

21 – Undressing the Emperor

A Historical and conceptual dismantling of the FLRW ansatz

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Abstract

The Friedmann–Robertson–Walker (FLRW) ansatz has become so embedded in modern cosmology that it is often mistaken for a consequence of the Einstein field equations rather than a discretionary symmetry assumption. Its historical emergence owed more to mathematical convenience, philosophical preference and intellectual fashion than to empirical mandate. Once installed, it became insulated from Popperian scrutiny: tensions and anomalies are invariably attributed to matter content, initial conditions or instrumentation, while the underlying geometry remains exempt from re-examination. This essay traces the origins,

consolidation and cultural entrenchment of the FLRW ansatz, and examines why it remains beyond criticism even when its offspring, Λ CDM, is continually on trial. The Time-Symmetric Parity Constraint (TSPC) offers an alternative approach in which the geometry itself is constrained and, crucially, falsifiable. The purpose here is not to deny the practical successes built upon FLRW, but to expose the unexamined assumptions that have protected it from challenge. The Emperor's clothes have been admired for a century. It is time to look more closely at what, precisely, he is wearing.

1. A Convenient Universe: How the FLRW ansatz was born

The history begins not with observation but with a preference.

When Einstein published his 1917 cosmological paper, he was faced with a theoretical embarrassment.¹ General relativity strongly encourages dynamical spacetimes. Einstein preferred a static universe which was philosophically attractive to him at the time. The most straightforward way out was to impose maximal symmetry: homogeneous and isotropic spatial slices with constant curvature. These assumptions were not inferred from evidence; they were imposed because they made the field equations soluble. The resulting cosmos was smooth, calm and compliant, provided the newly introduced cosmological constant held everything in place.

de Sitter, working at the same time, took an entirely different path.² His solution was empty of matter yet driven by Λ into exponential behaviour. It violated Einstein's philosophical instincts but not his mathematics. The contrast already revealed the

¹ A. Einstein, *Kosmologische Betrachtungen zur allgemeinen Relativitätstheorie*, *Sitzungsberichte der Königlich Preussischen Akademie der Wissenschaften* (1917). Seminal paper introducing Λ and assuming global homogeneity/isotropy.

² W. de Sitter, *On the relativity of inertia*, *Koninklijke Nederlandse Akademie van Wetenschappen* (1917). Vacuum Λ solution; demonstrates non-uniqueness of symmetric cosmologies.

degree to which symmetry choices determined cosmology. Einstein's preference was not uniquely enforced by the theory.

Friedmann's papers of 1922 and 1924 removed the artificial stasis and allowed the scale factor to evolve.³ He retained the symmetry assumptions, not because he believed the universe was homogeneous and isotropic, but because the mathematics remained manageable. Einstein initially rejected Friedmann's work as erroneous;⁴ when the arithmetic was shown to be correct, Einstein conceded but did not alter his view of the physical universe.⁵ The symmetry assumption had become invisible even to the person who first imposed it.

Lemaître, in 1927, independently rediscovered the same family of solutions and made the conceptual step of linking recession velocities to metric expansion.⁶ Einstein's famously curt response, that the calculations were correct but the physics "abominable", illustrates how strongly the framework resisted reinterpretation.⁷ The geometry was fixed; the problem lay, apparently, with the evidence.

The decisive blow came from Robertson and Walker in the mid-1930s.⁸ They showed, using group theoretic methods, that a spacetime with exact spatial homogeneity and isotropy must take the FLRW form. This was a mathematical demonstration of conditional inevitability: *if* one assumes maximal symmetry, *then* the metric must be FLRW. Their achievement was substantial, but it hardened a convenience into apparent

³ A. Friedmann, *Über die Krümmung des Raumes*, Zeitschrift für Physik, 10, 377–386 (1922). First derivation of dynamical expanding/contracting cosmological solutions.

A. Friedmann, *Über die Möglichkeit einer Welt mit konstanter negativer Krümmung des Raumes*, Zeitschrift für Physik, 21, 326–332 (1924). Completes the family of FLRW geometries; negative curvature solutions.

⁴ A. Einstein, *Bemerkung zu der Arbeit von A. Friedmann 'Über die Krümmung des Raumes'*, Zeitschrift für Physik 11, 326–328 (1922). Einstein's short note incorrectly rejecting Friedmann's dynamical solution.

⁵ A. Einstein, *Notiz zu der Arbeit von A. Friedmann 'Über die Krümmung des Raumes'*, Zeitschrift für Physik 16, 228 (1923). Einstein's published retraction acknowledging his error: "Die von Herrn Friedmann mitgeteilten Resultate sind richtig."

J. North, *The Measure of the Universe*, Oxford University Press (1965). Provides a detailed account of Einstein's rejection and later acceptance of Friedmann's mathematics.

G. F. R. Ellis, *Relativistic Cosmology*, *Proc. Int. School of Physics Enrico Fermi*, Course 47 (1971). Standard historical narrative: Einstein initially dismissed Friedmann's work, later admitted the error.

⁶ G. Lemaître, *Un Univers homogène de masse constante et de rayon croissant rendant compte de la vitesse radiale des nébuleuses extra-galactiques*, Annales de la Société Scientifique de Bruxelles, A47, 49–59 (1927). Introduces the expansion interpretation and links redshift to metric evolution.

⁷ G. Lemaître, *The Beginning of the World from the Point of View of Quantum Theory*, Nature 127, 706 (1931). Recounts Einstein's reaction to Lemaître's earlier 1927 paper: the mathematics was correct, but the physical interpretation "abominable". Note: The term "abominable" is used in Lemaître's later descriptions of Einstein's response. The original 1927 paper was presented to Einstein at the 5th Solvay Conference, and Einstein's words are preserved through Lemaître's own testimony.

⁸ H. P. Robertson, *Kinematics and World-Structure*, Astrophysical Journal, 82, 284 (1935). First formal group-theoretic derivation of the spatially homogeneous/isotropic metric.

A. G. Walker, *On Milne's theory of world-structure*, Proceedings of the London Mathematical Society, s2–42, 90–127 (1936). Completes the FLRW formalism; general derivation of the now-standard metric.

necessity. What had been a guess now looked like a theorem, and the assumptions that underpinned it faded from view. Few paused to ask whether the universe itself had ever applied for membership in the relevant symmetry group.

2. The Great Consolidation and Reinforcement: From ansatz to defended orthodoxy

The post-war decades transformed cosmology from a theoretical curiosity into a data-hungry discipline, but they also amplified the authority of the FLRW template.⁹ The emerging CMB observations were interpreted not as a test of the foundational ansatz, but as confirmation of it.¹⁰ The isotropy of the microwave background, measured from a single vantage point on an unremarkable, locally structured planet, was presented as evidence of global homogeneity.¹¹ This was a considerable extrapolation. It was also extremely convenient.

Inflation appeared in the early 1980s and, almost overnight, solved the problem of justifying the FLRW symmetries by enforcing them dynamically.¹² Inflation smooths curvature, suppresses anisotropy and flattens the universe.¹³ This was not merely a theoretical triumph; it retroactively legitimised the initial assumptions.¹⁴ A mechanism had arrived that produced the very properties baked into the original ansatz. The symmetry now looked like a prediction, though strictly it was the prediction of a mechanism designed to recover an assumption.

⁹ A. A. Penzias & R. W. Wilson, *A Measurement of Excess Antenna Temperature at 4080 Mc/s*, *Astrophys. J.* 142, 419 (1965). Discovery of the CMB; later used as evidence for near-isotropy and thus FLRW consistency.

¹⁰ G. F. Smoot et al., *Structure in the COBE DMR First-Year Maps*, *Astrophys. J. Lett.* 396, L1 (1992). First measurement of anisotropies; framed within an assumed FLRW background.

¹¹ J. Ehlers, P. Geren & R. K. Sachs, *Isotropic solutions of the Einstein–Liouville equations*, *Journal of Mathematical Physics* 9, 1344 (1968). Shows that CMB isotropy implies an FLRW universe only if *all* fundamental observers see an isotropic background; isotropy at one vantage point does *not* justify global homogeneity.

E. W. Kolb & M. S. Turner, *The Early Universe*, Addison–Wesley (1990), 4.3.

Standard reference; emphasises that one observer’s CMB isotropy cannot by itself justify the cosmological principle.

C. A. Clarkson & R. Maartens, *Inhomogeneity and the foundations of concordance cosmology*, *Class. Quantum Grav.* 27, 124008 (2010). Reviews the inference problem: CMB isotropy at a single location cannot establish spatial homogeneity without additional assumptions like the Copernican principle.

G. F. R. Ellis, *Issues in the philosophy of cosmology*, in *Handbook of Philosophy of Physics*, Elsevier (2007). Discusses the inferential gap between local observations and global cosmological conclusions.

¹² A. H. Guth, *Inflationary universe: A possible solution to the horizon and flatness problems*, *Phys. Rev. D* 23, 347 (1981). Original inflation model; mechanism enforcing isotropy, flatness and FLRW-like conditions.

¹³ A. D. Linde, *A new inflationary universe scenario*, *Phys. Lett. B* 108, 389 (1982). Early variant of inflation; consolidated the picture of a smoothing mechanism.

¹⁴ A. Albrecht & P. J. Steinhardt, *Cosmology for Grand Unified Theories with Radiatively Induced Symmetry Breaking*, *Phys. Rev. Lett.* 48, 1220 (1982). Influential inflation model reinforcing FLRW-compatible smoothing.

In the decades that followed, this consolidation hardened into reinforcement. As precision cosmology matured, departures from FLRW expectations no longer prompted re-examination of the underlying geometry, but increasingly triggered the elaboration of compensatory mechanisms. Inflationary variants proliferated, dark-sector interactions multiplied, and late-time dynamics were rendered progressively more flexible. Each modification preserved the background metric while relocating tension into matter content, initial conditions, or phenomenological extensions. The symmetry assumption was no longer merely inherited; it was actively defended.

Meanwhile, the rapid development of particle-based cosmology demanded a background geometry that could support tractable calculations.¹⁵ Every element of the emerging toolkit – Boltzmann hierarchies for the photon–baryon fluid, thermal freeze-out histories, nucleosynthesis yields, perturbation growth equations and later the first CMB anisotropy codes – assumed an FLRW spacetime at the outset. Nothing else was computationally feasible. Numerical relativity was in its infancy,¹⁶ and even modest departures from homogeneity made the equations analytically unmanageable. The community settled, pragmatically at first, on a metric that could be handled with pencil and paper and, later, with modest computation. As computational power increased, that pragmatism hardened into infrastructure: pipelines, simulations, and inference frameworks were built around FLRW assumptions, rendering geometric deviation not merely difficult but methodologically invisible.

Textbooks completed the consolidation. The history was rewritten as a steady ascent from observation to model. The guesswork, philosophical prejudices, and aesthetic motivations of the early decades were smoothed away. The origin story became a tale of empirical triumph. Students learned a universe, not an *ansatz*. The idea that the large-scale metric was ever negotiable evaporated.

In the last decade this reinforcement has become explicit. Tensions in expansion history, structure growth, large-scale anisotropy, and cosmic chronometry have not led to renewed scrutiny of the FLRW *ansatz* itself. Instead, they have been met with increasingly sophisticated extensions that preserve the background geometry while redistributing discrepancy across parameters, sectors, or epochs. What was once a simplifying assumption has become a protected premise. The question of whether the large-scale metric is correct is no longer asked, not because it has been answered, but because the prevailing interpretive framework does not allow it to be posed. Culturally,

¹⁵ S. Ma & E. Bertschinger, *Cosmological Perturbation Theory in the Synchronous and Conformal Newtonian Gauges*, *Astrophys. J.* 455, 7 (1995). Standard reference formalising linear perturbation theory; explicitly built on an FLRW background and foundational for all CMB and LSS calculations.

¹⁶ P. J. E. Peebles, *The Large-Scale Structure of the Universe*, Princeton University Press (1980), ch. 2–4. Classic early textbook; makes explicit that FLRW is adopted because only in a homogeneous–isotropic background can the Boltzmann hierarchy, growth equations and thermodynamic histories be calculated.

L. Smarr & J. W. York, *Kinematical conditions in the construction of space-times*, *Phys. Rev. D* 17, 2529 (1978). Shows that numerical relativity in the 1970s–80s could only handle small local systems, not cosmological-scale inhomogeneity.

the FLRW form acquired a status beyond its derivation. It defined normality. Dissent did not disappear, but it was displaced from methodological debate into sociological margin. When an assumption survives long enough, it becomes invisible; when it is challenged often enough, it becomes defended.

3. The Popper Problem: Falsifiability in one direction only

A systematic asymmetry developed. Λ CDM is called “testable” because its parameters may be constrained and its predictions scrutinised. But the FLRW geometry beneath it remains largely untested. The theory is falsifiable only where it chooses to be.

Consider the recurrent tensions. A mismatch in the Hubble constant becomes an issue for early-universe physics, distance-ladder calibration or exotic neutrino histories. A discrepancy in structure growth is blamed on baryonic feedback or selection effects.¹⁷ Large-scale anomalies are filed under cosmic variance or survey artefacts.¹⁸ At no point is the symmetry assumption placed at risk.

A similar pattern can be observed in recent attempts to reconcile the dynamics of galaxy clusters with modified-gravity frameworks. Zhang, Zonoozi and Kroupa (2026), revisiting the missing-mass problem in nearby clusters within Modified Newtonian Dynamics (MOND), show that revised stellar-population assumptions can substantially increase the estimated baryonic mass budget. This in turn reduces the residual discrepancy normally attributed to unseen matter.¹⁹ Their analysis does not eliminate the cluster problem entirely, but it illustrates how readily the inferred need for additional components depends on modelling choices concerning the baryonic inventory. The exercise is scientifically legitimate, yet it reveals the deeper methodological habit: discrepancies are repeatedly redistributed among adjustable ingredients while the background geometric framework itself remains untouched.

Popperian language is employed, but selectively.²⁰ Models that bolt extra components onto the right hand side of Einstein’s equations are treated as bold and falsifiable. The left hand side is taken as immovable, and with it the temporal structure that the metric imposes. The geometry is exempt from criticism because the rules of engagement silently declare it exempt.

¹⁷ Planck Collaboration, P. A. R. Ade et al., *Planck 2018 results. VI. Cosmological parameters*, *Astron. Astrophys.* 641, A6 (2020). Definitive Λ CDM parameter set based entirely on FLRW background cosmology.

¹⁸ D. J. Eisenstein et al., *Detection of the Baryon Acoustic Peak in the Large-Scale Correlation Function of SDSS Luminous Red Galaxies*, *Astrophys. J.* 633, 560 (2005). Key BAO measurement interpreted via FLRW distance–scale relations.

¹⁹ Dong Zhang, Akram Hasani Zonoozi and Pavel Kroupa, *Revisiting the missing mass problem in MOND for nearby galaxy clusters*, arXiv:2602.06082 (2026). The authors reassess baryonic mass estimates in cluster environments and show that revised stellar-population assumptions can substantially reduce the residual mass discrepancy within MOND.

²⁰ K. Popper, *The Logic of Scientific Discovery*, Hutchinson (1959). Classic source on falsifiability; relevant to selective application in cosmology.

What has changed in recent years is that this exemption has ceased to be passive. As tensions have multiplied, the geometry has not been re-opened to scrutiny but has instead been insulated by increasingly flexible interpretive moves. Parameters governing dark energy evolution, dark-sector coupling, neutrino mass, feedback efficiency, and selection bias are adjusted or extended, while the background metric is held fixed by methodological convention. Falsifiability is preserved formally, but displaced operationally.

The result is a model that is formally Popperian but selectively so. Careers, collaborations and computational pipelines are built on the FLRW scaffold, and increasingly depend on its preservation. Any discrepancy is redirected into sectors designed to absorb it. The framework remains falsifiable in principle, but resistant in practice.

This is not a scientific necessity. It is a methodological habit. Consensus, once achieved, generates its own weather system. Forecast-driven cosmology has intensified this effect. When success is defined by the optimisation of constraint within an assumed background, challenges to that background are rendered methodologically invisible. Geometry becomes infrastructure rather than hypothesis, and is no longer exposed to empirical risk. Careers, collaborations and computational pipelines are built on this FLRW scaffold. To challenge it is to question the shared background of an entire field.²¹ Small wonder that tensions are mopped up locally rather than traced back to the supporting beams.

Cosmic chronometers provide a revealing example. In principle they probe the accumulation of proper time directly. In practice, when embedded within freely deformable reconstructions of the expansion theory, their capacity to challenge the redshift-time relation is nullified: the data are retained, but their potential to test temporal structure is systematically defused. This does not explain chronometers. It indicts the framework.

None of this is sinister. It is simply predictable human behaviour. A well-established framework enjoys the benefit of every doubt. Novel hypotheses are expected to withstand scrutiny that the incumbent model never experienced. An occasional wry glance at the situation is justified, but it no longer suffices.

4. A Different Kind of Constraint: What TSPC does that FLRW cannot

TSPC takes the opposite route by constraining time and geometry together.²² It does not assume a global metric form. It does not posit a single universal scale factor. It does not treat large-scale homogeneity as a starting point. Instead, it imposes a global temporal

²¹ J. Butterfield & C. Isham, *On the Emergence of Time in Quantum Gravity*, Found. Phys. 32, 951 (2002). Discussion of preferred time structures and their non-uniqueness; relevant to FLRW foliation.

²² I. Salisbury, *The Time-Symmetric Parity Constraint: Paper 3, ante*, TSPC. Introduces the algebraic constraint, involutive tensor and global temporal symmetry.

symmetry through an involutive tensor field, constraining the metric directly rather than constraining the contents placed within it. Where FLRW assumes geometry and negotiates interpretation, TSPC fixes geometry and tests interpretation. The symmetry is imposed, not inferred, and its failure cannot be absorbed by auxiliary adjustment. This reversal has several consequences.

First, TSPC is falsifiable in ways that FLRW is structurally protected against. It demands that the Universe pass through minimal entropy at $T = 0^-$ and $T = 0^+$, with a symmetric rise to maximum entropy at T^{tip} . If the data contradict this, the framework fails without interpretative recourse. There are no loose parameters that can be tuned to rescue it.

Second, TSPC provides geometric explanations for phenomena that, within FLRW, can only be accommodated by introducing new fluids or new forces.²³ Apparent acceleration becomes an effect of the curvature profile near maximal expansion rather than evidence for a negative-pressure component. Large scale dipoles need not be attributed to unreasonably large peculiar motions. Curvature-weighting of photon paths resolves anomalies without invoking invisible matter.²⁴ Crucially, this constraint operates across domains that FLRW treats independently. Spatial geometry, signal propagation, and temporal ordering are no longer separable modelling choices. Once temporal admissibility is enforced, the freedom to deform the redshift–time relation in order to stabilise anomalies is removed. Geometry ceases to be a passive backdrop and becomes a disciplinary condition.

Third, TSPC does not start inside the FLRW box. It challenges the notion that the box was obligatory in the first place, and shows that its continued use now requires active justification rather than inherited assent. It opens the possibility that the observational awkwardness of the standard model arises not from missing ingredients but from misplaced assumptions.

The irony is that TSPC is more vulnerable than Λ CDM precisely because it constrains more and assumes less. That asymmetry is its scientific virtue.

5. Undressing the Emperor

The FLRW ansatz continues to enjoy deference after a century of use. Its robes – elegant, symmetrical, easily computed – have been admired and tailored, copied and embellished. Observations have been interpreted through its lines and curves. Discrepancies have been blamed on the accessories, never on the cut of the coat. The

²³ I. Salisbury. Papers 4-10 *ante*: Theoretical consequence papers: acceleration, Λ , dark matter, inflation, arrow of time, linked H_0 and S_8 tensions; and Papers 11–16 – empirical test papers: global constraint, void AP, HerS-3 lensing, gravitational waves, CMB and radio dipoles, cosmic chronometers. Establish that effects treated within FLRW by added fluids or new forces are treated instead as consequences of geometric restriction.

²⁴ I. Salisbury, Paper 18 *ante*: *The Galactic-Centre Gamma Excess Reconsidered*. Applies TSPC curvature-weighting to GC GeV/TeV excess.

assumption of maximal symmetry has been treated as a fact of nature because it was convenient to believe it so.

Once the symmetry choice is exposed as a historical artefact, the situation becomes unavoidable. We are not obliged to accept a single global scale factor or a single cosmic time. We are not compelled to model the Universe as a smooth fluid on perfectly symmetric slices. These were choices, not inevitabilities.

What recent evidence has added is that these choices are no longer neutral. The continued use of a fixed FLRW background now requires active defence against observations that constrain geometry, propagation, and time simultaneously. What was once a simplifying assumption has become a liability. The issue is no longer whether alternatives may be entertained, but whether the inherited framework can continue to claim empirical adequacy without confronting its geometric commitments.

TSPC reminds us that geometry itself can be constrained and tested. It refuses to grant FLRW a protected status. If the Universe does not respect the imposed temporal symmetry, the framework collapses immediately. That is how scientific hypotheses should behave.

In the end, to see that the Emperor has no clothes is not to mock him. It is to recognise that admiration has substituted for examination. The FLRW ansatz has endured not because it has survived decisive tests, but because its background geometry has largely been insulated from them. That insulation is no longer tenable. Geometry, time, and symmetry are now empirically constrained, and any framework that exempts its background structure from risk must justify that exemption explicitly. If the geometric background is not itself exposed to failure, cosmology will continue to explain tension by construction rather than by constraint.

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