A New Concept of the Universe Based on Established Physical Laws

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Abstract
We propose a simplified cosmological model based solely on established physical laws, treating the Universe as a Schwarzschild object. In this framework, cosmic expansion is interpreted not as the stretching of space, but as the consequence of continuous accretion of matter from beyond the observable horizon. Starting from an initial state with an effective radius of 13.7 billion light-years and a baryon density consistent with early-Universe estimates (~5.9 m^{-3}), the Schwarzschild relation applied to present baryonic density values predicts a radius of ~63 Gly. However, the actually observed radius of 46.5 Gly can only be reconciled if the mean baryon density is assumed to be approximately twice the observed value. This discrepancy, commonly attributed to dark matter, may alternatively be explained within a four-dimensional framework in which multiple three-dimensional subspaces coexist within the same volume. The scaling relations derived from the Schwarzschild condition show that mass increases linearly with radius, while mean density decreases as $1/R^2$. In this interpretation, the observed Big Bang can be reinterpreted as the emergence of a singularity within a Schwarzschild object, and the absence of a geometric center in S^3 geometry ensures that every observer perceives themselves at the center of expansion. The model further suggests that the Universe's future evolution cannot be reliably predicted, as it depends on the density and distribution of matter beyond the current horizon.
Keywords
Cosmology; Schwarzschild radius; cosmic expansion; singularity; dark matter; universe model

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1. Introduction

In physics, it is common to question results that contradict intuition. Here, we deliberately accept the consequences of standard gravitational relations and examine their implications on a cosmological scale. A key relation is the Schwarzschild condition, $R = 2GM/c^2$ (Dodelson & Schmidt, 2020), which defines the event horizon for a non-rotating, uncharged mass M. If this condition is applied globally, any object of non-zero mass and unlimited extent must satisfy it at sufficiently large scales. In the model, we assume that the Universe itself fulfills this condition, treated as a Schwarzschild object. Expansion is then interpreted not as intrinsic spacetime stretching but as a result of matter accretion from outside the horizon. The Big Bang is reinterpreted as the moment when a singularity formed within this Schwarzschild object (Popławski, 2016), with subsequent evolution driven by external inflow.

2. Model Assumptions

1. Physical laws are universal and identical across all regions of space.
2. The Universe is treated as a Schwarzschild object with radius equal to its Schwarzschild radius.
3. The Big Bang represents the formation of a singularity within this object.
4. Expansion is driven by continuous accretion of matter from outside.
5. Observational parameters are adopted from Planck 2018 (Planck Collaboration, 2020): cosmic age ≈ 13.8 Gyr, baryonic density ≈ 0.25–0.3 baryons/m^3, and observable radius ≈ 46.5 Gly.
6. In a 3-sphere (S^3) embedded in 4D space, there is no geometric center: every observer is effectively at the center (Weinberg, 2008; Faraoni, 2015).

3. Methods and Calculations

For a homogeneous region of space with mean density ρ, the enclosed mass within radius R is

$$M = (4/3)\pi R^3 \rho \tag{1}$$

Substituting this into the Schwarzschild relation

$$R_s = 2GM/c^2 \tag{2}$$

gives

$$R_s = (8\pi G/3c^2)\rho R^3 \tag{3}$$

For small R, one has $R_s \ll R$, but because R_s grows as R^3, there always exists a sufficiently large radius where the condition

$$R_s = R \tag{4}$$

is satisfied. Therefore, any space of finite nonzero density, when extended to a large enough scale, necessarily fulfills the Schwarzschild criterion.

For an initial baryon density of $n_0 = 5.9\ m^{-3}$, the calculation gives a mean density ρ_0

$$= n_0 m_p \approx 9.9 \times 10^{-27}\ kg\ m^{-3} \tag{5}$$

corresponding to a radius

$$R_0 \approx 13.7 \text{ Gly} \quad (6)$$

The enclosed mass at this radius is

$$M_0 \approx 8.6 \times 10^{52} \text{ kg} \approx 4.3 \times 10^{22} M_\odot \quad (7)$$

For a later state with baryon density $n_f = 0.27 \pm 0.05$ m^{-3}, the relation gives a central value of

$$R_f \approx 63.1 \text{ Gly} \quad (8)$$

with limits of 58 Gly (for n = 0.32) and 70 Gly (for n = 0.22). The corresponding mass is

$$M_f \approx 4.0 \times 10^{53} \text{ kg} \approx 2.0 \times 10^{23} M_\odot \quad (9).$$

As a consistency check, applying the same formula for a present-day radius of R = 46.5 Gly gives a mean density

$$\rho \approx 8.3 \times 10^{-28} \text{ kg m}^{-3} \approx 0.50 \text{ baryons m}^{-3} \quad (10)$$

and an enclosed mass of

$$M \approx 3.0 \times 10^{53} \text{ kg} \approx 1.5 \times 10^{23} M_\odot \quad (11)$$

These results confirm the analytic scaling derived directly from the Schwarzschild relations: mass increases in proportion to R, volume as R^3, and mean density decreases as $1/R^2$. The Planck density limit can then be applied to estimate the scale of the initial singular state. In the accretion model, the Universe is represented as a three-dimensional surface of a 3-sphere (S^3) embedded in four-dimensional space, defined by

$$x_1^2 + x_2^2 + x_3^2 + x_4^2 = R(t)^2 \quad (12)$$

Here the radius R(t) grows due to accretion according to the Schwarzschild relation (Eq. 2). Because S^3 is homogeneous and isotropic (the SO(4) group acts transitively), every point of the 3D space is simultaneously located on the surface and can be regarded as the 'center'. The growth of R(t) thus represents the global enlargement of the Universe driven by the inflow of matter. For completeness, we also note that for a rotating system the outer event horizon can be described by the Kerr relation:

$$r_+ = (GM / c^2) \left(1 + \sqrt{(1 - \alpha^2)} \right) \quad (13)$$

where $\alpha = Jc / (GM^2)$ denotes the dimensionless spin parameter. For the currently observed parameters of the Universe, adopting $\alpha = 0.5$ gives a horizon radius in close agreement with observations.

4. Results and Interpretation

For R ≈ 13.7 Gly, the implied density is about 5.9 baryons/m^3 (Planck Collaboration, 2020), consistent with estimates of early cosmological conditions. Starting from these parameters and adopting a mean baryon density of $n = 0.27 \pm 0.05$ m^{-3}, the Schwarzschild relation (Eq. 2) yields a characteristic radius of R ≈ 63.1 Gly (with limits of 58–70 Gly), a corresponding mass of $M \approx 4.0 \times 10^{53}$ kg ($\sim 2.0 \times 10^{23}$ solar masses), and a density decrease by more than twentyfold compared to the early state. This scaling directly illustrates the general law: while the radius increases by a factor of ~4.6 relative to the initial state, the enclosed mass grows by a similar factor, whereas the mean density falls approximately as $1/R^2$.

Alternatively, if the present radius of the observable universe is taken as R = 46.5 Gly, the calculation gives a mean density of ~0.50 baryons/m³ and an enclosed mass of ~3.0×10^{53} kg (~1.5×10^{23} solar masses). The baryon density obtained in this case is almost exactly twice as large as for the 63.1 Gly model, which suggests a 'missing half' relative to the expected value. This discrepancy may therefore point not to an observational error, but to a fundamental aspect of the chosen scale and could provide a clue to one of the unresolved issues in theories of the Universe's origin.

5. Discussion

This simplified model reframes cosmological expansion as a physical consequence of matter accretion, not as the stretching of space. It allows the exclusion, or at least significant reduction, of exotic components such as dark energy. However, it does not rule out the possibility of compact remnants from the Planck era, including hypothetical Planck-scale black holes, which could contribute to the unseen matter budget. A key conceptual feature is that in an S^3 geometry embedded in 4D, there is no central point: every observer is naturally located at the apparent center of expansion. This aligns with the observed isotropy of the Universe (Weinberg, 2008; Faraoni & Jacques, 2007).

Computational results indicate that for the currently adopted radius of the observable Universe, R = 46.5 Gly, the mean baryon density should be about 0.50 baryons/m³. However, the observed mean density is approximately a factor of two lower, which corresponds to a calculated radius of 63.1 Gly. This reveals a significant discrepancy between the predictions of the model and the observed density, suggesting that in the R = 46.5 Gly case a missing half of the expected matter content is implied. One possible explanation within the 4D framework is the hypothesis that the same four-dimensional volume of radius R may simultaneously host multiple three-dimensional subspaces of the same radius. In such a scenario, one universe could consist of matter and another of antimatter, geometrically coexisting but without direct interaction. This interpretation could potentially address the long-standing problem of baryon asymmetry: why we observe almost exclusively matter, even though baryogenesis theories predict that matter and antimatter should have been created in equal amounts (Popławski, 2016).

It must be emphasized, however, that this remains a tentative hypothesis, difficult to verify and potentially flawed. The model could still be mathematically consistent if the actual size of the Universe is larger and closer to the calculated value (~63 Gly), or if current measurements of baryon density are underestimated (Popławski, 2012; Popławski, 2010).

The model also suggests that future expansion cannot be reliably predicted, as it depends on the unknown density of matter outside the current horizon. If external density equals the early-universe value (~5.9 baryons/m³), expansion could accelerate dramatically, with density tending asymptotically toward zero. Certain gravitational anomalies may also originate from external mass distributions (Faraoni & Jacques, 2007). Remarkably, applying the Kerr metric with spin $\alpha = 0.5$ yields an event horizon radius that almost exactly matches the currently observed size of the Universe, without the need to introduce any additional mass. The geometric interpretation in the S^3 model embedded in R^4 reinforces this view: every point lies simultaneously on the "surface" and can be regarded as the center, naturally explaining the absence of a privileged observational position. This perspective coherently links the calculations with geometric intuition, suggesting that global homogeneity and isotropy may emerge directly from the intrinsic structure of space.

6. Conclusions

By modeling the Universe as a Schwarzschild object, we obtain a coherent framework in which expansion is interpreted as the consequence of continuous external accretion rather than the stretching of space. Within this concept, the Big Bang corresponds to the formation of a singularity at Planck density, and the absence of a geometric center in an S^3 geometry naturally explains the observed homogeneity and isotropy.

The derived scaling relations reproduce the observed correspondence between radius, enclosed mass, and mean baryon density, while the discrepancy in present-day density may provide a clue to the problem of baryon asymmetry (Popławski, 2016; Popławski, 2012; Popławski, 2010). In this sense, the model suggests that dark matter need not dominate the mass-energy content to the extent postulated by ΛCDM. Future evolution remains unpredictable, as it depends on the external density beyond the current horizon: if it is comparable to the early-Universe value, expansion could accelerate toward asymptotically vanishing density. The overall conclusion is that established physical laws, applied without invoking unverified exotic components, can yield a self-consistent cosmological scenario that addresses several of the conceptual difficulties of standard models (Brandenberger, Heisenberg & Robnik, 2021; Gaztañaga, 2022). Remarkably, the Kerr solution with spin $\alpha = 0.5$ reproduces the currently observed size of the Universe without requiring any additional mass. This alignment suggests that large-scale homogeneity and isotropy may emerge directly from the intrinsic S^3 geometry embedded in R^4, offering a simple and elegant explanation consistent with our overall findings.

7. References

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