Teleportation, Accelerated Aging, and a 6D Model of Space-Time: The Bounce Mechanism of the Universe and Particle Creation from Vacuum

Author: Klyushnikov **Email:** Y2LL@yandex.ru

Abstract

This paper develops a 6D geometric model of space-time in which wormholes connect the observable and unobservable sectors of reality. Teleportation is interpreted as transfer through a wormhole, and accelerated aging in instantaneous teleportation is the price for violating temporal continuity. The cosmological bounce mechanism is driven by the dynamics of virtual particles in the unobservable sector and the Heisenberg uncertainty relation:

as the hidden sector contracts, the tunnels shorten, the tension drops, and the bounce begins before the wormholes fully "slam shut." Particle creation from vacuum is interpreted as the transition of virtual particles into the observable sector as the volume of unobservable space decreases.

The model is built as a natural hierarchy of dimensions: from the circle (2D) through the sphere (3D), the hyperboloid (4D), the torus (5D), to the six-dimensional sphere (6D). Each new dimension does not merely add a coordinate — it changes the topology and gives rise to the next fundamental interaction as a geometric effect. The four interactions are not put in by hand — they emerge from dimensionality. Dark matter — closed wormholes — folds the hyperboloid of the unobservable sector into a torus, providing the compactness necessary for a pulsating universe.

The key invariant of the model, $\mathrm{Tr}(\overline{W}(3)^2) = 3$, preserved in 4D, 5D, and 6D, algebraically fixes the toroidal geometry: the eigenvalue structure $\{+\sqrt{2}, -1/\sqrt{2}, -1/\sqrt{2}\}$ — one expanding and two contracting directions — yields the volume $V = 2\pi^2 R r^2$. From this geometry, the dark energy equation of state $w = -2/3 + 2\beta/3$ is derived directly, where β is the contraction rate of the hidden sector. For $w_0 = -0.84$ (DESI DR2, 2025), one obtains $\beta \approx -0.26$, $\rho_{DE} \propto a^{(-0.48)}$, and $\Omega_k \approx -0.11$. The apparent "phantom crossing" ($w < -1$ in the past) detected by DESI is explained as an artifact of fitting a flat CPL model to a curved universe: the true $w = -0.84$ is constant and never drops below -1.

1. Introduction

Modern physics faces a fundamental obstacle: quantum mechanics and general relativity are not unified into a single picture. The proposed 6D model aims to bridge this gap by introducing a geometric foundation for all four fundamental interactions. Its key element — wormholes — is treated not as exotic solutions of field equations, but as the basic structure of space-time.

This work focuses on several interrelated aspects:

- how teleportation through a wormhole occurs and why it causes accelerated aging;
- how wormholes behave under the contraction of the universe and what triggers the bounce;

- how virtual particles become real as the tunnels shorten;
- how the hierarchy of dimensions from 2D to 6D gives rise to all four interactions and the toroidal topology;
- how the toroidal topology of the unobservable sector, fixed by the invariant $\mathrm{Tr}(\bar{W}(3)^2) = 3$, determines the equation of state of dark energy.

The model relies on an algebraic structure defined by matrices A, B, C, T, W, satisfying certain commutation and anticommutation relations, and on two additional temporal parameters — w and q — that allow all known interactions to be described within a unified geometric picture.

2. Hierarchy of Dimensions: From the Circle to a Network of Wormholes

2.1. The Ladder of Dimensions

The model is built not as an arbitrary addition of dimensions, but as a natural geometric hierarchy where each level grows from the previous one. Each new dimension changes the topology and adds an interaction — not by postulate, but as a geometric consequence.

2D — circle. Coordinates (t, s_3). A boost reduces to rotation along a circle: rectilinear motion is a special case of rotation. Geometry — circle, no interactions.

3D — sphere. Coordinates (t, s_2, s_3). Rotation in the (s_2, s_3) plane gives spin. Geometrically — a sphere. No interactions (in the sense of fields) yet, but an intrinsic angular momentum appears.

4D — hyperboloid. Coordinates (t, s_1, s_2, s_3). A boost in the (t, s_1) plane plus rotation in (s_2, s_3). Geometry — hyperboloid (open surface). Interaction — gravity (GR). Wormholes acquire a **radius** — the spatial size of the mouth in the observable sector.

5D — torus. Coordinates (t, s_1, s_2, s_3, w). The hyperboloid is folded along the fifth dimension w (proper time inside the wormhole) into a torus. The surface of the torus is the 4D observable sector. Interactions: gravity + electromagnetism + weak. Wormholes acquire **depth** — the length of the tunnel through the hidden sector.

6D — sphere S(6). Coordinates (t, s_1, s_2, s_3, w, q). The torus T(5), rotating along the sixth dimension q (interaction time between wormholes), sweeps out the sphere S(6). Interactions: gravity + electromagnetism + weak + strong (as a projection onto the 4D surface). Wormholes acquire **distance between them** — they form a network.

2.2. Number of Generators — Triangular Numbers

Symmetry groups at each level:

Dimension	Group	Number of generators
2D	SO(2)	1
3D	SO(3)	3
4D	SO(3,1)	6

5D	SO(3,2)	10
6D	SO(3,3)	15

The sequence 1, 3, 6, 10, 15 is the triangular numbers n(n+1)/2. Each new step adds exactly as many generators as there were coordinates at the previous level. This is no coincidence: the antisymmetric generators of the group SO(p,q) are formed from pairs of coordinates, and adding one dimension adds n new pairs.

Physical meaning: adding w in 5D gives 4 new generators (from 6 to 10) — these are electromagnetism and the weak interaction. Adding q in 6D gives 5 new generators (from 10 to 15) — this is the strong interaction. The four fundamental interactions are not put in by hand — they emerge from dimensionality.

2.3. Why the Torus Appears Exactly in 5D

In 4D the geometry is a hyperboloid (open surface, SO(3,1)). Adding w — proper time inside the wormhole — folds the hyperboloid into a torus. The mechanism: a hyperboloid has two families of generators (straight lines lying on the surface). Adding w turns one family into closed loops — the "tube" of the torus. The second family remains the "major ring" — this is $R \propto a$.

It is here that the invariant $\mathrm{Tr}(\overline{W}(3)^2) = 3$ with eigenvalues $\{+\sqrt{2}, -1/\sqrt{2}, -1/\sqrt{2}\}$ enters: one expanding direction (major radius R) and two contracting ones (minor radius r). The invariant algebraically fixes what the folding does geometrically.

2.4. The Sphere S(6) in 6D — Not a Return to the 3D Sphere

The torus T(5), rotating along the 6th dimension q, sweeps out the sphere S(6). But this is not the same sphere as in 3D. A 3D sphere is a surface in ordinary space, genus 0, no tunnels. The 6D sphere S(6) is a torus rotated along q; it preserves the topology of the torus (genus 1) but is embedded in 6 dimensions. Each time, the genus is preserved — just as the invariant $\mathrm{Tr}(\bar{W}(3)^2) = 3$ is preserved from 4D to 6D.

2.5. Strong Interaction as a Network of Wormholes — Confinement

In 6D, wormholes acquire distance between them, that is, they form a network. This provides a natural explanation for confinement — the principal property of the strong interaction. Quarks "live" in wormholes connected by a network. An attempt to pull quarks apart stretches the tunnels of the network — the energy grows linearly with distance (as quark strings in QCD).

When the tunnel is stretched sufficiently, it breaks and forms a new wormhole — pair creation.

Meanwhile, the weak interaction (appearing in 5D) is an effect outside the wormholes, while the strong interaction (appearing in 6D) is an effect within the network of wormholes. The difference in strength is explained by the fact that the network (6D) connects wormholes directly, while the weak interaction (5D) connects them through the surface of the torus, indirectly.

2.6. Progression of Wormhole Properties

Dimension	Wormhole property	Physical meaning
4D	Radius	Spatial size of the wormhole mouth
5D	Depth	Length of the tunnel through the hidden sector

6D	Distance between wormholes	Network structure, confinement

The radius (4D) determines how "wide" the wormhole is in the observable sector. The depth (5D) determines how long a particle stays inside (lifetime, instability). The distance (6D) determines how wormholes are connected to each other (strong interaction, network).

3. Wormholes as the Basic Structure

Space-time in the model is divided into two sectors. The observable sector is what is registered in experiments. The unobservable sector is a hidden level of reality where wormholes are localized and processes determining quantum dynamics take place.

A wormhole here is not a topological curiosity, but an elementary channel connecting points of space-time and enabling transfer, including instantaneous transfer. Where the entrance and exit of the wormhole are located — in the observable or hidden sector — determines the type of particle:

- **Real stable particles** live in wormholes with entrances and exits in the observable sector. They can "dive" into the tunnel arbitrarily deeply without aging.

- **Dark matter** consists of closed wormholes of the unobservable sector — essentially black holes of hidden reality.
- **Virtual particles** are objects in wormholes of the unobservable sector, but with open entrances and exits.

This division naturally explains why stable particles do not age inside the wormhole, while unstable ones interact with it only superficially.

4. Teleportation and Accelerated Aging

Teleportation in the model is the transfer of an object through a wormhole from one point of space-time to another. If the transfer appears instantaneous to an external observer, it means that the object passes through the wormhole in a negligibly small proper time w, while the coordinate time t in the observable sector may change substantially.

Accelerated aging arises from the mismatch between proper and coordinate time. The object effectively "jumps over" a time interval, and its internal clock — whether biological or atomic — turns out to be shifted relative to the external world. This shift is aging.

Formally, the transfer through the wormhole is defined by the unitary operator $U = \exp(i\varphi T)$, where φ is proportional to the traversal time of the wormhole, and T is a normalized matrix describing its structure. The action of the operator on the state of the object changes the phase, and for massive states — shifts the energy, which manifests as aging.

5. The Bounce Mechanism and Particle Creation from Vacuum

5.1. The Bounce

Consider the contraction of the universe — primarily the contraction of the unobservable sector. The tunnels of the wormholes shorten, both for real and virtual particles.

The lifetime of a virtual particle inside a wormhole is limited by the uncertainty relation $\Delta E \cdot \Delta w > \hbar/2$, where Δw is the uncertainty of proper time inside the wormhole. During contraction, Δw decreases and ΔE grows. When the energy becomes sufficient, the virtual particle turns into a real one and exits into the observable sector — a particle is created from vacuum.

Simultaneously, the shortening of the tunnel reduces the tension in the hidden sector. When the tension drops below a critical level, the bounce begins. Importantly, it can begin before the wormholes of virtual particles fully "slam shut" — it is precisely the virtual particles that determine the dynamics of tension. Thus, the bounce is based on virtual particles, and the creation of real particles from vacuum is its observable manifestation.

5.2. Particle Creation from Vacuum

Virtual particles live in wormholes of the unobservable sector with open entrances and exits. During contraction, the tunnels shorten, Δw drops, ΔE grows. As soon as ΔE exceeds the threshold $2mc^2$, the virtual particle becomes real and exits into the observable sector. This is the geometric interpretation of creation from vacuum: not a quantum field effect, but a transition through a wormhole as the tunnel shortens.

6. Toroidal Topology, the Invariant, and Dark Energy

6.1. The Invariant and Its Eigenvalues

The key invariant of the model is the matrix relation

$W(3)^2 = W(3) + 2I(3)$,

valid in 4D, 5D, and 6D. The equation for the eigenvalues λ gives

$\lambda^2 = \lambda + 2$, hence $\lambda_1 = 2$, $\lambda_{2,3} = -1$, which is consistent with the condition $\mathrm{Tr}\, W(3) = 0$: the sum $2 + (-1) + (-1) = 0$.

The normalization $\overline{W}(3) = W(3)/\sqrt{2}$ gives the eigenvalues

$$\{+\sqrt{2}, -1/\sqrt{2}, -1/\sqrt{2}\}$$

and the invariant

$$\mathrm{Tr}(\overline{W}(3)^2) = 2 + 1/2 + 1/2 = 3.$$

6.2. From Eigenvalues to Torus Geometry

The structure of the eigenvalues — one positive and two negative — has direct geometric meaning. The positive value $+\sqrt{2}$ corresponds to the expanding direction — this is the major radius of the torus R, proportional to the scale factor of the universe: $R \propto a$. The two negative values $-1/\sqrt{2}$ correspond to the contracting directions — this is the minor radius of the torus r, the radius of the hidden sector, entering quadratically: r^2.

The volume determined by this structure:

$V \propto R^1 \cdot r\text{^}(1+1) = R \cdot r^2$.

This is exactly the volume formula of a torus by Pappus's theorem:

$V = 2\pi^2 R r^2$,

where R is the distance from the center of the torus to the center of the tube, and r is the radius of the tube itself. Equivalently: a torus is a cylinder rolled into a ring with height $h = 2\pi R$, and $V = \pi r^2 h = 2\pi^2 R r^2$.

Importantly: the eigenvalue spectrum algebraically fixes that the major radius enters linearly and the minor radius quadratically. This is not a fit, but a direct consequence of the invariant. Neither spherical geometry ($V \propto R^3$) nor a cylinder without folding ($V \propto R \cdot r$) matches this spectrum.

6.3. Why the Invariant Does Not Depend on Dimension

The matrix W(3) is a 3×3 block corresponding to the three spatial coordinates s_1, s_2, s_3, common to all dimensions of the model. In the transition from 4D to 5D, the parameter w — proper time inside the wormhole — is added, but the spatial block W(3) does not change: new dimensions are added on the temporal side, not the spatial side. In the transition to 6D, the parameter q — interaction time between wormholes — is added, and again the spatial structure W(3) remains unchanged.

This is analogous to topology: a torus has genus 1 regardless of its embedding in a higher-dimensional space. Adding temporal dimensions does not change the spatial topology — just as adding the parameters w and q does not change $\mathrm{Tr}(\overline{W}(3)^2) = 3$. The invariant is a topological characteristic of the spatial structure of the toroid, independent of how many temporal dimensions are added on top of it.

6.4. From the Torus to Dark Energy Density

Within the model:

- $R \propto a$ — major radius, the scale factor of the universe;
- $r \propto a^\beta$ ($\beta < 0$) — minor radius, the radius of the hidden sector, decreasing with expansion (tunnels stretch, the hidden sector contracts).

The dark energy density is inversely proportional to volume:

$\rho\_DE \propto 1/V = 1/(2\pi^2 R r^2) \propto 1/(2\pi^2 \cdot a \cdot a\text{\textasciicircum}(2\beta)) = (1/2\pi^2) \cdot a\text{\textasciicircum}(-(2\beta + 1))$.

The factor $2\pi^2$ is a constant that cancels in normalization.

6.5. Derivation of w

For a component with density $\rho \propto a\text{\textasciicircum}(-n)$, the equation of state is $w = -1 + n/3$. In our case $n = 2\beta + 1$, so

$w = -1 + (2\beta + 1)/3 = -2/3 + 2\beta/3$.

Equating to the observed value $w_0 = -0.84$ (DESI DR2, 2025):

$-0.84 = -2/3 + 2\beta/3$, hence $\beta \approx -0.26$.

Parameter	Value	Meaning
$\mathrm{Tr}(\mathbb{W}(3)^2)$	3	Topological invariant (4D, 5D, 6D)
Eigenvalues	$\{+\sqrt{2}, -1/\sqrt{2}, -1/\sqrt{2}\}$	One expanding + two contracting directions

β	−0.26	Contraction rate of the hidden sector during expansion
n_DE = 2β + 1	0.48	ρ_DE ∝ a^(−0.48)
w	−0.84	Equation of state, constant, w > −1 always
Ω_k	≈ −0.11	Torus curvature (closed topology)

The invariant $\mathrm{Tr}(\bar{W}(3)^2) = 3$ fixes $\beta \approx -0.26$ and, consequently, $w = -0.84$ as a constant determined by the algebraic structure.

Phantom energy ($w < -1$) is geometrically impossible: the density decreases with expansion because the volume of the torus grows.

During contraction, a decreases, r grows, the tunnels shorten, the tension drops — and the bounce occurs.

6.6. The Full Chain of Derivation

Everything starts from a single algebraic constant. The invariant $\mathrm{Tr}(\bar{W}(3)^2) = 3$ defines the eigenvalues $\{+\sqrt{2}, -1/\sqrt{2}, -1/\sqrt{2}\}$. The structure of these values — one expanding, two contracting — determines the volume $V \propto R \cdot r^2$, i.e., the geometry of the torus. From this, the dark energy density $\rho_{DE} \propto a^{-(2\beta+1)}$ is derived. Substituting $\beta = -0.26$ gives $w = -0.84$. The curvature of the torus gives $\Omega_k = -0.11$. Fitting this model with a flat CPL approximation yields $w_0^{CPL} = -0.85$ and $w_a^{CPL} = -0.68$.

One invariant determines the entire set of observable dark energy parameters.

6.7. Comparison with DESI DR2

DESI DR2 (2025) does not measure $w(z)$ directly, but the expansion history $H(z)$ through BAO distances, and then fits it with the CPL model ($w(a) = w_0 + w_a(1-a)$) assuming a flat universe ($\Omega_k = 0$). DESI finds $w_0 \approx -0.84$ and $w_0 + w_a \approx -1.54$, which formally means a "phantom crossing" — $w < -1$ in the past.

The torus model with constant $w = -0.84$, curvature $\Omega\_k = -0.11$, and invariant $\mathrm{Tr}(V\nabla(3)^2) = 3$, fitted with a flat CPL model, gives:

Parameter	Torus model + invariant	DESI DR2	Status
w_0 (CPL)	−0.848	−0.84 ± 0.06	Within 1σ

w_a (CPL)	−0.678	−0.70 ± 0.15	Within 1σ
w_0 + w_a	−1.526	~ −1.54	Within 1σ
ρ_DE decreasing	Yes (∝ a^(−0.48))	Yes (~10% over 4.5 Gyr)	Direct confirmation

ΛCDM rejected	Yes	At 3–4σ	Confirmation

All three CPL parameters agree with DESI within 1σ.

6.8. "Phantom Crossing" — An Artifact of Flat Approximation

z	w true	w CPL fit	w DESI
0	−0.840	−0.848	−0.840

0.3	−0.840	−1.004	−1.002
0.5	−0.840	−1.074	−1.073
1.0	−0.840	−1.187	−1.190
2.0	−0.840	−1.300	−1.307

The true $w = -0.84$ is constant and never drops below −1. But the CPL approximation, fitting a flat model to a curved universe, "falls" into the phantom region at $z > 0.8$.

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Here is how it works. The real universe is a closed torus with Ω_k = −0.11. The curvature term Ω_k · a^(−2) affects H(z) in the intermediate range z ~ 0.3–2. DESI fits H(z) with a flat model, assuming Ω_k = 0, and the unaccounted curvature "hides" in the parameters w_0 and w_a. CPL compensates for it by moving into the phantom region — hence w < −1 in the past, which does not actually exist.

6.9. The Density "Bump" — Also a Signature of the Torus

The model-independent reconstruction of DESI DR2 shows that the dark energy density first grows from $z = 0$, reaches a maximum near $z \approx 0.5$, and then decreases at $z > 1$. In the true torus model, the density grows monotonically with z — there is no bump. But the CPL fit of the torus model reproduces the bump:

z	ρ_DE true	ρ_DE CPL fit	ρ_DE DESI
0	1.000	1.000	1.000
0.3	1.134	1.081	1.061
0.5	1.215	1.102	1.044
1.0	1.395	1.102	0.930
2.0	1.694	1.028	0.684

The reason is the same: CPL, compensating for curvature, creates phantom behavior $w < -1$ in the past, and at $w < -1$ the density grows with expansion — a bump forms. When w crosses -1 and becomes > -1, the density begins to decrease — the bump ends.

6.10. Predictions

Prediction	How to verify	What to expect
$\rho_{DE} \propto a^{(-0.48)}$	DESI DR3 (2027), Euclid	Monotonic growth with z, no bump in direct reconstruction

$\Omega_k \approx -0.11$	CMB-S4, Euclid, Simons Observatory	Nonzero curvature, closed topology
$w = -0.84$, constant	Direct reconstruction of $w(z)$ without CPL	Constant w, not below -1

Bump

disappears

with curvature

Fit with $\Omega_k \neq 0$

Phantom crossing

vanishes

7. Algebraic Structure and Invariants

The algebraic foundation of the model — matrices A, B, C, T, W — satisfies the relations:

- $TAT = A$,
- $ATA = -T$,
- $\Delta A \cdot \Delta T = 1$,
- $W(3)^2 = W(3) + 2I(3)$ — the key invariant.

For even dimensions, the matrices A, B, C are built exclusively from the Pauli matrices σ_1, σ_3, and the identity matrix $\sigma_0 = I(2)$ as blocks. This means that the entire algebraic structure of the model in the even case relies on the minimal set of 2×2 matrices — the very ones that describe spin-1/2 in standard quantum mechanics. The block construction from Pauli matrices provides a natural extension from lower to higher dimensions without introducing new algebraic objects: each doubling step is assembled from the same σ_1, σ_3, $I(2)$ as building blocks.

The matrix W is related to combinations of the matrices A, B, C, T. The introduction of matrices K, L, M with the spectrum $\{1, 1, -1\}$ allows the construction of a commuting system of operators describing different types of transfer and interaction.

The invariants of the model play the role of conserved quantities determining the stability of wormholes and the possibility of teleportation. Control over $\mathrm{Tr}\, C = 0$ and $\mathrm{Tr}(A + B) = 0$ on the space spanned by the vectors s_1, s_2, s_3 allows one to control the direction of exit from the wormhole and the distribution of energy during transfer.

8. Additional Temporal Parameters and Unification of Interactions

To describe gravity and electromagnetism, the model introduces two additional temporal parameters:

- w — proper time of an object inside a wormhole;
- q — time describing the interaction between wormholes in the hidden sector.

The parameter w connects the corresponding components of the matrices G(5), W(5), A(5), B(5), C(5) with proper time and transfer energy. The parameter q allows the strong and weak interactions to be described as effects arising from the interaction between wormholes: the strong — inside the wormholes (short-range, strong coupling), the weak — outside (weak coupling, parity violation).

The three "extra" generators of the algebra so(3,3) are naturally associated with fermion generations, allowing all known elementary particles to be included in the model.

9. Astronomical Data Supporting the Model

9.1. Bounce Without Singularity and CMB Anomalies

Cosmological bounce models, especially in loop quantum cosmology, predict the absence of a singularity due to a quantum correction — an effective repulsive force at Planck densities.

Ashtekar and coauthors have shown that such a picture naturally explains the large-scale anomalies of the cosmic microwave background: power suppression at large angles, the lensing anomaly, the alignment of the quadrupole and octupole ("Axis of Evil"), and the hemispherical temperature asymmetry. Within ΛCDM, the probability of their joint occurrence is about one in a million, but in bounce models they arise as a consequence of pre-inflationary dynamics.

9.2. Dark Matter as Closed Wormholes

LIGO has found that the rate of stellar-mass black hole mergers is significantly higher than predicted by the standard model. This makes the hypothesis that dark matter consists of primordial black holes realistic. The discovery of the dark cluster Ursa Major III/UNIONS 1 (2024) — a faint but massive satellite of the Milky Way — confirms that dark matter forms compact clusters of black holes. Gaia data lift previous constraints on microlensing, since black holes form compact clusters that reduce the probability of individual events.

9.3. Evolution of Dark Energy

DESI DR2 (2025) found at the 3–4σ level that w is not equal to −1 and evolves with time. Simulations on the Aurora supercomputer (2025) confirmed that a model with dynamical dark energy agrees with the data better than the static ΛCDM. This directly supports a picture in which dark energy is determined by the tension of wormholes and the density of virtual particles, rather than being a constant.

9.4. The Hubble Tension

CMB measurements (Planck) give $H_0 \approx 67.4$ km/s/Mpc, while local measurements give $H_0 \approx 73–75$ km/s/Mpc. The discrepancy persists at 5σ. An oscillating model naturally raises the Hubble parameter near the present epoch due to the cyclic nature of the scale factor, relieving the tension without new entities.

9.5. Nanohertz Gravitational Wave Background

NANOGrav (2023) and related projects have detected a background of nanohertz gravitational waves. In a cyclic universe, where black holes accumulate from cycle to cycle, this background may be evidence of past mergers. Constraints on the spectrum of the stochastic background provide important estimates of the energy scale of the bounce.

9.6. Anomalous Gamma Dipole

Kashlinsky and coauthors (2024) found that the dipole of the gamma-ray background (Fermi, 2.74–115 GeV) is shifted relative to the CMB dipole so much that it has moved from the northern to the southern hemisphere. The amplitude is about 7%, an order of magnitude larger than expected. Within isotropic ΛCDM this is inexplicable, but natural for a large-scale structure inherited from a previous cycle.

9.7. Mature Galaxies at High Redshift

JWST has discovered unexpectedly mature massive galaxies at $z > 10$, which is difficult to explain within the standard time frame of structure formation. In cyclic models, some black holes and structures may have carried over from a previous cycle.

9.8. Summary Table

Model prediction	Data	Agreement
Bounce without singularity	CMB anomalies (Planck)	Qualitative
Particle creation from vacuum	Parker, Starobinsky, Grib–Pavlov	Theoret. justified

Dark matter = closed wormholes	LIGO; UMa III/UNIONS 1; Gaia	Strong
$w_0 > -1$	DESI DR2: −0.84 at 3–4σ	Direct
$w > -1$ always	DESI DR2: $w_0 > -1$	Direct
ρ_DE ∝ a^(−0.48)	DESI DR2: ~10% over 4.5 Gyr	Qualitative

$\Omega_k \approx -0.11$	Not measured directly	Prediction
Hubble tension	$H_0 = 67.4$ vs 73–75	Qualitative
Nanohertz GW background	NANOGrav 2023	Direct
Gamma dipole	Kashlinsky 2024	Qualitative
Mature galaxies at $z > 10$	JWST	Qualitative

10. Practical Implications and Experimental Tests

The model predicts:

- particle creation from vacuum during the contraction of the universe or in strong gravitational fields;
- accelerated aging during instantaneous teleportation;

- specific quantum correlations related to the topology of the unobservable sector (Bell inequalities have already been verified within the model and are consistent with its predictions);
- nonzero curvature $\Omega_k \approx -0.11$;
- a monotonic dependence $\rho_{DE}(z) \propto a^{(-0.48)}$ without a bump in direct reconstruction.

Possible tests:

- anomalous aging of atomic clocks under conditions simulating transfer through a micro-wormhole;
- search for particle creation from vacuum in extreme fields;
- direct measurement of Ω_k in surveys Euclid, CMB-S4, Simons Observatory;
- model-independent reconstruction of $\rho_{DE}(z)$ using DESI DR3 and Euclid data;

- verification of the predicted running coupling for the weak interaction — the δb contribution to the beta function, derived in the model. The effect is at the boundary of current experimental uncertainty and requires either more advanced accelerators or a detailed reanalysis of already obtained data taking into account the predicted correction.

11. Conclusion

The 6D model unifies a geometric approach to wormholes with an algebraic structure describing quantum effects. Teleportation and aging, the bounce of the universe, and particle creation from vacuum receive a unified treatment.

The model is built as a natural hierarchy of dimensions: from the circle (2D) through the sphere (3D), the hyperboloid (4D), the torus (5D), to the six-dimensional sphere (6D). Each new dimension changes the topology and gives rise to the next fundamental interaction. The number of symmetry generators at each level — the triangular numbers 1, 3, 6, 10, 15 — confirms that the four interactions are not put in by hand but emerge from dimensionality. Wormholes sequentially acquire a radius (4D), depth (5D), and distance between them (6D), forming a network that naturally explains confinement.

The toroidal topology of the unobservable sector, arising from the folding of the hyperboloid by closed wormholes (dark matter), provides the compactness necessary for a pulsating universe and is algebraically fixed by the invariant $\mathrm{Tr}(\bar{W}(3)^2) = 3$, preserved in all dimensions from 4D to 6D. The invariant belongs to the spatial block s_1, s_2, s_3 and does not change when the temporal dimensions w and q are added.

From this invariant, the dark energy equation of state $w = -2/3 + 2\beta/3$ is derived directly. For $\beta \approx -0.26$, the model predicts $w = -0.84$ — a constant that matches DESI DR2. The apparent "phantom crossing" is explained as an artifact: DESI fits a flat model to a universe with curvature $\Omega_k = -0.11$, and the unaccounted curvature "hides" in the CPL parameters, creating the illusion of $w < -1$ in the past. All three CPL parameters (w_0, w_a, $w_0 + w_a$) agree with DESI within 1σ.

It is fundamentally important that in the model, 16 postulates of quantum mechanics are not postulated but derived as consequences. They are not put in by hand — they grow from the algebraic structure of the matrices and the geometry of wormholes. As a consequence, 42 results are obtained from the model, covering quantum mechanics, quantum field theory, and cosmology: from spin and entanglement to particle creation from vacuum, confinement, the bounce of the universe, and the equation of state of dark energy. All of these are not a set of independent statements, but a single chain where each result logically follows from the previous one.

The upshot can be formulated very concisely. The entire picture is built on a single matrix $T(n)$, where $n = 2, 3, 4, 5, 6$, and three parameters: φ — the phase of transfer through the wormhole, ρ — the distance between wormholes, R — the scale factor. The parameter ρ also admits a dual interpretation: the smaller the distance between wormholes, the greater their density, so ρ can also be regarded as a measure of the density of wormholes in the network. From this minimal set — one matrix and three parameters — all of physics unfolds: the four interactions, toroidal topology, dark matter, dark energy, the bounce, particle creation from vacuum, teleportation, and aging. All of physics in the palm of your hand.

The model makes concrete testable predictions: $\Omega_k \approx -0.11$, $\rho_{DE} \propto a^{-0.48}$, $w = -0.84 = \text{const}$, $w > -1$ always, running coupling for the weak interaction with a δb correction to the beta function. These can be verified with DESI DR3 (2027), Euclid (2026–2029), and CMB-S4 data, as well as with next-generation accelerators or through a detailed reanalysis of already accumulated data.

Appendix A. Algebraic Structure of Matrices in Dimensions 4D, 5D, and 6D

A.1. Basic Definitions

The model is described by a family of matrices $A(n)$, $B(n)$, $C(n)$, $T(n)$, $W(n)$, where $n = 4, 5, 6$ is the dimension of space-time. Since the observable world begins with the 4D case (the emergence of gravity and the wormhole radius), while the 5D and 6D cases correspond to the addition of the electroweak and strong interactions, respectively, all three cases are written out below in sequence.

Case 4D (4×4)

The matrix $T(4)$ is antisymmetric, with a single nonzero block J in the $(3, 4)$ plane:

$$T(4) = \begin{pmatrix} 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & 0 & -1 & 0 \end{pmatrix}.$$

The matrices $A(4)$ and $B(4)$ are block-diagonal, constructed from Pauli matrices:

$$A(4) = \begin{pmatrix} \sigma_3 & 0 \\ 0 & -\sigma_1 \end{pmatrix} = \begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & -1 & 0 & 0 \\ 0 & 0 & 0 & -1 \\ 0 & 0 & -1 & 0 \end{pmatrix},$$

$$B(4) = \begin{pmatrix} \sigma_3 & 0 \\ 0 & \sigma_1 \end{pmatrix} = \begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & -1 & 0 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & 0 & 1 & 0 \end{pmatrix}.$$

The matrix $C(4)$ is diagonal with blocks I_2 and $-I_2$:

$$C(4) = \begin{pmatrix} I_2 & 0 \\ 0 & -I_2 \end{pmatrix} = \operatorname{diag}(1, 1, -1, -1).$$

The diagonal form of $W(4)$:

$$W(4) = \operatorname{diag}(3, -1, -1, -1).$$

The matrix $W(4)$ contains the 3×3 submatrix $W(3) = \operatorname{diag}(3, -1, -1)$ satisfying the invariant relation $W(3)^2 = W(3) + 2I(3)$.

Case 5D (5×5)

In the transition from 4D to 5D, a fifth coordinate w is added — the proper time inside the wormhole. In the matrix $T(5)$, a symmetric block with parameter R appears in positions $(2,5)$ and $(5,2)$:

$$T(5) = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & R \\ 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & -1 & 0 & 0 \\ 0 & R & 0 & 0 & 0 \end{pmatrix}.$$

The matrix $A(5)$ — nonzero elements $A_{11} = A_{22} = 1$, $A_{34} = A_{43} = A_{55} = -1$:

$$A(5) = \begin{pmatrix} 1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & -1 & 0 \\ 0 & 0 & -1 & 0 & 0 \\ 0 & 0 & 0 & 0 & -1 \end{pmatrix}.$$

The matrix $B(5)$ — nonzero elements $B_{11} = B_{34} = B_{43} = B_{55} = 1$, $B_{22} = -1$:

$$B(5) = \begin{pmatrix} 1 & 0 & 0 & 0 & 0 \\ 0 & -1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 \end{pmatrix}.$$

The matrices $C(5)$ and $W(5)$ are diagonal:

$$C(5) = \mathrm{diag}(1, -1, -1, -1, -1),$$

$$W(5) = \mathrm{diag}(3, -1, -1, -1, -1).$$

Adding the dimension w extends W with another eigenvalue -1, without violating the invariant $W(3)^2 = W(3) + 2I(3)$.

Case 6D (6×6)

In the transition from 5D to 6D, a sixth coordinate q is added — the interaction time between wormholes. In the matrix $T(6)$, a new antisymmetric block with parameter ρ appears in the $(5,6)$ plane:

$$T(6) = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & R & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & -1 & 0 & 0 & 0 \\ 0 & R & 0 & 0 & 0 & \rho \\ 0 & 0 & 0 & 0 & -\rho & 0 \end{pmatrix}.$$

The matrix $A(6)$ — nonzero elements $A_{11} = A_{34} = A_{43} = A_{55} = 1$, $A_{22} = A_{66} = -1$. Compared to $A(5)$, the signs of elements A_{34}, A_{43}, and A_{55} are inverted from -1 to $+1$:

$$A(6) = \begin{pmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & -1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & -1 \end{pmatrix}.$$

The matrix $B(6)$ — nonzero elements $B_{11} = B_{22} = B_{66} = 1$, $B_{34} = B_{43} = B_{55} = -1$. Compared to $B(5)$, the signs of elements B_{34}, B_{43}, and B_{55} are inverted from $+1$ to -1:

$$B(6) = \begin{pmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & -1 & 0 & 0 \\ 0 & 0 & -1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & -1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \end{pmatrix}.$$

The matrices $C(6)$ and $W(6)$ are diagonal:

$$C(6) = \mathrm{diag}(1, -1, -1, -1, -1, -1),$$

$$W(6) = \mathrm{diag}(3, -1, -1, -1, -1, -1).$$

The simultaneous sign inversion in A and B in the 5D $\rightarrow$ 6D transition is the algebraic signature of the transition from the torus to the sphere $S(6)$. The parameter ρ in $T(6)$ is the distance between wormholes, giving rise to the strong interaction and the network structure.

Summary Table of Matrix Evolution

Matrix	4D	5D (added)	6D (added)
T	Block J in $(3,4)$	$+$ block R in $(2,5)$	$+$ block ρ in $(5,6)$

A	$\mathrm{diag}(\sigma_3, -\sigma_1)$	$+$ element $A_{55} = -1$	Inversion of A_{34}, A_{43}, A_{55}; $+\ A_{66} = -1$
B	$\mathrm{diag}(\sigma_3, \sigma_1)$	$+$ element $B_{55} = 1$	Inversion of B_{34}, B_{43}, B_{55}; $+\ B_{66} = 1$

C	$\mathrm{diag}(1,1,-1,-1)$	C_{22}: $1 \to -1$; $+C_{55} = -1$	$+C_{66} = -1$
W	$\mathrm{diag}(3,-1,-1,-1)$	$+W_{55} = -1$	$+W_{66} = -1$

The invariant $\mathrm{Tr}(\overline{W}(3)^2) = 3$ is preserved in all dimensions, since it belongs to the spatial block s_1, s_2, s_3 and does not change when the temporal dimensions w and q are added.

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