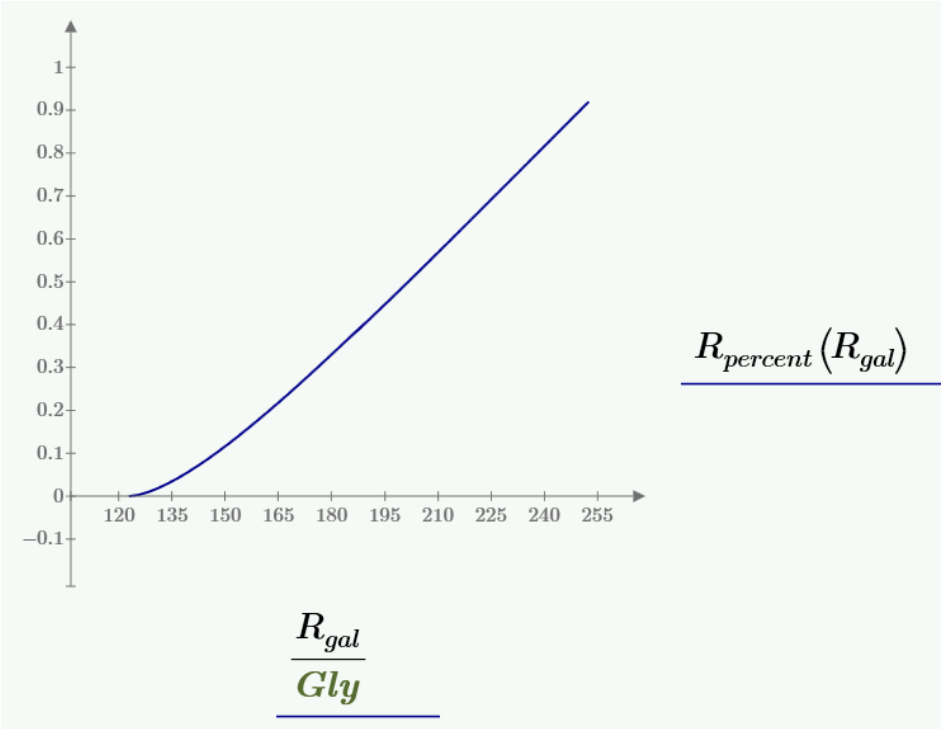


Fig. 8.2 - The ratio (%) of Doppler shift to the total z shift

9. Cosmic Microwave Background (CMB)

The cosmological principle states that at a "large-scale," the spatial distribution of matter in the Universe is isotropic and homogeneous. The most robust observational evidence for the cosmological principle is the CMB. The CMB is considered to be one of the Big Bang theory pillars. Therefore, people may claim that the Pivot Universe that has a preferred axis is improbable. I argue that even though the Pivot Universe has a preferred axis, it still agrees with the CMB observation. It was demonstrated in this article, that the Milky Way is located inside a sizeable observable Universe ring. A Milky Way observer sees a considerable 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 surfaces of the ring, the Universe is not isotropic and homogenous. In one direction, he will be facing the vacuum, which is 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.

Recently, in April 2020, a paper that summarizes observations done with Chandra X-ray Observatory was published. This paper concludes that the visible Universe is anisotropic on a large scale. This result, if confirmed, may shatter the CMB pillar of the BB theory. The main finding of these observations is that there is a lopsided expansion of the Universe. There is one region in the Universe that is expanding faster than the expected rate, while the second region expands at a slower than expected rate. [7]

The Pivot theory that has an axis of rotation can explain the lopsided image. The Milky Way is orbiting the Pivot at the constant radius. The gravitational z shift of a galaxy is constant because the radius of the galaxy determines it. But, because galaxies are orbiting the Pivot at different velocities, they are either approaching or receding the Milky Way. The difference in velocities causes a doppler shift. In paragraph 8, it was demonstrated that this Doppler shift is small in comparison to the gravitational z shift.

10. Olbers' paradox

Olber's paradox is that an 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 this paradox by claiming that space is expanding. Therefore, the emitted light from distance Galaxies is reduced via redshift so that the most distant Galaxies are not seen from the Milky Way. The Pivot Universe, on the other hand, claims that the visible Universe is finite with a limited number of stars and Galaxies. Outside the ring of the visible Universe, there is the darkness of space. An observer located inside the visible Universe ring sees a considerable number of Galaxies in whatever direction he looks, but eventually, in the background, he sees the total darkness.

11. Handedness of Galaxies

The Pivot theory explains yet an additional observation related to the handedness of the Universe. Longo and others [8] found an abundance of left-handed, or counterclockwise (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. 11.1 shows a sector of the observable Universe ring. The figure shows the equatorial plane of the visible Universe ring 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. It was explained earlier, that the Pivot theory postulates that all Galaxies rotate in the same direction, opposite to the Universe ring rotation. The location of the Galaxies, relatively 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, then the number of CCW Galaxies and CW Galaxies will differ by 7%.

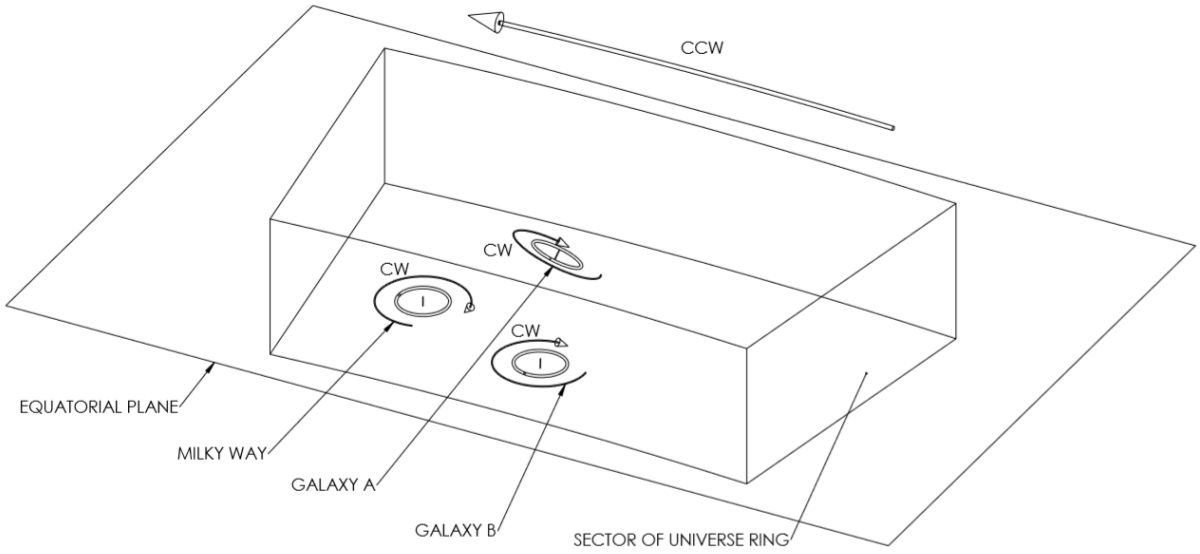


Fig. 11.1- Handedness of Galaxies

12. Summary

The Pivot theory describes a Universe that began as a primeval nucleus. It originated from the vacuum energy, as explained by QFT. This primeval nucleon was symmetric as it consisted of an equal number of neutrons and antineutrons. It accumulated mass from the infinite vacuum space energy. Eventually, it exploded when the velocity on its surface reached the speed of light. The explosion was not symmetric. Following the explosion, the primeval nucleus divided into two distinct parts: 1) the Pivot that contains more antineutrons than neutrons. Nevertheless, this nucleus is stable because neutrons and antineutrons do not annihilate each other. 2) a thin-shaped ring visible Universe that contained immediately after the explosion more neutrons than antineutrons. The free neutrons and the free antineutrons were not stable and decayed into within ~15 minutes to protons and antiprotons. The protons and the antiprotons annihilated each other until only protons remained in the visible Universe.
The Pivot drags space around it. The velocity of the visible Universe around the Pivot is the same as the velocity of the dragged space; this explains the Michelson-Morley experiment. This combined structure of the Universe is stable and 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 Pivot Universe explains fundamental issues in physics:

1) The vacuum space is absolute, eternal, and infinite that permeates everywhere. 2) Time is absolute and eternal. It flows without relating to anything. 3) The origin of gravity is the strong force. 4) The structure of a black hole is similar to a neutron star. 5) There is a maximum density in the Universe. 6) There is a connection between QM and GR. 7) The Pivot is the "dark matter", as it is not visible from the visible Universe. 8) There is no dark energy because the Universe is not expanding.

However, there are open issues, e.g., Is our Universe one among many others in the infinite space? How long did it take to the primeval nucleus to reach its final size before it exploded? Why was the explosion not symmetric, or in other words, why was the number of neutrons, in the visible Universe, higher than the antineutrons? Can frame-dragging of space described by Stokes flow?

How long did it take the Pivot Universe to rearrange after the primeval nucleus exploded? Will our Universe last forever?

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 [9]. 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 [9].

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

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 …is the distance between nucleons centers.

$r_1 = 10^{-13} cm$ …is Yukawa radius

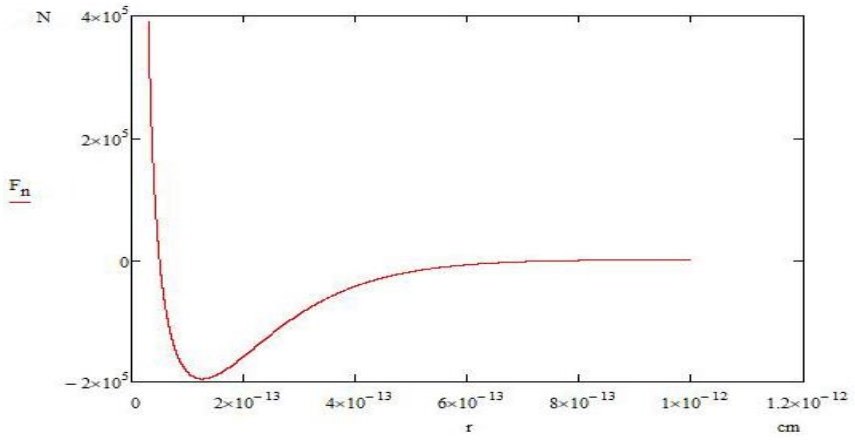


Fig. A.1 – Force between two nucleons as a function of the distance between them.

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.

Appendix B - Is a black hole a neutron star?

The Pivot is 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 Black holes in the visible Universe ring originate from the gravitational collapse of massive stars. Nevertheless, the final result is the same. A nucleus in which nucleons 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 neutron (or a proton), i.e., ~7.8*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 [10].

Note: There are additional theories regarding the maximal density in the Universe. The standard model of particle physics claims that there is a definite upper limit to the density of celestial bodies. The maximal theoretical density is Planck's density of 10^96 kg/m^3. However, intermediate between the neutron star density and the Planck's density there are hypothetical celestial bodies: The first is a quark star that has a density of 10^19kg/m^3. Strange Quark matter is actively studied with particle colliders, but this can only be produced at very hot temperatures (above 10^12 K) and in blobs the size of atomic nuclei, which decay immediately after formation. No stars made of strange quark matter were observed in the Universe. The second is a Preon star that has a density of 10^26kg/m^3. No evidence for quark and Preon stars has been found see [11]

I postulate that also a Black hole, precisely 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 ~ 7.8*10^17 kg/m^3.

While GR allows the density theoretically 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 [12] 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 [13]. 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:

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

where:

Mass of Neutron: $m_{neutron} = 1.6749275 \cdot 10^{-27} kg$

Radius of Neutron: $\mathrm{R}_{neutron} = 0.8 \cdot 10^{-13} cm$

3. The Schwarzschild radius of a celestial body is:

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

where:

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

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

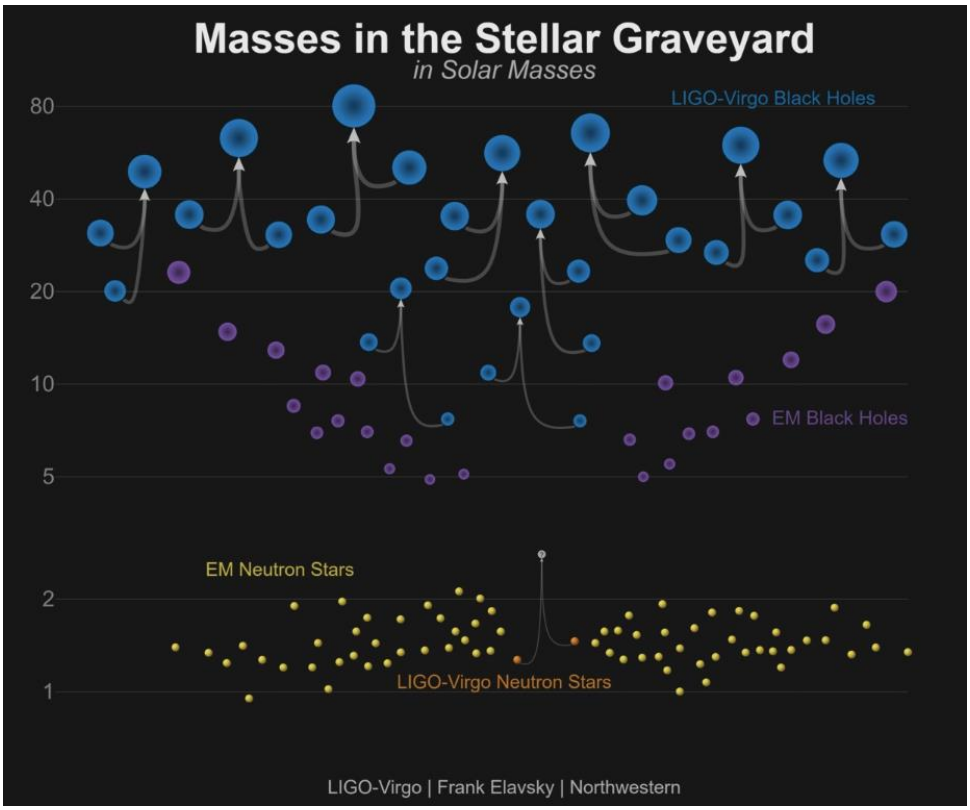
4. Equating Schwarzschild radius of the celestial body to its physical radius; $(\mathrm{R}_H = R_n)$:

Gives: $$M_{\lim it} = (\frac{R_{neutron} \cdot C^2}{2 \cdot G \cdot m_{neutron}^{1/3}})^{3/2} = 9.67 \cdot 10^{30} kg \sim 4.86 Sun - masses. \qquad (3)$$

and $$R_{\lim it} = 14.35 km$$

From the above calculations, it is shown that the limit between a neutron star and a Black hole is 4.86 Sun-masses and a radius of 14.35km. A celestial body with a mass higher than 4.86 Sun-masses will become a Black hole because its physical radius is smaller than its Schwarzschild radius.

Observations: This result of the minimal mass of a black hole in the Universe is in good agreement with observations. A summary of observations of black holes and neutron stars is shown in the following graph: [14] Note: There is a mass gap between the heaviest neutron stars and the lightest black holes. At this stage it is not clear why neutron stars with mass between ~2 to ~5 Solar-masses were not found.



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). 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 or a neutron star that is formed by gravitational collapse of a massive star must retain the angular momentum of this progenitor star. In SBH (Schwarzschild black hole), it is assumed that the mass collapses to an infinitely small point. However, as a point cannot have angular momentum the conclusion is that SBH is only a theoretical solution of GR. However, Kerr in 1963 suggested a solution Kerr black hole (KBH) that takes into consideration the spinning of bodies. Analyzing KBH solution shows:

1) KBH has a singularity ring at its center rather than the point singularity as in SBH. Therefore, matter can reside inside the singularity ring
2) There is a frame dragging of the space around the black hole nucleus.

I postulate that the nucleus of the Black hole resides inside the ring singularity. In other words R_n of the solid nucleus sphere $\leq$ the radius of the singularity ring that is equal to the spin parameter α defined by the Kerr solution.

$R_n \le \alpha$ ....is an assumption

where:

$\alpha = \frac{J}{M \cdot C}$ ...is the spin parameter defined by Kerr

J Angular momentum of the Black hole

M Mass of Black hole

$R_{outer} = R_H + \sqrt{R_H{}^2 - R_n{}^2}$ (4) ...is the outer event horizon

Frame dragging in the equatorial plane around the nucleus is calculated by:

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

Velocity at r:

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

In the following examples the tangential velocity on the surface of the nucleus $V(\mathrm{R}_n)$ of the biggest known and the smallest black holes are calculated:

1) The biggest supermassive black hole observed : $M = 2.1 \cdot 10^{10} \cdot Sunmasses$

$R_n = 2.34 \cdot 10^4 km$ from (1)

$R_H = 6.23 \cdot 10^{10} km$ from (2)

$R_{outer} = 6.2 \cdot 10^{11} km$ from (4)

$\Omega(\mathrm{R}_n) = 12.8 Hz$ from (5)

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

2) The smallest black hole (according to the current article): $M = 4.86 \cdot Sunmasses$

$R_n = 14.35 km$ from (1)

$R_H = 14.35 km$ from (2)

$R_{outer} = 14.35 km$ from (4)

$\Omega(\mathrm{R}_n) = 6.96 \cdot 10^3 Hz$ from (5)

$V(R_n) = 0.333 \cdot C$ from (6)

Appendix C - Can Stokes flow describe space?

GR describes space dragging by a spinning body, but GR does not explain how space adheres to the surface of the rotating body. I conjecture that this question can be answered by flow dynamics, specifically by Stokes flow. Stokes flow describes a case when the inertial forces are negligible compared to the viscous forces, i.e., Reynolds number is very small, the solution yields a steady-state spin of the sphere together with the fluid around it. Analyzing the structure of the Pivot universe gives: $J_{pivot} = 1.06 \cdot 10^{87}\, J \cdot \sec$. See (4.1).

But the inertial angular momentum of the Pivot is:

$$J_{pivot\_inertial} = \frac{2}{5} \cdot M_{pivot} \cdot {R_{pivot}}^2 \cdot \Omega(R_{pivot}) = 6.4 \cdot 10^{60}\, J \cdot \sec$$

This means that in the Pivot universe the viscous forces >> the inertial forces. Therefore, Stokes flow is applicable for celestial rotating bodies in space.

The following figure C-1 shows Stokes flow of a liquid around of a rotating sphere. The solution yields a steady state spin of the sphere together with the fluid around it. There is resemblance between this shape and what is observed in the cosmos. Observing a neutron star shows that it has an accretion disk in the equatorial plane and two opposing jets around the axis of rotation.

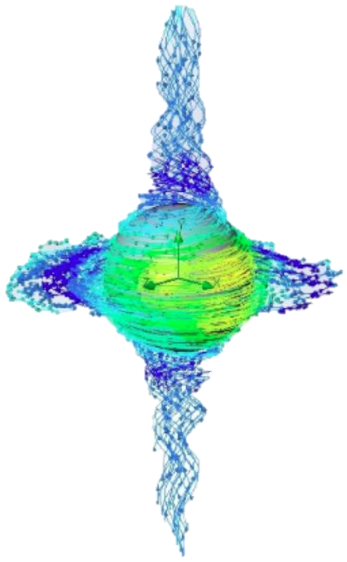


Fig. C-1 – Stokes flow of a viscous fluid dragged by a rotating sphere

Solving Stokes flow on the surface of the Pivot gives the torque τ :

$$\tau = 8 \cdot \pi \cdot \mu_{space} \cdot {R_{pivot}}^3 \cdot \Omega_{pivot}$$ ....where μ_{space} is the viscosity of the space .

On the other hand, $\tau = J_{pivot} \cdot \Omega_{pivot}$ where the dragged space on the neutron star surface is spinning at Ω_{pivot} . Therefore, the viscosity of space μ_{space} on the surface of the Pivot can be calculated by:

$$\mu_{space} = \frac{J_{pivot}}{8 \cdot \pi \cdot {R_{pivot}}^3} = 1.77 \cdot 10^{50} \cdot Pa \cdot s$$

The high viscosity of space on the surface of the primeval nucleus means that space adheres strongly to this surface. I speculate that the viscosity of space is dependent on gravity. It is maximal near a celestial body and drops substantially far away from this celestial body.

The reader is referred to an experiment of Stokes flow that is shown in NSF [15] (start time: 3:38 min). Relating to the Pivot universe, the origin of celestial bodies spin can be explained. Bodies orbiting the Pivot are dragged by the viscous space and simultaneously spin around their axis in the opposite direction to the Pivot spin.

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