What Narrows the Origin of the Moon Is Not Composition but One Quantity That Cannot Be Changed

— Of the angular momentum of the Earth-Moon system, the Moon's orbit carries **0.830144** and the Earth's spin only **0.169850** — the separator is whether a quantity can be changed afterwards or not — [Paper 686]

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— *From thinking to syncing.* —

Abstract

Discussions of the Moon's origin start from isotope ratios. But what narrows the hypotheses hardest is not composition; it is a conserved quantity.What weighs how much is counted here from the balance sheet.No new theorem or law is claimed. First, and this is the core. Almost all of the system's angular momentum sits in the Moon's orbit——the orbit holds 0.830144, the Earth's spin 0.169850 and the Moon's own spin less than 10^{-5} (Section 2). **Second, that division does not resemble the division of mass——the Moon is 0.012300 of the Earth by mass yet carries 0.830144 of the angular momentum, which is 67.4896 times as much per unit mass** (Section 2). **Third, returning all of it to the Earth makes the day four hours——put into the spin alone, the total gives a day of 4.065259 hours** (Section 3). **Fourth, even so the Earth does not break——the equatorial speed reaches only 0.345804 of the speed at which it would fly apart, so no refutation of the form "too fast to survive" is available** (Section 3). **Fifth, what narrows is therefore not size but invariance——composition can be exchanged afterwards; angular momentum cannot, so any account of the origin must bring this number with it from the start** (Section 3). **Sixth, the separator is whether a quantity can be changed afterwards or not——the same piece of "evidence" constrains differently according to whether it is conserved** (Section 4). **Keywords**: angular momentum, conserved quantity, origin of the Moon, giant impact, Earth's rotation, strength of evidence.

Scope of this paper (scope note): **No new theorem or law is claimed——the angular momentum of the Earth-Moon system, the giant-impact account and the tidal recession of the Moon are all standard (Canup and Asphaug 2001, Murray and Dermott 1999).No impact is computed——the mass and angle of an impactor are not derived; only the balance of a conserved quantity is examined.Isotope ratios are not entered——what it means that oxygen and titanium ratios match the Earth is not treated.Hypotheses are not scored individually——capture, fission and co-accretion are not judged one by one; only the condition imposed by a conserved quantity is stated.No time evolution is followed——the tidal recession of the Moon and the slowing of the Earth's spin are not treated; only today's division and the case of returning all of it are compared.Relation to earlier papers**: **Paper 522 showed that there are three ways of doing no work and that the zero sits in a different place in each——there the meanings of a zero were separated; here it is not a zero but an invariance that does the work. Both separate cases in which one form of an equation says different things.**What is added is **dividing the angular momentum into three parts**, **putting the per-mass ratio at $\mathbf{67.4896}$**, **giving the day of $\mathbf{4.065259}$ hours that returning all of it would make**, **showing with $\mathbf{0.345804}$ that even then nothing breaks**, and **placing the separator on whether a quantity can be changed afterwards**.

1. Notation and the Question

Setting: **divide the angular momentum of the Earth-Moon system into the Moon's orbit, the Earth's spin and the Moon's spin.**

$$L_{\text{orbit}} = \mu\sqrt{G(M_\oplus + M_{\text{Moon}})a}, \qquad L_{\text{spin}} = kM_\oplus R_\oplus^2\omega, \qquad \mu = \frac{M_\oplus M_{\text{Moon}}}{M_\oplus + M_{\text{Moon}}}$$

Take $k = 0.3308$, $a = 3.84399 \times 10^8$ m, and ω from the sidereal day.

Question: **which quantity narrows the hypotheses on the Moon's origin hardest?**

2. The Angular Momentum Is Not Where the Mass Is

Computation 2.1: **the three contributions were derived.**

component	angular momentum	share
Moon's orbit	$\mathbf{2.857968 \times 10^{34}}$	$\mathbf{0.830144}$
Earth's spin	$\mathbf{5.847478 \times 10^{33}}$	$\mathbf{0.169850}$
Moon's spin	$\mathbf{2.360856 \times 10^{29}}$	below $\mathbf{10^{-5}}$
total	$\mathbf{3.442740 \times 10^{34}}$	$\mathbf{1}$

All in kg m^2/s. The first two together are 0.99999314 of the whole.

> **Observation 2.2**
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> this is the core: almost all of what turns in this system has been carried off by the Moon.The Moon is 0.012300 of the Earth by mass yet carries 0.830144 of the angular momentum——that is 67.4896 times as much per unit mass, and an eye on mass alone never sees this division.

> **Observation 2.3**
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> the reason is that distance counts.Orbital angular momentum carries a factor $\sqrt{a}$, and the Moon sits at sixty Earth radii——a small mass far away can hold a large angular momentum.

3. Returned to the Earth, the Day Is Four Hours

Computation 3.1: putting the total into the Earth's spin gives a day of 4.065259 hours. The equatorial speed is then 2735.2481 m/s, which is 0.345804 of the 7909.8133 m/s at which the Earth would fly apart.

> **Observation 3.2**
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> this computation kills no hypothesis.An Earth with a four-hour day is not close to breaking up——no refutation of the form "such a division is impossible because it spins too fast" is available. What can be used is invariance, not size.

> **Observation 3.3**
>
> being conserved is what makes it strong evidence.Composition can be altered afterwards by exchanging material; angular momentum cannot be altered without an external torque——so any account of the origin must arrive already carrying 3.442740×10^{34} kg m^2/s.

Observation 3.4

the condition reduces to one number.Every hypothesis must answer why this much angular momentum is present, and failing that, no amount of agreement elsewhere suffices——this is not evidence that is hard to find but evidence that is hard to escape.

4. The Separator

Observation 4.1

the separator is whether a quantity can be changed afterwards or not.A changeable quantity leaves a hypothesis room to say that something happened later; an unchangeable one does not——the strength of evidence is set not by the size of a quantity but by the rule it obeys.

Observation 4.2

beside Paper 522.Paper 522 showed that there are three ways of doing no work and that the zero sits in a different place in each——there one zero said three different things; here one piece of evidence has different strength according to whether it is conserved. The same form of an equation means different things according to what binds it.

Observation 4.3

what is not said.Neither impact calculations nor isotope ratios are treated, and no hypothesis is scored——what is shown is that the condition imposed by a conserved quantity reduces to one number.

5. Roll Call and Closing

1. **orbit holds `0.830144`** (Computation 2.1): **the core.**
2. **spin holds `0.169850`** (Computation 2.1): **the remainder.**
3. **together `0.99999314`** (Computation 2.1): **the Moon’s spin is negligible.**
4. **Moon is `0.012300` by mass** (Observation 2.2): **small in mass.**

5. **67.4896 times per unit mass** (Observation 2.2): **the divisions differ.**
6. **distance enters as $\sqrt{a}$** (Observation 2.3): **being far carries it.**
7. **a day of 4.065259 hours** (Computation 3.1): **short.**
8. **0.345804 of the breakup speed** (Computation 3.1): **nothing breaks.**
9. **total 3.442740×10^{34} kg m^2/s** (Observation 3.3): **required from the start.**
10. **changeable or not** (Observation 4.1): **the separator; Paper 522.**

Closing: **What narrows the origin of the Moon is not composition but one quantity that cannot be changed.Of the angular momentum of the Earth-Moon system, the Moon's orbit carries 0.830144 and the Earth's spin only 0.169850.The Moon is 0.012300 of the Earth by mass yet carries four fifths of the angular momentum, 67.4896 times as much per unit mass——distance enters as $\sqrt{a}$, so a small mass far away can hold a great deal.Returning all of it to the Earth's spin gives a day of 4.065259 hours, and even then the equatorial speed is only 0.345804 of the breakup speed——so this computation offers no refutation of the form "too fast to survive".What does the work is invariance, not size: composition can be exchanged afterwards and angular momentum cannot.The separator is whether a quantity can be changed afterwards or not.Placed among the earlier papers——Paper 522 separated three meanings of one zero; here one piece of evidence changes strength according to whether it is conserved.To be honest——neither impact calculations nor isotope ratios are treated, and no hypothesis is scored.**

References

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