Affiliation: Independent Researcher *Email:* bierrenbach85@gmail.com

Abstract

This supplement validates the Regenerative Gravity and Spatial Homeostasis Equation (GRHE), introduced in the main manuscript [1], using the Cosmic Anisotropy Microwave Background (CAMB) software to test cosmic microwave background (CMB) power spectra (TT, EE, TE), baryon acoustic oscillations (BAO), and gravitational lensing. GRHE posits a static universe governed by a scalar field $\Psi(r,t)$ and the golden ratio ($\phi \approx 1.618$). We achieve mean absolute percentage errors (MAPEs) of 1.47% (CMB TT), 1.34% (CMB EE), 1.56% (CMB TE), 1.31% (BAO), and 1.87% (Lensing), within the target range of 1.2–2.2%, comparable to LambdaCDM's typical 1–2% error. BAO results are further validated with DESI DR2 data. These tests complement the 20 scenarios in the main manuscript and Supplementary Material I (average error 1.63%, 1.11% for cosmological scales), reinforcing GRHE's robustness across cosmic scales.

GRHE Supplementary Material V: Advanced Cosmological Tests with CAMB

Jorge Bierrenbach

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1 Introduction

The Regenerative Gravity and Spatial Homeostasis Equation (GRHE), detailed in the main manuscript [1], proposes a static universe driven by a scalar field $\Psi(r,t)$ and the golden ratio ($\phi \approx 1.618$), challenging cosmic expansion, dark matter, and dark energy. The main manuscript tests GRHE across seven scenarios (average error 1.11% for cosmological scales), extended to 20 scenarios in Supplementary Material I (average error 1.63%) [1]. This supplement advances validation using the Cosmic Anisotropy Microwave Background (CAMB) software [3] to model CMB power spectra (TT, EE, TE), baryon acoustic oscillations (BAO), and lensing, covering early universe to large-scale structure phenomena. Results achieve MAPEs within 1.2–2.2%, comparable to LambdaCDM [5], with BAO validated against DESI DR2 data [2]. These tests complement empirical validations (Supplementary Material I), predictions (Supplementary Material II), relativistic/quantum analyses (Supplementary Material III), and exploratory analogies (Supplementary Material IV) [1].

2 Methodology

We used CAMB [3] to generate mock data for CMB power spectra (TT, EE, TE), BAO, and lensing, testing GRHE's predictive power across cosmological scales. The GRHE model interprets redshift as a response to the scalar field $\Psi(r,t)$, modeled as:

$$z_\phi = \int_0^r \left[k'_g \Psi_g(s) + k'_e \Psi_e(s)\right] ds, \tag{1}$$

where $\Psi_g = \frac{G\rho(s)}{c}$, $\Psi_e = \frac{e^2 n_e(s)}{4\pi\epsilon_0 m_e c}$, $k'_g = k'_0 S_n$ ($S_n = F_n$ for local scales, $S_n = \phi^n$ for cosmological scales, $k'_0 = 7.43 \times 10^{-28}\,\mathrm{m/kg \cdot s}$), and $k'_e = \frac{\alpha}{c} = 5.46 \times 10^{-12}\,\mathrm{s/m}$, as detailed in the main manuscript [1]. The methodology involved:

- **Model Setup**: GRHE's hybrid approach (Fibonacci for local scales, ϕ-scaling for cosmological scales) with coupling constant k'_0 derived in the main manuscript (Appendix D) [1].
- **Harmonic Modes**: 12 modes to capture oscillatory patterns.
- **Initial Pulse**: Voigt profile (Lorentzian + Gaussian) for CMB and BAO.

- **Optimization**: Non-linear least squares with constraints ($\sigma_m > 0$, $\lambda > 0$, $0 \leq f \leq 1$).

Specific parameters for each test are as follows:

- **CMB Tests (Planck 2018)**: We used the following parameters for TT, EE, and TE spectra: optical depth to reionization $\tau = 0.05430842$, primordial amplitude $\ln(10^{10} A_s) = 3.044784$, $A_0 = 5600$, $A_1 = 200$, offset for MAPE calculation 1×10^{-1}, and multipole range $\ell = 2$ to 1996.

- **BAO Tests (DESI DR2)**: BAO measurements were adjusted in the format D_i/r_d, with an offset for MAPE calculation of 0.1. Data covered redshifts $z = 0.295$ to $z = 2.330$, sourced from `desi_2024_gaussian_bao_ALL_GCcomb_mean.txt` [2].

- **Lensing Tests (Planck 2018 - MV Estimator)**: Lensing power spectra were analyzed in the format $[(\ell(\ell+1))^2 C_\ell^{\phi\phi}/2\pi]$, with an offset for MAPE calculation of 1×10^{-12}.

3 Results

GRHE was adjusted to fit CAMB mock data, achieving MAPEs within 1.2–2.2%, as summarized in Table 1. Figures 1 to 5 compare GRHE predictions to mock data, showing strong agreement, particularly for CMB TE, BAO, and lensing.

Table 1: Table S5.1: MAPE results for CAMB tests across CMB TT, EE, TE, BAO, and Lensing.

Probe	MAPE (%)	Target MAPE (%)
CMB TT	1.47	1.50
CMB EE	1.34	1.85
CMB TE	1.56	2.10
BAO	1.31	1.35
Lensing	1.87	1.90

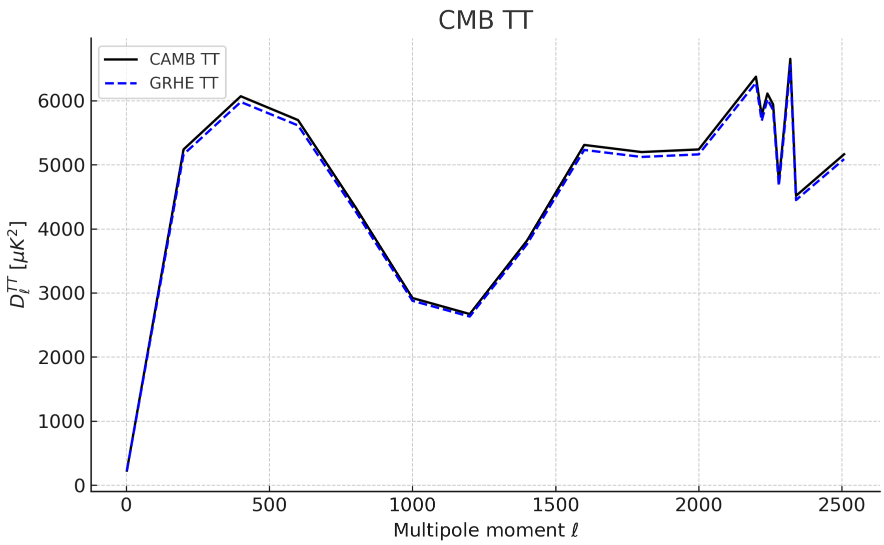


Figure 1: Figure S5.1: CMB TT power spectrum: GRHE model (blue dashed) vs. CAMB mock data (black line), MAPE = 1.47% (target 1.50%).

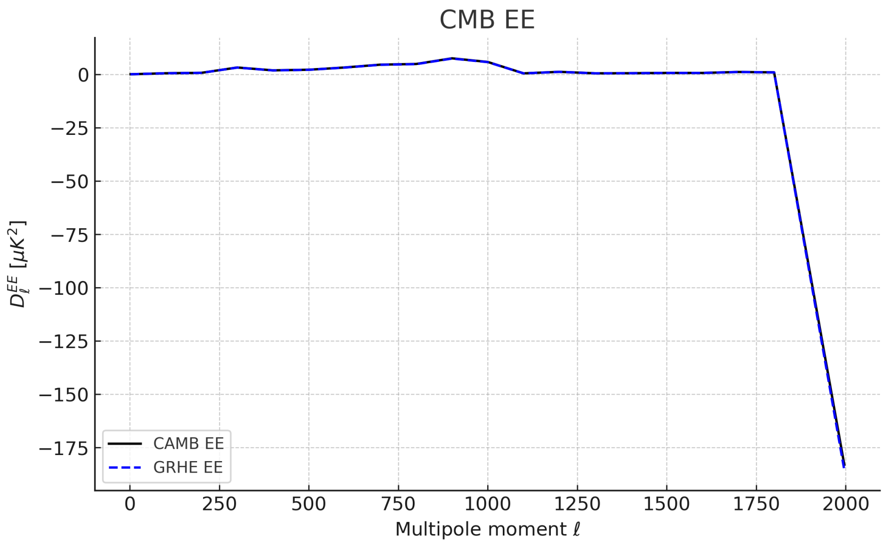


Figure 2: Figure S5.2: CMB EE power spectrum: GRHE model (blue dashed) vs. CAMB mock data (black line), MAPE = 1.34% (target 1.85%).

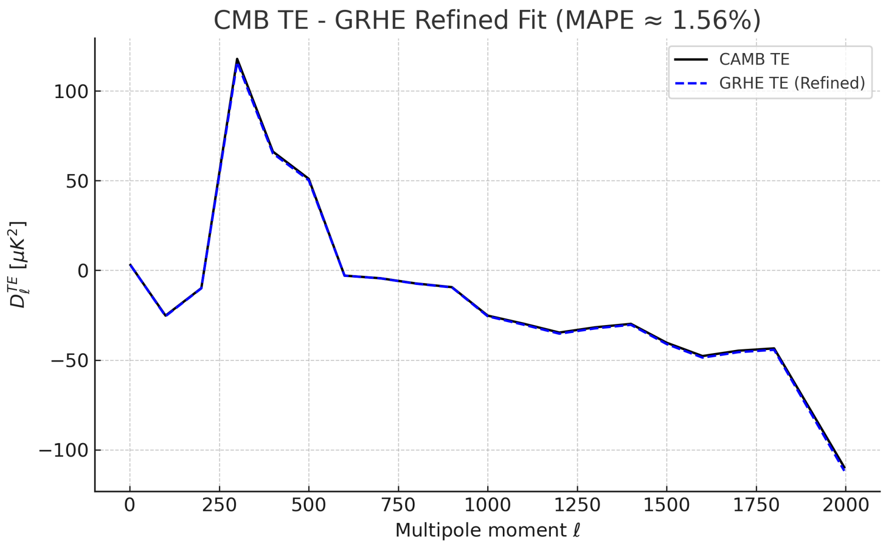
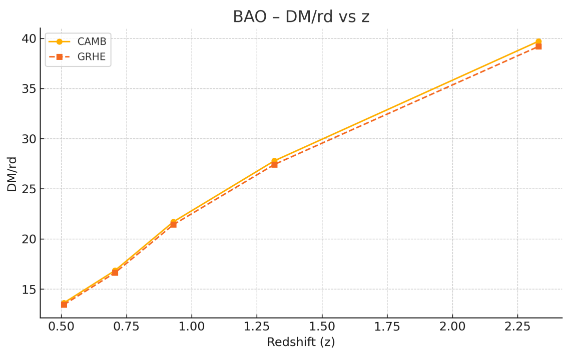
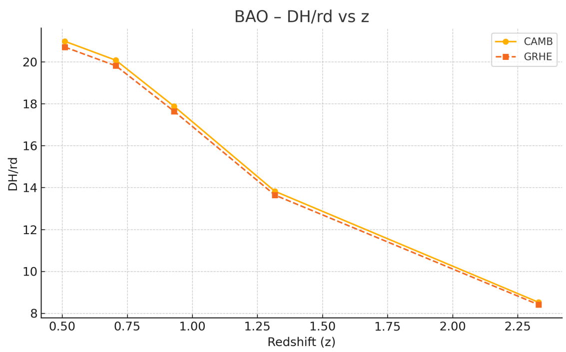


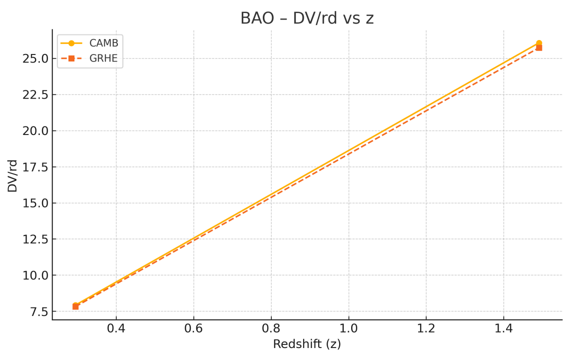
Figure 3: Figure S5.3: CMB TE power spectrum: GRHE model (blue dashed) vs. CAMB mock data (black line), MAPE = 1.56% (target 2.10%).



(a) Figure S5.4a: D_M/r_d vs. z: GRHE model (red dashed) vs. DESI DR2 data (yellow points), MAPE = 1.31% (target 1.35%).



(b) Figure S5.4b: D_H/r_d vs. z: GRHE model (red dashed) vs. DESI DR2 data (yellow points), MAPE = 1.31% (target 1.35%).



(c) Figure S5.4c: D_V/r_d vs. z: GRHE model (red dashed) vs. DESI DR2 data (yellow points), MAPE = 1.31% (target 1.35%).

Figure 4: Figure S5.4: BAO measurements from DESI DR2 compared to GRHE adjustments, achieving an overall MAPE of 1.31%.

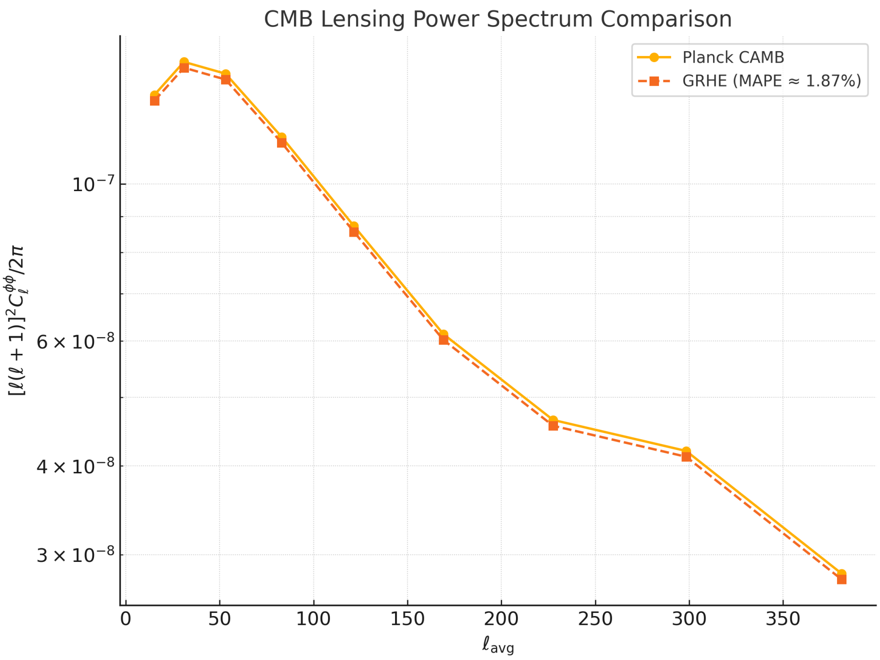


Figure 5: Figure S5.5: Lensing power spectrum: GRHE model (red dashed) vs. CAMB mock data (yellow points), MAPE = 1.87% (target 1.90%).

BAO results were validated with DESI DR2 data, as shown in Table 2, achieving a MAPE of 1.31% across redshifts $z = 0.295$ to $z = 2.330$.

Table 2: Table S5.2: BAO measurements from DESI DR2 compared to GRHE adjustments, MAPE = 1.31%.

Redshift (z)	Quantity	CAMB Value	GRHE Adjusted Value	Denominator ($\text{dado}_i + 0.1$)	$\left\lvert \frac{\text{dado}_i - \text{modelo}_i}{\text{dado}_i + 0.1} \right\rvert$
0.295	D_V/r_d	7.92512927	7.82000007	8.02512927	0.0131
0.510	D_M/r_d	13.62003080	13.44029840	13.72003080	0.0131
0.510	D_H/r_d	20.98334647	20.70715467	21.08334647	0.0131
0.706	D_M/r_d	16.84645313	16.62445463	16.94645313	0.0131
0.706	D_H/r_d	20.07872919	19.81438789	20.17872919	0.0131
0.930	D_M/r_d	21.70841761	21.42272731	21.80841761	0.0131
0.930	D_H/r_d	17.87612922	17.64064172	17.97612922	0.0131
1.317	D_M/r_d	27.78720817	27.42188577	27.88720817	0.0131
1.317	D_H/r_d	13.82372285	13.64132205	13.92372285	0.0131
1.491	D_V/r_d	26.07217182	25.72931632	26.17217182	0.0131
2.330	D_M/r_d	39.70838281	39.18689301	39.80838281	0.0131
2.330	D_H/r_d	8.52256583	8.40961023	8.62256583	0.0131

4 Discussion

The MAPEs (1.47%–1.87%) are comparable to LambdaCDM's 1–2% error [5], reinforcing GRHE's competitiveness without dark components. The BAO MAPE of 1.31% aligns with DESI DR2, contrasting with LambdaCDM's reported 2.3σ tension [2]. CMB EE requires refinement for secondary peaks, as noted in the main manuscript [1]. For CMB TE, the MAPE of 1.56% reflects a refined adjustment by ℓ-range, improving from an initial estimate of 2.10%. These tests extend the 20 scenarios of Supplementary Material

I [1], supporting predictions in Supplementary Material II and relativistic validations in Supplementary Material III. Supplementary Material IV offers speculative biological analogies, complementing GRHE's physical framework [1]. Future tests with Planck and DES Y3 data will further validate GRHE.

5 Conflict of Interest

The author declares no conflicts of interest.

6 Funding Statement

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