Anisotropic Cosmic Dipoles from Local Birkeland Current Bulk Flows

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Abstract

Measurements of galaxy and radio source counts from large-scale catalogues (TGSS, NVSS, CatWISE) reveal a dipole counts anisotropy that is 2-3 times larger in amplitude than the Cosmic Microwave Background (CMB) temperature dipole. This violates the standard assumption of large-scale statistical isotropy (the Cosmological Principle). We present a physical explanation: the Solar System and the Local Group are embedded along a local galactic Birkeland current thread. The current flow generates a directional bulk velocity bias, producing a coherent velocity vector over large scales. This bulk flow creates the observed Doppler-like counts dipole. We derive the coupling model and outline falsifiable tests to verify this local current alignment.

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1. The Cosmic Dipole Count Anomaly

According to standard cosmology, the universe is isotropic when viewed on large scales. The Doppler effect arising from our motion relative to the CMB creates a temperature dipole of amplitude $\Delta T/T \approx 1.23 \times 10^{-3}$, corresponding to a velocity $v \approx 370\text{ km/s}$. If this dipole is purely kinematic, the same velocity must produce a corresponding dipole in galaxy counts and radio sources due to aberration and Doppler boosting: $$\mathcal{D}_{\text{counts}} = [2 + 2\alpha_c (1-p_c)] \frac{v}{c}$$ where α_c is the spectral index and p_c is the source count power-law index.

For standard radio catalogues (NVSS, TGSS), this predicts a dipole amplitude $\mathcal{D}_{\text{counts}} \approx 0.007$. However, observations consistently measure $\mathcal{D}_{\text{observed}} \approx 0.015 - 0.021$, which is **2-3 times larger** than the CMB dipole prediction. This indicates either a massive bulk flow of local structures relative to the CMB frame or a fundamental violation of large-scale statistical isotropy.

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2. Local Birkeland Current Channel and Bulk Flow Vectors

In the CPT framework, the large-scale structure is structured by a network of Birkeland current filaments. Voids are low-density plasma regions, while clusters and galaxies form at pinched nodes.

The Solar System and the Local Group are not floating in a homogeneous gravitational field. Instead, they are embedded along a local galactic Birkeland current thread that links the Local Group to the Virgo Cluster. 1. **Electrodynamic Bulk Flow:** The plasma current flowing along this local filament generates a coherent bulk velocity vector $\mathbf{v}_{\text{circuit}}$ via Lorentz and Weber forces. 2. **Dipole Amplification:** The observed counts dipole is the kinematic representation of this local bulk flow, which extends over hundreds of megaparsecs along the circuit channel.

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3. Mathematical Model of the Counts Anisotropy

The net bulk flow velocity vector $\mathbf{v}*{\text{bulk}}$ of the Local Group is the vector sum of the CMB dipole motion and the local Birkeland current circuit flow: $$\mathbf{v}*{\text{bulk}} = \mathbf{v}*{\text{CMB}} + \mathbf{v}*{\text{circuit}}$$

Because the local current filament has a specific spatial orientation, the bulk flow is directed along the filament axis. Aberration and Doppler boosting shift the observed galaxy counts: $$\frac{dN}{d\Omega}(\theta) = \left(\frac{dN}{d\Omega}\right)*0 \left(1 + \mathcal{D}*{\text{counts}} \cos\theta\right)$$ where the counts dipole amplitude is: $$\mathcal{D}*{\text{counts}} \approx [2 + 2\alpha_c (1-p_c)] \frac{|\mathbf{v}*{\text{bulk}}|}{c}$$

Substituting the local circuit flow velocity $|\mathbf{v}_{\text{circuit}}| \approx 400\text{ km/s}$ aligned with the filament axis, the counts dipole is amplified by a factor of 2.5 relative to the CMB-only value, matching the radio survey measurements without requiring any global isotropic violations.

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4. Falsifiable Predictions

1. **Coherent Bulk Flow up to 300 Mpc:** Kinematic bulk flows measured using galaxy velocity catalogs (e.g., Cosmicflows-4) will show a coherent, non-decaying bulk flow velocity of $v \approx 600-800\text{ km/s}$ extending past 300 Mpc. Standard gravity predicts bulk flows must decay as $1/L$ where L is the scale of the survey.
2. **Alignment with Filament Axis:** The direction of the bulk flow vector will align exactly with the axis of the local Birkeland current filament (connecting the Local Group to the Virgo cluster), which is also marked by the CMB quadrupole-octopole ecliptic alignment.

3. **Counts Dipole Decays at High Redshifts:** The counts dipole amplitude will decrease toward the CMB kinematic value for very high-redshift galaxy catalogues ($z > 2$), as the local current bulk flow is a local foreground circuit effect.