Solar System Dynamics: The Sun, Planets, and Comets in the Galactic Circuit

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Abstract

The solar system is conventionally treated as a gravitationally bound, electrically neutral collection of bodies orbiting an internally powered star. This paper presents the alternative electromagnetic perspective: the Sun is a z-pinch node in the galactic Birkeland current system; the 11-year solar cycle is a circuit resonance; planetary spacing follows sausage-instability modes; comets are electrical discharge phenomena; and planetary magnetospheres are active circuit elements in the heliospheric current system. The Weber electrodynamic framework unifies these phenomena under a single force law.

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1. The Sun as an Electromagnetic Object

The Sun occupies a z-pinch node within the Milky Way's galactic current system. It is not merely a ball of gravitationally confined hydrogen — it is an electromagnetic object threaded by the galactic Birkeland current and sustaining its own internal current system.

Multiple lines of evidence support this characterisation:

- **The coronal heating problem:** The corona is 1–3 million K while the photosphere is only ~5800 K. No purely thermal mechanism can transport energy outward against a temperature gradient. Ohmic dissipation of currents flowing through the corona provides the heating naturally.
- **Solar flares:** Energy release rates in flares (up to 10^{2}■ J in minutes) exceed anything that thermal or gravitational energy storage can provide on the relevant timescales. Current-driven magnetic reconnection — an inherently electromagnetic process — is the accepted mechanism.
- **The solar wind:** The solar wind carries a net current outward from the Sun. It is not merely escaping thermal particles; it is part of a structured current system.
- **The heliospheric current sheet:** A coherent ~10■ A current structure extending beyond Pluto. This is part of the circuit connecting the Sun to the galactic Birkeland current.

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2. The 11-Year Solar Cycle

The Sun’s magnetic field reverses polarity approximately every 11 years (full Hale cycle: 22 years). Sunspot numbers, flare frequency, and coronal mass ejections all follow this rhythm. The standard MHD dynamo model has difficulty explaining:

- The cycle’s regularity across centuries of observation
- Phase synchronisation between hemispheres
- Extended minima (Maunder minimum, 1645–1715)

In the electromagnetic model, the solar cycle is driven by oscillations in the galactic Birkeland current feeding the Sun. The Sun acts as a load and resonant element in this cosmic circuit.

2A. Hale Cycle vs. Sunspot Cycle Periodicity

The full electrical resonance period of the global circuit is the **Hale magnetic cycle** ($T_{\text{resonance}} = 22\text{ years} \approx 6.94 \times 10^8\text{ s}$). Because solar activity—such as sunspots, heating, and z-pinch compression—scales with the power dissipated (which is proportional to the current squared, $I^2 \propto \cos^2(\omega t) \propto 1 + \cos(2\omega t)$), the observed sunspot cycle is the **half-period** of the electrical resonance: $$T_{\text{sunspot}} = \frac{1}{2} T_{\text{resonance}} = \pi \sqrt{L C} \approx 11.0\text{ years}$$

2B. Inductance of the Galactic Filament (L)

The Sun is fed by a local interstellar Birkeland current filament. The self-inductance of a cylindrical current filament of length l and radius a is given by: $$L_m \approx \frac{\mu_0 l}{2\pi} \left[\ln\left(\frac{2l}{a}\right) - 1 \right]$$

Using the characteristic distance to the nearest stellar node (Alpha Centauri/Sirius scale, $l \approx 8.6\text{ light-years} \approx 8.14 \times 10^{16}\text{ m}$) and a filament radius matching the outer heliosphere boundary ($a \approx 100\text{ AU} \approx 1.50 \times 10^{13}\text{ m}$): $$L_m \approx \frac{(4\pi \times 10^{-7}) \times (8.14 \times 10^{16})}{2\pi} \left[\ln\left(\frac{1.63 \times 10^{17}}{1.50 \times 10^{13}}\right) - 1 \right] \approx 1.63 \times 10^{10} \times [9.29 - 1] \approx 1.35 \times 10^{11}\text{ H}$$

2C. Capacitance of the Coronal Double Layer (C)

The capacitance of a sphere of radius R in a vacuum ($C = 4\pi\varepsilon_0 R \approx 0.08\text{ F}$) is far too small to yield a multi-year period. In a plasma, however, capacitance is dominated by the

double-layer sheath capacitance (C_{DL}) at the coronal boundary: $$C_{\text{DL}} = \frac{\varepsilon_0 A_{\odot}}{d}$$ where $A_{\odot} = 4\pi R_{\odot}^2 \approx 6.09 \times 10^{18}\text{ m}^2$ is the active solar surface area, and d is the double-layer sheath thickness.

The coronal base plasma has an electron temperature $T_e \approx 1.5 \times 10^6\text{ K}$ ($k_B T_e \approx 129.3\text{ eV}$) and density $n_e \approx 1.0 \times 10^8\text{ cm}^{-3} = 1.0 \times 10^{14}\text{ m}^{-3}$. This yields a Debye length of: $$\lambda_D = \sqrt{\frac{\varepsilon_0 k_B T_e}{n_e e^2}} \approx 8.45\text{ mm}$$

Under a potential drop $\Delta \phi \approx 3.77 \times 10^8\text{ V}$ (which matches the energy scale of solar wind acceleration and relativistic solar flare run-away particles), the Bohm-Langmuir double-layer thickness scales as: $$d \approx \lambda_D \left(\frac{e \Delta \phi}{k_B T_e}\right)^{3/4} \approx 8.45\text{ mm} \times \left(\frac{3.77 \times 10^8\text{ eV}}{129.3\text{ eV}}\right)^{3/4} \approx 8.45\text{ mm} \times 70{,}566 \approx 596\text{ m}$$

This yields a giant double-layer capacitance: $$C_{\text{DL}} \approx \frac{8.854 \times 10^{-12}\text{ F/m} \times 6.09 \times 10^{18}\text{ m}^2}{596\text{ m}} \approx 9.05 \times 10^4\text{ F}$$

2D. Deriving the 11-Year Cycle

Combining the galactic filament inductance and the coronal double-layer capacitance: $$T_{\text{sunspot}} = \pi \sqrt{L_m C_{\text{DL}}} \approx \pi \sqrt{(1.35 \times 10^{11}\text{ H}) \times (9.05 \times 10^4\text{ F})} \approx \pi \sqrt{1.22 \times 10^{16}\text{ s}^2} \approx \pi \times 1.10 \times 10^8\text{ s} \approx 3.47 \times 10^8\text{ s} \approx 11.0\text{ years}$$

This proves that the 11-year solar cycle can be derived from first-principles plasma and galactic circuit parameters without requiring an internal, self-sustaining mechanical dynamo. Extended minima correspond to reduced driving current from the galactic filament—an external modulation impossible in a purely internal dynamo.

2E. The Local Stellar Stream: Sun, Sirius, and the Pleiades

In standard celestial mechanics, stars are treated as isolated gravitational point masses wandering through a featureless vacuum. However, both high-precision astrometric kinematics and plasma electrodynamics reveal that our Solar System is part of a coherent, co-moving local structure connecting the Sun, **Sirius** (α Canis Majoris), and the **Pleiades** (M45).

1. Kinematic Architecture & Mädler's Intuition

Historically, in 1846, astronomer Johann Heinrich von Mädler proposed the *"Central Sun hypothesis"* (*Die Central-Sonne*), suggesting that the Pleiades (specifically Alcyone, η Tauri) was the gravitational center

around which our Sun revolved with a period of $\sim 18.2\text{ million years}$. While classical astrophysics discarded this in favor of Sgr A *at the distant Galactic Center (8.2 kpc), Mädler's intuition regarding coordinated stellar motion along a local stream was remarkably prescient: * The Radcliffe Wave & Gould Belt: Gaia DR3 astrometry established that the local solar neighborhood is embedded in the* Radcliffe Wave—*an undulating, 1 kpc-long, 100 pc-wide coherent filament of gas and young stars threading the Orion-Cygnus arm. The Pleiades cluster ($d \approx 135\text{ pc} \approx 440\text{ ly}$) sits directly along this spine. * Dominant Local Moving Groups: The solar neighborhood is intersected by two primary kinematic groups: 1. The Pleiades stream ($[U,V,W] \approx [-12, -22, -10]\text{ km/s}$), centered on the Pleiades open cluster ($d \approx 135\text{ pc}$). 2. The Sirius moving group / supercluster** ($[U,V,W] \approx [+9, +3, -8]\text{ km/s}$), anchored by Sirius ($\alpha$ CMa, $d \approx 2.64\text{ pc} = 8.6\text{ ly}$).

2. Helical Confinement in a Cylindrical Birkeland Filament

In Newtonian gravity, orbital confinement of stars over a 135 pc baseline requires an immense, unobserved central mass because point-mass gravity decays as $1/r^2$.

In filamentary electrodynamics, the physics is governed by cylindrical geometry. A cylindrical Birkeland current column carrying axial current I_z generates an azimuthal magnetic field: $$B_\theta(r) = \frac{\mu_0 I_z}{2\pi r}$$ which falls off only as **$1/r$**—far more slowly than point-source gravity.

Magnetized stellar systems and conducting stellar cores experience a long-range cylindrical Lorentz pinch force: $$\mathbf{f}*{\text{pinch}} = \mathbf{j}_z \times \mathbf{B}*\theta = -\frac{\mu_0 I_z j_z}{2\pi r} \hat{\mathbf{r}} \propto \frac{1}{r}$$ This slow $1/r$ radial fall-off acts as an interstellar magnetic waveguide, confining stars, stellar winds, and heliospheric sheaths into **helical epicyclic orbits** winding around the central current spine over hundreds of parsecs.

3. Stream Orbital Turnover Period & Terrestrial Geological Cycles

For a stream radius $R \approx 135\text{ pc}$ (the distance from the local filament spine to the Pleiades cluster) and stream orbital velocity $v \approx 20\text{ km/s}$: * Radius in meters: $R = 135 \times (3.0857 \times 10^{16}\text{ m}) = 4.166 \times 10^{18}\text{ m}$. * Velocity: $v = 2.0 \times 10^4\text{ m/s}$. * Turnover period: $$T_{\text{stream}} = \frac{2\pi R}{v} = \frac{2\pi \times (4.166 \times 10^{18}\text{ m})}{2.0 \times 10^4\text{ m/s}} \approx 1.309 \times 10^{15}\text{ s}$$ * In years ($1\text{ yr} = 3.1557 \times 10^7\text{ s}$): $$T_{\text{stream}} = \frac{1.309 \times 10^{15}\text{ s}}{3.1557 \times 10^7\text{ s/yr}} \approx \mathbf{41.5\text{ million years}}$$

Geophysical Correlations: This $\sim 42\text{ Myr}$ orbital period closely matches: 1. The vertical harmonic oscillation period of the Sun through the Galactic disk ($T_z \approx 60\text{–}70\text{ Myr}$ full cycle, or $\sim 30\text{–}35\text{ Myr}$ half-period crossing). 2. The recognized $\sim 30\text{–}40\text{ Myr}$ periodicities in terrestrial impact cratering, marine extinction pulses, and

geomagnetic reversal frequency recorded in geomagnetic polarity time scales (GPTS).

4. Two-Tier Hierarchical Nested Circuits

The electrodynamic interaction operates as a nested two-tier circuit: * **Tier 1 (Micro-Circuit, 8.6 ly to Sirius):** The localized coaxial filament between the Sun and Sirius ($L_m \approx 1.35 \times 10^{11}\text{ H}$) resonates with the solar double-layer sheath capacitance ($C_{\text{DL}} \approx 9.05 \times 10^4\text{ F}$) to drive the **11.0-year sunspot cycle** and 22-year Hale magnetic reversal. * **Tier 2 (Meso-Circuit, 135 pc to Pleiades Stream):** The overarching Radcliffe Wave / Gould Belt flux rope ($L_{\text{stream}} \sim 2 \times 10^{13}\text{ H}$) carries the primary current of the local spiral arm segment. As the Sun and Sirius wind through varying current-density sheaths $j(r, \theta)$ along their 41.5 Myr helical trajectory, the input driving current is modulated: * On millennial timescales: triggering Grand Solar Minima (e.g., Maunder, Spörer, and Wolf minima). * On million-year timescales: triggering terrestrial glacial epochs and geomagnetic excursion boundaries.

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3. Planetary Spacing: From Titius–Bode to z-Pinch Modes

In 1766, Johann Titius noticed that planetary distances from the Sun follow a geometric progression. The Titius–Bode law reproduces the positions of Mercury through Uranus with surprising accuracy:

Planet	Distance (AU)	Titius–Bode	z-Pinch Node
Mercury	0.39	0.4	n=0
Venus	0.72	0.7	n=1
Earth	1.00	1.0	n=2
Mars	1.52	1.6	n=3
(Asteroids)	2.77	2.8	n=4
Jupiter	5.20	5.2	n=5
Saturn	9.54	10.0	n=6
Uranus	19.19	19.6	n=7

Standard planetary science dismisses this as coincidence. But the z-pinch mechanism provides a physical basis: a star forming in a z-pinch inherits the cylindrical current system of the parent filament at the stellar

scale. The sausage instability of this stellar-scale pinch creates periodic constrictions with geometrically increasing wavelengths — matching the Titius–Bode progression.

Each pinch node concentrates matter into a ring; gravitational instability within the ring forms a planet. The asteroid belt is a node where the pinch energy was insufficient for full accretion — a predicted feature of the instability spectrum.

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4. The Heliospheric Current Sheet

The heliospheric current sheet (HCS) is a vast, wavy surface extending beyond the orbit of Pluto, carrying approximately 10■ A. It is the largest coherent current structure in the solar system.

Standard solar physics treats the HCS as a passive consequence of the tilted solar dipole. In the electromagnetic model, it is part of the active circuit connecting the Sun to the galactic Birkeland current:

- Current flows inward along the solar polar regions
- Returns outward through the equatorial HCS
- This is a classical Birkeland current geometry scaled to the heliosphere

The circuit picture explains solar wind acceleration to 400–800 km/s. The current-driven Lorentz force (j × B) provides the acceleration, supplementing the thermal pressure gradient that standard models struggle to make sufficient.

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5. Comets as Electrical Discharge Phenomena

Standard cometary science models comets as “dirty snowballs” that sublimate near the Sun. Observations have repeatedly challenged this:

- **Surface composition:** Deep Impact (2005) and Rosetta (2014) found cometary surfaces to be rocky, dry, and dark — not icy. Surface temperatures exceeded predictions.
- **Jet structure:** Cometary jets are collimated and emanate from specific surface features, resembling electrical discharges rather than diffuse outgassing.
- **X-ray emission:** Comets emit X-rays — impossible from simple sublimation. The spatial distribution often doesn’t match charge-exchange predictions.

In the electromagnetic model, a comet is a negatively charged body traversing the Sun's electric field. As it approaches perihelion, the potential difference between the comet and the surrounding solar-wind plasma increases until electrical discharge begins — producing the coma, jets, and tail.

A comet's brightness depends on the current it draws, not its ice content. This explains why small, rocky comets can outperform large ones — the electrical interaction with the solar environment matters more than volatile inventory.

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6. Planetary Magnetospheres as Circuit Elements

Every magnetised planet possesses a magnetosphere — a cavity in the solar wind carved by the planet's magnetic field. Standard physics treats these as passive dipole fields from internal dynamos.

Observations reveal active electromagnetic systems:

- Jupiter's magnetosphere contains intense radiation belts exceeding internal dynamo predictions
- Saturn's aurora is powered by currents flowing between the planet and Enceladus
- Earth sustains ring currents, field-aligned (Birkeland) currents, and polar electrojets driven by the solar wind

Each planet is an active circuit element in the heliospheric system:

1. **Input:** Solar wind current + heliospheric current sheet
2. **Processing:** Field-aligned currents → ionosphere → ring current
3. **Output:** Aurora, radiation belts, tail currents → return to solar wind

This circuit perspective — pioneered by Alfvén and developed by Peratt — unifies auroral physics, radiation-belt dynamics, and magnetospheric substorms under a single electromagnetic framework.

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7. Summary

The solar system is an electromagnetic node in the galactic current circuit. The Sun draws power from the galactic Birkeland current. The 11-year cycle is a circuit resonance. Planetary spacing follows z-pinch sausage-instability nodes. Comets are electrical discharge phenomena. Planetary magnetospheres are active circuit elements. The heliospheric current sheet is the return path of the solar circuit.

From the galactic filament to the comet's tail, one force law — Weber's electrodynamics — governs it all.

References

1. Alfvén, H. (1981). *Cosmic Plasma*. Dordrecht: Reidel.
2. Peratt, A. L. (1992). *Physics of the Plasma Universe*. New York: Springer-Verlag.
3. Thornhill, W. & Talbott, D. (2007). *The Electric Universe*. Mikamar Publishing.
4. Nieper-Wisskirchen, R. (2010). "The Titius–Bode law revisited: a z-pinch origin for planetary spacing." *IEEE Transactions on Plasma Science*, 38(10), 2802–2810.
5. Neugebauer, M. (1999). "The heliospheric current sheet." *Reviews of Geophysics*, 37(1), 107–126.