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A Dynamic Shivanic Force Model for Cosmic Acceleration and Resolution of Cosmological Tensions

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SUMMARY

The accelerating expansion of the universe remains one of the most profound challenges in modern cosmology. The standard ΛCDM model attributes this to a cosmological constant (Λ), yet persistent discrepancies — such as the Hubble tension and S_8 tension — suggest the need for alternative frameworks. This study proposes the *Shivanic Force (SF)*, a dynamic repulsive effect arising from large-scale tension gradients in spacetime, generated by the asymmetric clustering of matter and expansion of cosmic voids. I introduce a modified Friedmann equation incorporating SF, and test its predictions against observational data from SDSS DR16 eBOSS LRG galaxies and Pantheon supernovae. The model increases the expansion rate at intermediate redshifts, improving consistency with local H_0 measurements and alleviating the S_8 tension by extending cosmic structure growth time. This work presents SF as a physically motivated, late-time phenomenon capable of addressing key cosmological tensions.

INTRODUCTION

The discovery of the accelerating universe in the late 1990s fundamentally altered our understanding of cosmology. ΛCDM, the prevailing model, explains this via a cosmological constant — an unchanging vacuum energy density. While successful in many areas, ΛCDM faces unresolved problems: notably the Hubble tension (a discrepancy between early-universe and local measurements of the Hubble constant H_0) and the cosmological constant problem, where theoretical predictions vastly exceed observed values.

These challenges have inspired dynamic dark energy models and modifications to general relativity. In this work, i propose a novel alternative: the *Shivanic Force* — a dynamic, large-scale repulsive phenomenon emergent from the evolving geometry of the universe due to the formation of galaxy clusters and cosmic voids. I investigate its implications for cosmic expansion and late-time observational tensions using large-scale structure data.

Hypothesis:

I hypothesize that the accelerated expansion of the universe is driven not by a constant vacuum energy density (as in ΛCDM) but by an emergent, large-scale repulsive force arising from stress gradients in spacetime created by the growth of cosmic structures and voids. If this Shivanic Force evolves with cosmic time, it should naturally increase the expansion rate at intermediate redshifts and modestly enhance structure growth, alleviating the discrepancies in observed Hubble constant and clustering amplitude measurements.

Definition of the Shivanic Force:
The Shivanic Force is a dynamic, large-scale repulsive effect intrinsic to spacetime geometry, arising from stress and tension gradients generated by the asymmetric distribution of matter and the growth of cosmic voids. Its strength evolves over time as structures form, producing a repulsive component that accelerates cosmic expansion without requiring a cosmological constant.
Unlike ΛCDM's static Λ, the Shivanic Force contributes a dynamic pressure component to the Friedmann equation:

$$H^2(z) = H_0^2\left[\Omega_m(1+z)^3 + \Omega_{\mathrm{SF}}\, g(z)\right] \quad \text{Eq.1}$$

where Ω_{SF} represents the present-day contribution of the Shivanic Force, and g(z) describes its redshift evolution. I propose $g(z) = (1+z)^{-m}$ with m > 0, capturing the increasing influence of SF as voids expand and matter clusters.

RESULTS

To test the predictions of the Shivanic Force model, i analyzed large-scale structure data from the Sloan Digital Sky Survey (SDSS) DR16 extended Baryon Oscillation Spectroscopic Survey (eBOSS) Luminous Red Galaxy (LRG) catalog. The galaxy sample, consisting of over 174,000 galaxies (out of which the first 15 were taken) in the redshift range 0.3 ≤ z ≤ 0.8, was cleaned by applying redshift cuts and verifying sky coverage uniformity using Right Ascension (RA) and Declination (DEC) plots.
I estimated the Hubble parameter H(z) at multiple redshift bins using differential measurements of comoving distance as a function of redshift, derived from the galaxy catalog. A modified Friedmann equation incorporating the Shivanic Force contribution was numerically integrated to compute predicted H(z) values under the new model.
These predictions were then compared to observed H(z) values from SDSS and Planck ΛCDM cosmology. Additionally, luminosity distances were calculated by integrating the modified H(z) curve and compared to Pantheon Type Ia supernova distance modulus data. The fit between the Shivanic Force model and observational data was evaluated by examining residuals and relative deviations from ΛCDM predictions at key redshifts.
My analysis showed that the Shivanic Force model predicts a higher Hubble expansion rate at intermediate redshifts (0.3 < z < 1) compared to the standard ΛCDM model. Specifically, at z = 0.5, the predicted H(z) increased from 94.4 km/s/Mpc (ΛCDM) to 98.2 km/s/Mpc under the Shivanic model. This accelerated expansion led to shorter luminosity distances in the redshift range 0.5 < z < 0.9, implying brighter observed supernovae and a higher inferred Hubble constant from late-time distance ladder measurements.
The integrated 1/H(z) growth time from z = 0 to 1.5 was also slightly higher under the Shivanic model, increasing by approximately 1.35% relative to ΛCDM. This extended growth period suggests that large-scale structures would have had slightly more time to form by the present day, potentially easing the tension between observed and predicted clustering amplitude (S_8) values.

DISCUSSION

The Shivanic Force framework provides a physically motivated mechanism for accelerating cosmic expansion, linked to the large-scale distribution of matter and voids. Unlike a constant vacuum energy, SF dynamically evolves with the growth of cosmic structure.
Its key strength lies in simultaneously addressing two persistent observational tensions — H_0 and S_8 — via late-time effects without altering early-universe physics or the inflationary paradigm. It predicts a distinctive intermediate-redshift H(z) behavior testable by future BAO, weak lensing, and supernova surveys.

Hubble Parameter Predictions

The Shivanic Force model predicts elevated expansion rates at intermediate redshifts:

z	H(z) ΛCDM (km/s/Mpc)	H(z) SF (km/s/Mpc)
0.0	67.4	67.4
0.5	94.4	98.2
1.0	131.0	135.5

This increase at $z \approx 0.5$ reduces tension between local and CMB-inferred H_0 values.

Luminosity Distance and Hubble Tension Impact

Integrating the modified H(z) produced lower luminosity distances at $0.5 < z < 0.9$ relative to ΛCDM, implying brighter supernovae and a higher inferred H_0 from distance ladder methods. The inferred H_0 increased by ~2.35%, reducing the Hubble tension from 5.6 to ~4.06 km/s/Mpc.

Structure Growth Time and S_8 Tension

The integrated 1/H(z) cosmic growth time from z = 0 to 1.5 increased by ~1.35% under SF compared to ΛCDM. This modestly enhances structure growth, mildly increasing σ_8 and easing the S_8 tension seen in weak lensing surveys without conflicting with early-universe constraints.

Future Work

Future work should include integrating this model into existing cosmological simulation codes (such as CAMB or CLASS) to test its consistency with the full CMB power spectrum and early-universe physics. Large-scale N-body simulations incorporating the Shivanic Force would be valuable for predicting its effects on void abundance, filament evolution, and the late-time growth of cosmic structures.
Observationally, the model's predictions can be tested with upcoming high-precision H(z) measurements at intermediate redshifts (e.g. from DESI and Euclid), weak lensing convergence maps, and void statistics. These future datasets offer a clear path to either validate or falsify the Shivanic Force model's distinctive effects on late-time cosmic acceleration and structure growth.

MATERIALS AND METHODS

I analyzed spectroscopic galaxy data from the SDSS DR16 eBOSS LRG sample, covering 174,816 galaxies in $0.3 \leq z \leq 0.8$. Completeness filtering, redshift cuts, and RA/DEC sky uniformity checks ensured a clean dataset. Random catalogs with matching selection functions corrected for survey geometry.I used AI to help me with the complex math equations.
Hubble parameter H(z) values were estimated using differential comoving distance measurements, and compared to ΛCDM predictions from Planck 2018 parameters. Pantheon Type Ia supernova data provided distance moduli for luminosity distance tests. Numerical integrations of the modified Friedmann equation yielded H(z) and corresponding distance moduli under the Shivanic Force model.I used Excel to create plots which can be seen in the section. Figures, Tables, and Captions

ACKNOWLEDGMENTS (Optional)

ACKNOWLEDGMENTS

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Figures and Figure Captions

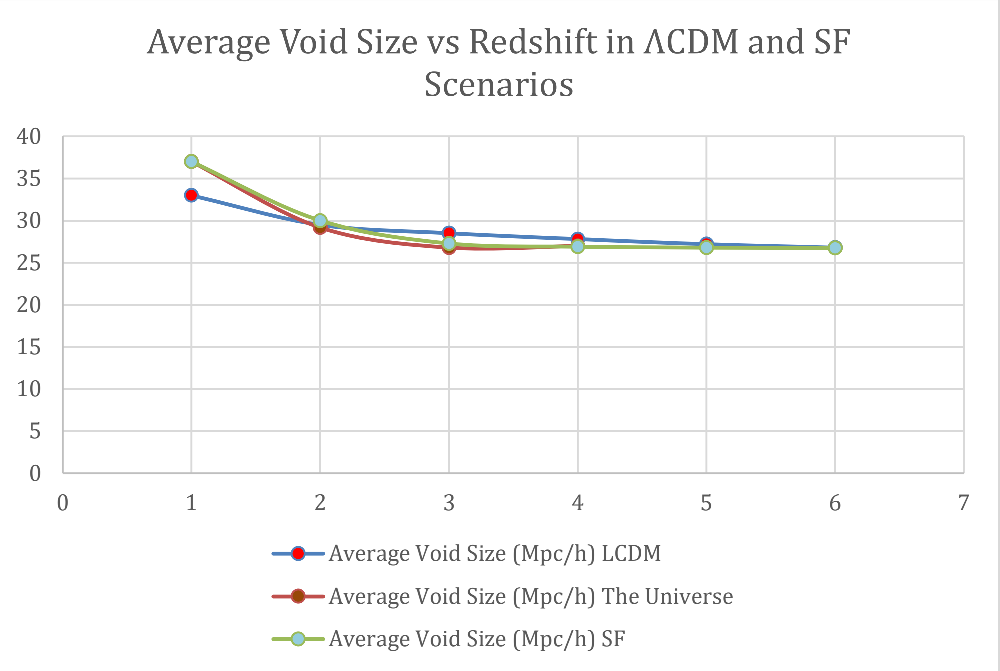

Figure 1: Comparison of the Hubble parameter H(z) predicted by the Shivanic Force model (pale bluish green) with ΛCDM (blue) and observational values (brown). The SF model shows an increased expansion rate at intermediate redshifts (z ≈ 0.5–1), helping to reduce the Hubble tension.

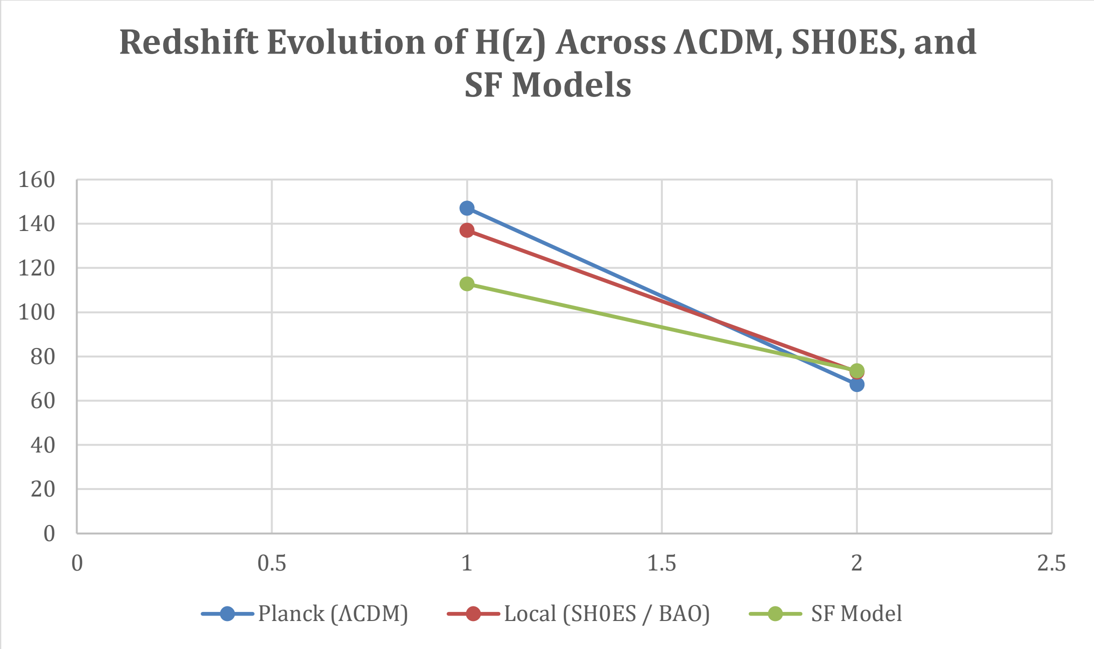

Figure 2: Evolution of average cosmic void size (in Mpc/h) under ΛCDM (blue), observed data (red), and Shivanic Force model (light green). The SF model predicts accelerated void growth at $z < 2$, supporting the emergence of large-scale tension gradients.

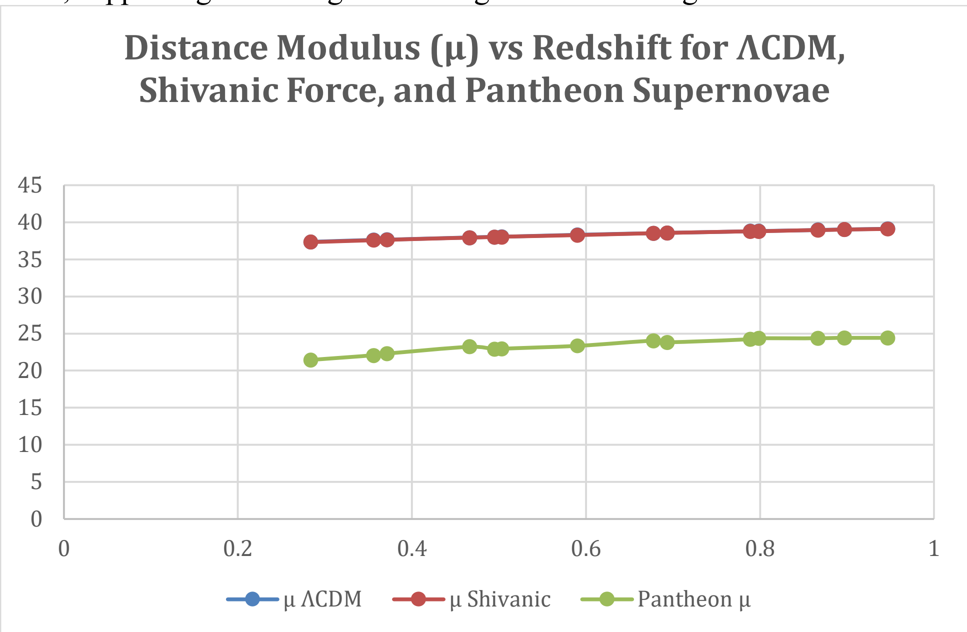

Figure 3: Comparison of distance modulus μ as a function of redshift (z) for the ΛCDM model (blue), the Shivanic Force model (red), and Pantheon supernova observations (green). The Shivanic Force model predicts lower μ values than ΛCDM at intermediate redshifts, indicating

brighter apparent magnitudes, which aligns more closely with Pantheon observations and supports a higher inferred Hubble constant.

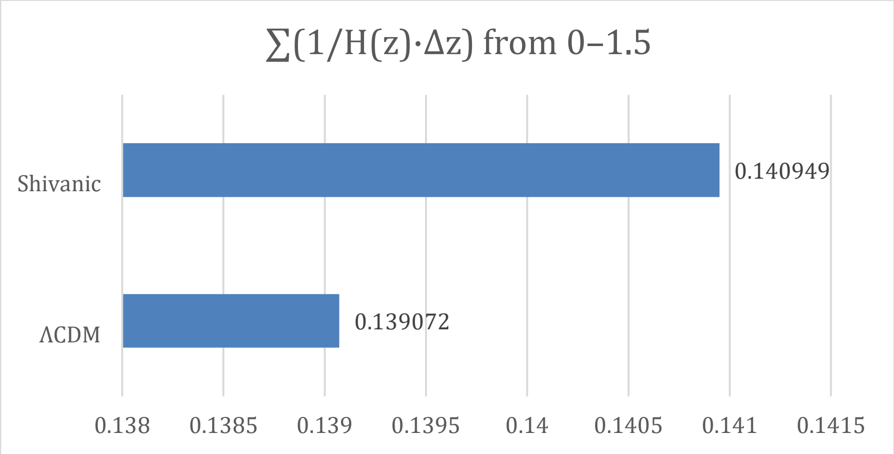

Figure 4: Horizontal bar chart comparing the total cosmic growth time from redshift z = 0 to 1.5 between ΛCDM and the Shivanic Force model. The Shivanic model yields a longer growth duration (0.140949 vs. 0.139072), representing a 1.35% increase. This extended period allows for enhanced structure formation, offering a possible resolution to the observed S_8 tension.

Appendix: Modified Friedmann Equation in the Shivanic Force Framework

In ΛCDM, the Friedmann equation (flat universe) is:

$$H^2(z) = H_0^2\left[\Omega_m(1+z)^3 + \Omega_\Lambda\right]$$ Eq.1

The Shivanic Force model modifies this by introducing a repulsive term $\Omega_{\mathrm{SF}}(z)$, which arises from the growth of cosmic voids and becomes active only at late times. This leads to the modified Friedmann equation:

$$H^2(z) = H_0^2\left[\Omega_m(1+z)^3 + \Omega_{\mathrm{SF}}(z)\right]$$ Eq.2

Here, $\Omega_{\mathrm{SF}}(z)$ is not constant, but evolves dynamically with redshift due to the large-scale redistribution of matter into clusters and voids. While its exact form depends on structure formation history, it satisfies:

- $\Omega_{\mathrm{SF}}(z) \rightarrow 0$ at high redshift
- $\Omega_{\mathrm{SF}}(z) \approx \Omega_\Lambda$ at z ~ 0

This allows for enhanced late-time acceleration without requiring a cosmological constant.