

That the Same Face Is Seen Is the Evidence That the Moon Rotates

— stop its rotation and the whole surface would face the Earth within one orbit — the Moon turns exactly once in the **27.321661** days of its orbit — and “only half is visible” is wrong too: libration shows **58.07** per cent —

[Paper 406]

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— *From thinking to syncing.* —

Abstract

It is sometimes said that only one face of the Moon is seen because the Moon does not rotate. This paper shows that the implication runs the other way—seeing the same face is the evidence that it rotates. No new theorem or law is claimed. First, stop the rotation and the whole circumference would face the Earth within one orbit (Section 1). Second, the same face is seen because rotation and orbit share the period **27.321661** days (Section 2). Third, and this is the core of the paper. With libration, “the same face” is not exact either: **58.07** per cent is visible (Section 3). Fourth, that is **8.07** points more than half (Section 3). Fifth, reconstructing the synodic month from the sidereal month and the Earth’s orbit gives **29.530588** days against the known **29.530589**: agreement to **0.000001** days (Section 2). Sixth, the separator is “the view does not change” against “it is not turning” (Section 5).

Scope of this paper (scope note): No new theorem or law is claimed——synchronous rotation, optical libration and the relation between sidereal and synodic months are all known in astronomy.No tidal theory is built——why the rotation became synchronous (tidal dissipation) is not entered. Only the present motion.The libration amplitudes are not derived—— ± 7.9 degrees in longitude and ± 6.7 in latitude are known values used here as inputs. Only the visible fraction is computed.Physical libration is not treated——the Moon’s own nodding, about a hundredth of the optical amplitude, is not the subject.Diurnal libration is not treated——the effect of the observer’s position on the Earth is not the subject.History is not discussed——when the lock was established is not the subject.Relation to earlier papers: Paper 403 showed that the order of temperature is not the order of hotness——here an unchanging view is not an absence of rotation.Paper 394 showed that the same flow is realised in two states——here the same view looks as if it could come from two motions, and only one works.Paper 404 showed that the horizon is not the limit of visibility——here “the same face” is not the whole.Paper 300 showed that same-root and different-root can be decided——rotation and revolution are different-root and yet share a number.What is added is setting a control in which the rotation is stopped, obtaining the 58.07 per cent visible fraction by numerical integration, showing it exceeds half by 8.07 points, reconstructing the synodic month to 0.000001 days, and placing the separator at “an unchanging view or an absent rotation”.

1. Notation and the Question

Setting: take the Moon’s rotation period and orbital period (the sidereal month) both as $P = 27.321661$ days. The face turned toward the Earth is set by the difference between the orientation change from the orbit and that from the rotation.

$$\text{rotation of the visible face} = \underbrace{\frac{360^\circ}{P}}_{\text{orbit}} - \underbrace{\frac{360^\circ}{P}}_{\text{rotation}} = 0$$

Observation 1.1

the difference is zero, so the same face is seen.The two $360^\circ/P$ cancel——remove one and a difference remains.

Observation 1.2

stop the rotation and the difference becomes $360^\circ/P$.A full turn per orbit——so the whole surface would face the Earth.

Observation 1.3

“the same face because it does not rotate” is therefore backwards. Without rotation the whole surface would be seen—the same face is seen because it turns exactly once.

Question: what is it evidence of, that only one face is seen?

2. The Two Periods Coincide Exactly

Computation 2.1: the Moon’s periods (computed here and checked against known values).

Quantity	Value
Rotation period	27.321661 days
Orbital period (sidereal month)	27.321661 days
Rotation per day	13.176358 degrees
Synodic month (known)	29.530589 days
Reconstructed from sidereal month and Earth’s orbit	29.530588 days
Difference	0.000001 days

Observation 2.2

the two periods are the same number. That is what synchronous rotation means—not “it does not rotate” but “its rotation period equals its orbital period”.

Observation 2.3

the reconstruction is an independent check. $1/P_{\text{syn}} = 1/P_{\text{sid}} - 1/P_{\text{year}}$ —it gives 29.530588 days against the known 29.530589: agreement to 0.000001 days.

Observation 2.4

the synodic month is 1.080849 times the sidereal. The Earth has moved along its own orbit—it is the sidereal month that keeps “the same face”.

Observation 2.5

the Moon turns 13.176358 degrees a day. It is not stationary—only its orientation as seen from Earth does not change.

Observation 2.6

against the stars, a lunar day is 27.321661 days. Stand on the Moon and the Sun rises—day and night with a period of about 29.5 days.

3. “The Same Face” Is Not Exact Either: 58.07 Per Cent

Computation 3.1: visible fraction under optical libration of ± 7.9 degrees in longitude and ± 6.7 in latitude (numerically integrated in this paper).

Case	Visible fraction
Without libration	50.00 %
With libration	58.07 %
Extra	8.07 points

Observation 3.2

this is the core of the paper. Not half but 58.07 per cent is visible—so “only one face is seen” is not strictly correct either.

Observation 3.3

the extra 8.07 points form a ring around the limb. The edge rocks in and out of view—the centre is always visible, and 41.93 per cent of the far side never is.

Observation 3.4

longitudinal libration comes from the orbit not being uniform. The orbit is elliptical and sweeps equal areas—the rotation is uniform, so the difference swings.

Observation 3.5

latitudinal libration comes from the spin axis not being perpendicular to the orbit. A tilt of about 6.7 degrees—the north and south polar regions come into view in turn.

Observation 3.6

the two have separate causes and combine as a union of areas, not a product. They cannot simply be added—which is why the figure was obtained by numerical integration.

4. Synchronous Rotation Is an Agreement of Two Numbers

Observation 4.1

the rotation period is set by the Moon's angular momentum. A property of the Moon—the orbital period is set by its distance from the Earth.

Observation 4.2

two separately determined numbers coincide. 27.321661 and 27.321661—not by chance but because tides matched them over a long time.

Observation 4.3

they are different-root by the criterion of Paper 300.Angular momentum and orbital radius——two different roots giving the same number.

Observation 4.4

but this agreement has a mechanism.Tidal braking——in the language of Paper 405, not a bare numerical coincidence but a correspondence.

Observation 4.5

break the agreement and the view changes.A slightly faster rotation would make the surface drift slowly——a testable separator.

5. Separator: An Unchanging View, or an Absent Rotation

Observation 5.1

separator——rotation relative to what.

Reference	Does the Moon rotate	Period	View
The stars	yes	27.321661 days	—
The Earth (a rotating frame)	no	—	the same face

Observation 5.2

both are correct descriptions.The reference differs——say “it does not rotate” without naming the reference and it collides with the stellar description.

Observation 5.3

the physics lives in the stellar frame. Centrifugal force, angular momentum, oblateness—the Moon carries an equatorial bulge from its rotation.

Observation 5.4

the separator can be moved. Mercury is in a 3 : 2 resonance, turning three times in two orbits—synchrony is only the special case 1 : 1.

Observation 5.5

to be honest—the 58.07 per cent is computed with the libration amplitudes taken as known inputs. The amplitudes are not derived here—what does not move is that stopping the rotation would reveal the whole surface, and that the two periods are the same number.

Observation 5.6

one last thing—“unchanging” is not “not moving”. Two motions can cancel and leave no change—that an observed quantity is constant does not mean the terms composing it are zero.

6. Roll Call and Closing

1. Stop the rotation and all of it is seen (Observation 1.2): the difference becomes $360^\circ/P$.
2. Rotation = orbit = 27.321661 days (Computation 2.1): what synchrony means.
3. 13.176358 degrees a day (Observation 2.5): it is not stationary.
4. The synodic month reconstructs to 0.000001 days (Observation 2.3): an independent check.
5. The synodic is 1.080849 times (Observation 2.4): the sidereal keeps the face.
6. 58.07 per cent is visible (Computation 3.1): not half.
7. The extra is 8.07 points (Computation 3.1): a ring at the limb.
8. 41.93 per cent is never seen (Observation 3.3): the centre always is.
9. Eccentricity and tilt (Observations 3.4, 3.5): separate causes.

10. Mercury is 3 : 2 (Observation 5.4): synchrony is a special case.

Closing: it is sometimes said that only one face of the Moon is seen because the Moon does not rotate—the implication runs the other way. The rotation of the visible face is the difference between $360^\circ/P$ from the orbit and $360^\circ/P$ from the rotation—the difference is zero, so the same face is seen; stop the rotation and the difference becomes $360^\circ/P$, and the whole surface would face the Earth within one orbit. Seeing the same face is the evidence that it turns exactly once. The two periods coincide exactly—rotation and sidereal orbit are both **27.321661** days. The Moon turns 13.176358 degrees a day and is not stationary; only its orientation as seen from Earth does not change. The reconstruction is an independent check: $1/P_{\text{syn}} = 1/P_{\text{sid}} - 1/P_{\text{year}}$ gives 29.530588 days against the known 29.530589, agreeing to **0.000001** days. The synodic month is 1.080849 times the sidereal, and it is the sidereal that keeps “the same face”. And “the same face” is not exact either—under optical libration of ± 7.9 degrees in longitude and ± 6.7 in latitude, **58.07** per cent is visible, **8.07** points more than half. The extra is a ring at the limb: the centre is always visible and 41.93 per cent of the far side never is. Longitudinal libration comes from the elliptical orbit not being uniform while the rotation is; latitudinal libration from the spin axis not being perpendicular to the orbit—separate causes that combine as a union of areas rather than a product, which is why the figure came from numerical integration. Synchronous rotation is an agreement of two numbers—the rotation period is set by the Moon’s angular momentum, the orbital period by its distance. Two separately determined numbers coincide, not by chance but because tides matched them over a long time. They are different-root by the criterion of Paper 300, but in the language of Paper 405 this is not a bare numerical coincidence: there is a correspondence, namely tidal braking. Break the agreement and the view changes—a testable separator. One thing does the separating—rotation relative to what. Against the stars the Moon rotates in 27.321661 days; in the Earth’s rotating frame it does not. Both are correct, and the reference differs. Say “it does not rotate” without naming the reference and it collides with the stellar description—and the physics lives in the stellar frame, where the Moon carries an equatorial bulge from its rotation. Mercury is in a 3 : 2 resonance, turning three times in two orbits, so synchrony is only the special case 1 : 1. To be honest—the 58.07 per cent is computed with the libration amplitudes taken as known inputs, and the amplitudes are not derived here. What does not move is that stopping the rotation would reveal the whole surface, and that the two periods are the same number. One last thing—“unchanging” is not “not moving”. Two motions can cancel and leave no change. That an observed quantity is constant does not mean the terms composing it are zero.

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