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Helaical rising of the new moon as a precursor of the beginning of Hegri lunar month

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Abstract The dependence of the helical setting of the new crescent on its helical rising on the day of conjunction is studied. The data for a complete 33-cycle are used for this propose. The relation indicates general tendency of increasing the positive duration of the crescent lag as a function of its helical rising. It shows an evident seasonal variation depending on the declination of the Sun.

More frequent positive durations of the crescent lag after Sunset on the day of conjunction occurs in the spring and summer solstice and vice versa in the autumn and winter solstice. The ratio of the monthly frequency of the positive duration across the examined cycle varies at various months across the cycle ranging from higher value (69.697%) in March to the lower value (44.117%) in January.

Introduction

The visibility of the thin lunar crescent just after the conjunction has considerable historical and cultural importance; many societies have used the lunar phase's cycle as the basis for their calendars. Even today a variety of cultures, including the 22% of the world population that holds the Islamic faith still begin their months with the first sighting of the crescent Moon. It is well known that the new crescent of the Moon is a feeble object and its contrast with respect to the brightness of evening twilight is generally small. For this cause, it is not easy to observe the crescent of the new Moon at a closer distance to the setting Sun, Rashed (2004). Therefore Muslims tried to suggested criteria for the probability of the crescent visibility, Ilyas (1997).

Heliacal rising occurs after a star has been behind the Sun for a season and it is just returning to visibility. There is one morning, just before dawn, when the star suddenly reappears after its absence. On that day it ‘‘blinks’’ on for a moment just before the Sunrise and just before it is then obliterated by the Sun's presence. That special morning is called the star's heliacal rising. Each day that passes after the heliacal rising, the star will appear to rise earlier and remain in the sky longer (that is, not blink) before its soft glow is obliterated by the rising Sun.

Not all stars have heliacal risings because some stars remain above the horizon all the time. Only certain stars rise and flash into existence in the predawn glow of the horizon. Because these helical risings were so specific, just one day, they were

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used by many different ancient civilizations to mark specific events such as the drought season and planting time.

The ancient Egyptians based their calendar on the heliacal rising of Sirius and devised a method of telling the time at night based on the heliacal risings of 36 stars called decan stars (one for each 10° segment of the 360° circle of the zodiac/calendar), (Brittons and Walker, 1969). Sirius was a very important star to the ancient Egyptians, calling it the Star of Isis or the Nile Star. About 5000 years ago, the helical rising of Sirius occurred earlier, around June, 25. When the Egyptians saw Sirius rising just before the Sun they knew it would soon be time for the flooding – inundation – of the Nile River, around which, all Egyptian life was woven. They depended upon the flooding of the Nile for the fertility of their lands.

It was up to the Egyptian priests, who attended to the calendar, to see the first rising of Sirius fall the gem on the statue of Isis at the ancient temple of Isis-Hathor at Denderah, they would announce to the people that the New Year had begun. They also defined the length of lunar months from observing helical rising of the new Moon, Galal (2010).

In 3285 BCE Sirius had replaced Draconis as the star marker of the Summer Solstice and the beginning of the Egyptian New Year.

The Sumerians, the Babylonians, and the ancient Greeks also used the heliacal risings of various stars for the timing of agricultural activities. To the Māori of New Zealand, the Pleiades are called Matariki and their heliacal rising signifies the beginning of the New Year (around June). It is not surprising that the Plains Indians would use heliacal risings to signal the coming and going of the solstice.

In this work we make a trial to study the dependence of helical rising and setting of the new crescent on the time across the year.

Data and analysis

The time lag of the new crescent on the day of conjunction after Sunset is one of the commonly used parameters related to crescent visibility. The time lag of the new crescent after Sunset is the difference between the time of the Moonset and the Sunset.

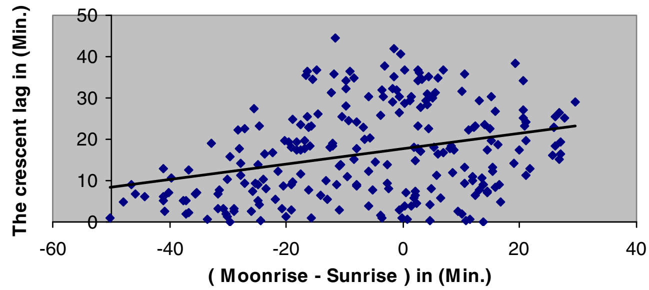

Fig. 1 Relation between the positive value of crescent lag (min) and the value of the (Moonrise–Sunrise) (min).

Studying the behavior of the crescent lag matching the difference between Moonrise and Sunrise for selected time intervals covering a 33 – lunar cycle, starting from 1st January 1976 A.D. to 8th January 2008 A.D. corresponding to the interval from the new Moon of Moharrum 1396 A.H. to the new Moon of Moharrum 1429 Monzur Ahmed (2000) and Nautical Almanac (1976–2008). The data were determined for Cairo, as a selected location, on the day of conjunction.

The study of the value of the (Moonrise–Sunrise) between −20 and 20 min indicates more probability of the crescent visibility due to the prevailing values of the positive crescent lag as seen in Fig. 1. Also from Fig. 1 we can notice that the value of the (Moonrise–Sunrise) less than −40 min cannot be taken as an indicator of the crescent visibility.

The relation between the difference of Moonrise and Sunrise against (+ ve) crescent lag can be represented by the following empirical formula:

$$Y = 0.1861X + 17.756, \text{its correlation coefficient; } R^2 = 0.0966$$

Studying the frequency distribution of the crescent lag across the examined 33-year lunar cycle after Sunset on the day of conjunction shows that the positive crescent lag is more frequently in March, May, June, August, and October and vice

Table 1 The ratio of the monthly frequency distribution of the crescent lag across the 33 – lunar.

The months	The frequency distribution of the positive crescent lag across the 33 – lunar cycles	The ratio of the positive crescent lag across the 33 – lunar cycles (%)	The frequency distribution of the negative crescent lag across the 33 – lunar cycles	The ratio of the negative crescent lag across the 33 – lunar cycles (%)
Jan	15	44.117	19	55.882
Feb	17	54.839	14	45.161
Mar	23	69.697	10	30.303
Apr	18	56.25	14	43.75
May	23	67.647	11	32.353
June	21	63.636	12	36.364
July	19	55.882	15	44.118
Aug	22	66.667	11	33.333
Sep	17	54.839	14	45.161
Oct	22	64.706	12	35.294
Nov	16	50.000	16	50.000
Dec	20	58.824	14	41.176

Table 2 The seasonal frequency distribution of the crescent lag across the 33 – lunar cycles.

Season	The frequency distribution of the positive crescent lag across the 33 – lunar cycles	The ratio of the positive crescent lag across the 33 – lunar cycles (%)	The frequency distribution of the negative crescent lag across the 33 – lunar cycles	The ratio of the negative crescent lag across the 33 – lunar cycles (%)
Spring	62	63.265	36	36.735
Summer	62	63.265	39	38.614
Autumn	55	54.455	43	43.878
Winter	54	54.545	45	45.455

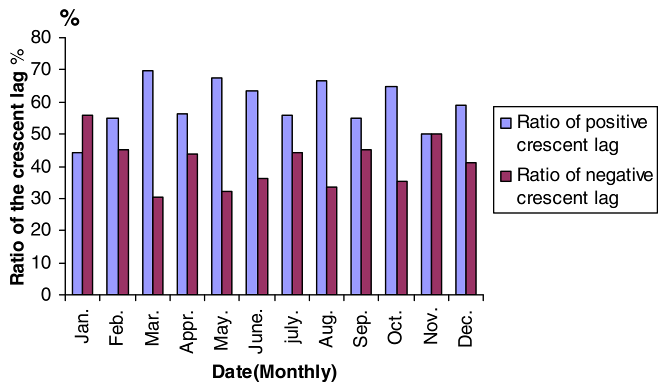

Fig. 2 the ratio of the monthly frequency distribution of the positive and negative crescent lags (min) across the examined 33 – lunar cycles.

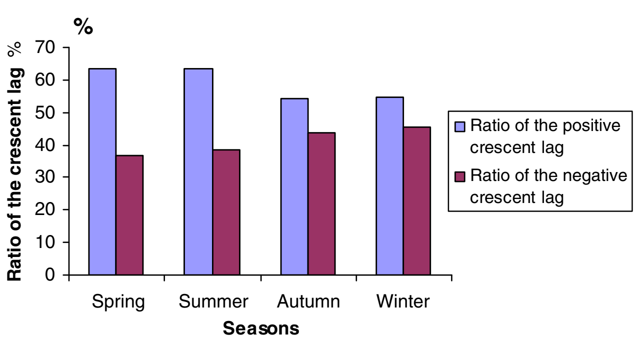

Fig. 3 the ratio of the seasonal frequency distribution of the positive and negative crescent lags (min) across the examined 33 – lunar cycles.

versa for the negative crescent lag as shown in Table 1. Investigating the ratio of the monthly frequency of positive crescent lag across the examined lunar cycle shows that the higher values occurs in March, May, June, August, and October, while the lower value occurs in January and vice versa for the values of the negative crescent lag as seen in Table 1 and Fig. 2.

Also investigation of the ratio of the seasonal frequency distribution of the positive values of the crescent lag across the examined lunar cycle after Sunset on the day of conjunction shows that the higher values occurs in spring and summer. While the distribution of the higher negative values occurs in autumn and winter as seen in Table 2 and Fig. 3.

Conclusions

The study reveals obvious dependence of the crescent duration on the interval of its helical rising with respect to the Sun. Generally the positive crescent lag occurs at values of helical rising ranging from −20 to 20 min, with a maximum frequency at the 0-value. The scatter of the points on the graph may be attributed to the effect of the variation of Sun's declination across the year. This explanation the seasonal behaviour of the crescent helical rising and its impact to the crescent duration after sunset on the day of conjunction.

The seasonal variations illustrate the prevailing of the (+ ve) crescent lag during spring and summer.

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