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Does the Dark Matter really exist?

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Abstract

Astrophysicists now know that 80% of the matter in the universe is `Dark Matter' which is the most vexing mystery OF ALL THE MANY MYSTERIES of modern astronomy. Most astronomers believe in the existence of the Dark Matter and some are not The Dark Matter problem arose because of a mismatch in the masses of galaxies and larger cosmic structures. The constituents of these systems—stars and gas in the case of galaxies, gas and galaxies in the case of galaxy clusters—move about but do not escape, because they are checked by the gravitational pull from the rest of the system. The laws of physics tell us how much mass has to be present to counterbalance the motions and thereby prevent the dispersal of the system. Disconcertingly, the tally of mass that astronomers actually observe falls far short of that. I will summarize how the astronomers calculate its mass and explain why some of them disbelieve in the existence of Dark Matter by searching for mistakes in the calculation method of dark matter.

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Introduction

One of the themes of the history of physics has been the discovery that the world familiar to us is Only a tiny part of an enormous and multi-faceted universe. From Copernicus, we learned that the Earth is not the center of the universe, from Galileo, that there are other worlds. More recently, Hubble's extragalactic astronomy taught us that our galaxy is a tiny part of an expanding universe, And the observation of the cosmic microwave background by Penzias and Wilson revealed an era of Cosmology before the formation of structure. Over the past seventy years, astronomers have recognized another of these shifts of perspective. They have shown that the stuff that we are made of accounts for only 4% of the total content of the universe.

Dark matter is something beyond the stuff we encounter here on Earth. We all consist of neutrons, protons, and electrons, and our particle physics experiments with cosmic rays and accelerators tell us that a whole set of particles interact with each other to make up the world we see. the Standard Model describes these known particles and their interactions. But careful astronomical measurements, computer-based simulations, and nuclear theory calculations have all led us to believe that the particles described by the Standard Model account for only 4% of the mass of the universe. What makes up the missing 96%? Physicists believe, based on cosmological measurements described that 23 % is dark matter and 73 % is dark energy. Dark energy and dark matter are very different.

The story of the dark matter started, in 1933, when the Swiss Astronomer Fritz Zwicky published astonishing results from his studies of galactic clusters. In his paper he concluded that most of the matter in clusters is totally invisible. Zwicky argued that gravity must keep the galaxies in the cluster together, since otherwise they would move apart from each other due to their own motion. By determining the speed of motion of many galaxies within a cluster from the measurement of the Doppler-shift of the spectral lines he could infer the required gravitational pull and thereby the total mass in the cluster by using Sir Isaac Newton integral calculation methods. Much to his surprise the required mass by far exceeded the visible mass in the cluster. His results were received with great scepticism by most astronomers at that time.

By the 1990s, dark matter was required to explain not just the motion of galaxies, but also how those galaxies and other large structures in the universe form, and the detailed pattern of temperature fluctuations in the cosmic microwave background radiation left over from the early universe.

With these distinct reasons to believe that dark matter is a real part of our universe, scientists struggled to understand what comprises dark matter. Could it consist of familiar objects like brown dwarfs and large planets—made of the stuff of the Standard Model, but not emitting light and therefore invisible to astronomers? Both theory and experiment eventually pointed away from this simple explanation, strongly suggesting that dark matter is something entirely new and different. A generation of experiments was developed to look for new types of particles—beyond the Standard Model—that could account for some or all of dark matter.

But could it be wrong could our calculation and evidence of dark matter be wrong?

Could we have somehow a miscalculation in it?

Is the calculation of dark matter based on some mistakes?

Is the integral formula used by Sir Isaac Newton not ideal to calculate masses in galaxies?

And is the additional calculated mass ‘(a dark, invisible) matter’ unnecessary to explain the motion of galaxies and how it form?

Work plan

Firstly, I will start by explaining some essential and basic ideas to understand how scientists observe the universe and how they measure its' components (visible matter and dark matter). Therefore, I will talk about Doppler Effect, 21-CM Emission Line and Rotation Curve.

Furthermore, to make the explanation easier and interesting I will explain how to measure the 21-CM Emission Line and Rotation Curve at which matter orbit our galaxy, the Milky Way.

Secondly, I will test and discuss the integral calculation, already used by Sir Isaac Newton to calculate the masses and orbital speed of galactic discs, which used to determine the dark matter by presenting the calculation of dark matter in an easy way to understand graphics. Then, I will use the discrete addition of masses in a galactic plane to examine and compare the results of the integral calculation.

Objective

In this research, the calculation of dark matter is depicted in easy to understand graphics. The results are then logically tested, discussed, and compared. On one hand, dark matter is determined with integral calculation methods, already used by Sir Isaac Newton to calculate the masses and orbital speeds of galactic discs. On the other hand, discrete addition of masses in a galactic plane is used to examine and compare the results of the integral calculation.

BACKGROUND

I. DOPPLER EFFECT[1]

Consider a source of light. If the source is stationary with respect to observers, the observed wavelength λ_{obs} will be the same as the emitted wavelength λ_{em} :

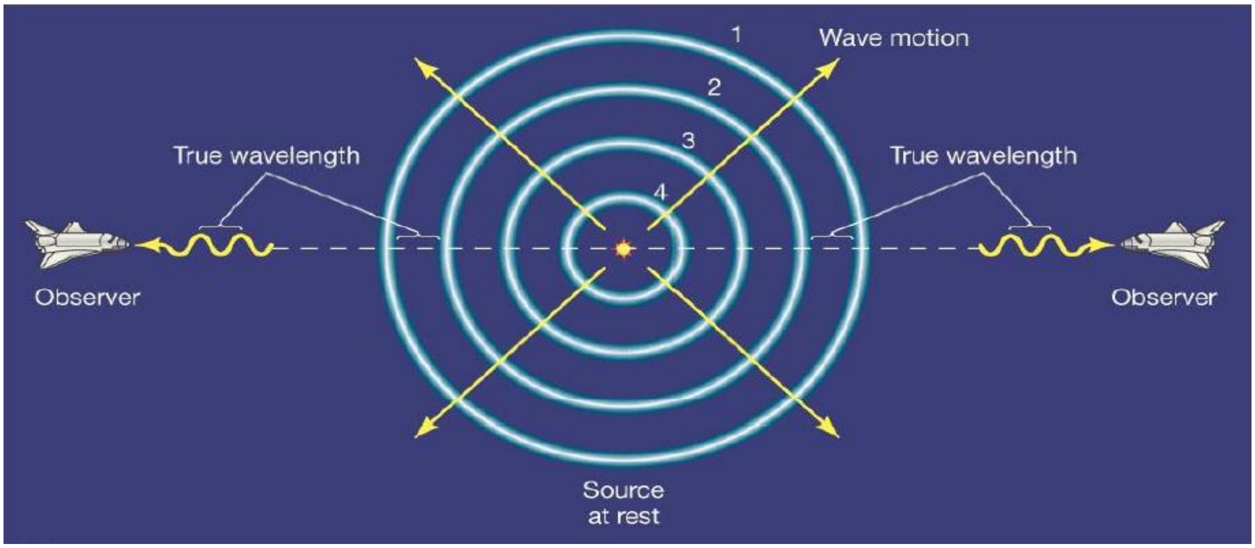

Figure 1: Doppler Effect

But if the source is moving with respect to observers, the waves will be compressed in the direction of motion, resulting in a shorter observed wavelength, or bluer light. Similarly, the waves will be stretched out in the opposite direction, resulting in longer observed wavelengths, or redder light:

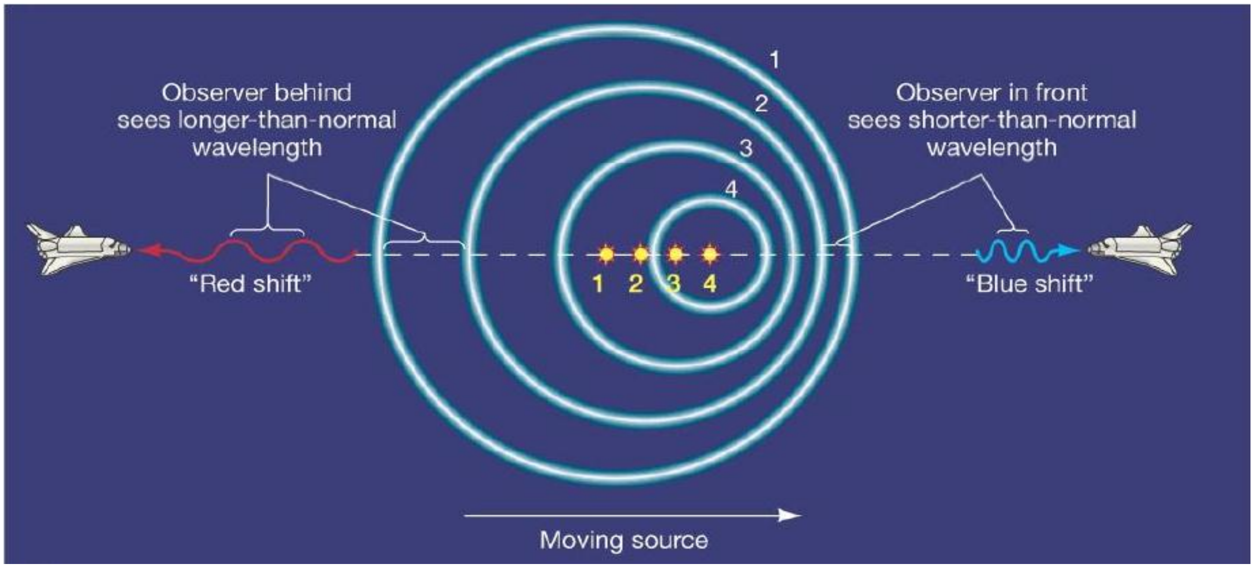

Figure 2: Doppler Effect

Mathematically, if the source is moving toward the observer, the observed wavelength λ_{obs} will be shorter than the emitted wavelength λ_{em} by $\Delta\lambda$:

$$\lambda_{obs} = \lambda_{em} - \Delta\lambda$$

And if the source is moving away from the observer, the observed wavelength λ_{obs} will be longer than the emitted wavelength λ_{em} by $\Delta\lambda$:

$$\lambda_{obs} = \lambda_{em} + \Delta\lambda$$

In both cases, the change in wavelength $\Delta\lambda$ is given by:

$$\Delta\lambda = \lambda_{em} \times \frac{\Delta V}{c}$$

where ΔV_{total} is the source's speed relative to the observer and ΔV is the *component* of ΔV_{total} *along the line of sight between the source and the observer*:

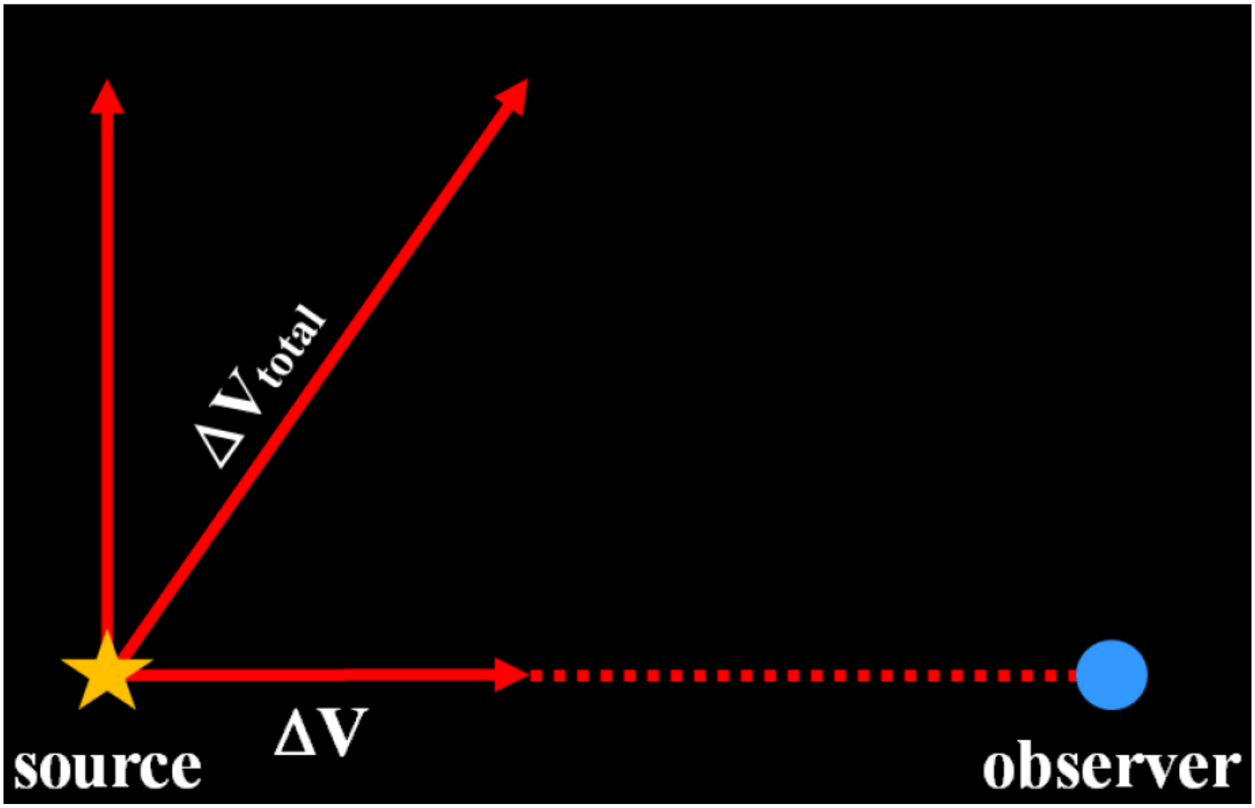

Figure 3: sources' speed

II. 21-CM EMISSION LINE[2, 3]

If we want to measure Doppler shifts of matter orbiting our galaxy, we must look in the plane of our galaxy. However, dust blocks visible light in the plane of our galaxy:

Figure 4: the Milky Way galaxy

Consequently, we must observe at a different wavelength.

Radio waves penetrate dust as if it were not even there. Furthermore, our galaxy consists primarily of cold hydrogen gas, and cold hydrogen gas emits light at 21 cm, a radio wavelength.

Cold hydrogen gas consists of a proton and an electron in the ground state. Because both particles are charged and spinning, they have magnetic fields along their rotation axes. Like bar magnets, it takes more energy to keep them together if their magnetic fields are aligned than if they are oppositely aligned. If a hydrogen atom is in the aligned state, after an average timescale of 11 million years, it will randomly de-excite to the oppositely aligned state, releasing the small difference in energy as a 21 cm photon:

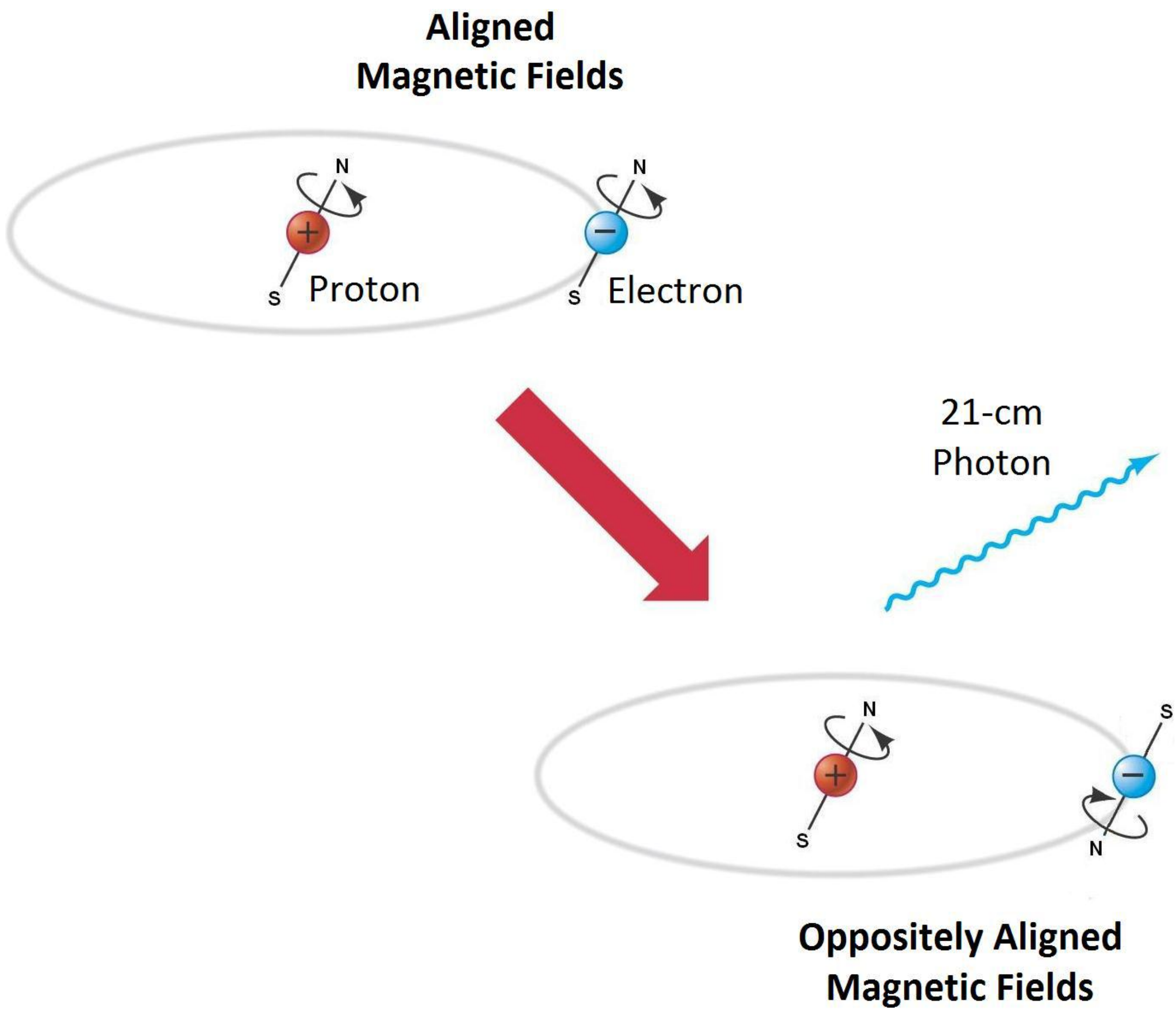

Figure 5: cold hydrogen gas emission

Although this is a rare occurrence, cold hydrogen gas is so abundant in our galaxy that this results in a strong signal, making the plane of our galaxy glow at this radio wavelength:

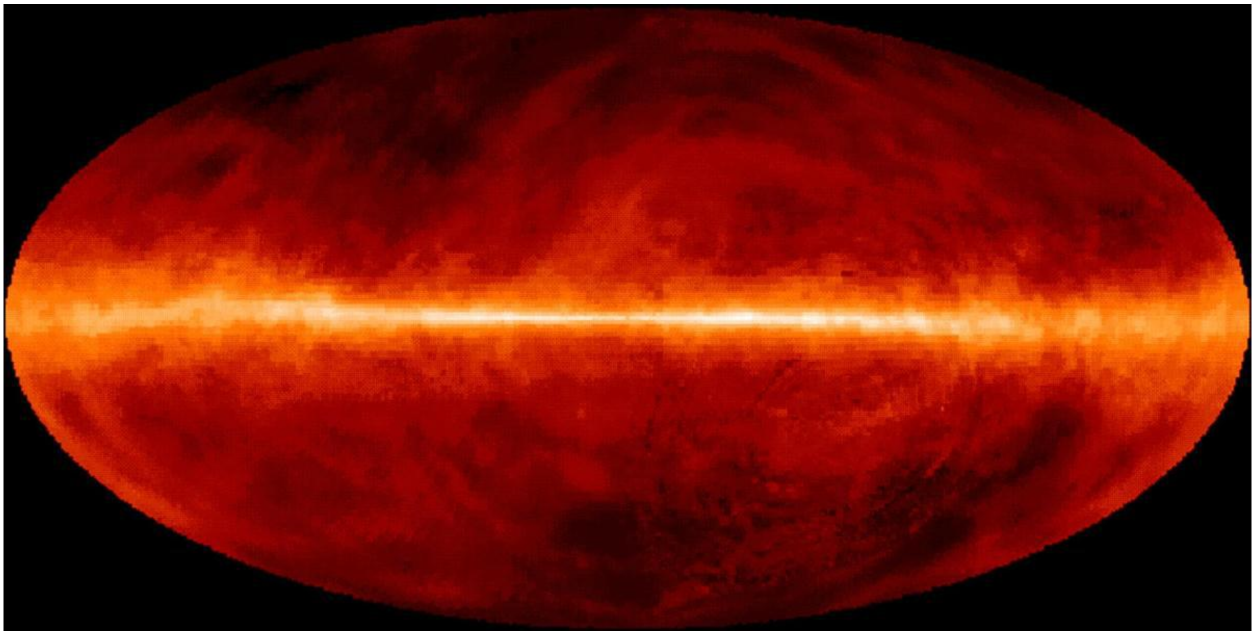

Figure 6: plan of our galaxy at 21 cm radio wavelength

III. ROTATION CURVE[4-6]

a) Radio Spectra [3]

Consider taking a radio spectrum of the center of our galaxy:

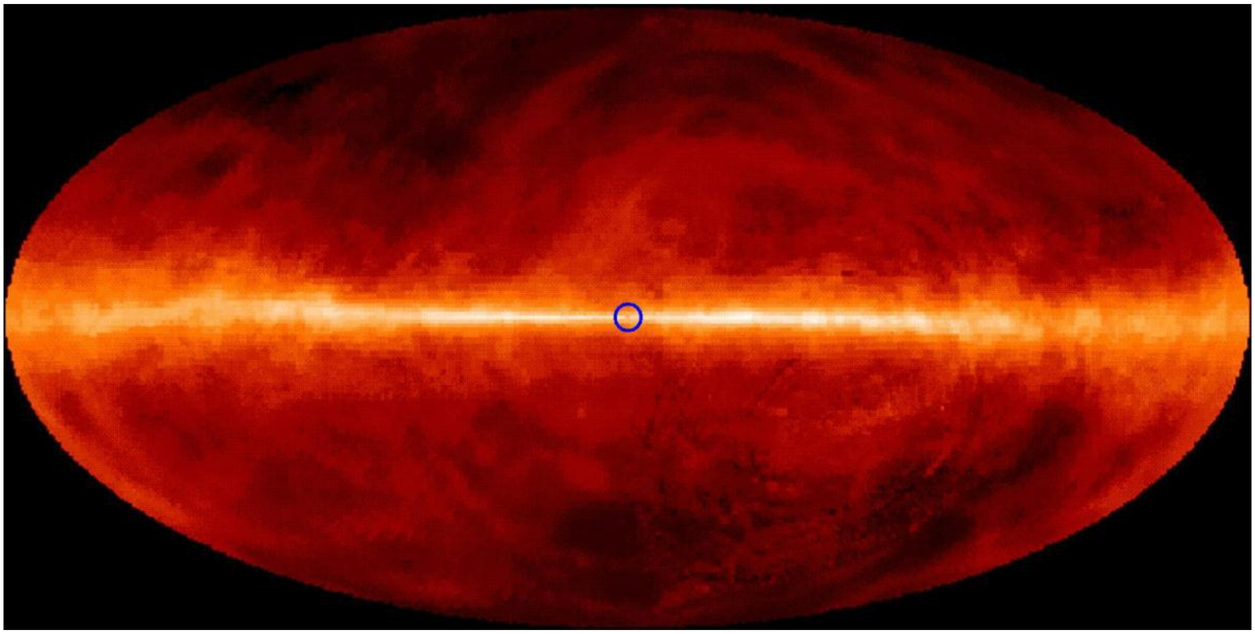

Figure 7: Radio spectrum of the center of our galaxy

To figure how it look like around 21 cm, consider the following figure, which shows what our galaxy might look like face on. Our location is marked by the yellow dot near the bottom of the figure. The dotted line marks the line of sight from us to (and through) the center of our galaxy:

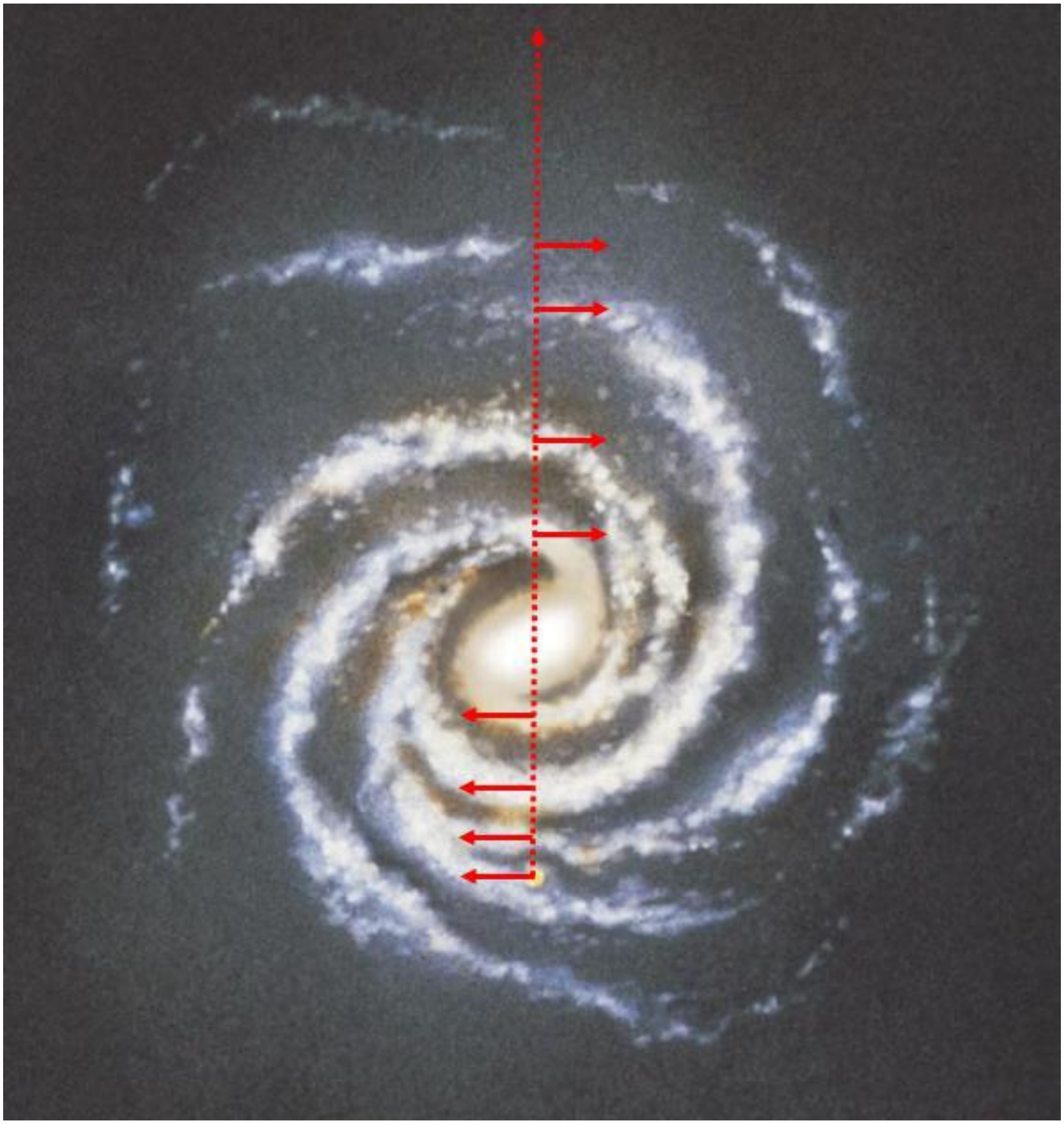

Figure 8: The line of sight from us to the center of our galaxy

Notice that the line of sight intersects spiral arms of our galaxy, and hence cold hydrogen gas, at many points. However, at all of these points, the gas is orbiting our galaxy neither toward us nor away from us, but perpendicular to the line of sight. Consequently, the 21-cm light that this gas is emitting is neither blueshifted nor redshifted. The radio spectrum should simply consist of a single emission line with $\lambda_{obs} = \lambda_{em}$:

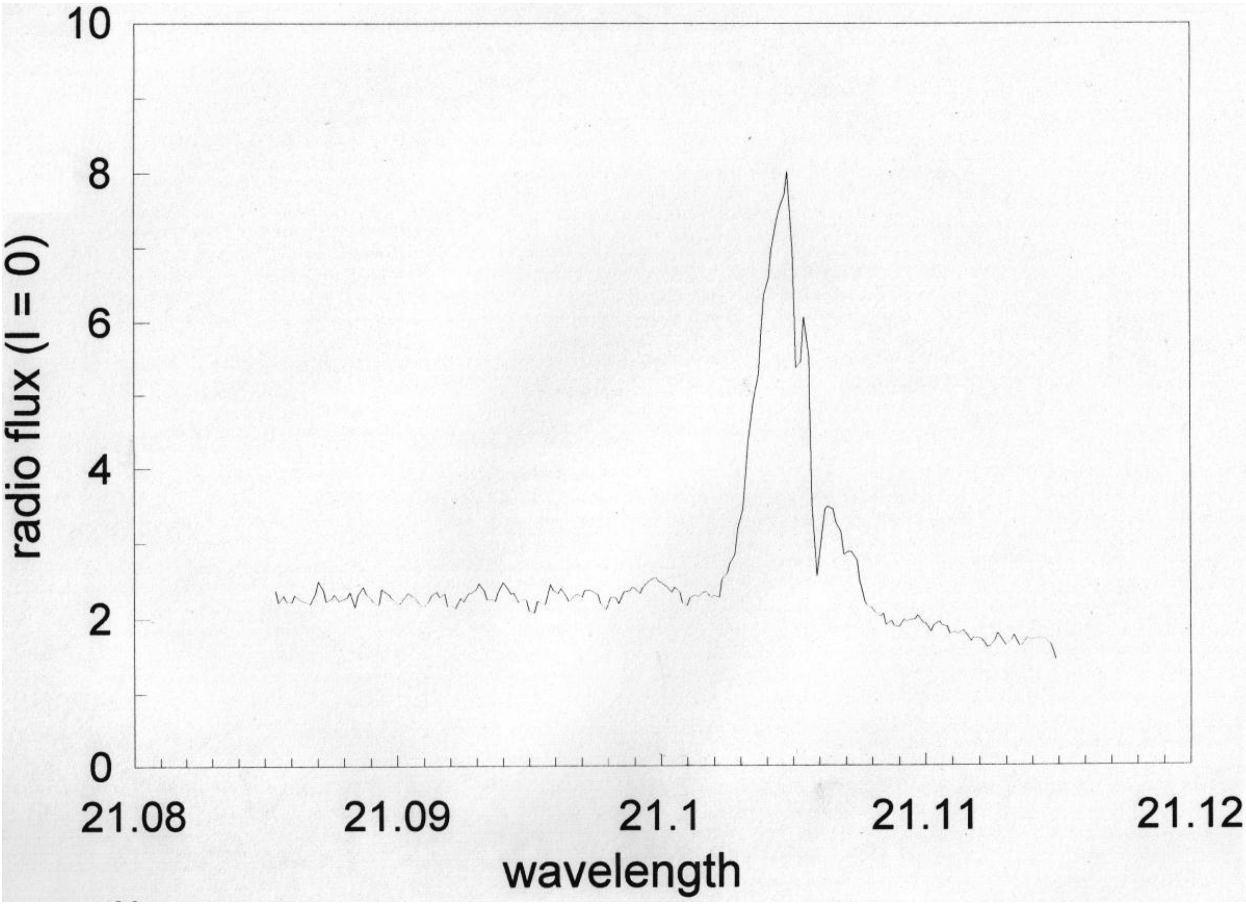

Figure 9: graphic showing the wavelengths of the radio flux coming from the line of sight which pass thought the center of our galaxy

Now consider taking a radio spectrum not of the center of our galaxy, but at a greater Galactic longitude:

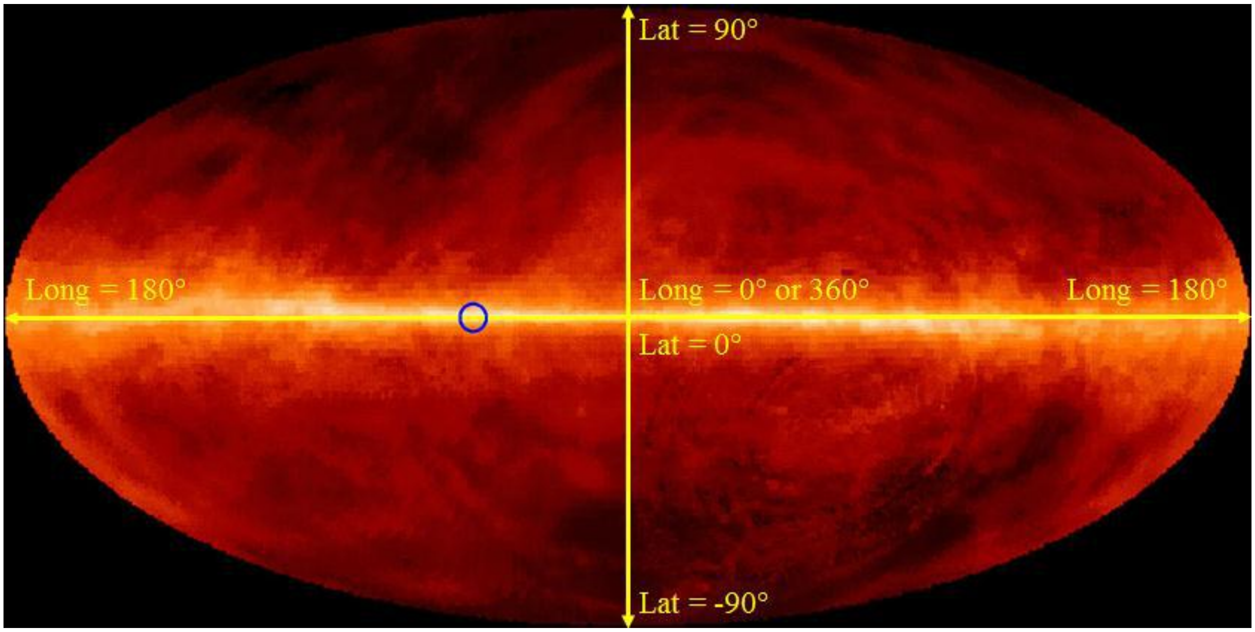

Figure 10: radio spectrum of the center of our galaxy with latitude and longitude lines

In this case, the line of sight intersects spiral arms, and hence cold hydrogen gas, at different points. Furthermore, these regions of gas are orbiting our galaxy not perpendicular to the line of sight, but each with a different component of its speed along the line of sight:

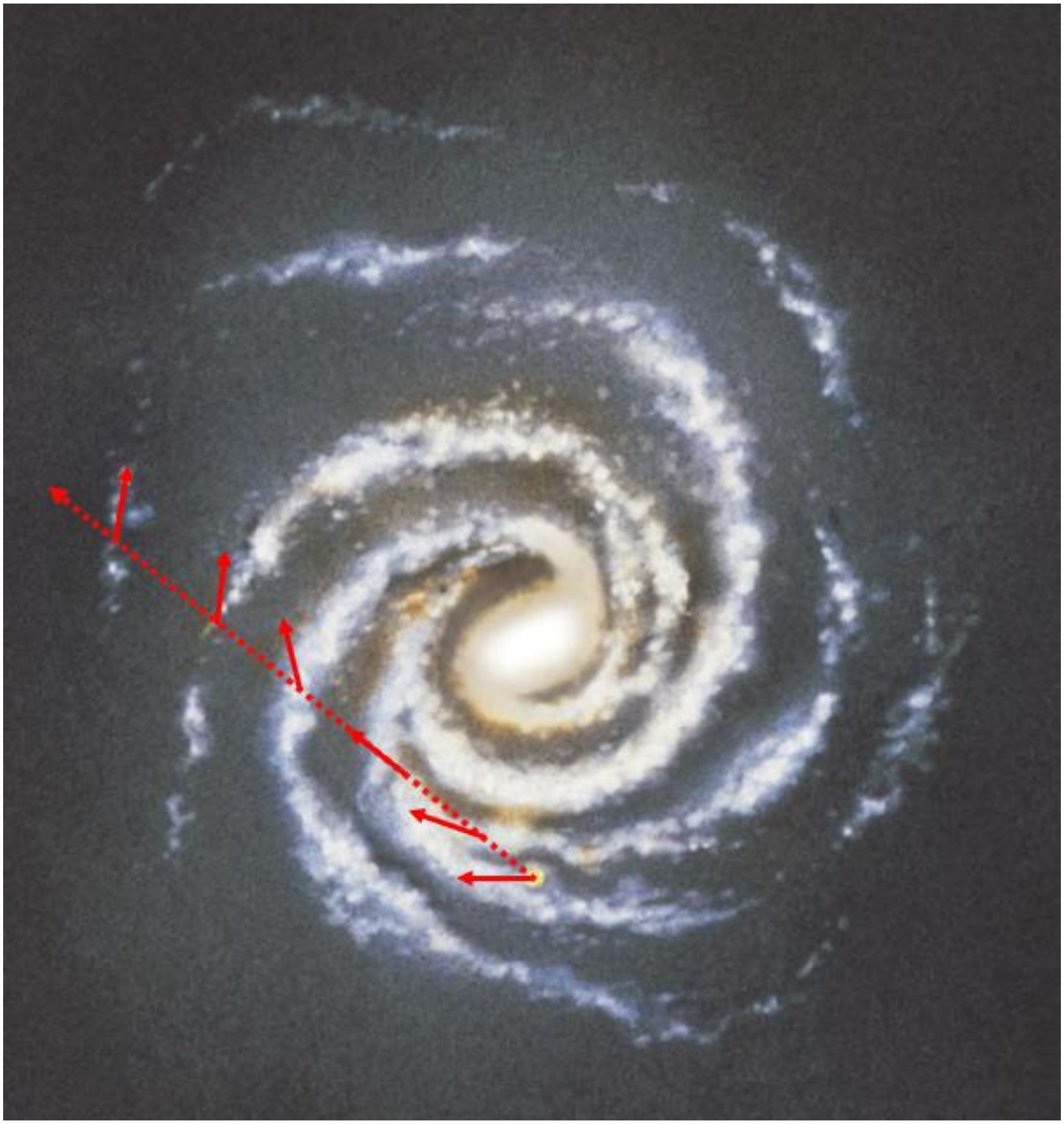

Figure 11: our galaxy face on with line of sight not passing the center of our galaxy

Consequently, the 21-cm light that these regions of gas are emitting should be Doppler shifted each by a different amount, resulting in a more complicated spectrum:

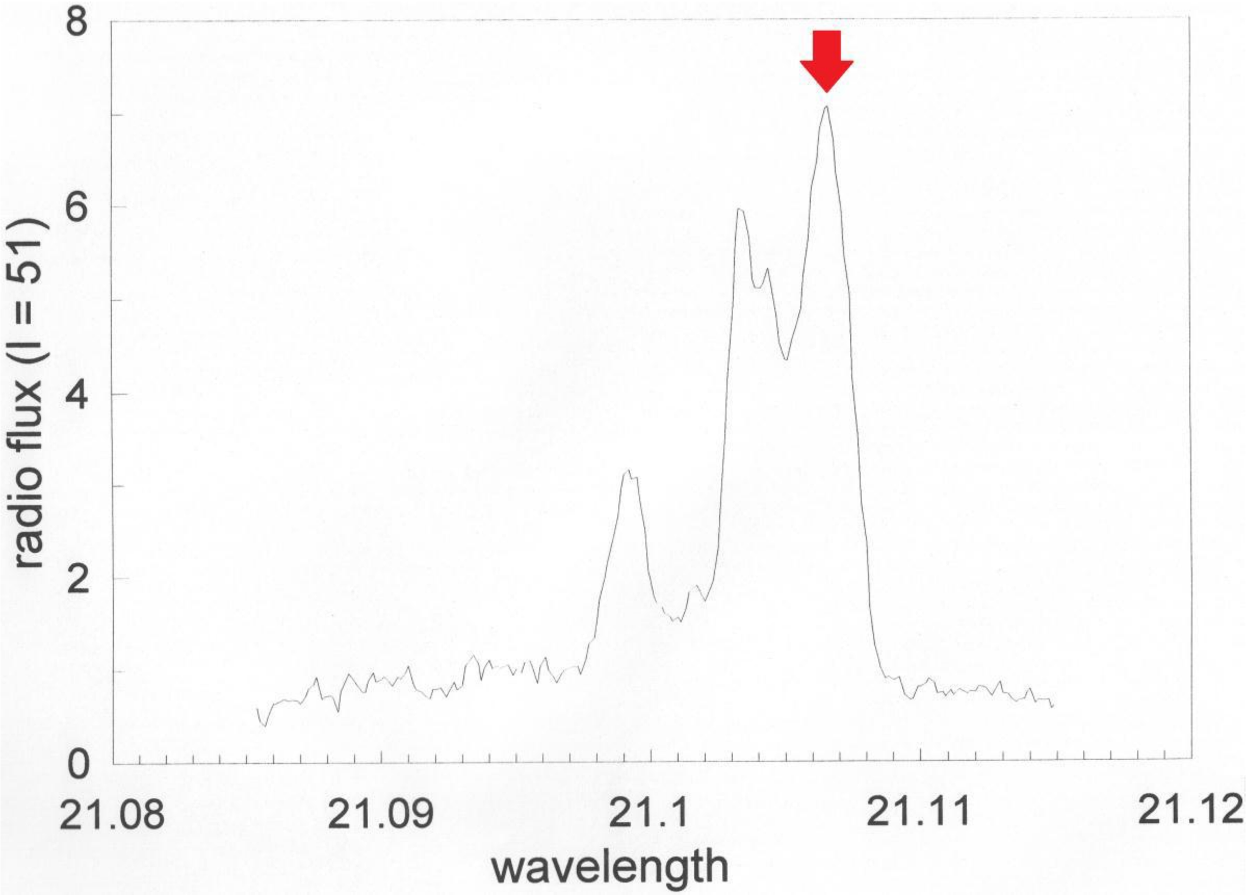

Figure 12: graphic showing the wavelengths of the radio flux coming from the line of sight which not pass thought the center of our galaxy

However, one of these regions of gas is special, because its motion is neither to the left nor to the right of the line of sight, but along the line of sight. Consequently, the 21-cm light that this region of gas is emitting should be more redshifted than that of any other region along this line of site. This most-redshifted emission is marked by the red arrow in the above spectrum.

b) Measuring Radial Distances and Orbital Speeds

The most-redshifted region of gas along any line of sight is special because both (1) its distance from the center of our galaxy **R** and (2) its orbital speed around our galaxy **V** can be easily calculated.
By calculating R and V for many lines of sight (for many Galactic longitudes), we can determine how the speed at which our galaxy rotates changes with distance from its center. This is called our galaxy's **rotation curve**.
With our galaxy's rotation curve, we can then determine how much mass must be present within any radius R to make our galaxy rotate at speed V at this radius. I.e., we can "weigh" our galaxy out to any radius R!

Measuring Radial Distances [6, 7]
First, consider a single line of sight. The most-redshifted region's distance from the center of our galaxy R can be calculated from (1) our distance from the center of our galaxy **R_{sun}** = 8.1 kpc and (2) the Galactic longitude **l** at which the spectrum was taken:

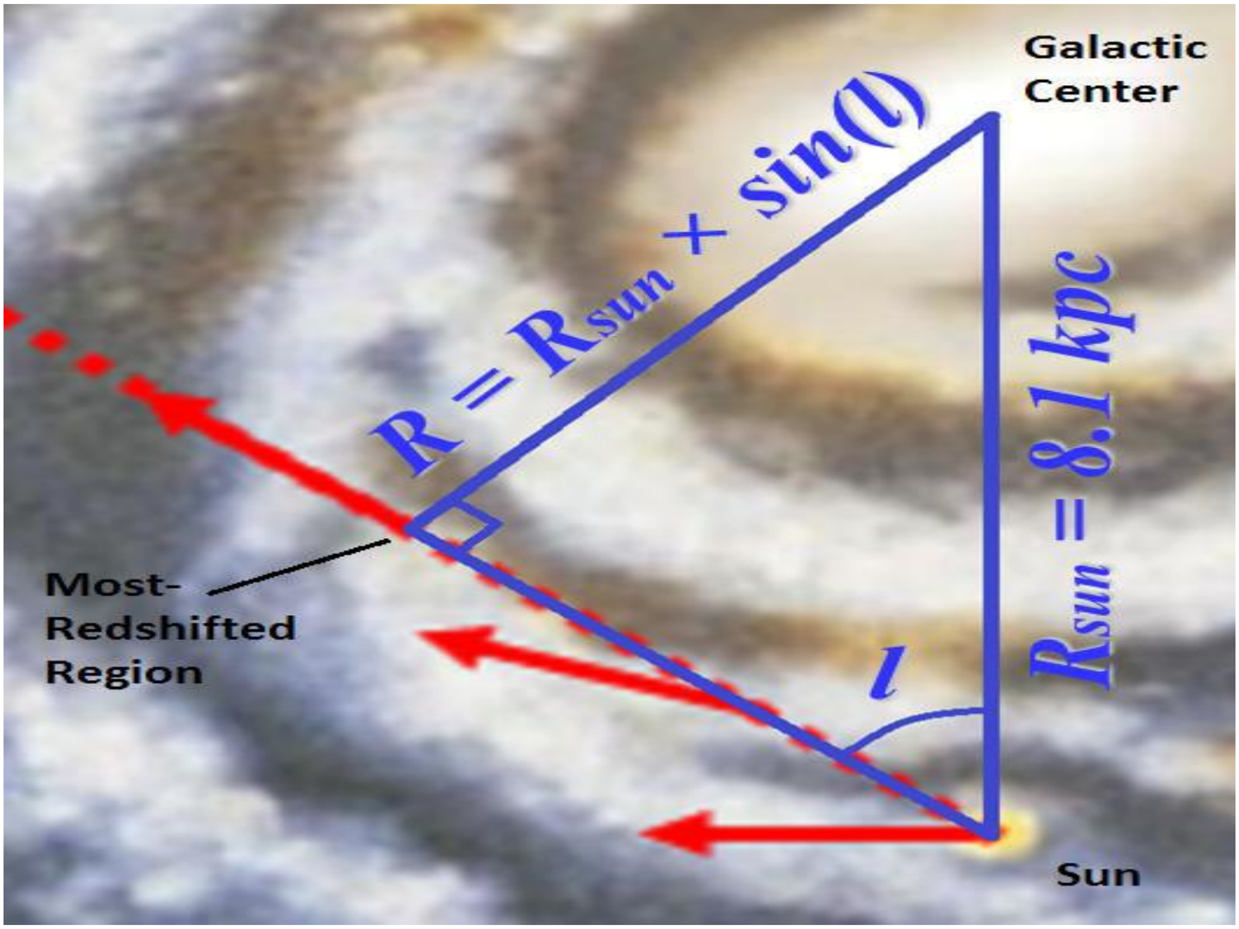

Figure 13: Measuring radial distance

Measuring Orbital Speeds[6-8]

The most-redshifted region's orbital speed around our galaxy is the same as the component of its speed along the line of sight V . The *difference* between V and the component of *our* speed along the line of sight is given by the Doppler effect equation from Section I, here solved for ΔV :

$$\Delta V = c \times \frac{\Delta\lambda}{\lambda_{em}}$$

Where

$$\Delta\lambda = \lambda_{obs} - \lambda_{em}$$

and λ_{obs} is the wavelength of the most-redshifted component of the spectrum:

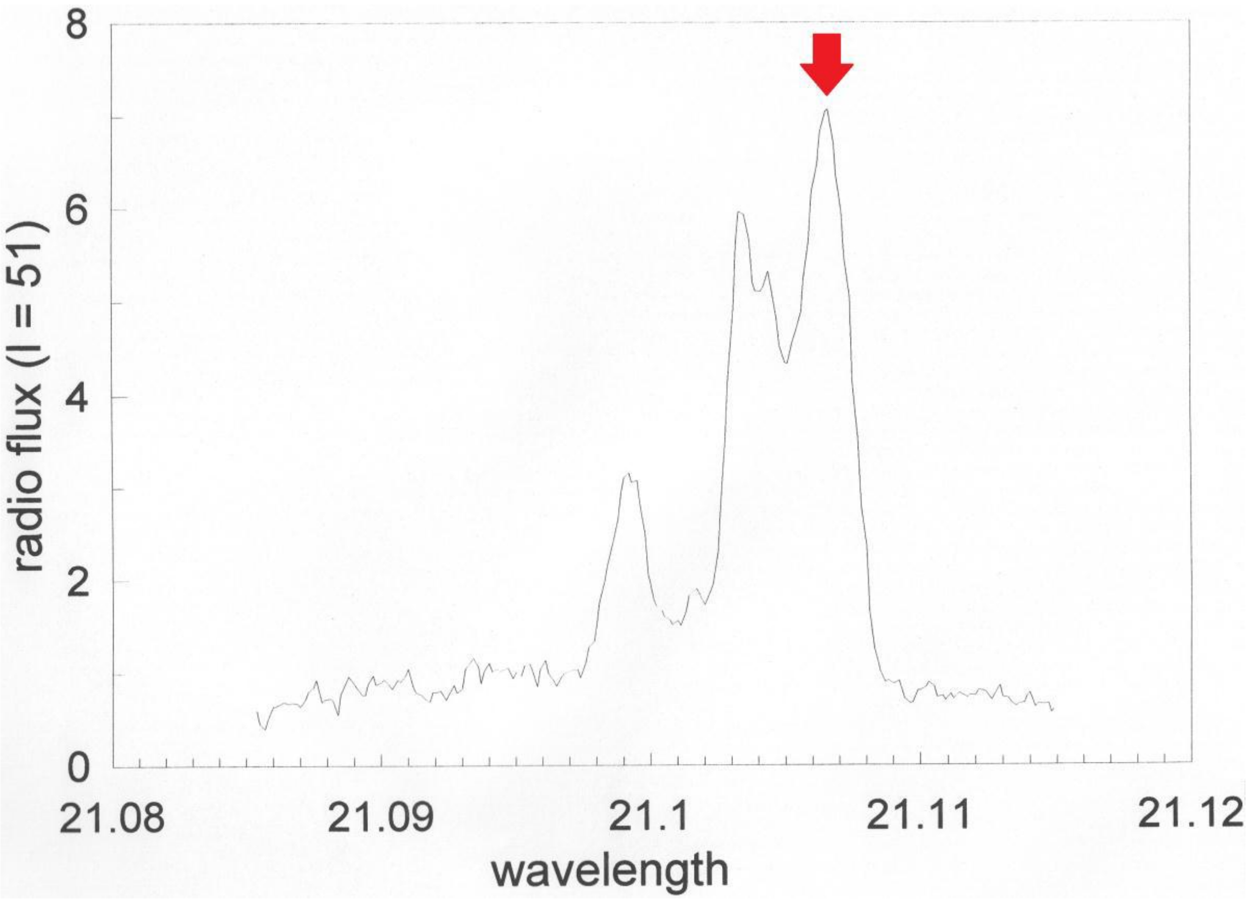

Figure 14: graphic showing the wavelengths of the radio flux coming from the line of sight which not pass thought the center of our galaxy

and λ_{em} = 21.106 cm is the precise wavelength at which cold hydrogen gas emits.

The component of *our* speed along the line of sight can be calculated from (1) our orbital speed around our galaxy V_{sun} = 220 km/s, which has been measured with respect to other galaxies in all directions around us, and (2) the Galactic longitude l at which the spectrum was taken:

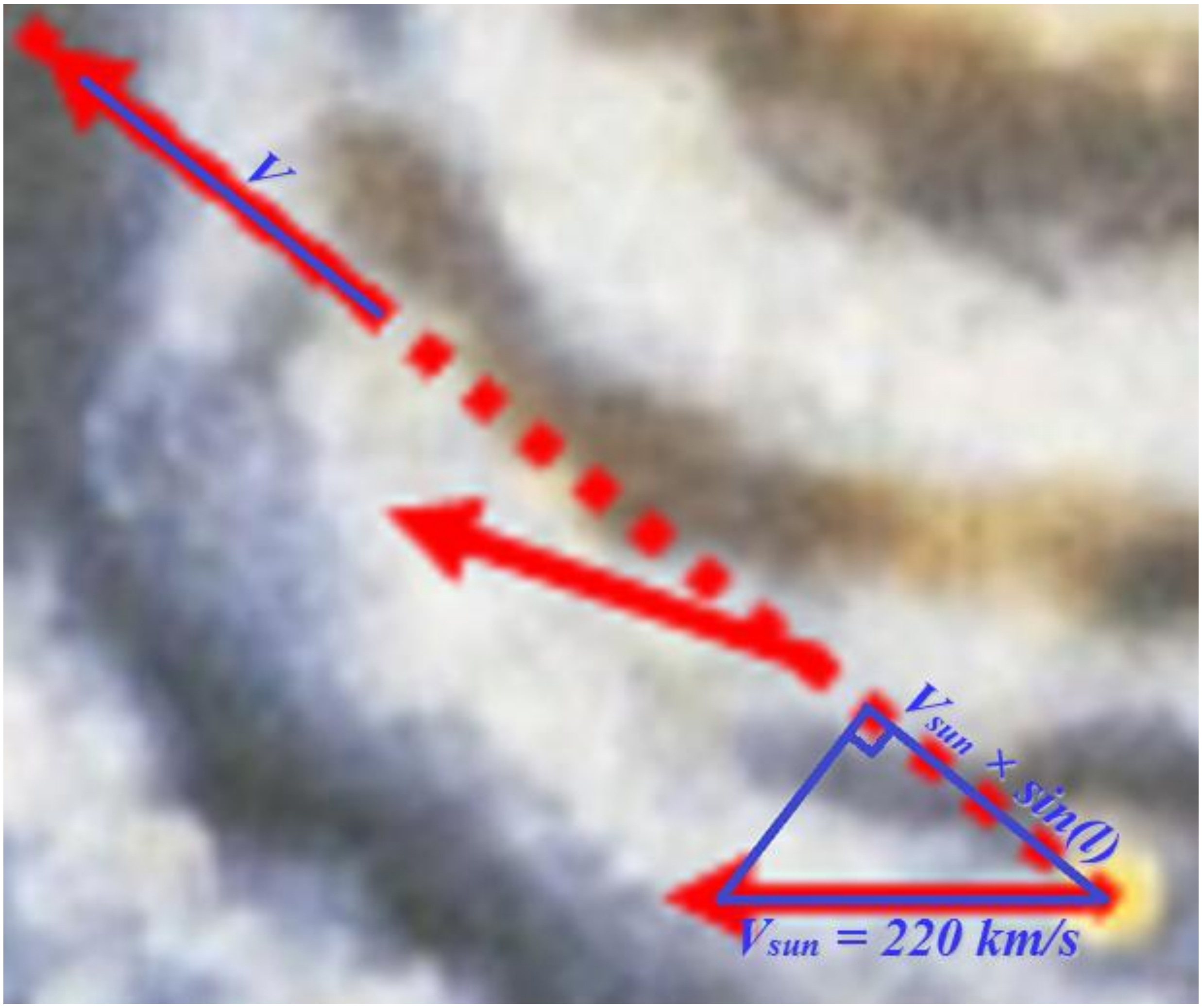

Figure 15: Measuring the component of our speed along the line of sight

Consequently, the most-redshifted region's orbital speed around our galaxy is given by:

$$V = \Delta V + \left[V_{sun} \times \sin(l)\right]$$

By taking spectra at many Galactic longitudes (Section l) and calculating R and V of the most-redshifted region of gas from each spectrum (Section ll), we will measure how the speed at which our galaxy rotates changes with distance from its center: our galaxy's rotation curve.

IV. RADIAL MASS DISTRIBUATION[7-9]

Consider Earth orbiting the sun. It is currently at distance R and moving at speed V. If the sun suddenly had no mass, Earth would continue along its current trajectory, leaving the sun. If the sun suddenly had infinite mass, it would deflect Earth's trajectory into the sun. Consequently, the sun must have just the right amount of mass to constantly deflect Earth's trajectory into its near-circular orbit:

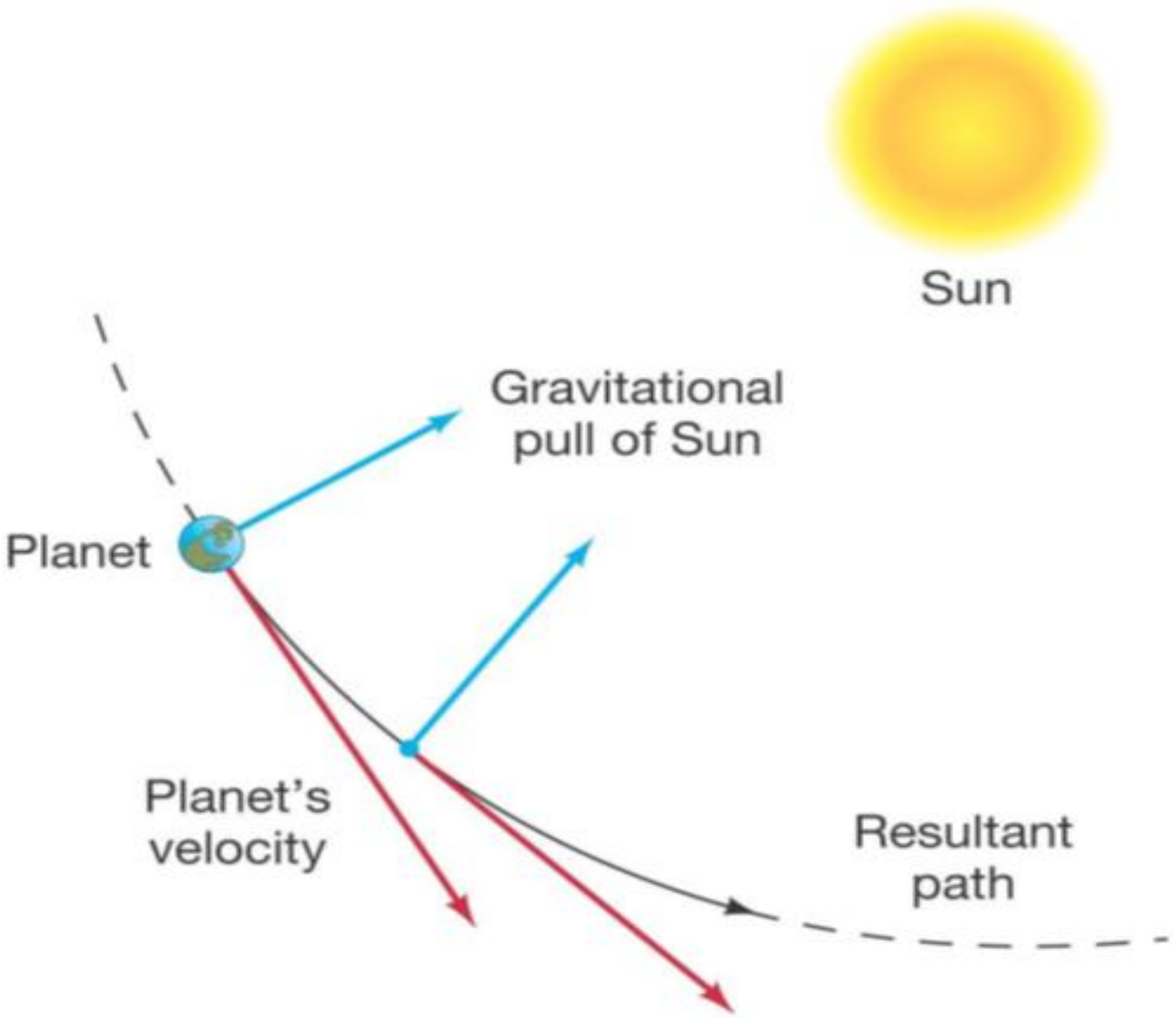

Figure 16: Earth orbiting the sun

The amount of mass required to keep an object that is moving at speed V in a circular orbit of radius R is:

$M(<R) = V^2 R / G$ [8]

where M(<R) is the total mass within radius R. In the case of the solar system, nearly all of the mass is concentrated at the center, in the sun. Hence, M(<R) ≈ Msun for any R. Solving for V yields[8]:

$V = [GM_{sun} / R]^{1/2}$

Consequently, V decreases as R increases. E.g., Mercury moves quickly but Neptune moves slowly. This is called a **Keplerian rotation curve** and is depicted as curve A below:

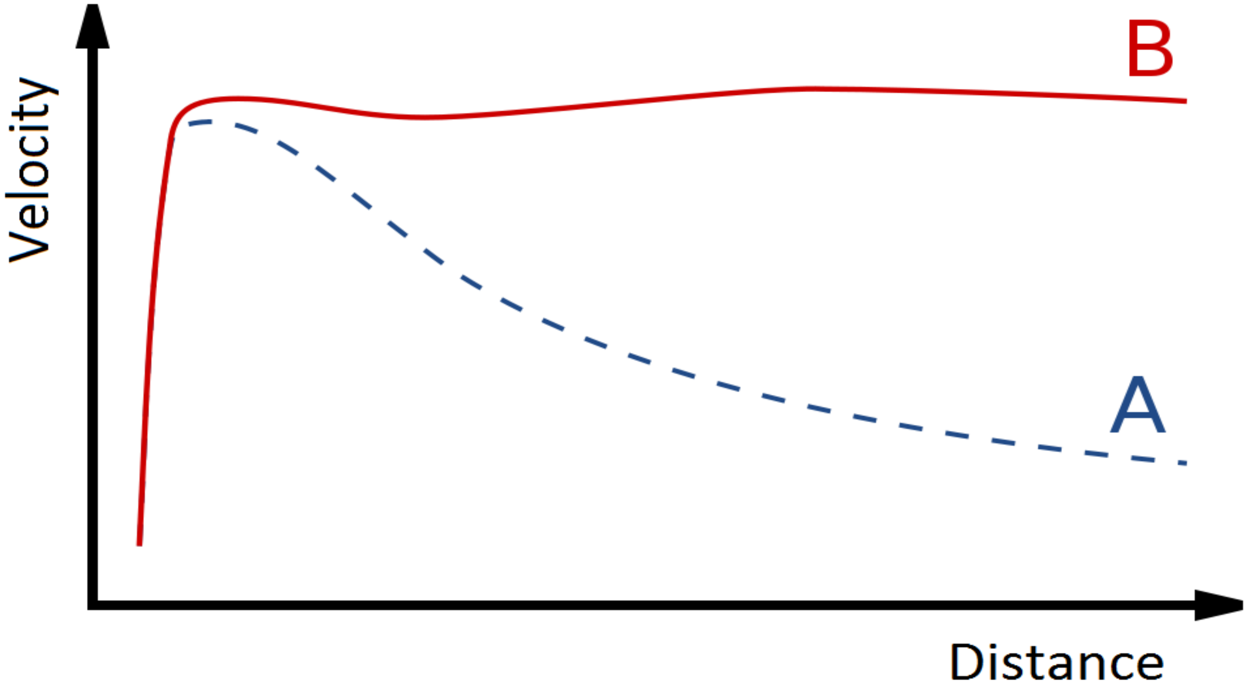

Figure 17: Keplerian and Flat rotation curve

Now consider galaxies. If most of the mass is concentrated at or near the center, galaxies should also have Keplerian rotation curves. But if the mass is spread throughout the disk, M(<R) will increase with R, in which case:

$$V = [GM_{sun} / R]^{1/2}$$

If M(<R) increases in proportion to R, they cancel out and V is approximately constant. This is called a **flat rotation curve** and is depicted as curve B above.

By measuring our galaxy's rotation curve, you can determine whether its mass is concentrated at or near its center or is spread throughout its disk. You can also use the first equation of this section to calculate how much mass must be contained within any radius M(<R) to make the matter at that radius orbit in a circular (or near-circular) orbit. I.e., you can "weigh" our galaxy out to any radius R!

The method that I used before to determine how much mass is concentrated at or near an area with radios r called the "Integral formula" by Sir Isaac Newton which used to determine the Dark Matter in galaxies.

Evaluation of the Dark Matter

I. The Basics

The determination of forces, masses, and orbital speeds in a galactic plane is a many-body-problem, for a galactic plane contains thousands of suns and other masses. However, Newton made the calculation of gravity, speed, and masses in a galactic plane shaped body possible with the discovery of a simple integral formula.

- ✓ The commonly used method to solve galactic problems is the integral formula by Newton. Galactic masses are determined with the help of orbital speed that can be measured in the galactic plane. The masses are thereby combined into a single mass in the center, which turns a complicated many-body-problem into an easily calculated two-body problem.
- ✓ The results of the integral calculation are tested through the addition of masses in a rotation symmetric, gridded, galactic circular plane. It contains 357 mass points in 10 rings around the center.

Both calculation methods ought to verify the existence of dark matter. Though a slight discrepancy between the two methods can be expected because of the grid lining, it should remain below a 1% tolerance.

II. Calculation of mass in a galactic plane with integral method according to Newton

The visible mass density of a galaxy and the actually measured orbital speed of said masses around the center are illustrated in a graph. The process of calculating a mass starts with the mass density of a galaxy as shown in *Figure 18*. *Figure 19* illustrates the orbital speed of masses measured with same formula that I used before with the red shift of star light. Close to its center a galaxy rotates similar to a solid body. This turns into a flat rotation outside of the center.

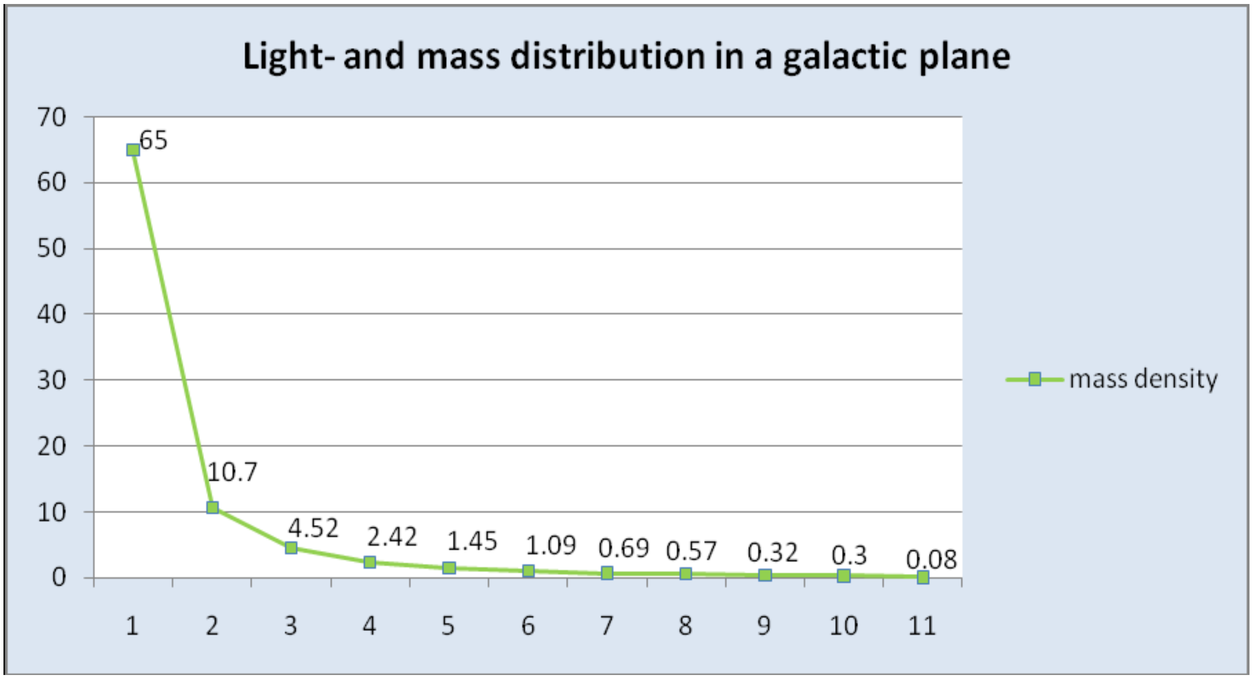

Figure 18: typical mass density distribution

The curve represents a typical mass density distribution that can be measured with the help of the ratio of light intensity versus mass in a galactic plane. The curve in *Figure 18* is not calculated – it is observed. The center of the galaxy is located on the left side, where the largest mass density can be found. Toward the right side, the mass density decreases by 400 – 1000 approximately in the general case.[4, 10]

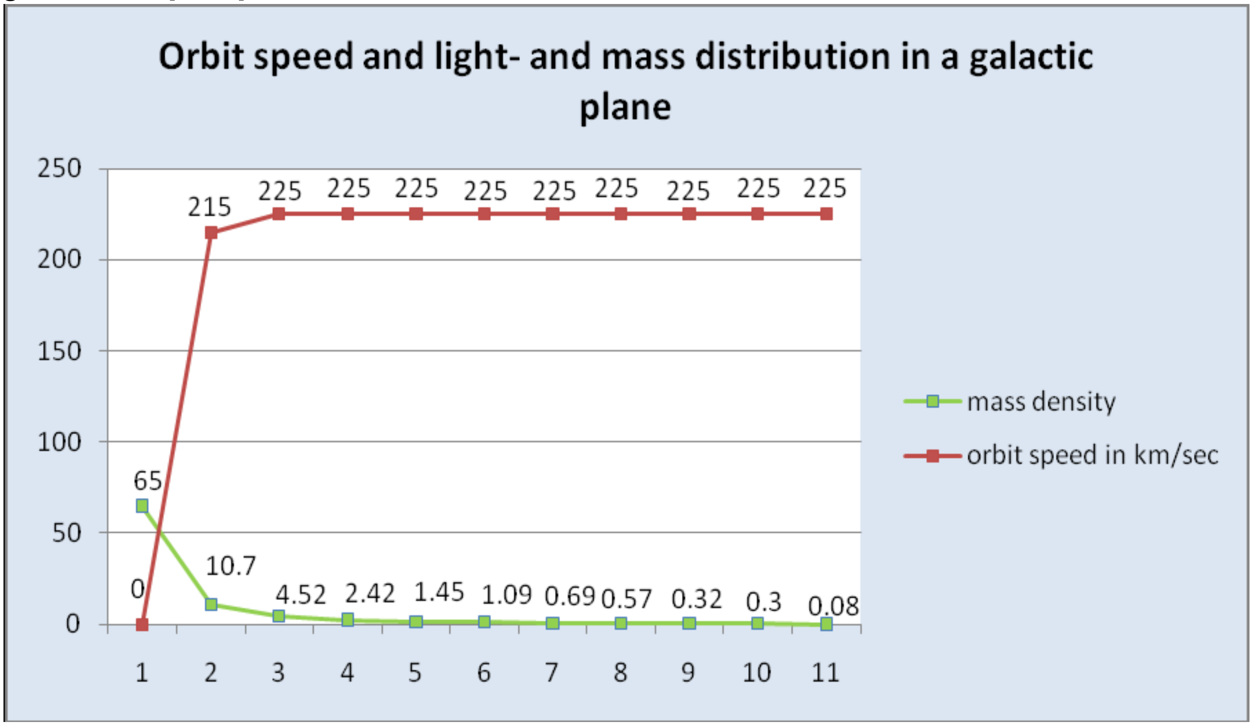

Figure 19: The speed distribution as observed, typically, in all galaxies added to the graph in figure 18

The even distribution of speed, typically observed in all galaxies, is added to the graph in *Figure 18*. The (red) curve indicates that the masses reach their constant speed of 225km/sec very quickly. The curve is idealized. In reality, the values are close to, but not exactly the same speed.[4]
Both curves represent the values usually measured in common galaxies.
The mass of a galaxy can now be calculated with the measured orbital speed. It is assumed that the mass distribution in a plane is equal to that in a sphere. The value of the calculated mass should at least approach the value of the visibly measured mass. The mass of a galaxy is determined with the formula[11]:

$$V = \sqrt{\frac{\gamma \times M}{r}} \approx \frac{1}{\sqrt{r}} (F1) \quad \text{with V=constant} \quad M = \frac{V^2 \times R}{\gamma} (F2)$$

The predetermined constant speed V in all galaxies causes the, with F2, calculated masses to change only with the radius r. The formulas F1 and F2 are used for plane mass distributions, as well as sphere mass distributions. (1 Mass unit = 1.12E+39kg / 1 radius unit = 9.46E + 19m)
With r = 1, the calculated mass value M of an average galaxy in this example is 71.6 mass units. Consequently, with r = 10, the mass is 716.
The following *Figure 20* includes the calculated mass as a pink curve. This linear mass curve is noted in scientific literature and commonly accepted.

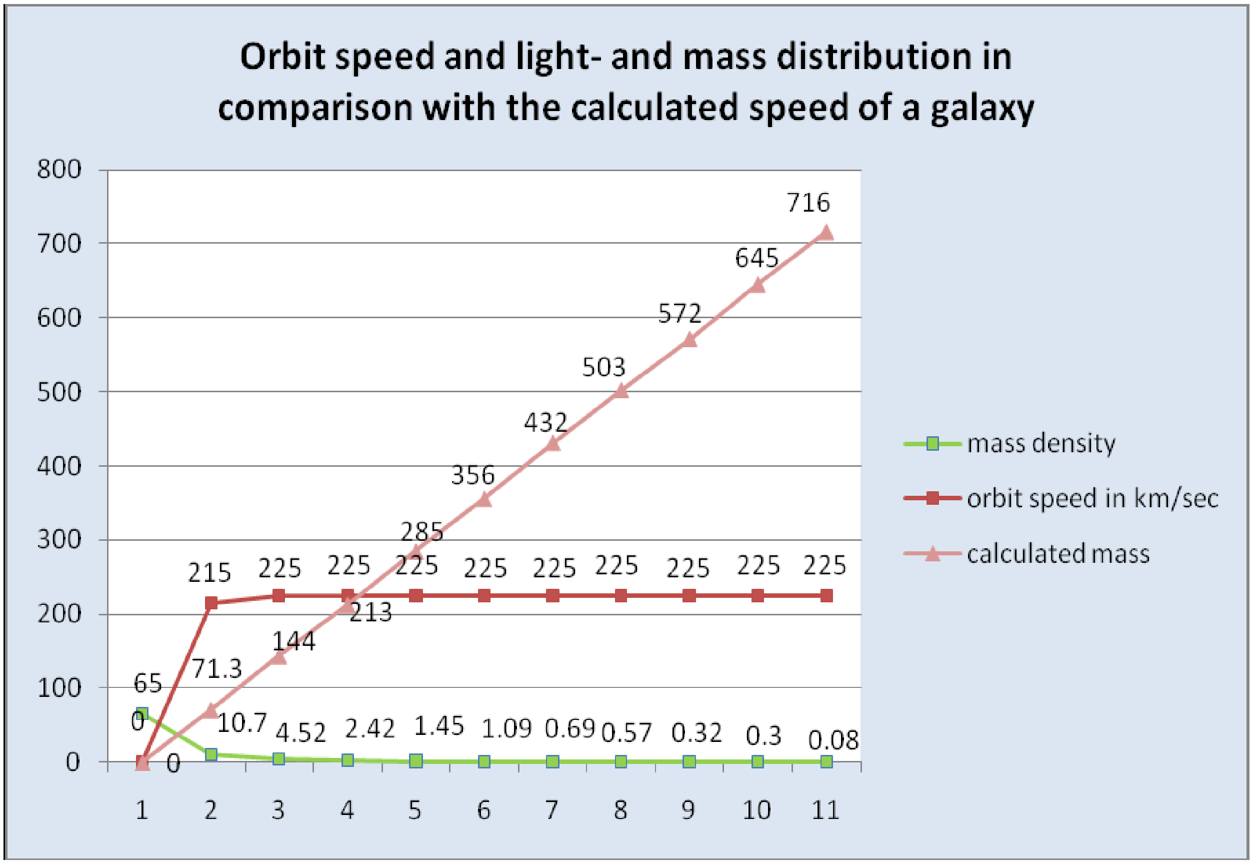

Figure 20: The calculated mass with the integral formula added to figure 19

comparison of the two mass curves reveals a discrepancy. Instead of being similar, they oppose each other. The curve representing the visible mass approaches zero, while the calculated mass continuously increases. The curves cross only at one point, which is marked with a small circle in Figure 20.

If the speed of a mass around the center of a galaxy (r = 1) is calculated with F1, the result matches the orbital speed in the graphics. V = 232 km/sec. (A slight discrepancy is intentional to keep the markers from being identical.) Hence, the calculated mass value of a galaxy close to the center is sufficient for the masses to remain on a stable orbit (black arrow).

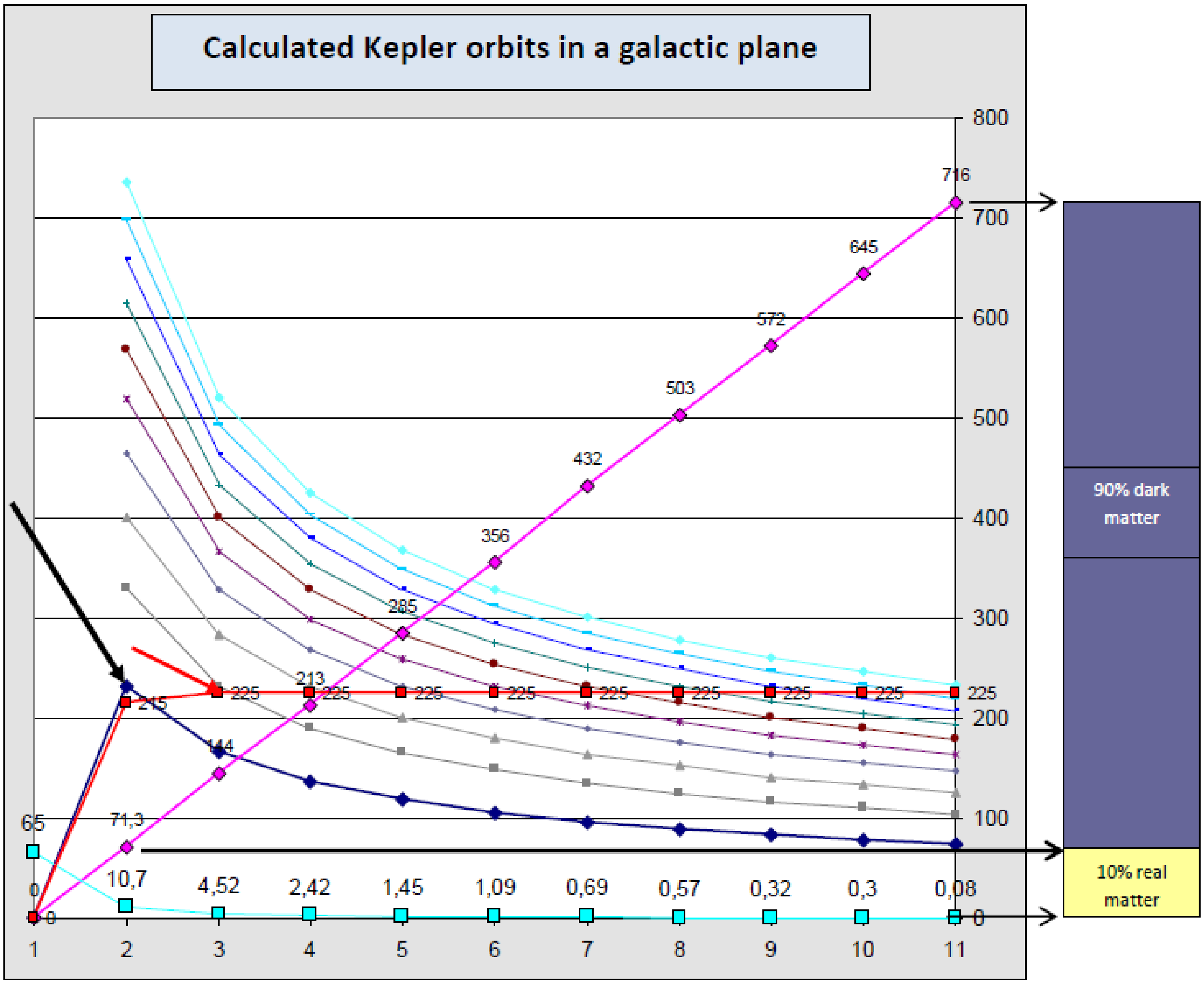

Figure 21: The distribution of dark and visible matter

If this calculated mass (M = 71.3) is used to determine the orbital speed with r = 2, the result is smaller than expected. Should the masses move along Kepler orbits, their speed decreases with an increasing distance to the center. However, in reality the orbital speeds do not decrease, but stay constant at 225 km/sec.

It is a proven fact that the majority of masses are concentrated around the center of the galaxy: “*Because the core region of a spiral galaxy has the highest concentration of visible stars, astronomers assumed that most of the mass and hence gravity of a galaxy would also be concentrated toward its center. In that case, the farther a star is from the center, the slower its expected orbital speed. Similarly, in our solar system, the outer planets move more slowly around the sun that the inner ones. By observing how the orbital speed of stars depends on their distance from the center of a galaxy, astronomers, in principle, could calculate how the mass is distributed throughout the galaxy”.[12]*

Therefore, to increase the orbital speed in the calculation so that it matches the measured values, the center mass has to be bigger. Since the visible mass cannot be modified, an additional (invisible) mass is needed.

Doubling the mass in the center allows for the mass with r = 2 to orbit at a speed of the required 225 km/sec, which is illustrated with a red arrow. *Figure 20* shows the curves for respective radii r = 3, 4, 5, 6, 7, 8, 9, and 10. Each curve crosses the red orbital speed curve in its radius mark. The resulting group of curves illustrates how a growing center mass is necessary to maintain a constant orbital speed. Consequently, the mass of the entire galaxy increases as well. By assuming r = 1 and M = 71.3 to be the basis for this calculation example, a ten times larger mass is required at the edge of the galaxy to facilitate an orbital speed of 225 km/sec. In 1933, Fritz Zwicky determined that a 400-times larger mass is needed for a constant speed in the Coma-Galaxy, and invented the invisible *dark matter*. The same problem appeared in 1960 when Vera C. Rubin examined galactic orbital speeds. Ever since, the expression *dark matter* has played a vital role in modern physical and cosmological sciences.

The ratio of visible mass to invisible (dark) mass is 1:10. A galaxy has a ten times larger mass than what is visible. Nevertheless, this ratio varies for 1:5) to 1:100 .[13]

The Father of Dark Matter—and More

Bulgarian born and Swiss naturalized, Fritz Zwicky found his scientific home at the California Institute of Technology. From his perch on Caltech's Mount Wilson Observatory, Zwicky discovered more of the exploding stars known as "supernovae" than all his predecessors combined. But astrophysicists today admire him mostly for his theoretical insights into such phenomena as neutron stars, gravitational lenses, and—perhaps most important of all—dark matter.

Zwicky's observations of supernovae in distant galaxies laid the foundation of his theoretical work.

As he detected supernovae in ever-more distant galaxies, he realized that most galaxies combined in clusters. Careful measurements of the light from clusters led him to suggest the existence of dark matter. That may represent his greatest legacy, but he made other key contributions to strophysics.

He predicted that galaxies could act as gravitational lenses, an effect first observed in 1979, five years after his death. And he and his colleague Walter Baade predicted the transition of ordinary stars into neutron stars, first observed in 1967.

III. Addition of visible masses for the purpose of checking the calculated masses[14]

The mass density in a galaxy is different from its number of masses. While mass density pertains to a single plane unit, the number of masses is the product of the number of plane units multiplied with the mass density. To turn the visible mass density of a galaxy into a comparable number of masses, the plane has to be grid lined. The mass density of every single unit can be determined with concentric grid lining of the plane (the 3rd and 4th rings are not completely concentric because of the number of mass points). Only then is it possible to add up the combined mass of a galaxy.
In this example, a rotation symmetrical circular plane is gridded into 357 mass units. Starting in the center toward the edge of the plane are ten concentric rings. The larger the rings, the more mass units – also called mass points – are present.

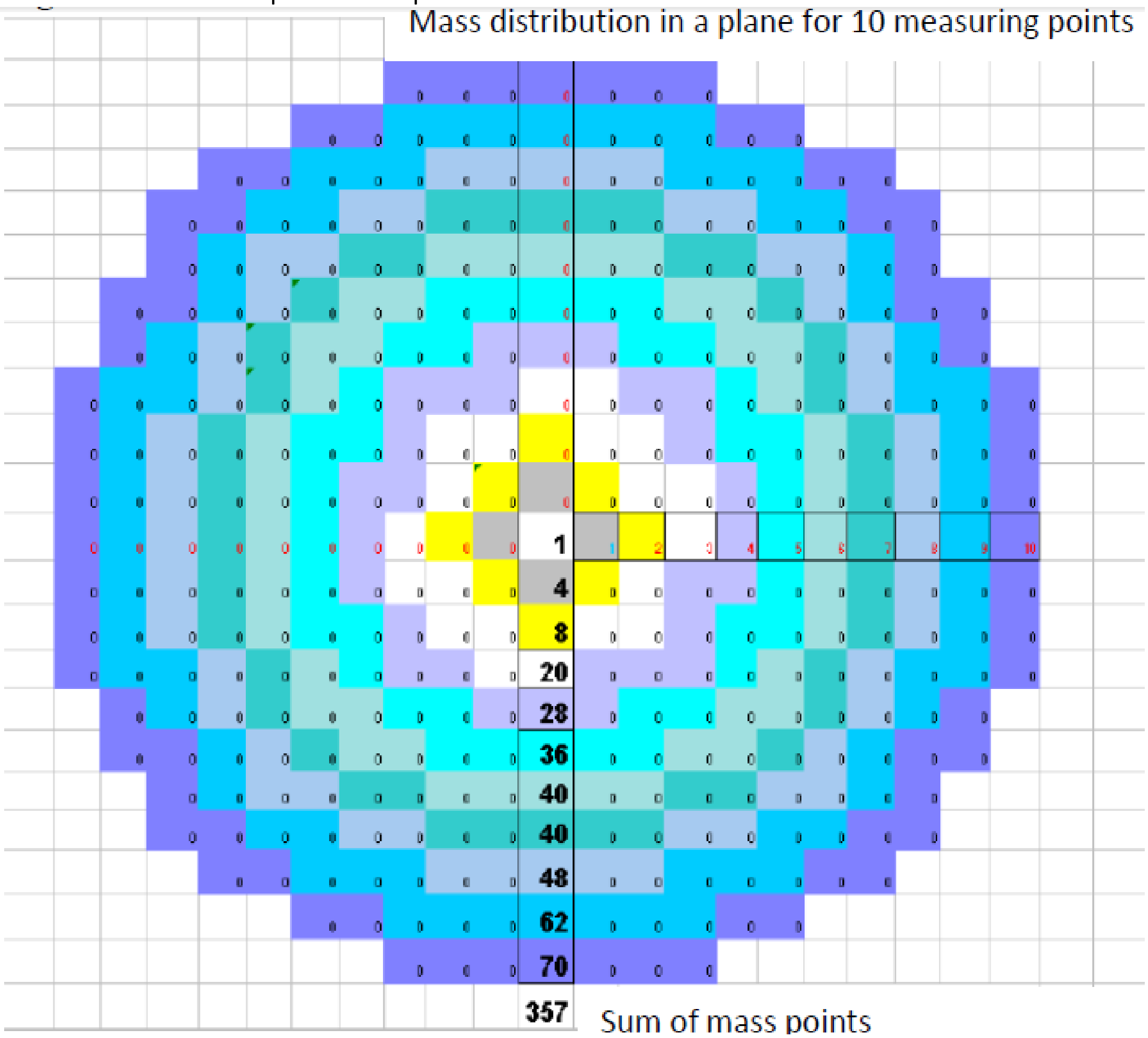

Figure 22: Mass distribution in a plane for 10 measuring points

In order to add the masses, the number of mass points per ring has to be multiplied with the measured mass density in the galactic plane. This is done according to the following principle: a point in the center has the mass density 65, which equals 1 x 65 = 65 mass units. This is repeated for every ring.

Table 1: calculating the added masss in plane shaped galaxies

Number of gridded mass units		Mass density according to the brightness : mass ratio		Number of masses per ring	Addition of number of masses per ring	Radius
1	x	65	=	65.00	65	
4	x	10.7	=	42.80	108	1
8	x	4.52	=	36.16	144	2
20	x	2.42	=	48.40	192	3
28	x	1.45	=	40.60	233	4
36	x	1.09	=	39.24	272	5
40	x	0.69	=	27.60	300	6
40	x	0.57	=	22.80	323	7
48	x	0.32	=	15.36	338	8
62	x	0.30	=	18.60	356	9
70	x	0.08	=	5.60	**362**	10

[14]

Then the masses per ring are added up and graphed as seen in *Figure 23*. With the addition of the last ring (the outer most ring), the calculation is complete. The visible combined mass of the average galaxy is therefore 362, which are approximately 200 billion “earthly” sun masses.

The number of masses is similar to the visible mass of an average galaxy[14].Adding these values to *Figure 18* results in *Figure 23*:

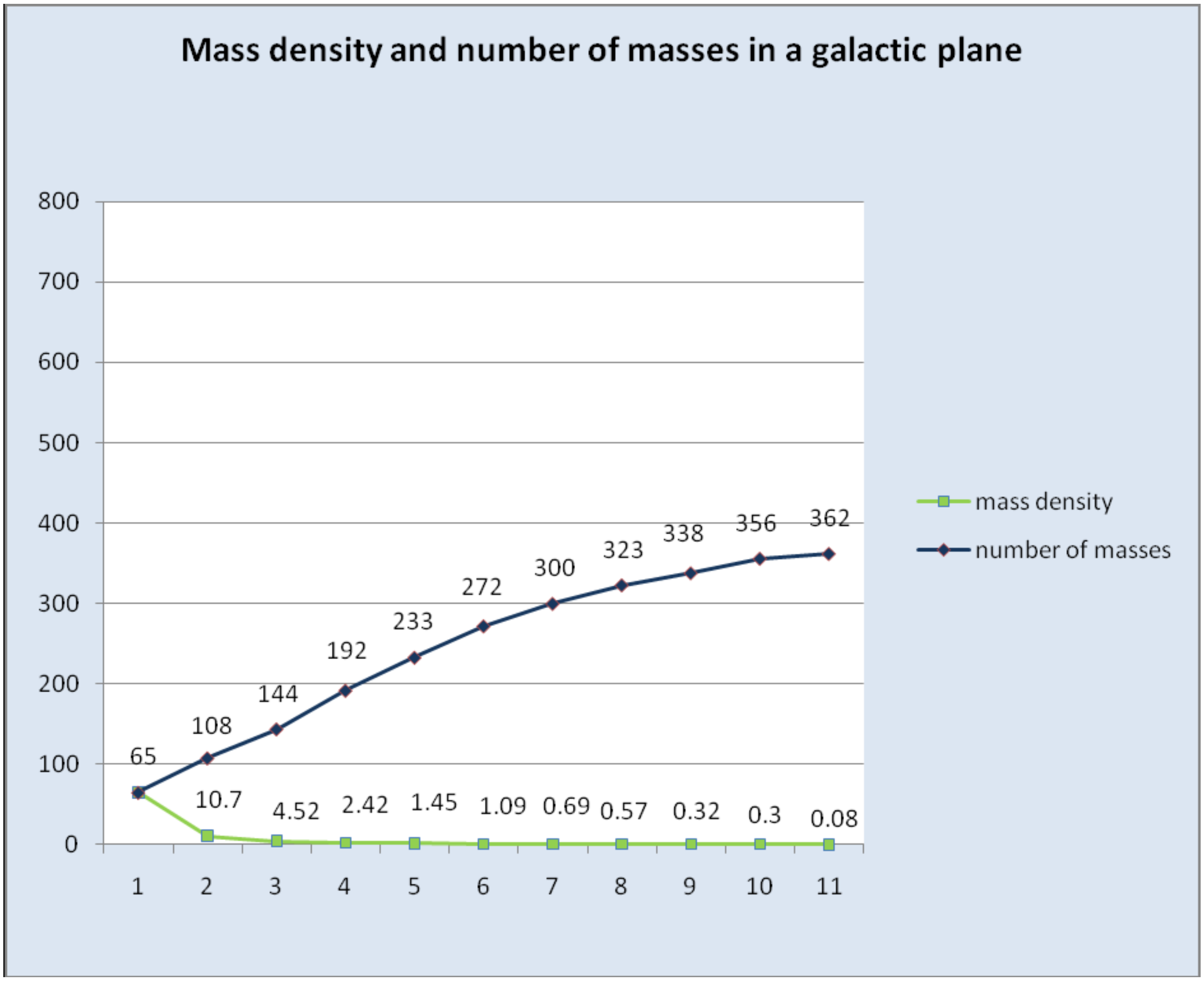

Figure 23: The curve of added masses added to figure 19

The number of masses increases toward the edge, because with every step, another ring is added to the sum. The combined mass number of the galactic plane can be found at the right of *Figure 23*. It is obvious that the mass density decreases toward the edge, the number of masses, however, increases. The two curves do not oppose each other; the mass density causes the increase in number of masses.

IV. Comparison of calculated masses with added masses in a plan (plan shaped galaxy)

Once the curve for the added masses (dark blue) is included in the graphic, the values can easily be compared to the calculated masses.

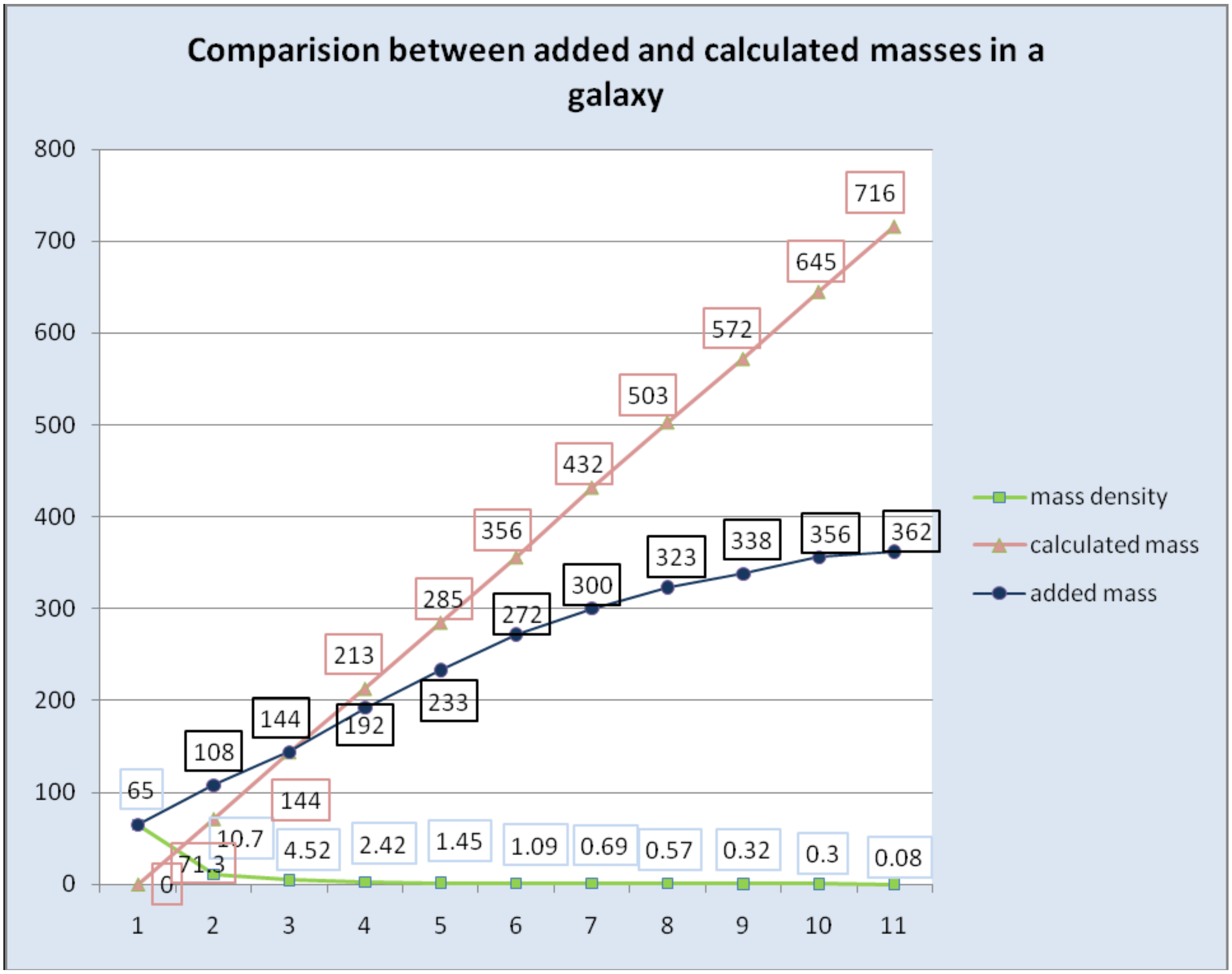

Figure 24: The curve of calculated masses added to figure 23

Surprisingly, the comparison reveals that the added number of masses in a galaxy amounts to only about half of the calculated combined mass. The ratio between dark and visible calculated matter and added matter shrinks from 10 : 1 to only 2 : 1.

The added mass as test for the integral calculation provides the only exact value for the *visible* masses! This was not the expected result of 700 mass units of dark matter and 70 units of visible mass. If the calculated 70 mass units are put in relation with the visible 362 mass units, it becomes clear that only 19.3% of the visible masses are calculated with the integral method. Which means that a wrong (too small) mass ratio of 5 : 1 is calculated.

Furthermore, the fact that the center of the galaxy has a bigger added than calculated mass (up to r = 2) indicates that the integral method harbors a fundamental error for the calculation of masses in many-body-problems that were transformed into two-body problems. To be precise, the number of masses will be calculated in a sphere.

V. Comparison of calculated masses and added masses in a sphere (sphere shaped galaxy)

Since the integral calculation of masses in a sphere is equal to that in a plane (with formulas F1 and F2), the results are similar as well. Hence, in a sphere, the calculated masses increase toward the outer edge if their speed remains constant. To check these results, the masses only need to be added up discretely. (A sphere has a slightly different mass density than a plane, which required the adjustment of values in the following table.) As before, the orbital speed shall be constant. The sphere in this example has 5065 mass points, because the number of mass points per sphere ring grows at a different rate than that in a plane.

Table 2: calculating the added masses in sphere shaped galaxies

Number of gridded mass volume units		Mass density according to the brightness : mass ratio		Number of masses per sphere ring	Addition of number of masses per sphere ring	Radius
1	x	430	=	430	430	
6	x	41	=	246	676	1
74	x	8.2	=	607	1283	2
98	x	3.3	=	323	1606	3
250	x	1.9	=	475	2081	4
342	x	1.1	=	376	2457	5
578	x	0.7	=	276	2733	6
586	x	0.55	=	404	3137	7
914	x	0.33	=	302	3439	8
990	x	0.33	=	327	3766	9
1226	x	0.2	=	245	**4011**	10

[14]

Following the multiplication of mass density and number of mass units, the number of masses per sphere ring is added up and graphed in *Figure 25*. The combined mass of the galaxy can be found once all masses are added. In this example, it is 4011 mass units.
1 mass unit = 1.0E + 39kg / 1 radius unit = 19.0E + 19m / orbital speed is constant at 400 km/sec. (Note: the galaxy in this example does not exist; however, the values serve the purpose of comparing and contrasting calculated and added masses in plane and sphere. A galaxy with the determined masses would favor a too large elliptical galaxy).

The added number of masses is illustrated in *Figure 25* by the light blue curve. As a comparison, the calculated mass (with a constant orbital speed) curve is also present as pink curve.

It is clearly visible, that the calculated and added masses at the edge of the galaxy differ by only +15.5%, whereas the values in a plane differ by almost +100%. Close to the center of the galaxy, the calculated masses are smaller (!) than the added values (only 68%). Similar characteristics of curves and values could be seen in the example with planes (66%). (Note: the grid lining of the sphere causes a slight curve variance in the figure).

Depending on the mass density distribution, the calculated positive and negative discrepancy of values indicates a dynamic median value.

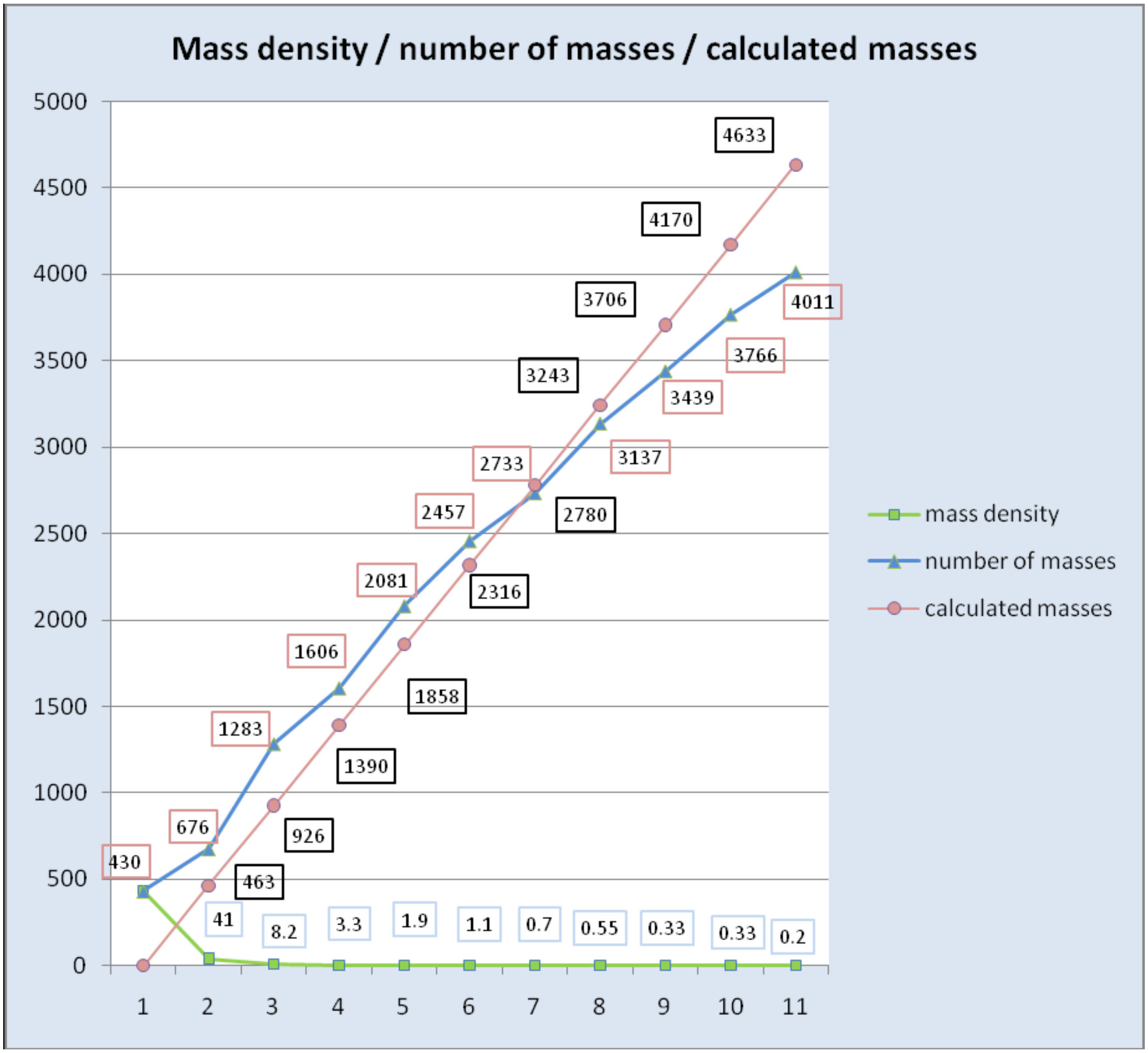

Figure 25: The added and calculated masses in sphere shaped galaxies

Conclusion

The graphic comparison of calculated and added mass values of plane and sphere galaxies indicates:

- ✓ Discrete calculation of masses leads to correct values in plane and sphere galaxies.
- ✓ An additional calculated mass (a dark, invisible) matter is unnecessary in plane and sphere galaxies.
- ✓ The masses of sphere and plane galaxies must not be calculated with the same integral formula.

The calculation of dark matter is based on at least two mistakes:

- ✓ The integral calculation according to Sir Isaac Newton is not ideal for masses in a plane or field galaxy. Newton used his formula only for the calculation of gravitational forces – never for masses. This even applies to the determination of masses in spheres, because the calculated and added values differed along the curve.
- ✓ The mass density of a galaxy determined with the ratio of brightness and mass is commonly assumed to be equal to its real mass. This error reduces the real mass by almost 90%, and is the main reason for the “existence” of dark matter.

Table of Tables

Table of Figures

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