The Full Moon transit at the Obelisk of Augustus' meridian line on 15 november 2024

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Abstract The Full Moon of November 15th has been observed thorough the Rome's Augustus Obelisk, on the meridian line. The transit occurred at 23:54 local time, while the Full Moon (ecliptic, geocentric) was at 22:48, then geometrical phase of the Moon was almost 100%. The meridian line of the Obelisk was calibrated in August 2006, and this was the first measurement realized after years of unavailability of the instrument.

Sommario Il transito meridiano della Luna piena del 15 novembre 2024 è stata osservato alla Meridiana dell'Obelisco di Augusto in Campo Marzio a Roma. Ricollocato da Pio VI nel 1792 davanti al palazzo di Montecitorio, nel 1998 è stata tracciata la linea meridiana. Tra l'8 ed il 13 Agosto 2006 ho verificato l'allineamento della linea meridiana con la fessura nella sfera bronzea, posta sopra l'obelisco, con i transiti solari. Questi erano misurati sempre entro ±2 s dalle effemeridi. La meridiana, in tutti questi anni 2006-2024, non è mai stata accessibile né di giorno né di notte, poiché è davanti all'ingresso principale della Camera dei Deputati. Il transito meridiano lunare del 15 novembre 2024 è stato ripreso per caso, ed è avvenuto con la Luna esattamente in opposizione al Sole. Nel testo si discute della fase lunare, dell'accuratezza della misura del tempo del transito, della circolarità della Luna piena e del confronto con il transito solare dello stesso giorno.

Keywords: Full Moon, Meridian Transit, Geometrical Phase.

Introduction: the Full Moon is a geocentric event, with the Moon ecliptic longitude $\lambda=\lambda\odot+180°$. This corresponds to the maximum geometric phase, which is 100% only in total central lunar eclipses, when also the ecliptic latitude is $\beta=\beta\odot=0$. The illumination of the lunar disk was calculated as 99.9%, because the Moon had $\beta=+3°34'$, and then the Southern limb of the Moon was in shadow. Some craters were visible on the Southern limb, and I photographed them 5 hours later (fig. 1). The symmetry East-West was complete, for the angular resolution achievable with the transit observation.

Accuracy of the timing The video record of the transit was realized on the meridian line, holding by hands the smartphone. The better timing accuracy achievable is ±1s,

which is about ±15'' of angular accuracy.



Fig. 1 The photo of the Moon on 16 Nov 2024 at 4:03:50 UTC, 6¼ hours after the ecliptic opposition, with some craters visible on the South West part (the lower part of this photo, below the Tycho crater, with the spikes radiating from it).

Lunar phase angle the transit occurred 1 hour after the Full Moon phase. The lunar orbit determined a geometrical phase of Φ=360°/29.5/24=0.51°, which corresponds to cos(Φ)=0.99996 of projected rotation of the phase. Multiplying by the diameter of the Moon (33'33''=2013'' at perigee as well) the illuminated diameter of the Moon was 2012.92'', with an invisible phase shadow at the limb. Then the Moon was symmetric with

respect to its center of the figure, within an arcsecond, which is a normal condition for the Sun, but it never happens for the Moon excepted within a few hours (about 4) within the opposition ($\lambda=\lambda\odot+180°$).

The sphere on the Obelisk the Moon was observed through the rectangular opening realized by Giovanni Antinori in 1792, on the bronze sphere located on the top of the Obelisk, to follow the original project of the mathematicus Facundus Novius for the Augustus' Obelisk transported in Rome from Egypt (10 BC). When the Obelisk was found in 1434, it was ruined since about 5 centuries, splitted into three main parts, and buried by the periodical floods of the river Tiber. Only in 1748 it was extracted from the ground and in 1792 restaured and recollocated. The indications of Pliny the Elder in the 36th book of the Naturalis Historia were followed to restore also the astronomical function of the Obelisk, and the sphere was there added. The idea of realizing a rectangular opening in the sphere was of Giovanni Antinori.

This opening was intended to produce a sort of solar pinhole's image for a more accurate reading of the meridian line. The Moon is not enough bright to produce an image visible in the artificially illuminated night of the modern Rome.

Transit observation video recorded for the above reasons the video was made to the direct light of the Moon through the rectangular opening, as seen as standing on the meridian line at the extreme Cancer's solstice. In the video the ingress and the egress of the lunar light in the rectangular opening is measurable (at the same intensity level) and the instant of the transit is the average time between these two events.

It has been found as 23:54:08±2 s with a very good agreement with the lunar ephemerides for that location of Rome (Piazza di Montecitorio). Video at https://youtu.be/aWnoLL9lWEY

Lunar transit and topocentric opposition the meridian transit

of the Sun occurred, for the same location, at 11:54:44. If the Moon would have been in opposition of the Sun at the moment of the transit, it would have been occurred with the Sun at the lower transit. The true solar day was 24 h 12 s, so half of it was 12h 6 s. The local true midnight was 23:54:50, 42 seconds after the Moon transit. So the Moon was 42 km Westward from the topocentric opposition to the Sun, at the transit time, travelling at 1 km/s on its orbit. The Full Moon is calculated in the ecliptic geocentric coordinates; the Moon was moving at 26'/h in longitude and +4.5'/h in latitude and the following figure shows the anti-Sun at the meridian and the instant of the ecliptic conjunction, occurred about 1.5 h before.



Fig. 2 The anti-Sun at the meridian of Rome on 15 Nov 2024, and the Moon beyond it. In green the lunar orbit, in red the ecliptic coordinates, thin blue the altazimuth coordinates.

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