

# Fractal Causality — Whitepaper Part III: Falsifiability, Testing, and References

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## E) Falsification Criteria

Most vulnerable predictions:

- Wrong sign of  $f_{NL}$  at measured  $n_s$  (e.g.,  $n_s \sim 0.965$  but  $f_{NL} \ll 0$ ).
- No scale dependence in  $r(k)$  when model predicts running.
- $|\delta r_s| > 1e-3$  from BAO would violate mass-spectrum constraints.
- Absence of predicted 21 cm oscillations in SKA sensitivity bands.

Smoking-gun confirmations:

- Correlated CMB anomalies with predicted  $f_{NL}$  and  $n_s$ .
- LISA stochastic background with the model's spectral slope.
- Euclid/DESI detection of  $P(k)$  log-oscillations.

## How to Test Fractal Causality (Practical Guide)

- 1) CMB: use Planck 2018 and successors to jointly fit  $n_s$ ,  $f_{NL}$ ,  $r$  with predicted correlations.
- 2) LSS: search for log-periodic oscillations in matter power; precision-test BAO scale at  $1e-4$  to  $1e-3$ .
- 3) GWs: target  $r \geq 0.03$ ,  $n_t \sim 3 - \alpha$  in the mHz band (LISA).
- 4) 21 cm: test  $\Delta P/P \sim 1e-3$  for  $k \sim 0.01-0.1 \text{ Mpc}^{-1}$  at  $z \sim 10-20$  (SKA).
- 5) Halo demographics: look for clustering excesses at  $M \sim 1e^{13} - 1e^{15} \text{ Msun}$ .

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