Perihelion motion of Mercury

(Translated from Polish into English by Andrzej Lechowski)

In the article the author shows that the motion of the perihelion of Mercury can easily be explained within the framework of classical physics. To present this phenomenon, you can use a computer program in which models of celestial bodies give each other accelerations. This mutual acceleration takes place quite similar to that happening in nature.

tags: perihelion motion, classical physics

Do you want to see and know, how arises and performs perihelion motion of Mercury and other planets of the Solar System? Perihelion motion can be seen in a situation that was modelled by a computer program. There are moving models of two objects - a planet and the Sun. Objects in the modelled situation accelerate each other by a similar mathematical functions such as the one presented by Isaac Newton in the law of universal gravitation. Of course, in the modelled situation there had to be used a different scale of distances between objects and their relative accelerations and speeds. Because what changes in nature in the hundreds and thousands of years, it is presented as an illustrative image that changes within a few tens seconds or minutes.

To see how perihelion is moving, copy the file Merkury.zip (http://pinopapliki2.republika.pl/Merkury.zip), *) in which there are two executive programs exe and working files gas. By means of executive program open corresponding working file and run the process. In the working file there are encoded the initial processes of parameters (orbital motion of the planet): the position in the coordinate system and the initial velocity. And changes in motion of objects during the process, as mentioned above, follow on the principle of their mutual acceleration.
After starting the process there follows motion of objects relative to each other and change in speed. And that acceleration is performed according to Newton's function, in which is also exponential factor. To bring the essence of the phenomenon, which manifests itself in the form of perihelion motion of Mercury and other planets as well, below is an example of the change in the gravitational field of the Earth. Below are three mathematical functions that describe changing accelerations with a change in distance, and graphs of these functions. These three functions illustrate, how small is the difference of acceleration, when it runs, as presented by Newton, and when is a bit different, because is changing additionally in accordance with the exponential function. In the graphs 2) and 3) there is shown the sequence of these functions in two scales. One chart shows the sequence of function with marked radius of the Earth and the gravitational acceleration equal to 9.814 m/s^2, and the second chart shows the sequence of function of the marked mean value of the distance to the Moon from the Earth and the Earth's gravitational acceleration (in the distance from the Earth) equal 2.696 * 10^(-3) m/s^2 (In line with the accepted custom in physics on the charts accelerations are negative, which means that the acceleration vector is directed towards the centre of the Earth.)

$$-\left(\frac{6.6732\cdot10^{-11}\cdot5.9736\cdot10^{24}}{x^2}\right)$$

$$-\left(\frac{3.975112754\cdot10^{14}}{x^2}\right)\cdot\exp\left(\frac{-1.76612818375\cdot10^{4}}{x}\right)$$

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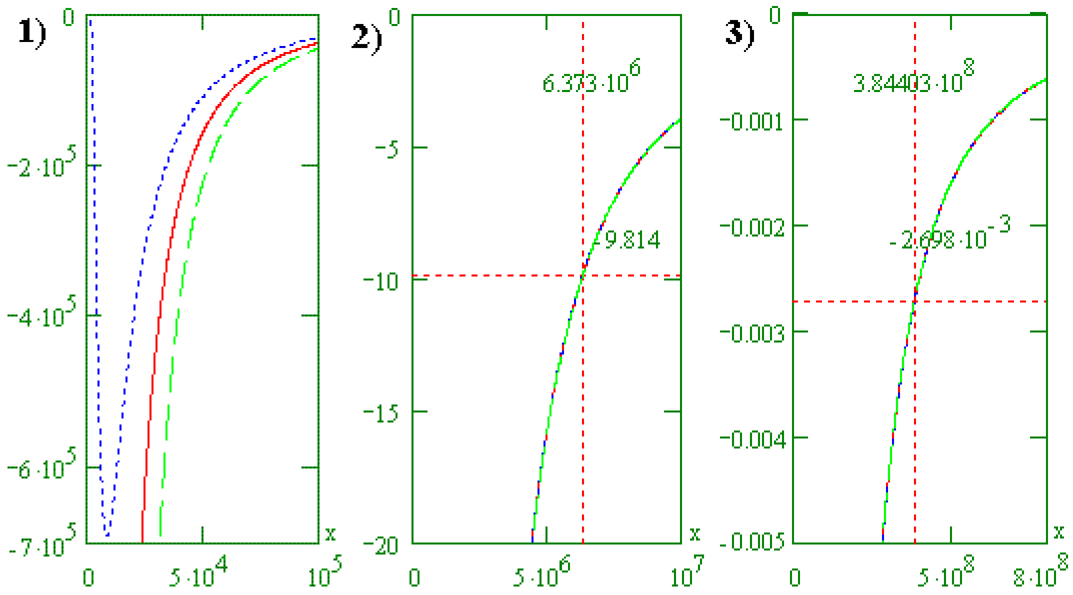
Mass of the Earth - 5.9736*10^24 kg
Gravitational constant -
6.6732*10^(-11) m^3*kg(-1)*s^(-2)
Earth radius - 6.373*10^6 m
Distance from the Earth to
the Moon - 3.84403*10^8 m

$$\boxed{6.6732\cdot10^{-11}\cdot5.9736\cdot10^{24}=3.986302752\cdot10^{14}}$$



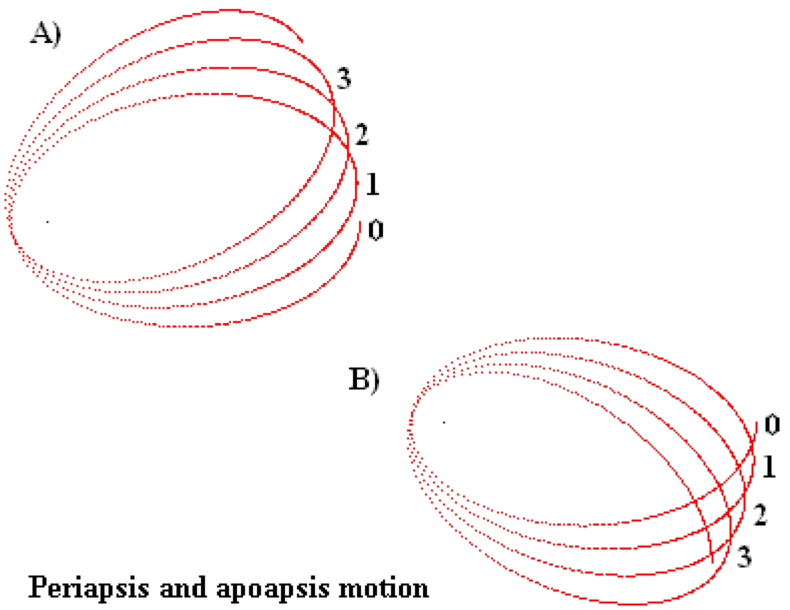
The first function has been known since the time of Newton. The two further functions are formed when in Newton's function we put an exponential factor in the form of exp(-B/x) and exp (B/X). (In these two functions, the coefficient B=1.76612818375 and dimension of the coefficient B is m, or meter.)

It is worth mentioning that the coefficient B = 1.76612818375, and the proportionality coefficient 3.975112754 * 10^14 were chosen because they are solving the system of two equations with two unknown quantities. And parameters for these equations were chosen in such a way that the graphs of these functions exactly overlapped each other at two specific points which are marked in Figures 2) and 3). For this reason, the proportionality coefficient 3.975112754 * 10^14 is not the same as the product of the gravitational constant G = 6.6732 * 10^(-11) and the mass of the Earth 5.9736 * 10^24 kg. This difference indicates the existence of certain errors that are present in the given parameters of the Earth. And the cause of erroneous parameters, may be that either the author does not know the exact values of these parameters (and did not use such parameters as should have been used), or these wrong parameters are present in physics, because they have not been accurately determined.

From the charts can be seen that significant differences in the sequence of the presented functions occur at small distances, counting from the beginning of the coordinate system. So they are in the distance at which none of the three functions doesn't longer reflect the actual gravitational field of the Earth, because the distances are smaller than the radius of the Earth. However, at large distances on the charts (at appropriate scale) functions differ imperceptibly. These changes (differences) can be related to what happens in nature.

And in nature, taking just into account the Solar System and the existing large distances of the planets from the Sun, the exponential coefficient is almost negligible, because almost equal to 1. But actually in the running process (when there are changes in the distance between the planet and the Sun), this coefficient is subject to change according to the distance x. In the actual situation, the planet's distance from the Sun is very high, so at this distance the difference between this coefficient and 1 is very small. For this reason, the influence of this coefficient in the description of perihelion motion of the planet is also very small. But in situations modelled by means of a computer program the exponential factor is not so much similar to value 1. For this reason, in the modelled situation, you can see how is changing the position of the perihelion and aphelion of the moving planet.

In the computer program Gas2n.exe, in its source code, there is an exponential coefficient in the form exp(-B/x), and in the program Gas2n-Merkury.exe there is exponential coefficient in the form of exp(B/x). The exponential factor at sufficiently large distances x in both cases in terms of numbers is almost equal to 1. But in one case, this factor is slightly less than 1, and in the second case is slightly larger than 1. As a result of this difference in the two executive programs exe shape of the planet's orbit is changing in a different way. In the schematic drawing it looks as follows.



Periapsis and apoapsis motion

In the figure are marked sequential positions of apoapsis

From sensory activity - to see - to mental activity - to know - there is a relatively simple way. It's sufficient to analyse the facts and draw appropriate conclusions. You can rely on the law of universal gravitation, which gave Newton and properly adjust it. This should be done just in a way that additionally takes into account the exponential coefficient, that Newton in his theoretical research and inferences did not recognize.

In order to get to know, you have to help yourself to see. Astronomers can see some experimental facts mentally, can confront them with each other and on this basis can imagine what the rosette trajectory looks like, in which, for example, moves Mercury around the Sun. Readers of this article may open programs Gas2n.exe and Gas2n-Merkury.exe to imagine the motion of Mercury and see it in a different scale of the model. On the basis of the facts that result from astronomical observations and measurements, astronomers conclude that the perihelion motion occurs in the same direction in which the planet orbits. This means that the time between successive positions of the perihelion points, the planet performs lap around the sun by angle slightly greater than 2*□. For this reason orbit varies in such a way as if planet moved along an ellipse, which rotates very slowly in the same direction. Of course, the direction of the perihelion demonstrates the way in which changes acceleration of the planet during its orbital motion.

Using the Gas2n-Mekury.exe there can be observed perihelion motion, which is similar to the motion of Mercury's perihelion (the picture above diagram B). And using program Gas2n.exe, you can also watch the perihelion motion that takes place in the opposite direction than the direction of the perihelion of Mercury.

Is this second type of motion possible and is it present somewhere in nature, in some other (than ours) planetary system? Perhaps it is. And what really is in fact, can be confirmed only by further researches. Because the existence of such perihelion motion is dependent on whether in the nature is possible emergence of such resultant gravitational field, that would accelerate outsider bodies according to such acceleration function, which in its structure would be present exponential coefficient exp(-B/x), where B would be a positive coefficient.

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*) Note: Computer modelling programs that can be copied from "pinopa's page" operate properly on computers running Windows ME and Windows XP.

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