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ON THE TIME-SPACE CONTEXT OF MOON-RELATED BELIEFS

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Abstract
The article explores the laws in the seeming movement of the moon and which aspects of this need special consideration while interpreting ethnoastronomy. The examples used refer to the Estonian geographical latitude 58–60 degrees north.
The classical worldview originates mainly from the area of 40 degrees latitude. If we consider the three main economic regions of the world – Europe, the USA and Japan-China – all these remain roughly on the latitude of the Mediterranean region. Since most science and pedagogical theories originate in these regions, the one-sidedness of textbooks is quite understandable. There are no long-term changes in the movement of the moon. The precession of the orbit (the node shift) and the repetition of eclipses (the Saros) fall into a cycle of less than 20 years. Secular changes (such as the precession of the axis of the earth) do not influence the seeming movement of the moon.
On greater latitudes (55 to 70 degrees) the moon's axis is usually perpendicular to the horizon. Thus, the full moon is always seen in the same position and figures seen on its surface should be stabile. The uniqueness of northern folklore, its astronomical aspects included, has enchanted researchers for more than a century.

Keywords: moon, ethnoastronomy

Thanks to astrology on the one hand and Hollywood on the other, the science of stars is much more popular among people than elementary physics and mathematics. Being a teacher of physics in a tertiary education establishment with education in astronomy, I have seen ample proof of this. Since I have always put emphasis on practical observation, I have been repeatedly surprised by how little people know about the apparent movement of the luminaries. School physics teaches us their sizes, distance, orbits, even their surface forms. But where and when we can see them, when they rise and set, do they go high or low – sometimes even a person with higher education in astronomy may have not the slightest idea. This applies especially to the moon, the best known of all celestial bodies.

In the following I wish to present a trivial overview of the laws in the seeming movement of the moon and which aspects of this need special consideration while interpreting folkloristic astronomy

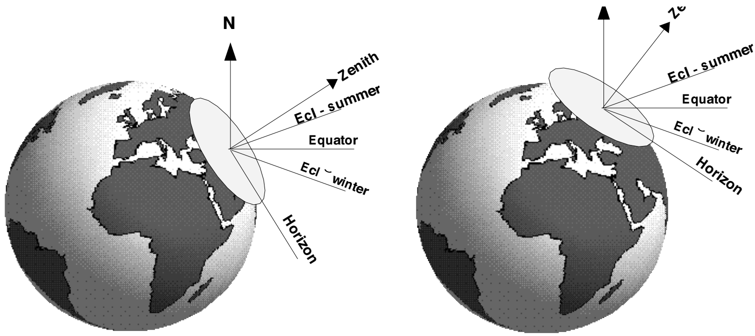

Figure 1. *Topocentric view: the altitude of the celestial equator is lower at higher latitudes, making the altitude of ecliptic dependent on time and date of observation.*

material. The reader should keep in mind that the examples I use refer to the Estonian geographical latitude 58–60 degrees north.

THE TOPOCENTRIC VIEW

The main difference between a geographic map and a celestial chart is that the first is adequate in both global and local sense. The city of Tartu is on the same spot on a map of the county, Estonia or the whole world. Logically, the same should go for star maps. Instead, in fact, there is no place on the whole planet where the sky above would look exactly the same as the maps depict it. The rotation and revolving of the Earth causes the sky above the observer to change continually and what can be seen at any given moment depends both on the location of the observer as well as the time of observation. If the geographical co-ordinates and time of the observation are known, computer programs easily reconstruct the view.

The view the starry sky presents from a certain (topographic) location on the planet surface is called topocentric. The observer on the surface directly accesses only the topographic view and our contemporary concept of the universe (the geo- or heliocentric concept) is the result of thousands of years of observation, interpretation and thinking. Unfortunately, this is – greatly thanks to the school education system – the only astronomical intellectual equipment of a contemporary adult and its practical application sometimes yields absurd results.

Let me give you an example. In late summer 2002, Venus was at its biggest eastern elongation and positioned 46 degrees left of the sun. Our school education insists that Venus as the brightest planet thus should be easily observable in the evening sky.

However, we can not find it there. If we have a look at the almanac of Tartu Observatory (Kalender 1923–1939, 1941–2006), we see that Venus sets in Tartu only half an hour after the sun (in Tallinn, the time difference is even smaller, only 23 minutes). If you initiate some planetarium simulation program, you see both nearing the horizon at the same time: Venus on the azimuth 60 degrees (westward from south), the sun 46 degrees north, on the azimuth 106 degrees.

The reason for this is the latitudinal effect, an important element of the topocentric world view. The roots of our school education originate in 40–50 degrees latitude – and there, indeed, is Venus easily observable, setting about two hours after the sun.

LATITUDINAL EFFECT

The conflict between the picture prompted by school education and the reality results from the fact that the classical sky view it is based on originates mainly from the area centered on 40 degrees latitude. If we consider the three main economic regions of the world – Europe, the USA and Japan-China – all these are roughly on the latitude of the Mediterranean region. Since science and pedagogical theory predominantly originate in these regions, the one-sidedness of textbooks is quite understandable. It is also clear that for most of the civilized world, this one-sidedness is comfortable and suitable.

An exception here is the Scandinavian region – its corresponding areas in America and the Far East fall on wild and sparsely populated regions. The uniqueness of northern folklore, its astronomical aspects included, has enchanted researchers for centuries. But if we consider comparing astronomical folklore recorded here with any culture, it should be more akin to the Nenets or the Sami rather than a classical Hellenistic culture, due to the latitudinal effect.

Let us imagine our topocentric world as a plate that is glued on the globe in one certain geographical spot. Let us project this world on the plate (i.e. on the tangent plane of the earth) (see Fig. 1) with the astronomically significant baselines: the celestial equator, the ecliptic and the directions of poles. Since the ecliptic is tilted relative to the equator, here are depicted the two directions to mark the altitude of the northern (summer) and southern (winter) constellations of the ecliptic.

Since the moon and the planets move near the ecliptic, their visibility is determined by the angle of the ecliptic relative to the horizon. Thus for the evening sky, the ecliptic is lower in the autumn than in spring. While at lower latitudes this difference is quantitative in nature (the moon and the planets are either high or low), from the 60th degree latitude upwards this difference becomes qualitative: in the autumn period they are very low on or even below the horizon.

THE SEEMING MOVEMENT OF THE MOON

I have chosen the moon to illustrate the postulates stipulated above since – at least in Estonia – this is the celestial body with the largest number of and very contradictory folkloristic records. Since the records of oral folklore of Estonians as well as of many other European nations originate mostly in the 19th century and are strongly influenced by the collectors' (traditional!) school education, this is a field where there is hope for applied astronomy to bring some order.

The moon is a celestial body exceptional in the solar system in that it is the only big natural satellite that rotates around its mother planet not on equatorial but orbital plane. To be more precise, near the orbital plane, as the five-degree angle takes it far enough from the ecliptic to significantly affect visibility in our critical region. Secondly, the moon is a very big satellite and is close enough to the planet to display details visible to the naked eye (phases, dark spots, earthglow). Researchers of cosmic civilisations are convinced that these peculiarities in the movement of the moon have had major influence on the development of civilisation on earth; the moon has even been interpreted as the "cosmic miracle" put on its orbit by some cosmic civilisation (Lissevich 1981).

For a person without formal school education who perceives the world as a "flat disk and the sky like an upturned kettle above it", the time–space concept of the earth and moon where the phase of the moon depends on from which direction the sun is shining on it, is not accessible. That person can only make observations about the shape of the crescent, its position (height from horizon) and orientation relative to the vertical axis (upright, on its side, upside down, on its back). Hence also such observations, sayings and suggestions. To which side the crescent is facing is explained in the name: J-shaped new moon ("horns" facing left) or C-shaped old moon ("horns" facing right). Of course, they can also be distinguished by the observation time: young moon in the evening, old moon in the morning.

The seeming movement of the moon in the sky is the result of three spatial movements – the rotation of the earth, the revolving of the earth around the sun, and the revolving of the moon around the earth. In the starry sky – the celestial sphere, as it is called by astronomers – each of them is a "great circle" formed as a result of the intercrossing of corresponding plane (the earth's equator, the earth's orbit and the moon's orbit) with the imaginary observer-centred sphere. Since these planes are at an angle relative to each other, the corresponding great circles intersect, too. The trajectory of the moon as seen from the earth is a complicated one, traditionally divided into daily movement (because of the rotation of the earth) and into two perpendicular movements in the starry sky: movement along the ecliptic and perpendicular to it. Since the sun also moves along the ecliptic, it is their relative (angular) distance (i.e. the angle between the sun and the moon) that determines the phase of the moon. How far above the horizon we see the moon depends on which ecliptic point (zodiacal sign) the moon is positioned in and what is the latitude of the observer.

Figure 2 displays the moon's culmination height in different phases as depending on the season. The left panel corresponds to the vernal equinox in March–April. As we can see, the evening new moon is usually over 30 degrees high, consequently being visible for several hours after sunset. The old moon, on the contrary, is low and rises only a little before the sunrise. In autumn, the situation is

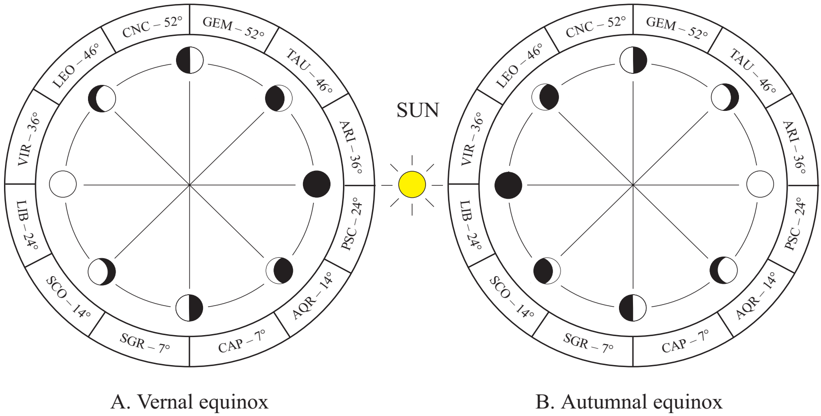

Figure 2. *Location and altitude of moon phases for different seasons (60 degrees latitude)*

reversed – in the higher-rising constellations we can see the (morning) old moon, while the new moon moves on low altitudes and is visible only for a little while in the evening. Turning the circle of zodiacal signs of Figure 2 we can determine the position of the moon and its culmination height for any month (the sun's position in the zodiacal ring is indicated by the position of the new moon).

The moon's seeming movement perpendicular to the ecliptic is a result of the five-degree angle between the moon's orbital plane and the ecliptic (the plane of the earth's orbit). These five degrees may add to the angle of the ecliptics (if the vernal equinox concurs with the moon orbit's ascending node) or lessen it to the same amount (if the ascending node concurs with the autumnal equinox). In the first case, the changes in the moon's altitude increase, while in the second they decrease.

Before we start making any conclusions there is another important detail to consider: the folklore of northern countries lacks the background made up of the constellations of the ecliptics – the zodiac (Kuperjanov 2002, 2003; Lintrop 1997; Prüller 1968). In classical astronomy, the movement of the moon is observed relative to the constellations while in folk astronomy only relative to the horizon and quarters. The psychology of seeing causes us to perceive a "half of the skies" above which we lose contact with the horizon to be about 20 degrees (Eelsalu 1996).

Thus – if the moon moves at more than 20 degrees above the horizon, it is simply "in the sky" and its exact position is considered of no importance. And, if the moon moves at less than 5 degrees above the horizon, it is significantly concealed by earthly objects.

TEMPORAL CONTEXT

The interest of historians towards astronomic events is largely led by interest in chronological pinpointing. Moon-related beliefs are of little use for this purpose.

Long-term changes in the moving of the moon are caused by the precession of the earth's axis and the moon's orbit due to the gravitational pull of the sun. The former causes the vernal and autumnal equinoxes to drift along the ecliptic with a cycle of 26,000 years. This has given much food for astrology and astral mythology, but has had no effect on moon-related myths – neither the moon's movement in the starry sky nor its height from the horizon are influenced by the precession. However, the shift of nodes can have a crucial role in untangling one of the key problems of moon-related folklore, namely the contradictory nature of moon-related beliefs.

A certain "validating" period is needed for some observation to become fixed in oral folklore. If this period is too long, interpretational misunderstandings emerge – the same person is unable to validate the observation. The cycle of 18.6 years is too long for undertaking a thorough study – the three necessary cycles give us 56 years as the minimum period – but short enough to allow to overcome confusion, the instability of nature, in two cycles. Thus, different concepts of the same phenomena may emerge depending on which fact was emphasised.

Let me give an example with the "autumn new moon". In September, the new moon is only poorly visible in Tartu. However, the old moon rises long before midnight and sets only in the afternoon of the following day.

But this is the "average moon", since in autumn the moon's orbital nodes are nearly 90 degrees from the equinox and the orbit's angle does not influence the moon's culmination height to any significant level. The maximum effect is achieved in 2007 when the moon passes through the ascending node on March 19 only a few day/degrees from the vernal equinox ("the sun's ascending node"). As a result, the evening new moon on March 25 will rise in Tartu to a height of 60 degrees (5 degrees higher than usual), and the morning old moon on March 12 is visible for only 3 hours at merely 2.5 degrees above the horizon. In Helsinki and Oslo (60 degrees latitude) the old moon barely reaches the horizon while in Lahti and Bergen the moon is below the horizon and not visible at all.

Naturally, this can be observed by a local observer, but this observation can not be proven before the year 2025. Whether the observation develops into a fixed saying depends on the local people and circumstances. Thus also the principally correct conclusion "spring moon grows, autumn moon harvests" is for our successors to ponder, if the intermittent years do not erase it from our cultural memory.

SPATIAL CONTEXT

The most important conclusion to be drawn from the latitudinal effect is that connecting the visibility of the phases of the moon with seasons marks a region of belief formation at near 60 degrees latitude.

But even more important in spatial context is the orientation of the moon relative to the horizon. The two main astronomic factors regulating this are the following:

1. Since both the moon and the sun move along the ecliptic, the moon's crescent is always perpendicular to the ecliptic. The angle between the moon and the horizon is determined by the angle between the ecliptic and the horizon.

2. Since the moon's rotation axis is more or less perpendicular to the ecliptic (83 degrees), the angle between the ecliptic and the horizon determines the orientation of dark spots visible on the full moon.

Since the ecliptic intercrosses the horizon, it is always parallel to the horizon at some point. In which direction and how high this point is located depends on the time of day as well as the date. The maximum height is determined by the summer solstice (in the constellation of Gemini), and the minimum height accordingly by the winter solstice (Sagittarius). Depending on the latitudes, the height of the horizontal part of the ecliptic can be:

* latitude 40 degrees – 23.5 to 73.5 degrees
* latitude 60 degrees – 6.5 to 53.5 degrees

The angle between the ecliptic and the horizon is the greatest at the point where it crosses the horizon. We get the maximum angle adding 23.5 degrees (the angle between the ecliptic and the equator) to the angle between the equator and the horizon. Thus

* latitude 40 degrees – 73.5 degrees
* latitude 60 degrees – 53.5 degrees

What should be concluded from this? At low latitudes (40 degrees and less), the crescent is near the horizon and usually "on its back", resembling a boat. The spots on the moon are then seen from its side – as a rabbit (the rising moon) or a hunched granny (the setting moon). On degrees of latitude 60 and higher, the crescent is usually "upright", only in spring months (February to April) "on its back". Correspondingly the autumn old moon is also "on its back". Since in Estonia spring is the period with the clearest nights, the saying "clear moon is on its back" can have a reasonable explanation.

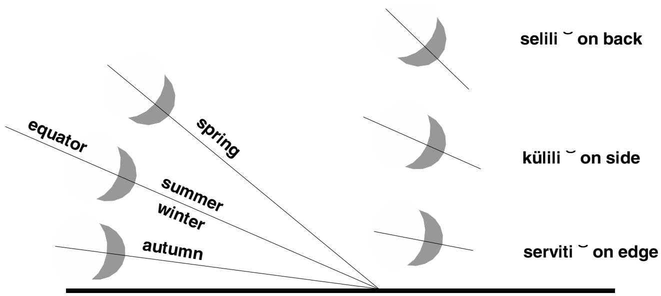

Figure 3. *Orientation of the new moon crescent for different seasons, as compared to Estonian folk lore.*

Full moon in Estonia is also mainly “upright”, with the moon’s north pole facing upwards. The spots usually form two figures. But with this we also need to remember the distance from the horizon – in winter when the moon is shining high above our heads, it makes contact with the horizon only at rising and setting. However, the greatest angle of the rising and setting moon corresponds to the greatest angle of the ecliptic, i.e. the time around the vernal equinox – and this is when we can hope to see the (Easter) bunny on the moon.

IN CONCLUSION

There are no long-term changes in the movement of the moon. Both the precession of the orbit (the node shift) as well as the repetition of eclipses (the Saros) fall into a cycle of less than 20 years. Secular changes (such as the precession of the axis of the earth) do not influence the seeming movement of the moon.

The moon’s position and movement relative to the horizon are determined by geographical latitude. If the full moon’s dark spots are described as different morning and evening figures or if the crescent is compared to a boat, the corresponding legend must originate in a latitude no more than 40 degrees. If a legend claimed to originate from the southern hemisphere describes the old moon as C-shaped, we are dealing with an obvious misinterpretation or even deceit.

On great latitudes (55 to 70 degrees) the moon’s axis is – no matter in which quarter the moon is – usually perpendicular to the horizon. Thus, the full moon is always seen in the same position and figures seen on its surface should be stable.

At 55 to 70 degrees latitude, the different position of the ecliptic relative to the horizon at different times of year must be taken into account in interpreting beliefs relating to the phases of the moon. Since the southern part of the zodiac is only 7.5 degrees above horizon (and the moon can be even lower!), the autumn new moon, summertime full moon and springtime old moon are very poorly visible. Thus the Estonian belief that the young moon grows and the old moon harvests could be connected, instead,

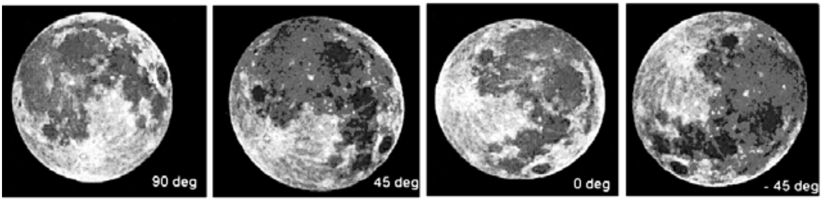

Figure 4. *Full moon at the horizon – different geographical latitudes. Different arrangement of dark spots leads to different legends.*

with the seasonal nature of farm works: in spring we see mainly the young moon, in autumn the old moon. From the fact that this is a universal belief among the otherwise very contradictory moon-related beliefs, and considering the astronomic background of the region, we can conclude that our ancestors have been farmers in the north for a very long time.

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