

The 1.11 Million Year Cycle: A Period Common to Earth's Magnetic Field Polarity and Outer Solar System Dynamics

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Abstract

Geomagnetic polarity reversals are widely held to occur at random, with no periodicity to their timing — a position well supported by over 50 years of statistical analysis. This paper shows that the same reversal record, examined not as a sequence of reversal timings but as the prevailing polarity condition through time, displays a clear periodicity near 1.11 million years. Using the standard 0–30 Ma geomagnetic polarity timescale sampled on a 1000-year grid, a continuous-frequency spectrum reveals twelve dominant cycles between 0.2 and 6 Ma, refined here to five significant figures. Two of the next-strongest peaks relate to the dominant 1.11019 Ma cycle by simple, clean ratios — 0.74013 Ma ($2/3$) and 3.33146 Ma ($3\times$) — each within a tenth of a percent of an exact fit. Independently of this terrestrial result, two distinct mechanisms in the outer solar system yield periods of the same length: the Uranus–Neptune orbital energy exchange, established via numerical integration of the outer planets (the LONGSTOP project), gives 1.119 Myr — a drifting, near-resonant beat; and the Jupiter–Uranus perihelion anti-alignment, a stable secular frequency difference computable directly from measured planetary precession rates, gives 1.107 Myr — a fixed period. All three determinations, from three unrelated physical systems and methods, agree to within a fraction of a percent. The origin of these harmonic relationships, and of the agreement between the terrestrial and planetary figures, is left for future papers.

1. Introduction

The mainstream position on geomagnetic polarity reversals is stated plainly and consistently across the literature: reversals occur at random, with no periodicity to their timing. The U.S. Geological Survey states it in the most direct terms available to the public: "These reversals are random with no apparent periodicity to their occurrence" [7]. The British Geological Survey concurs: "Reversals are not predictable and are certainly not periodic in nature. Hence we can only speak about the average reversal interval" [8].

This position is not merely a popular simplification — it has a solid academic pedigree going back to Allan Cox's foundational 1968 analysis, which modeled the lengths of geomagnetic polarity intervals as arising from a Poisson (memoryless, random) process [1]. Subsequent work refined the statistical model — noting the true distribution has somewhat fewer very-short intervals than a pure Poisson process would predict, and is better described by a gamma renewal process [2] — but the underlying conclusion has held for over half a century: whatever governs when the field flips, it does not do so on a fixed clock. Constable [4] and McElhinny & McFadden [5] are standard references for the modern form of this statistical argument.

This is correct. If the question asked of the data is "when does the next reversal happen, given the last one," the honest answer from over 50 years of analysis is: not predictably. But this is not the only question worth asking of the same data. The standard position concerns the timing of events — the discrete moments the field flips. It says nothing about the prevailing polarity condition — which state, normal or reversed, dominates at any given moment, integrated over the unequal and highly variable lengths of the intervals between flips. This paper shows that the geomagnetic reversal record displays precisely that: no periodicity in reversal timing, but a clear and repeatable periodicity in the resulting polarity condition, near 1.11 million years, with a family of harmonically related periods around it.

The paper then asks a second, independent question: does a period of similar length appear anywhere in the dynamics of the solar system itself, arrived at without any reference to Earth's magnetic field? Two such periods are identified, from two distinct physical mechanisms — the Uranus–Neptune orbital energy exchange (a drifting, near-resonant beat) and the Jupiter–Uranus perihelion anti-alignment (a fixed secular frequency difference). Both sit within a fraction of a percent of the geomagnetic figure, and of each other. The explanation for why these independent timescales agree so closely is left for a future paper.

Some hint that the reversal record itself is not purely featureless is not without precedent in the mainstream literature either — Lowrie [2] notes "the rate of reversals since the Late Cretaceous shows a steady increase on which a cyclical variation appears to be superposed," and an earlier review by the same author [3] identifies this more specifically as a roughly 30-million-year cyclicity with a more distinctive 15-million-year harmonic in reversal rate, distinct from the "random timing" conclusion drawn about intervals themselves. The present paper follows this same distinction — periodicity is present, but visible only once the data is framed as the prevailing polarity tracked through time, not merely a sequence of instantaneous events. The geomagnetic observation appears, in graphical form, in Tomes' 2025 book *Wobbly Universe* [6]; the present paper establishes it on a fully quantitative footing, alongside its solar-system counterpart.

2. The 1.11019 Ma Periodicity in Earth's Magnetic Polarity

2.1 Data and method

The reversal record used here is the standard 0–30 Ma geomagnetic polarity timescale (CK95), giving 122 reversal boundaries. From this, a polarity series was built as a simple ± 1 signal — +1 for normal polarity, –1 for reversed — sampled on a regular 1000-year (1 ka) grid across the full 30 million years, giving 30,000 evenly spaced points. The spectrum was computed at continuously variable frequency, not via FFT binning: a Lomb–Scargle periodogram evaluated across a fine, continuous grid of candidate periods. The results below focus on the 0.2 to 6 Ma range, where the twelve dominant peaks of interest lie. Peaks were selected directly by amplitude — the twelve tallest features in the spectrum within that range.

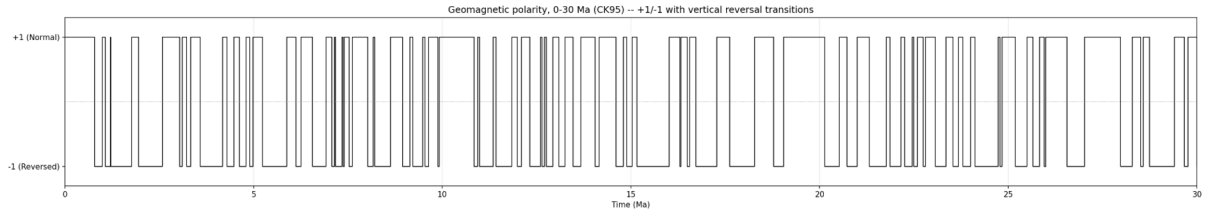


Figure 1. Geomagnetic polarity, 0–30 Ma (CK95), as a ± 1 waveform with vertical reversal transitions.

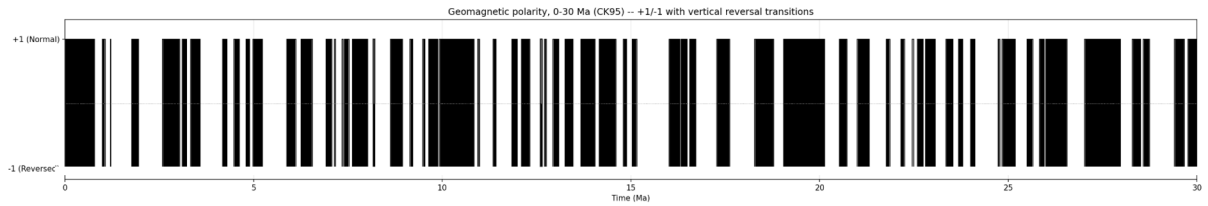


Figure 2. The same record rendered as a filled polarity strip; the eye reads the prevailing condition rather than the event timings.

2.2 The selected cycles

The twelve tallest peaks in the spectrum, by raw amplitude, in order of period (five significant figures): 0.38360, 0.40064, 0.71417, 0.74013, 0.87019, 1.11019, 1.22856, 1.42712, 1.94361, 2.26965, 2.76487, 3.33146 (all in Ma).

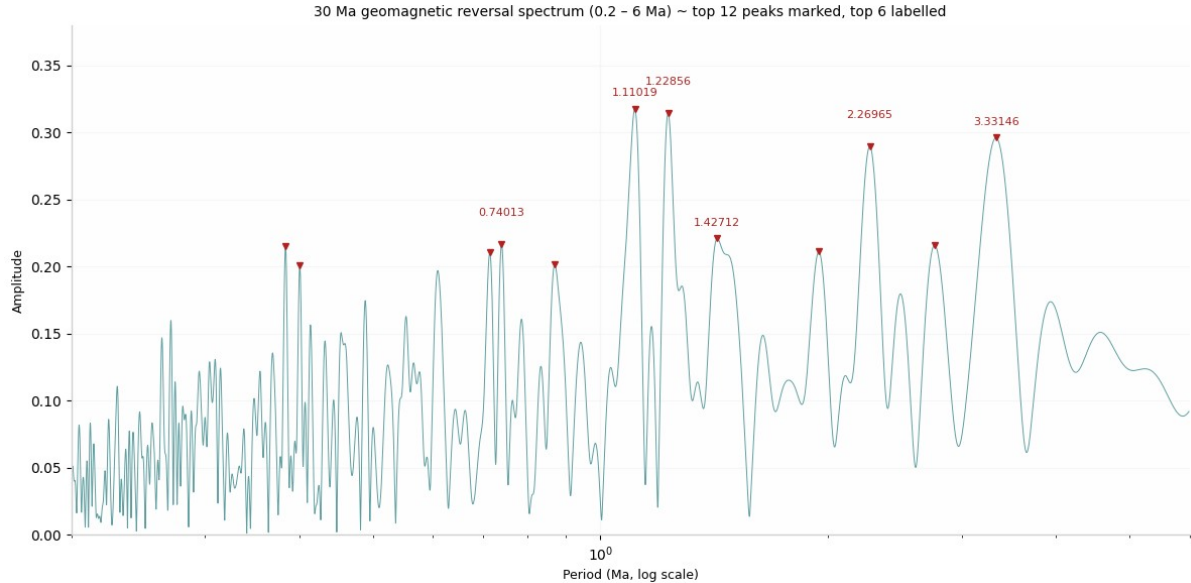


Figure 3. Lomb–Scargle spectrum of the 30 Ma polarity record, amplitude vs. period on a log scale, restricted to the 0.2–6 Ma range; all twelve peaks marked, the top six by amplitude labelled.

2.3 The 1.11 Ma peak, precisely determined, and confirmed by folding

Refining the dominant peak in the 30 Ma spectrum to five significant figures gives 1.11019 Ma. The periodicity is not only visible as a spectral peak — folding the entire 30 Ma polarity

record on top of itself at this exact period, and averaging, gives a strikingly clear result: a smooth, single-humped wave swinging from roughly -0.6 to $+0.6$ across the cycle, rather than the flat noise a non-existent period would produce. At the highest peak 22 of the 27 folded cycles, and at the lowest trough 22 of 27, are in the expected direction of polarity ($\chi^2(1) = 10.7$, $p \approx 0.001$ in each case).

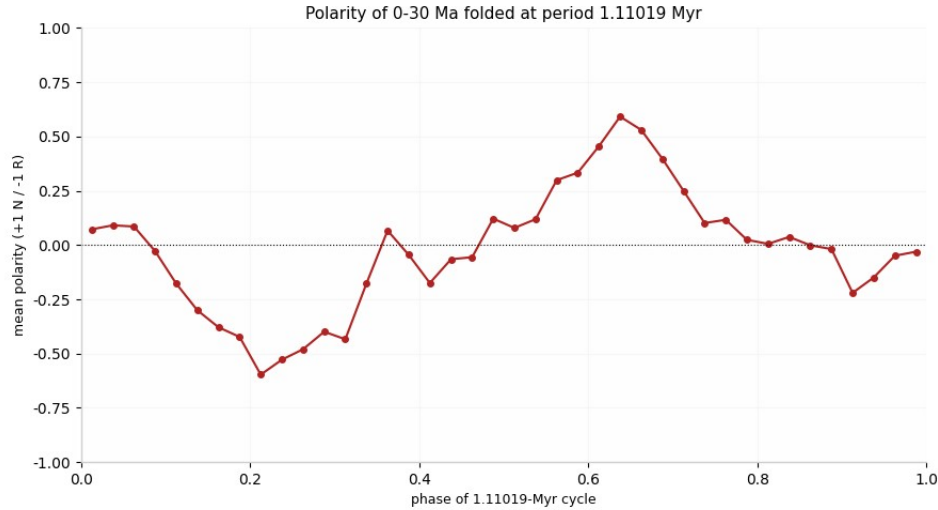


Figure 4. Polarity of 0–30 Ma folded at period 1.11019 Myr — a smooth, single-humped wave swinging from roughly -0.6 to $+0.6$ across the cycle.

2.4 Harmonic relationships within the 1.11 Ma family

Two of the largest peaks relate to the dominant 1.11019 Ma peak by simple, clean ratios. The 0.74013 Ma peak sits at $2/3$ of the dominant period (a perfect fifth above it in frequency), and the 3.33146 Ma peak at $3\times$ the dominant period. Both fits are within a tenth of a percent of exact:

Peak (Ma)	Ratio to 1.11019 Ma	Nearest simple ratio	Deviation from exact
0.74013	0.66667	$2/3 = 0.66667$	0.0005%
3.33146	3.0008	$3 = 3.00000$	0.027%

Table 1. The two strongest harmonic relationships in the geomagnetic spectrum, relative to the 1.11019 Ma dominant peak.

A common fundamental. The three harmonically related periods can be placed on a common fundamental by multiplying the dominant peak by 1, its $2/3$ companion by 1.5, and its $3\times$ companion by $1/3$. This gives 1.11019, $0.74013 \times 1.5 = 1.11020$, and $3.33146 / 3 = 1.11049$ Ma — an average of 1.11029 Ma. The fundamental period of the family is thus 1.1103 Ma to four significant figures, the three harmonic estimates agreeing with one another to within 3×10^{-4} .

3. Two Independent Periods of the Same Length in the Outer Solar System

This section sets the geomagnetic figure aside entirely and asks an independent question, using entirely different data and methods: does a period of similar length appear anywhere in the

dynamics of the solar system itself? Two candidates are examined below, each derived from outer-planet orbital dynamics with no reference to terrestrial geomagnetism. Their proximity to the geomagnetic figure is noted, but not explained, here.

3.1 The Uranus–Neptune orbital energy exchange

Bertotti & Farinella [9] state that Uranus and Neptune exchange orbital energy over a 1.1 million year cycle. Uranus and Neptune sit near — but never lock into — a 2:1 mean-motion resonance. Their mutual gravitational perturbation produces a slow, cyclic exchange of orbital energy: Neptune's semi-major axis and eccentricity grow while Uranus's shrink, then the exchange reverses. This result traces to the LONGSTOP project (Milani, Nobili, Carpino, and collaborators — a numerical integration of the outer planets over timescales up to 100 million years) and a later, independent 200-million-year integration [11]. The more precise figure, from the primary source [10], based on the LONGSTOP 1B integration, gives this period as 1.119 Myr; Bertotti & Farinella simply rounded this to "1.1 Myr" in their text.

This is a near-resonant beat, not a fixed secular period, and it drifts: the underlying orbital-element periods can shift by more than 1% over 1–20 million year intervals, so 1.119 Myr should be treated as the present-epoch value of a slowly wandering timescale, not a constant. For reference, the Uranus–Neptune synodic (conjunction) period is 171.42 years, so the 1.119 Myr modulation spans roughly 6,458 conjunctions.

The scale and possible cause of the drift. The same LONGSTOP 1B integration that established the 1.119 Myr period also identified a second, much longer term in the same semi-major-axis variations: a "small divisor" with a period of approximately 31 Myr [12]. In perturbation theory, a small-divisor term arises when a particular combination of orbital frequencies happens to sum close to zero, producing a slow, large-amplitude modulation superimposed on a faster signal. This is a specific, documented longer periodicity in the same dynamical system that produces the 1.119 Myr line — a plausible candidate for a genuine longer wave modulating the shorter cycle, rather than the shorter cycle's period wandering without structure. The mainstream dynamical-astronomy literature offers a separate, and more commonly cited, explanation for why the outer planets' orbital elements are difficult to pin to a single fixed period over long baselines: the giant-planet system (Jupiter through Neptune) has been characterised as chaotic, with a Lyapunov time reported in the range of roughly 4 to 19 million years depending on integration method, often summarised as approximately 10 Myr [13]. The two observations are not necessarily in conflict: a system can carry well-defined secular spectral lines over multi-million-year baselines while its exact trajectory remains formally chaotic. On the view explored here, the apparent "drift" in the 1.119 Myr figure is best read as the signature of the 31 Myr wave (and possibly others not yet identified) modulating it in a regular way, not as evidence of underlying featureless divergence.

A further observation connects this longer term back to the geomagnetic record. The ~31 Myr small divisor that modulates the 1.119 Myr energy-exchange cycle sits close to the roughly 30 Myr cyclicity in reversal rate reported by Lowrie [3, 2] — with its more distinctive 15 Myr harmonic. The parallel therefore appears to operate at two levels: the prevailing polarity condition at 1.11 Ma, and the reversal rate itself at ~30 Ma, each with a documented counterpart in the

same outer-planet dynamical system. No causal connection is claimed here; the proximity is recorded because both figures are independently established in the mainstream literature.

3.2 The Jupiter–Uranus perihelion lock

A second, independent, and — unlike the above — genuinely fixed period arises from a different mechanism: the angle between Jupiter's and Uranus's perihelion directions ($\Delta\pi = \pi_{\text{Jupiter}} - \pi_{\text{Uranus}}$) librates around 180° , staying anti-aligned within roughly $\pm 70^\circ$. The period of this libration is set purely by the difference between the two planets' secular perihelion precession frequencies, conventionally labelled g_5 (Jupiter) and g_7 (Uranus):

$$\text{Period} = 360^\circ \div (g_5 - g_7)$$

Using modern catalogue values ($g_5 = 4.2575''/\text{yr}$, $g_7 = 3.0868''/\text{yr}$): $\Delta g = 1.1707''/\text{yr} \rightarrow \text{Period} = 1,296,000'' \div 1.1707''/\text{yr} = 1,107,030 \text{ years} \approx 1.107 \text{ Myr}$. Unlike the Uranus–Neptune beat, this is a stable, directly computable secular frequency difference — not an epoch-dependent estimate, and not subject to the same drift.

Footnote. A note of "1.108 Myr" for an outer-planet energy-exchange cycle sat in the author's records for decades, its original source untraceable — repeated searches consistently failed to locate where the figure had come from. The source was finally recovered from an old personal notebook, which allowed the calculation described above to be reconstructed and checked. The recovered figure — 1.108 Myr — and the freshly computed value from modern catalogue g_5/g_7 data — 1.107 Myr — agree to within one part in a thousand: what had been missing was not the number but its derivation.

4. Three Independent Determinations of the Same Period

The two sections above, taken together, offer the following situation. The solar system provides two genuinely independent periods, both close to 1.11 Myr, arising from two different physical mechanisms; and the geomagnetic reversal record provides a third, from entirely unrelated data and an entirely unrelated method:

Period (Myr)	Source	Mechanism	Type
1.11019	Earth's magnetic polarity (0–30 Ma, CK95)	Lomb–Scargle spectrum of ± 1 polarity signal	Empirical spectral
1.119	Uranus–Neptune orbital energy exchange (LONGSTOP)	Near-resonant beat of a 2:1 near-mean-motion resonance	Drifting beat
1.107	Jupiter–Uranus perihelion anti-alignment	Secular frequency difference $g_5 - g_7$	Fixed secular

Table 2. The three independent ~1.11 Myr determinations. The geomagnetic figure comes from spectral analysis of Earth's reversal record with no planetary input; the planetary figures come from numerical integration and catalogue precession rates with no geomagnetic input. All three agree to within a fraction of a percent.

5. Discussion

Each half of this result is modest on its own. The geomagnetic half does not claim that reversal timings are periodic — the gamma renewal description of interval lengths is untouched. It claims only that the prevailing polarity condition through time — the quantity the reversal record directly encodes — is periodic at 1.11019 Ma, with a harmonic family around it ($2/3$ and $3\times$ within 0.03%). The solar-system half makes no new dynamical claim: both planetary periods are documented in the mainstream literature, one as the LONGSTOP Uranus–Neptune energy-exchange period and the other as a trivial consequence of the standard secular frequency solution.

What is not modest is the triangulation. Three determinations of the same period, from three unrelated physical systems (Earth's core dynamo, a pair of near-resonant giant planets, a fixed two-planet secular frequency difference), arrived at by three unrelated methods (spectral analysis of a reversal record, numerical integration, catalogue precession arithmetic), agree to within a fraction of a percent. Either this is a coincidence of remarkable precision, or there is a common cause coupling these systems at this timescale. Identifying and testing that common cause is beyond the scope of this paper and is left for a future work.

6. Conclusion

The geomagnetic reversal record, when examined as a prevailing polarity rather than as a sequence of reversal timings, shows a highly significant 1.11019 Ma cycle and clear harmonic relationships centred on it — most notably its $2/3$ and $3\times$ multiples at 0.74013 and 3.33146 Ma. Independently, two distinct mechanisms in outer solar system dynamics — one a drifting near-resonant beat between Uranus and Neptune, one a fixed secular frequency difference between Jupiter and Uranus — produce periods of 1.119 and 1.107 Myr. All three figures agree within a fraction of a percent. The origin of the harmonic relationships within the geomagnetic spectrum, and of the agreement between the terrestrial and planetary figures, is left for future papers.

References

- [1] Cox, A. (1968). Lengths of geomagnetic polarity intervals. *Journal of Geophysical Research*, 73(10).
- [2] Lowrie, W. (1990). Geomagnetic reversal history. *Terra Nova*, 2(3).
- [3] Lowrie, W. (1989). Magnetic Polarity Time Scales and Reversal Frequency. In: Lowes, F.J., Collinson, D.W., Parry, J.H., Runcorn, S.K., Tozer, D.C., Soward, A. (eds), *Geomagnetism and Palaeomagnetism*, NATO ASI Series C, Vol. 261. Springer.
- [4] Constable, C. (2000). On rates of occurrence of geomagnetic reversals. *Physics of the Earth and Planetary Interiors*, 118.
- [5] McElhinny, M.W. & McFadden, P.L. (1998). *The Magnetic Field of the Earth: Paleomagnetism, the Core, and the Deep Mantle*. International Geophysics Series, Vol. 63. Academic Press.
- [6] Tomes, R. (2025). *Wobbly Universe: Harmonics Theory Reveals the Cycles and Previously Hidden Structures of the Universe*.

- [7] U.S. Geological Survey. Is it true that Earth's magnetic field occasionally reverses its polarity?
- [8] British Geological Survey. Reversals: Magnetic Field.
- [9] Bertotti, B. & Farinella, P. (1990). Physics of the Earth and the Solar System: Dynamics and Evolution, Space Navigation, Space-Time Structure. Kluwer, Dordrecht.
- [10] Milani, A., Nobili, A.M., & Carpino, M. (1987). Secular variations of the semimajor axes: theory and experiments. Astronomy and Astrophysics, 172.
- [11] Applegate, J.H., Douglas, M.R., Gürsel, Y., Sussman, G.J., & Wisdom, J. (1986). The outer solar system for 200 million years. Astronomical Journal, 92(1).
- [12] Nobili, A.M., Milani, A., & Carpino, M. (1989). Fundamental frequencies and small divisors in the orbits of the outer planets. Astronomy and Astrophysics, 210.
- [13] Sussman, G.J. & Wisdom, J. (1992). Chaotic Evolution of the Solar System. Science, 257(5066).

Note: This paper combines and replaces two earlier papers placed on viXra, [viXra:2610.0032](#) and [viXra:2610.0033](#) because of the very similar periods found in each.