Earth: Day Zero — Paper IV

The Earth–Moon Alternator

A Minimal Tidal-to-Dynamo Coupling Test

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Frozen Canonical Version v1.0

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Abstract

Frozen Papers I–III established the sequence of questions leading into this paper. Paper I defined the Antarctic Entrance → Hawai'i/Mauna Kea Middle Mountain → Arctic Exit geometry; Paper II asked whether one planetary event could generate those Earth-side responses while leaving a coherent Earth; Paper III asked whether material from the Arctic-exit branch could remain with Earth and later become the Moon. [1–3]

Paper IV asks the next question in deliberately minimal form: **once a Moon exists, does the Earth–Moon pair become a long-lived coupled dynamical system capable of influencing planetary magnetic evolution?**

The term *alternator* is used as an analogy, not as a claim that Earth and Moon form a literal electrical circuit. The established coupling is mechanical: lunar tides exchange angular momentum between Earth's spin and the Moon's orbit, slowing Earth and driving lunar recession over time. [5–7] Magnetic-field generation is a separate physical process produced by motion in electrically conducting planetary cores. [9, 10]

The stronger Day Zero hypothesis is therefore modular. A newly formed, initially close Moon may have supplied unusually strong tidal forcing to the early Earth; such forcing can drive fluid motions and turbulence in rotating cores and has been investigated as a possible contributor to ancient dynamo action. [9, 12] Similar mechanically forced dynamo mechanisms have also been proposed for the early Moon. [17, 18] These published mechanisms establish physical admissibility of the component processes, not proof of a unified Day Zero alternator.

Paper IV does not require the Moon to possess a long-lived global magnetic field. Modern single-crystal paleomagnetic work argues strongly against a sustained lunar paleomagnetosphere through most lunar history and may limit any core dynamo to the Moon's earliest interval. [20, 21] Nor does Paper IV require Day Zero to create Earth's first-ever magnetic field from zero: evidence for a Hadean geodynamo near 4.2–4.0 Ga has been reported, but its interpretation remains contested. [13–15]

In the author's preferred shorthand, Day Zero may have *jump-started* Earth's magnetic system. In this paper, *jump-started* is an umbrella term for a major post-event dynamo transition—onset, reset, strengthening, or renewed sustainment—and does not require that electromagnetism or Earth's first-ever field began from zero at Day Zero.

Paper IV therefore separates two layers. The **mechanical alternator**—tidal exchange of energy and angular momentum—is established physics. The **magnetic consequence**—a non-negligible contribution from that forcing to dynamo-relevant core motion—is the unresolved Day Zero claim. Origin-of-life chemistry, atmospheric evolution, ultraviolet shielding, oxygen production, and the proposed immediate post-impact electrical-discharge state are outside this paper.

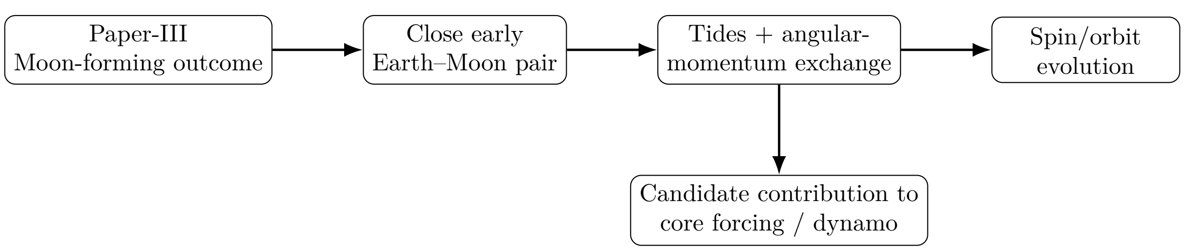

Figure 1: Minimal Paper-IV logic. The mechanically established Earth–Moon coupling is separated from the stronger magnetic claim. The alternator hypothesis asks whether early tidal forcing materially contributed to dynamo-relevant core motion; it does not assume a literal electrical circuit or a permanently magnetized Moon.

1. Research Status and Scope

The Moon is now assumed to exist. This paper asks what kind of coupled Earth–Moon system that new Moon creates.

Paper IV inherits the frozen outputs of Papers I–III without reopening their geometry, impact mechanics, or lunar mass-transfer branch. [1–3] The selected sequence is

$$\begin{aligned}\text{Day Zero event} &\to \text{Moon-forming outcome} \to \text{close Earth–Moon pair}\\ &\to \text{tidal coupling} \to \text{spin/orbit evolution}\\ &\to \text{possible magnetic consequence.}\end{aligned}$$

The final arrow is the only new scientific burden in this paper. The first four are either inherited from earlier Day Zero papers or established components of celestial mechanics.

The canonical claim is not that the Moon alone powers Earth's magnetic field. It is narrower:

> **The newly formed Earth–Moon pair may have functioned as a persistent coupled dynamical system in which lunar tidal forcing contributed to the fluid motions and energy budget relevant to early planetary magnetic evolution.**

That wording permits ordinary thermochemical convection to remain the dominant geodynamo source. Contemporary reviews still regard convection as the leading explanation for the long-lived terrestrial dynamo, while recognizing that tides could have been dynamically important on the faster-spinning early Earth. [9]

2. The Two-Layer Alternator Claim

The Earth–Moon pair is unquestionably mechanically coupled. The new question is whether that mechanical coupling also mattered to Earth's magnetic evolution.

The word *alternator* is an analogy for a coupled system that continually exchanges mechanical energy and angular momentum while magnetic fields are generated inside moving conductive cores. It is not a claim that Earth and Moon are connected by a wire, share one permanent magnetic field, or pass a required electric current directly between them.

Paper IV separates the claim into two layers:

Layer	**Question**	**Status**
Mechanical alternator	Does the Earth–Moon pair exchange angular momentum and dissipate mechanical energy through tides?	Established physics
Magnetic consequence	Does some of that mechanically available forcing reach the terrestrial core strongly enough to contribute materially to dynamo-relevant motion?	Day Zero hypothesis

Table 1: The two-layer Paper-IV claim. The first layer does not require Day Zero. The second is the actual new burden.

2.1 The Alternator in One Chain

The whole hypothesis can be stated in one line: a close Moon strengthens tides; some of that forcing may reach Earth's core; that extra motion may matter to magnetic evolution.

The canonical chain is

close Moon → strong tidal coupling
→ core-coupled mechanical forcing → possible dynamo contribution.

The first step is ordinary Earth–Moon mechanics. The final two steps contain the Paper-IV uncertainty. Mechanically forced dynamo processes are physically developed in terrestrial and lunar contexts, so the proposed coupling is not a new category of physics. [9, 12, 17, 18] Those studies do not establish the Day Zero common-cause system, and Paper IV does not require lunar forcing to dominate Earth's geodynamo. It asks only whether the post-Paper-III Earth–Moon state makes the contribution physically non-negligible.

3. The Mechanical Coupling Is the Firmest Layer

Before discussing magnetism, we start with the part nobody needs Day Zero to invent: Earth and Moon already exchange angular momentum through tides.

Let Earth's spin angular momentum be L_{E} and the Moon's orbital angular momentum be L_{orb}. In a stripped-down two-body accounting, an internal tidal torque τ transfers angular momentum approximately as

$$\frac{dL_{\mathrm{E}}}{dt} \approx -\tau, \qquad \frac{dL_{\mathrm{orb}}}{dt} \approx +\tau,$$

with additional solar torques and dissipative complexities entering a full model. The opposite signs capture the basic exchange: Earth spins down while the Moon's orbit expands. [5–7]

This establishes an available mechanical forcing channel only. It does not by itself show that appreciable tidal power reaches Earth's core.

The corresponding mechanical power available to be dissipated within the coupled system is schematically

$$P_{\mathrm{tide}} \sim \tau \left(\Omega_{\mathrm{E}} - n\right),$$

where Ω_{E} is Earth's spin frequency and n is the Moon's orbital mean motion. This is not a new Day Zero equation; it is only the simplest way to show why a closer Moon and faster-spinning Earth can imply a much stronger tidal environment than the modern one.

Reconstructions of the early Earth–Moon distance remain model-dependent because dissipation changes with ocean depth, mantle state, rotation, resonance structure, and the presence or absence of a magma ocean. [6, 8] Paper IV therefore does not freeze a unique early lunar distance or tidal power.

4. Earth-Side Magnetic Burden

Earth's field comes from moving conductive liquid in the core. The alternator question is whether the new Moon supplied a meaningful extra mechanical push to that motion.

Earth's magnetic field is generated by fluid motion in its electrically conducting outer core. Long-term geodynamo maintenance is usually modeled through thermal and compositional convection, and that remains the leading conventional explanation. [9,11]

The Day Zero alternator adds only a possible forcing channel. A close Moon produces tidal deformation; tidal deformation interacting with differential rotation can excite instabilities, waves, and turbulence in rotating fluid interiors. [9,12] A recent dedicated analysis found that lunar tidal forcing could plausibly have been strong enough to trigger turbulence in Earth's core during part of early Earth history and possibly contribute to dynamo action, while also finding modeled regimes in which tides were too weak by themselves to reproduce paleomagnetic field amplitudes. [12]

The diagnostic bookkeeping must therefore distinguish the total mechanical tidal power from the smaller part, if any, that actually reaches dynamo-relevant core motion. The following expression is schematic rather than a closed geodynamo energy equation:

$$P_{\mathrm{core}} = P_{\mathrm{conv}} + P_{\mathrm{tide}\to\mathrm{core}} + P_{\mathrm{other}}, \qquad 0 \le P_{\mathrm{tide}\to\mathrm{core}} \le P_{\mathrm{tide}}.$$

Paper IV does not prescribe the value of $P_{\mathrm{tide}\to\mathrm{core}}$. It asks whether that contribution is non-negligible in a physically admissible early Earth–Moon state.

For bookkeeping, define a core-coupling fraction

$$\epsilon_{\mathrm{core}} = \frac{P_{\mathrm{tide}\to\mathrm{core}}}{P_{\mathrm{tide}}}, \qquad 0 \le \epsilon_{\mathrm{core}} \le 1.$$

No preferred value is frozen. The calculation must supply or bound ϵ_{core} from physical coupling, rather than choosing it to make the magnetic result work. This single parameter keeps the alternator test simple: first determine the mechanically available tidal power, then determine what fraction can actually reach dynamo-relevant core motion.

4.1 Jump-Start: Onset, Reset, or Amplification

In plain language, Day Zero may have "jump-started" Earth's magnetic system. That can mean starting, resetting, strengthening, or prolonging dynamo activity; it does not require a field to begin from absolute zero.

The developmental Day Zero archive sometimes framed the event as a strong dynamo-forcing transition. [4] The canonical paper keeps the chronology open. Hadean zircon paleomagnetism has been interpreted as evidence for a substantial geomagnetic field as early as approximately 4.2 Ga, while other detailed analyses challenge whether those zircons preserve primary Hadean magnetic signals. [13–15]

Paper IV therefore uses *jump-start* as a compact umbrella term while leaving the detailed chronology open. The physically distinct variants remain **onset**, **reset**, or **amplification/sustainment**. Their common test is the same: did the Day Zero event and the newly created Earth–Moon coupling add physically meaningful forcing to terrestrial magnetic evolution?

5. The Moon Need Not Remain Magnetized

The alternator does not require a permanently magnetic Moon. The Moon can contribute mechanically even if its own global dynamo was brief.

Returned lunar materials and crustal magnetic anomalies motivated longstanding proposals for an ancient lunar dynamo, including mechanically forced models tied to precession, tides, and impact-driven rotational changes. [16–19]

More recent paleomagnetic work strongly disfavors a long-lived lunar paleomagnetosphere through most of lunar history and may limit a core dynamo to a comparatively early interval. [20,21] That does not defeat Paper IV because the Moon's required role is primarily mechanical. What would fail is a stronger version demanding that the modern Moon remain globally magnetized as part of the alternator.

6. A Minimal Alternator Test

The calculation can stay small: establish the early tidal forcing, determine how much of it can reach the core, and ask whether that contribution is dynamically meaningful.

Paper IV does not require a four-billion-year magnetohydrodynamic simulation. For a selected post-Paper-III starting state, the minimum calculation needs only four outputs:

1. the early Earth spin, lunar separation, orbital motion, tidal torque, and mechanically available tidal power;
2. a physically justified estimate or bound for ϵ_{core} and therefore $P_{\text{tide}\to\text{core}}$, rather than equating all tidal dissipation with core forcing;
3. whether the resulting terrestrial core response is capable of contributing to dynamo-relevant flow;
4. whether the same coupled evolution remains compatible with Earth–Moon angular momentum, lunar recession, rotation, and available paleomagnetic constraints.

No target percentage is frozen. A viable result may show that lunar forcing is secondary but meaningful. The alternator becomes stronger only if the same admissible Earth–Moon evolution produces a quantitatively defensible terrestrial-core contribution without requiring a separate unsupported electromagnetic circuit.

7. Evidence-Use Rule

Published papers show that the pieces exist. They do not prove that Day Zero assembled those pieces into this particular system.

The literature cited here supports the following component statements:

- Earth–Moon tides exchange angular momentum and alter spin/orbit evolution; [5–7]
- liquid-metal core motion generates planetary dynamo fields; [9,10]

- early terrestrial tidal forcing may have been dynamically strong enough to generate core turbulence and perhaps contribute to a dynamo; [12]
- mechanically forced lunar dynamos have physically developed models; [17, 18]
- both terrestrial Hadean paleomagnetism and the duration of lunar dynamo activity carry significant observational uncertainty. [13, 14, 20, 21]

None of those references independently establishes the Day Zero alternator. The integrated Day Zero claim remains the hypothesis under test.

8. Falsification Architecture

The alternator is allowed to fail without dragging Papers I–III down with it.

Paper IV is modular. The following outcomes would weaken or falsify specific versions of the claim:

F1. Tidal insignificance. If physically admissible early Earth–Moon states robustly yield lunar tidal forcing too weak to alter terrestrial core dynamics at any relevant stage, the dynamo-contribution version of the alternator fails.

F2. Energy inconsistency. If the required $P_{\text{tide}\to\text{core}}$ exceeds the mechanically available P_{tide}, or can be obtained only by assigning an unsupported fraction of tidal dissipation directly to the core, the claimed coupling fails.

F3. Orbital contradiction. If a tidal history strong enough to support the alternator cannot evolve toward observationally admissible Earth–Moon angular momentum, recession, and rotation states, that branch fails.

F4. Magnetic contradiction. If the model requires a long-lived lunar global dynamo or a Hadean terrestrial field history that robust paleomagnetic evidence excludes, that version fails.

F5. Literal-circuit requirement. If the alternator can work only by assuming an unsupported direct electrical current or permanent shared magnetic circuit between Earth and Moon, the canonical Paper-IV hypothesis fails.

A failed Paper-IV alternator does not automatically erase the Paper-I geometry, Paper-II event class, or Paper-III lunar consequence. [1–3]

9. Permitted Paper-IV Verdicts

The most likely early result is not simply yes or no; the mechanical coupling can be established while the magnetic contribution remains unresolved.

The canonical verdict is **MECHANICAL LAYER SUPPORTED / MAGNETIC CONTRIBUTION UNRESOLVED**. Published work makes tidal forcing of early planetary cores physically serious enough to test, but does not yet establish the specific Day Zero common-cause alternator. [9, 12]

Verdict	**Meaning**
Mechanical layer supported	The Earth–Moon tidal/angular-momentum coupling is consistent with established celestial mechanics.
Magnetically admissible	Tidal forcing can reach a regime capable of contributing to dynamo-relevant core motion without violating system constraints.
Alternator supported	One admissible post-Day-Zero evolution yields both the mechanical coupling and a quantitatively meaningful magnetic contribution.
Unresolved	The component physics is admissible, but the required integrated calculation has not yet demonstrated the Day Zero coupling.
Falsified	No admissible Earth–Moon history can provide the claimed magnetic contribution without violating mechanical, energetic, orbital, or paleomagnetic constraints.

Table 2: Permitted Paper-IV verdicts. The mechanical Earth–Moon coupling is much better established than the stronger Day Zero magnetic interpretation.

10. What Paper IV Does Not Establish

This paper stops at Earth–Moon dynamics and magnetic evolution. Everything biological, atmospheric, and immediate-discharge related stays outside.

Paper IV does not establish:

- the origin of life, habitability, atmospheric composition, ultraviolet shielding, or biological oxygen production;
- any "encentropy" or biological-organization mechanism;
- the duration or intensity of an immediate post-Day-Zero plasma/lightning/discharge state;
- that Earth's modern magnetic field is powered primarily by the Moon or that the Moon retained a permanent global field;
- a literal electromagnetic circuit connecting Earth and Moon.

Those exclusions are deliberate. The immediate electromagnetic-reset or high-discharge aftermath is a separate question from the long-lived alternator.

11. Advancement Condition

If the alternator survives, the next paper can ask what the immediate electromagnetic aftermath of Day Zero actually looked like.

Paper IV advances only if a physically admissible post-Paper-III Earth–Moon state produces a coherent tidal history and a non-negligible, quantitatively defensible $P_{\text{tide}\to\text{core}}$ without violating orbital or paleomagnetic constraints.

The advancement question is therefore:

> **Does a newly formed, initially close Moon make the early Earth–Moon pair not merely an orbiting two-body system, but a mechanically coupled system whose tidal energy and angular-momentum exchange could have jump-started, reset, strengthened, or sustained an important stage of planetary magnetic evolution?**

If the answer is yes, the Earth–Moon alternator earns further investigation. The immediate high-temperature plasma, electrical-discharge, atmospheric, and field-reset consequences remain reserved for a separate paper.

Conclusion

Paper IV deliberately reduces the Earth–Moon alternator to a testable core. The Earth and Moon are unquestionably mechanically coupled through tides; that coupling transfers angular momentum, changes terrestrial rotation, and drives lunar recession. Planetary dynamos arise from moving conductive fluids, and published geophysical work shows that strong early tides can, under some conditions, excite core turbulence and perhaps contribute to magnetic-field generation.

The Day Zero extension is therefore neither "the Moon creates Earth's magnetism" nor "Earth and Moon are one electrical circuit." In the paper's shorthand, the event and newly created Earth–Moon pair may have *jump-started* Earth's magnetic system: that is, produced a major onset, reset, strengthening, or sustainment transition in dynamo-relevant core motion. The narrower physical proposition is that the close Moon supplied a persistent mechanical forcing channel and that some calculable part of that forcing reached the terrestrial core strongly enough to matter to magnetic evolution. The hypothesis does not require that lunar forcing dominate the geodynamo; a secondary but physically meaningful contribution is sufficient.

The mechanical layer is established; the magnetic contribution remains unresolved. The alternator now reduces to a bounded tidal-to-core coupling test rather than a metaphor that can absorb any outcome.

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