BAO background, null propagation, and the perturbation-level programme in Dimensional Coherence Theory

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Dimensional Coherence Theory (DCT) is a Brans–Dicke scalar–tensor framework with matter minimally coupled to the conformal physical metric $\tilde{g}_{\mu\nu} = P\, g_{\mu\nu}$ ([2]). This paper **retracts** the historical background-level BAO argument based on multiplying comoving angular-diameter distances by $1/\sqrt{P_0}$: for spatially homogeneous $P(t)$, radial *null* photon worldlines in FLRW obey $0 = P(-\mathrm{d}t^2 + a^2\,\mathrm{d}\chi^2)$, so $\mathrm{d}\chi/\mathrm{d}t = 1/a$ and P drops out — the standard comoving ruler $\chi(z)$ is unchanged. The published $\Delta\chi^2 \approx 33.6$ "5.8σ" figure therefore targeted a **geometrically inconsistent** distance map, not a prediction of the homogeneous conformal ansatz. Late-time operational statements such as $H_{\rm phys} = H_E/\sqrt{P_0}$ must be derived from matter proper time on $\tilde{g}$ and must not be inserted into the same null-integral pipeline as an ad hoc inverse power of $\sqrt{P}$. Background BAO from homogeneous P alone is **degenerate** with ΛCDM at the level of $\chi(z)$; tests migrate to inhomogeneous P, disformal channels, and the perturbation-level programme $(\mu_b, \mu_{\rm DM}, \Sigma)$ on a ΛCDM background. The Jensen inequality, applied to convex functionals of P, constrains *biased* or LOS-averaged observables built from $1/\sqrt{P(\mathbf{x})}$, not the homogeneous null comoving distance. The smoking-gun cluster-scale discriminator remains $M_{\rm lens}/M_{\rm dyn}(z \sim 1.5) = 1.30$ ([1, 2]).

I. INTRODUCTION

Dimensional Coherence Theory (DCT) couples matter to $\tilde{g}_{\mu\nu} = P\, g_{\mu\nu}$ with Gross–Pitaevskii / 600-cell structure [2]. The historical claim that *homogeneous* background DCT rescales BAO comoving distances by $1/\sqrt{P_0}$ while leaving r_d fixed is **geometrically inconsistent**: for spatially homogeneous $P(t)$, radial null rays satisfy $\mathrm{d}\chi/\mathrm{d}t = 1/a(t)$ because P cancels from $0 = P(-\mathrm{d}t^2 + a^2\,\mathrm{d}\chi^2)$. Thus standard photon comoving distances $\chi(z)$ — and homogeneous-background BAO fits tied to them — are **not** shifted by an overall time-dependent conformal factor acting uniformly on $-dt^2$ and $a^2\,d\chi^2$. The legacy $\Delta\chi^2 \approx 33.6$ audit figure implemented a mistaken distance map, not a theorem about null propagation in DCT.

Operational late-universe statements such as $H_{\rm phys} = H_E/\sqrt{P_0}$ (SH0ES-scale prose in [2]) must be grounded in matter proper time on $\tilde{g}$, not reverse-engineered into the null comoving integral with an ad hoc inverse power of $\sqrt{P}$.

This paper is structured to: (a) document the Friedmann sector and the null-cone cancellation, (b) restate what remains testable at background BAO (inhomogeneous P, disformal extensions, clock/redshift definitions), (c) summarise the Jensen bound as it applies to *positivity-weighted nonlinear functionals* of $P(\mathbf{x})$ rather than to $\chi_{\rm null}$, and (d) carry the perturbation-level programme and the cluster-scale $M_{\rm lens}/M_{\rm dyn}$ discriminator forward unchanged.

A. Summary of key results

The two most important quantitative results are:

$$\Delta\chi^2_{\rm BAO,\,legacy\,script} \approx +33.6 \quad \text{(obsolete distance map — not a physic} \tag{1}$$

the legacy audit $\Delta\chi^2$ artefact computed from the mistaken D_M rescaling against DESI Y1 redshift bins [5] (not a null-cone prediction; see Sec. III), and

$$\frac{M_{\rm lens}}{M_{\rm dyn}}(z \sim 1.5) = 1.30\,, \tag{2}$$

the smoking-gun perturbation-level prediction for the lens-to-dynamical mass ratio, falsifiable by Euclid 2027–2029 [7].

II. BACKGROUND-FRAME DCT AND THE CONFORMAL-FRAME MAPPING

In the canonical DCT action [2]

$$S = \frac{1}{16\pi G}\int d^4x\sqrt{-g}\Big[PR - \frac{\omega(P)}{P}(\partial P)^2 - 2V(P)\Big]\,, \tag{3}$$

the Brans–Dicke amplitude $P(x,t)$ has equilibrium value $P_0 = 0.851$ at the present epoch and a coupling function $\omega(P) = (cP^2 - 3)/2$ with $c = 138{,}189$, giving $\omega_0 \equiv \omega(P_0) \approx 50{,}037$. The conformal physical metric is $\tilde{g}_{\mu\nu} = P\, g_{\mu\nu}$, and the modified Friedmann equation in the Jordan frame yields

$$\left(H + \frac{\dot{P}}{2P}\right)^2 = \frac{8\pi G}{3}\rho\,. \tag{4}$$

Three screening mechanisms enforce $P(x,t) = P_0$ at all redshifts $z < 10^6$ [2]: the Brans–Dicke stiffness $1/(2\omega_0 + 3) \sim 10^{-5}$, the Avrami exponential screening, and the Yukawa cutoff at the field mass $m \sim 65$ Mpc. As a

TABLE I. Status of background BAO under homogeneous conformal $P(t)$ (this revision). The legacy audit script implemented a mistaken distance rescaling; null photon comoving distances are unchanged (Sec. III). The perturbation-level program operates on a ΛCDM background with linearised $\mu_b(a)$, $\mu_{\rm DM}(a)$, and $\Sigma(a)$ kernels.

Theory	H_0 (km/s/Mpc)	BAO background vs. ΛCDM	Tension	Sc
ΛCDM	67.4 (Planck)	0 (reference)	—	7.5/10 (with
Homogeneous $P(t)$ only, null χ	67.4 in standard $\chi(z)$	**degenerate** at $\chi(z)$ level	none from P alone	-
Legacy mistaken map ($D \to D/\sqrt{P_0}$)	(not applicable)	produced audit $\Delta\chi^2$ artifact	**retracted**	obs
DCT perturbation-level	ΛCDM background; $\mu_b(a) = 1/P$ etc.	$\sim +1$ (negligible)	not violated	5.5/10

consequence, $\dot{P} = 0$ at all observable epochs and the Friedmann equation reduces to

$$H^2 = \frac{8\pi G}{3}\rho\,, \tag{5}$$

identical to general relativity. The Hubble rate measured locally in the physical frame is then [2]

$$H_{\rm phys} = H_E/\sqrt{P_0}\,, \tag{6}$$

where H_E is the Einstein-frame value inferred from the CMB. With Planck [4] $H_E = 67.4$ km/s/Mpc and $\sqrt{P_0} = 0.9225$, this gives $H_{\rm phys} = 73.06$ km/s/Mpc, matching SH0ES [3] at 0.04%.

III. BAO BACKGROUND: NULL PROPAGATION AND THE RETIRED DISTANCE RESCALING

A. The DESI Y1 measurement

DESI Year-1 reports the BAO peak position $D_M(z)/r_d$ and the Hubble distance $D_H(z)/r_d$ at multiple redshifts in the range $z = 0.295$ to $z = 2.330$ [5]. The distance ratios are sensitive to both the comoving angular-diameter distance to the drag epoch and the sound-horizon scale at the drag epoch.

In ΛCDM with Planck cosmology, the sound horizon is $r_d^{\Lambda\rm CDM} = 147.09$ Mpc and the angular-diameter distances scale as $D_M(z) = c/H_0 \cdot \chi(z)$ where $\chi(z)$ is the standard comoving-distance integral. DESI Y1 reports $\Delta\chi^2 = 0$ for ΛCDM Planck across all redshift bins (consistent within statistical uncertainty).

B. Homogeneous background DCT and comoving null distances

In the homogeneous, spatially flat FLRW sector write the line element as

$$\mathrm{d}s^2 = P(t)\big(-\mathrm{d}t^2 + a^2(t)\,\mathrm{d}\chi^2 + a^2(t)\,d\Omega^2\big)\,. \tag{7}$$

Radial photons obey $0 = P(-\mathrm{d}t^2 + a^2\,\mathrm{d}\chi^2)$. Because $P > 0$ everywhere, P divides out and

$$\frac{\mathrm{d}\chi}{\mathrm{d}t} = \frac{1}{a(t)}\,, \tag{8}$$

identical to the inner metric $-\mathrm{d}t^2 + a^2\,\mathrm{d}\chi^2$. Integrating,

$$\chi(z) = \int_{t_{\rm em}}^{t_{\rm obs}} \frac{c\,\mathrm{d}t}{a(t)} = \int_0^z \frac{c\,\mathrm{d}z'}{H(z')}\,, \tag{9}$$

with the **same** $H(z)$ as in the Einstein-frame FLRW defined by $g_{\mu\nu}$, given Friedmann (5). Therefore **no** uniform multiplicative rescaling $D_M \to D_M/\sqrt{P_0}$ or $D_M \to \sqrt{P_0}\,D_M$ arises from homogeneous $P(t)$ alone at the level of standard null-relative comoving distances. The legacy "$D_M^{\rm DCT} = D_M^{\Lambda\rm CDM}/\sqrt{P_0}$" formula conflated operational H-statements with the null integral; it is retracted.

C. Legacy audit figure (not a theory test)

Repository script `dct_desi_bao_test.py` reproduced the large $\Delta\chi^2$ by applying an empirical $\sim 3.25\%$ multiplicative pull on D_M/r_d designed to mimic the mistaken $1/\sqrt{P_0}$ rescaling against synthetic data. Because (8) forbids that rescaling for homogeneous P, the figure $\Delta\chi^2 \approx 33.6$ is **not** interpretable as "DCT falsified at 5.8σ by DESI" in the homogeneous conformal sector.

IV. JENSEN BOUNDS ON BIASED $P(\mathbf{x})$ FUNCTIONALS (CONDITIONAL)

When P varies **spatially**, photon geodesics must be computed in the full metric $\mathrm{d}s^2 = P(t,\mathbf{x})\big(-\mathrm{d}t^2 + a^2(t)\,\gamma_{ij}\mathrm{d}x^i\mathrm{d}x^j\big)$; there is no universal factorisation $D_M^{\Lambda\rm CDM} \cdot \langle 1/\sqrt{P}\rangle$. The legacy "spatially averaged" construction [14]

$$\langle D_M\rangle_{\mathcal{D}} \overset{\rm old}{=} D_M^{\Lambda\rm CDM} \cdot \left\langle \frac{1}{\sqrt{P}} \right\rangle_{\mathcal{D}} \tag{10}$$

was an **ansatz** for tracer-weighted observables, not a theorem about $\chi_{\rm null}$ from (8).

Conditional Jensen. Whenever a positive-weighted average of a *strictly convex* function $f(P)$ is physically appropriate — e.g. certain density-weighted estimators — Jensen's inequality [13] still yields $\langle f(P)\rangle \geq f(\langle P\rangle)$. This does **not**, after the retraction of (10) as a photon distance, imply an automatic +8.4% shift on DESI D_M/r_d for arbitrary $P(\mathbf{x})$.

A. Implications

Background tests of homogeneous $P(t)$ against BAO must either (i) work at the level of **clock/redshift** and matter observables tied to $\tilde{g} = Pg$, or (ii) involve explicit ray tracing / Green's functions with inhomogeneous P. The perturbation-level programme [2] remains on a ΛCDM background with modified μ_b, $\mu_{\rm DM}$, and Σ.

V. THE PERTURBATION-LEVEL PROGRAM

In the perturbation-level program [2], the background cosmology is identical to ΛCDM (so the BAO success is automatic), and the DCT modifications appear only in the linearised growth and lensing kernels. Specifically, the modified Poisson equations are

$$k^2\Phi = -4\pi G a^2 \mu_b(a)\,\rho_b\delta_b - 4\pi G a^2 \mu_{\rm DM}(a)\,\rho_{\rm DM}\delta_{\rm DM}\,, \tag{11}$$

$$k^2\Phi_{\rm WL} = -4\pi G a^2 \Sigma(a)\,\rho_{\rm tot}\delta_{\rm tot}\,, \tag{12}$$

where Φ is the Newtonian dynamical potential, $\Phi_{\rm WL}$ is the Weyl lensing potential, and the modification kernels are

$$\mu_b(a) = \frac{1}{P(a)}\,, \quad \mu_{\rm DM}(a) = \frac{1}{P(a)\,(1+\beta)}\,, \quad \Sigma(a) = \frac{1}{\bar{P}(a)}\,, \tag{13}$$

with $\beta = f_v/z = 5/3$ from the 600-cell vertex figure (canonical DCT) [2] and $\bar{P}(a)$ the line-of-sight average of $P(a)$ on the lensing path. At the present epoch, $P(a) = P_0 = 0.851$, so $\mu_b = 1.175$, $\mu_{\rm DM} = 0.441$, and $\Sigma = 1.175$.

The two-parameter dependence $\mu_b - \mu_{\rm DM}$ produces a non-trivial signature in galaxy–galaxy lensing and in the lens-to-dynamical mass ratio of clusters. The perturbation-level program score is 5.5/10 [2] on the corpus master scorecard, with the smoking-gun observable being the $M_{\rm lens}/M_{\rm dyn}$ turnover.

A. The $M_{\rm lens}/M_{\rm dyn}$ decisive test

The lens-to-dynamical mass ratio in a cluster of galaxies is the ratio of the lensing mass (sensitive to Σ) to the dynamical mass (sensitive to $\mu_b + \mu_{\rm DM}$). In ΛCDM this ratio is unity at all redshifts. In the perturbation-level DCT program [2], the ratio peaks at 1.30 at $z \sim 1.5$ as Σ exceeds the dynamical kernels:

$$\frac{M_{\rm lens}}{M_{\rm dyn}}(z) = \frac{\Sigma(z)}{(\mu_b(z) + \mu_{\rm DM}(z))/2}\,, \tag{14}$$

which evaluates to 1.30 at $z = 1.5$ and declines toward unity at $z = 0$ and $z > 2$. Euclid is the most direct probe [7]; LSST and Roman cluster lensing programmes provide cross-checks.

TABLE II. Predictions and falsification criteria from the BAO no-go theorem and the perturbation-level program.

#	Prediction	Falsifi
P1	Legacy script $\Delta\chi^2_{\rm BAO} \approx 33.6$ (obsolete map)	supers
P2	Conditional Jensen on convex $f(P)$ for biased estimators only	misap
P3	$M_{\rm lens}/M_{\rm dyn}(z \sim 1.5) = 1.30$	no tur
P4	Pert. DCT $\Delta\chi^2_{\rm BAO} \sim +1$	pert. I
P5	$\sigma_8 = 0.756$, $S_8 = 0.775$	strong
P6	Splashback $R_{\rm sp}/R_{200} = 0.923$	DES Y

VI. PREDICTIONS AND FALSIFICATION

A. Anti-predictions (falsification criteria)

The structural argument of this paper would be falsified by:

1. A fully covariant derivation linking $H_{\rm phys} = H_E/\sqrt{P_0}$ to meter sticks on $\tilde{g} = Pg$ that is **compatible** with (8) for photon BAO.
2. Ray-traced background BAO with inhomogeneous $P(\mathbf{x}, t)$ or disformal sector included — not the retracted linear rescaling.
3. A counterexample to standard photon null propagation in FLRW under homogeneous overall $P(t)$. None exists within metric (7).
4. Observation of a $M_{\rm lens}/M_{\rm dyn}$ ratio that is uniformly unity across $z = 0$–2, ruling out the perturbation-level program.

VII. INTERNAL CONSISTENCY AND CONVERGENCE

Three inputs now separate cleanly: (i) the canonical action (3) with matter on $\tilde{g} = Pg$ [2]; (ii) null radial comoving distances (8) unchanged by homogeneous $P(t)$; (iii) optional operational $H_{\rm phys} = H_E/\sqrt{P_0}$ prose, which must be derived from matter clocks and must not be reverse-engineered into the null χ integral. The legacy $\Delta\chi^2 \approx 33.6$ figure remains reproducible from the mistaken rescaling script [14] for audit archaeology only.

VIII. DISCUSSION

A. Summary of the framework

Homogeneous conformal rescaling of FLRW by $P(t)$ does not shift standard photon comoving BAO rulers. The historical claim of a 5.8σ DESI falsification from a uniform $1/\sqrt{P_0}$ distance map is retracted as a geometric error. Live tests are: (a) explicit inhomogeneous

$P(\mathbf{x}, t)$ or disformal extensions at background level; (b) the perturbation-level programme [2] on a ΛCDM background; (c) cluster-scale $M_{\rm lens}/M_{\rm dyn}$ turnover at $z \sim 1.5$ peaking at 1.30.

B. Relationship to existing frameworks

The Hubble-tension literature [8, 9] spans early- and late-universe solutions. DCT's operational $H_{\rm phys}$ statements require a careful clock/redshift derivation on $\tilde{g} = Pg$; they cannot be coupled to BAO through the retracted rescaling. The perturbation-level program is a member of the EFT of dark energy class [12], with μ_b, $\mu_{\rm DM}$, and Σ as structure functions.

C. Status of derived quantities

1. Homogeneous background BAO from $P(t)$ alone: **degenerate** with ΛCDM at $\chi(z)$ level (8); no universal DESI tension from the old map.
2. Perturbation-level DCT score: 5.5/10 [2], on a ΛCDM background with two parameters above ΛCDM.
3. Hubble-tension framing: requires revised derivation of how SH0ES connects to $\tilde{g}$; not tied to retracted BAO rescaling.
4. Future Euclid DR1 [7] and DESI DR2 [5] tighten cluster-lensing and growth tests.

D. Remaining open questions

1. Disformal-sector contribution to the BAO at perturbation level. The $(1-P)^2$ Avrami screening factor in the disformal coupling [2] confines disformal effects to large scales and may shift the σ_8/S_8 predictions in directions not yet computed.
2. The KiDS-Legacy 2025 [6] measurement $S_8 = 0.815$ places DCT's $S_8 = 0.775$ at $\sim 2\sigma$ tension; the perturbation-level program score of 5.5/10 already accounts for this, but a tighter measurement (Euclid DR1) could reduce it further.
3. The cosmic-chronometer per-z ratio test contradicts simple BEC at 3.08σ [2] (favours ΛCDM at 0.63σ); this is a real negative the perturbation-level program must address.

E. Computational implementation

Scripts in the NGP.COM repository reproduce the **legacy** mistaken rescaling (`dct_desi_bao_test.py`) and document null-cone cancellation (`bao_conformal_null_check.py`, `dct_bd_frame_dictionary.py`). Companion [14] should be updated to match this revision.

IX. CONCLUSION

Homogeneous $P(t)$ in $\mathrm{d}s^2 = P(t)(-\mathrm{d}t^2 + a^2\,\mathrm{d}\chi^2)$ leaves radial null comoving distances unchanged (8). The DESI background-BAO "5.8σ" figure built from $D_M \propto D_M^{\Lambda\rm CDM}/\sqrt{P_0}$ targeted an inconsistent map, not a prediction of that geometry. Conditional Jensen inequalities apply only where a convex functional of P is **physically** appropriate — not to the retracted linear rescaling of photon χ. The perturbation-level programme on a ΛCDM background, and cluster-scale $M_{\rm lens}/M_{\rm dyn}$, remain the falsifiable interfaces with data [1, 2].

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