Mass determination of a galaxy with the parallelogram of forces

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Objective

The purpose of this paper is to describe an additional method of mass determination in galaxies: the calculation of masses with the parallelogram of forces. The explanation of this calculation method and its results is followed by a short comparison with two other methods. This paper does not aim to provide a pecise calcualtion of masses in a galaxy, but to illustrate different methods of calculation based on logic. The three different methods are:

1. The **Integral calculation** , used since Newton to determine the masses and orbital speeds in a galactic plane. This method lead to the assumption of the existence of dark matter. Characteristics: inside masses are combined to a single point of masses and then used for calculation.
2. The **Discrete calculation**, does not produce results comparable to the integral calcualtion. Characteristics: Visual libration orbit and gravitational orbit are distinguished. Mass forces are first calcualted and then combined. Results can be verified with values measured in reality.
3. The **Parallelogram of forces calculation,** works geometrically or mathematically with the Pythagoras theorem. Characteristics: Only three variables are used as basis for calculation: the actual force on the object, and its direction, the speed and the mass of the object. A radius is not necessary for this calcualtion.
4. The start variables for the calcualtions (combined mass M, radius r, Force F, and orbital speed v)and the results of all three methods are compared and discussed.

Fundamentals of the calculations

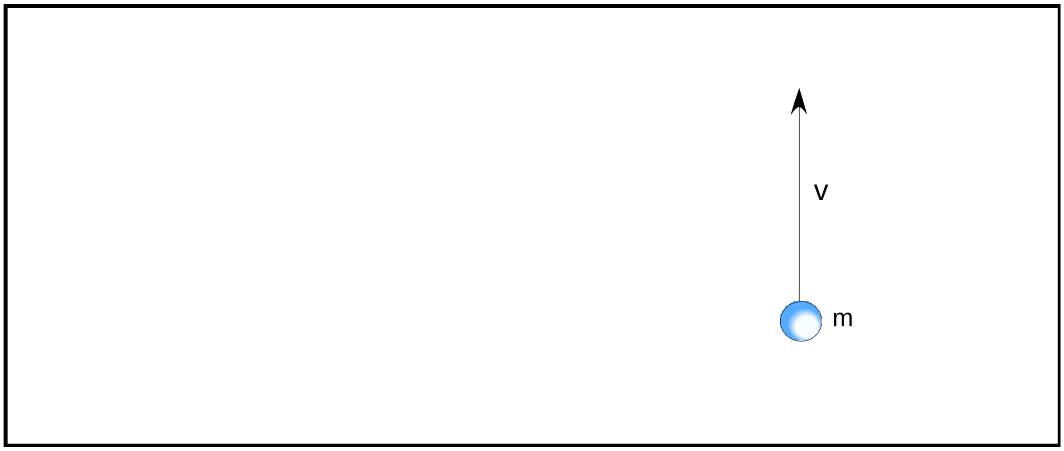
The calculation of forces, masses,and orbital speeds in a galactic plane is always a many-body problem, because a galactic plane consists of thousands of suns and other masses. There are always several different possibilities to determine the graviational forces in a plane shaped galactic body. Nevertheless, such a calculation should be as close to reality as possible, for example, with the help of a **parallelogram of forces**.

A general example that covers all possible *what-ifs* is used to illustrate the calculation, which is based on the following dynamic expressions:

- ✓ A single mass m within a number of masses M is observed. The mass m experiences a force F (the reason for this force F is one or several other masses), from a certain direction. Furthermore, this mass m moves through space at a certain speed v, and lastly, has a certain mass m. Only these three variables, mass m, acceleration (calculated from the force F and mass: a=F/m), and speed v are used for the calculation of the mass exerting forces.

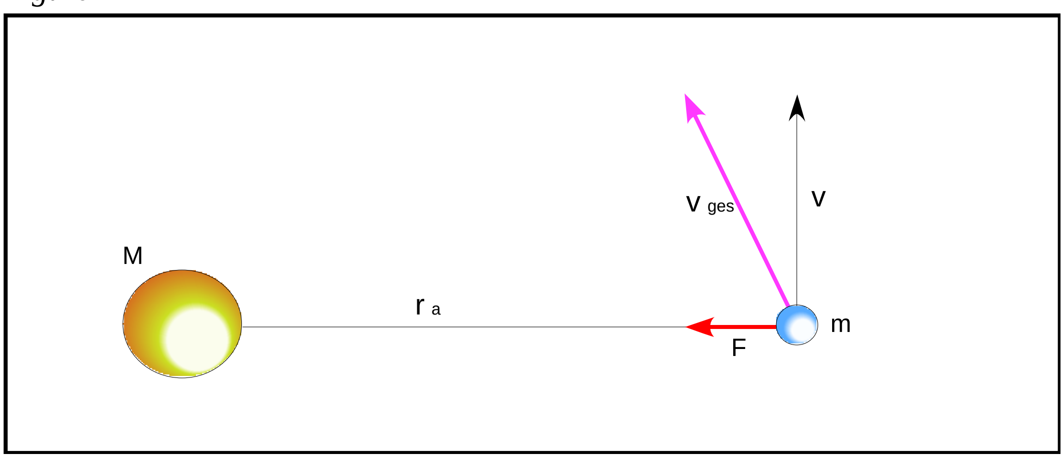
- ✓ It is also important to include the observer, who is describing the movement of masses from his point of view and compared to his surrounding.
- ✓ Known variables are: speed v (black arrow)
  Force F (red arrow in *Figure 2*)
  Mass m (blue circle)

Figure 1



In space (in a vacuum), the blue body moves at a constant speed **v** in the same direction. Without an exogenous force, the body retains its original speed **v**. (Newton's First Law of Motion)

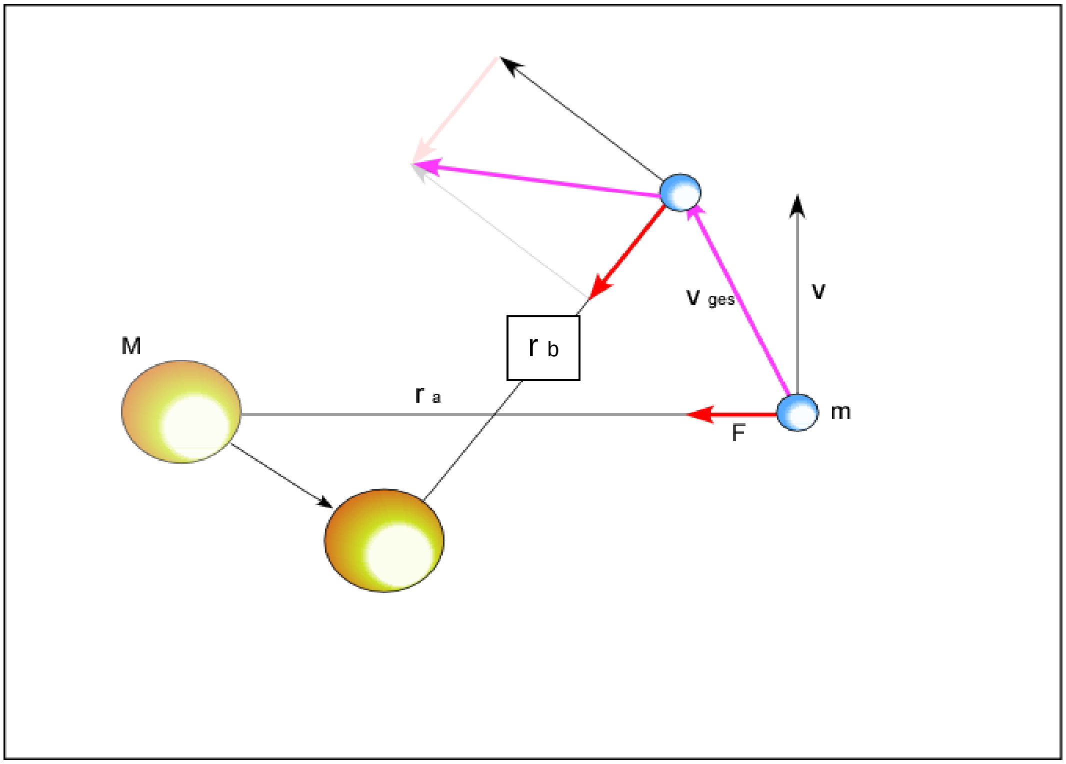
Figure 2



The presence of a heavier second body/mass **M** (or masses), colored in apricot, causes the blue body **m** to move in a different direction. The force **F** (red arrow) exerted by the bigger mass accelerates the blue mass **m** in a different direction, so that it has to leave its original track. The new direction of movement is illustrated with a violet arrow $\mathbf{v}_{ges}$.

Where **v** $_{\mathbf{ges}}$ is different from **v**. The measurement of all calculation variables is repeated regularly after a certain time interval.
The distance between the two masses shall be called $\mathbf{r_a}$. However, the distance $\mathbf{r_a}$ must not be confused with a constant radius, because it is unknown if the mass **M** remains stationary.

Figure 3



In order to determine the force **F,** the distance between masses has to be reevaluated with after each time interval. Beacuse of the changing location of he combined mass **M,** $\mathbf{r_a}$ is not equal to $\mathbf{r_b}$. This is similar to the mass **M**, since it can be a combination of masses at different locations; therefore, the value of its mass is not necessarily equal after every time interval.(Masses are subject to interacting gravitational forces.) The gravitational force **F** between masses is calcualted with the formula:

$$F = \frac{\gamma \cdot m \cdot M_{\text{var.}}}{r_{b\,\text{var}}^{2}} \qquad \textbf{(F1)}$$ for different time intervalls:

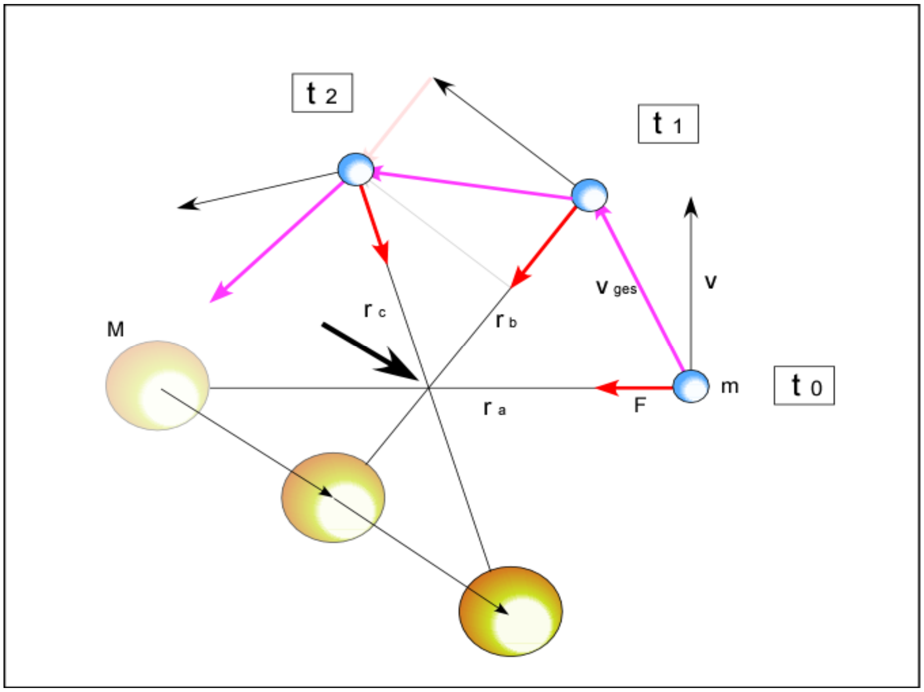
M = var. And also $\mathbf{r_a}$ = var. (to be seen as distance only)

This leads to a continuously changing force **F** = var. On the mass **m**. The distance after acceleration is calculated with the formula

$$S = \frac{\frac{F_{\text{var}}}{m} \cdot t^{2}}{2} \qquad \textbf{(F2)}$$

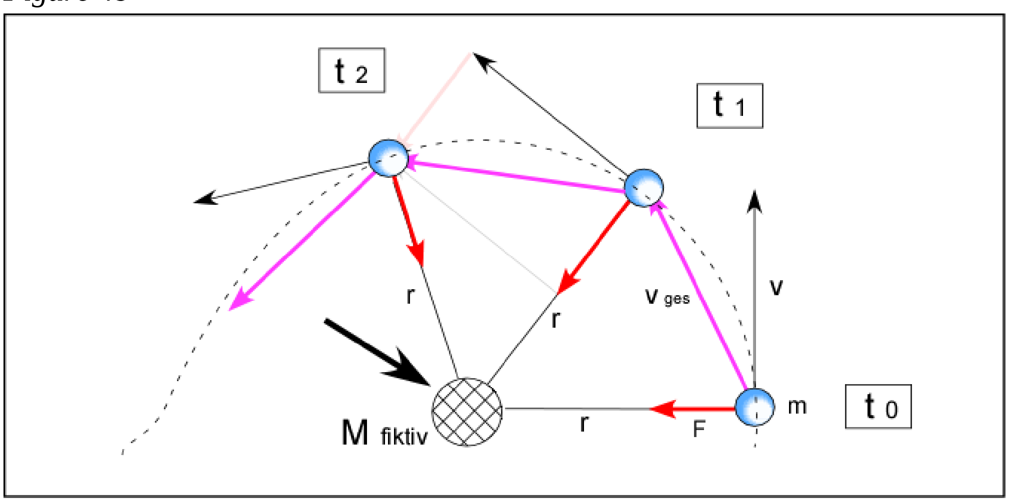
The addition of another time intervall illustrates that the mass **m** appears to move around a rotation center. The distance to this center, however, does not matter.

Figure 4a



It is essential for the further observation to understand that the **crossing point of distance lines** between mass **M** and mass **m** is nothing but an assumed rotation point of mass **m** (marked with a thick black arrow). This crossing point can be at any distance from mass **m**, and can therefore not be used to determine the mass **M** through the orbital speed of mass **m**.
If, for example, the combined mass **M** consists of an invisible black hole, such a crossing point could be wrongly seen as a rotation point.
For illustrative purposes, a gravtitationally active mass **M** is removed from *Figure 4b*.

Figure 4b

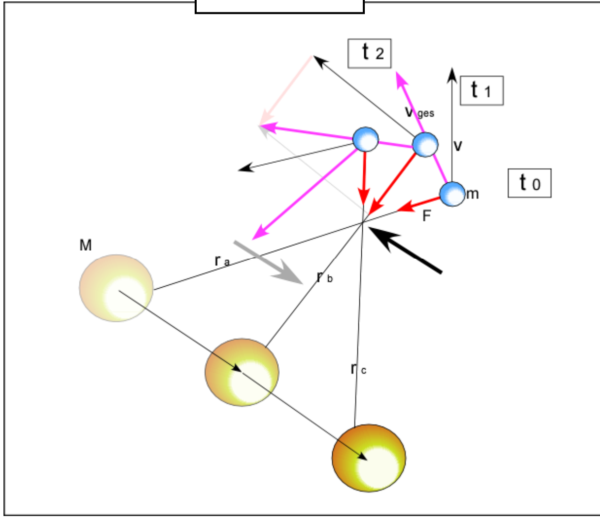


A mass **m** moves at a certain speed **v** and is exposed to a certain force F from one non-stationary direction that accelerates it in said direction.
An observer who is ignorant of a distant mass **M** that forces mass **m** on its track with a constant force **F**, could calculate a fictional mass **M** at the cross point of vectors (a fictional rotation point) with the formula:

$$M = \frac{v^2 \cdot r}{G} \qquad \textbf{(F3)}$$

With a shorter radius (the distance between mass **M** and mass **m** is cut in half in this example), the newly calcualted mass $\mathbf{M}_{\mathbf{fiktiv}}$ would only have half of the original mass **M**. Consequently, <u>this</u> calculation of masses is only a <u>fictional</u> mass calculation. The real mass **M** is completely different from the fictional mass $\mathbf{M}_{\mathbf{fiktiv}}$, which does not exert any gravitational forces on mass **m**. Even though the force F is constant, a large number of different fictional masses can be calculated, depending on the variable cross points (which depend on the speed of mass m), or the assumed radius $\mathbf{r}_{\mathbf{var}}$.

Figure 4c



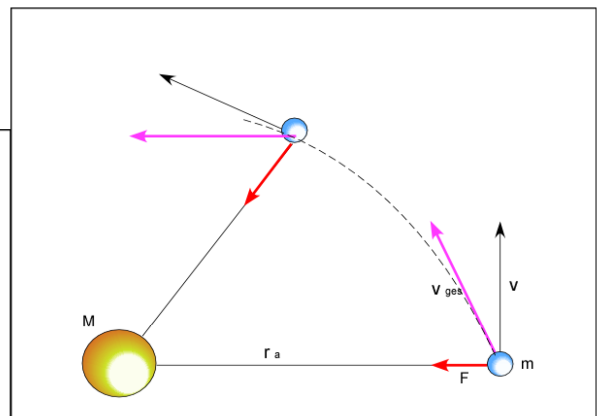


Figure 4d

Figures 4c and 4d show a fast moving mass **M** (*Figure 4b*) and a stationary mass **M** (in *Figure 4c*). The mass **m** moves at different speeds **v**, depending on the movement of mass **M**. Every calculation of mass **M** with the different *ortibal speeds* ***v*** combined with a changing radius **r** results in different fictional masses **M**. The correct value of mass **M** can only be calculated this way if **M** is stationary and the mass **m** orbits on a planetary track.

Another example for the calculation of a fictional mass is the observeable orbit of a geo-stationary satellite in the sky. The fictional mass in the center of the satellite's small libration track is easily calculated over the visual orbital speed **v**. However, the fictional mass is only a fraction of the real mass exerting forces on the satellite and forcing it on its orbit: Planet Earth. If such a realization is applied to a galactic plane or field of masses, it becomes clear that even though visual and measurable orbital speeds v or masses m are present and can be used to determine center massses, such calcualted masses are fictional in nature and stand in no correlation to the real masses.

Determining a mass **M** through an orbitting mass **m** and its orbital speed **v** with formula **(F3)** is impossible in a **parallelogram of forces calculation**, because of the unknown radius $\mathbf{r}_{\mathbf{var}}$ and the uncertainty if mass M is stationary or not.

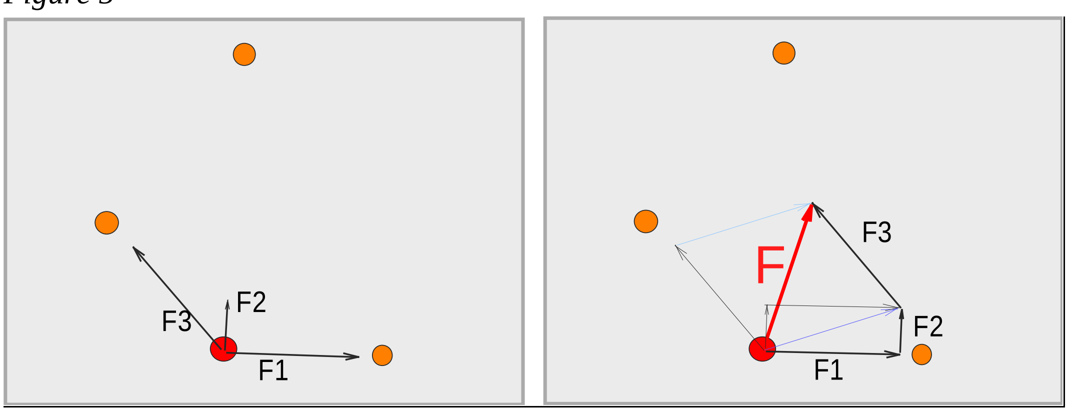
The prarllelogram of forces calculation method makes it possible to determine an orbital speed **v** for the mass **m**, if mass **M** is known. However, it is impossible to determine a mass **M** with the orbital speed **v** of a known mass **m**.

If a mass **m** and its orbital speed **v** are known, there is only one (indirect) way to calculate a mass **M**: trial and error. A mass **M** has to be placed on the plane until it matches the given values of orbital speed **v** and mass **m**.

The next step is to examine a collection of several masses under the same circumstances for a **parallelogram of forces calculation**.

The calculation of the combined forces **F** on a mass **m**, requires the addition of single forces that affect mass m. This addition is done step by step with two forces and a prarallelogram.

Figure 5



The observed mass **m** (marked in red) is affected by three other masses. Their exerting forces vary and depend on their distance to mass **m**. The three forces **F1, F2, F3** are represented by differently long arrows that point in varying directions. To add the forces, a parallelogram is created for the forces **F1** and **F2**. The resulting force (blue arrow) is added to **F3** with yet another parallelogram to determine the combined force exerted on mass **m** at $\mathbf{t_0}$. After each time interval, the forces have to be recalculated, if the combined force **F** accelerates mass **m,** and therefore change their location compared to mass **m** over time.

The orbit or track of mass m can only be determined with the constant recalculation of location points over time. This form of force addition is the foundation of a **parallelogram of forces calculation**. The summary can be geometrical or mathematically with the Pythagoras theorem. The parallelogram of forces can illustrate the fundamental characteristics of a plane or field of masses.

In this example, a field contains 22 equal masses. Each mass has a value of 22. Hence, the combined field has 22 x 22 = 484 mass units.

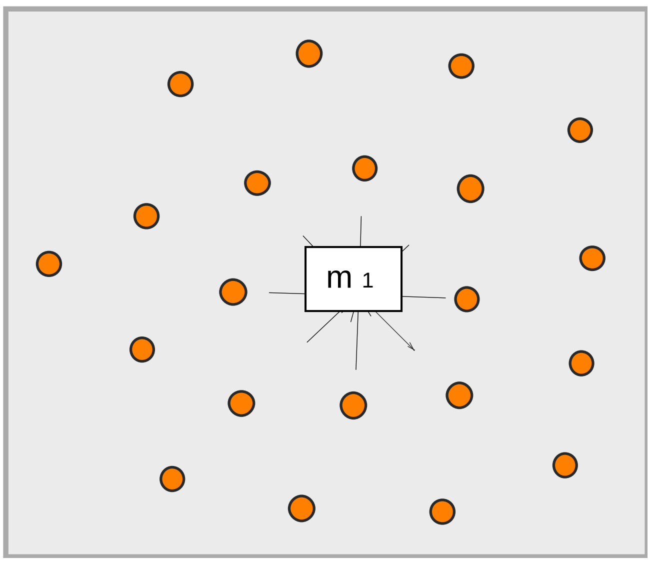


Figure 6
At first, a mass point **m 1** close to the center of the field is examined. Every mass in the field exerts a force on the observed mass **m1**. The differently long lines represent these forces and their direction. The addition of all 21 forces via parallelogram of forces is necessary to determine the combined force on mass point **m1.**The order of addition is irrelevant for the result. However, it is a good idea to structurize the addition to prevent the addition of a single mass twice. In this example, the addition follows the face of a clock, beginning with 12 o'clock.

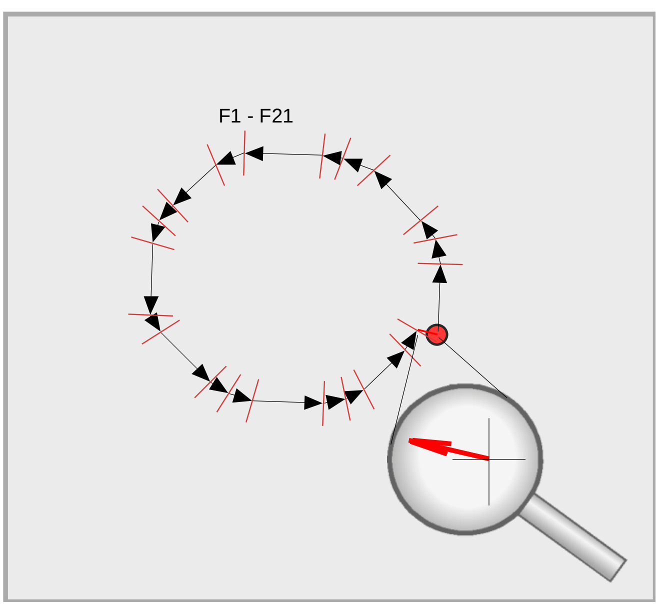


Figure 7
The single arrows (F1–F21) are added geomotrically according to *Figure 5*. The red circle represents mass **m1**. After all single arrows are added without altering their direction of length(!), the distance between starting point and end point is the combined force on mass point **m1**. *Figure 7* shows this as red arrow under the magnifying glass.

Mass m1 experiences a slight acceleration to the left. Should the mass move to the left, the combined forces would pull it back to the right after a short period of time. This indicates that mass point **m1** is very close to the center of the combined masses, where the sum of gravitational forces equals zero. To keep the masses from moving back and forth, they are provided with an orthogonal speed **v** of 0.15 m/s to the acceleration. Hence, the masses slowly move on a stable orbit around a mass free center. It shall be noted again, that a radius is irrelevant and cannot be determined with the given data. The location of mass point **m1** over time can now be calculated with the help of a sinus curve.

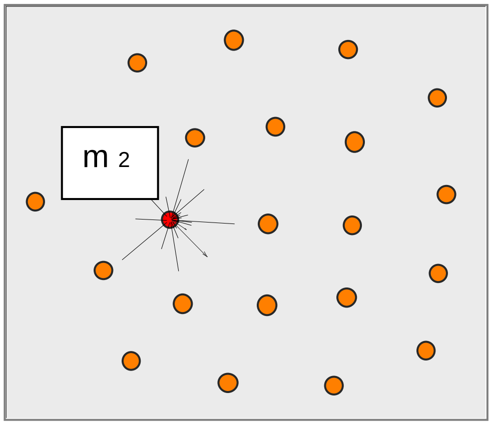


Figure 8
examines an additional mass **m2**, which is located between the center and the edge of the plane. Again, the single forces of all 21 mass points on **m2** are represented by straight lines of varying length in different directions. These forces are also added geometrically with paralellograms of forces.

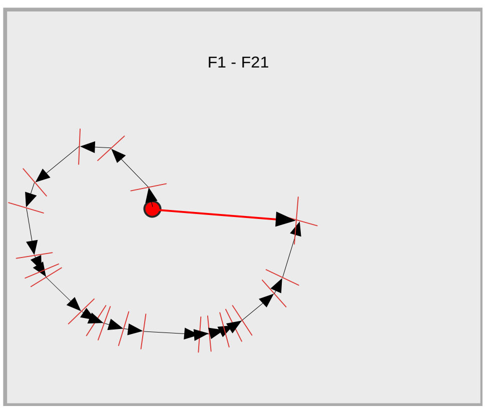


Figure 9
shows the geometrical addition of forces for the mass **m2**. The mass m2 experiences a much stronger acceleration toward the center of the plane than mass m1.
The addition of forces was conducted against the clock in this example.

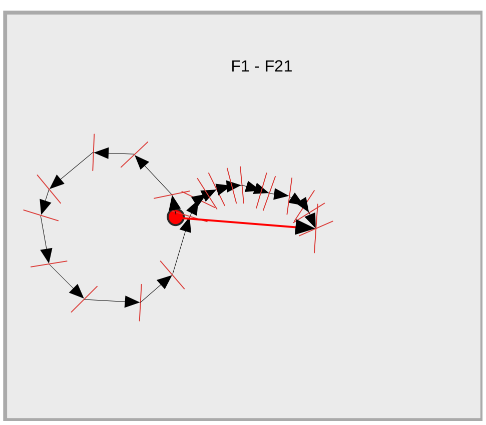


Figure 10a
Shows a different addition method for single forces. While *Figure 9* illustrates the geometrical addition of all forces counterclock wise, Figure 10a sums up the forces of masses closest to mass **m2**, followed by masses with an increasing distance. The forces of the closest masses add up to zero (represented by an almost complete circle). In Figure 10b, the area of masses with a combined force

of zero is shaded in light blue. Apparently, only the masses outside of this area exert any significant gravitational forces on **m2**.

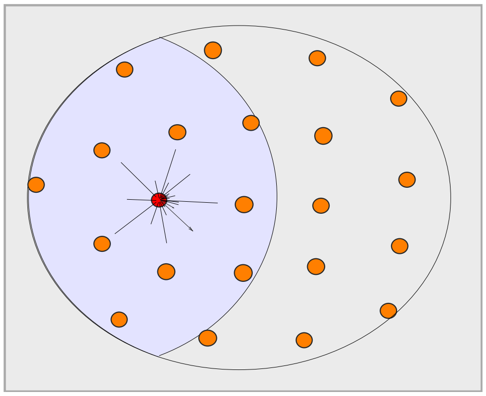


Figure 10b
Separation of galactic plane into two areas: The forces of masses within the light blue colored area annull each other to exert a combined force of zero on mass **m2**. The remaining masses in the sickle shaped area pull mass **m2** to the right. To prevent **m2** from falling into the center of the plane, it needs to move at a speed **v** of 1.5 m/sec in a direction orthogonal to the exerted forces. The speed necessary to keep **m2** on a stable orbit has to be about 10 times bigger than that of mass **m1**.

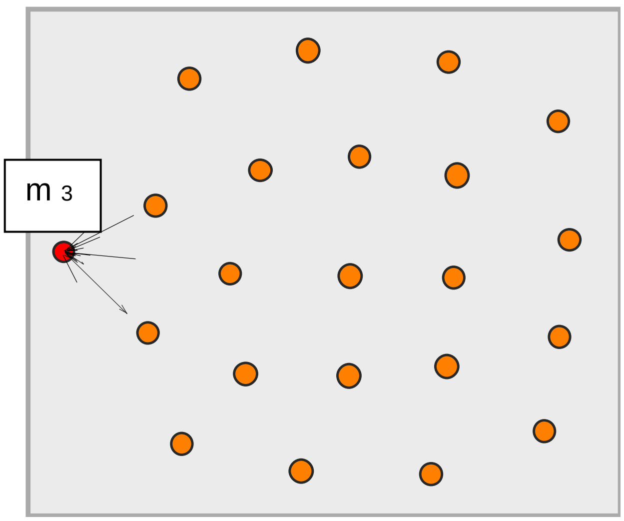


Figure 11
examines the forces on a mass **m3**, at the edge of the plane. As before, the 21 forces are illustrated as straight lines of varying lengths and directions, and geometrically added with the help of a parallelogram of forces.

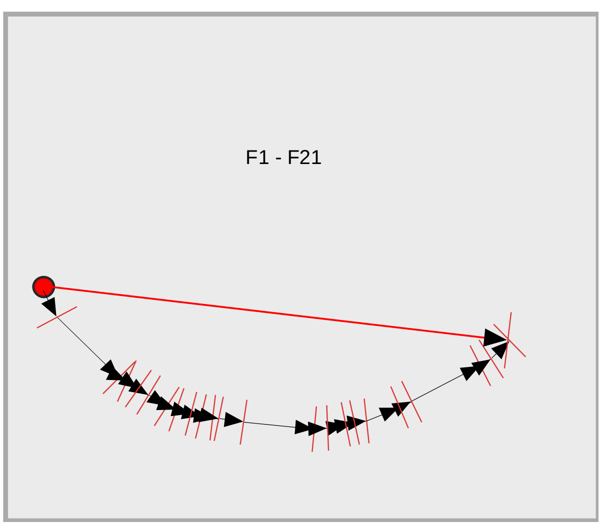


Figure 12
shows the combined forces on mass **m3**. To prevent m3 from accelerating toward the center of the plane, it needs to move on a stable orbit with a constant speed **v** of 10 m/sec, which is 7 times bigger than the speed of mass **m2**. (These ratios change depending on the number of mass points.)
Consequently, the orbital speeds of masses in a homogenous galactic plane consistently increase toward the outer edge.
The result of transferring the collected data per

time intervall for masses **m1** through **m3** in a new figure is a shape close to a circle consisting of **(x/y)** points. A radius is still unnecessary, especially if the new curve is chaotic. However, should the curve be very similar to a circle, a radius **r** could be determined and used (with the combined force **F**)to create a fictional mass $\mathbf{M}_{\mathbf{fiktiv}}$ in its center. Nevertheless, this fictional mass $\mathbf{M}_{\mathbf{fiktiv}}$ must not be confused with the **real combined mass** of the galactic plane.

If a mass **m** is exactly in the middle of the plane, all of the exerting forces add up to be zero, which leads to an orbital speed of zero. A fictional mass that is calculated with this speed is consequently zero as well. The real combined mass of the plane, however, is 484.

This example proves that the fictional mass value of a galactic plane has absolutely no correlation with its real combined mass.

Parallelogram of forces calculation

Using the formula (F3) for the calculation of a **fictional mass** that exerts forces on m1 - m3 leads to the following values:

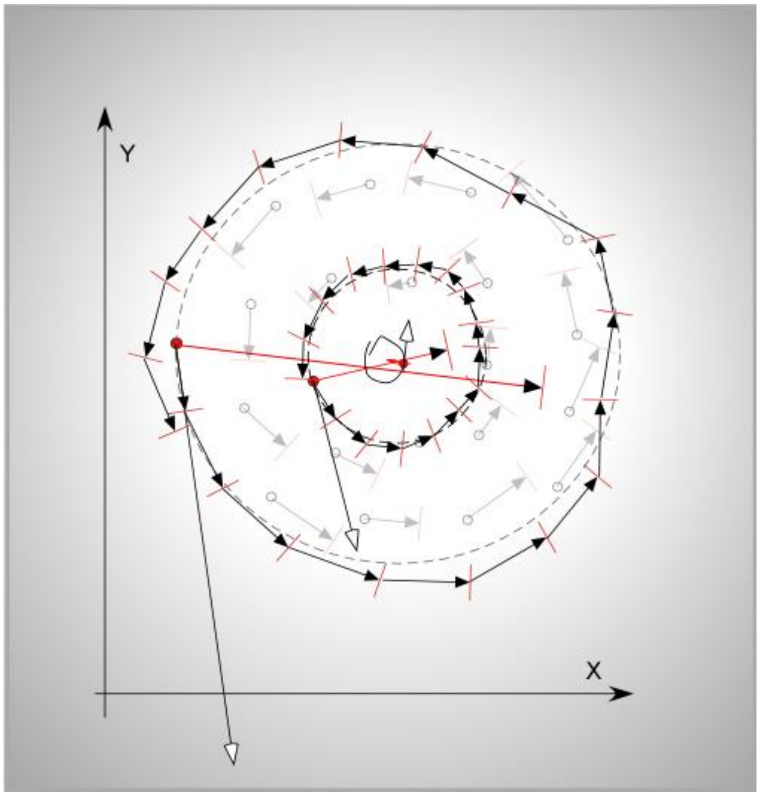
$$M_{fiktiv} = \frac{v^2 \cdot r}{G} \qquad \textbf{(F3)}$$

Given values			***Calcualtable values***			***Fictional calculation without correlation to real mass distribution***		
Mass point m	Location points x/y **beginning**	M real **(as factor)**	F **as factor**	v	Location points x/y **per interval**	r **(approx. value) factor x 10** $^{-10}$	V **given**	M **fictional**
m1=22	X1/y1	484	0,27	0,15	new X1/y1	1	0,15	**0,03**
m2=22	X2/y2	484	160,	1,5	new X2/y2	5	1,5	**16,9**
m3=22	X3/y3	484	560	10,0	new X3/y3	11	10,0	**1649**

The third column of the table shows a real combined mass **M** of 484 mass units, which is a direct result of the 22 given mass points. The force **F** of these single masses, their speed **v**, and location points **(x/y)** per interval can be calcualted with the given mass points and their beginning locations. The calcualted fictional masses, which appear to be the rotation center of all masses m1 – m3, cannot be compared to and does note stand in any correlation to the real combined masses. At the edge of the galactic plane, the fictional mass is 3.4 times bigger, and in the center, it is much smaller than the combined real mass.

Figure 13 summarizes the results of all previous calculations (*Figures 6 – 11*). The location points **(x/y)** of the masses **m1**, **m2**, and **m3** over approximately 20 time intervalls are entered into a x-y coordinate system. The red circles indicate the end locations of the three masses, as determined geometrically with the Pythagoras theorem. The grey circles represent the movement of other masses within the plane. According to *Figure 13*, the following can be noted for a homogenous mass plane: The speed **v** (arrows with white heads)of single masses increases toward the edge of the field, as well as the gravitational forces (red arrows). The single masses do not move on circular or planetary orbits, but libration tracks, which can be observed especially well when looking at mass **m1**. This mass moves on an orbit around a mass free center! Consequently, the orbits in Figure 13 are not illustrated as complete circles with a constant radius. Even though the orbits turn into almost perfect circles with a large number of masses, they still move on libration tracks.

Figure 13



Comparison of calculation methods in a galactic field with a homogenous mass distribution

Parallelogram of forces calculation

Given values				***Calculatable values***		***Fictional calculation** without correlation to real mass distribution*		
Mass point m	Location point x/y **beginning**	M real	F **as Factor**	v	Location point x/y **per interval**	r **(approximate value) Factor x 10 $^{-10}$**	V **given**	M **fictional**
m1=22	X1/y1	484	0.27	0.15	New X1/y1	1	0.15	**0,03**
m2=22	X2/y2	484	160	1.5	New X2/y2	5	1.5	**17**
m3=22	X3/y3	484	560	10	New X3/y3	11	10	**1650**

Discrete calculation

Given values				***Calculatable values***				***Fictional calculation** without correlation to real mass distribution*
Mass point m	Location points x/y **beginning**	M real	F	V grav.	r grav.	r **visual according to center**	V **visual**	M **fictional**
m1=22	X1/y1	484	0.27	5.0	10	1	0.15	**Not calculatable**
m2=22	X2/y2	484	160	1.0	8	5	1.5	**Not calculatable**
m3=22	X3/y3	484	560	0.5	3	11	10	**Not calculatable**

Integral calulation

Given values			*Calculated values*		*Visually measured values*		*Calculated values*	
Mass point m	r **visual accor-ding to center**	V **visual**	F		M real **combined mass**	V **Visual**		M **Calculated according to center**
m1=22	1	0.15	0.27		484	0.15		**0.03**
m2=22	5	1.5	160		484	1.5		**17**
m3=22	11	10	560		484	10		**1650**

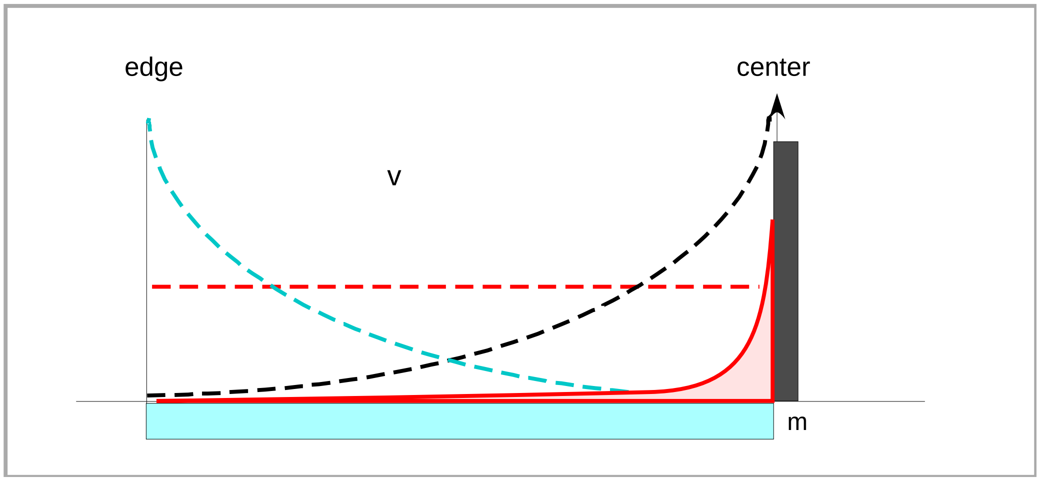
Results

The comparison of the three calculation methods shows that the parallelogram of forces calculation and the **discrete calculation** have the same results, as the ratio of speed and mass remains the same. Furthermore, it is impossible to discretly calculate a combined mass. The calcualtion of said mass leads to fictionional (useless) results when the paralellogram of forces is used. Only the trial and error method provides results for a combined mass. The combined masses of distant galaxies are thus determined with their speed.
The **integral calculation** however, leads to results with a limited comparability to the previous calculation methods. If a combined mass is determined with the integral method, the results match those of the fictional mass calculation with a paralellogram of forces; and , therefore, are equally useless. Consequently, the integral calculation method succumbs to a general error when used to determine the masses in a galactic plane.

It is impossible to determine a combined mass M with the integral calculation method.

The speed of a mass increases toward the edge of a homogenous mass plane (compare to *Figure 14* blue curve). This is reversed if the majority of masses (99.9%) are located in the center of the plane, equal to our solar system, for example (compare to *Figure 14* black curve). If a medium between the two (homogenous mass distribution versus one center mass) with a constant speed throughout the plane is desired, the discrete as well as parallelogram of forces calculation can be used to determine the distribution of masses (compare to *Figure 14* red curve). Surprisingly, such a mass distribution is similar to galactic mass distributions found in scientific literature.

Figure 14



The speed of single masses depends on the mass distribution within a mass field or plane. The dotted lines represent the speeds belonging to the equally colored mass distribution. The edge of the plane is to the left side of the figure, and the center is to the right

The tables for a constant speed are as followed for the three different calculation methods:

Comparison of calculation methods in a galactic field with a given mass distribution

Parallelogram of forces calculation dynamic model

Given values			***Calculatable values***			***Fictional calculation*** *without correlation to real mass distribution*		
Mass points m	Location points x/y **beginning**	M real	F **as Factor**	v	Location points x/y **per interval**	r **(approximate value) Factor x 10** $^{-10}$	V **given**	M **fictional**
m1=12	X1/y1	357	710	225	New X1/y1	1	225	**75**
m2=1.1	X2/y2	357	16	225	New X2/y2	5	225	**367**
m3=0.08	X3/y3	357	1.35	225	New X3/y3	10	225	**734**

Discrete calculation static model

Given values		*Calculatable values*						***Fictional calculation*** *without correlation to real mass distribution*
Mass points m	Llocation points x/y **beginning**	M real	F	V grav.	r grav.	r **visual accord-ing to center**	V **visual**	M **fictional** **Calculation not possible**
m1=12	X1/y1	357	710	240	1.2	1	225	-
m2=1.1	X2/y2	357	15.9	200	4.5	5	225	-
m3=0.08	X3/y3	357	1.35	160	7.5	10	225	-

Integral calculation static as well as dynamic model

Given values					*Calculated values*		*Visually measured values*			***Calculated values*** ***1. table***
Mass points m	r **visual according to center**	V **visual**	F		M **calculated with v**		M real **combined mass**	V **visual**		M **fictional** **Comparable value**
m1=12	1	225	705		**72**		357	225		**75**
m2=1.1	5	225	14		**360**		357	225		**367**
m3=0.08	10	225	0,57		**720**		357	225		**734**

Results

Despite the differences in calculation methods, the parallelogram of forces and **discrete calculation** produce the same results. Equal to the homogenous mass distribution example, the speed to mass ratio in a given galactic field is similar in both calculation methods. It is not possible to determine a combined mass **M** with the discrete calculation method. Even though this is possible with the other method, the results are only fictional and therefore useless.

If, however, the combined mass M of a galaxy has to be calculated with only the speed of its single masses, as commonly done to determine the weight of distant galaxies, the **combined mass M has to be modelled**, until the single masses move at the desired speed.

The results of the **integral calculation method** only produces results with a limited comparability to the previous calculation methods.
Again, if a combined mass is determined with the integral method, the results match those of the fictional mass calculation with a paralellogram of forces; and, therefore, are equally useless. The discrepancy between the real, visible masses and the calculated masses is equal to that between the calculated fictional masses and real masses in teh first example. Since any discepancy between masses indicates an error, the integral calculation method is not ideal in determining the combined mass of a galaxy with only the speed as a given value.

The **integral calculation method** uses the center of a mass field as rotation center of a planetary orbit with a certain radius r. Nevertheless, as proven earlier, the masses move on libration tracks without a combined center mass, not on Kepler orbits.

The calculation of a combined mass M with the integral method, which combines single masses to a point in the center, results in a fictional mass and is therefore wrong without any exceptions.

The existence of dark matter is based on the calculation of a combined mass **M** with the integral method only. Consequently, dark matter is nothing but a miscalculation.