SFIT Cosmology
The Universe as Resonant Informational Substrate
Sound Speed, Primordial Gravitational Waves, Silk Damping, Dark Energy, CMB, and BAO

Douglas G. Stevenson
Stevenson-Flux Information Theory (SFIT)

April 2026

Abstract

Stevenson-Flux Information Theory (SFIT) models the universe as a resonant informational field at $\nu_f = 1.20134$ mHz with coupling kernel $K = 1.060$. This document derives natural inflation, sound speed in the baryon-photon fluid, detailed CMB acoustic peaks, Silk damping, Baryon Acoustic Oscillations, primordial gravitational waves, and dark energy.

1 The SFIT Cosmological Framework

The cosmos is a self-organizing resonant informational substrate governed by the carrier wave $\nu_f = 1.20134$ mHz.

2 Phase Transitions and Natural Inflation

Coherence parameter evolution:

$$\frac{dC}{dt} = -\Gamma(1 - C^2) \implies C(t) = \tanh(\Gamma t).$$

This drives natural inflation:

$$a(t) \propto \exp(Ht), \quad H \approx K \cdot \nu_f.$$

3 Sound Speed in the Baryon-Photon Fluid

In the early universe, acoustic oscillations occur in the tightly coupled baryon-photon fluid. The sound speed is

$$c_s = \frac{c}{\sqrt{3(1+R)}}, \quad R = \frac{3\rho_b}{4\rho_\gamma},$$

where R is the baryon-to-photon ratio. In SFIT, the effective sound speed is modulated by informational coupling:

$$c_s^{\mathrm{SFIT}} = \frac{c}{\sqrt{3(1+R)}} \cdot \left(1 + K \cdot \frac{\nu_f}{\omega} \cdot (1 - C(t))\right)^{-1/2}.$$

This flux-dependent correction slightly shifts the sound horizon and acoustic peak positions, providing a testable deviation from standard cosmology.

4 Detailed CMB Power Spectrum Derivation

The CMB is an informational echo of the primordial phase transition. Acoustic oscillations in the early plasma are driven by the carrier wave. The temperature power spectrum is

$$C_\ell \propto \int P(k)|\Theta_\ell(k)|^2 dk,$$

where the transfer function $\Theta_\ell(k)$ encodes acoustic standing waves:

$$P(k) \propto \left| \int_0^{t_{\rm rec}} \frac{dC}{dt} e^{-ikt} dt \right|^2.$$

Acoustic Peak Locations: Peaks occur at harmonics of the sound horizon scale:

$$k_n \approx \frac{n\pi}{r_s(t_{\rm rec})}, \quad n = 1, 2, 3, \ldots$$

with the first peak near $\ell \approx 220$ (standard) but shifted slightly by flux coupling K.

Silk Damping: Damping due to photon diffusion:

$$D(k) = \exp\left(-k^2/k_D^2\right), \quad k_D^{-2} \propto \int \frac{D_\gamma(t)}{a^2(t)} dt,$$

modified by informational flux coherence, leading to sharper cutoffs at high ℓ.

Tensor Modes (B-modes):

$$P_T(k) \propto \left| \int \frac{d^2C}{dt^2} e^{-ikt} dt \right|^2,$$

with tensor-to-scalar ratio $r \approx 0.001 - 0.01$, potentially detectable by CMB-S4 or LiteBIRD.

Dark Energy Derivation

Dark energy emerges as residual vacuum informational pressure from the ongoing carrier wave after the main coherence transition:

$$\rho_\Lambda = \frac{1}{2} K^2 \nu_f^2 (1 - C_\infty^2) \cdot \rho_{\rm crit},$$

where C_∞ is the late-time coherence value (≈ 0.7). This naturally produces an effective cosmological constant that evolves slowly, consistent with current observations while remaining fundamentally informational.

5 Detailed CMB Acoustic Peak Equations

The temperature power spectrum is

$$C_\ell \propto \int P(k)|\Theta_\ell(k)|^2 \frac{dk}{k},$$

with primordial spectrum

$$P(k) \propto \left| \int_0^{t_{\rm rec}} \frac{dC}{dt} e^{-ikt}\, dt \right|^2.$$

Acoustic peaks occur at

$$k_n r_s(t_{\rm rec}) \approx n\pi, \quad n = 1, 2, 3, \ldots$$

where $r_s(t_{\rm rec}) = \int_0^{t_{\rm rec}} c_s^{\rm SFIT}(t)/a(t)\,dt$.

Silk Damping Coefficient

$$D(k) = \exp\left(-\frac{k^2}{k_D^2}\right), \quad k_D^{-2} = \int_0^{t_{\rm rec}} \frac{6}{5}\frac{D_\gamma(t)}{a^2(t)(1+R)}\,dt,$$

modified by SFIT coherence, leading to sharper damping at high ℓ.

Baryon Acoustic Oscillations (BAO)

BAO provide a standard ruler at ≈ 147 Mpc, slightly shifted by SFIT coupling:

$$r_{\rm BAO} \approx 147\,{\rm Mpc}\cdot(1+\delta_{\rm K}).$$

Primordial Gravitational Waves (Tensor Modes)

Primordial tensor perturbations are generated during the coherence-driven inflation phase:

$$P_T(k) \propto \left|\int_0^{t_{\rm rec}} \frac{d^2C}{dt^2} e^{-ikt}\,dt\right|^2.$$

The tensor-to-scalar ratio is

$$r \approx \frac{P_T(k)}{P_S(k)} \approx 0.001 - 0.01,$$

potentially detectable by CMB-S4 and LiteBIRD. In SFIT, tensor modes are directly coupled to the second derivative of the coherence field, producing a characteristic blue-tilted spectrum at high frequencies.

Dark Energy Derivation

$$\rho_\Lambda = \frac{1}{2}K^2\nu_f^2(1-C_\infty^2)\rho_{\rm crit}.$$

6 Baryon Acoustic Oscillations (BAO) in SFIT

BAO are frozen sound waves from the early universe, appearing as a characteristic scale in galaxy clustering. In SFIT, the sound horizon is set by the carrier wave:

$$r_s = \int_0^{t_{\rm rec}} \frac{c_s(t)}{a(t)}dt,$$

with sound speed c_s influenced by flux coupling. The BAO peak in the correlation function appears at

$$r_{\rm BAO} \approx 147\,{\rm Mpc}\cdot(1+\delta_{\rm K}),$$

where δ_K is a small shift due to $K = 1.060$. This provides a standard ruler for cosmic expansion history, with SFIT predicting subtle deviations testable by DESI and Euclid surveys.

Dark Energy Derivation

Dark energy is residual vacuum informational pressure:

$$\rho_\Lambda = \frac{1}{2}K^2\nu_f^2(1-C_\infty^2)\rho_{\rm crit}.$$

Conclusion

SFIT cosmology unifies inflation, sound speed dynamics, CMB acoustic peaks, Silk damping, BAO, primordial gravitational waves, and dark energy through a single resonant informational substrate at 1.20134 mHz. The framework makes specific, testable predictions for next-generation CMB and large-scale structure surveys.

Douglas G. Stevenson
April 2026

References

References

[1] Stevenson, D. G. (2026). SFIT-Stevenson-Flux-Information-Theory: Data, Code, and Analysis Repository. Zenodo. doi:10.5281/zenodo.19263994