Newton Gravity Force in a Spiral Galaxy

by Eng. David Levi

Proof that a spiral galaxy fully obeys Newton's Law of Universal Gravitation

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Chapter 1. **Introduction**

Based on the current mainstream concept, the orbiting of stars around the center of spiral galaxies seems to disobey Newton's Law of Gravitation.

According to Wikipedia , Newton's Law of Universal Gravitation seems to mean (quote): http://en.wikipedia.org/wiki/Newton%27s_law_of_universal_gravitation

> *"In spiral galaxies the orbiting of stars around their centers seems to strongly disobey to Newton's law of universal gravitation."*

I will prove that a spiral galaxy fully obeys Newton's Law of Universal Gravitation.

Chapter 2. **Gravitation**

Let's start by understanding the power of gravity.

Wikipedia: http://en.wikipedia.org/wiki/Law_of_gravity

> *"**Gravitation** or **gravity** is a natural phenomenon by which all physical bodies attract each other. Gravity gives weight to physical objects and causes them to fall toward one another.*
>
> *Gravity is the weakest of the four fundamental forces of nature.*
>
> *On the other hand, gravity is the dominant force at the macroscopic scale, that is the cause of the formation, shape, and trajectory (orbit) of astronomical bodies, including those of asteroids, comets, planets, stars, and galaxies. It is responsible for causing Earth and the other planets to orbit the Sun; for causing the Moon to orbit Earth; for the formation of tides; for natural convection, by which fluid flow occurs under the influence of a density gradient and gravity; for*

> *heating the interiors of forming stars and planets to very high temperatures; for solar system, galaxy, stellar formation and evolution; and for various other phenomena observed on Earth and throughout the universe."*

Therefore, we shouldn't give up on this critical power!

Chapter 3. **Newton's Solution for a Spiral Galaxy**

The answer for the problem had already been given by Newton's Law of Universal Gravitation:

> *"Every point mass attracts every single other point mass by a force pointing along the line intersecting both points."*

In other words, every point mass (a star, for example) attracts every other point mass (another star) by a force called 'Gravity Force'.

Therefore, the equivalent Gravity Force vector that attracts any star should be the sum of the total Gravity Force vectors from all the stars in the system.

Based on Newton, the Gravity Force is:

> *"The force is proportional to the product of the two masses and inversely proportional to the square of the distance between them."*

In the Solar System, for example, we can use Newton gravity formula to calculate the Gravity Force with which any planet, moon or Sun attracts Earth.

We should find that the total Gravity Force vectors of all the other planets are negligible with regards to the Gravity Force vector from the Sun (as the Sun includes over 99% of the total mass in the entire Solar System.)

Hence, the Gravity Force on Earth is based on the Gravity Force with the Sun.

However, a spiral galaxy isn't a solar system!

In a spiral galaxy the total mass of all stars in the galaxy is much higher than the mass of the super massive black hole.

Based on Wiki, the Milky Way black hole (for example) is 4.1 million $M_{\odot}$, while the total mass of the Milky Way galaxy is: 0.8–1.5×10^{12} $M_{\odot}$. This is a ratio of about 4 to 1,000,000.

Therefore, the mass of the Milky Way black hole is almost negligible with regards to the total mass in the galaxy (about 400 billion stars). This is the opposite scenario from a solar system. Therefore, we need to make the correct calculation in order to verify the real gravity results in a spiral galaxy.

Based on Newton, the total Gravity Force on any star in a spiral galaxy is the sum of all the Gravity Force vectors that attract this star in the galaxy. This means that we need to verify the gravity contribution of the black hole with the gravity contribution of the stars in the spiral arm (and even consider the contribution of all other stars in the galaxy). The outcome of this calculation will be called the Equivalent Gravity Force Vector. For each star in the galaxy we need to calculate its own Equivalent Gravity

Force Vector. This Gravity Force has a direct impact on the rotation energy of that star.

In order to understand how to calculate the Equivalent Gravity Force let's use a very simple orbiting system.

Chapter 4. Gravity Force in a Simple Orbiting System

Let's use the Sun and Earth (without any other planets or moons) as an example of Gravity Force. We know very well how to calculate the Gravity Force that attracts Earth to the Sun. Let's call it as follow:

Gravity Force – F, Radius – R, Sun mass – M.

In the following examples we will set the following:

- Split the Sun into two equally stars. The mass of each star will be ½ x M.
- One star will be set at the same place as the Sun. This star will be called Hoster.

- The Earth will revolve around the Hoster. The radius is – R.
- The second star will be moved on the vector of the radius to different distances from Earth.
- So, while Earth revolves around the Hoster, the second star will keep its position on the same vector line of the radius R (but at different distances), so those two stars should be in one line with Earth.
- We will calculate the Gravity Force vector with which each star attracts Earth. The sum of those forces should is the Equivalent Gravity Force affecting Earth.
- This equivalent Gravity Force can be represented by a virtual Hoster. Based on the radius R, we will calculate the equivalent mass of the virtual Hoster. The Idea is that instead of using a two-star system, we will find the equivalent mass that can replace those two stars.

The calculation:

1. Let's keep the second star at the same place as the Hoster. In this case, each star attracts Earth with a Gravity Force of ½ x F. The equivalent Gravity Force vector on Earth is as follow:

   Equivalent Gravity Force vector = ½ x F (from the Hoster) + ½ x F (from the second star) = F.

   As stated, this Equivalent Gravity Force Vector could be represented by a virtual Hoster. Its equivalent mass will be M (as the sum). This is quite clear, as those two stars put together have the same mass as the Sun.

2. Let's move the second star further away from the Hoster, so its distance will be doubled than the current distance from Earth to Hoster. In this case, the gravity contribution of the second star will be decreased by four. (Please remember that *The Gravity Force is inversely proportional to the square of the distance between any star and Earth).* Therefore, its contribution to the gravity on Earth will be ¼ x F.

Hence, the new Equivalent Gravity Force Vector on Earth is:

Equivalent Gravity Force Vector = ½ x F (from the first star) + 1/8 x F (from the second star) = 5/8 x F.

Therefore, the equivalent virtual Hoster mass is 5/8 x M.

Hence, by using a virtual Hoster at a mass of 5/8 x M we can get the same Gravity Force on Earth as the two-star system.

3. Let's position the second star at the opposite direction from the Hoster with regards to Earth. Hence, Earth will be placed in between the Hoster and the second star. The distance to each direction will be the same. In this case, the Gravity Force from each side of Earth will be half of F, but with an opposite polarity. Therefore, the sum of those Gravity Force vectors will be zero. Hence, the equivalent mass of the virtual Hoster is zero.

4. Let's position the second star at the opposite direction from the Hoster with a radius of 2 x R

(doubled distance of R). The new equivalent Gravity Force on Earth is:

Equivalent Gravity Force = ½ x F (from the first star) - 1/8 x F (from the second star) = 3/8 x F.

Therefore, the equivalent mass of the virtual Hoster is 3/8 x M.

5. Let's position the second star at the opposite direction from the Hoster with a radius of ½ x R (half distance of R). The new Equivalent Gravity Force on Earth is:

   Equivalent Gravity Force = ½ x F (from the first star) - 2 x F (from the second star) = -1.5 x F.

   This time, we got a negative Gravity Force. This means that Earth should be repelled by the Hoster.

6. Let's split the second star to several stars with a different mass in each one. Let's position those divided stars in the same vector line as R but at different random locations on both sides of Earth.

The Equivalent Force Vector should be the sum of all Gravity Force Vectors with which those stars and the Hoster attract Earth.

However, the stars in one side should contribute a Gravity Force in one direction while the stars in the side of Earth should contribute a Gravity Force in the opposite direction. Therefore, in order to get the Equivalent Force Vector, we need to sum up all vectors in one direction and subtract it from the sum of all vectors in the other direction.

Based on the Equivalent Gravity Force, we can calculate the equivalent virtual Hoster's mass.

This mass of the equivalent virtual Hoster can replace this entire system.

Chapter 5. **Gravity Force in a Spiral Galaxy**

Now, let's go back to the spiral galaxy. In the Milky Way there are 400 billion stars in about seven spiral arms.

Therefore, in each arm there are about 70 billion stars (assuming that all stars are located in the arms and the arms are equally). Our Sun is located in one of those arms.

To make it simpler, let's assume that all the stars in that arm are located in a long straight line and ignore the gravity influence of the other arms.

In order to calculate the equivalent Gravity Force that attracts the Sun, we need to verify the following:

- The Gravity Force vector with which the black hole attracts the Sun.
- The Gravity Force vectors of all the stars in the arm which are located between the Sun and the black hole.
- The Gravity Force vectors of all the stars in the arm which are located between the Sun and the outer side of the arm. Please be aware that all those vectors contribute a negative Gravity Force.

The Equivalent Gravity Vector is the sum of all the gravity vectors. Obviously, it is quite difficult to calculate 70 billion gravity vectors. However, there is a simple way.

The rotation energy force of the Sun is an excellent indicator for the equivalent Gravity Force vector that attracts the Sun in the galaxy (as there must be full balance between those two forces).

The rotation energy is a direct outcome of the sum mass and its velocity.

The radius of the Sun is about 26,000 light year, therefore it's quite easy to calculate its virtual Hoster equivalent mass.

The Sun revolves around this virtual Hoster and completes one cycle in 240 million years.

Actually, any star in the galaxy revolves around its own virtual Hoster. Each virtual Hoster has a unique equivalent mass which fits that specific star.

Now, let's move the Sun inwards and outwards in the spiral arm in order to verify how the equivalent Gravity Force (and as an outcome – the virtual Hoster's equivalent mass) should be.

So, if the Sun is located at the outmost side of the arm, all the gravity vectors forces will be in the same direction.

Therefore, it should have the greatest Gravity Force. As we move the Sun inwards in the arm, the stars at the outmost side (with relevant to the Sun location) will contribute a negative Gravity Force. Hence, the equivalent Gravity Force vector will be decreased as the Sun moves inwards in the spiral arm.

Therefore, the maximal Gravity Force (the maximal virtual Hoster's equivalent mass) will be achieved by placing the Sun at the outmost side of the arm. The minimal Gravity Force (minimal virtual Hoster's equivalent mass) will be achieved by placing it at the most inwards side of the arm.

That is the opposite scenario from a typical solar system.

This proves Newton's Law of Universal Gravitation for a spiral galaxy. It also explains why the star velocity increases as its location is further from the center of the spiral galaxy.

Chapter 6. **Evidence**

There is evidence for this theory. It's a star called S2.

Super massive black hole:
http://en.wikipedia.org/wiki/Supermassive_black_hole

> *"The star S2 follows an elliptical orbit with a period of 15.2 years and a pericenter (closest distance) of 17 light-hours (1.8×10^{13} m or 120 AU) from the center of the central object."*

S2 is located between the Milky Way black hole center to the inwards side of the spiral arms.

Based on Newton:

> *"Every point mass attracts every single other point mass by a force pointing along the line intersecting both points."*

Therefore, in one side S2 is attracted by the Gravity Force of the black hole. On the other side it is attracted by the mass in the spiral arms (with regards to the spiral arms –

the nearby section of the inwards spiral arms to S2 has a higher gravity effect). However, those Gravity Force vectors have opposite polarities. The sum of those vectors should give us the equivalent Gravity Force vector on S2.

Hence, S2 rotation energy should be based on that equivalent Gravity Force. However, the scientists have completely neglected the Gravity Force vectors of the spiral arms. They have estimated that rotation energy should be based only on the black hole's Gravity Force. Therefore, they have concluded that the total mass of the black hole is 4.1 million $M_{\odot}$.

> *"From the motion of star S2, the object's mass can be estimated as 4.1 million $M_{\odot}$, or about 8.2×10^{36} kg"*

However, the mass of the whole Milky Way galaxy is : $0.8\text{-}1.5\times10^{12}$ [$M_{\odot}$].

This is an astonishing ratio of four/one million... (on 4 Kg of mass in the black hole, there are 1,000,000 Kg (1,000 Tons) of mass in the spiral arms.

Actually, the black hole can be likened to an engine that rotates the whole spiral galaxy while spiral arms are like the biggest propeller in the universe. So, how could it be that an engine of 4 Kg rotates a propeller of 1,000,000 kg (or 1,000 tons)? This is absolutely illogical.

With a ratio of such magnitude, the spiral arms should disconnect from the galaxy!

Therefore, this 4.1 million $M_{\odot}$ represents the equivalent Hoster mass.

In order to extract the real mass of the rotatable super massive black hole, we must add the Gravity Force vector with which each point of mass in the spiral arms attracts S2.

Now it's quite clear that the total mass of this black hole should be significantly higher than this relatively low mass.

Chapter 7. **Ejected Star from a Spiral Arm**

Let's assume that one star has drifted out of the spiral arm and try to figure out what should be the outcome.

We know that the Gravity Force is : *"inversely proportional to the square of the distance between them."* Therefore, the nearby stars contribute a significant portion of the equivalent Gravity Force that attracts this star in the galaxy. If an unfortunate star drifts out of the spiral arm (not inwards or outwards in the arm – but just out of the arm), then its equivalent Gravity Force should decrease.

Hence, there will be no balance between its rotation energy and its new decreased equivalent Gravity Force. Therefore, it will be kicked out of the arm and eventually out of the galaxy.

This also proves that there are no stars in between the spiral arms!

With regards to our solar system – we'd better keep our position in the spiral arm.

Chapter 8. **Orbital Speed of a Star (in a Spiral Arm) vs. its Distance from the Center**

Wikipedia:
http://en.wikipedia.org/wiki/Galaxy_rotation_curve

> *"If disc galaxies have mass distributions similar to the observed distributions of stars and gas, then the orbital speed would always decline at increasing distances in the same way as do other systems with most of their mass in the centre, such as the Solar System or the moons of Jupiter".*

This is incorrect!

As I have already proven, a spiral galaxy isn't a solar system. In a solar system, most of the mass is in the center, while in a spiral galaxy there are significant portion of mass outside the center. In order to estimate the orbital speed vs. distance, let's assume that all the stars in spiral arms keep their positions and do not drift inwards or outwards. Therefore, it is like a rigid spiral disc. In this case, it is expected that all points of mass should complete one cycle simultaneously.

The circumference of a circle is: $c = 2\pi r$

Where: C is circumference, r is Radius and π is a dimensionless constant approximately equal to 3.14159.

Let's use the following example:

For first star, R1 = 10,000 ly

C = 2 x 3.14 x 10,000 = 62,800 ly

For second star, R2 = 20,000 ly

C = 2 x 3.14 x 20,000 = 125,600 ly

Both stars complete one cycle at the same time (rigid spiral disc). The circumference of the second star is double that of the first one, therefore its orbital speed must be double with regards to the first one.

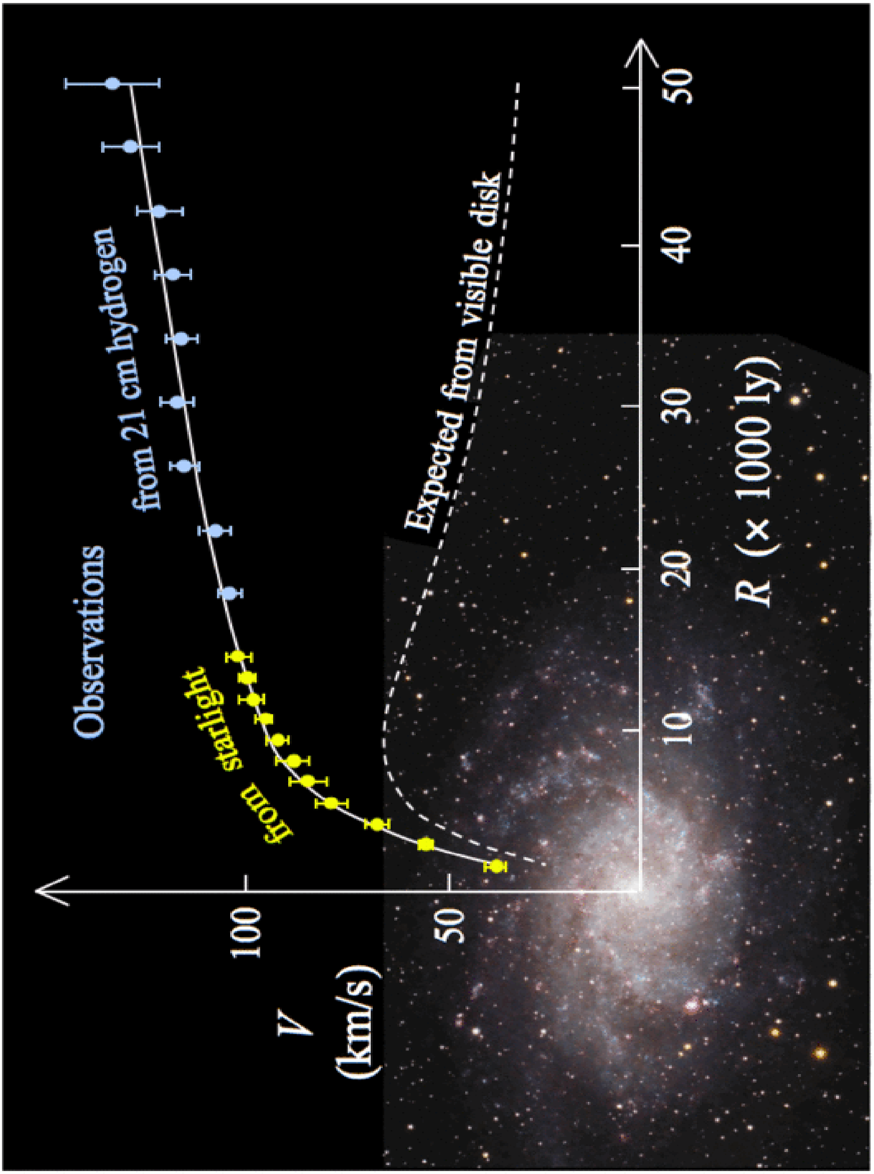
Hence, the orbital speed must increase with the increasing distance, assuming that the stars keep their positions in the spiral arms.

Chapter 9. **Rotation Curve Problem in a Spiral Galaxy**

Wikipedia:
http://en.wikipedia.org/wiki/Galaxy_rotation_curve

> *"**Galaxy rotation problem** is the discrepancy between observed galaxy rotation curves and the theoretical prediction, assuming a centrally dominated mass associated with the observed luminous material. When mass profiles of galaxies are calculated from the luminosity profiles and mass-to-light ratios in the stellar disks, then they do not match with the masses derived from the observed rotation curves and the law of gravity."*
>
> *"The **rotation curve** of a disc galaxy (also called a **velocity curve**) is a plot of the magnitude of the orbital velocities (i.e., the speeds) of visible stars or gas in that galaxy versus their radial distance from that galaxy's centre, typically rendered graphically as a plot."*

Let's examine the following diagram from Wikipedia:



http://en.wikipedia.org/wiki/File:M33_rotation_curve_HI.gif

R1 = 10,000 ly, the observation velocity is 90 km/s.

R2 = 20,000 ly, the observation velocity is 105 km/s.

Based on our calculations, in a rigid spiral disc the orbital velocity must increase with increasing distance. At a double distance, the orbital speed must be doubled.

So, if R1 = 10,000 ly and observation orbital velocity is 90 km/s, than for R2 = 20,000 ly the expected speed must be 90 x 2 = 180 km/s.

However, this isn't the case. We need to explain why the speed is only 105 km/s while based on our expectation from a rigid spiral disc it should be 180 km/s.

The answer is quite simple – a spiral galaxy disc is not a rigid disc.

We must give some freedom to the stars to drift inwards or outwards in the arm.

If we move a star outwards in the arm it has two vectors.

One vector is vertically to the center – let's call it outwards vector

The other vector is horizontal to the center – let's call it "backwards vector".

Let's make the mathematical calculation:

The backwards vector should decrease in speed from 180 km/s (expected speed) to 105 km/s (observed speed).

So we need to decrease the speed by 75 km/s.

This is achievable by decreasing the circumference of a circle that the star will have to travel in that same period of time – T.

The ratio between 75 to 180 is 0.41666.

So if we decrease the distance in the circumference of a circle from 125,600 ly by this ratio, then:

125,600 x 0.41666 = 52,332 ly

We then achieve the 105 km/s as observed.

Hence, in the same period of time – T, the star's total travel should be:

125,600 – 52,332 = 73,268 ly (instead of 125,600 ly).

So, the star will start at R=10,000 ly, make a complete travel of 73,268 ly and get to the point where R = 20,000 at the same time - T. By doing this movement the star's speed at R=20,000 will be exactly 105 km/s as observed.

Technically, we can make a calculation for a star which is drifting inwards.

In this case, the star will drift inwards from 20,000 ly to 10,000 ly in the same time frame – T.

If we move a star inwards in the arm it has two vectors.

One vector is vertical to the center – let's call it inwards vector.

The other vector is horizontal to the center – let's call it forwards vector.

The star will have to increase the circumference distance in order to meet the observed speed.

In any case, the mathematical calculation proves that a spiral galaxy isn't a rigid disc. The stars must drift outwards or inwards in the arm while the entire arm rotates around the center of the galaxy. In the next issue we will find in which direction the stars are really drifting.