The Theory of the Lunar Motion

(Lunar cycles)

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Abstract

Continuous attempts to create theories of the Moon's motion have been made since the time of Isaac Newton.

The theory of the Moon's motion which would take into account the influence of the Sun, Earth and other planets proved to be one of the most complicated tasks in astronomy.

In this article, a physical model of the lunar motion built on the basis of the statements of the "Comprehensive Law of Motion of Objects in Planetary Type Systems" is presented.

It is shown that the Moon's motion is formed by a complex combination of the gravitational attraction from the Earth and the Sun, acting on the Moon in the direction of the planetary system's motion.

In accordance with the physical model presented, a calculation of the Moon's motion is performed.

The results of the calculations of the Moon's motion in the field of mutual interaction of the Earth, Sun, and Moon, agree with the motion observed and confirm the Theory of Lunar Motion set forth here.

Any quantity of bodies (planets) affecting the Moon's motion could be included in the the calculations.

The results of the calculations verify the "Comprehensive Law of Motion of Objects in Planetary Type Systems".

Contents

Introduction (Modern representations)

The Moon's motion around the Earth is considered today as a combination of several motions:

– revolution around the Earth along the elliptical orbit;

– rotation of the lunar orbit plane. Its nodes shift to the west, making complete turn during the period of 18.6 years;

– rotation of the lunar orbit's major axis with the period of 8.8 years (in the direction opposite to the nodes' movement);

– periodical changes in the lunar orbit's inclination to the ecliptic in the range of 9°59' to 9°19';

– periodical change of the lunar orbit's size: the perigee changes in the range of 356.41 to 369.96 thousand km, and the apogee in the range of 404.18 to 406.74 thousand km;

– gradual movement of the Moon from the Earth as a result of tidal acceleration (about 4 cm per year).

Some investigators add several other motions to this list.

Because of the fact that each orbital element experiences a great number of perturbations with different periods and amplitudes, the actual motion of the Moon is immensely complicated, and its study constitutes one of the most difficult tasks of celestial mechanics [1].

Expressions including tens of thousands members (coefficients and arguments in the trigonometrical functions) are used in the calculations of the motion of the Moon, and there is no limit in their number if a more high precision is required.

Theory of Lunar Motion

The above-listed motions of the Moon are not independent ones, combination of which determines the resulting lunar motion. These motions themselves are the effects of some hidden interactions unexplored for today.

In the article [2], [3] (Comprehensive Law of Motion of Objects in Planetary Type Systems), a description of physical interactions not previously known, which form the planets' orbits observed and allow to explain the complex character of the Moon's motion, is presented.

According to the article [2], the Moon relative to the Earth (likewise the Earth relative to the Sun) performs its motion in two planes: revolution around the Earth in the plane of equator, and — in the form of periodical oscillations — in the direction of motion of the Earth-Moon planetary system (Fig. 9).

At the same time, the Moon along with the Earth similarly performs the motion relative to the Sun in two planes: rotation in equatorial plane and — in the form of periodical oscillations — in the direction of movement of the Solar System (Fig. 9).

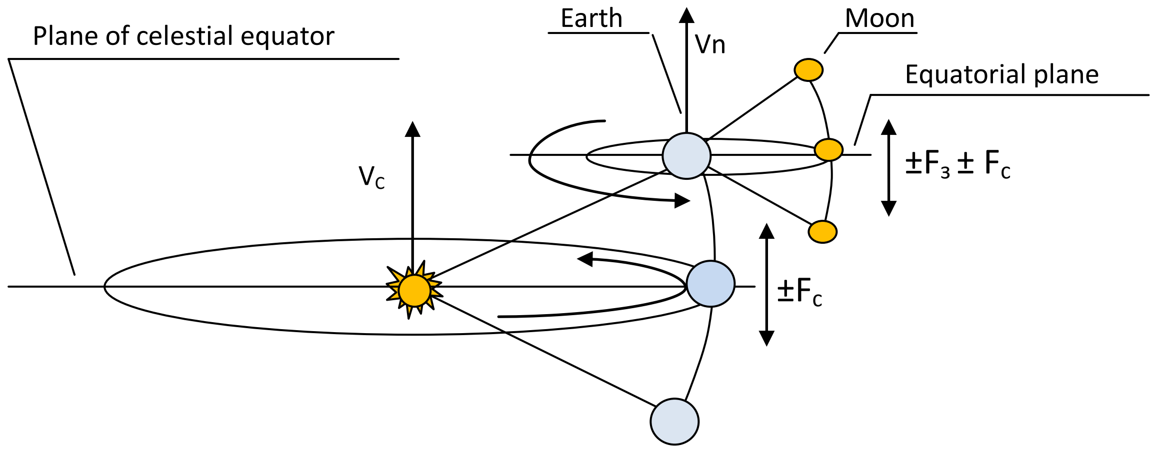


Fig. 9. Physical model of the planets' motion. The Earth relative to the Sun and the Moon relative to the Earth are shown on one side for clarity.

The combination of these two motions just forms the observed orbits of planets.

It is safe to assume the planets' rotation in the equatorial plane as uniform.

As it was shown in [2], the cyclic oscillations of the planets along the direction of the motion of the planetary system, taking place under the influence of the gravitation force F of the central body, play a major role in the shaping of the observed orbit.

The calculation of this motion gives an estimate of the declination, dynamics of the declination change, and inclination of the plane of the planet's rotation at any instant of time. It also gives the duration of the planetary cycles and the speed of motion in the direction of the planetary system's motion.

The superposition of the cyclic oscillations of the planet along the direction of the planetary system's motion in the equatorial plane allows to build the observed orbit of the planet, determine the orbital speed of the planet's motion along the observed orbit at any time and the dynamics of the change of its movement.

The calculation of the oscillatory movement of the Moon along the direction of the planetary system's motion shall be performed with simultaneous taking into account of the oscillatory motions of the Earth relative to the Sun, of the Moon relative to the Sun, and of the Moon relative to the Earth.

The calculation of the oscillatory motion of the Moon along the direction of the planetary system's motion and the Moon's inclination formed by this motion, is performed using the same methods as in the calculation of the Earth's inclination (see [2]).

The total acceleration of the Moon (in the system Sun-Earth-Moon) consists of the acceleration caused by the gravitational force F_E of the Earth, and gravitational force F_S of the Sun, acting in the direction of the planetary system's motion, Fig. 10.

And the vectors of these forces become alternatively parallel and anti-parallel. At a certain moments, one or both these forces can be equal to zero.

The complex combination of these forces, permanently changing both in amount and direction, determines the complicated character of the Moon's motion.

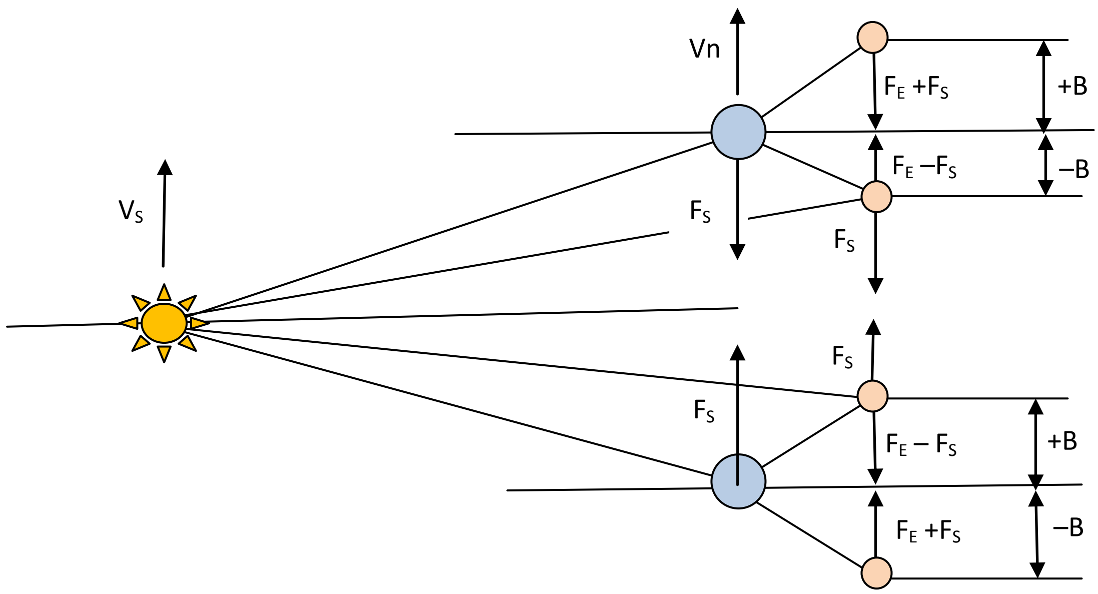


Fig. 10. Complex combination of gravitational forces acting on the Moon.

In the table below is presented a fragment of the calculation of the inclination (motion) of the Moon, determined by the gravitational force components FS and FE of the attraction of the Sun and Earth.

The calculation was performed with the time intervals of 3600 s. In this period of time, the parameters which determine the Moon's motion are assumed as constant.

(All the presented calculations are not final, they are given for estimation. More precise calculations must include changing the distances of the planets from the central body, acceleration of the Earth under the action of the Moon's gravitation, gravitational interaction with the other planets, and some other perturbations).

Table. **The fragment of the calculation of the inclination (motion) of the Moon, changing under the action of the components of gravitational force F_S and F_E from the Sun and the Earth. In this calculation, the accelerations of the Moon and the Earth caused by the component FS of the Sun's gravitational force are assumed equal. The accelerations ΔV_E were taken from the table with the calculation of the cyclic oscillations of the Earth performed in-parallel.**

Lunar cycles

r = 384467 km

b = ±131495 km

A = γm/r2 = 0,0027090643108

Δt = 1ч=3600сек

алуны =Asinφ

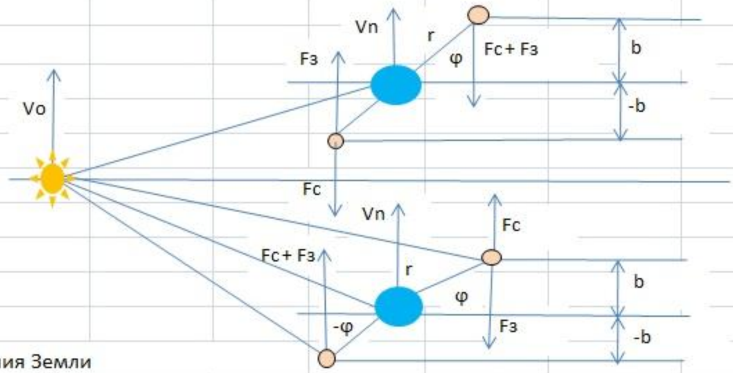
ΔVлуны=a*Δt

∑ΔV=ΔVз+ ΔVл

ΔVз - из таблицы расчёта ускорнения Земли

Vn=V(n-1)-ΔVлуны

bn=b(n-1)-ΔSn



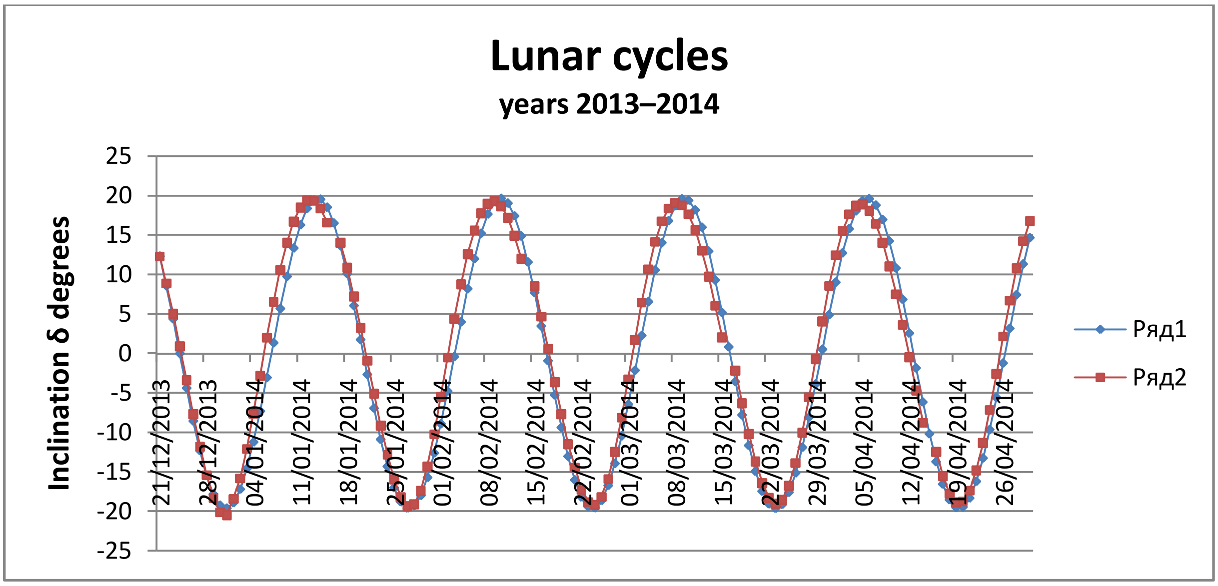
алуны	ΔVлуны	∑ΔV	Vn	S луны	ΔSn км	bn	Sinф	Склонение, δ	Источник *
			219,736			-82012,376	-0,2133145	12,3166	12,3166
-0,00057788	-0,0020804	-0,0105	219,7255	791011,699	957,8894	-81054,487	-0,210823	12,17058656	
-0,00057113	-0,0020561	-0,0105	219,715	790973,885	965,2912	-80089,196	-0,2083123	12,02346557	
-0,00056433	-0,0020316	-0,0105	219,7045	790936,16	972,605	-79116,591	-0,2057825	11,87531122	
-0,00055748	-0,0020069	-0,0105	219,694	790898,523	979,8299	-78136,761	-0,203234	11,72613773	
-0,00055057	-0,0019821	-0,0104	219,6836	790860,976	986,9653	-77149,795	-0,2006669	11,57595936	
-0,00054362	-0,001957	-0,0104	219,6732	790823,519	994,0106	-76155,785	-0,1980815	11,42479041	
-0,00053662	-0,0019318	-0,0104	219,6628	790786,153	1000,965	-75154,819	-0,1954779	11,27264522	

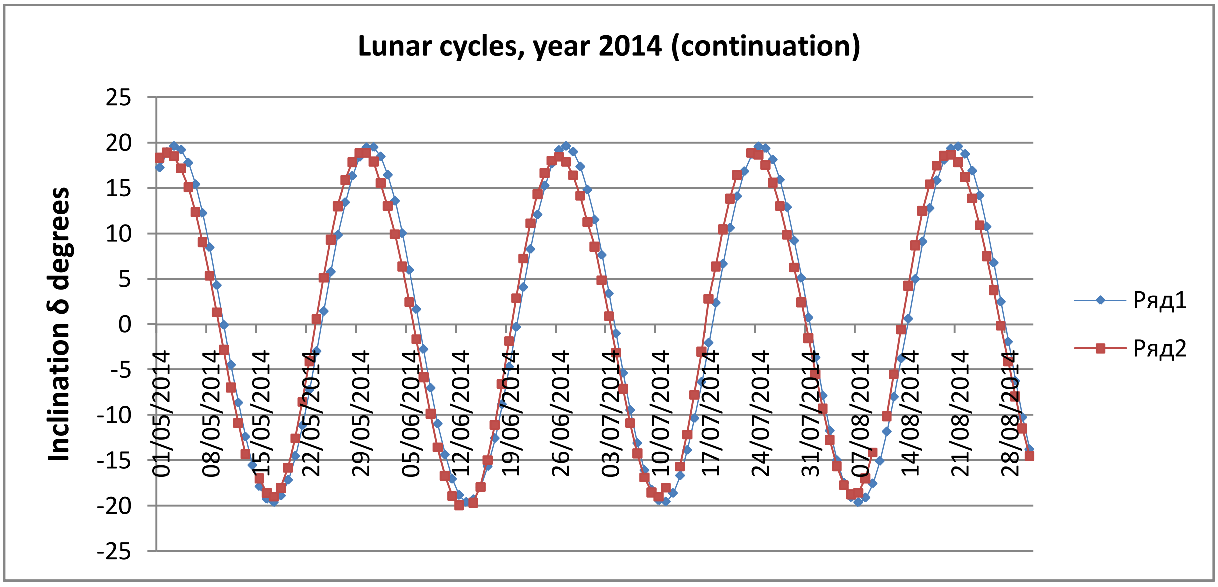
*[4]

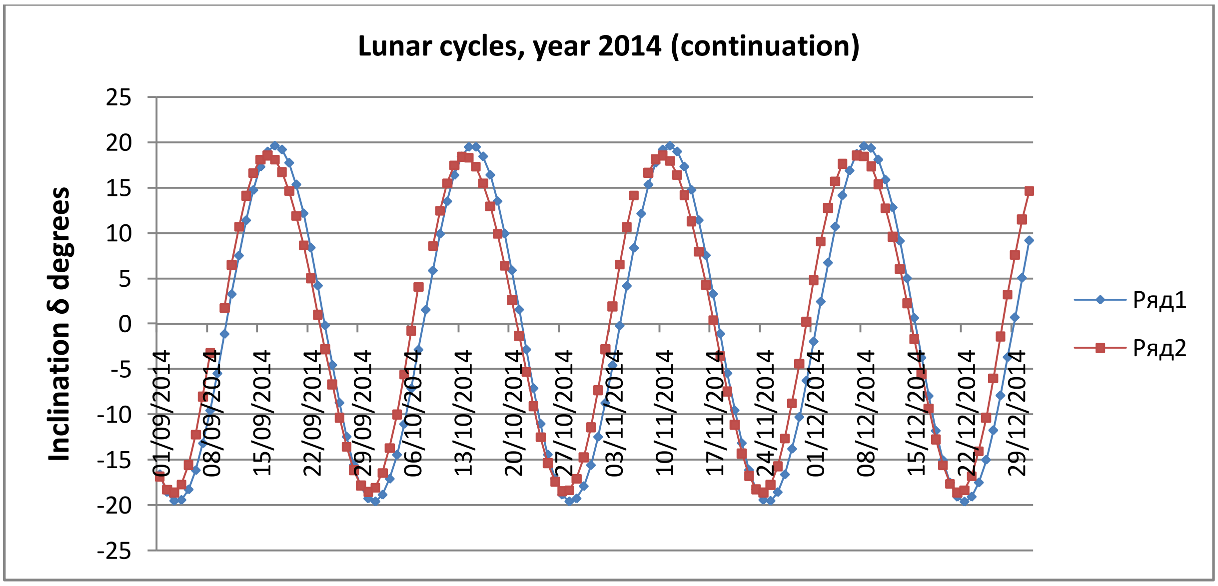
Diagram 1 shows the calculation of the Moon's inclination (motion) determined by the cyclic oscillations of the Moon along the direction of the planetary system's motion, occurring under the action of only the components F_S and F_E of the gravitational force from the Sun and the Earth (row 1).

The values of inclinations (motions) of the Moon from the published sources [4] are superimposed on this diagram (row 2).

Diagram 1. **Moon's cycles under the influence of the components F_S and F_E of the gravitational force from the Sun and the Earth, acting along the direction of the planetary system's motion.**







It can be seen from the diagram that the sinusoid of the lunar motion built on the basis of the Theory of Lunar Motion repeats the one built on the data from the published sources.

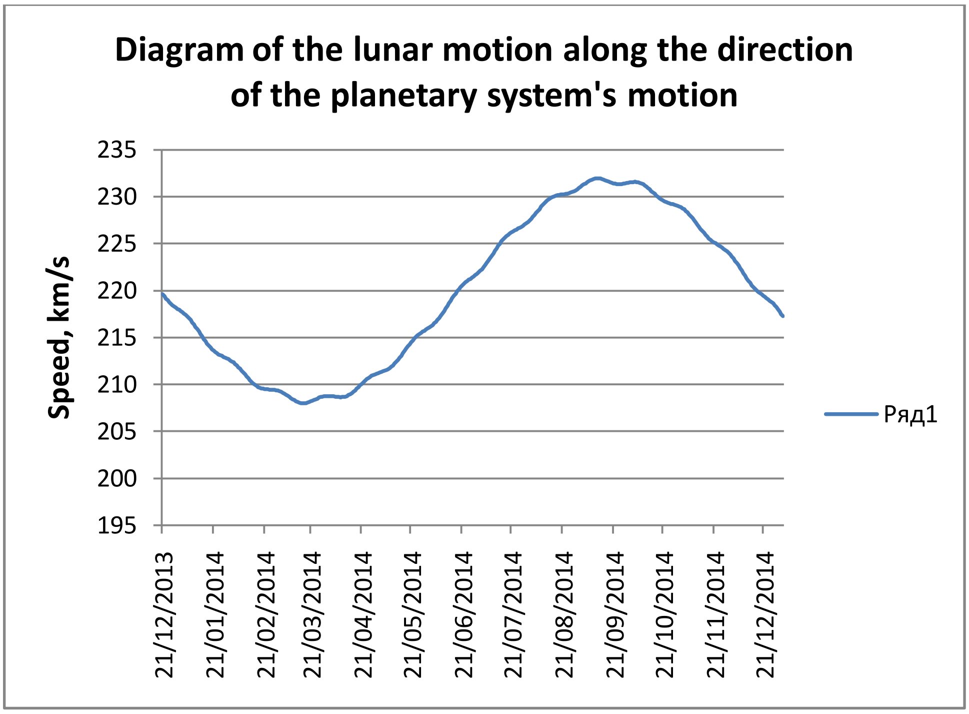
The calculations demonstrate and confirm that the lunar motion and its observed orbit are formed by the cyclic oscillations of the Moon, occurring along the direction of the planetary system's motion under the action of the components of gravitational attraction of the Sun and the Earth.

It was noted in the Introduction that tens of thousands of members (coefficients and arguments in trigonometrical functions) are used in the modern calculations of the lunar motion. The calculation presented here was performed using actually two variables — gravitational components F_S and F_E of the attraction of the Sun and the Earth, acting on the Moon along the direction of the planetary system's motion.

The calculated Moon's inclination, the dynamics of its changing, and duration of the lunar cycles, determined by the oscillatory motion of the Moon along the direction of the planetary system's motion, agree with the observed values and the data from the published sources.

Diagram 2 presents the graph of the changing of the speed Vn of the lunar motion in the direction of the Solar System's motion.

Diagram 2. The diagram shows a non-uniform character of the Moon's motion along the direction of the planetary system's motion. This motion forms the non-uniform motion of the Moon along the observed orbit.



Conclusions

The calculations of the Moon's cycles confirm the "Theory of Lunar Motion" presented here and verify the "Comprehensive Law of Motion of Objects in Planetary Type Systems".

The Theory of Lunar Motion and the used methods of calculations allow to take into consideration an influence of any number of objects on the character of the motion of the Moon.

References:

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