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A Secular Variation in the Moon's Orbit Inclination Supposing the Moon is an Ejected Body: About the Lunar Nodal Point and The Precession Constant

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ABSTRACT
Supposing the Moon as if it has been ejected in a past geological period, the author of this paper analysed the possible variation of the Moon's orbit inclination, from that moment of possible ejection, until now, in the ecliptic frame of axis. Admitting that the obliquity of ecliptic could be greater in that distant geological past, the author supposes that the inclination of Moon's orbit related to ecliptic plan could decreased from an abstractly supposed great value (for instance around "40°") to five degrees now. That could impose the acceptance of a possible secular variation in the Moon's orbit inclination, related to the ecliptic plan.

Keywords: The Earth's Moon distance, the Moon's orbit inclination, the lunar nodal point, the precession.

INTRODUCTION
The precision in the astronomical observations have been rising in the last centuries, some of which were detected by astronomers, particularity in the Earth's Moon Dynamic. In a past paper (1), the three well known particularities were presented in more detail, namely they being the great eccentricity of the Moon's synchronous orbit, the Moon's unusual orbit inclination, and the Moon's great mass related to the Earth's mass.

The author tried to explain all these particularities in that paper, supposing the Moon as if it were an ejected body from a terrestrial equatorial band. Indeed, if the heavy Moon was suddenly ejected (in some dramatic geological past period) the Earth would have suddenly lost then 0.0123 of its mass, diminishing its attraction power over the Moon, and step by step the Moon's initial ejected circular orbit become more elliptical, under the Sun's attraction.

MORE ABOUT THE MOON'S ORBIT
Let us suppose the ecliptic as an orbital plane and the Earth as a body whose gravity centre is situated in this plane. Around five centuries ago, Galileo Galilei (2), detected the "lunar secular acceleration" of the Moon's longitude (of about 11"), meaning that the Moon's orbit is changing not only its shape, but also its growth. This implies that the well-known increase of the Earth – Moon distance exists, and it grows with some centimetres yearly.

In the last century, some genuinely interesting studies about fossils proved that around the Cambrian-Neoproterozoic eon border, the Moon was closer to the Earth (3). Indeed, before the Ediacaran geological period (630Mya-541Mya), (4), (5), there was a great and long glaciation period when the obliquity of the ecliptic could have been more 40°. After the Ediacaran period, from the beginning of the Phanerozoic eon (541Mya) the obliquity of the ecliptic was certainly less 40°. Consequently, during the Ediacaran geological period, a considerable tectonic activity took place which caused changing in the Earth's momentum of inertia, variation in the Earth's angular momentum and a great piece from the continental platform could suddenly have been ejected.

Therefore, supposing that the Moon could have been ejected in the past geological period, and the obliquity of the ecliptic was greater, the Moon's orbit inclination related to the ecliptic plane could be that of the obliquity of the ecliptic at that moment, for instance 40°. In the same moment of ejection, the Moon's orbit inclination related to the celestial equatorial frame (the declination) would be almost null; also, at the beginning of the same ejection, the draconic period and the synodic period could be about one terrestrial day.

After ejection, the Moon's orbit (always around the Earth's gravity centre) would leave the celestial equatorial plane in incremental steps. Now, after a great geological period, due to Sun's attraction, its orbit's inclination is about 5° related to the ecliptic plane, and not around 40° as was supposed in the abstract approximation from the moment of ejection. Finally, currently, the draconic period when Moon surrounds the ecliptic plane is 27,212221 days and its synodic period is 29,530 589 days (6).

Meanwhile, the inclination of the celestial equatorial plane related to the ecliptic plane diminished from that abstractly proposed value of 40°, to the actual obliquity of the ecliptic of 23,4°.

Briefly, if the Moon were ejected, then between its last quarter and its first quarter, under the Sun's stronger attraction, its elliptical orbit (around the Earth's gravity centre) and its eccentricity would be submitted to a continuous increase; another significant consequence could be the secular diminution of the Moon's orbit inclination related to the ecliptic plane.

ABOUT THE MOON'S NODAL POINT

In celestial mechanics, the intersections of Moon's orbit with the ecliptic plane are the well-known, "lunar nodal points"; their retrogradation cause the principal periodical component in the wobble of Earth's rotation axis, namely the nutation period.

Supposing the Moon as an ejected body, it is of interest to verify if the retrogradation of the lunar points is only a periodical phenomenon, or it also has a discreet secular component**.** For this, the distance between two successive nodal points must be precisely known. Looking at an interval of a century, the distance between the two nodal points in 1900.0 was 19°341162; in 2000.0, it was 19°341357, which proves there is a very real, small, but secular increase component of 0,7 arcsec within the given timeframe (6).

Also, performing a simple analysis for values of others some precise periods regarding the Earth-Moon dynamic for 1900.0 and 2000.0, a secular variation is also noticeable, all of which have increased (6). For instance, all the important monthly periods, namely the synodic, draconic, sideral, tropic, were augmented by 0.1 seconds from 1900.0 to 2000.0 (an infinitesimal secular value indeed, but a tangible increase over a century).

It would be interesting to compare the values for the draconic, synodic, and sideral periods, with those from past centuries, as they could be shorter.

Naturally, as the Moon's orbit continued growing, each of its intersection with the ecliptic plane could only come later and later, causing the phenomenon of retrogradation of nodal points (*like being in a station where a train passes with a circular trajectory and a passenger that is always late manages to climb only in the following wagon, and never in the one occupied before, meaning in a retrograded position).*

At the moment of ejection, the draconic and the synodic period could have been around one day; afterwards, as studies of fossils proved, due to the increase of the Moon's orbit, the synodic period became longer and the Moon always intersects ecliptic plane later and later.

SIMPLE QUESTIONS ARISE

Can it be concluded that the retrogradation of the lunar nodal points are caused by the secular component in the Moon's orbit inclination? Could it be that the retrogradation of the lunar nodal points does not only have a 18,6 periodical component but also an infinitesimal secular component?

ABOUT THE PRECESSION PHENOMENON

Creating a reference system of axes in the sky may be the most abstract achievement of the human being. More than two millennia ago some people did it. They defined the ecliptic reference system of axes and the equatorial reference system of axes and their intersection, the equinox line; which then indicated an important reference point in the sky, the 5-magnitude star, gamma Arietis, whose coordinates were obviously (0,0).

It is well known that this intersection of these two imaginary celestial reference planes was supposed to be fixed until Hipparchus discovered a secular variation in its direction, namely, the well-known phenomena of precession.

Consequently, now, the intersection indicates a celestial point near a faint 7-magnitude star in the Pisces zodiacal constellation (7); also now, the ecliptically coordinates of gamma Arietis are about +33 ° longitude and +7° latitude (using the catalogue for star position of 2000 (7)).

It is noticeable in the coordinates of gamma Arietis that the ecliptic longitude component is greater, and the precession was first detected in the ecliptic longitude. Consequently, this component is known as "the constant of precession". Ptolemy (100-170 AD) gave us the value of 38" for the yearly value of "the constant of precession" (8).

Supposing now the ecliptic reference frame as an inertial one; it must then be admitted that it is the celestial equatorial reference axis which is moving, and imposes a variation in the direction of the equinox line due to a change in the Earth's equator position. The two reference axes have the same origin, while each variation of their intersection is due to a rotation. As the precession is a secular phenomenon it must also be caused by a secular component in the Earth's equator position change.

After Bradley has discovered the nutation period it became a widely known fact that the Moon acts on the Earth's rotation axis through the tangential component on its orbit, in accordance with the Euler formula regarding the Earth as a solid body with a fixed point. Due to the periodical retrogradation of the lunar nodal point, the Earth's rotation axis has the well-known periodical phenomenon of nutation (18,6 years). But the retrogradation of lunar nodal points has an additional, very little, secular component, mentioned in the precedent chapter, also imposing a secular change in the Earth's rotation axis (from Eratosthenes, around 2300 years ago, the obliquity of the ecliptic decreased by 15' (1)).

In fact, a secular changing in the Moon's orbit inclination could involve a secular component in the position of the Earth's rotation axis, which naturally implies a change (also in a secular manner) in the position of the equatorial plane, specifically in its intersection with the ecliptic plane.

Briefly, because the Moon's orbit retrogradely intersects the ecliptic plane, the equatorial plane will also retrogradely intersect the ecliptic plane. To conclude, it could cause the retrogradation of the equinox line and could explain the precession phenomenon.

REMARQUES ABOUT THE "PRECESSION CONSTANT"

Regarding the "precession constant", a valid remarque is that even this value has a small secular variation; thus, in 1900.0, its yearly value was 50"2564 while for 2000.0 the yearly value was computed at 50"2937.

A question may arise regarding past values calculated of the "constant of precession".

Indeed, considering the difference in the yearly precession value, from 38'' during the time of Ptolemy, to 50¨ nowadays (at the beginning of the XXIst century), could it be supposed as a consequence of the secular component of the "constant of precession" itself?

CONCLUSIONS

Supposing the ecliptic reference axis as an inertial one, and neglecting the planetary precession, this paper present simpl**y** a possible secular component in the Moon's orbit inclination caused by the Moon, supposed as being ejected. Indeed, the Ediacaran geological period was submitted to a remarkable climatic variation (from a long "snowball Earth" period, before the Ediacaran period, to the Phanerozoic eon, after Ediacaran period). That proves there were changes in the Earth's moment of inertia and in its angular momentum direction, causing a real diminution of the obliquity of the ecliptic during the Ediacaran geological period. If then a heavy piece of a continental platform could have been ejected suddenly, while the Earth would have lost 0.0123 of its mass, it would also diminish its attraction power suddenly, and the ejected body would not return on Earth but begin to orbit around it.

As fossil analysis proved afterwards, the Moon's orbit around the Earth's gravity centre grows under the Sun's attraction, over the length of the great geological period, step by step, the synodic period increased whereas the Moon's orbit inclination decreased to the current 5 °. As a consequence, the lunar nodal points have a retrograding position on the ecliptic plane.

Due to Bradley discovery of the nutation, it can be supposed the Moon's tangential forces situated on its orbit act on the Earth's rotation axis and leads to changes in the intersection of the terrestrial equatorial plan with the ecliptic plane, causing the precession phenomenon.

Consequently, thus can be explained both the well-known particularities in the Earth's Moon dynamic (the eccentricity and the position of the Moon's orbit, the Moon's mass), as well as the phenomenon of the retrogradation of the lunar nodal point and the precession phenomenon, which could be in fact the astrometric consequences of the (supposed) Moon's ejection, in the Ediacaran geological period.

References

(1) Ciobanu, M.Z, (2024) *The Earth's Rotation Axis and The Moon's Orbit.* European Journal of Applied Sciences, vol. 2, no. 2, 2024-03-09, https://doi.org/10.14738/aivp.122.16660.

(2) Smart, W.M. *Celestial Mechanics*, London New York-Toronto, 1953. (3) Barrere, M. (1978) *Les nautiles temoins ... de la Lune*. LA RECHERCHE, vol 96, 1978-01

(4) Wikipedia (*the Neoproterozoic period*)

(5) Encyclopaedia Britannica (*the Ediacaran period*)

(6) *The Astronomical Almanac*

(7) *Sky Catalogue 2000.0*

(8) Newton, R.R., *MNRAS* (1974) 169, 331-342

(9) Melchior, *Paul. Geodesie et Astronomie Geodesique*, vol. 1, 1971