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HEAT IN CELESIAL MECHANICS

The mass of the Moon and the motion of the Moon in space

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ABSTRACT

Determination of the mass of the moon, the direction of the circular motion of the moon, the influence of the radiated heat of the sun on the moon, the influence of the radiated heat of the moon on the earth and the earth on the moon, the course of motion of the moon in space, the determination of the forces acting on the circular motion of the moon, torque, energy gain, and velocity gain as a cause of constant lunar motion.

Keywords: Moon, radiant heat, angular velocity, hypocycloid, torque

INTRODUCTION

In official astrophysics, the mass of the moon is determined by the tide of the sea, which is an estimate, not an actual value. In addition, the motion of the moon is shown as the motion along the ellipse curve, as well as the motion of the Earth, which is also inaccurate, since the moon in space moves along a curve which in analytical geometry is called a hypocycloid and is significantly different from the ellipse curve. How to determine the real mass of the moon and how to determine the forces acting on the moon is explained below

The mass of the Moon

The Moon is a natural and only satellite for which all orbital and technical characteristics are reliably known and determined by measurements except for the mass which cannot be determined by measurements. The mass of the Moon has been determined implicitly based on the flood and ebb tide Earth's seas and it is equal to 7.4×10^{22} *kg* which is accepted, even though the details on the manner of calculation are not known and it is not known who calculated the mass of the Moon in this way and when. According to our current knowledge of thermodynamics, the radiated heat of the Sun has greater effect on the flood and ebb tide of Earth's seas than the gravity of the Moon.

The Moon's mass can be calculated if we apply the derived equation which includes the known speed of the Earth and the Moon and known distance between the Earth and the Moon as the causes of circular motion of the Moon

$$m_{Mj} = \frac{v_{Mj} \times L_{Mj}^2 \times n_Z}{G} = \frac{v_{Mj} \times L_{Mj} \times v_Z}{G \times L_Z \times 2 \times \pi} = \frac{1.023 \times (384,4 \times 10^6)^2 \times 29,76 \times 10^3}{66,74 \times 10^{-12} \times 149,5 \times 10^9 \times 2 \times \pi} \approx 7,2 \times 10^{22} \quad (kg) \qquad 1)$$

n_Z - mean number of revolutions of the Earth around the Sun; v_{Mj} – speed of the moon *(m/s)*; L_{Mj} – distance between the Earth and the Moon *(m)*; v_Z – speed of the Earth *(m/s)*; G – gravitational constant *(m^3/kg s^2)*; L_Z – distance between the Earth and the Moon *(m);* which is close to 7.4×10^{22} *kg*.

All sizes in the equation are accepted in official astronomy and are not constant except the masses of the moon and earth. The values entered change with the slope angle of the Earth's path towards the plane of the equator of the Sun. Orbital inclination angle of the Moon's orbit relative to the Earth's equator and the speed of the Moon is determined by the speed of the Earth. The same equation can be used to determine the masses of all other natural satellites which belong to other planets, provided that all values in the equation are reliably known.

Movement of the Moon in space

Viewed from the Earth, if apparently at rest, the Moon moves circularly around the Earth with an average

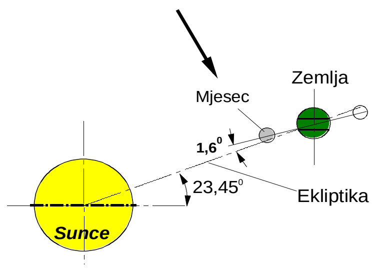

Figure 1

speed of 1.023 *m/s* in the sidereal cycle at an average distance from the Earth of 384.4x10[6] m and it follows an apparent closed curve (ellipse) with the Earth in the foci of such a curve. If the motion of the Moon when viewed from space, is directed towards the Earth's North Pole as is shown in figure 1) then the motion of the Moon shall be observed together with the circular motion of the Earth. The Moon then describes the curve which is described by the point on a circle which rolls around the other circle but from the interior side and it describes a curve, a hypocycloid and therefore, it has opposite direction to the Earth's rotation around its rotational axis and the circular motion of the Earth around the Sun. The opposite direction of the Moon's circular motion from the direction of Earth's motion proves that the Moon could theoretically not have originated from a part of Earth as assumed.

The Moon makes one complete orbit around the Earth 13.37 times a year and it travels 1/13.37 of the Earth's path in one orbit as is shown in figure 2). The figure shows the distance which the Moon travels in orbit around the Earth on the length of the Earth's path and which is divided in 12 equal parts.

From the movement diagram it can be seen that from the position **A** to position **B** the Moon overtakes the Earth, and from position **B** to position **C** the Earth overtakes the Moon. From the movement diagram we can also see that the Moon travels the shorter distance from **A** to **B** by two average distances between the Earth and the Moon, whereas from **B** to **C**, the Moon travels a distance which is longer by two average distances between the Earth and the Moon in one orbit. From this it follows that the average speed of the Moon between point **A** and point **B** is:

$$v_{Mj1\,sr.} = \frac{1/2\times L_{uMj} - 2\times L_{Mj}}{t_{Mj}/2} = \frac{1/2\times 2.415\times10^6 - 2\times384,4\times10^6}{2,36\times10^6/2} = 0,372\times10^3 \quad (m/s) \qquad 2)$$

and with that speed it overtakes the Earth, if the time of one orbit of the Moon around the Earth is $t_{Mj} = 2\times\pi\times L_{Mjsr.}/v_{Mj\,sr.} = 2\times\pi\times384,4\times10^6\ /1.023 = 2,36\times10^6\ s$ at the total lenght of its path $L_{uMj} = 2\times\pi\times384,4\times10^6 = 2.415\times10^6$ *m*, and between point B and point C, the average speed of the Moon is.

$$v_{Mj2\,sr.} = \frac{1/2\times2.415\times10^6 + 2\times384,4\times10^6}{t_{Mj}/2} = 1,674\times10^3 \quad (m/s) \qquad 3)$$

So the Earth overtakes the Moon with an average speed of $v_{Zsr.} - v_{Mj2sr.} = 29,76\times10^3 - 1,674\times10^3 \approx 28.10^3$ *m/s* and the average total speed of the Moon is:

$$v_{Mj\,sr.} = \frac{v_{Mj1sr.} + v_{Mj2sr.}}{2} = \frac{1,674\times10^3 + 0,372\times10^3}{2} = 1,023\times10^3 \quad (m/s) \qquad 4)$$

If we view the movement of the Moon in space, then the speed of the Moon is equal to the speed of the Earth:

$$v'_{Mj\,sr.} = \frac{(v_Z + v_{Mj}) + (v_Z - v_{Mj})}{2} = \frac{2\times v_Z}{2} = v_Z = 29,76\times10^3 \quad (m/s) \qquad 5)$$

v_Z - speed of the Earth; v_{Mj} – speed of the Moon

and the average speed of the Moon relative to the Earth of $v_{Mj\,sr.} = 1023\ m/s$ remains the same.

Orbital motion speeds of natural satellites are used in the official astronomy for determining the masses of the planets, and the mass of the Earth was in this way determined by using the speed of the circular motion of the Moon around the Earth:

$$\frac{G\times m_{Z=}\times m_{Mj}}{L_{Mj}^{2}} = \frac{m_{Mj}\times v_{Mj}^{2}}{L_{Mj}} \rightarrow m_Z = \frac{v_{Mj}^{2}\times L_{Mj}}{G} =$$

$$m_Z = \frac{1.023^2\times384,4\times10^6}{66,74\times10^{12}} \approx 6\times10^{24} \quad (kg) \qquad 6)$$

which is incorrect, even though obtained results numerically coincide with the calculated mass of the Earth through the Earth's gravity? This is the same mistake as is calculating the mass of the Sun through the speed of the Earth's circular motion around the Sun. Masses of the planets cannot be determined based on the speeds of natural satellites because these speeds are not constant and they depend on the change of the motion speed of the planets, as was already been mentioned in the chapter on the Earth.

Moon's movement diagram

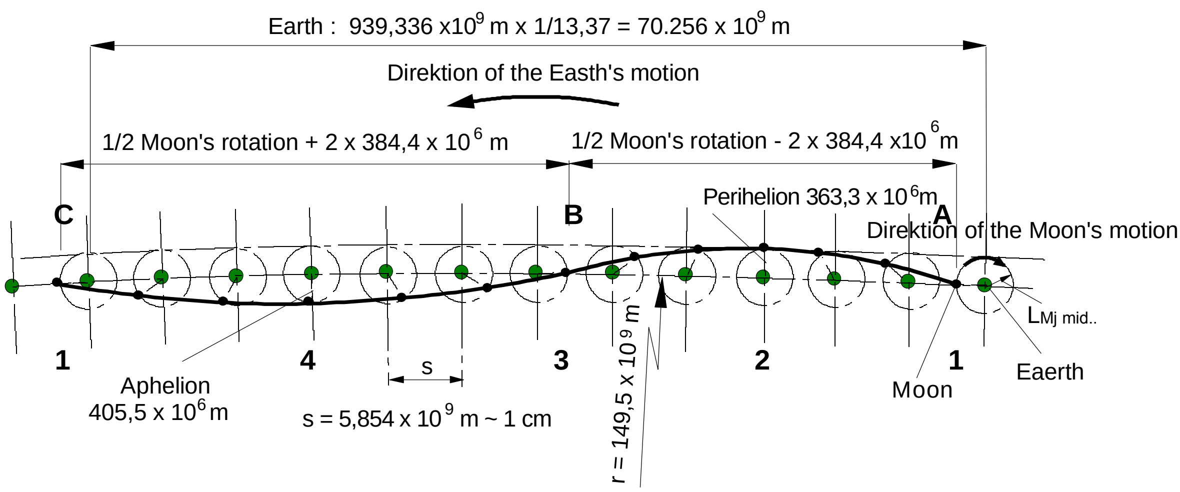

Figure 2

Effect of the heat on the motion of the Moon

The Moon is exposed only to the gravitational forces and forces of radiated heat of the Earth towards the Moon and of the Moon towards the Earth, and its circular motion around the Earth dictates the circular motion of the Earth around the Sun. The opinion that the Sun also acts upon the Moon is wrong. The Sun cannot act on the Moon with its gravity or with its force of radiated heat because the Moon and the Earth together comprise one whole on which the Sun acts upon. In the thermodynamic sense, the influence of the radiated heat of the Sun on the Earth is equal to the influence of the radiated heat of the Sun on the Moon, which means that the temperature on the Moon changes in the same way as on the Earth, depending on the absorption coefficient of the soil. Just as the Earth, the Moon also radiates all the heat it receives from the Sun into the surrounding space, because otherwise its heat would increase, provided that the orbital characteristics or absorption coefficient α i.e. emission coefficient ε remain unchanged.
The Earth acts upon the Moon with its force of gravity F_{gZ} and with the repulsive force of the radiated heat $F_{TZ\rightarrow Mj}$, but the Moon also acts upon the Earth with the same forces and in this way, the distance between the Earth and the Moon remains the same. These forces are equal and opposite and this can be mathematically verified.

Although the Earth has a low average temperature of just $288^0 K$ $(15^0 C)$, it still radiates its heat into the surrounding space i.e. towards the Moon with a power of $\Phi_Z^{'} = 390\ W/m^2$ as was calculated in the *chapter on the Sun* and with the average emission coefficient of *ε* = *α* = 0.285. This means that the following power of radiated heat (heat flow) reaches the Moon:

$$\Phi_{TZ\rightarrow Mj} = \frac{\Phi_Z^{'} \times r_Z^2 \times \varepsilon}{L_{Mj}^2} = \frac{390\times(6,368\times10^6)^2\times0,285}{\left(384,4\times10^6\right)^2} = 0,030 = 30\times10^{-3} \quad (W/m^2)$$

or the entire projection area of the Moon $A_{Mj} = d_{Mj}^2 \times \pi / 4$

$$\Phi_{Mj}^{'} = \Phi_{Z\rightarrow Mj} \times A_{Mj} = 30\times10^{-3}\times(3,473\times10^6)^2\times\pi/4 = 284,2\times10^9 \quad (W)$$

with the heat mass:

$$m_{TZ\rightarrow Mj} = \frac{\Phi_{Mj}^{'}\times3600}{c^2} = \frac{284\times10^9\times3600}{\left(3\times10^8\right)^2} = 113,6\times10^{-4} \quad (kg)$$

and frequency of the temperature of the Earth $288^0 K$ $\left(15^0 C\right)$

$$f_{TZ} = \frac{c\times T\times10^6}{k_T} = \frac{3\times10^8\times288\times10^6}{751} = 1,15\times10^{14} \quad (s^{-1})$$

and it generates the following repulsive force:

$$F_{T\,Z\rightarrow Mj} = m_{T\rightarrow Mj}\times c\times f_{T\rightarrow mj} = 113,6\times10^{-4}\times3\times10^8\times1,15\times10^{14} = 39,19\times10^{19} \ (kgm/s^2; N) \qquad 8)$$

This force is reduced by the radiated heat of the Moon which is received from the Sun with the following average temperature according to the performed measurements of maximum and minimum temperature:

$$T_{Mj\ sr.} = \frac{+120+(-160)}{2} = -20^0 C = 253^0 K$$

which corresponds to the following frequency of temperature:

$$f_{TMj\ sr.} = \frac{c\times T_{Mj\ sr.}\times10^6}{751} = \frac{3\times10^8\times253\times10^6}{751} = 1,01\times10^{14} \quad (s^{-1}) \qquad 9)$$

It is possible to determine the heat which the Moon receives from the Sun and which the moon Radiates into the surrounding space with the emission coefficient of ε ≈ 0.8 by using the average temperature at the surface of the Moon:

$$\Phi_{Mj} = \varepsilon \times \sigma \times \left(\frac{T}{100}\right)^4 \times 1 = 0,8 \times 5,67 \times \left(\frac{253}{100}\right)^4 \approx 186 \quad (W/m^2) \qquad 10)$$

and at the distance of 384.4x10[6] towards the Earth to the whole area:

$$\Phi_{TMj\to Z} = \frac{\Phi_{Mj} \times r_{Mj}^{\ 2}}{L_{Mj}^{\ 2}} \times A_Z = \frac{186 \times (1,736 \times 10^6)^2}{(384,4 \times 10^6)^2} \times (12,735 \times 10^6)^2 \times \pi / 4 = 483,2 \times 10^9 \quad (W)$$

with the heat mass:

$$m_{TMj\to Z} = \frac{\Phi_{Mj\to Z} \times 3600}{c^2} = \frac{483,2 \times 10^9 \times 3600}{\left(3 \times 10^8\right)^2} = 19,3 \times 10^{-3} \quad (kg)$$

and it generates the following repulsive force:

$$F_{T\ Mj\to Z} = m_{Mj} \times c \times f_{T\ Mj} = 19,3 \times 10^{-3} \times 3 \times 10^8 \times 1,01 \times 10^{14} = 58,6 \times 10^{19} \quad (kgm/s^2; N)$$

Total repulsive force of the radiated heat is then:

$$F_{TZ\leftrightarrow Mj\ uk.} = F_{TZ\to Mj} - F_{TMj\to Z} = 58,6 \times 10^{19} - 39,19 \times 10^{19} \approx 19,4 \times 10^{19} \quad \left(kgm/s^2;\ N\right) \qquad 11)$$

If we compare the total force of radiated heat which acts between the Earth and the Moon with the Earth's gravitational force on the Moon:

$$F_{gZ} = \frac{G \times m_Z \times m_{Mj}}{L_{Mj}^{\ 2}} = \frac{66,74 \times 10^{-12} \times 6 \times 10^{24} \times 7,2 \times 10^{22}}{(384,4 \times 10^6)^2} \approx 19,4 \times 10^{19} \quad (kgm/s^2, N) \qquad 12)$$

it follows that the Earth's force of gravity is equal and opposite to action of the force of radiated heat, which is a requirement for maintaining the same average distance. If the largest measured distance between the Moon and the Earth is 405.51×0^6 *m* (aphelion), the Moon cannot get further away from the Earth because the Earth's gravity will be larger than the repulsive forces of radiated heats due to the change of the volume of the Moon.When the Moon reduces the distance to 363.*310[6] m* (perihelion), which was also measured, than the repulsive force of radiated heats will be greater than the Earth's gravity so the Moon can't get any closer to the Earth. The effect of the heat between the Earth and the Moon is the same as that between the Sun and the Earth with a difference that the Moon has significantly larger effect of the heat on the Earth than the Earth has on the Sun. This applies to all natural satellites.
According to the calculated repulsive force of the radiant heat of the Moon and Earth $F_{TZ\leftrightarrow Mj\ uk.} = 19,4 \times 10^{19}$, or the total gravitational force of gravity, which is numerically equal to the repulsive force, it is also possible to determine the mass of the moon according to the equation:

$$\frac{G \times m_Z \times m_{Mj}}{L_{Mj}^2} = F_{TZ\leftrightarrow Mj\ uk}\ ili\ F_{gZ} = 19,4 \times 10^{19} \ \rightarrow\ m_{Mj} = \frac{L_{Mj}^2 \times F_{gZ}}{G \times m_Z} = \frac{(384,4 \times 10^6)^2 \times 19,4 \times 10^{19}}{66,74 \times 10^{-12} \times 6 \times 10^{24}} = 7,158 \times 10^{22} \quad (kg) \qquad 13)$$

which is approximately equal to the mass of the Moon $7,2 \times 10^{22}$ *kg* according to the above equation.1) and the gravity of the Moon is:

$$g_{Mj} = \frac{G \times m_{Mj}}{r_{Mj}^2} = \frac{66,74 \times 10^{-12} \times 7,2 \times 10^{22}}{(1,736 \times 10^6)^2} = 1,59 \quad (m/s^2) \qquad 14)$$

Momentum of force of the motion of the Moon

Unlike the Earth, the momentum of force of the movement of the Moon can be easily determined because orbital and technical characteristics of the Moon as well as the Earth which the Moon orbits are reliably known. When the Moon is in point **1**, the Moon is on the Earth's path and is at the average distance from the Earth and the gravitational force and repulsive force of the radiated heat of the Earth and the Moon are in equilibrium. In this poitn, the Moon moves at the speed of the Earth increased by the speed v_{Mj2sr}, and due to this, the centrifugal force appears:

$$F_{cf1} = \frac{m_{Mj} \times (v_Z^2 + v_{Mj2sr.}^2)}{l_{MJsr.}} = \frac{7,2 \times 10^{22} \times \left\{(29,76 \times 10^3)^2 + \left(1,674 \times 10^3\right)^2\right\}}{384,4 \times 10^6} = 16,64 \times 10^{22} \quad \left(kgm/s^2; N\right) \qquad 15)$$

which generated the momentum of force:

$$M_{t1} = F_{cfZ} \times L_{Mjsr.} = 16,64 \times 10^{22} \times 384,4 \times 10^6 \approx 6,39 \times 10^{31} \quad \left(kgm^2/s^2; Nm\right) \qquad 16)$$

according to, which the increase in the kinetic energy of the Moon is:

$$E_{kMj}^{'} = \frac{M_{t1}}{2} = \frac{6,39 \times 10^{31}}{2} = 3,19 \times 10^{31} \quad \left(kgm^2/s^2; Nm\right) \qquad 17)$$

and therefore the increase in speed is:

$$v_{pr.1} = \sqrt{\frac{E_{Mj}}{m_{Mj}}} = \sqrt{\frac{3,19 \times 10^{31}}{7,2 \times 10^{22}}} = 21 \times 10^3 / 13,37 \approx 1,57 \times 10^3 \quad (m/s) \qquad 18)$$

This speed decreases until it reaches the average speed in this section of the path at $v_{Mj1sr.} = 0,372\ m/s$ because the Moon moves in an opposite circular motion from the Earth's direction of movement and the Moon overtakes the Earth at that speed with an average angular speed of $\omega_{Mj1} = v_{Mj1sr.} / L_{Mjsr.} = 0,372 / 384,4 \times 10^6 = 9,67 \times 10^{-10}\ s^{-1}$. When the Moon arrives at point **2**, it is at a distance of $363,3 \times 10^6\ m$ from the Earth (perihelion) and, with the same angular speed $\omega_{Mj1,}$ it has the lowest speed at that section of the path: $v_{Mj1\min} = 363,3 \times 10^6 \times \omega_{Mj1} = 363,3 \times 10^6 \times 9,67 \times 10^{-10} = 0,351 \quad (m/s).$
The cause of the decrease of distance between the Earth and the Moon to $363,3 \times 10^6\ cm$ is the reduced speed of the Moon and the distance cannot decrease further due to the force of radiated heat of the Moon, because it is greater than the Earth's force of gravity which is the same reason previously explained in the chapter *Thermodynamic effects of the Sun on the Earth*. This force returns the Moon to the average

Demonstrating the influence of forces on the moon

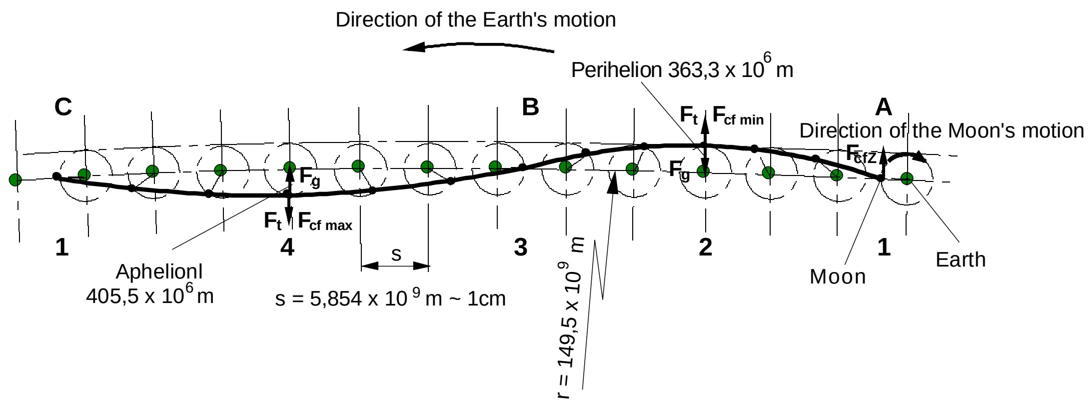

Figure 3

speed at this part of path until it reaches point **3** in which it has the same speed as in point **1**. After passing through the point **3**, the Moon increases its speed until it reaches the average speed of $v_{Mj2sr.} = 1,674 \times 10^3 \ m/s$ and the Earth overtakes the Moon at the speed of $v_Z - v_{Mj2sr.} = 29,76 \times 10^3 - 1,674 \times 10^3 = 28,08 \times 10^3 \ m/s$.

When the Moon reaches point **4**, the Moon is at the distance of $405,5 \times 10^6 \ m$ from the Earth (aphelion) and, with the same angular speed , it reaches the maximum speed of

$$v_{Mj2\max} = 405,5 \times 10^6 \times \omega_{Mj2} = 405,5 \times 10^6 \times 4,35 \times 10^{-6} = 1,76 \times 10^3 \ m/s,$$

whereas the centrifugal force of the circular motion of the Earth brings the Moon back to the point 1. The average circular speed of the Moon is not constant because it follows the circular speed of the Earth which is dependent on the change in the speed of the circular motion around the Sun. The Moon has a greater circular speed when the Earth is in aphelion (summer) because then the Earth's circular speed is also greater, and when the Earth is in perihelion (winter), then the speed of the Moon is lower. These differences in speed are not large so they are not noticed from the Earth.

On average, every year the distance between the Moon and the Earth increases by $3,8 \ cm$ as was measured with laser (lidar) due to the fact that the circular speed of the Earth increases with the decrease of the Earth's orbital inclination, which leads to the increase in the speed of the Moon, and thereby to the increase of the centrifugal force of circular movement of the Moon which pushes the Moon farther away.Demonstrating the influence of forces on the moon:

Conclusion

From this it can be seen that the radiated heat of a body with a much lower temperature of thermal radiation than the sun's temperature in an airless space creates a repulsive force that maintains a constant distance between the bodies by gravitational forces. It is also seen that the Sun does not affect the Moon, but only the Earth, that is, natural satellites should be viewed in conjunction with the home planet. For the Moon, the only unknown reason for the opposite circular motion from the circular motion of the Earth remains.

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