Quantum of Quanta (QoQ).

Something is missing in our picture of the world… Our past limps on three crutches and still runs into infinity. Our present is explained through the unexplainable. We have locked ourselves inside a cone and are flying within it into an infinite future.

We calculate perfectly, yet we still understand so little…

We decided that this Universe is for us and about us simply because we invented the words “we”, “the Universe”, and “for”. Strange carbon formations on the surface of a cold stone, orbiting an unremarkable star on the outskirts of an entirely ordinary galaxy, inside a thin filament of lesser emptiness within a greater emptiness… learned to turn the heat of thermonuclear fusion into pride.

Shall we try another way?

Version 1.0

Three Walls. The Curse of the Wise

Unto you—of probing mind,
of hungry eye and of keen word—
a lesson and an admonition.

And quarks, the least, were bound with gluons unseen… And waves were, and nuclei were… And the void was made firm, and the firmament made void… And out of the solid void there came beasts not yet beheld… And the proudest of them hungered for Truth… And they begat the Wise in their midst…

And age after age the wise arose, and sought the Eidos—the unseen First-Form. For they believed, saying: "If we search out the Draft, then shall Meaning appear; and if we obtain the Seal, then shall the image lie within things."

And they devised Number, and measured all things thereby, and Number became unto them a luminary: they aligned their ways, they set their scales aright; the straight and the crooked they joined, and out of the seen they found the unseen.

And the tower of numbers grew, and the scrolls were multiplied, and the statutes of measure were made strong. And it was unto them according to their labour: there stood by the way an iron run, and the voice overcame the far, and the eye touched the bound of heaven.

And on a day they saw: their tower is unfinished, their temple unstable, their house unsteady. For they have three walls… one in Motion is righteous, another in Light is skilful and unseen is the third; they foretell the ways unto the small and unto the great, and are right in their numbers.

And the third wall—whether it be, or be not, none knoweth… now hath it one window, now many… turn from it—the wind is stilled; turn unto it—afar is seen…

And those walls rose into a height uncountable, and the wise were proud of them.

But one wall—whose name is the Whole—was not; and a wind from the endless abyss walked through their chambers, and the stones in the walls were unlike, and the runes of numbers would not fold into one…

And the wise held those walls with all their strength, with craft and with abstruseness, and with a mighty spell, saying: "Utter not overmuch; shut thy mouth, and pray unto Number…"

And the wise heard: "Measure hath exalted itself above Meaning; Number hath gone up upon the throne and is become an idol. Ye have mastered the reckoning, yet have not obtained understanding. Ye sought the Eidos, and found but a measure unto it; ye hold the Draft, yet the First-Form holdeth not you. Ye know 'How much,' but ye know not 'Why.'"

And the quiet voice of the great Vast, and of hEr frail Burden, spake:

"Let Measure be a servant, and not a lord; Number a guide, and not a throne. And render unto the Draft that which is of the Draft, and unto Meaning that which is of Meaning. Set no altars unto runes; lift not the fortune of coincidences unto dogma. Let every 'how much' serve the 'wherefore;' let every Seal seek the First-Form."

If thou buildest a temple of understanding, lay the fourth wall in the foundation: unboastful, yet whole— that the Name of a thing may cleave unto hEr way and unto hEr wyrd. For a house wherein Number is without Meaning is no house, but a harbour of phantoms; and a house wherein Meaning is without Measure is a foolish tent, fallen to the wind."

And it was spoken unto every one that heareth:

"Measure with measure, yet raise it not into an idol.

Fashion the Draft by the Seal, and the Seal by the First-Form;

And then shall the two stones be not a wall without a window, but a threshold unto understanding.

And there shall the Boundless Vast dwell with her Burden, in the seasons appointed unto them, and they shall bring forth their firstborn, and all shall abide in Accord.

For salvation is not in Number, nor in contempt of Number; but in this: that number be in Meaning, and Meaning in Truth."

Wherefore let My word abide with you:
Beeng — of what and how
Seeng — of you
Told — of dawn and day
Pretold — of sunset and shade…

Space

«…Everywhere am I, and within Me all is.
Great Vast is My Name.»
(Beeng 01:00)

Space is primary and absolute.

Its primacy and absoluteness lies in the fact that it cannot be redefined in terms of any other concept. At most, what presently seems possible to say is that space is:

- that which is everywhere,
- that within which everything is located.

Space Quantum (SQ). Discreteness

«The dawning and the going down am I;
The before and the after am I;
The stone and the root am I.
Span is My measure;
Stature is My might;
Zizhdal is My Name.»
(Beeng 01:01)

Space (macrospace) consists of elementary quanta—fundamental Planck-scale hypercubes, which we call the Space Quantum (SQ) [1]. Each SQ has an internal microspace with its own dimension d. This dimension can be arbitrarily large; it is integer-valued and local.

For symbols and abbreviations used, see Appendix 7. Notation Conventions.

Changes in microdimension d. SER

The dimension of SQ cells can change between individual dimension states d.

Transitions follow the SER (Space Expansion Rule):

- Degradation: $SQ_d \to 2\times d\times SQ_{d-1}$
- Reverse: $2\times(d+1)\times SQ_d \to SQ_{d+1}$.

Geometry and topology

«And above as afar;
And afar as forth;
And forth as round about;
And round about as here;
And here as beneath;
And beneath as there;
And there as above;
Ubiquity is My Name.»
(Beeng 01:02)

- Each SQ is a hypercube with edge length ℓ_p.
- Its internal volume is $V_d = \ell_p^d$.
- An SQ connects to its neighbors via its (d−1)-faces; one SQ has 2^d such connections.
- The faces of the hypercube label discrete orthogonal coordinate directions that define the local frame of space.
- A network of such connected cells forms macrospace with mean dimension D.
- Space discreteness implies a requirement of "unboundedness", which is possible only under a condition of "closedness". The best implementation of these principles is a T^D hypertorus with

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[1] Hypothesis: in the course of further research, other classes of topology for the "carrier cell" may be identified—with their own face combinatorics F(d) and, consequently, their own C(d) = 2·F(d) (simplicial (d-simplex), orthoplex (cross-polytope), etc.). This would yield different mathematics.

periodic boundaries[2]. The rules and specifics of the geometry of such a space are described in Appendix 1. Geometry of Discrete Multidimensional Space.

- Due to variants of "connectivity", SQ with higher local dimension d can form macrospaces with mean dimension $D < d$ (by selecting sub-networks). The case $D > d$ is impossible. This also sets an observational constraint on the current macro-dimension: it is certainly not less than 3.

SQ charge

«My Burden is My yoke,
Fount is My Name.
From Me shall all be taken,
And in Me shall all abide. »
(Beeng 02:01)

- Each SQ contains charge q.
- SQ charge is equivalent to mass (hereafter measured in kg).
- SQ charge is a discrete quantity.
- SQ charge can:
  - be emitted from SQ into space, forming substance (emission),
  - be absorbed back into SQ when substance is destroyed (absorption);
  - transitions occur when local configuration conditions of the environment ("windows") coincide; integrality and balances are preserved (charge conservation).
- SQ charge governs the expansion dynamics of the space of the observable Universe and the full gravitational "connectedness" of Space.
- Further in the text, the following terms will/may be used:
  - the cell "charge", the "metric" (spatial) charge—the cell's actual charge;
  - for computational convenience, the elementary charge may be set equal to 1 (as may distance, time, volume, and mass).
- The total charge of a cell of dimension d: $N_d = 2 \times d \times d!$—always an integer number of elementary charges—$q_d = N_d \times Q_{abs}$. After substance emission, the SQ charge becomes non-full, but it still remains an integer number of Q_{abs}.

Charge quantum (ChQ)

SQ charge consists of elementary charges = the charge of a zero-dimensional cell $Q_{abs} = 1.82865 \times 10^{-134}$ kg.

Charge Quantum (ChQ).

Charge interaction

«And until then—
ever of old, and for ever,
For the small one and for the great one,
Unto the statured one and unto the bowed one,
Written afore are Eternal Bonds.»
(Beeng 06:00)

SQ charges interact with each other. Charge interaction between SQ is fundamental and is realized in an arbitrary bubble of the Universe through the gravitational constant G—a meta-parameter of the Universe that reflects the coupling between charges (masses). The G constant is fixed and invariant.

Operationally, G is a single coefficient that maps the masses (charges) of the interacting objects and the distance between them into the observable attractive force:

$$\mathbf{F = G \times m_1 \times m_2 / r^{(d-1)}}.$$

[2] The family of such spaces is broader, but topologically the T^D hypertorus is the best observational match.

d – space dimension

Interaction quantum (IQ)

«If thou be Vastspan,
And Span be thy Burden,
Unto thy Bonds do I ordain Span —
And Bondspan do I name it.»
(Beeng 06:02)

Fundamental interaction (force quantum) is the attractive force between two mass quanta (elementary charges) at a distance of one space quantum.

Interaction Quantum (IQ).

Mass (charge) attraction is a more fundamental interaction of the Universe than the interactions of the Standard Model, and it does not require a carrier particle (graviton).

Interaction range

«…And he that is farther — to him less of the brethren,
But he that is nigh — to him all.»
(Beeng 06:03)
«…And ye shall call it —
Testament of Isaac.»
(Beeng 06:04)

Each (space) cell of dimension d has a fixed charge Qd, consisting of 2^d elementary charges. This charge acts on the surrounding cells (in the broad sense—on the medium). Nominally, the force at a discrete distance r (the number of orthogonal steps) is described as

$$F_d(r)=Q_d / r^{d-1}.$$

The force quantum is indivisible: at a node, the interaction either exists (one full quantum or more) or it does not. Therefore, there is a maximum interaction range R_d—the last step after which $R_d(r) < 1$ and the interaction becomes zero.

Hierarchy of radii (top to bottom):

- $d \geq 3$. The radius is stable for any d and equals 2.
- d = 2. Phenomenon. Doubling of the radius: $R_2 = 4$. This creates a "support" regime and helps the 3D framework maintain connectedness ("props up" connectedness) under degradations. This radius staircase is one of the reasons why 3D becomes the first stable volumetric regime at minimal cost.
- d = 1. The interaction range returns to $R_1 = 2$.
- d = 0. Phenomenon. Formally, the force increases with distance ($F_0 \propto r$). Physical interpretation: zero-dimensional states are unstable in isolation and spontaneously tend to coalesce into d = 1 (a seed of dimension growth).

Disclaimer. Everything above is a direct consequence of the model's discreteness. Nevertheless, the radius staircase provides a natural mechanism that may be a significant factor when SER is switched into reverse mode.

Note on "4/3" (2D node, r = 3). The formal nominal value $F_2(3) = 4/3$ conflicts with quantum indivisibility. We record this unique case as an open technical node: an integer scheme or a physical / geometric interpretation is needed.

At present, the most acceptable explanation of the phenomenon appears to be that dimension 2 is an unstable state (simultaneously: (i) the interaction range jumps to 4 and (ii) quanta cannot be at a distance equal to 3), and that within it Space Quanta SQ undergo a phase transition from scattered elements to connected space (spontaneous unification) / from connected space to scattered elements (spontaneous localization).

Quantumness

«And My king is My servant,

And My servant is My king;
Wyrd is My Name.»
(Beeng 02:07)

- Space is discrete; it consists of SQ.
- SQ states are discrete: microdimension changes sequentially in integer steps between individual dimension states d.
- The minimal time interval for a transition is the time quantum t_{abs}.
- Transitions follow SER (Space Expansion Rule):
  - Degradation: $SQ_d \rightarrow 2 \times d \times SQ_{d-1}$
  - Reverse: $2 \times (d+1) \times SQ_d \rightarrow SQ_{d+1}$.

This process leads to an increase in the number of cells and an increase in the radius of space – see Space Expansion Rule (SER).

- The cell state is described by the "wave function" Ψ_d: a probability vector for which allowed event will occur at the next SER step (see Appendix 2. SQ Wave Function: Fate):

Fate:

  - (1) decrease in dimension (Down: D→D−1),
  - (2) holding the current dimension (Hold: D→D),
  - (3) increase in dimension (Up: D→D+1),

Burden:

  - (4) emission of charge (substance) into macrospace,
  - (5) absorption of such charge (substance) from space.

Heredity

«My Burden is My verity,
Canon is My Name.»
(Beeng 02:05)

- The base rule $SQ_d \rightarrow 2 \times d \times SQ_{d-1}$ is preserved at all steps.
- The parent charge is split equally among the offspring, preserving the overall balance. The system has no arbitrary "smearing" of charge—it is discrete and quantized. Under SER reverse transition, the charges of all SQ_d sum into SQ_{d+1}.
- The SQ edge always remains Planck-length ℓ_p; under any transition it does not stretch or shrink.
- Face orientation is inherited: the offspring replicate the parent's frame system, ensuring consistency of the local space lattice.
- Connectedness is preserved: the children inherit the parent's boundary connections through the corresponding faces.

Information. SQ SSD

Hypothetically, SQ faces can be treated as discrete state registers (state carriers) with information capacity proportional to the face area of the corresponding dimension ("pixels", "memory slots")[3]. For now, assume 1 "pixel" = 1 bit.

If SQ faces are treated as discrete state registers, it is hypothetically consistent that one could "write" into them the "algorithmics" of our Universe bubble (physics, interaction rules, local constants, rules of dynamic homeostasis, local coefficients, etc.).

For a cell of dimension d:

— number of faces: $2 \times d$
— "pixels" per face: 2^{d-1}

[3] Within the present text, this assumption is not used in any calculations and yields no physical consequences (no anisotropy, chromaticity, birefringence, or scattering). It is introduced as an auxiliary abstraction for possible future sections (for example, on encoding neighbor links / the history of SER steps / entropy).

— total slot grid: $B_d = d \times 2^d$.

As dimension grows, "available memory" grows exponentially, while the requirement to "encode" charge grows logarithmically in content (polynomially in arguments). Therefore, higher dimensions create an increasing surplus of information carriers.

The critical point is d = 3: from this point downward, "memory" is strictly sufficient only for charge distribution, while the "algorithmics of the world" (complex interaction rules) no longer "fits". This can serve as an additional explanation of the behavior of Space and Matter at low dimensions (see Curtain of the Curtain). The multidimensional world is rich and diverse, but entropy advances and wins.

Properties of local dimensions

d	Faces $2\times d$	Pixels per face 2^{d-1}	Total pixels $d\times 2^d$, bits on faces	ChargeQ $=2^d\times d!$	Long-range interaction law	r_{max}*[4]	Fate
0	1	1	1	1	$1/r^{-1}$	Force increases with distance	Up — find another $SQ_0 \rightarrow SQ_1$
This is, obviously, a paradox. But zero-dimensionality is paradoxical in itself, so for now we accept the picture dictated by the mathematics.							
1	2	1	2	2	$1/r^0$	2	Up — find another $SQ_n \rightarrow SQ_{n+1}$ Down — decay back into $SQ_n \rightarrow SQ_{n-1}$ Hold — remain unchanged
2	4	2	8	8	$1/r^1$	4	
3	6	4	24	48	$1/r^2$	2	
4	8	8	64	384	$1/r^3$	2	
5	10	16	160	3840	$1/r^4$	2	
n	2n	2^{n-1}	$n\times 2^n$	$2^n\times n!$	$1/r^{n-1}$	$2^{n/(n-1)}$	

- d = 0. Faces: 1. Face area: 1. Charge: 1. Direction: degenerate—the only Fate option is to join with an identical object and form d = 1. "Wave function": Ψ_0 is degenerate (one configuration, probability 1). Step outcome: only Up (0→1); Hold/Down are not defined. Emission is impossible.

- d = 1. Event: two SQ_0 merged into SQ_1. Faces: 2. Total face area: 2. Charge: 2. Burden: from two SQ_0 is transferred to the new 1D cell. Charge conservation holds. Fate: the probability of three outcomes appears (up to SQ_2—Up, down to SQ_0—Down, unchanged—Hold). Ψ_1: a single uniform configuration (with point symmetry "left–right"); there is no migration of quanta—any permutation is identical to the original. Outcomes: Hold is unstable; Up is possible under external "pushing apart", Down—under "pulling in" (but there is no wandering).

- d = 2. Event: four SQ_1 merged into SQ_2. Faces: 4. Total face area: 8. Charge: 4. Burden: from four SQ_1 is transferred to the new 2D cell. Charge conservation holds. Fate: the probability of three outcomes (up to SQ_3—Up, down to SQ_1—Down, unchanged—Hold) is preserved.

- d = 3. Event: six SQ_2 merged into SQ_3. Faces: 6. Total face area: 24. Charge: 8. Burden: from six SQ_2 is transferred to the new 3D cell. Fate: the probability of three outcomes (up to SQ_4—Up, down to SQ_2—Down, unchanged—Hold) becomes a genuinely probabilistic phenomenon.

- From here on, everything follows the same typical scenario. However, dimensions 1 and 2 clearly stand out among the others. Starting from dimension 3 and above, the "interaction

[4] Since this is a discrete interaction (elementary charge / elementary distance / elementary time), the interaction range is measured only in integer units. This means there can be no "fractional" forces or distances. Therefore, the interaction range always has a finite radius. Moreover, for d ≥ 3 this radius is always equal to 2.

range" of charges stabilizes at 2. At level 2 it equals 4, and at level 1 it equals 2. I will return to this phenomenon once the Background Process gains a "support" of stability and, more broadly, to "why 3D is so special" …

- d = 4. With all other processes remaining analogous, another phenomenon appears at this dimension level (and persists for all subsequent dimensions): starting from dimension 4, the interaction range becomes constantly 2.

Matter

«My Burden is the seed of all that is,
Allbeeng is My Name.»
(Beeng 03:01)

Matter is derivative of space.

Mass

«My Burden is My blood outpoured:
By it I know a brother,
By it I bid a guest,
By it I draw nigh…»
(Beeng 03:02)

Mass is a property of Matter that expresses the amount of charge; it is the form in which space charge exists in the state of substance. In other words, mass is the same physical entity as cell charge, but realized in the emitted form of Matter.

Charge is one, with two manifestations: spatial (metric) charge remains in the cells and drives the unfolding of Space; mass charge is emitted into substance and follows its own dynamics. In essence, it is the same property, separated by its carriers.

Mass is a measure of Matter interaction. Matter interaction is proportional to mass.

Mass quantum (MQ)

«My Burden is world-dust,
Solidspan is My measure. »
(Beeng 03:03)

Charge of a zero-dimensional SQ space cell. Equivalent to the charge quantum ChQ.

Emission (window)

«…*And Promised Hour shall come –*
The scrip shall be rent;
And Vast shall let fall
A little of Her Burden…»
(Beeng 04:00)

Emission is the release of part of the charge from cells into the form of substance. Conditions for the emission window:

- the space scale matches the scales of Matter elements in the required quantity (there is enough space to "fit");
- the state of the substance already present in space (density, pressure, temperature) and the state of the emitted charge are equivalent (compatible) for integration.

At early steps, charge exits the cells in an elementary form (size and state), while the already emitted substance exists in a primary hot and dense state. As space expands, Matter undergoes a cascade of phase transitions: elements grow larger, and temperature and density decrease. From some stage onward, such substance ceases to be scale-compatible with the elementary nature of the emitted charge—the emission window closes.

Absorption (window)

The reverse process (absorption) is associated with a drop of cell dimension below three. At D < 3, the familiar conditions for Matter existence break down: chemistry disappears, interactions collapse, and Matter cascades into ever smaller elements. When dispersion reaches an elementary scale compatible with the cells, the absorption window opens: charge integrates back into the cells.

Between these two stages, substance emission and absorption are quantum in nature, enter the cell wave function as an "emission" component, and account for vacuum "fluctuations" that do not lead to the birth of stable objects.

Density

«And it shall be strait and unquiet unto you,
Until the frost shall come;
And when the straitness shall pass,
Then shall the stars above Solid shine forth…»
(Beeng 04:03)

Density is the distribution of mass in space; a property of how substance occupies volume. Density determines the phase state of Matter and the degree of time slowdown.

Motion

«And shall there be no rest for any:
Having gone forth but once,
It shall find rest within new seed only…»
(Beeng 05:03)

Only at the moment of primary release (emission) can substance be in a quasi-stationary state conventionally called rest. As space expands, there is more "room" for substance; from some stage onward, substance transitions to motion, which does not cease until substance decays at the end of evolution.

Motion is the displacement of substance in a conditional "forward" direction in space, where "forward" is set by the combined action of two factors of the gravitational component:

- the slope created by mass distribution, and
- dimension gradients within the gravitationally connected region of space.

See Appendix 3. Gravity in Discrete SQ Space

Matter motion manifests a standard set of properties.

Inertia is the preservation of direction and pace of motion under an unchanged environment.

Momentum is a measure of the amount of motion, defined by mass and velocity.

Angular momentum is a measure of a system's rotational motion about a chosen center.

Acceleration is the change of a body's velocity over time. It arises under the action of force and is linked to external factors—changes in mass distribution and the emergence/change of space dimension gradients.

Causality: motion is impossible at a speed exceeding the maximum permitted for a given amount of mass (see the Limit speed).

Mass motion in space—any change of its position—causes a local restructuring of the metric: a redistribution of dimension gradients (see the Dynamic homeostasis).

Interaction

«And until then—
ever of old, and for ever,
For the small one and for the great one,
Unto the statured one and unto the bowed one,
Written afore are Eternal Bonds.»
(Beeng 06:00)

Matter interacts with Space (with the charge of the cells): it affects it and experiences a reciprocal effect.

At every moment, at every point (cell) of space, there exists the resultant of all masses acting on that point (cell). Long-range interaction propagates with inverse proportionality to distance for the given Space metric and not faster than the maximum permitted speed (see the Limit speed).

The continuous balance of interactions between Space and Matter is maintained by the dynamic homeostasis mechanism.

Dynamic homeostasis is the functional manifestation of these interactions in time: it aligns and restructures local states when the resultant changes (see the Dynamic homeostasis).

«…And there — Ere, and here — Ere,
And to all — Ere, and ever — Ere …»
(Beeng 07:00)

Matter creates a slowing of time in space, proportional to the amount of mass and the speed of its motion: the greater the mass and speed, the more slowly the "clocks go" in its vicinity. More details are in the next section, Time.

Time

«From why even unto therefore the path doth lead,
From before even unto after Zizhdal doth go;
If Vast be wider, Zizhdal lighter,
If Burden be lesser, then Bonds weaker,
If Gift be greater, then sloth stronger…
And swifter — Ere, and slower — Ere,
And there — Ere, and here — Ere,
And to all — Ere, and ever — Ere…»
(Beeng 07:00)

«And evere-faced and evere-handed — Ere;
And every-where and all-ways-ere — Ere;
And when-evere and each-evere — Ere;
And His name is Ere. »
(Beeng 07:01)

Time is multiple and relative.

Time quantum (TQ)

«My Ere — no-one's Ere,
no-one's Ere — every-one's Ere,
every-one's Ere — Spans' Ere,
Spans' Ere — Erespan...»
(Beeng 07:02)

- Time is discrete.
- The time quantum is the duration of a tick (a "second") of Absolute Time—t_{abs}.
- Time has a rate: the tick duration measured in the number of time quanta.
- Time slowdown is an increase in the number of time quanta within one tick. Each mass quantum adds one time quantum to its "own" second.
- A time rate of one time quantum per tick is characteristic of Absolute Time. All other "times" are the result of interaction between Substance and Space.
- A time rate of one time quantum per tick is characteristic of the local time of a single charge quantum. For the charge of a dimension-0 cell, time flows at one quantum per tick.

Absolute Time

«…Erespan — the most Ere,
the most Ere — eternity's Ere,
eternity's Ere — Beeng Ere,
Beeng Ere — My-Ere.»
(Beeng 07:02)

- Absolute Time is a universal rhythm that exists in the Universe independently of Matter and Space. An absolute second is not observable from within; it is needed as a reference against which universe bubbles exist.
- It flows uniformly and homogeneously; each tick corresponds to one time quantum.
- The absolute SER rate is one step per one tick t_{abs} of this Absolute Time.
- On the Absolute Time scale, the entire unfolding sequence of our space—from the initial cell to the zero-dimensional state—finishes almost instantaneously (within the number of ticks required to degrade all cells into the zero-dimensional state).
- Absolute Time does not participate in processes inside a Universe; it is an external counter against which universe bubbles appear and disappear. We are inside our bubble. Within it, Absolute Time is not observable.

Global Time

«From My Burden in My Loss, withal,
With My Gifts shall ye receive your Ere…»
(Beeng 08:00)
«Granted Ere — shewn Ere,
Shewn Ere — Seeng Ere,
Seeng Ere — Your-Ere.»
(Beeng 08:02)

- Global Time is formed at the moment the mass charge is emitted from the cell charge during inflation. Before substance emission, Global Time coincides with Absolute Time.
- After substance emission, it is orthogonal to Absolute Time: it is not a slowed-down version of it, but exists on its own axis determined by the internal properties of the bubble.
- At the moment of substance emission, Matter is a "quasi-unified" object in a state of "rest", composed of charge quanta. The time of this object flows at a rate equal to the number of time quanta per tick, which equals the number of charge quanta in Matter (substance).
- The total amount[5] of Global Time corresponds to the period required for substance evolution: from its emission to its destruction and reintegration into zero-dimensional cells.
- The maximum duration of Global Time is set by the moment when all cells degrade into the zero-dimensional state. After that, Global Time disappears and becomes equal to Absolute Time.
- After "inflation", mass charge is no longer emitted: the amount of Matter is fixed, and this determines the lifetime of the local-universe bubble.
- The concentration of substance mass determines the mode of interaction with the lattice of space cells[6]. The higher the mass density, the more strongly its motion slows Global Time in that region, forming an internal time scale for the entire causally connected region.
- Thus, Global Time is the integral of the entire history of substance and space within a given Universe (bubble).
- Time in this concept is not a space coordinate. It arises as an orthogonal property tied to cell evolution and the interaction of mass with metric charge.[7]

Local Time

«…Unto all Ere — unto none Ere,
Unto none Ere — not unto her Ere,
Unto her Ere — unto every-one Ere,
Unto every-one Ere — unto Spans Ere,
Unto Spans Ere — Their-Ere.»
(Beeng 09:02)

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[5] It is quite possible that the total amount of Global Time can be treated as equivalent to the reserve of space multidimensionality: the difference between the average cell dimension $\bar{D}$ and three-dimensionality. While $\bar{D} > 3$, there exists a temporal resource for Matter evolution; the larger this reserve, the more "elastic" Global Time is and the harder it is to slow it down. In the limit $\bar{D} \to 3$, the reserve is exhausted and Global Time disappears. This may also have mathematical implications for modeling cosmological evolution.

[6] Global Time is realized only in a pure vacuum—in space devoid of substance. It expresses the evolution of the cell structure itself. The appearance of mass converts Global Time into local scales, which begin to differ depending on substance density and motion. In this sense, Global Time is an ideal limit accessible only in the absence of Matter. Everything we actually observe is always colored by local slowdowns.

[7] For interpretation in GR terms, the entire reserve of Global Time can be treated as an additional dimension embedded into a 3D subnetwork. This corresponds to the classical description of time as the fourth coordinate in the metric. However, within SER this representation is not fundamental; it serves as a convenient translation between models. This approach has limits of applicability: before substance emission into space, and when the SQ metric drops below three, it is not applicable.

- Local time τ is the time/property measured by an observer or a body (object) within a specific region of space under specific circumstances. The object's proper time.
- It is determined by the mass of the body/object, the speed of mass motion, and its position within the gravitational fields of other bodies.
- Local time arises as a deviation from Global Time: the global rhythm sets the common scale, while local deviations are formed by individual conditions of motion and mass.
- During the period when Matter is a "quasi-unified" object in a state of "rest", its local time equals the global time.
- Matter begins its evolution: proto-charges of substance assemble into configurations, and the "quasi-unified" object breaks into parts. Along with it, many local times arise for each Matter object, proportional to the number of charge quanta in its mass. From this moment, Global Time as a single notion does not exist—it is the overall time budget of this Universe and simultaneously the maximum slowdown limit (tick duration) available in this Universe.
- The local-time rate is additionally slowed due to the need for mass to overcome the density of metric cell charge during motion.
- The higher the metric charge of the cells, the larger the mass and the higher the object's speed, the harder it is to move, and the stronger the local-time slowdown.
- The smaller the charge (later in the Universe), the smaller the object's mass and speed, the easier it is to move, and the closer local time is to global time.
- For each object, local time is continuous and self-consistent; different objects can have different rhythms.
- Local time is always slowed relative to global time; the degree of slowdown depends on mass, speed, and the local density of metric charge.
- Local time disappears along with the destruction of mass (substance), since there is no subject relative to which it could be counted (it degenerates into Global Time). Local time disappears (becomes equal to Global Time) in the absence of speed—in a state of rest.
- Only differences in local-time rates between two regions are observed: red / blue shifts, delays, and "tick offsets" are not absolute values but deltas between "there" and "here". This implies a practical rule:
  - motion / orbital dynamics "feel" the full potential (the sum of contributions),
  - frequencies/shifts "see" the difference between local time rates.

Resultant of masses and local time

«And unto every one, and with every one,
And unto them all, and with them all,
By kindred and by nighness,
By Stature and by Burden,
They all do call forth guests,
And Bonds do draw them all.»
(Beeng 09:04)

At every moment, for each space cell, a local time-rate slowdown is defined as a function of two factors: the resultant of masses acting on it and the velocity of Matter flow through that region.

The resultant of masses is the causally timely sum of contributions from all masses affecting a given cell; the contribution of an individual mass decays as a power law with distance, with an exponent determined by the effective dimension of the local metric.

The resulting (reduced) mass at the target cell is the already "aggregated" influence of surrounding masses, accounting for the discrete falloff of interactions (masses within the gravitationally connected region of the cell) and gradients. This mass is also equal to some number of mass quanta $N(Q_{abs})$.

The second factor is Matter motion through the cell: the higher the local effective speed at which mass traverses the cell, the larger the additional temporal correction caused by the resistance of the metric charge of the cell boundaries to this flow.

Thus, local clocks belong to space (the cell); the "clock" of any mass at a given point coincides with the clock of the cell in which it is located. In strong fields or under large flows, the contributions of both factors add up: the gravitational component is set by the mass resultant, and the kinematic component by the traversal speed, which does not exceed the maximum permitted for the given mass.

The duration of a local second is some number of time quanta $N(t_{abs})$ per one tick.
Distances in discrete space are likewise a finite number of Planck lengths $N(\ell_{abs})$.
For a cell with charge $N(Q_{abs}) = 1$, with no influence from other masses (charges), time flows at a rate (the local-second duration is) $N(t_{abs}) = 1$.

For a neighboring cell (distance $r = N(\ell_{abs}) = 1$), each influencing mass quantum adds one time quantum to the duration of the local second: $t_{loc} = 1 + N(Q_{abs}) / Q_{abs}$.

In practice, there are several ways to determine the specific value of the time quantum t_{abs}:

- **From the global substance budget**: the total amount of substance/energy of the bubble is known; one must choose a reference "limit" state (closure of the emission window) in which maximal tick stretching is reached, and map it to t_{abs} as the minimal tick of Absolute Time.
- **From a locally observed second**: choose a reference point (e.g., near Earth’s surface), estimate the mass resultant at that point, and require that the sum of added time quanta from all contributions equals exactly one SI second. This yields t_{abs} via the observed "Earth second" as a local-environment reference.
- **From local temporal gradients**: take two nearby points A and B where the differential of the mass resultant is known (or modeled) (e.g., for a small elevation above the surface). Measure the relative second stretching $\Delta\tau/\tau$ between A and B. Then the universal tick t_{abs} is directly recovered from the base law via the linkage "measured time gradient ↔ computed mass-resultant gradient".
- Kinematically, from the limit step: assume that the limit speed of a mass quantum is "one space quantum per one time quantum".

After fixing t_{abs}, the limit speed for a mass quantum in our bubble is uniquely set as "no faster than one space quantum per tick". This is a constructive bound of discrete kinematics, independent of particular fields and implementations; observable speeds (including the speed of light) are particular realizations that do not exceed this bound.[8]

Limit speed

«And as is your greed for My Loss —
So heavy Fetters unto you…»
(Beeng 10:00)

- At the moment the emission window closes, a unique state is reached in which there exists a finite causally connected volume where all possible substance has been emitted (see Inflation III. Curtainthere is “enough” Space to accommodate the entire Universe in the state of an ultrarelativistic plasma;
- a cell “weighs” less than a particle;
- the conditions in which Matter exists (density, pressure, temperature) can “assemble” Standard Model particles out of the “quanta” of Matter emitted by cells;
- the gravity due to the cells’ metric charge weakens and becomes effectively negligible for the stability of Standard Model particle structures.

This also implies that, regardless of the exact time at which it occurs, we are dealing with large—but finite—densities, temperatures, and pressures.

Inflation III.). From this point on, no additional mass can be added. The substance distribution on these scales is nearly homogeneous, so local clocks across the entire domain (the new-Universe bubble) run almost synchronously.

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[8] It should be noted that preliminary estimates using all of these approaches indicate a time quantum substantially smaller than the Planck time and, accordingly, a limit speed substantially higher than the "light" (photon) speed.

The degree of time slowdown achieved by this moment is unique, finite, and maximally admissible under these conditions. It is a slowdown "ceiling" that cannot be exceeded by anything, because no further mass will appear. If this state is taken as a rest reference (a quasi-stationary state), then time slowdown at rest maps uniquely to the amount of substance: each object at rest is assigned its share of this limit slowdown—strictly proportional to the amount of substance in the object.

This state can be read in two equivalent ways:

- All Matter quanta are simultaneously at rest in their cells, and together they stretch the tick to its limit value.
- A single Matter quantum, within one tick t_{abs}, traverses the entire volume of space, cell by cell, and over this run stretches the tick by the same limit amount.

Both are different pictures of the same time slowdown.

This is where the notion of limit speed is born: it is the speed at which even a single substance quantum can "cover" the entire volume of the Universe within the minimal tick and thereby reach the same limit slowdown as the entire mass at rest.

Exactly the speed with which that quantum must cover the full volume of its bubble at that moment is fixed as the limit speed achievable in this Universe—the maximum rate of causal change.

Since no larger mass will ever appear in the Universe, this speed remains definitively set. It follows that for any finite mass in this space there exists its own maximum attainable speed: the larger the mass, the lower its upper limit; the smaller the mass, the higher. In the limiting case of minimal mass, the attained speed is practically equal to the established limit speed.

Derivatively, the photon must have a nonzero but extremely small mass: in that case its actual speed is proportionally and strictly lower than the limit speed.

Observability effects: we see what we see

«For I do see,
But ye — only to grope for the walls,
For I see the root,
But ye — only fruit and leaves…»
(Beeng 10:03)

In real experiments, only relative temporal effects are recorded: we compare the two ends of the path—the source regime and the receiver regime. In QoQ, the local second at any point is the base time tick increased by as many "quantum shares" as the number of mass quanta attributed to the given cell. Therefore, the measurable quantity is the difference between the two endpoints in the number of such "quantum shares" (proportional to the difference in reduced masses at the endpoints). Everything that happens along the ray's path contributes to the flight time and the trajectory geometry, but is not converted by the instrument into a frequency shift at the endpoints.

Intuitively, a question arises:

- in voids, the acting mass per cell is minimal (cell charge ~10^3 mass quanta at our model dimension 4.81),
- in structures, it is colossal (e.g., near Earth's surface the total equivalent is ~10^{110} mass quanta),
- should we "see" this colossal relative shift?

But the instrument compares the ends of the path, and both ends almost always sit in structures (galactic sources and ourselves). Hence, what is compared is "structure with structure", while the giant "void ↔ structure" contrasts lie along the path and manifest as:

- an addition to the flight time (an optical delay along the path),
- a weak refocusing of the ray (lensing and defocus from the mass distribution).

Neither produces a "loud" endpoint frequency difference along typical "galaxy → galaxy / Solar System" paths. Hence the absence of "visual" miracles: we see small deltas of frequency (or ticks) between two mass-saturated endpoints, rather than an absolute "void regime". Hence the absence of "visual" miracles: we see small deltas of frequency (or ticks) between two mass-saturated endpoints, rather than an absolute "void regime".

For local tests (on Earth), the picture is even simpler: the base regime is already "heavy", and lifting by tens to hundreds of meters changes only a tiny fraction of that base regime. Since the observed effect is proportional to the fraction of change rather than the absolute magnitude, we obtain ppm-level discrepancies in clock rates—exactly what experiments show.

Domain

«And there shall appear from Beeng giants of stature —
Spans small and unseen:
Of Vast eternal
And of Burden bestowed,
Of Bonds unbroken,
And Trinity of Ere.»
(Seeng 01:02)

An unlikely event arising from an enormous number of trials.

BIOS

The domain inherits absolute quantities:

- Space Quantum (SQ).
- Charge Quantum (ChQ), which is also the Mass Quantum (MQ): Q_{abs}. Any mass is an aggregate of such quanta.
- Time Quantum (TQ) (absolute second) t_{abs}: the base tick of the event sequence, common to the Universe. It requires computation.
- Limit speed $V_{abs} = \ell_{abs} / t_{abs}$. The limit speed of a mass quantum for moving by 1 space quantum per 1 time quantum. It is numerically determined after computing the time quantum t_{abs}.
- Interaction Quantum (IQ). The minimal act of interaction between two charge quanta at a distance of one space quantum.

Depending on the dimension of the primary SQ, the opening and closing moments of the emission window, and the amount of emitted Matter (Substance), it forms its own local constants—derivatives, particular realizations based on the absolutes.

OS: Mass, Motion, and Time

«And rejoice ye, and be exceeding glad;
And bear ye Gifts unto Mine Altars;
And hold ye hands in hands;
And in Dance of dances be zealous,
To the honor of Accord Beatitude. »
(Seeng 04:00)

There is no "rest" in the Universe—everything moves. Therefore there is no single time even for the right and left hand (the differences are very small, but they exist), and the entire Universe is a large "patchwork quilt" of local objects and the conditions surrounding them.

- To obtain a single comparable picture, a mapping-and-synchronization mechanism is needed, one that must account for all factors of each set of local conditions.
- Accordingly, one can redefine the "basic matter relation" as a factor dependence on the absolutes and the local cell metric. I do not fix specific functional forms—only the set of factors, their physical meaning, and limiting cases.

Basic quantities and notation

«And all that becometh — of them it becometh,
And all that shall be — of them it shall be,
And all that sinketh — into them it sinketh.
From the first span unto the last,
Obedient unto Parsimony…»
(Seeng 01:03)

- Absolutes: ℓ_{abs}, Q_{abs}, t_{abs}, $V_{abs} = \ell_{abs} / t_{abs}$, F_{abs}.
- SQ charges: q_m (mass charge, substance mass), q_Λ (metric charge, SQ charge).
- Local effective dimension: D_{eff}.
- Local clocks "belong" to the SQ cell: the local-time rate is set by the metric state of that cell.

- Quantitative measure of an object's mass in quantum counting (dimensionless "how many mass quanta" in a body / a space cell):
  - N_M — "how many mass quanta are in the body": Q_{M_body} / Q_{abs} — a dimensionless count of body mass.
  - N_S — "what is the metric charge of the medium" in the chosen region: Q_{eff} / Q_{abs} — a dimensionless count of space charge.

Limit speed for a given amount of mass

Instead of a universal limit—a mass-dependent limit:

$$V_M^{lim} = V_{abs} \times F(N_M, N_S)$$

Properties of F:

- $0 < F \leq 1$;
- Discreteness and nonzero values. Since charge is discrete and absolute, $N_M \geq 1$ and $N_S \geq 1$; they cannot become zero, either separately or simultaneously.
- Degenerate regimes:
  - $N_S = 1$: the cell is charged by one elementary quantum charge of space (zero-dimensional state). The metric is undefined; macroscopic notions of distance/time are absent.
  - $N_S = 2$: a transitional (line-like) state with degenerate geometry. There is no full macrometric.
  - The cell is charged by one elementary quantum charge of space (zero-dimensional state). The metric is undefined; macroscopic notions of distance / time are absent.
  - These cases should be treated as a different phase state of Space.
- Mass slows: as N_M increases, F does not increase (the limit speed does not grow with the "amount of mass");
- The metric slows: as N_S increases, F does not increase (the "heavier" the space, the lower the limit);
- Flat baseline: for $N_S \geq 3$ and approaching the minimum accessible in the observable world, we take $F \equiv$ const (a baseline "flat metric"). The best reference is the interior of a typical cosmic void at the R* coherence scale, where N_S is fixed in the reference-medium description.

Factor structure

The energy–dynamical content of an observed body (what in SR is expressed via E, p, and m) is proportional to the product of:

- Mass scale: N_M — the quantum count of the body's mass (how many mass "bricks" it contains).
- Absolute speed scale: V_{abs} — the base "speed step" from the absolutes ℓ_abs and t_abs.
- Kinematic factor: the ratio V_M^{lim} / V_M (how close the body is to its local limit speed).
- Metric factor: N_S — the space charge level (derived from the effective cell dimension D_{eff}).
- Configuration factor Δd: anisotropies (dimension gradients) of space.
- Dimensional background: ΔD — on cosmological distances, an observationally visible pattern of space degradation as one approaches the observer.

The form of this function requires refinement. However, a number of its properties are evident:

- If a body moves much slower than its local limit ($V_M \ll V_M^{lim}$), the kinematic multiplier behaves as unity; as the limit is approached, the "price" of further acceleration rises rapidly, so V_M never crosses V_M^{lim} (local causality).
- The higher the dimension of the cells in a space region (the larger the charge and N_S), the slower the local "cell clock" runs, and the more strongly dynamics is suppressed.
- If the medium is quasi-stationary and isotropic (no gradients), the configuration multiplier equals unity; with pronounced gradients, it provides a correction.

OS: Synchronization with the classical framework

«And in that Dance be ye
From Promised Hours

Even unto Hours of Doom,
And Seeng shall be betwixt these…
And ye shall call that Seeng,
At the first — Testament of Isaac…»
(Seeng 04:01)

«And serve unto Ere, and drag Fetters,
And chase Sparks, yet reach them not;
And send forth Posts, and meet them,
And greet all by the sprinkled Sparks…
And ye shall call that Seeng,
Thereafter — Testament of Abraham…»
(Seeng 04:03)

Thus, the general statement. Each body has its own speed ceiling, set by two quantities: N_M—the quantum count of the body's mass, and N_S—the metric "saturation" of the medium at the R* coherence scale. The kinematic factor only indicates how close the actual speed is to this ceiling and enforces local causality: the actual speed always remains below its ceiling.

Reductions to the "classical" framework. This statement serves as a scaffold from which familiar theories are obtained by fixing factors:

- Special Relativity. The medium is locally homogeneous: N_S is fixed; for fundamental carriers, the dependence of the ceiling on N_M is negligible. Only the kinematic factor is active.
- Newtonian mechanics. Add "small speeds" to the SR conditions: the kinematic factor yields a negligible correction—recovering classical kinematics.
- Gravitational (GR-like) regime. Allow N_S to evolve smoothly in time and across regions (dimension gradients and dynamic homeostasis): the slowing of the medium's local "clocks" reproduces the observed weak-field effects.

The quantities are discrete and nonzero (at minimum: $N_M \geq 1$, $N_S \geq 3$); no "infinities" arise, and the speed ceiling is physically unattainable.

"Light" speed

«And Sparks shall become the measure of Seeng,
And the mirror thereof, and of all therein.
For I do grant unto them the lightest Fetters,
And unto others — after Stature, and Burden attained…»
(Seeng 04:05)

Let me reiterate: "light speed" is a local attribute of our bubble. The number c used by mainstream physics is the operational speed of the lightest available carriers that simultaneously transport the interaction on which our sensors are built (electromagnetism).

Therefore, the measured c is the photon's speed ceiling under our specific conditions—within our energy band and at our medium's metric saturation—i.e., a particular (though critically important) case of the general rule.

Without entering the territory of nucleosynthesis, I will formulate only the general criteria for the moment when c is finally established in our local physics:

1. ***The mass emission window is closed***. The amount of substance in the Universe bubble is fixed. Its structure begins to form—this sets the overall limit kinematics, but does not yet provide an operational "light speed".
2. ***Matter became "self-contained"***. The cell charge becomes much smaller than the "grains" of substance; the gravitational influence of Qsq at the R* scale becomes negligible for the existing substance fraction.
3. ***A stable "lightest"*** interaction carrier appeared. An excitation with the minimal available N_M in this medium, stable against decay over path lengths much greater than R*, and universally

tied to the interaction on which our instruments are built (electromagnetism). This is exactly the carrier we call the photon in the bubble.

4. ***Universality and reproducibility of measurements***. In the "flat window" (N_S is nearly constant over R*), the measured speed of this carrier:
   — does not depend on direction within tolerances;
   — does not depend on frequency / energy within the operating range (no vacuum dispersion in this window).

Then this speed becomes an operational constant of the bubble—what classical physics calls the "speed of light".

Planck constant

«Therefore, lay ye up Raging Drops,
And when ye have gathered — give Posts to drink;
And when Languor shall withdraw — send them forth,
Until a new thirst shall come.»
(Seeng 05:03)

Obviously, the fixation of the limit speed simultaneously fixes the causal–quantum framework of the bubble's future physics.

In the electromagnetic–radiative physics of our sensors there is an obvious "hint" at this moment, or its "vicinity": the Planck time t_p, earlier than which this physics refuses to operate. It is quite plausible that this very moment is the point of emission-window closure, at which c and the entire subsequent physics of this Universe bubble are formed. The emergence of a stable "lightest" carrier, the fixation of operational c, and the quantum of action h are events that finalize our bubble physics; they neither set nor constrain the SER's own tick t_{abs}. The time quantum t_{abs} is expected to be substantially smaller than t_p, and early processes (inflation, emission/closure of the substance emission window, etc.) naturally fit before and within the interval that the classical picture labels "Planckian".

Together with the fixation of c and h, proto-excitations of the lattice acquire a field form: stable dispersions are established, action is quantized, interaction channels and quantum numbers are fixed. Before this moment we have "pre-field" excitations with sliding parameters; after it—particles in a 3D description.

Geometric etiology (hypothesis)

At the moment the emission window closes (see Inflation III. Curtain), the average cell dimension is still large (on the order of $D \sim 41 \pm 1$). Matter is present in all dimensions at once. Depending on which-dimensional subnetwork we observe matter from, we see the part of it that is "turned" toward that dimension—we observe it from that side.

«Lot shall I cast — and Spark shall shine forth,
Lot shall I cast — and Solid shall arise,
Lot shall I cast — and Posts shall take flight,
And Beatitude shall descend upon Seeng.»
(Seeng 01:04)

"Carousel"

Any measurement in our three-dimensional laboratory is a projection of their full state onto three axes; we see only the "side of the carousel" that has turned toward us, while the rest remains off-frame. By repeating the observation, we "freeze" the carousel at different phases and obtain stable probabilities—precisely because the cell geometry consists of repeating, standard faces. Wavefunction collapse is not a whim of nature, but a geometric choice of projection.

In our 3D, this step manifests as the familiar quantization of energy and momentum—not because "particles are built that way", but because inter-dimensional kinematics is granular in this way.

"Spinning top"

A spinning top with a red mark on its rim. While it spins fast, the mark enters the field of view through our "three-dimensional slit" more or less often—this is the probability of seeing "red". A full rotation is the entire multi-dimensional configuration; an observation is an instantaneous projection. The statistics of repeated trials is not randomness "from nowhere", but the geometry of rotations relative to 3D.

As dimension degrades toward $D \to 3$, the invisible part of the "carousel" / the pauses between the mark hitting the "window" should shrink—quantumness becomes less vividly expressed as a purely geometric effect. On human time scales, nothing changes in practical quantum physics: h is already fixed and remains numerically the same. Local clocks speed up as the medium becomes rarified, while the number of projection variants decreases; these two effects compensate each other in the observed event rate. What changes is the probability distribution, not the "speed of the quantum".

Spin

Spin is a stable class of orientations of a multi-dimensional configuration relative to the 3D subnetwork. Under projection from SO(D) to SO(3)/SU(2), exactly the classes we observe in fundamental physics remain: 0 (scalar), 1/2 (spinor), 1 (vector), 2 (tensor).

Intuitive rhymes.

Spin 0 (Higgs): a "fully symmetric" projection, resonating with the idea that mass interaction is a universal, dimension-invariant part of the picture.

Spin 1/2: a two-sheet orientation (return at 4π), naturally from SU(2).

Spin 1: a vector orientation of one "visible" axis relative to the window.

Spin 2: a symmetric tensor projection (a gravitational-wave-like class). If the gravitational interaction is fundamental, then such a necessity, apparently, does not arise.

Substance as anti-space (hypothesis)

It should also be noted that a more "symmetric" view of substance as "anti-space" may be fully viable, and quite possibly more adequate. The charges of substance and space have opposite signs: substance "borrows" mass from space; negative space charge drives space expansion; positive substance charge yields classical gravity; a positive gradient of metric inhomogeneities turns into a negative one, and so on. And it is expected that this "symmetry" will yield the same set of observable phenomena.

SER

The evolution of the Universe is the evolution of Space.

Space Expansion Rule (SER)

«For unto every Zizhdal
Canon is appointed:
With Stature waning,
To multiply afterborn
By his Ownfold. »
(Told 04:01)

«And when the storm shall break,
Or Reins shall overtake,
Then unto all the younger, at any hour,
Open ye the father-house gates…»
(Told 04:05)

When transitioning from dimension d to (d−1), one cell SQ_d produces 2d new SQ_{d-1} cells. We call this process a SER step.

This number is determined by the geometry of a d-dimensional hypercube. A hypercube of dimension d always has 2d faces of dimension (d−1). Each of these faces serves as an “exit site” for a new cell. Therefore, under degradation, SQ_d necessarily yields exactly 2d cells SQ_{d-1}.

Conversely, under folding: 2d neighboring quanta of dimension d−1 can merge into a single quantum of dimension d under the same caveats.

Fundamental principles

«Be fruitful, in Mine image,
Multiply, after My likeness,
Hold ye the truth straitly,
And keep ye Parsimony faithfully.»
(Told 04:03)

Quantization.

- Discreteness. Dimension transitions do not occur smoothly, but in jumps: $SQ_d \rightarrow 2d\ SQ_{d-1}$. Space unfolds in “chunks”.
- Minimal interval. A single step cannot occur faster than a time quantum. This guarantees discrete evolution and makes SER “quantized” in time.
- Probabilistic character. A transition is not mandatory at every t_p. For each SQ, there exists a degradation probability that depends on its current dimension and local conditions.

Conservation laws.

- Conventional conservation laws (energy, momentum, angular momentum) apply without modification.
- In all SER events—decay, reverse assembly, emission of substance, and reverse absorption—the total charge is conserved; only its distribution and bookkeeping change (in SQ ↔ in substance).
- The inheritance of SQ geometry and topology can also be viewed as a form of conservation law (see Heredity).

Cosmological consistency

SER starts from a single high-dimension cell. On average, its action reproduces ΛCDM scaling: today’s horizon radius is ≈ 46.14 Gly, the H(z) curves match Planck 2018, and the number of cells at key epochs (Recombination, Dark Ages, Today/Now) corresponds to the radii of standard cosmology. SER does not replace ΛCDM; it provides its “mechanics”: how space actually unfolds.

The set of fundamental constants is identical to the conventional one and is used without modification. All processes and phenomena occur within the constraints imposed by these constants.

Transition rate

«And ye shall not rest,
And ye shall not faint…
Lot — by My,
Wyrd — by Your,
Dances — by Their…»
(Told 04:07)

- Tick: over a time interval of at least one time quantum, each SQ makes one transition attempt under the SER rule.
- The decay fraction is set by the wavefunction, which specifies the full quantum state of the space cell at the current tick:
  - the event component — FATE — the probability of executing a SER step on this tick. Outcomes are: a decrease in dimension (decay, "Down"), an increase in dimension (reverse, "Up"), or preserving the state ("Hold");
  - the emission component — BURDEN — the probability of emitting part of the charge into substance / absorbing substance from space back into charge.
- The large number of SQ and the homogeneity of conditions statistically ensure a constant decay fraction. At a given dimension, all SQ are described by the same wavefunction and are in the same (isotropic) conditions; at each tick they perform independent attempts of the same type. Over large ensembles, this “the same trial, many times” yields a stable mean fraction of successful decays per tick within a causally connected region. This implies a stable proportional growth in the number of SQ while conserving total charge, and on macroscales—smooth, predictable expansion of the Universe; in the Λ-dominated era, this appears as an almost constant expansion pace (the observed Hubble parameter).

Gravitational anomalies

«And they whom Lot yet favoureth,
Take I your youths
Unto My teaching as Watchmen stern…
That My Gifts they may guard…»
(Seeng 03:04)

For a more complete interpretation of gravity, see Appendix 3. Gravity in Discrete SQ Space.

The quantized nature of SER already at early stages of the Universe’s evolution provides a basis for local deviations. Rare but recurring "Hold" outcomes at early stages lock in local zones where the mean local dimensionality lags behind the mean across the whole domain (a gradient of effective dimensionality).

After the emission of substance, these local patches act as gravitational anchors: ordinary matter settles and accumulates there, forming the initial condensation centers. The subsequent uniform expansion of space carries these pockets to cosmological distances. They become nodes of the future large-scale structure.

These local zones are not static; they are characterized by dynamic homeostasis: at every location where the resultant of masses forms a center, the spatial lattice forms a corresponding local dimensionality gradient, proportional to the sum of the acting masses. Such an anchor is maintained and adjusted as the system configuration changes.

The "Hold" outcome is quantum-probabilistic and is realized across a huge number of independent trials; when averaged over a causally connected region, such patches emerge statistically uniformly. This preserves the observed isotropy and homogeneity on average, while simultaneously providing a realistic spectrum of large inhomogeneities.

“Dark matter”. Dimensionality gradients.

«To multiply them,
And be bone of Seeng,
And gather Sparks…»

(Seeng 03:05)

Deviations (“SER lags”) generate extended pockets. Their integrated effect is observed as “additional mass” in rotation profiles and lensing—what classical physics calls dark matter.

To reproduce the observed gravitational effects in halo regions, it is sufficient to have a stable local uplift of effective dimensionality at radii of order 8–10 kpc. In practice, this is realized as a “staircase” of fractions of elevated levels within the halo.

Scenario A (dense staircase): 5D ≈ 32%, 6D ≈ 12%, 7D ≈ 3.5%, 8D ≈ 1.0%, 9D ≈ 0.3%, 10D ≤ 0.03%.

Scenario B (moderate staircase): 5D ≈ 24%, 6D ≈ 8%, 7D ≈ 2.0–2.5%, 8D ≈ 0.5%, 9D ≈ 0.1–0.2%, 10D trace-level.

Other nearby combinations of fractions that yield a similar “additional mass” effect are also admissible. The presence of a denser inner core requires a small increase in the fractions of levels ≥7D in the central kiloparsecs while keeping the outer staircase unchanged. Such a stable positive deviation yields the correct order of additional “mass” for the flat tails of rotation curves and for weak/strong lensing, without postulating “dark matter” particles.

The mean background dimensionality is preserved (model-wise ⟨D⟩ ≈ 4.81); statistical isotropy and homogeneity of the background are not violated; the stability of the picture is supported by dynamic homeostasis.

For more detail, see Appendix 4. Relic Dimension Gradients.

“Black holes” — Astroscotomas

«But whom surfeit doth possess—
Upon him shall plagues be sent:
Dumbness and unseen—
Lest the covetous do nurse pride…»
(Seeng 03:07)

Local regions of space in which mass has reached such a degree of compactness that its gravitational field fully closes the trajectories of light and particles. From the outside, such regions manifest only through gravitational influence and accretion effects, while anything that crosses their boundary disappears from the observable world. Inside an astroscotoma, the density of substance is finite and increases toward the center, but does not become infinite. The substance is conserved and can transition into other phase states, including the breakdown of elementary particles into more elementary charge carriers.

There are two types of such objects.

1. “Old” ones. Central galactic astroscotomas. They form in early epochs of evolution from primary density inhomogeneities and grow together with galaxies, concentrating a significant fraction of the mass of their nuclei.
2. “New” ones. “Wandering” astroscotomas. They arise at later stages from collapsed stars and subsequent mergers of compact objects. They move through the interstellar and intergalactic medium, interacting with it via accretion and gravity.

An astroscotoma is not a hole or a singularity: it is a causally hidden but physically finite mass configuration. Its opacity is determined by the geometry of space and speed limits, not by the destruction of matter or the disappearance of time. For an external observer, it is a blind spot in the structure of the Universe, retaining all its mass and all physical laws within—simply hidden behind an opacity barrier.

For more detail, see Appendix 5. Astroscotomes.

“Dark energy” — Expansion of space — SER as such. Entropy

«And unto all and each,
Bid I lay Wyrd in Doom,
Seeng to fashion, Vast to widen,
Told to bear, and Pretold to draw nigh…»
(Seeng 03:09)

The global SER background (a statistical bias toward lower internal dimensionality with the birth of new SQ) leads to a global metric discharge—at the macro level, this appears as expansion. Local "islands" of elevated dimensionality on this background yield DM, while the smooth component of the process yields the Λ-effect.

By the "entropic trend" in SER we mean the directionality of cell dynamics between two regimes:

- Reverse (folding): coarsening of cells, growth of effective dimensionality. Driving force: gravity. In reverse, the cellular medium folds toward higher dimensionality due to gravitational attraction and SQ coalescence. This is a probabilistic process: high-dimensional cells form an "attraction" field for their neighborhood; they grow / burst. Overall, it resembles continuous "bubbling".
- Forward (unfolding / SER): refinement of cells, dimensionality degradation. Driving force: cell charge. As long as charge is present in the system, it pushes SQ apart, leading to dimensionality degradation (refinement) and an increase in the number of cells.
- Substance pulls toward reverse, but cannot quickly "collapse" back into charge. For the full degradation of substance, the following are required:
    1. Dilution: cosmological expansion and a drop of SQ dimensionality below 3 must reduce the density of substance to a level compatible with the SQ "reception quanta".
    2. Matching of the reception window: local cells must have sufficient information capacity (and suitable morphology) to rewrite substance into charge.
- In the presence of high matter density, large masses, and cell charge that significantly exceeds the elementary level, the overall process flow is directed toward reducing the residual SQ charge and, as a consequence, toward the expansion of space. The "windows" for transferring part of the charge into substance and the "windows" for the reverse return do not coincide in place or time; in aggregate this yields a predominance of unfolding. All else equal, the SQ network naturally moves toward states with a larger number of cells and a smaller mean charge.

Reverse-engineering the Universe

Previously on Quantum of Quanta Show

If the SER rule is applied in reverse mode, the parameters of the initial state can be reconstructed from the current number of Space Quanta (SQ) [9]. The reverse mode provides a quantitative estimate of the starting dimensionality of the fundamental SQ and formalizes the path from "today" back to the "beginning".

«And all that is for you, and all that is yours—
In his Burden, in My Gifts:
Spark the first and the uttermost abyss,
In Great Tightness, Hundredfold…»
(Told 02:02)

Goal:
From the present-day known radius of the causally connected region, obtain:

- The current number of Planck-scale Space Quanta within the causal sphere;
- The degradation level index L under the SER rule;
- The number of levels that must be traversed "upward" (by folding) to reach a single quantum;
- Determine the internal dimensionality d of that single quantum;
- Determine the current macrodimensionality D of space.

Input data:

- Radius of the causally connected region today: $Rhor_0 = 4.36520\times10^{26}$ m

[9] A similar move—extrapolating the Friedmann metric backward in time—is precisely what enabled the Big Bang concept to be introduced as an initial state.

- Number of Space Quanta (SQ) inside this region (current-space volume / Planck volume): $Nhor_0 = 8.25215\times10^{184}$
- Folding rule (reverse SER): at a step with dimensionality d we apply
$$2 \times d \times SQ_{d-1} \rightarrow SQ_d$$
- Constraints: clearly, the starting dimensionality d_0 cannot be below 3, as that would contradict the observed physics.

Result:

the number of SER "steps" from the current state to a merger into 1 SQ is 96 or 97. Added to the current SQ dimensionality, this yields the dimensionality of the "primordial" SQ.

With the minimally admissible (observational) macrometric of macroscopic space $D_0 \approx 3$ and an admissible $d_0 \approx 3$, we obtain a fractional dimensionality[10] of the single SQ: $d_{start} = 99.36$. With an integer $d_{start} = 100$, we obtain an estimate of the current macrodimensionality $d_0 \approx 4.81$.

That is, 97 full SER steps bring the causally connected SQ domain from the micro-metric state dstart (100–99.36) to the state d_0 (4.81–3).

For a number of reasons, one cannot assert that these numerical estimates are the true characteristics of the current Universe, because:

- It is not fixed that the Universe consists only of the causally connected region, which makes an arbitrary $d_{start} \geq 100$ possible.
- The space fabric accessible to us behaves as three-dimensional: locally, ordinary 3D geometry; globally, an almost flat FLRW[11]. This is consistent with the CMB[12] / BAO[13] and standard cosmology as a whole. However, it is not asserted that the current $d_0 \approx 3$, because SQ with $d > 3$ can form connected, stable subnets of any admissible macrodimensionality D. Yet the same logic implies a hard constraint: $D \leq d$.

One may postulate that there exists a finite number of SER steps which, for an arbitrary $d_{start} \geq 100$, under the unfolding rule SER $SQ_d \rightarrow 2 \times d \times SQ_{d-1}$, brings the Universe's causally connected region from a single SQ to the observed state $Rhor_0$ without contradiction. In this case:

- The observational picture of the Universe is reproduced.
- The chronology of the Universe's evolution is preserved (both its characteristic stages and its pace).
- The observed present-day morphology, composition, and structure of the Universe's causally connected region are explained, as well as their evolution.
- There are no contradictions or "fine-tuning" required to match the observational effects of ΛCDM.
- There are no contradictions or "fine-tuning" required to match the Standard Model of particle physics and quantum field theories; the framework serves solely as their "battlefield."

Model Dimensionality Parameters

Going forward, the range ($d_{start} = 100 \rightarrow d_0 = 4.81$) will be used as the "model" dimensionality parameters for the Universe's evolution. If the Universe beyond the causally connected region is also homogeneous and isotropic, then other combinations of d_{start} and d_0, consistent with SER logic, will yield proportionally equivalent results.

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[10] The fractional dimensionality of the primary SQ dstart will be interpreted when we consider the initial stage of the Universe's evolution. The fractional dimensionality d(0) is treated as the mean dimensionality of individual SQ across a causally connected domain, because SER does not proceed with non-uniformities and non-simultaneities.

[11] Friedmann–Lemaître–Robertson–Walker (FLRW) metric — the standard cosmological model metric (Friedmann–Lemaître–Robertson–Walker).

[12] CMB (Cosmic Microwave Background) — relic microwave radiation: light that "decoupled" from matter at recombination (≈380 thousand years after the beginning). Its small temperature "spots" and the peak in the anisotropy spectrum are a trace of acoustic waves in the early plasma.

[13] BAO (Baryon Acoustic Oscillations) — baryon acoustic oscillations: the same acoustic physics, but imprinted as a faint "rippling" in the galaxy distribution—a standard ruler of ~150 Mpc (comoving).

Evolution. The History of One Universe

This season on Quantum of Quanta Show

SER—the Universe's evolution will rely on the classical periodization and the known (confirmed) sizes of the causally connected region characteristic of the corresponding epochs (see Appendix 6. Classical Periodization of the Universe's Evolution).

First event — Little Pop (Big Bang)

«And Mine and Yours shall sunder,
And Silence shall shudder,
And the Wise shall name it Great Blast,
But I do call it—Sacrifice Prime…»
(Told 03:00)

A multidimensional cell—a fundamental hypercube with internal dimensionality d = 100—begins the first unfolding step[14] under the SER rule. One SQ_{100} degrades into 200 SQ_{99}.

Time: 0 - t_{abs}

Radius: $1,61626\times10^{-35}$ m - $9,45195\times10^{-35}$ m

The SQ_{100} cell has a charge of 2.16339×10^{54} kg (the baryonic mass of the observable Universe without dark matter plus the "mass of dark energy").

Mass is one with Space: its property, its charge. For now, there is not enough room for mass to be converted into substance. The charges are distributed equally among the daughter SQs. They act as the driver of SER unfolding.

Second step

«And there shall ensue Unquiet Sacrifices,
Zizhdal upon Zizhdal,
The tribes of the younger,
For succour unto the elders…»
(Told 04:02)

In SER terms, the "second step" is the onset of the inflationary regime: space transitions from the first event to a stable, tick-by-tick unfolding.

A multidimensional cell—a fundamental hypercube with internal dimensionality d = 99—continues to "unfold" space under the SER rule. Two hundred SQ_{99} split into 39,600 SQ_{98}.

- Time: one SER tick elapses.
- Radius: 5.50904×10^{-34} m.
- The charge is transferred equally to the daughter SQs.
- Charge per SQ: 1.08170×10^{52} kg.

Matter (mass) and space are one: mass is a property of space, i.e., charge.

Here and in what follows, absolute times are given on the "classical" cosmological scale (ΛCDM). In my framing, the local course of time depends on the emergence and distribution of matter: as matter is emitted, the pace of local clocks slows down, and the "real" duration of processes/stages in local clocks differs sharply from what we infer from "today," at today's time rate.

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[14] Possible triggers of the first event (hypothesis):
an encounter with another multidimensional object (e.g., an SQ with d = 73) — a tidal disruption during an attempted absorption: the interaction of such objects is enormous, but they cannot "fit into" each other in a "civilized" way, so the outcome resolves as a catastrophe; this may explain the "fractional" effective value of the First SQ—mutual "mixing" of SQs with different d at the start; saturation of combinatorial connectivity: statistically, it is more favorable to split into many states than to remain in a single one; a quantum transition or tunneling into a lower-dimensionality state.

“Inflation”

For some time, nothing fundamentally changes. SER expands space. There is no operational physics yet, because the total spatial volume is insufficient for the existence of even a single particle.

«The Chosen shall rest—
And the host shall appear;
The host shall sink—
And the legion shall arise …»
(Told 04:00)

Inflation I. Uneventful

At roughly the 22nd SER step, space reaches the scale of individual elementary particles. Attempts begin to emit part of the charge into the form of matter. These are not yet stable formations, but photon-like and neutrino-like excitations of space already become plausible.

The SQ dimensionality is d = 78, and the charge per SQ drops to 6.25867×10^4 kg.

The only notable feature of this stage is the emergence of primordial inhomogeneities in space due to the quantized (probabilistic) nature of SER-step transitions. Some SQs “lag behind” the global SER background. The number of SQs grows to 3.45663×10^{49}, which is already sufficient for such low-probability events to materialize.

The expansion of space continues.

«And by waning Stature, Seeng shall show itself;
And by waning Stature, Vast shall unbend itself;
And by gaining Spans, Vast shall fill itself …»
(Told 03:03)

Once Space reaches the characteristic scales of photon-like and neutrino-like particles, it triggers repeated “attempts” for those particles to form. Massive (tons), yet miniature (of Planck volume) “proto-particles” try to “exist” separately from Space. The conditions are still insufficient, but the emission window for Matter into Space opens, and the second phase of inflation becomes markedly more “lively”.

Matter begins to “try” to decouple from Space, “assembling” itself into whatever stable form it can sustain. The causes and consequences of this process are described in detail in the section Background Process.

At this stage, the “release” of mass into Space begins. Since we have no “other” physics available beyond the one that surrounds us, the only accessible target is the configuration we actually inhabit; that is precisely what must be identified and constructed.

The quantum character of the processes does not guarantee that particles form at an exact time. But the rapidly expanding Space—and the fact that it is already large enough to accommodate particles—rapidly raises the probability of their emergence. Photon-like and neutrino-like excitations of Space gain strength.

The proportions between conventional Matter (substance) and Space’s expansion potential (the residual cell charge) are set precisely at this stage of releasing (separating) mass from Space.

Inflation II. The Lively Phase. The Crossroads

«And that Loss may turn to Gifts
I covenant with you in the ordained hour:
My Spans shall be enough for where,
And their Stature shall be enough for how,
That to smith and potter and baker
There shall be enough for all. »
(Told 05:00)

Everything remains stable. Space keeps expanding. But, gradually, an ultrarelativistic plasma begins to “make its way” into it.

We reach the 42nd SER step. The radius of Space reaches 9.03390×10^{5} m. The SQ dimensionality is 58.

This is the peak of Matter separating from Space. A size threshold is reached at which Space can “accommodate” standard Matter physics in the form of an ultrarelativistic plasma[15]. At the same time, the cell charge drops to values comparable to the masses of elementary particles. By this moment, the cell charge should have fallen to 1.23892×10^{-38} kg. Four basic conditions hold simultaneously:

- there is “enough” Space to accommodate the entire Universe in the state of an ultrarelativistic plasma;
- a cell “weighs” less than a particle;
- the conditions in which Matter exists (density, pressure, temperature) can “assemble” Standard Model particles out of the “quanta” of Matter emitted by cells;
- the gravity due to the cells’ metric charge weakens and becomes effectively negligible for the stability of Standard Model particle structures.

This also implies that, regardless of the exact time at which it occurs, we are dealing with large—but finite—densities, temperatures, and pressures.

Inflation III. Curtain

«And Your-Ere, their firstborn, shall come;
And all, everywhere and ever shall come to be…»
(Told 03:03)

By about the 59th step (±1), the charge drops to $1{,}34521\times10^{-72}$ kg, and space expands to $1{,}60822\times10^{126}$ cells—already genuinely cosmological in scale, with a radius of $1{,}89362\times10^{7}$ m. Temperature and density decrease naturally.

At this stage, the "window" for Matter closes, because the physics that has formed by this point cannot "integrate" such quanta of Matter into itself under the prevailing conditions (density, temperature)[16]. "Vacuum" fluctuations (emission and absorption of cell charge) continue thereafter, but they are manifestations of the "emission" component of the cells’ wave function and do not form stable objects. The evolution of Matter begins.

In other words, the Universe passes another "crossroads": there is space in excess, but the cell charge is already so small, and density and temperature have dropped so far, that Matter can no longer "accept" new "portions" of Matter quanta—one has to work with "what already exists."

At the moment the emission window for Matter closes, the limit speed of causal propagation is established—see the "Light" speed.

Background Process

Meanwhile, a Duomo for Homo rises.

«And Posts shall ask: forth — how to fly,
That word be brought;
And Posts shall ask: down — how to fall,
That lading be borne;
And Posts shall ask,
If here be here, and where be there …»
(Seeng 06:00)

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[15] The specific phase state of Matter is not within the scope of this exposition, so I do not insist on an ultrarelativistic plasma. What matters is that the amount of Matter is fixed and finite, and the volume of Space is defined; therefore, the state of Matter has finite, measurable parameters.

[16] It is possible that attempts of mass to "escape" from the cells continue to this day, and for the same reason this mass has no physical "tunnel" into the Universe and cannot be emitted "for good", generating energy fluctuations of the vacuum / space.

Returning to the thesis that we have exactly the physics we have, we must acknowledge that we need to find precisely this physics within the Universe's evolutionary process. A kind of "Hadron–Baryon" principle arises, by analogy with the anthropic principle.

A hard condition of this principle is the existence of a 3D flat space that delivers exactly the interaction regime that is observed.

3D

Accordingly, starting from some stage (in theory possible from the very first, but in practice requiring a "sufficient" number of "dice rolls" / attempts to raise the probability), space may form / attempt to form stable lower-dimensional subnets.

Observationally, it is roughly in this period that our stable 3D subnet formed out of higher-dimensional cells, which ultimately made possible the establishment of observable physics (baryonic matter, interactions, chemistry) and the observable phenomenology of astronomy. Otherwise, this text would not have been written by me—a large, slow, gravity-bound, electromagnetically coupled body.

Etiology of 3D

Among the many possible explanations for why space would form a three-dimensional subnet, the most plausible hypothesis is that all admissible stable subnets of all possible dimensionalities form and exist simultaneously. Space does not preselect "its" dimensionality in advance—it realizes everything permitted by the geometry and the metric of the given SER step (the cells' local dimensionality).

Each subnet is a combinatorial realization of the possible orthogonal directions of connectivity between the faces of cells of that dimensionality. Within the manifold of space, with current mean dimensionality D, subnets of all dimensionalities ≤ D exist simultaneously, to the extent they can be realized geometrically and physically.

As SER evolves (D→D−1), those subnets for which a carrier of the corresponding dimensionality no longer exists gradually lose continuity and break down. Space does not allow "holes"—the set of admissible (percolating) subnets is constrained by the minimum locally present cell dimensionality. If anywhere in Space there exists at least one cell of rank dmin, then no continuous subnet of rank > d_{min} can exist, even if higher-rank cells occur nearby, because continuity cannot be ensured at the scale of the whole Space.

Matter (mass) is universal and is present in all subnets simultaneously. Elementary particles may manifest in any dimensionality where their existence is not forbidden geometrically or energetically. Therefore, the observed structure of substance is the result of a single mass manifesting across multiple subnets, while the concrete form and stability of an object depend on the subnet's local dimensionality in which that object is realized.

At the current stage of evolution (with model mean dimensionality D ≈ 4.81), space permits the existence of one fourth-dimensional subnet and two intersecting third-dimensional subnets that coincide along two of the three orthogonal directions.

This implies a phenomenological possibility of effects of mutual interpenetration and cross-subnet realization of objects. However, their observability is limited by the resolution provided by each subnet: an object is present across subnets, but each subnet displays only the part of the object consistent with its dimensionality (its "projection / section" onto that frame).

Thus, the multidimensional structure of space does not exclude—but rather ensures—a single physical origin of matter across all dimensionalities, differing only in manifestations tied to intersections, orientation, and the dimensionality of subnets.

Chance coincidences

Within the SER unfolding, there is a strong temptation to relate the observed fraction of substance (baryonic matter) in the ΛCDM model to the combinatorial fraction of faces that, at some moment in the evolution of space, become engaged (or fixed) in our three-dimensional subnet.

In other words, at a certain SER step (coinciding with the period of substance emission), the ratio "faces of the 3D frame to the total number of faces of space" numerically rhymes with the empirical proportions "substance / dark energy".

However, at the present stage this coincidence remains no more than a tempting correlation. I have not found rigorous arguments that would allow building a causal chain between the geometric fixing of the 3D-subnet faces and the cosmologically measured component fractions. Until such a justification appears, I treat this correspondence as an interesting, but as yet unconfirmed, hint.

Also, during the open emission window, the degradation of the cell charge passes through several levels that rhyme with the mass scales of the future Standard Model particles. Initially, this is treated only as numerical rhymes, but it could potentially be shaped into a working hypothesis of particle etiology: stable species arise when the lattice charge scale and the medium's readiness coincide.

BBN

«And Vast shall tremble–
And divers Ons shall be;
And Solid shall be aflame–
And fold Ons shall be ...»
(Told 05:06)

During the emission of substance and after it, the modern physics of the Standard Model takes shape. The role of Space at these stages is to:

- supply matter with charges of an acceptable "caliber";
- provide the "battlefield" volume required for newly emerging particles;
- cool the medium and reduce mass density;
- avoid "tearing apart" newborn particles via the gravity of its metric charge;
- in general, "do no harm, and do not interfere."

Accordingly, Space prepares for the "birth" of new particles along three channels:

- it must be large enough, in absolute size, for a given particle species to appear. For example, for baryonic matter to emerge one needs at least 10^{35} m^3; before that point—around the 67th ±1 SER step—there is simply not enough room for nucleosynthesis; BBN proceeds on "prepared positions" at the 69–70th step;
- the cell's mass charge must be commensurate with the particles being created. Since charge is subdivided only when a new generation of cells is born, it must "grind down" to the particle's mass scale. For example, for the W and Z bosons, the charge drops to acceptable values already toward the end of "inflation," around steps 40–41; the electroweak breaking then occurs later—around steps 56–57;
- at the moment particles "manifest," the metric charge must be sufficiently weak (in relative terms) so that gravity does not "rip" the newborn particle apart. During "inflation" and after it (in classical terms: reheating), the cell's metric charge crosses the 10^{-35}–10^{-45} kg mark, and its impact on the stability of matter structures becomes effectively negligible;
- i.e., Space's job is to exist in sufficient quantity and not get in the way.

Substance concentrates around the inhomogeneities that formed during the "Gloomy Inflation," later giving rise to BAO and the large-scale structure.

Space vs Substance

«For as Vast is,
So is Solid;
For Solid is no horse,
And Vast is no rider.»
(Told 07:02)

From this point on, the evolution of Space and Matter proceeds in parallel. Below, I present this evolution in two readings. The observational picture is the same; only the interpretation differs.

«That which is Beeng unto Me, is Beeng for everyone;

That which is Seeng unto you, is Seeng for you;
That which is Seeng unto the Lot, is Seeng for them;
That which is Lossless Seeng, is Seeng for none.»
(Seeng 02:00)

In the conventional classical interpretation (ΛCDM), the driving force is Matter (and its contribution to the metric). In Quantum of Quanta, Space is primary (the SER rhythm), and the differences are an effect of how time runs.

ΛCDM — Conventional Classical View	**QoQ - Quantum of Quanta**
Matter plays the active role: Space is "stitched" to Matter and expands together with its contents.	Space plays the active role: it sets the pace and the rules of the stage, while Matter merely enacts the available modes (phase states) within those rules.
Matter "pushes Space outward"; matter phase transitions are a factor in the rate of expansion, and the observed pace is a function of matter's history.	Space expands independently according to its internal laws, providing Matter with a "battlefield." As Matter fills the Space available to it, it changes its properties—density, temperature, and phase behavior.
Time	
A single continuous time scale is built into the spacetime metric as a coordinate axis; under extreme time dilation, mathematical pathologies (singularities) arise[17].	Discrete, quantized time—proportional to quantized mass charges—forms local domains that assemble coherently into the observed global picture.
Substance	
"Given" via the state of the primordial singularity.	Appears as a part of the SQ charge emitted from cells.
Inflation	
A distinct physical regime of the early Universe; introduced as a special mechanism to explain homogeneity, flatness, and the spectrum of primordial fluctuations.	An early SER regime before the emission of Substance: the unfolding cadence is single and uniform in Absolute time, while the observed specificity of the early epoch arises from the absence of mass driven slowing of local clocks and from the subsequent appearance of Substance as a new active factor.
Fundamental constants of the Universe	
Fundamental constants (G, c, h, Λ) were introduced and calibrated empirically as parameters that fix the observed picture; the space quantum is a derived combination. The speed of light is a universal limiting speed for all objects; massless carriers move at c.	The gravitational constant (via the force quantum) and the space quantum (distance) are defined outside our local Universe. The limiting speed of mass (not the "speed of light", but the limiting speed of a single mass quantum) and the quantum of action h are set at the moment when Substance is fully emitted into Space and remain constant thereafter.
Law of space expansion	
Changes in the observed expansion tempo are tied to phase states and to the distribution of Substance.	The observed non-uniformity arises from differences in the pace of local clocks across regions of different density; expansion proceeds evenly, and the differences are temporal.
Parameters are chosen so that expansion curves match observations by tuning the parameters of Matter evolution (phase transitions, component fractions, "dark" sectors) to the expansion curves. Substance becomes the driver, and Space becomes a passive trailer. The explanation is retrospective, via a choice of stages and fractions, with no single unifying principle. As a result, there are three distinct expansion regimes.	A single SER cadence (a constant fraction of decays per tick) reproduces the observed picture via local time that changes inversely with the density of Substance (charge).
Causally connected domain	
Observably accessible Substance, with a shared history, "pulls" the metric front and sets the observed horizon.	Emerges once, at the moment when the limiting speed is established; its radius is fixed by the SER structure and then follows the expanding Space while preserving internal connectedness.
Inhomogeneities and structure	

[17] the mathematical apparatus itself initially contains both zeros and infinity

Inhomogeneities are introduced after the fact via inflation and quantum fluctuations as a forced mechanism to break primordial homogeneity.	Inhomogeneities are a natural consequence of SER quantization, producing dimensional gradients; Space cannot be smooth from the start.
Dark energy	
Λ is a separate term in the Einstein equations, describing accelerated expansion via a constant vacuum energy density. It is a phenomenological parameter of unknown nature, yet required for agreement with observations.	Absent. Space expands due to the growth in the number of space cells as cell metric degrades under SER.
Dark matter	
Dark matter is a hypothetical invisible mass introduced to explain rotation curves and structure growth; its nature is unknown, yet without it calculations do not match observations.	Absent. The effect is a gradient of inhomogeneity in the dimensionality of space cells.
Gravitational effects	
Curvature of the spacetime metric under mass and energy.	Relativistic effects are local manifestations of SER inhomogeneity (dimensional gradients).
Λ era	
As Substance density falls, its contribution to expansion becomes negligible; observationally, Λ = SER.	As Substance density falls, local time on average “catches up” with global time; observationally, SER = Λ.
At low Substance density, the interpretations converge: the observed expansion dynamics are the same.	
H(z) consistency	
Three explicit H(z) regimes, with phase junctions fitted by parameters.	A smooth decline toward an “almost plateau” without kinks: the external H(z) follows from uniform SER after mapping through local clocks.

«And Allbeeng shall spill abroad through Ubiquity;
And Ubiquity shall grant expanse;
And Allbeeng therein shall find all manner:
The ardour of tender age, and the Solid of full age,
And the wasteland of old age ...»
(Told 07:01)

Recombination

«And he hungered to be every where,
And he became every where,
And he was King Kingon,
And he became Post Solemon.»
(Told 06:07)

Nothing particularly dramatic would unfold until the driving force of Substance finally runs down. Yet one fact deserves special attention: between 1.04440×10^{13} s and 1.34100×10^{13} s, the Universe becomes transparent to light.

Recombination is not a spatial event, but another phase transition of Substance. Electrons bind to protons, scattering collapses, and photons acquire the ability to propagate along near-straight trajectories.

For Space itself, nothing “happened”. Space did not become “transparent” — Substance did, for the first time ceasing to obstruct light. And it is precisely this moment that makes observation possible: a background appears against which history becomes visible. From here astronomy begins — not as a new phase of the Universe, but as a new degree of its reflectability.

On large scales, the density of Substance is already such that the mean dimensionality is effectively averaged out, and deviations are only local. In this “quiet”, the cadence of the early world is imprinted — what classical theory describes as baryon acoustic oscillations. Here it is already present, yet it requires no separate mechanism: it is simply the rhythmic memory of the early Space’s quantum structure.

Curtain of the Curtain

«And it shall be unto Me but a little,
But unto you—ever.
Till the winds do blow the clay from between the stones,
And the stones be worn into sand…»
(Pretold 01:00)

From this point onward, evolution follows the observable track. Stars and galaxies are born and die. Astroskotomas are born and merge; they "eat" stars and roam the boundless reaches. Substance ages, stars dim, clusters thin out, yet the cadence of Space remains unchanged. Here Quantum of Quanta no longer introduces new phenomena; it only shows that the observed Λ is neither a force nor an energy, but a mirror-reflection of Space's own perpetual motion.

Space's expansion continues—not slowing and not accelerating, but simply unfolding step by step by its internal SER rule. The rhythm is constant; the mass of Substance disperses; time speeds up and converges toward the Global.

In projection, this yields a stable Λ "plateau": the apparent expansion rate stabilizes around an average value of about 58 km/s/Mpc. From my standpoint, this corresponds to a phase of Space in which 3-dimensional SQ dominate. Under current models this will occur in roughly ~69 billion years. In SER terms, this is the moment when time flows at its "pure" speed, without constraints (slowdowns) imposed by mass.

When the average dimensionality of the cells approaches three-dimensionality, matter will begin to disintegrate. Global time will accelerate again, and SER will enter a phase of rapid collapse toward the zero-dimensional state. The era of substance will end; in absolute time, it will be just another bubble that deflated.

«And all that was—
Nowhere shall it be;
And that which was everywhere—
Never shall it be.
And I shall take away Your,
And Their shall become My.»
(Pretold 01:09)

Behind the Curtain

«And Beeng aboundeth with Seengs,
As a furnace with flames.
And Lot casteth tumurim,
And Doom meteth out unto Seed…»
(Seeng 02:01)

For any Universe "bubble," SER operates as a universal mechanism that links microscopic SQ transitions to the cosmological scale.

- **Start.** The Universe's evolution is initiated by the degradation of the first, highest-dimensional SQ—interpreted as the Little Pop (the Big Bang).
- **Clocked regime and decay share.** Per one time quantum, each SQ executes one transition attempt under the SER rule. For a given dimensionality within a causally connected region, the statistics of independent attempts converge: on each tick, a certain fraction of SQ completes a SER transition.
- **Quantum character.** The discrete and probabilistic nature of SER steps inevitably generates inhomogeneities. These, in turn, become the seed layer for future gravitational anomalies.
- **Inhomogeneities and structure formation.** Local delays in degradation—or, conversely, reverse transitions—create surplus zones of dimensionality. At macroscopic scale this manifests as "dark matter," halo structures, and the cores of "black holes." Meanwhile, the

overall large-scale structure remains observationally homogeneous and isotropic in its measurable parameters.

- **Emergence of Substance.** Prior to Substance emission, the unfolding tempo is single and uniform in Absolute time (interpreted in ΛCDM as "inflation"). After Substance is emitted from SQ, Matter and Space evolve in a coupled manner.
- **Causal connectivity.** The causally connected region is an observation window, not a boundary of Space. SER operates irrespective of its size; local events rely only on the immediate neighborhood and do not propagate influence faster than the limiting signal speed. The radius of Space is not required to coincide with the radius of the observable domain.
- **Macroscale tempo and operational rate.** The operational rate is the net growth of SQ count per unit time; in relative form it reads as the expansion tempo of Space.
- **Breakdown.** Degradation of Space below dimensionality 3 triggers decomposition (breakdown) of Substance and interactions:
    - **Midlife Crisis.** Transition of macrodimensionality from 3 to 2. The weak interaction fails. The last stars go out. The neutrino loses mass. Electrons are torn away from nuclei. Chemistry collapses. The proton disassembles into quarks and gluons. Photons fade. Particles continue to decay.
    - **Old Age.** Transition of macrodimensionality from 2 to 1. Photons and neutrinos decay (there is no "place" for them to persist).
    - **Oblivion.** Transition of macrodimensionality from 1 to 0. Space fragments into disconnected SQ. Entropy prevails. The Universe becomes an "archive" of itself. Space Quantum becomes Space Qubit. Matter is absorbed by the cells of Space and reverts into charge.
    - As Matter disintegrates, time accelerates: local times "dissolve" into the Global, and the Global converges toward the Absolute.

«And the winds of darkness do blow,
Over the coals of Altars of old;
And Burden resteth in the dust,
Upon the ruins of former majesty.
And the stubborn Lot casteth to and fro,
And maketh prayer unto Me…»
(Pretold 02:05)

- **Finish.** SER will continue until SQ "unfold" into the most elementary state—dimensionality 0. The final stage of evolution is the redistribution of mass/energy across SQ and its conversion into charge—the intrinsic property of Space.
- **Conception.** Relics of large-scale structure and gravitational anomalies survive into the Age of Oblivion as local metric gradients—"elders" of connectivity. The background is powerless against the seeds of a new dawn. Some of them will "assemble" back up into high-dimensional states and give rise to a new Universe; others will "detonate" halfway through… SQ are quantum objects.

Appendix 1. Geometry of Discrete Multidimensional Space

For Section - Geometry and topology

Observed Space:

- Continuous and unbroken at accessible scales; without discontinuities or overlaps.
- Connected: from any region one can reach any other along a finite trajectory.
- Locally Euclidean: inertial "straight" exists; small regions are described by lines and planes.
- Orientable: "left/right" do not mix under loops.
- Homogeneous and isotropic on average on large scales; local granularity is averaged out.
- Causal: there is a finite signal propagation speed; "influence" propagates stepwise and consistently.
- Boundaries between media (dense/rarefied regions) do not break integrity: fields and trajectories continue across interfaces.
- Observations do not imply the existence of "dimension jumps" in a single step along a path; transitions appear smooth.

For such a macro-reality to be possible on a discrete substrate, SQ must tile without gaps or kinks, preserve local straightness, and allow smooth (yet discrete) transitions between different "media". This corresponds to tiling by equal hypercubes with a Planck-scale edge, where differences between regions are set by the internal state of the cells (dimension and metric charge), and connections occur only via fully matching faces. Then macro-level continuity is a consequence of correct micro-level tiling.

Rules for constructing space from hypercubes

- Full face matching. Joining is possible only with full matching of faces of the same dimension. Partial, diagonal, and other "insets" are geometrically forbidden.
- Dimensional adjacency. Neighbors can only be cells whose dimensions differ by one (d with d±1). Any larger jump is implemented by a finite "staircase" of adjacent levels.
- Two-sidedness of internal faces. Any internal shared face separates exactly two volume cells—one on each side. One neighbor yields a gap, three or more yield overlap; both cases are excluded.
- Absence of kinks. Edges are always of Planck length; connections do not change the edge length and do not introduce "skew" joints.
- Staircase gradient. A transition from a region of dimension d to a region of dimension d+Δ is implemented as a finite sequence of layers …→(d)→(d+1)→…→(d+Δ). This is how smoothness at the macro-level is achieved under discreteness at the micro-level.
- Orthogonality of directions. Within each cell, axes are pairwise orthogonal; this guarantees an unambiguous "straight" (entry through a face—exit through the opposite face).

Where is the "edge"?

Birth from a single SQ cell naturally suggests the intuition that the Universe's "bubble" should be a literal bubble—some region with uniform "rules of the game", but:

- interactions are discrete yet continuous; mass motion does not imply "hitting" something or "flying out" somewhere—meaning the "rules of the game" cannot have a "side out-of-bounds line" and must be causally continuous;
- neither visually nor analytically are any preferred directions or regions identified—on the contrary, homogeneity and isotropy are observed;
- locally we observe Euclidean behavior (lines are straight, planes are flat) and inertial "straight", and this holds throughout R*;
- moreover, SQ join only by full face matching; a "cut" in the lattice produces an unmatched face and breaks connectedness. An "edge" in the literal sense is incompatible with the rule of joining without gaps or kinks.

Conclusion: to reconcile a discrete cubic lattice with the absence of an "edge", opposite faces of some finite existing SQ block must be identified pairwise (periodically) via:

- Full face matching. Gluing only "face-to-face" via Planck-scale faces of the same dimension; diagonal or curvilinear joints are excluded.
- Dimensional adjacency. Transitions between regions of different dimension are implemented as a "staircase" (…→d→d+1→…), without jumps or breaks.
- Two-sidedness of internal faces. Each internal face separates exactly two cells—no "hanging" and no "multiple" joints.
- Absence of kinks. Edges are strictly of Planck length; no "bending" of faces to close the shape.
- Orthogonality of directions. The local frame preserves mutual axis orthogonality in each cell; inertial "straight" is "entered through a face → exited through the opposite face".
- Periodicity in integer steps. Any "loop" along a closed direction is an integer number of SQ along each axis; this naturally sets the alignment scales R*.

These conditions are best satisfied by a D-dimensional hypertorus (with periodic boundaries):

- it does not require bending faces or changing edge length (it preserves discrete geometry);
- it is compatible with the "dimension staircase" and with SER (no breaks under degradation/reverse);
- it preserves locally Euclidean kinematics (inertial "straight");
- it allows arbitrary integer periods along the axes (alignment scales R*);
- homogeneity / isotropy on average is maintained, and local Euclidean behavior is not violated. There are no special directions or edges;
- topology is observationally silent. If the periodicities are larger than the causal diameter, repeated objects ("multi-images") do not have time to appear—we see an ordinary "boundless" cosmos without "mirrors"[18];
- it is compatible with lower-dimension sub-networks. Stable 3D sub-networks (and others) can exist within it without breaking overall connectedness or violating the joining rules. This will be useful slightly below (see Stable lower-dimension sub-networks);
- stability under SER. Periodic boundaries do not hinder dimension degradation and the "growth" of the number of SQ, nor the SER reverse; closedness is preserved automatically.

Motion "straight" and "through" under alternating dimensions

- Straight-trajectory rule: within a cell, entry through a face continues as exit through the opposite face; at a junction of adjacent dimensions, the geometric continuation is chosen.
- Here "through" is a combinatorial abstraction (a transition through an opposite face under continuous cell gluing), not a physical passage like a tunnel/film. In our world there are no objects on the scale of a fundamental cell; even a photon spans on the order of 10^{48} cells. Therefore, "through" describes lattice connectivity, not motion through a "hole" in matter or space.

Stable lower-dimension sub-networks

- In a multidimensional network, stable lower-dimension sub-networks can form consistently by simply selecting the required number of mutually orthogonal directions and fixing them across the entire domain.
- Their boundaries obey the same two requirements: full face matching and adjacency only of neighboring dimensions.

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[18] And what if they are "equal"? We still would not see "the right as the left". And this does not exclude that the causally connected region is the entire Universe we have.

- Their boundaries obey the same two requirements: full face matching and adjacency only of neighboring dimensions.

Significance of the impact

The geometry of joining is strict but neutral: it ensures continuity, unbrokenness, and correct transitions without gaps or overlaps. Planck-scale discreteness does not generate its own trajectory fluctuations and does not require additional prohibitions on speeds, directions, or "topography".

This is important for several reasons:

- it allows relying on the familiar macro-picture (inertial "straight", Euclidean behavior of small regions, isotropy on average);
- it keeps the distribution of cell metric charge as the key physical factor (rather than joining specifics);
- it does not forbid the formation of stable lower-dimension sub-networks without breaking space integrity;
- the discrete substrate reproduces the real continuous picture.

Appendix 2. SQ Wave Function: Fate

For Section — Quantumness

A part of the SQ wave function is responsible for selecting the direction of the SER step.

At each SER tick (t_p), each SQ_d cell has three admissible probabilistic outcomes:

- Up (d→d+1, reverse),
- Down (d→d−1, decay under SER),
- Hold (keeping d).

Here it is necessary to fix the primary framework under test: what counts as an admissible outcome, which local factors can bias the choice, and how this ties to geometry and observable kinematics.

Influence of geometry

The geometric rules for constructing discrete multidimensional space introduce systemic static rules linking cell states across zones and clusters. At any moment:

- Neighbor constraint: the dimensions of neighboring cells differ by no more than 1.
- Face matching: shared faces fully match in size (dimension).
- Dimension staircase: as a consequence of the two axioms above, a dimension transition in gradients is only possible with step 1 (staircase-like).

Iterative mechanism

- Static rules directly imply that:
  - Down starts from the most "high-dimensional" cell of a cluster
  - Up starts from the least "high-dimensional" cells of a cluster
- The state of the "neighbors" directly permits / prohibits certain outcomes:
  - The presence of d−1 neighbors forbids Up
  - The presence of d+1 neighbors forbids Down
- Combinatorially, an Up step requires same-d neighbors on all faces of the d-cell (the faces must raise their dimension by 1 simultaneously by "embedding" the neighbors into themselves).
- Consequently, the Down step is combinatorially "easier" (fewer conditions are required).
- A combination of conditions that forbids Up and Down yields Hold (at the same time, Hold is an independent option of Fate).

Dynamic patterns

The same mechanisms allow one to state that:

- Repeating Hold for two ticks in a row is minimally necessary and sufficient to form a zone of "lagging" cells (local inhomogeneities of space).
- Any Up "waits for" the neighborhood to catch up before the next Up.
- Many such local dynamic iterative patterns can exist (and plausibly do exist), with varying complexity (number of steps, a zone of interdependent ticks, etc.). From this one can draw a general conclusion:
  - Among several geometrically admissible outcomes, preference goes to those that are non-conflicting for geometry—those that do not violate face-matching rules in the immediate neighborhood,
  - Minimum frustration (additional axiom): among all geometrically admissible outcomes, preference goes to the one that minimizes the number of face-matching conflicts at the next tick in the local neighborhood (a local criterion),

- The restructuring of cell dimension in Space proceeds in cascades along permitted geometric patterns[19].

Macroparameters of Fate – Doom

The QoQ approach assumes that the resulting share of decays (active cells), expressed as the "growth" of Space, is constant at each global SER tick. This sets a frame for the wave function: at each tick, Ψ distributes outcomes across cells and options (Up/Down/Hold) while preserving the overall pace.

Dynamic homeostasis as a whole operates with a zero sum: it redistributes dimension in proportion to the dynamics of substance, while maintaining an overall entropy trend due to the overall "dispersion" of substance.

As a result, these two macro-factors are balanced and, in combination, reflect the main regular systemic outcome of Ψ: maintaining a constant fraction of degrading SQ per unit of global time.

It is also possible that the fixed share of outcomes at each tick is not a manifestation of stochasticity, but a consequence of the mathematics of discrete systems of this type; however, since a full mathematical apparatus for a strict description of such systems and processes is not yet available, this cannot be stated conclusively.

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[19] I allow that the set of geometrically permitted cascades forms a hierarchy of self-similar structures; in this sense, the dynamics of local dimension patterns may potentially be described using mathematics akin to fractal mathematics.

Appendix 3. Gravity in Discrete SQ Space

For Section — Gravitational anomalies

Basic postulates

- Space is primary. The Universe begins with space. It is discrete and consists of fundamental Planck-scale cells (SQ).
- Mass is a fundamental property of space. Mass is embedded in space and manifests as charge:
    - mass charge q_m (or a part of the cell's total charge) was emitted into substance (Matter / energy) at an early stage of the Universe's evolution;
    - spatial (metric) charge q_Λ remained in the cells;
    - the amount of mass emitted as substance could have been "set" at the moment of release, depending on the space volume available at that time and the SQ dimension.

Interaction

All masses in the Universe interact with each other proportionally to the magnitude of their charge and inversely proportionally to distance (to the power of SQ dimension minus 1). This includes interaction with the charge of space cells.[20]

- With each other: masses act on each other directly.
- With space: masses simultaneously interact with the charges of SQ cells.
- SQ charges also interact with each other. Since in a region of SQ with uniform internal metric d the cell charges are equal, inter-cell interaction is effectively 0 (it acts as a background). It manifests when there is a space-cell dimension gradient (regions of SER non-uniformity).
- For each gravitationally connected ensemble of masses, at every moment a local space dimension gradient corresponds and/or is established. The center of this gradient lies at the geometric center of mass (local center of mass), and the gradient magnitude is proportional to the total acting mass of the ensemble.

Dynamic homeostasis

Interactions are characterized by dynamic homeostasis. Systems "live" in continuous restructuring, adaptation, mutual tuning, and the emergence / evolution / decomposition of structures and local links.

For each gravitationally connected ensemble of masses in space, at every moment there exists a region of increased dimension. Its center coincides with the geometric center of mass, and its "height" (contrast) corresponds to the total acting mass. Substance (mass) motion in space induces space adaptation—a restructuring that follows changing conditions in gravitationally connected regions. Regions can overlap, intersect, merge, pass through each other, and split—there are no constraints on their behavior in space—substance and space remain continuously in a state of dynamic homeostasis, limited only by the propagation speed of influence.

Evolutionary origin and development

- *Start*. Substance is nearly homogeneous and dense. Primary quantum inhomogeneities provide the seed of form—a weak dimension contrast onto which substance flows.
- *Growth*. As the "stones assemble", this correspondence becomes a stable rule: wherever there is a local center of mass, there is also a region of increased dimension, which is maintained and guides the distribution of substance.
- *Maturity*. In mature systems, a balance persists: the compact central part is stable over long times, while the periphery continuously restructures in response to accretion, angular-momentum loss, tides, and external perturbations.
- *Dissolution*. If connectedness is lost (mass leaves, the center of mass shifts), the region gradually fades back to the background on roughly the same order of causal delay with which it previously grew.

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[20] There is no separate interaction carrier. A discrete cell with its charges is already a "space quantum". Waves and effects are collective dynamics of directions, not an exchange of particles.

Practical implications

Without claiming full coverage:

- *Co-motion*. Regions of increased dimension drift together with the substance "frameworks".
- *Causal delay*. The characteristic adjustment time for a scale R is $\tau \approx R/c$. This yields observable offsets between mass peaks (from lensing) and gas/light during fast events (collisions, fly-bys).
- *Shape*: the core remains the most stable component, while the periphery smoothly restructures and catches up with a delay.
- *Locality of restructuring*. The actual restructuring occurs at region peripheries; the interior volume changes slowly. Global profiles are stable, while the periphery is diffuse and dynamic.
- *Threshold and hysteresis*. Local bulges are sustained only after a threshold is reached (in "effective" mass / surface density) and vanish when falling below a lower threshold.
- *Self-limitation*. Strengthened attraction is converted into a new quasi-balance (virial balance, angular momentum, feedback), not into infinite contraction; contrast growth is limited by local face-matching constraints and causal delay.
- *Local emergences*. In a diffuse medium, temporary bulges without a compact center are possible; they persist as long as surface density and retention time suffice, then dissolve.
- *Tidal limitation*. In group/cluster environments, external tidal fields truncate region peripheries (tidal truncation), setting a natural outer scale.
- *Shape diagnostics*. The shape and elongation of regions encode interaction history: elongated bridges, asymmetries, lobes ↔ recent tides/fly-bys; a more convex and symmetric shape ↔ isolated evolution.
- *Energy balance instead of collapse*. Stronger attraction is converted into virial heating / angular-momentum redistribution (increased velocity dispersion, orbital restructuring), so the system moves to a new quasi-balance rather than collapsing.

Motion in space

Motion in space is governed not by individual transitions at the scale of a single cell, but by attraction fields formed within a connected region. These fields have two contributions:

- the Matter contribution (ordinary gravity),
- the Space contribution—dimension gradients ΔD maintained by dynamic homeostasis, which create an additional attraction potential.

The sum of these contributions determines the observed trajectories and effects. The ΔD contribution is scale-dependent: on stellar–planetary scales it is a subtle correction, while on galactic and cluster scales (8–10 kpc and beyond) it is comparable to, or dominant in, the total attraction.

Gravitational effects

This potential (the sum of the Newtonian contribution of baryonic mass and the additional potential from dimension gradients ΔD—an equivalent metric-mass of Space arising from relic ΔD and dynamic-homeostasis ΔD) reproduces, in a unified way, the full spectrum of gravitational phenomena.

A. Space–kinematic effects are interpreted in the "mass + ΔD" framework; the $1/r^2$ law is preserved:

- Newtonian statics and Keplerian orbits are the baseline. The bare mechanics of hot and cold rocks.
- Pericenter precession: a subtle radial slope in the total source ⇒ the ellipse does not close.
- Geodetic (de Sitter) precession: rotation of the inertial frame around a non-rotating source due to a weak radial slope.
- Frame dragging (Lense–Thirring): rotation of the orbital plane/spin due to source rotation.
- Tidal effects (geodesic deviation): second derivatives of the "mass + ΔD" potential (Roche, tidal truncation, streams).
- Light deflection / gravitational lensing (weak/strong/micro): the "lensing mass" map tracks ΔD—mass maps derived from lensing effectively map the total source of gravity:

- Achromatic: the mechanism introduces no dispersion; the deflection angle does not depend on frequency; there are no "rainbows" or "prisms".
- Image morphology (stretches/shifts) is set by the geometry of mass and ΔD distributions, not by any "optical" properties of the medium.
- No optical activity of Space: no scattering and no birefringence; a single ray does not split by polarization.

B. Temporal effects (see the Section Time)

- Shapiro time delay.
- Gravitational redshift / blueshift.
- Gravitational time dilation.

C. Dark-matter-like effects (see Appendix 4. Relic Dimension Gradients)

- Flat galaxy rotation curves.
- Binding and velocity dispersions in clusters.
- Statistical weak lensing over wide fields.

D. Gravitational waves.

A family of phenomena across different "scales":

- from the combined signal of supermassive astroscotoma pairs in galactic nuclei, slowly inspiraling over very long times,
- through mergers of compact binaries: astroscotoma–astroscotoma (BBH), neutron star–neutron star (BNS), astroscotoma–neutron star (BH–NS),
- and down to single events such as core collapse and supernova explosions, unstable rapidly rotating neutron stars, and strong tidal/disruptive events (disruption of a neutron star/white dwarf by an astroscotoma, highly eccentric passages—pericenter "kicks").

These are characterized by a common set of properties:

- source scale / compactness (high energy density in a small volume);
- asphericity (no spherical symmetry in mass / momentum distribution);
- a rapidly varying quadrupole (not quasi-static; a characteristic time $\lesssim$ the system dynamical time);
- non-stationarity (mass / angular-momentum redistribution, outflows, jets, instabilities).

They trigger a sharp, aspherical ΔD restructuring via local SER dimension transitions. The restructuring propagates causally as a local-causal front (a "neighbor-to-neighbor" step). At large distances it is observed as a quadrupolar packet (sometimes with a "chirp") and a single background step.

We are dealing with different scales of the same phenomenon—dynamic homeostasis: from local field re-basing during weak/slow processes to a long-range front (what classical language calls a gravitational wave) during fast aspherical catastrophes.

Appendix 4. Relic Dimension Gradients

For Section – "Dark matter". Dimensionality gradients.

ΛCDM requirements

The modern cosmological model ΛCDM includes a set of key assumptions:

- there exists an additional gravitating component, "dark matter," invisible in the electromagnetic spectrum;
- its mass is roughly 5–6 times the mass of all baryonic matter;
- it is distributed throughout the Universe, forms large-scale halos around galaxies and clusters, and is also present in the intergalactic medium;
- it is required to explain:
  - flat galaxy rotation curves,
  - the stability of galaxy clusters and the retention of satellites,
  - weak and strong gravitational lensing,
  - the growth of perturbations before and after recombination,
  - the heights of acoustic peaks in the CMB and the BAO structure,
  - the shape of the fluctuation spectrum and the structure growth rates.

Thus, ΛCDM postulates a global presence of dark mass in order to satisfy, simultaneously, the requirements of both early- and late-time cosmology.

What is actually required

Within the framework of discrete Space made of fundamental cells (SER)—carriers of metric charge—the conclusions are different:

- for local dynamics, local variations of metric charge (dimension gradients) within halos and filaments are sufficient;
- a global "dark matter budget" across the Universe is not required—the additional effective mass does not need to be distributed everywhere;
- in early epochs, the role of the "invisible component" is naturally played by the high-dimensional background, where the cells' metric charge was much larger, reproducing the effects of a "cold" gravitating component;
- as SER degrades dimensionality, local contrasts persist in the regions where galaxies and clusters form, delivering the observed effects without introducing a separate entity.

I. Late Universe: observational effects

In local zones (halos, filaments, clusters), it is sufficient to have local volume fractions of elevated dimensionality—stepwise gradients of effective dimensionality within the cell composition:

- A shift in the mixture by a few percentage points toward higher-dimensional cells creates an equivalent excess of mass. The gradient structure is regulated by dynamic homeostasis and by the geometric "stitching" rules of cells.
- This local excess reproduces:
  - flat rotation-curve tails,
  - stabilization of satellites and stellar streams,
  - the required lensing of light over tens to hundreds of kiloparsecs.
- Substructure arises due to the granularity of the ΔD distribution, but on average the profile remains smooth—consistent with the observed "halo".

Thus, the gravitational effects are achieved without a global mass add-on—only through local redistribution of charge.

Baseline setup

The mean dimensionality across the Universe is taken as 4.81 (Model Dimensionality Parameters). The minimal global mixture that yields this mean without introducing extra components is: 0.81 five-dimensional cells and 0.19 four-dimensional cells (others are negligible in the mean background).

Scenario

In the observed picture of flat rotation-curve segments, there is a characteristic level of additional acceleration on the order of 10^{-10} m/s² (reference a_ref = 1.0000×10^{-10} m/s²). We use this reference as a scale measure of the effect.

A stable positive deviation of cell composition in the halo region over tens of kiloparsecs (hereafter "delta-dimensionality") must increase the mean charge per cell enough to produce the additional gravity and match the reference level.

1) Halo shell (the main halo volume).

To reproduce flat rotation-curve tails at radii of 8–10 kpc and the correct order of weak lensing, the following combinations of stepwise dimensional uplift are approximately sufficient:

- Option A (ceiling up to the 10th step, D_{max}): 5D — 24–28%, 6D — 8–10%, 7D — 2.0–2.5%, 8D — 0.50–0.70%, 9D — 0.10–0.15%, 10D — ≤0.03%. Total fraction of "uplifted" volume: 35–41%.
- Option B (ceiling up to the 9th step, $D_{max} = 9$): 5D — 30–32%, 6D — 12–14%, 7D — 3.0–3.5%, 8D — 0.8–1.0%, 9D — 0.20–0.30%. Total fraction of "uplifted" volume: 46–51%.

Such a stable increase of charge across the halo volume is sufficient to reproduce flat rotation-curve tails and the correct order of weak lensing at the observed radii. For the outer halo (~30 kpc), a much thinner ladder is sufficient: 5D — 10–14%, 6D — 2–3%, 7D — ≤0.30%, 8D — ≤0.05% (total 12–18%; ceiling D_{max} = 9–10 is admissible).

2) Compact core (optional, no more than 0.1 of the halo volume).

For a steeper central profile—which is natural, as this is the region of the galaxy's primary center of mass—a thin additional admixture of upper dimensional levels is admissible (fractions are relative to the core volume): 6D — 4–5%, 7D — 1.0–1.5%, 8D — 0.3–0.5%, 9D — 0.05–0.10%, 10D — ≤0.02%.

In this case, we obtain a sufficient gradient for a moderately sharper rise of velocities in the center and a moderately enhanced central weak lensing, without changing the behavior on the flat radii. The core is an addition to the shell, not a replacement; the shares of levels 9–10 in the core are intentionally tiny, to remain compatible with the global budget of higher levels and to avoid "overweighting" the background.

Spatial placement

The positive dimensional deviation is sustained in the perigalactic shell and slowly declines toward outer radii; across the halo volume it is stably maintained above the background level (delta-dimensionality ΔD_{halo} = +0.3…+0.5 at 8–10 kpc).

In large systems, a moderately compact central core comprising no more than 0.1 of the halo volume is admissible, where a localized enhancement of the effect may occur (around the primary center-of-mass region).

This macro-pattern reproduces what is observed: flat rotation-curve tails, weak lensing of the correct order, and "mass" outside the disk / bulge—without introducing additional dark-matter entities.

The deviation structure is granular on scales of a few kiloparsecs, but in aggregate produces a smooth profile. This explains why, on large scales, the halo appears quasi-continuous, while on small scales substructures are present (satellites, tidal streams).

Cross-check / allocation

The total volume of elevated-dimensionality zones is distributed non-uniformly: the large-scale "cosmic web" (walls, filaments, nodes) occupies 18–24% of the Universe, and within it the levels D≥7 account for 3.0–3.8% of the global volume (working center around 3.5%). Of this share, galaxy halos account for about 15–20%, i.e., ~0.45–0.76% of the cosmic volume. The rest is filaments and nodes. This arrangement is far from "percolation" and does not break background homogeneity and isotropy.

On average across the Universe, the mean dimensionality remains 4.81: higher levels are localized in the web and halos, voids remain close to the background (4–5D), and the global share of D≥7 is narrow (3.0–3.8%). This delivers the same observable set of effects attributed to "dark matter" in ΛCDM—flat rotation-curve tails, gravitational binding in clusters, weak and strong lensing—

without introducing a separate substance and without rebuilding the overall cosmological picture (background expansion parameters, Planck parameters, and BAO / CMB are preserved).

The deviation structure remains granular on scales of a few kpc and smooth in aggregate: on small scales substructures are visible (satellites, tidal streams), while on large scales the halo is quasi-continuous with a correctly decaying profile.

Robustness with respect to mean dimensionality

The real mean values of cell dimensionality and their mixtures may differ from the model value 4.81 (in the limit—higher, up to a nominal 15.26, or lower, down to 3.0). In that case, the order of the required local deviation to reproduce observed halo effects remains comparable and tends to decrease as the mean dimensionality increases: for higher-dimensional cells, the "charge step" is significantly larger than for lower-dimensional ones. Therefore, at a higher mean dimensionality, the same observed effect is achieved with a smaller relative gradient of the local composition.

The computed numbers are model reference points, but the deviation order is stable:

- it remains approximately the same across a wide range of mean dimensionalities;
- it decreases as the mean dimensionality increases (due to the larger "charge step" at higher d);
- globally, elevated-dimensionality zones D≥7 occupy 3.0–3.8% of the Universe's volume (working center around 3.5%). This is sufficient for filaments, nodes, and halos while preserving $\langle D \rangle = 4.81$ and the "voidness" of the background.

II. Early epoch: CMB, BAO, and perturbation growth

At recombination, the mean dimensionality of Space was high ($D \approx 15$). This implies:

- charge per cell was orders of magnitude larger than today;
- the lattice behaved like a cold, effectively pressureless component;
- the mean free path and pressure of such cells were negligible.

It is precisely this high-dimensional background that behaves, in the linear phase of perturbation growth, like ΛCDM "dark matter": it supports fluctuation development, delivers the required acoustic peak heights in the CMB, and sets the BAO scale.

Thus, in our picture the "dark-matter equivalent" is present in the background then, but it does not need to remain globally present on average today.

III. Evolution from early epochs to the present

The mechanism is naturally determined by the SER rule:

- each generation of cells transitions to lower dimensionality, creating a stepwise cascade;
- background metric charges decrease, but local contrasts persist in higher-density regions (future halos and clusters);
- part of the "dark-matter equivalent" is gradually reallocated from the background into local structures;
- globally, the mean picture remains isotropic and homogeneous, while local zones are exactly what provides the observed late-time effects.

Conclusions

ΛCDM requires postulating a global additional mass across the Universe in order to explain both early- and late-time effects at once.

In the SER concept, these two task classes are solved separately:

- early-time effects are explained by the high metric charge of the background at large dimensionalities;
- late-time effects are explained by local dimensional contrasts in halos and filaments.

Additional mass as a separate entity is not required: the space lattice already carries the required charge and redistributes it over the course of evolution.

Therefore, all observed dark-matter effects (CMB, BAO, structure growth, galaxy dynamics, lensing) are reproduced without introducing "invisible" matter that no one has found. The classical model relies on a stopgap—a global component—whereas the same reality is explained by the intrinsic properties of Space.

The decay (degradation) of SQ cells proceeds continuously, so local inhomogeneities naturally "dissolve" over time—the dimensional (charge) contrast decreases. The mass of matter does not disappear. To preserve the observed connectivity of structures, the system compensates for degradation within dynamic homeostasis via one of the modes (or a mixture of them):

- **Scale mode**. The elevated-dimensionality region grows in size while contrast falls moderately: connectivity is maintained by a larger coverage area.
- **Contrast mode**. The region keeps its size but adapts its contrast (driven by the current mass configuration and by inflows of matter/angular momentum).
- **Mixed mode**. A small expansion of the region is accompanied by a moderate increase of contrast.

In all cases, the same homeostasis rule applies: restructuring proceeds causally (no faster than c) and brings the system to a new quasi-balance (virialization, angular momentum, feedback). Hence, continuous dimensional degradation does not break connectivity—it is compensated by scale growth, contrast reinforcement, or a combination of both, depending on the local mass history and environment.

Appendix 5. Astroscotomes

For Section — “Black holes” — Astroscotomas

Astroscotoma (*astro*- from Ancient Greek ἄστρον, “star, celestial body”; *scotoma* from Ancient Greek σκότωμα, “darkness, dimming of sight”; classically: “black hole”) is a connected region of the cosmos where mass has reached critical compactness such that an opacity barrier (the horizon) causally disconnects the interior from an external observer; no outgoing null trajectories to the outside exist.

Externally, the object manifests only through gravity and accretion processes; anything that crosses the boundary disappears from the observable world. Inside, densities are finite and increase toward the center; phase transitions of matter are allowed, up to deep decomposition of Standard-Model particles.

All quantities remain finite; there is no need for singularities or infinities.

Formation mechanism

They arise where mass concentrated within a bounded volume reaches a threshold compactness—i.e., a mass-to-volume relation at which the surrounding spatial geometry restructures and light trajectories no longer have open directions outward. An opacity barrier forms, beyond which the escape speed at the boundary equals the maximum attainable speed for the electromagnetic sector, and external interaction (except gravitational) becomes non-detectable.

Internal picture

Matter that ends up beneath this barrier does not vanish, does not lose mass, and does not turn into a singularity: it continues to exist in other phases, and may undergo deep decomposition into more elementary charge carriers. Mass and density remain finite, but become causally isolated from the rest of space. This transition corresponds to a natural phase reconfiguration of matter and space: the system retains all mass and energy, but changes its coupling regime with the surrounding Universe, completes the natural evolution of gravitational compaction, and forms a stable, causally hidden[21], yet physically finite configuration—an astroscotoma.

Intuitive density range. Broadly, the spectrum may run from nuclear-scale densities for low-mass objects (stellar regime) to “diffuse” states for supermassive ones, where the mean internal density can be below that of water and even air. This is not a “hard wall,” but an integral characteristic of the volume hidden behind the barrier.

Observational regime

The primary luminosity is produced outside the opacity barrier—in and above the region of the innermost stable circular orbit (ISCO), where the disk and corona radiate.

The geometry of photon paths produces a characteristic shadow or silhouette against the emitting plasma and appears in radio-interferometric images of the near-horizon region with pronounced gravitational lensing.

Collimated relativistic jets are observed, associated with accretion and rotation.

During mergers, gravitational waves are detected with a characteristic subsequent damped phase (ringdown).

Crossing the opacity boundary remains observationally silent (signals from inside are causally inaccessible in the electromagnetic channel), and for an external observer the astroscotoma manifests only through gravity and accretion.

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[21] An astroscotoma need not be perfectly opaque or strictly “silent”: I do not exclude emissions that are inaccessible to electromagnetic methods. First, radiation produced deep below the barrier undergoes extreme gravitational redshifting and geometric suppression, becoming an effectively negligible flux for an external observer. Second, under deep decomposition of matter the transport channel may rely on carriers more elementary than the standard photon (in the language of our microphysics: more fundamental carriers of charge and/or metric perturbations), which makes the electromagnetic “microscope” too coarse an instrument. Observationally, this means: the absence of an EM signal does not prove the absence of internal dynamics—it only marks the limits of the communication channel being used to probe the object.

There is no reflective hard surface outside the barrier—therefore there is no persistent "surface" glow or surface bursts.
Proximity to the barrier sharply narrows the photon escape cone, enhances redshifting, and stretches observed timescales.

Non-photonic or ultra-weak emission channels are not excluded; the absence of an electromagnetic signal may indicate the limit of the accessible communication channel, not the absence of internal dynamics.

Typology

Galactic-central (GC-type, "old")

They originate in early epochs in the cores of local density inhomogeneities—the future nodes of large-scale structure. Rare mass excesses are retained and serve as "seeds" which, as the region evolves, grow via accretion and mergers to the threshold compactness; this is how supermassive objects form in galactic centers. Thereafter comes slow co-growth with the galaxy: gas fueling, capture of stars and compact bodies, and episodic nuclear mergers.

Internal picture (minimum assumptions). Densities are finite and rise toward the center; phase transitions are possible up to deep decomposition of Standard-Model particles. Singularities are not required.

Astrophysical (AF-type, "wandering," "new")

They arise at later stages from collapsing stellar cores and subsequent mergers of compact objects; the mass range runs from stellar to intermediate.

Local gravitational collapse upon exhaustion of pressure support, possible fast-spin states at early stages, followed by further accretion from the interstellar/intergalactic medium and mergers. Such objects migrate, interacting with their environment via gravity and accretion.

Appendix 6. Classical Periodization of the Universe's Evolution

For Section — Evolution. The History of One Universe

This Appendix adopts a unified method for computing the radius across all epochs: the present-day comoving radius of the observable Universe, R0, is converted into the proper radius of the same observable region at the epoch of interest with redshift z:

$$R(z)= R_{now} / (1+z).$$

I emphasize that this is the *present-day observable region* mapped back in time using the scaling $a = 1/(1 + z)$[22]. This choice:

- provides smooth matching at epoch boundaries (the end of the previous equals the start of the next in both z and R);
- anchors the values to the reference parameters of Planck 2018 (anchors: z_{eq} and z* of the last-scattering surface);
- ensures uniformity.

For the earliest stages, where only time t is specified rather than z, the scaling is taken as $R \propto t^{1/2}$ (radiation domination) or $R \propto t^{2/3}$ (matter domination); the boundaries are again matched to the neighboring epochs where z is already specified.

R_{now}, R_{start}, R_{end} – radius today / at the start of the period / at the end of the period (m).
t_{now}, t_{start}, t_{end} – time at the start of the period / at the end of the period (s / yr).
Z_{now}, Z_{start}, Z_{end} – redshift today / at the start of the period / at the end of the period.

Today (event) / Today / Now

The present moment is the peak of the Λ-domination epoch. The Universe has reached an age of almost 14 billion years, and accelerated expansion is fully determined by "dark energy".

	start	end (now)
z		0 (by definition)
t, s		4.35495×10^{17}
t, yr		1.37970×10^{10}
R, m		4.36520×10^{26}

- Cosmological parameters (Planck 2018):
  - $\Omega\Lambda = 0.6847$ (dominant contribution)
  - $\Omega_m = 0.3153$ (secondary contribution)
  - $\Omega r = 9.1\times10^{-5}$ (negligible)

Radius-change drivers: accelerated expansion driven by the Λ term; matter and radiation no longer play the leading role.

Λ-domination / Λdom

The Λ-domination epoch began when the "dark energy" density became equal to the matter density. From that point onward, the cosmos transitioned to accelerated expansion, and the Λ term has governed the Universe's dynamics up to the present time.

	start	end (now)
z	0.29497 (equality moment $\rho m\ a^{-3} = \rho\_\Lambda$)	0 (by definition)
t, s	3.12105×10^{17}	4.35495×10^{17}
t, yr	9.88900×10^{9}	1.37970×10^{10}
R, m	3.00890×10^{26}	4.36520×10^{26}

Radius-change drivers: dominance of the Λ term and accelerated expansion. Matter remains secondary, and the radiation contribution is negligible. The possible range of radius estimates at the beginning of the epoch depends on how the equality boundary is defined (using the mean Planck 2018 parameters or accounting for the Ω_m and ΩΛ uncertainties); the spread does not exceed 1–2%.

[22] this is not the Hubble radius, R_H=c/H(z), and not the «particle horizon at that time».

Large-scale structure formation / Struct Form

Post-reionization growth of gravitational instabilities: dark matter halos, galaxies, groups, and clusters form; the "cosmic web" emerges. Matter dominates; the Λ contribution grows and reaches equality with matter at the epoch boundary.

	start	end
z	5.6768	0.29497
t, s	3.15576×10^{16}	3.12105×10^{17}
t, yr	1.00000×10^{9}	9.89001×10^{9}
R, m	6.53780×10^{25}	3.0089×10^{26}

Radius-change drivers: matter domination (growth of density contrasts) and a gradual strengthening of Λ toward the epoch boundary. The possible range for R_{start} (on the order of a few percent) is due to the fact that z(t) at ~1 Gyr is obtained by inverting the FRW relation in the matter-dominated regime; refining the parameters (H_0, Ω_m) and accounting for a small radiation correction produce minor shifts. The endpoint (z_{end}, R_{end}) is fixed strictly by the equality $\rho m\ a^{-3} = \rho\_\Lambda$.

Reionization / Re-ion

Transitional period in which the first ionizing background from stars/quasars gradually "opens windows" in the intergalactic medium, driving hydrogen into the ionized state. Structures are already forming, but the large-scale pattern of the "cosmic web" is only beginning to strengthen.

	start	end
z	9.5913	5.6768
t, s	1.57788×10^{16}	3.15576×10^{16}
t, yr	5.00000×10^{8}	1.00000×10^{9}
R, m	4.12151×10^{25}	6.53780×10^{25}

Radius-change drivers: matter domination; the growth of the first ionization sources increases the medium's transparency, but the Λ term still has almost no effect on the expansion dynamics. The possible range for R_{start} is related to refining z(t): in full ΛCDM, with a small radiation correction included, the value decreases by approximately 0.1–0.3% (i.e., R1 ~ 4.11–4.12×10^{25} m).

Cosmic Dawn / Cosm Dawn

Period of the first light sources (the first stars and protogalaxies); the preconditions for an ionizing background are established, which will later lead to reionization.

	start	end
z	20	9.5913
t, s	6.31152×10^{15}	1.57788×10^{16}
t, yr	2.00000×10^{8}	5.00000×10^{8}
R, m	$2{,}07867\times10^{25}$	4.12151×10^{25}

Radius-change drivers: matter domination; the Λ contribution is negligible. The possible range for radiuses within ≈ ±(0.1–0.3)% is related to whether a small radiation correction is included and to the exact choice of Planck 2018 parameters.

Dark Ages / Dark Ages

Interval after recombination, when the Universe was transparent but no light sources yet existed. The gas consisted mainly of neutral hydrogen and helium. During this time, the first gravitational fluctuations formed, but stars and galaxies had not yet ignited.

	start	end
z	1020	20
t, s	1.34100×10^{13}	6.31152×10^{15}
t, yr	4.25000×10^{5}	2.00000×10^{8}
R, m	$4{,}27542\times10^{23}$	$2{,}07867\times10^{25}$

Radius-change drivers: matter domination, with a partial radiation contribution in the early phase; expansion slows compared with the radiation-dominated epoch, but the Λ term is still negligible. The radius range depends on where the end of the "Dark Ages" is placed (the emergence of the first light sources: $z \approx 30–15$); this choice can shift R by ~±10%.

Recombination / Light

Epoch when protons and electrons combined into neutral hydrogen and helium. The Universe became transparent to radiation—this is when the Cosmic Microwave Background (CMB) originated, which we observe today. A short interval (about 10^5 years) after the Big Bang, when the temperature dropped to ≈ 3000 K and electrons recombined with protons, making the Universe transparent to radiation. Redshift $z \approx 1100$. Recombination is a narrow transitional stage between the plasma phase and the transparent phase.

	start	end
z	1180	1020
t, s	$1{,}04440\times10^{13}$	1.34100×10^{13}
t, yr	3.31000×10^{5}	4.25000×10^{5}
R, m	$3{,}69619\times10^{23}$	$4{,}27542\times10^{23}$

Radius-change drivers: matter domination with a noticeable radiation contribution; the expansion rate gradually decreases. The possible radius range is determined by refining the criterion for the "end of recombination" (accounting for $z \approx 1089.92$ from Planck 2018), which can change R by approximately 15–16%.

Matter domination / Matter

After radiation–matter equality, the expansion dynamics becomes governed by matter (primarily "dark" matter). The plasma is still opaque, but the scale factor already grows according to the matter-law. The epoch ends at the onset of recombination.

	start	end
z		not relevant prior to Recombination
t, s	$1{,}48321\times10^{12}$ (radiation–matter equality)	$1{,}04440\times10^{13}$ (onset of recombination = 331 000 yr)
R, m	$1{,}27418\times10^{23}$	$3{,}69619\times10^{23}$

Radius-change drivers: matter-dominated ΛCDM dynamics, with $R \propto a \propto t^{2/3}$.

Photon domination / Photon

After nucleosynthesis, the Universe remains in a state of hot ionized plasma. Photons are tightly coupled to baryons (via electrons), and they govern the dynamics: the plasma is opaque, and photons cannot propagate freely. Radiation-dominated evolution continues up to Recombination.

	start	end
z		not relevant prior to Recombination
t, s	1.20000×10^{3}	1.48321×10^{12}
R, m	$7{,}4480\times10^{12}$	$1{,}27418\times10^{23}$

Radius-change drivers: radiation-dominated ΛCDM dynamics, with $R \propto t^{1/2}$.

Big Bang nucleosynthesis / BBN

Period when, at temperatures on the order of 10^9 K, during the first minutes of the Universe, light nuclei began to form—deuterium, helium-3, helium-4, and lithium-7. The balance of processes set the present-day H/He ratio. The radius evolution follows radiation-dominated dynamics.

	start	end
z		not relevant prior to Recombination
t, s	1.80000×10^{2}	1.20000×10^{3}
R, m	2.8580×10^{12}	7.4480×10^{12}

Radius-change drivers: radiation-dominated ΛCDM dynamics, with $R \propto t^{1/2}$.

Neutrino epoch / Neutrino

During this period, neutrinos cease to interact effectively with matter and "decouple" from the plasma. They begin to propagate freely through the Universe, forming the relic neutrino background. Radiation-dominated dynamics continues.

	start	end
z		not relevant prior to Recombination
t, s	1.00000×10^{1}	1.80000×10^{2}
R, m	6.7400×10^{11}	2.8580×10^{12}

Radius-change drivers: radiation-dominated ΛCDM dynamics, with $R \propto t^{1/2}$; increasing time from 10 to 180 s (×18) increases the radius by a factor of 4.2426.

Lepton epoch / Lepton

Phase when the Universe's dynamics is governed by leptons (electrons, muons, neutrinos, and their antiparticles). At temperatures $\sim10^{10}$ K, active lepton annihilation and interaction processes occur. By the end of the epoch (a few seconds after the Big Bang), most leptons annihilate; an excess of electrons remains, which is required for subsequent atom formation.

	start	end
z		not relevant prior to Recombination
t, s	1.00000×10^{0}	1.00000×10^{1}
R, m	2.13220×10^{11}	6.7400×10^{11}

Radius-change drivers: radiation-dominated ΛCDM dynamics, with $R \propto t^{1/2}$; increasing time from 1 to 10 s (×10) increases the radius by a factor of ≈ 3.1623.

Hadron epoch / Hadron

Period when the Universe's temperature dropped enough for quarks to cease existing as a plasma and bind into stable hadrons—protons and neutrons. By the end of the epoch, hadrons annihilate with antihadrons; a small baryon excess remains, which determines present-day matter. The radius evolution corresponds to the radiation-dominated phase.

	start	end
z		not relevant prior to Recombination
t, s	1.00000×10^{-6}	1.00000×10^{0}
R, m	2.13220×10^{8}	2.13220×10^{11}

Radius-change drivers: radiation-dominated ΛCDM dynamics, with $R \propto t^{1/2}$; increasing time from 10^{-6} to 100 s (×10^{6}) increases the radius by a factor of 1000.

Quark–gluon plasma / QGP

Stage when the Universe was so hot ($T \approx 10^{12}$ K) that quarks and gluons did not form bound states (hadrons) but existed as a dense plasma. As the temperature dropped below the characteristic scale, quarks began to bind into nucleons. Radii are computed using the ΛCDM scaling $R \propto t^{1/2}$.

	start	end
z		not relevant prior to Recombination
t, s	1.00000×10^{-12}	1.00000×10^{-6}
R, m	2.13220×10^{5}	2.13220×10^{8}

Radius-change drivers: radiation-dominated ΛCDM dynamics, with $R \propto t^{1/2}$; over the interval from 10^{-12} to 10^{-6} s (an increase by 10^{6}), the radius grows by $\sqrt{10^{6}} = 1000$.

Electroweak symmetry breaking (event) / ElWeak

Transition in which the W± and Z_0 fields acquire mass, and the electromagnetic interaction separates from the weak interaction.

	start	end
z		not relevant prior to Recombination
t, s	1.00000×10^{-12}	1.00000×10^{-12}
R, m	2.13220×10^{5}	2.13220×10^{5}

Radius-change drivers: none.

Radiation-dominated plasma / RAD

Hot ultra-relativistic plasma (leptons, photons, neutrinos, and at the earliest times—quarks/gluons). The scale dynamics is radiation-like: $a \propto t^{1/2}$. At the end of the epoch, electroweak separation occurs (event).

	start	end
z		not relevant prior to Recombination
t, s	1.00000×10^{-28}	1.00000×10^{-12}
R, m	2.13220×10^{-3}	2.13220×10^{5}

Radius-change drivers: from 10^{-28} to 10^{-12} s, the Universe evolves in a "radiation-like" regime, where the characteristic scale grows as the square root of t.

Reheating / REH

Very short phase after inflation, when the inflaton energy is transferred into a hot particle plasma. Radii are taken from standard cosmology: once the plasma is established, the scale factor grows as in radiation domination, $a \propto t^{1/2}$.

	start	end
z		not relevant prior to Recombination
t, s	1.00000×10^{-32}	1.00000×10^{-28}
R, m	2.1322×10^{-5}	2.13220×10^{-3}

Inflation / INFL

Short phase of exponential expansion of the Universe. Here the radius grows as $R \propto e^{Ht}$; the growth is specified via the number of e-folds. For the baseline, we take N = 60 e-folds (typical range 50–60), which addresses the classical horizon and flatness problems.

	start	end
z		not relevant prior to Recombination
t, s	1.00000×10^{-36}	1.00000×10^{-32}
R, m	1.86710×10^{-31}	2.1322×10^{-5} *(growth by e60 ≈ 1.1420×10^{2})*

Radius-change drivers: exponential growth R → R·eN with the chosen N = 60 provides the required "smoothing" of the metric prior to reheating.

Grand Unification / GUT

Interval prior to inflation in which (in the model picture) the strong and electroweak interactions are indistinguishable; X/Y boson decays and the emergence of baryon asymmetry are allowed.

	start	end
z		not relevant prior to Recombination
t, s	1.00000×10^{-43}	1.00000×10^{-36}
R, m	5.90418×10^{-35}	1.86710×10^{-31}

Radius-change drivers: radiation-dominated ΛCDM evolution; the radius growth is consistent with the scale factor, and radii are matched at the boundary with inflation.

Planck epoch / PLANCK

The Planck epoch opens the history of the Universe—an interval in which the laws of quantum gravity governed the dynamics of space and matter. The ΛCDM model is formally not applicable here, because for $t < t_P$ (5.39×10^{-44} s) the theory breaks down. In the QoQ model, space began from a single fundamental hypercube of dimension 100, and within this epoch only one SER expansion step occurred, producing an ensemble of 200 Space Quanta of dimension 99. Thus, the Planck epoch is the moment of the Sacrifice of the Primordial, when the first step in the unfolding of the Universe was made.

	start	end
z	formally → ∞ (temperature and density are infinite)	
t, s	5.39130×10^{-44}	1.00000×10^{-43}
t, yr	1.71000×10^{-51}	3.17000×10^{-51}
R, m	1.61626×10^{-35} (Planck length)	5.90418×10^{-35} (by the SER rule, growth from 1 to 200 SQ)

Radius-change drivers: quantum-gravitational dynamics and the first SER step (100→99). Within ΛCDM, the radius is not defined at this point, but in the model it is set by the discrete expansion of fundamental hypercubes.

Appendix 7. Notation Conventions

Символ / Symbole	**RU**	**EN**	**RU значение**	**EN meaning**
QoQ	Квант Квантов	Quantum of Quanta	Название концепта / рамка модели	Concept name / model framework
SQ	Квант Пространства	Space Quantum	Квант пространства (фундаментальная ячейка)	Space quantum (fundamental cell)
SQ(d)	SQ мерности *d*	SQ of dimension *d*	Ячейка SQ в состоянии локальной мерности *d*	SQ cell in local dimension state *d*
SQ0 / SQ1 / SQ2	SQ(0) / SQ(1) / SQ(2)	SQ(0) / SQ(1) / SQ(2)	Шорткаты для SQ(d) при d=0/1/2	Shorthands for SQ(d) at d=0/1/2
SER	Правило расширения Пространства	Space Expansion Rule	Правило переходов/развёртки пространства	Rule governing space expansion transitions
Ψd (Ψ_d)	волновая функция состояния Ψd	state wave function Ψd	Набор/вектор вероятностей исходов шага SER для данной ячейки (Up/Down/Hold и др. допустимые события)	A set/vector of probabilities over SER step outcomes for a given cell (Up/Down/Hold and other allowed events)
Up / Down / Hold	исходы SER	SER outcomes	Исход шага SER (повышение / понижение / удержание *d*)	SER step outcome (increase / decrease/hold *d*)
d	локальная мерность	local dimension	Локальная мерность ячейки SQ	Local dimension of an SQ cell
D	глобальная мерность	global dimension	Глобальная / средняя мерность макропространства	Global / mean dimension of macrospace
ΔD	градиент мерности	dimension gradient	Пространственный градиент глобальной мерности	Spatial gradient of global dimension
Q	заряд SQ	SQ charge	Заряд ячейки SQ (массо-эквивалент в модели)	SQ cell charge (mass-equivalent in the model)
Q_{abs}	абсолютный заряд	absolute charge	Абсолютный заряд 0D-ячейки (единица счёта заряда)	Absolute charge of a 0D cell (charge unit)
ChQ	квант заряда	Charge Quantum	Единица заряда (квант)	Charge unit (quantum)
MQ	квант массы	Mass Quantum	Единица массы (квант)	Mass unit (quantum)
IQ	квант взаимодействия	Interaction Quantum	Единица взаимодействия (квант)	Interaction unit (quantum)
t_{abs}	квант времени	time quantum	Минимальный интервал времени в модели	Minimal time interval in the model
ℓ_{abs}	абсолютный квант длины	absolute length quantum	Квант длины (масштаб ребра SQ)	Length quantum (SQ edge scale)
ℓ_P	планковская длина	Planck length	Планковская длина	Planck length
t_P	планковское время	Planck time	Планковское время	Planck time
Vd	внутренний объём (мерность *d*)	internal volume (dimension *d*)	Внутренний объём SQ при мерности *d*	Internal volume of SQ at dimension *d*
r	расстояние	distance	Расстояние (в формулах)	Distance (in formulas)

m, m_1, m_2	масса	mass	Масса (в формулах)	Mass (in formulas)
F	сила	force	Сила (в формулах)	Force (in formulas)
G	гравитационная постоянная	gravitational constant	Гравитационная постоянная	Gravitational constant
c	скорость света	speed of light	Скорость света	Speed of light
H_0	постоянная Хаббла	Hubble constant	Константа Хаббла	Hubble constant
H(z)	параметр Хаббла	Hubble parameter	Параметр Хаббла как функция z	Hubble parameter as a function of z
NX	счётчик NX	X counter (NX)	Целочисленный счётчик количества X (объектов/событий X — как определено по месту в тексте)	An integer counter of X occurrences (objects/events X as defined in-text)
NM	счёт массы (в квантах)	mass-quanta count	Безразмерный счёт массы через Qabs/MQ	Dimensionless mass count via Qabs/MQ
NS	счёт заряда пространства	metric-charge count	Безразмерный счёт метрического заряда через Qabs/ChQ	Dimensionless metric-charge count via Qabs/ChQ
Q_{eff}	эффективный заряд	effective charge	Эффективный заряд (по месту определения)	Effective charge (as defined in-text)
V_{abs}	предельная скорость	limiting speed	ℓabs/tabs (по месту определения)	ℓabs/tabs (as defined in-text)
VM_{lim}	предельная скорость (массо-зависимая)	mass-dependent limiting speed	Предел скорости как функция NM/NS	Speed limit as a function of NM/NS
ΛCDM	модель ΛCDM	ΛCDM model	Стандартная космологическая модель	Standard cosmological model
FLRW	метрика FLRW	FLRW metric	Стандартная метрика космологии	Standard cosmological metric
CMB	реликтовое излучение	Cosmic Microwave Background	Реликтовое излучение	Cosmic Microwave Background
BAO	барионные акустические осцилляции	Baryon Acoustic Oscillations	BAO	BAO
BBN	нуклеосинтез	Big Bang Nucleosynthesis	BBN	BBN
QGP	кварк-глюонная плазма	Quark–Gluon Plasma	QGP	QGP

Appendix 8. Constants and Particle Properties

Below are reference constants and ΛCDM parameters from Planck 2018 (A6) and the Standard Model (SM). The values are provided for informational purposes as baseline inputs and are rounded to 5 significant figures in SI units.

Constants

Name	Наименование	Обозначение	Значение	Комментарий	Ед. изм.
Planck length	Планковская длина	ℓ_P	1,61626E-35	ребро SQ	m
Planck time	Планковское время	t_P	5,39125E-44		s
Light speed	Скорость света	c	299792458		m/s
Hubble constant now	Постоянная Хаббла	H_0	67,36		km / (Mpc * s)
Mass of the Observable Universe with Dark Matter	Масса наблюдаемой Вселенной с ТМ	Q_{m+DM}	9,35370E+53		kg
Mass of the Observable Universe w/o Dark Matter	Масса наблюдаемой Вселенной без ТМ и ТЭ	Q_m	1,46390E+53	Общий массовый заряд наблюдаемой Вселенной	kg
Dark Power Mass in the Observable Universe	Масса ТЭ в наблюдаемой Вселенной	Q_Λ	2,01700E+54	Общий метрический заряд наблюдаемой Вселенной	kg
Gravitational constant	Гравитационная постоянная	G	6,67430E-11		m3 / (kg*s2)
Aboulut charge SQ	Массовый заряд SQ	Q_{abs}	1,23739E-135		

Particle masses and radii

The values are given as reference within the conventional Standard Model; in the computational part, only orders of magnitude were used for estimates (e.g., when estimating the number of cells per particle). Detailed physical interpretations (including discussion of the “photon mass”) are outside the scope of this Appendix.

Name	**Наименование**	**Mass, kg / Масса, кг**	**Пространственный размер, радиус м / Spatial dimension, radius m**
Photon γ	Фотон γ	0	0
Neutrino ν	Нейтрино ν	0,000E+00	1,000E-19
Electron e^-	Электрон e^-	9,10938E-31	1,000E-19
Positron e^+	Позитрон e^+	9,10938E-31	1,000E-19
Proton p	Протон p	1,67262E-27	8,400E-16
Neutron n	Нейтрон n	1,67E-27	8,400E-16
Quark	Кварк	зависит от типа / depends on the type	1,000E-19
Gluon g	Глюон g	0	1,000E-19
Higgs boson H	Бозон Хиггса H	2,230E-25	1,000E-19
W-boson	W-бозон	1,430E-25	1,000E-19
Z-boson	Z-бозон	1,630E-25	1,000E-19

Appendix 9. Russian–English Glossary of Term Equivalents

RU	EN
абсолютное время	absolute time
абсолютный заряд (Qabs)	absolute charge (Qabs)
абсолютный квант длины	absolute length quantum
абсорбция	absorption
абсорбция (окно)	absorption (window)
адрон	hadron
Адронная эпоха	Hadron epoch
аннигиляция	annihilation
антипространство	anti-space
астроскотомы	astroscotomes
барион	baryon
барионные акустические осцилляции	baryon acoustic oscillations (BAO)
барьер непрозрачности	opacity barrier
бозон	boson
бродячие (астроскотомы)	wandering (astroscotomes)
вакуум	vacuum
вектор вероятностей	probability vector
вещество	substance
взаимодействие	interaction
взаимодействие зарядов	charge interaction
вириальное равновесие	virial equilibrium
внутренний объём	internal volume
внутренний объём (мерность d)	internal volume (dimension d)
внутренняя устойчивая орбита	innermost stable circular orbit (ISCO)
волновая функция	wave function
волновая функция SQ	SQ wave function
гало	halo
геометрия и топология	geometry and topology
гиперкуб	hypercube
гипертор с периодическими границами	hypertorus with periodic boundaries
Глава	Chapter
глобальная (средняя) мерность	global (mean) dimension
гравитационная волна	gravitational wave
гравитационная постоянная (G)	gravitational constant (G)
гравитационно-связанная область	gravitationally bound region
гравитационные аномалии	gravitational anomalies
гравитационные эффекты	gravitational effects
гравитационный потенциал	gravitational potential
гравитация	gravity
градиент мерности	dimension gradient (ΔD)
градиент мерности (ΔD)	dimension gradient
грань SQ	SQ face
давление	pressure
дальнедействующий фронт	long-range front
дальность взаимодействия	interaction range
движение	motion
деградация	degradation
деградация (мерности)	degradation (of dimensionality)
дельта-мерность	delta-dimensionality
динамика	dynamics
динамический гомеостаз	dynamic homeostasis
дискретное многомерное пространство	discrete multidimensional space
дискретное пространство	discrete space
дискретность пространства	space discreteness
добавочный потенциал	additional potential
Доминирование материи	Matter domination
заряд SQ (Q)	SQ charge (Q)
затухающее звено	ringdown
изотропия	isotropy
изотропия наблюдаемая	observed isotropy

Инфляция	Inflation
информационная ёмкость	information capacity
информация	information
квант взаимодействия (IQ)	interaction quantum (IQ)
квант времени (tabs)	time quantum (tabs)
квант времени (TQ)	time quantum (TQ)
квант действия (QA)	quantum of action (QA)
квант заряда (ChQ)	charge quantum (ChQ)
квант квантов (QoQ)	quantum of quanta (QoQ)
квант массы (MQ)	mass quantum (MQ)
квант пространства (SQ)	space quantum (SQ)
квант силы (FQ)	force quantum (FQ)
квантовость	quantumness
кварк	quark
кварк-глюонная плазма (QGP)	quark–gluon plasma (QGP)
компактное ядро	compact core
конус побега	escape cone
конфигурационные условия	configuration conditions
конфигурация	configuration
Космическая заря	Cosmic Dawn
космическая паутина	cosmic web
космическое микроволновое фоновое излучение (CMB)	cosmic microwave background (CMB)
космологическая модель ΛCDM	ΛCDM model
космологическая постоянная (Λ)	cosmological constant (Λ)
космологический красный сдвиг	cosmological redshift
красный сдвиг	redshift
Лептонная эпоха	Lepton epoch
локальная мерность (d)	local dimension (d)
локальная метрика	local metric
локальная причинность	local causality
локальное время	local time
макропространство	macrospace
масса	mass
масса в квантах (NM)	mass-quanta count (NM)
масса приведённая	reduced mass
массовый заряд	mass charge
материя	matter
мерность	dimension
метрика FLRW	FLRW metric
метрико-масса	metric mass
метрический заряд	metric charge
микромерность	microdimension
микропространство	microspace
наблюдаемая Вселенная	observable universe
наблюдаемость	observability
наблюдаемый домен	observable domain
нарушение симметрии	symmetry breaking
наследственность	heredity
нейтрино	neutrino
нейтрон	neutron
нити	filaments
Ноша	Burden
нуклеон	nucleon
нуклеосинтез (BBN)	big bang nucleosynthesis (BBN)
оболочка гало	halo shell
обратная связь	feedback
однородность	homogeneity
окно (условие)	window (condition)
окно абсорбции	absorption window
окно приёма	reception window
окно эмиссии	emission window
операционная система (OS)	operating system (OS)

ортогональные координатные направления	orthogonal coordinate directions
параметр Хаббла	Hubble parameter (H(z))
переход	transition
Планковская эпоха	Planck epoch
плотность	density
плотность массы	mass density
плотность энергии	energy density
покраснение	redshifting
постоянная Планка	Planck constant (h)
постоянная Хаббла	Hubble constant (H_0)
Потолок скорости	speed ceiling
Правило расширения пространства (SER)	Space Expansion Rule (SER)
предельная скорость (Vabs)	limiting speed (Vabs)
предельная скорость (массо-зависимая) (VMlim)	mass-dependent limiting speed (VMlim)
Приложение	Appendix
Примечание	Note
причинная сфера	causal sphere
причинно-связанная область	causally connected region
причинность	causality
пространство	space
протон	proton
Пузырь (Вселенной)	(Universe) bubble
равнодействующая масс	resultant mass
Радиационно-доминированная плазма	Radiation-dominated plasma
радиус горизонта	horizon radius
Развёртка	unfolding
Раздел	Section
ребро SQ	SQ edge
реверс	reverse transition
Реверсный режим	reverse mode
регистр состояния	state register
реинтеграция	reintegration
Реионизация	Reionization
Рекомбинация	Recombination
реликтовое излучение (CMB)	cosmic microwave background (CMB)
реликтовое излучение	Cosmic Microwave Background
реликтовые градиенты мерности	relic dimension gradients
Реогрев	Reheating
решётка ячеек пространства	space-cell lattice
свёртка	folding
свойства локальных мерностей	properties of local dimensions
сеть ячеек / сетка SQ	SQ network / lattice
симметрия	symmetry
скорость протекания	transition rate
скорость света ©	speed of light (c)
слоты памяти	memory slots
Современность	Today / Now
спин	spin
стандартная модель (SM)	standard model (SM)
стены	walls
Судьба	Fate
такт	tick
такт SER	SER tick
тёмная материя (DM)	dark matter (DM)
тёмная энергия (DE)	dark energy (DE)
Тёмные века	Dark Ages
температура	temperature
топология	topology
угловой момент	angular momentum
узлы	nodes
Формирование крупных структур	Large-scale structure formation
Фотонное доминирование	Photon domination

шаг SER	SER step
центральные галактические	galactic-central
электрон	electron
Электрослабое разделение	Electroweak symmetry breaking
эмиссия	emission
эмиссия (окно)	emission (window)
энергия	energy
энтропия	entropy
Эпоха нейтрино	Neutrino epoch
эффективная мерность	effective dimension
ячейка (пространства)	(space) cell
BIOS	BIOS
FLRW метрика	FLRW metric
GUT-эпоха	Grand Unification (epoch)
NX	NX counter
OS	OS
SSD SQ	SQ SSD
Λ-доминирование	Λ-domination
ΛCDM	ΛCDM model