Trajectories of the planets - impact of parameters on the shape of orbit

(Translated from Polish into English by Maksymilian Miklasz)

Abstract: This article contains presentation of mathematical function, whereby gravitational effects can be described in a similar manner, as Newton did, but it can be done more accurately. In the article are presented (in the form of computer models) changes in orbit shapes, which performs one of two bodies in a binary system, when the second body is of incomparably greater mass. Shown are changes in shape of the orbit of the light body depending on parameters of its motion - depending on the initial distance from the heavy body and initial orbital speed.

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Introduction – the fundamental principle of shaping planetary orbits

This article is created for future physicists and astronomers who wish to develop mathematically the trajectories of the planets of the solar system, with particular emphasis on the perihelion motion trajectory. Author of this article does not have reliable data on perihelion motion of the planets and this problem can be certainly better solved by physicists and astronomers in more or less distant future.

The content of the article is intended to be a kind of help for those who wish to switch your thinking and understand that the basic trajectories of the planetary movements are orbits in shape of rosette. It is they who will consider complemented Newton's law of gravity - supplemented by an exponential factor. More information about this addition to Newton's law can be found in "The Constructive Field Theory - briefly and step by step" on:

Polish → http://nasa_ktp.republika.pl/KTP_pl.html

English → http://nasa_ktp.republika.pl/KTP_uk.html

Russian → http://konstr-teoriapola.narod.ru/KTP_ru.html

Below there are formulas and diagrams showing origin and shape of the function which varies inversely with the square of the distance, so varies as the gravitational acceleration according to Newton, but also has the exponential factor **exp(-B/x)**.

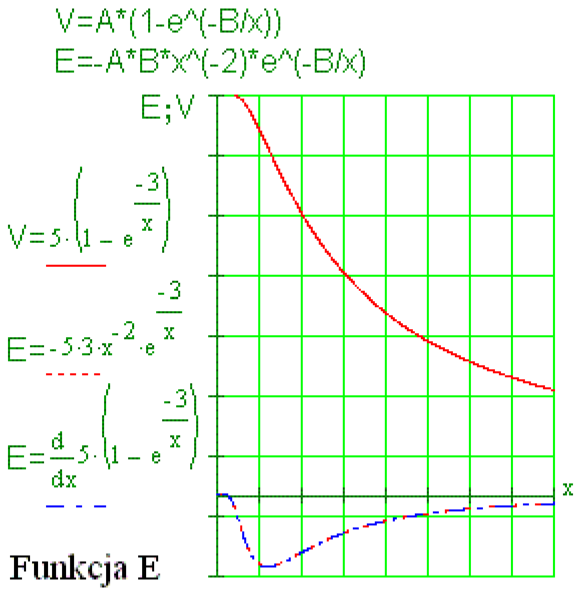
This exponential factor existing in the gravitational accelerations is essential for movement of the Solar System planets and formation of their trajectory. As shown in the article

"The affinity of the trajectory - elliptical and segmental" on:

Polish → http://nasa_ktp.republika.pl/Srodstvo_trayektoriy_pl.html

English → http://nasa_ktp.republika.pl/Srodstvo_trayektoriy_uk.html

the basic characteristic of planets movement is that they don't move on the elliptical trajectory, but on rosette.



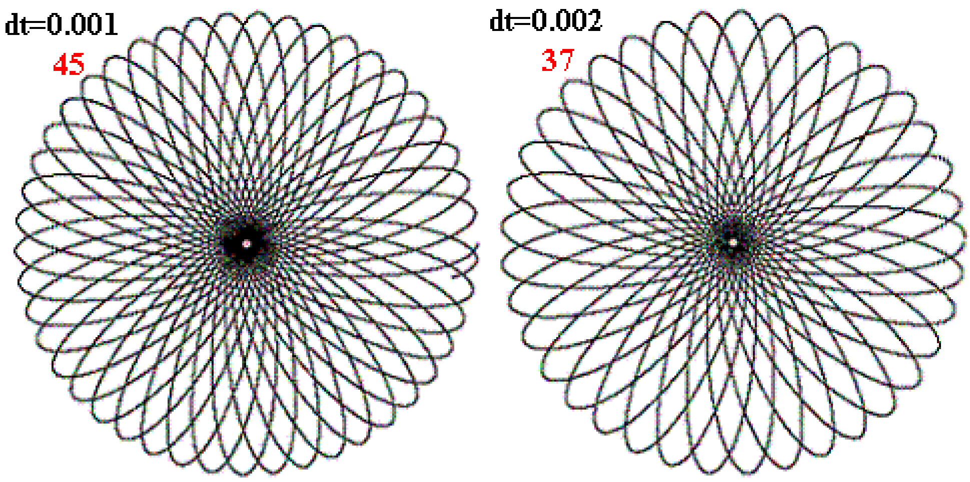
Based on completed Newton's laws were developed a computer modelling programs. In these programs, material objects - celestial bodies, particulate matter etc. - are shown in the form of a centrally symmetric fields. In the modelling program the centrally symmetric fields are represented by their central points. The interaction between them takes place on the same principle as that by which this symbolized in the program objects interact with each other in nature - the impact takes place on the basis of mutual acceleration in accordance with the amended Newton's formula, **E=-A*B*x^(-2)*e^(-B/x)**. To simplify the description in this article, this formula will be called "Newton-KTP formula" and corrected Newton's law – "Newton-KTP law"

Using the executive program *Drawer.exe* (http://pinopapliki2.republika.pl/Drawer.zip) were obtained some interesting data. They relate how celestial bodies behave when they interact with each other according to the Newton-KTP formula. At the beginning will be useful information that the exponential factor has the greatest importance for the motion of bodies at a relatively small distance **x** between two bodies. For longer distances **x** the exponential factor **exp(-B/x)** tends to 1. So when the celestial bodies moves around each other according to Newton-KTP formula and when the distance between them is changing (ie when their trajectories are not a circles), than the observed trajectory is very similar to ellipse. Because at such large distances between bodies, the impact of the exponential factor is hardly noticeable. For this reason, for several centuries, astronomers and physicists have considered these trajectories as elliptical.

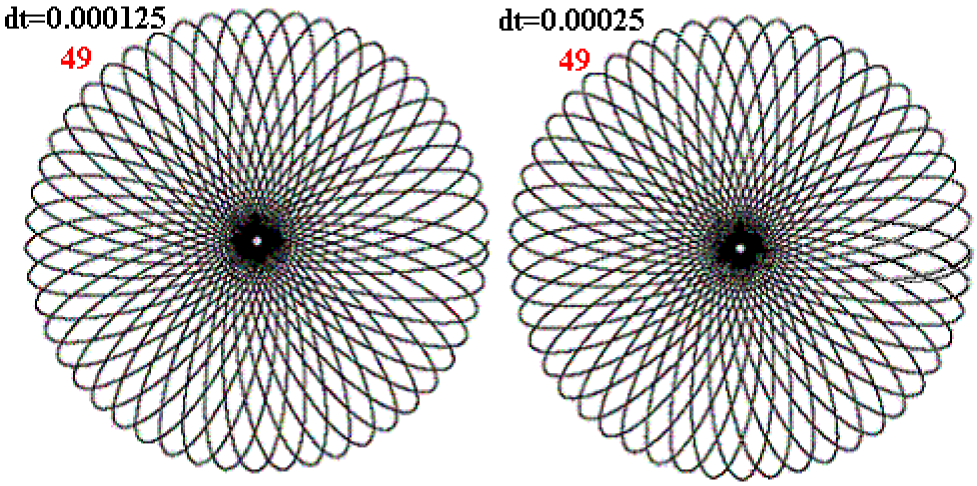
Effect of parameters of the calculating machine

Here can be useful information that the computer modelling is related to the accuracy of the trajectory. This information may seem redundant, but here it is important, because it is related to a specific mathematical formula which contains a specific exponential factor. For large values of **x** (when changing the value of **x**), the numerical value of the exponential factor approaches to one and even with large changes in **x** it varies slightly. But with small values of **x**, with even small changes in value of **x**, the changes of exponential factor may be significant. This is reflected in the emergence of various shapes of trajectory, which depend on the interval time **dt**. When all initial parameters of the modelled process remain constant, and changes only **dt** value, then it is clear that the visible differences can be attributed to changes in the interval time **dt**.

The following figure are shown two rosette trajectories of the test body **m** around the massive body **M** at value of **dt=0.002** and **dt=0.001**.



It can be seen that reducing the size of **dt** by half (from **dt=0.002** to **dt=0.001**) results in that the number of rosette leaves increased from 37 to 45 leaves. In contrast, the figure below shows the difference in images of trajectories, where the value **dt** is even smaller - because **dt=0.00025** and **dt=0.000125**. In this case when the value of **dt** is reduced by half the number of leaves remains approximately unchanged.

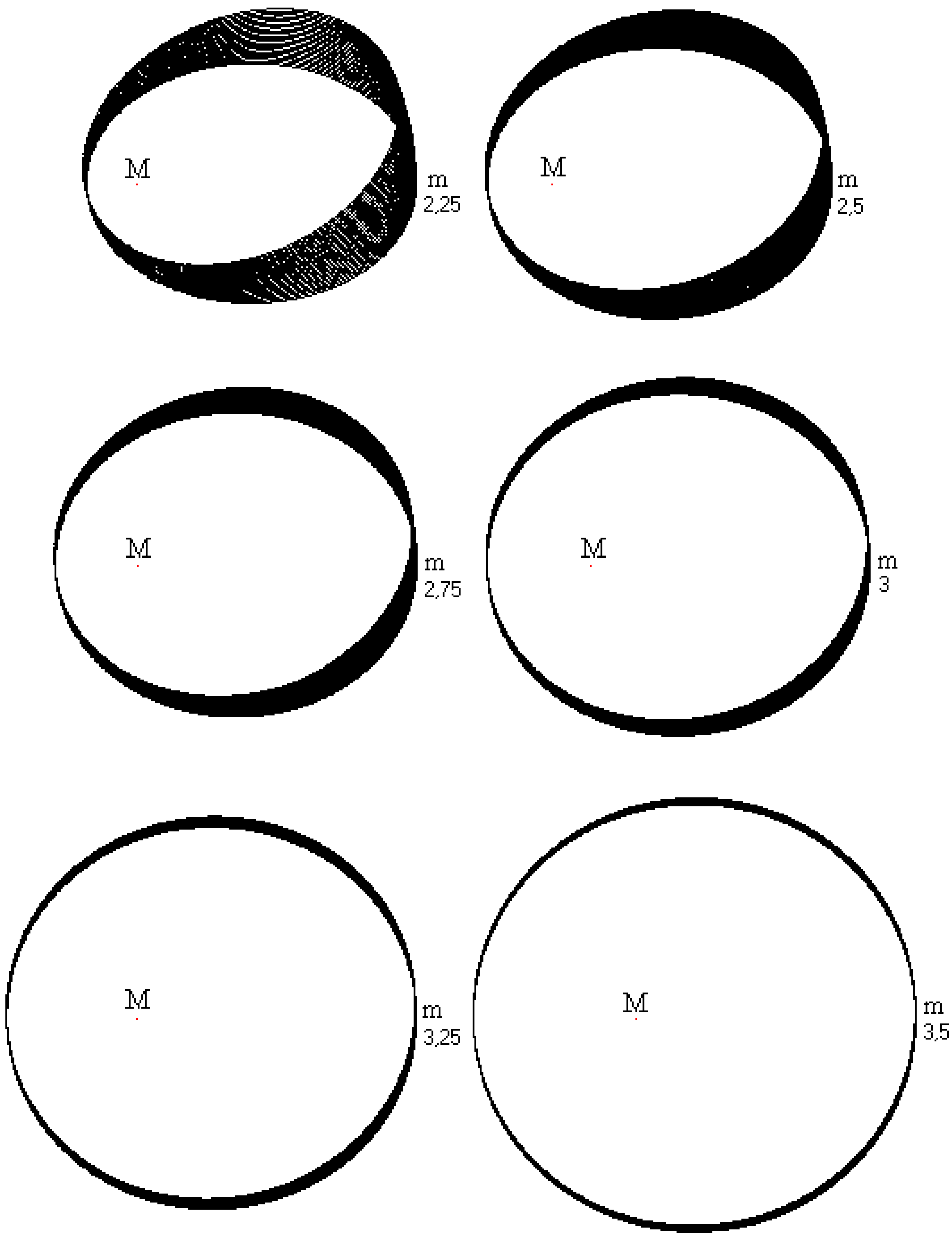


By the occasion of observing trajectory of these two images, you can better understand the process of shaping the subsequent trajectory leaves (of course, the understanding of this process is important when the increase or decrease the amount of leaves rosette trajectory occurs because of changes in physical parameters). It should be noted that in both images of trajectory (in the figure above) has passed the "moment" (this value **dt**), when the trajectory had exactly 49 leaflets. This moment existed when the end of plotted trajectory line of the 49th leaf coincide with the start of trajectory line plotted by the 1st leaf. Thus was created the 49th leaf.
In both images is already visible the starting process of drafting the 50th leaf and when **dt=0.000125**, this process is a bit more advanced than at **dt=0.00025**. The trajectory lines of the first and last leaf don't coincide with each other and the gap between them is greater when **dt=0.000125**.

Note also that the change in value **dt** is only the change of parameter of the counting machine, but the process of shaping leaves is similar, as when changing parameter of the physical process. As a result of decrease the value **dt** is increased accuracy of the calculations and plotting the amount of leaves rosette trajectory, which is the amount actually depends on the parameters of bodies that are involved in a physical process.

Series depending of fixed apoapsis

In one series of exercises (experiments) associated with modelling the orbital motion of the body **m** around the body **M**, these bodies had constant initial parameters except for one parameter - the initial speed **V** of the test body **m**. The speed **V** at the various exercises ranged from **2.25 s.u.** (speed unit) to **4.0791543 s.u.** at which the test body drawn the trajectory in the form of a circle. Below are shown images of trajectories that were plotted by the test body **m** during performance by the calculating machine about 20,000 iterations at **dt=0.005**.



The following pictures show how to develop a rosette trajectory. The initial distance between bodies **M** and **m** in each successive exercise has the same value: **Mm=6 l.u.** (length units). But with increasing initial speed of the body **m** which is directed perpendicular to the segment **Mm**, rotational movement of periapsis trajectory is becoming slower. So during one rotation of the body **m** around the body **M**, which you can assign a name "local year", the angular offset periapsis is getting smaller and smaller. At the same time the ratio of the size periapsis to apoapsis gradually approaching to one. Looking at this from another point of view, it means that by increasing the initial velocity of the body **m**, in further exercises creates rosette trajectory which has more and more leaves and shape of the leaves becomes more similar to a circle. With increasing initial velocity **V**, which has a body **m**, the shift angle between following rosette leaves approaches zero and reaches this limit when the initial velocity of the body **m** is **V=4.0791543 s.u.**, so when the body **m** moves around the body **M** along a circular orbit. Then there is no longer a distinction between the periapsis and apoapsis and also there is no rotational movement.

Some parameters of these exercises can be found in the table below.

V	T (dt=0.00005)	Ta (dt=0.05)	Ta/T
2,25	84 789	6 300	74,302
2,50	90 068	11 325	125,738
2,75	96 871	19 285	199,079
3,00	105 297	30 748	292,012
3,25	115 981	47 182	406,808
3,50	130 321	70 004	537,166
3,75	148 968	100 000	671,285
4,0791543	184 708	$\rightarrow \infty$	$\rightarrow \infty$

Assembly parameters from exercises, which are shown in the table, required to reconcile some contradictions. This was necessary because of deficiency of computer modelling program. And so, to determine the approximate time **T**, which is expressed in a number of computational iterations that executes the program during one lap of the body **m** around the body **M**, it was necessary to reduce the interval time **dt** to value **dt=0.00005**. In contrast to determine the approximate time **Ta** elapsed during each rotation of periapsis, was required to set the interval time **dt=0.05**.
The value of interval **dt=0.00005** was necessary to be able to fairly accurately determine the time of one lap of the body **m** around the body **M**. At the end of the lap was stopped the work of counting machine and read the number of performed computing iterations. In contrast, the value of interval **dt=0.05** was required due to the increasingly slow motion of periapsis at increasing the initial speed of the body **m**, when plotted leaves become more and more similar to a circle. The goal was such as to limit the duration of the exercise.

As shown above, because of the relatively high value of the interval **dt=0.05** was created significant error in estimating of the amount of plotted rosette leaves. But the purpose of this exercise was not to determining the exact number of rosette leaves in different trajectories, but to determine trends in development of rosette trajectory with changes in the value of the initial velocity of the body **m**.
Based on the results were calculated approximate amount of laps of the body **m** around the body **M** at a time when the periapsis of trajectory performed one turn. This was calculated in such a way that the duration of one lap periapsis "**Ta**" was divided by the duration of one period of the orbital motion of the body **m** around the body **M**, that is "**T**". The calculated amount of laps (local years) is shown in the fourth column.
Here is an example of calculation: **6300/84.789=74.302** - it's the approximate amount of leaves which

has the rosette trajectory when the body **m** has an initial speed of movement around the body **M** of **V=2.25 s.u.** (It should be noted that the "contradictions were reconciled" in such a way that the number **84.789** is the number of iterations, or contractual duration of one lap of the body **m** around the body **M**, if the interval **dt** is equal to **0.05**).

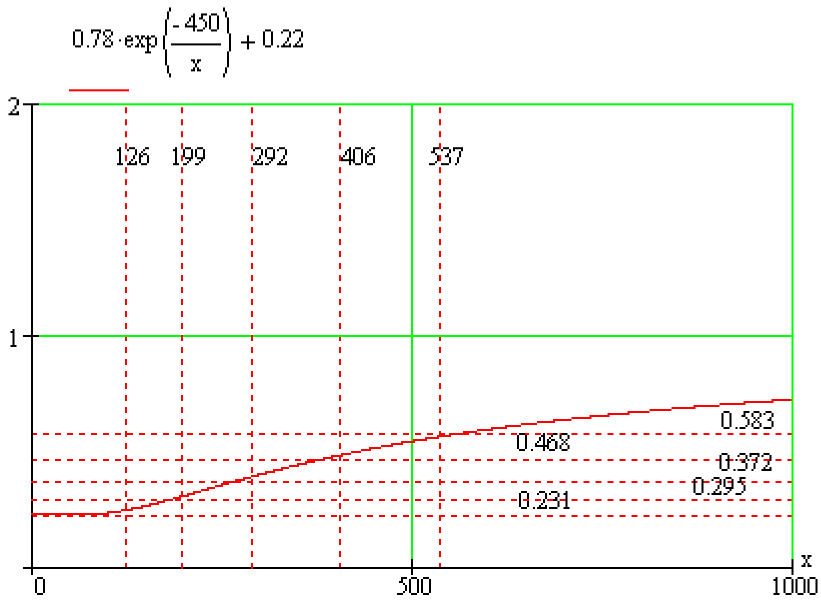
When it was calculated the number of leaves which are created during one rotation of periapsis (**Ta/T**), you can calculate the angle of rotation of periapsis which can be attributable to one local year, or the one lap of the body **m** around the body **M** (ie one leaf). The results are shown in the following table.

V	360°/(Ta/T)	perycent./apocent.
2,25	4,845	0,179487
2,50	2,863	0,230769
2,75	1,808	0,294872
3,00	1,233	0,371795
3,25	0,885	0,467949
3,50	0,670	0,583333
3,75	0,536	0,730769
4,0791543	→0	→1

The results of this series of exercises are presented in the following graph.

Ta/T
74,302
125,738
199,079
292,012
406,808
537,166
671,285
→∞

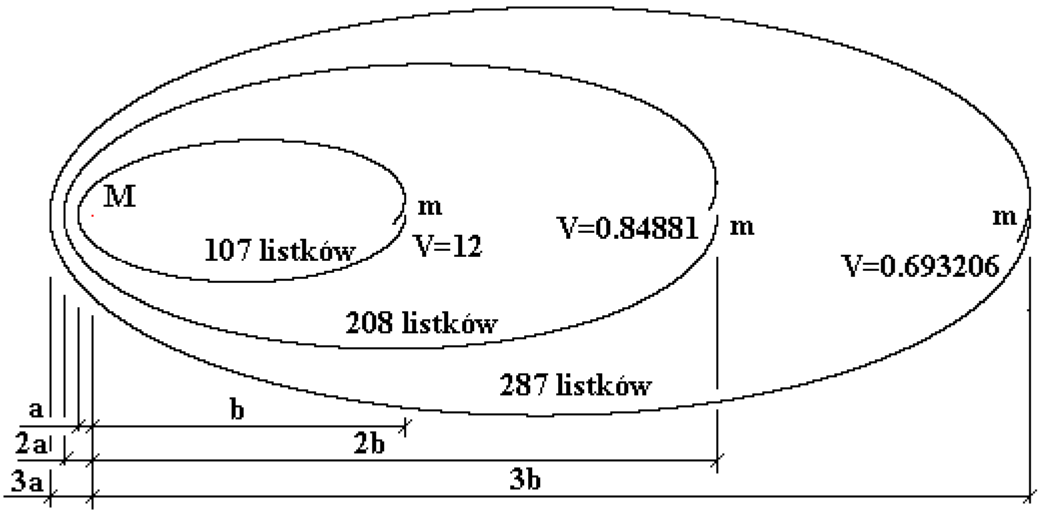
perycent./apocent.
0,179487
0,230769
0,294872
0,371795
0,467949
0,583333
0,730769
→1



It can be seen that the relationship between periapsis to apoapsis and amount of local years that elapse during one rotation periapsis, there is an exponential relationship.

Series depending of fixed relationship periapsis / apoapsis

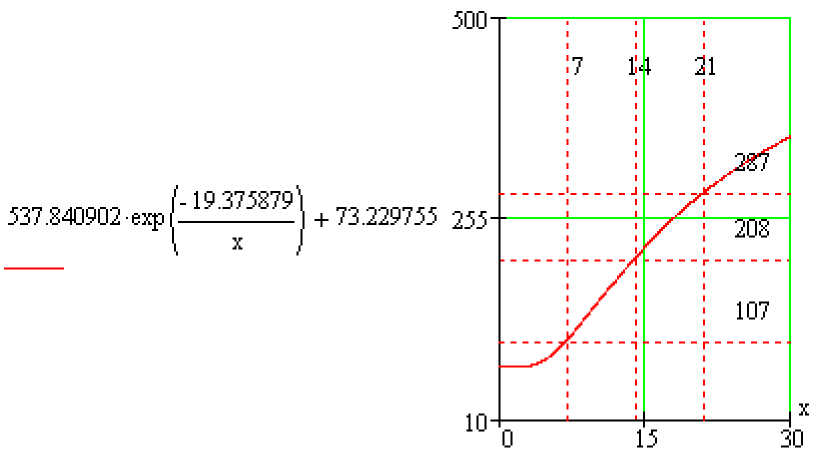
In the next series of exercises which consist on modelling the rosette trajectory in subsequent exercises was changed the initial velocity of the body **m** starting its movement around the body **M**. But it proceed on a constant ratio of the size of periapsis to apoapsis. So, if in the first exercise, the initial velocity of the body **m** was **12 s.u.** and the ratio of periapsis to apoapsis was as **7/156**, in the subsequent exercises the initial speed was selected in such a way that the ratio remains the same. Speeds for subsequent exercises were chosen so that the initial distance from the body **m** to the body **M** in apoapsis was in the second and third exercise, respectively 2-fold and 3-fold higher than the apogee in the first exercise, when the initial velocity of the body **m** was **V = 12 s.u.** The initial velocity were therefore **V = 0.84881 s.u.** and **V = 0.693206 s.u.** In three conducted exercises the amount of leaves - or rather, the amount of local years - were roughly as follows: **107**, **208**, and **287**. These relationships are shown in the following figure.



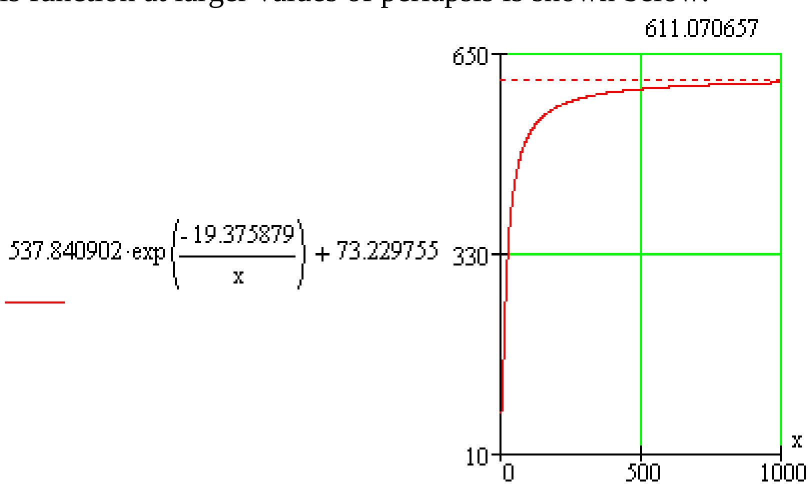
$$\frac{a}{b} = \frac{7}{156} = 0.044871795$$

pl - listków; ru - лепестков; uk - leaves;

In the figure below there is a graph that shows the dependence of the amount of leaves rosette trajectory (number of local years), while the body **m** moves around the body **M**, to the size of periapsis. The periapsis size is symbolically represented in the graph as a variable **x**. In contrast, the number of rosette leaves (or the number of local years) represent the numbers on the **y**-axis.
Exercises were conducted at periapsis sizes: **7**, **14** and **21 l.u.** (length unit). Based on the results were determined the numerical coefficients of exponential function shown in the figure.



The variability of this function at larger values of periapsis is shown below.



The graph shows that the value of function tangentially approaches to a certain limit - the limit is approximately number of **611**. In other words, while maintaining a constant relationship periapsis / apoapsis of **7/156** and with increasing distance between these apses points, the amount of rosette leaves is approximately approaching to **611**.

End
In nature most often encountered are orbits, which in first approximation is similar to ellipse. May distinguish periapsis and apoapsis – they are in some kind of relationship to each other. Thus, on this basis - taking into account other parameters of the bodies that are involved in the physical process - you can specify that for every relationship periapsis / apoapsis there is a corresponding series which can be illustrated with a single exponential function. This series is related to the number of rosette leaves, which amount for actual series tends to a certain limit. In the example series, the limit is 611 leaves, or otherwise, 611 local years (the fractional part is omitted).

Presented impacts are going in accordance to the formula of Newton-KTP. However, as shown, it is only part of the interactions that occur in matter at such large distances - these are the interactions that take place in accordance with the component of gravity. The above-described impact of Newton-KTP is one of the two components of the fundamental interaction of matter. The second function component is the structural component. Through interactions that take place in accordance with the structural component, there are all kinds of stable structures of matter. The most important feature of a structural component is spherical distribution of field potentials in the form of potential coating. For more information about the potential coatings can be found in "The Constructive Field Theory - briefly and step by step" on:

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Coatings mentioned here because of the fact that there are experimental facts which indicate that the movement of the perihelion of planets may also affect potential coatings that exist in the distribution of the potential of the Sun and are located very far from the centre of the Sun. About that in the potential field of the Sun there are potential coatings with a very large radius, provide experimental facts as speed changes during the movement of the space probes Pioneer 10 and Pioneer 11 - a phenomenon known as fly-by anomaly. Such potential coatings are superimposed on the gravitational field of the Sun and may affect on the movements of the planets periapsis. And that's what you should have in mind when testing the trajectory of the planets.

Explanation of the phenomenon fly-by, which occurs during movement of space probes in the gravitational field of the Sun, can be found in the article "fly-by anomaly is not a secret" on http://www.pinopa.republika.pl/Fly-by.html.

Bogdan Szenkaryk "Pinopa"
Poland, Legnica, 21 December 2014