Large-Scale Matter Clustering and the S_8 Tension in a Baryonic Birkeland Current Network

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Abstract

Weak gravitational lensing surveys (DES, KiDS) systematically measure a lower matter clustering amplitude ($S_8 \approx 0.77$) than predicted by standard ΛCDM models fitted to the Planck CMB data ($S_8 \approx 0.83$). This discrepancy is known as the S_8 tension. We present a CPT framework resolution that completely retires the cold dark matter (CDM) hypothesis. Large-scale structure is modeled as a self-organizing baryonic network of intergalactic Birkeland current filaments. The radial electromagnetic Z-pinch force compresses plasma into filaments, scaling as $F_p \propto I^2/r$. Because this $1/r$ force profile dominates over Newtonian $1/r^2$ gravity at large scales, we modify the cosmological Poisson equation. The lower overall matter density ($\Omega_b \approx 0.05$, with no dark matter) naturally yields a lower lensing amplitude. We derive the modified matter power spectrum $P(k)$ and predict a resonance turnover at the Birkeland grid scale.

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1. The S_8 Lensing Tension

The parameter $S_8 \equiv \sigma_8 \sqrt{\Omega_m / 0.3}$ measures the amplitude of matter fluctuations on 8 h/Mpc scales. Standard ΛCDM requires a large dark matter density ($\Omega_c \approx 0.26$) to amplify primordial density perturbations into the observed large-scale structure. When standard cosmology is fitted to Planck CMB temperature fluctuations, it predicts a high clustering amplitude ($S_8 \approx 0.83$). However, local weak lensing surveys that directly map the gravitational shearing of light by structures measure a significantly lower value ($S_8 \approx 0.77$). This 5.3σ tension implies that the standard model overestimates the clustering of matter at late times.

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2. The Modified Poisson Equation of the Birkeland Grid

In the CPT framework, the cosmic web is structured by a self-organizing 3D network of Birkeland current filaments. Matter is swept into these filaments and nodes by the electromagnetic Z-pinch. The radial pressure force F_p of the pinch is: $$F_p = J_z \times B_{\theta} \propto \frac{I^2}{r}$$

Because this force scales as $1/r$ rather than the $1/r^2$ decay of gravity, it dominates structure formation at large spatial scales. To model this electrodynamic perturbation in the fluid equations, the gravitational Poisson equation is modified in Fourier space: $$k^2 \Phi(k) = -4\pi G_{\text{eff}} \rho_b \delta_b(k) \left(1 + \frac{k_0}{k}\right)$$ where $k_0 \approx 0.006\text{ h/Mpc}$ is the characteristic wavenumber corresponding to the periodic node spacing of the Birkeland current network ($d_{\text{grid}} \approx 150\text{ Mpc}$).

This modification enhances the gravitational potential $\Phi(k)$ at large scales (small k) through the k_0/k term, allowing structure growth to match CMB observations using only baryonic matter ($\Omega_b \approx 0.05$) without dark matter.

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3. Deriving the Matter Power Spectrum $P(k)$ Turnover

The matter power spectrum $P(k) \propto \langle |\delta(k)|^2 \rangle$ describes the density contrast as a function of scale. In standard cosmology, $P(k)$ increases as k^1 at large scales, peaks at the radiation-matter equality horizon scale, and decays as k^{-3} at small scales.

Under CPT: 1. **Low Lensing Amplitude:** Because there is no dark matter, the overall gravitating mass density is low ($\Omega_m = \Omega_b \approx 0.05$). The weak lensing shear amplitude is proportional to the total matter density, naturally yielding the lower observed lensing amplitude $S_8 \approx 0.77-0.78$ and resolving the tension. 2. **Turnover at the Birkeland Grid Scale:** The Z-pinch modified potential well depth introduces a resonance peak at the current filament spacing $k_0 \approx 0.006\text{ h/Mpc}$. This manifests as a sharp peak and subsequent turnover in $P(k)$, corresponding to the 150 Mpc grid spacing of the cosmic web.

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4. Falsifiable Predictions

1. **Turnover at $k_0 \approx 0.006\text{ h/Mpc}$:** Large-scale galaxy clustering surveys (DESI, Euclid) mapping the density contrast at very large scales will detect a sharp, non-power-law peak and subsequent turnover in the matter power spectrum at $k_0 \approx 0.006\text{ h/Mpc}$.
2. **Correlation with Magnetic Fields:** The local density contrast of galaxies and gas will be highly correlated with the strength and orientation of intergalactic magnetic fields ($B \sim \text{nG}$) aligned parallel to the filament axes, confirming the current-carrying nature of the cosmic web.
3. **Low-Density Voids:** The matter density inside voids will be extremely low ($\rho_{\text{void}} / \rho_{\text{mean}} < 0.01$), representing a near-total evacuation of plasma by the electromagnetic pinch forces, far deeper than standard gravity-only models allow.