

# The Galaxy of Universes

*A cosmological model of the Big Bang as a local collapse within a spiral mega-structure*

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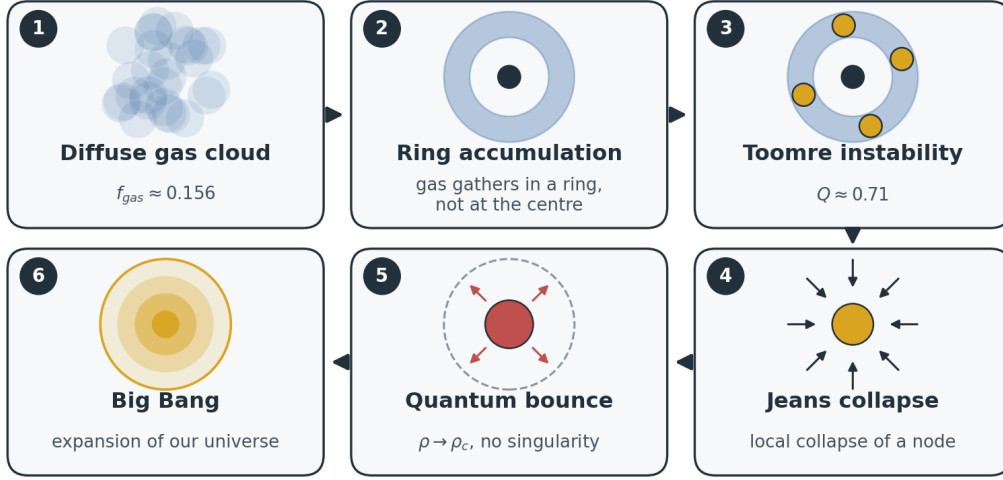
## Abstract

It is proposed that the Big Bang is not the absolute origin of reality, but a local collapse event within the arm of a spiral mega-structure of vastly greater scale — a “galaxy of universes”. This work develops the complete mathematical chain of the model: the reformulation of the collapsing core at the Planck scale, the shear and winding dynamics of the spiral arm, the stability validation through the Toomre criterion, the quantum bounce mechanism (Loop Quantum Cosmology) that avoids the classical singularity, the determination of the physical scale of the parent galaxy (size, dark-matter halo, number of arms and number of node-universes hosted), and two observationally falsifiable predictions: the “dark flow” and the search for collisions between bubble universes in the cosmic microwave background. Four conceptual limitations of the model are explicitly identified and addressed, including its epistemological boundary regarding the ultimate origin of the parent structure.

## 1. General approach

The central hypothesis of this work is that the Big Bang that gave rise to our observable universe does not represent the absolute origin of all reality, but a local collapse event that took place within the arm of a much larger mega-structure: a galaxy of universes. Under this hypothesis, our universe is one of  $N \approx 10^8$  regions (“nodes”) that collapse by compression of dark matter and baryonic gas inside that parent structure, reaching in each collapse a quantum limit at which, instead of a classical singularity, a quantum bounce (Big Bounce) takes place.

Figure 1 summarizes the complete chain of the mechanism, from the diffuse gas cloud to the expansion that we identify as our own Big Bang. The following sections develop each link of this chain with its corresponding mathematical formalism.



**Figure 1.** Chain of the local collapse: from the diffuse gas cloud to the Big Bang, through ring accumulation, Toomre instability, Jeans collapse and the quantum bounce.

## 2. Choice of geometry and composition

The spiral-galaxy template (formation by gas collapse with conservation of angular momentum, arms as density waves, dominant diffuse halo) was compared against the Solar-System-type template (mass concentrated in a single central body, clean Keplerian orbits). The spiral model was adopted, since it allows the node-universes to be placed along the arms, in displaceable compression zones.

Regarding the composition of the collapsing core, it was established that only dark matter (attractive, able to clump together) is compatible with a collapse-and-bounce mechanism; dark energy, with its negative pressure and repulsive effect, would prevent the collapse under standard physics ( $\Lambda$ CDM). The cosmic dark-matter/baryonic-matter ratio adopted, following the Planck fractions ( $DE \approx 68\%$ ,  $DM \approx 27\%$ , baryonic  $\approx 5\%$ ), is:

$$f_{DM/bar} \approx 5.4 \Rightarrow f_{gas} = 1/(1+5.4) \approx 0.156$$

## 3. Reformulation of the local collapse at the Planck scale

A first estimate ( $M_c \approx 10^{59}$  kg) proved untenable: the structural radius fell deep inside the Schwarzschild radius itself. The model is therefore re-anchored natively in Planck units, fixing the minimum distance of influence at:

$$d = 4 \cdot \ell_P \approx 6.465 \times 10^{-35} \text{ m}$$

The total parity radius  $R$  (local halo mass equal to the mass of the collapsing core  $M_c$ ) is obtained from the adapted Roche limit:

$$R = 1.44 \cdot d \approx 9.309 \times 10^{-35} \text{ m}$$

with  $M_c = M_{cluster} = m_p \approx 2.176 \times 10^{-8}$  kg (Planck mass). The corresponding Schwarzschild radius is  $r_s = 2GM_c/c^2 \approx 3.228 \times 10^{-35}$  m, giving a confinement ratio  $R/r_s \approx 2.88$ : the structure lies outside the event horizon, sustaining itself as an extended object instead of collapsing into a trivial black hole. The combined orbital velocity turns out to be sub-luminal:

$$v = \sqrt{2GM_c/R} \approx 1.77 \times 10^8 \text{ m/s} \approx 0.59c$$

## 4. Shear, winding and spiral geometry

With  $x \equiv r/R$ , the orbital velocity profile and the shear rate are expressed in closed form:

$$v(r)^2 = (GM_c/R) \cdot (1/x + 1) \quad \Gamma(x) = 1 + 1/(2(x+1))$$

At the parity radius ( $x=1$ ),  $\Gamma(1) = 1.25$ . Adopting a standard pitch angle of a real galaxy ( $\alpha = 20^\circ$ ), the characteristic winding time is:

$$t = 1/(\Gamma \cdot \Omega \cdot \tan \alpha) \approx 1.16 \times 10^{-42} \text{ s} \approx 21 \cdot t_p$$

The arm geometry, a logarithmic spiral  $r(\theta) = R \cdot e^{b\theta}$  with  $b = \cot(20^\circ) \approx 2.747$ , requires  $\approx 8.0$  complete turns to project from the Planck scale to the current Hubble radius ( $\approx 1.3 \times 10^{26} \text{ m}$ ).

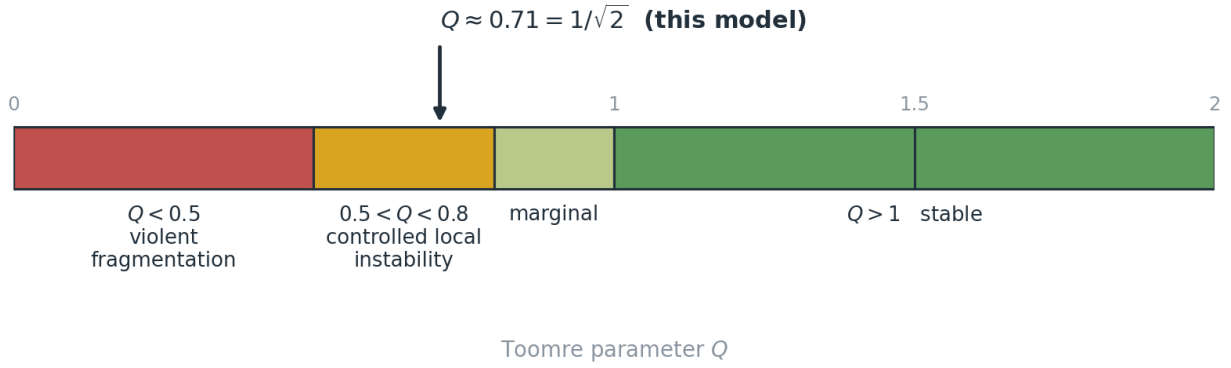
## 5. Stability validation: the Toomre criterion

The surface density and the velocity dispersion of the arm, computed with the conventions listed below, give:

$$\begin{aligned} \Sigma &\approx 1.599 \times 10^{60} \text{ kg/m}^2 & v_s &= v/\sqrt{3} \approx 0.34c & \kappa &= \Omega\sqrt{2(2-\Gamma)} \approx 2.33 \times 10^{42} \text{ s}^{-1} \\ Q &= v_s \cdot \kappa / (\pi G \Sigma) \approx 0.71 = 1/\sqrt{2} \end{aligned}$$

**Conventions and sensitivity.** The values above are not an independent derivation: they follow from four adopted conventions. (i)  $\Sigma = 2m_p/(\pi R^2)$ : the core mass  $M_c = m_p$  plus a local halo of equal mass (the parity condition of Section 3), spread over a disc of radius  $R$ . (ii)  $\Omega = v/R$ , with  $v = \sqrt{2GM_c/R}$  the combined orbital speed of Section 3, evaluated at  $x = 1$ . (iii)  $\kappa^2 = 2\Omega^2(2-\Gamma)$ , the standard epicyclic relation for a shear rate  $\Gamma = -d \ln \Omega / d \ln r$ , with  $\Gamma(1) = 1.25$  from Section 4. (iv)  $v_s = v/\sqrt{3}$ , the one-dimensional component of an isotropic velocity dispersion, together with the gas form of Toomre's parameter,  $Q = v_s \kappa / (\pi G \Sigma)$ .

Combining them,  $Q = (1/\sqrt{2}) \cdot [2M_c/(\pi R^2 \Sigma)]$ , so with convention (i)  $Q$  equals  $1/\sqrt{2}$  exactly. The value 0.71 is therefore a consequence of the conventions, not an independent coincidence, and should not be read as evidence by itself. Since  $Q \propto 1/\Sigma$ , other reasonable choices give other values:  $\Sigma = M_c/(\pi R^2)$ , without the halo, gives  $Q \approx 1.41$ ; a Keplerian  $\Omega = \sqrt{GM_c/R^3}$  with  $\Gamma = 3/2$  gives  $Q \approx 0.41$  (0.82 if  $\Sigma = M_c/(\pi R^2)$  is also used). The classification of the arm in the regime  $0.5 < Q < 0.8$  thus depends on these conventions. The model adopts (i)-(iv) because they are consistent with the parity condition of Section 3, and this dependence is a limitation of the present version.



**Figure 3.** The value obtained,  $Q \approx 0.71$ , falls in the regime of controlled local instability ( $0.5 < Q < 0.8$ ): the arm is globally stable but locally prone to generating gas condensations.

This is precisely the regime that triggers a local Jeans collapse, giving rise to the seed universe without allowing the cloud to disperse into the void.

## 6. The local quantum bounce mechanism (LQC)

For the virialized gas ( $M \approx 8.5 \times 10^{41}$  kg,  $\approx 4 \times 10^{11}$  solar masses: the largest gas mass per node compatible with the rotation curve of the parent galaxy, see Section 7.5), the standard Friedmann equation is replaced by its effective Loop Quantum Gravity version:

$$H^2 = (8\pi G/3) \cdot \rho \cdot (1 - \rho/\rho_c)$$

with  $\rho_c \approx 5.16 \times 10^{96}$  kg/m<sup>3</sup> (Planck critical density). When  $\rho \rightarrow \rho_c$ , the factor  $(1 - \rho/\rho_c)$  vanishes, halting and reversing the contraction analytically and avoiding the classical singularity. The minimum radius of the bounce turns out to be:

$$a_b = (3M/4\pi\rho_c)^{1/3} \approx 3.4 \times 10^{-19} \text{ m}$$

## 7. Physical scale of the parent galaxy

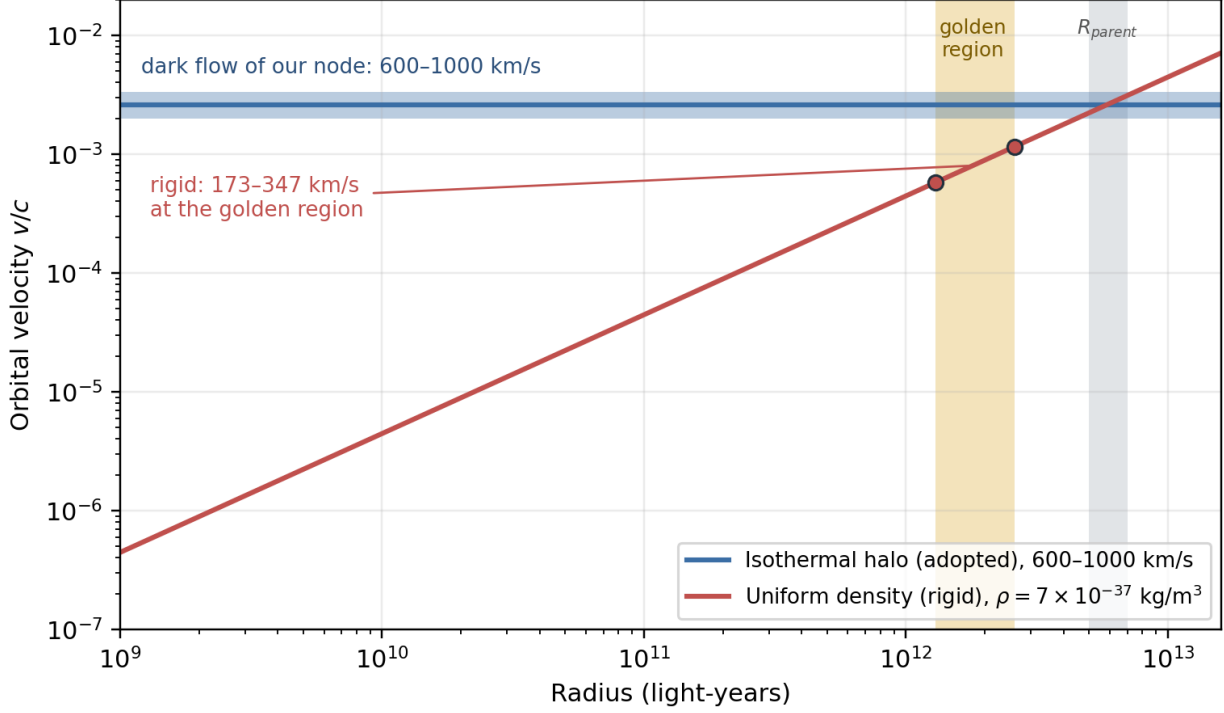
The radius of the observable universe ( $\approx 46.5$  billion light-years) is reinterpreted as the size of a single node, not of the whole structure. Adopting  $N \approx 10^8$  nodes, and assuming an approximately uniform filling of the volume ( $R_{\text{parent}} \approx R_{\text{node}} \cdot N^{1/3}$ ), the radius of the parent galaxy is of the order of several trillion light-years ( $\approx 5\text{--}7 \times 10^{12}$  ly, depending on the exact value of  $N$  adopted).

### 7.1 — Discarding rigid rotation and adopting the isothermal halo

A uniform-density model predicts a rotation rate independent of radius ( $\Omega = \sqrt{4\pi G\rho/3}$ , constant) and a circular speed that grows linearly,  $v = \Omega r$ . Causality is not what rules it out here. With the mean density of the parent galaxy found in Section 7.5 ( $\approx 7 \times 10^{-37}$  kg/m<sup>3</sup>),  $v$  would reach  $c$  only at  $r = c/\Omega \approx 2.2 \times 10^{15}$  ly, far beyond  $R_{\text{parent}}$ , and at  $R_{\text{parent}}$  it would give  $\approx 800$  km/s. (The limit of 30.9 billion light-years quoted in earlier versions corresponds to a density of  $\approx 3.8 \times 10^{-27}$  kg/m<sup>3</sup>, close to the critical density of our own universe, and does not apply to the parent galaxy.)

The uniform-density model is discarded for a different reason: the speeds do not match at the golden region. With uniform density,  $v = 173\text{--}347$  km/s at  $1.3\text{--}2.6 \times 10^{12}$  ly, whereas the dark flow assigned to our node, which lies in that region, is 600–1000 km/s; a rigid rotation would reach those speeds only at  $4.5\text{--}7.5 \times 10^{12}$  ly, outside the golden region. An isothermal dark-matter halo (profile  $\rho(r) \propto 1/r^2$ ) is adopted instead: it is the standard

description of flat rotation curves in real galaxies and gives the same speed ( $v \approx 600\text{--}1000$  km/s) at every radius, which is what the identification of the dark flow in Section 9.1 requires.

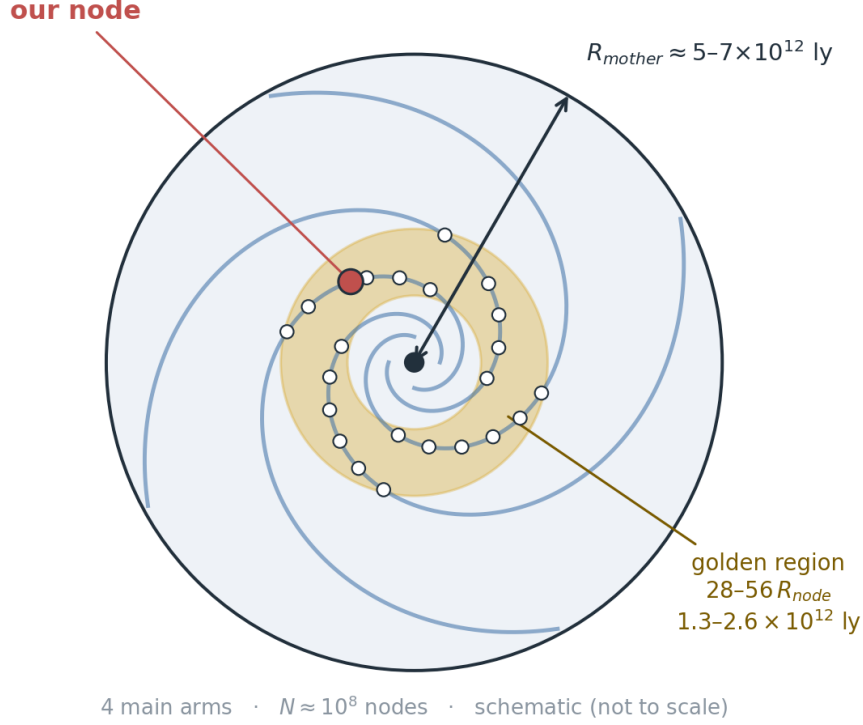


**Figure 2.** Comparison between the uniform-density (rigid) rotation at the mean density of the parent galaxy (discarded: too slow at the golden region) and the flat-curve isothermal halo (adopted).

## 7.2 — The golden region: where universes form

By direct analogy with the Milky Way — where dense gas does not accumulate right next to Sgr A\*, but in a ring located between 28 and 56 times the radius of its sphere of influence — the golden region is defined using the radius of a node ( $R_{\text{node}}$ ) as the reference unit:

$$R_{\text{gold}} \in [28.0, 56.0] \cdot R_{\text{node}} \approx [1.3, 2.6] \times 10^{12} \text{ ly}$$



**Figure 6.** Schematic view of the parent galaxy: the golden region (golden band) hosts the node-universes; our own node sits at some point within that strip.

### 7.3 — Dark-matter halo: mass and density

Using the isothermal profile  $M(r) = v^2 r / G$ , the total mass needed to sustain the rotation of the whole parent galaxy is  $\approx 5.4 \times 10^{50}$  kg (for  $v = 800$  km/s and  $R_{\text{parent}} = 6 \times 10^{12}$  ly). This is the *total* gravitating mass of the structure, dark matter and gas together, so it must also account for the mass locked in the node-universes. Section 7.5 shows that the numbers close with dark matter dominating the gas by the ratio 5.4 of Section 2, and requires no fine-tuning.

### 7.4 — Number of arms: swing amplification

Applying swing amplification theory (Toomre-Lin-Shu) with a flat rotation curve and an isothermal profile, the preferred number of arms turns out to be independent of the radius and the orbital velocity, depending only on the gas fraction:

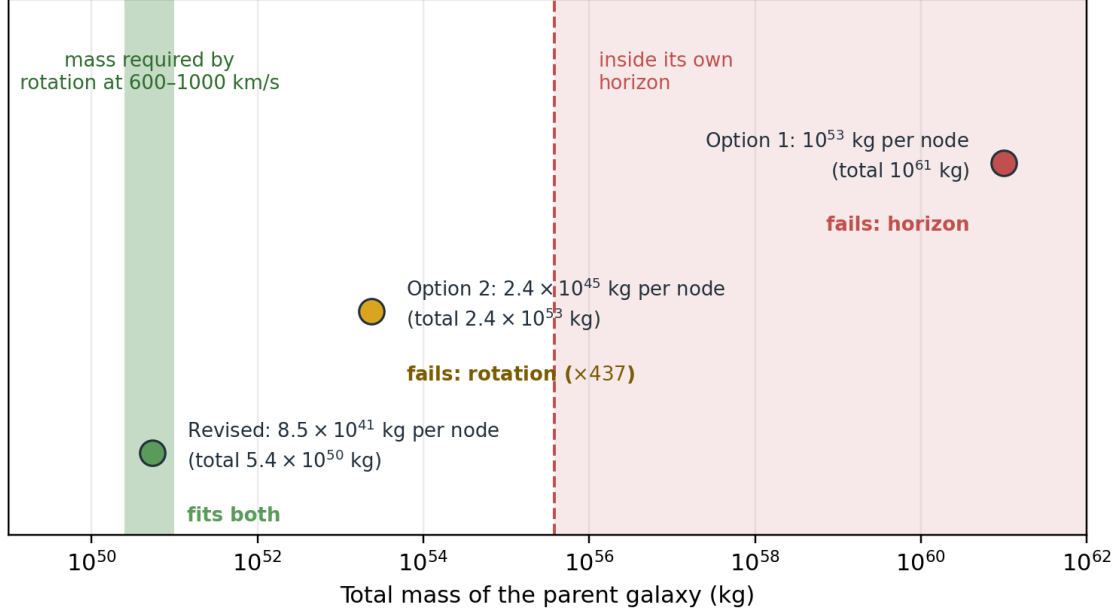
$$m \approx 2/(\pi \cdot f_{\text{gas}}) \approx 4.07 \Rightarrow 4 \text{ main arms}$$

Distributing  $N \approx 10^8$  nodes among 4 arms corresponds to  $\approx 2.5 \times 10^7$  universes per arm.

### 7.5 — Mass budget of the parent galaxy

The mass of the parent galaxy must satisfy three conditions at once. (i) **Rotation:** the flat curve fixes the total gravitating mass inside  $R_{\text{parent}}$ :  $M = v^2 R / G \approx 5.4 \times 10^{50}$  kg for  $v = 800$  km/s and  $R_{\text{parent}} = 6 \times 10^{12}$  ly ( $2.5\text{--}9.9 \times 10^{50}$  kg over the ranges 600–1000 km/s and  $5\text{--}7 \times 10^{12}$  ly). (ii) **Horizon:** the mass must stay far below  $R c^2 / 2G \approx 3.8 \times 10^{55}$  kg, otherwise the structure lies inside its own Schwarzschild radius (the same failure discussed in Section 3). (iii) **Composition:** the dark-matter to gas ratio of Section 2 (5.4) applies to the arm.

Two natural choices for the mass that the parent galaxy “sees” in each node fail. With  $10^{53}$  kg per node (the content of the observable universe), the total is  $10^{61}$  kg and the Schwarzschild radius exceeds  $R_{\text{parent}}$  by a factor  $\approx 2.6 \times 10^5$ . With  $2.4 \times 10^{45}$  kg per node (Section 6), the total is  $2.4 \times 10^{53}$  kg: the horizon is respected, but the circular velocity would be  $\approx 16\,700$  km/s instead of 600–1000 km/s, i.e. the mass is  $\approx 437$  times too large (Figure 8).



**Figure 8.** Total mass of the parent galaxy under three choices of node mass, against the mass required by the rotation curve (green band) and the horizon limit (red region).

A consistent set follows if the rotation curve is taken as the constraint. With  $M = 5.4 \times 10^{50}$  kg and  $f_{\text{gas}} = 0.156$ , the gas mass is  $\approx 8.5 \times 10^{49}$  kg and the dark-matter mass  $\approx 4.6 \times 10^{50}$  kg. If at most all the gas ends up locked in  $N = 10^8$  nodes, each node holds at most  $\approx 8.5 \times 10^{41}$  kg ( $\approx 4 \times 10^{11}$  solar masses). The consequences are:

| Quantity                                | Value                                                               | Check                                                                            |
|-----------------------------------------|---------------------------------------------------------------------|----------------------------------------------------------------------------------|
| Total mass $M$                          | $5.4 \times 10^{50}$ kg                                             | $v^2 R/G$ at 800 km/s                                                            |
| Schwarzschild radius $r_s$              | $\approx 8.5 \times 10^7$ ly ( $r_s/R \approx 1.4 \times 10^{-5}$ ) | far below the horizon limit                                                      |
| Mean density inside $R_{\text{parent}}$ | $\approx 7 \times 10^{-37}$ kg/m <sup>3</sup>                       | matches the $\approx 10^{-36}$ kg/m <sup>3</sup> ambient density of Section 10.1 |
| Dark matter / gas                       | $4.6 \times 10^{50} / 8.5 \times 10^{49}$ kg                        | ratio 5.4 (Section 2)                                                            |
| Mass per node (upper bound)             | $8.5 \times 10^{41}$ kg                                             | $N = 10^8$ , all gas locked                                                      |
| Bounce radius $a_b$ for that mass       | $\approx 3.4 \times 10^{-19}$ m                                     | was $4.8 \times 10^{-18}$ m for $2.38 \times 10^{45}$ kg (earlier version)       |

This budget is adopted in the present version. The agreement of the mean density with the ambient value quoted in Section 10.1 was not imposed, which supports it. Section 6 has been updated accordingly: the gas mass of  $2.4 \times 10^{45}$  kg (cluster scale) used in the earlier version is incompatible with  $N = 10^8$  nodes at the rotation speed of the model, and the bounce radius changes by a factor  $\approx 14$  without affecting Sections 3–5. Regarding the size of the parent galaxy, the relation  $R_{\text{parent}} \approx R_{\text{node}} \cdot N^{1/3}$  gives  $\approx 2.3 \times 10^{12}$  ly with the average node size and  $\approx 2.2 \times 10^{13}$  ly with the size of our node; the value  $5\text{--}7 \times 10^{12}$  ly

adopted here is an order-of-magnitude estimate of the same order as the geometric mean of both ( $\approx 7 \times 10^{12}$  ly). The results depend only weakly on it: the rotation mass scales linearly with  $R_{\text{parent}}$ , and the margin with respect to the horizon limit is large.

## 7.6 — Construction of the parent galaxy from earlier generations

Under the conjecture of Section 8.1, the parent galaxy is assembled as follows. The total reservoir is fixed:  $\approx 5.4 \times 10^{50}$  kg, of which  $\approx 8.5 \times 10^{49}$  kg is gas. The origin of that reservoir remains outside the model (Section 10.2).

**Stage 1 — dense phase.** The gas is concentrated in a narrow ring, so its surface density  $\Sigma$  is high and  $Q < 0.5$ . Since  $Q \propto 1/\Sigma$ , reaching  $Q \approx 0.71$  from an assumed  $Q \approx 0.2$  requires lowering  $\Sigma$  by a factor  $0.71/0.2 \approx 3.6$ . The “enormous amount of gas” is therefore not a larger total mass but a higher concentration of the same mass. Nodes formed in this phase are unstable (Generations 1 and 2).

**Stage 2 — dispersal.** The debris of the unstable nodes spreads the gas over a wider ring and heats it (higher velocity dispersion), so  $\Sigma$  falls and  $Q$  rises. A ring about 3.6 times larger in area suffices in this illustration; the golden region of Section 7.2 ( $1.3\text{--}2.6 \times 10^{12}$  ly) has an area ratio of  $\approx 4$  between its outer and inner radii.

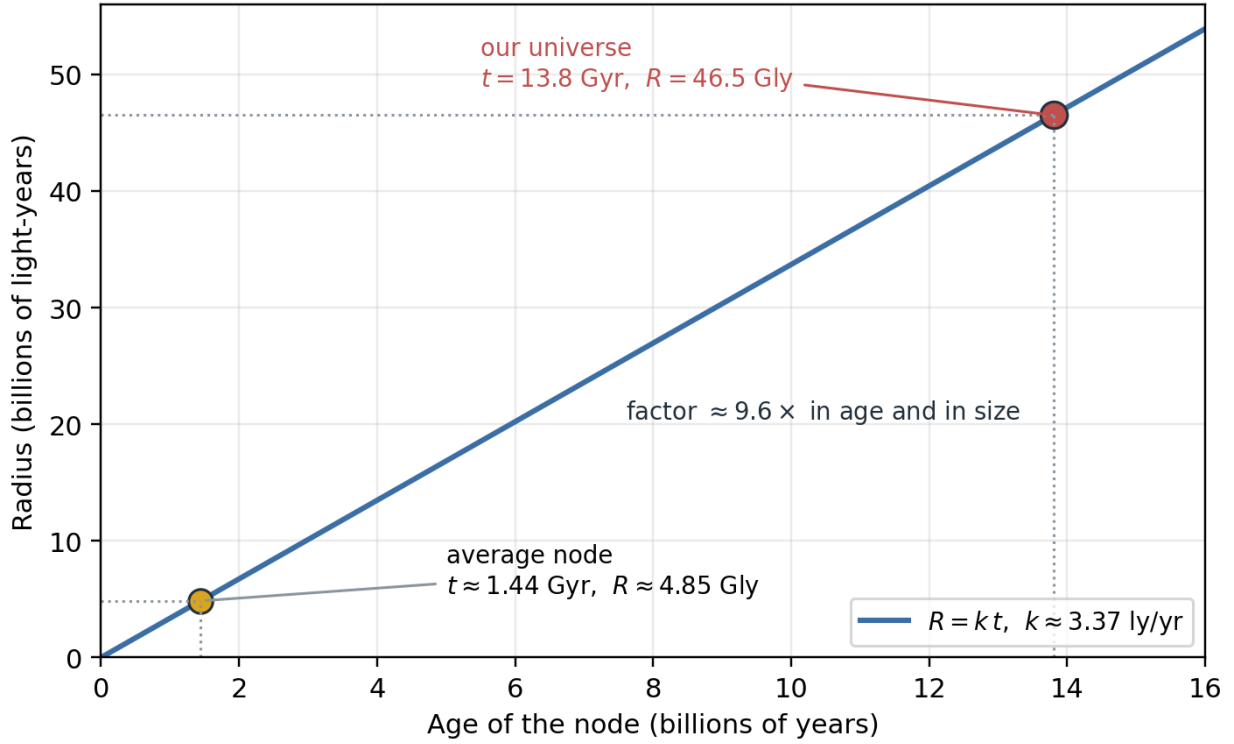
**Stage 3 — steady state.**  $Q$  settles near 0.71 and stable nodes form, our universe among them (Generation 3 onwards), up to  $N \approx 10^8$  nodes.

**Time scales.** Crossing the golden region (width  $1.3 \times 10^{12}$  ly) at 800 km/s takes  $\approx 5 \times 10^{14}$  years, and the orbital period at  $2 \times 10^{12}$  ly is  $\approx 4.7 \times 10^{15}$  years. Either recycling is local (each zone reuses its own gas), or the generations are separated by at least  $\approx 5 \times 10^{14}$  years. In the second case the arm pattern has turned by only about a tenth of a revolution between generations. Both readings are compatible with the model; which one holds changes the history of the parent galaxy and is left open.

## 8. Size distribution: the age-size mechanism

Since all nodes share the same post-bounce expansion physics, size and age are proportional:  $R(t) = k \cdot t$ , with  $k$  calibrated with our own data ( $R_{\oplus} = 46\,500$  M ly,  $t_{\oplus} = 13\,800$  M years):

$$k = R_{\oplus}/t_{\oplus} \approx 3.37 \text{ ly/year}$$



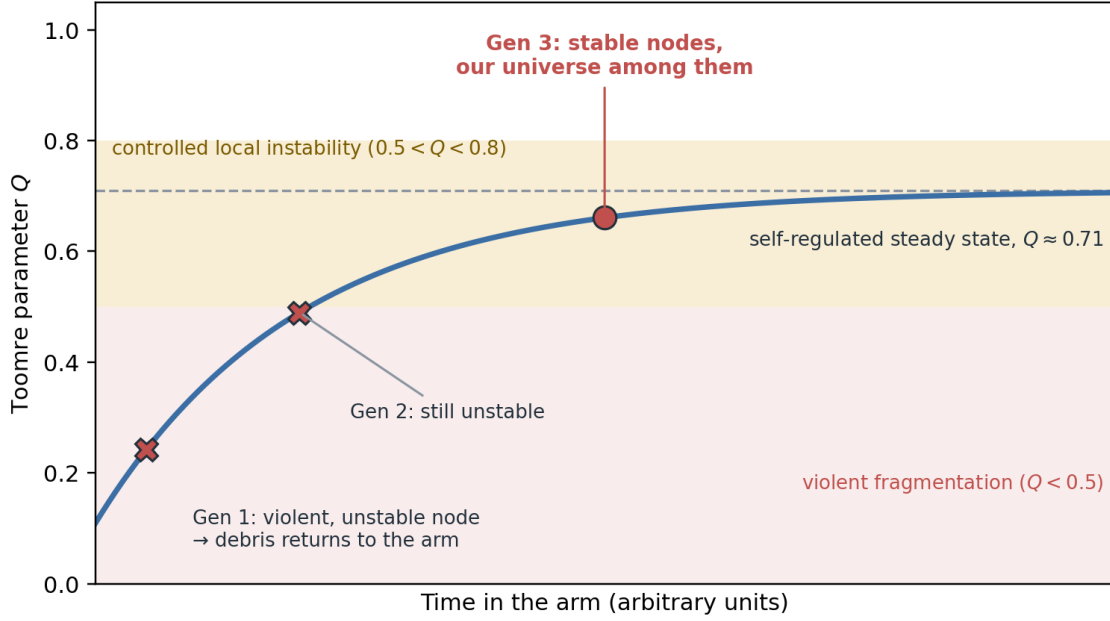
**Figure 4.** Linear age-size relation; our universe turns out to be  $\approx 9.6$  times older (and larger) than the average node of the structure.

The average node would have an age of only  $\approx 1.44 \times 10^9$  years, versus the  $13.8 \times 10^9$  years of our universe — a factor of  $\approx 9.6\times$ , consistent with the same size factor. This is analogous to continuous star formation in real galaxies: most nodes are young, and ours belongs to the first waves of collapse in the golden region.

### 8.1 — Generations of nodes and recycling of the arm gas

Section 8 established that nodes differ in age. This subsection adds a conjecture about what the earliest nodes did, without altering any result of Sections 3–8. Toomre’s criterion (Section 5, Figure 3) distinguishes three regimes. When the arm is gas-rich and dynamically cold ( $Q < 0.5$ ), collapse is violent: fragments form, but their bounce is too abrupt to leave a stable, smoothly expanding universe; we call these *unstable nodes*. **Conjecture:** the first generations of nodes (Generations 1 and 2) formed in that regime. Their gas was not lost: the hot, mixed debris returned to the arm, redistributing mass and raising the velocity dispersion.

In real galactic disks, star formation, feedback and gas return drive  $Q$  toward a self-regulated value; we assume the same holds for the arm, so that  $Q$  relaxes from below toward  $\approx 0.71$  (Figure 7). Nodes formed after this relaxation — Generation 3 onwards, ours among them — are the stable ones described in Sections 5–6. In this reading, the universal condition  $Q \approx 0.71$  of Section 10.1 describes the steady state, not the transient.



**Figure 7.** Schematic evolution of the Toomre parameter in the arm under the generational conjecture: the first generations form at  $Q < 0.5$  and fail, returning their gas; later generations form in the self-regulated regime near  $Q \approx 0.71$ . Qualitative sketch, not a calculation.

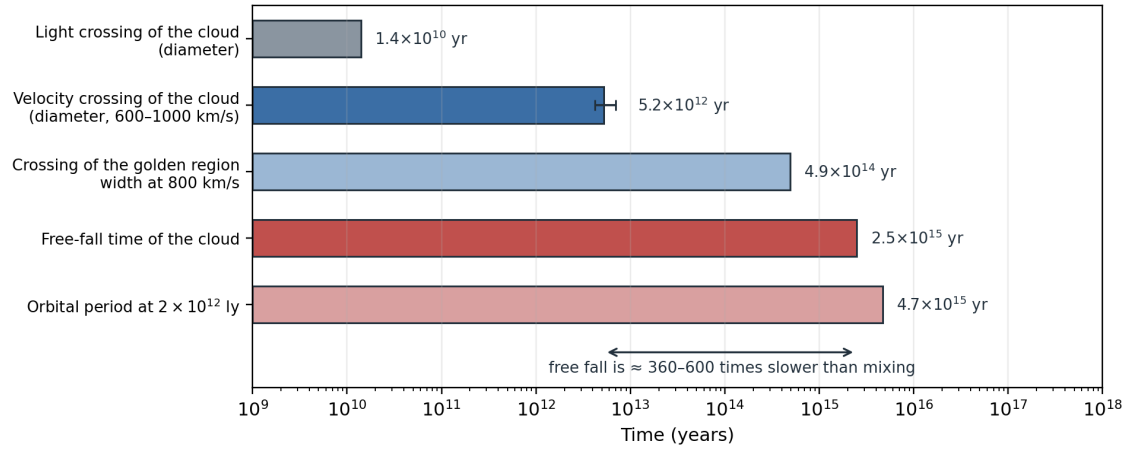
**Consistency with the rest of the model.** (i) Age-size (Section 8): our node,  $\approx 9.6$  times older than the average, belongs to the early part of the steady state, and the many younger nodes formed under the same  $Q \approx 0.71$ . (ii) Section 10.1 is unchanged. (iii) Section 9.2: unstable neighbours leave debris, not bubbles, which reduces the number of possible CMB collisions relative to the raw geometric count (Section 9.3).

**Homogeneity of the CMB.** Under this conjecture, stable nodes form from gas that has been processed and mixed by earlier generations, so it would start with small density contrasts. This is a hypothesis about initial conditions, not a derivation: the model does not yet compute the amplitude ( $\approx 10^{-5}$ ) or the spectrum of the primordial fluctuations, which in the literature are obtained from inflation or from a slow-contraction phase. Section 8.2 develops a candidate mechanism for the homogeneity and identifies what remains to be computed.

## 8.2 — Homogenization of the CMB across the node

The CMB has the same temperature ( $\approx 2.725$  K) over the whole sky, with relative differences of only  $\approx 10^{-5}$ . In the model, three ingredients can be combined to account for this. They are stated separately because they have different status.

**(a) Thermal contact before the collapse.** All the matter of a node comes from a single bound cloud. With the mass per node of Section 7.5 ( $8.5 \times 10^{41}$  kg) at the ambient density of the parent galaxy ( $\approx 7 \times 10^{-37}$  kg/m<sup>3</sup>), the cloud has a radius of  $\approx 7 \times 10^9$  ly. Crossing its full diameter at the velocity dispersion of the arm (600–1000 km/s) takes  $\approx 4\text{--}7 \times 10^{12}$  years ( $\approx 5 \times 10^{12}$  years at 800 km/s); using the radius instead would halve these values. Its free-fall time is  $\approx 2.5 \times 10^{15}$  years, i.e.  $\approx 360\text{--}600$  times longer than the diameter crossing time (Figure 9). The cloud therefore has time to mix and thermalize several hundred times over before it collapses, so the temperature of the matter that ends up in the bounce can be uniform. This is an order-of-magnitude estimate that assumes the ambient density and a dispersion equal to the rotation speed.



**Figure 9.** Time scales of the collapsing cloud of one node. Mixing (velocity crossing of the diameter) is about 360–600 times faster than free fall, which supports thermal equilibrium before the bounce. Order-of-magnitude estimate.

**Earlier generations as preparation.** By Section 8.1, the gas of stable nodes has been processed and mixed by the unstable Generations 1 and 2. This adds a second reason for a common starting state, but it is a hypothesis: no observation of those generations exists, and the model does not require them to be visible.

**(b) Smooth contraction and the spectrum.** A contracting cloud tends to amplify anisotropies and to fragment, so uniformity before the bounce is not enough. In the matter-bounce scenario, a contracting phase dominated by pressureless matter generates a scale-invariant spectrum of scalar perturbations, and in Loop Quantum Cosmology the tensor-to-scalar ratio after the bounce is negligible (Wilson-Ewing 2013). The collapsing node of this model (dark matter and gas with negligible pressure, followed by the LQC bounce of Section 6) has the same structure, so this scenario is a natural candidate to supply the amplitude and the spectrum of the fluctuations.

**(c) What is still open.** Three points are not solved here. First, that work finds that the observed amplitude requires a critical density of about  $10^{-9}$  times the Planck density, whereas this paper uses  $\rho_c \approx 5.16 \times 10^{96} \text{ kg/m}^3$ , the full Planck density. Second, the growth of anisotropies during the contraction has not been checked for this cloud. Third, the amplitude  $\approx 10^{-5}$  has not been computed with the parameters of the model.

**Evidence and tests.** There is no direct evidence of Generations 1 and 2, and this paper does not claim any. What the model offers are consequences that can be tested: (i) the bound on bubble collisions of Section 9.3; (ii) if the matter-bounce mechanism is adopted, a tensor-to-scalar ratio far below the current upper limits, of order  $10^{-3}$  or less, which future polarization experiments could probe, and a positive running of the spectral index, which would distinguish it from standard inflation; (iii) large-scale anomalies of the CMB as possible traces of the neighbouring nodes, without a quantitative prediction yet. A detection of primordial gravitational waves well above  $10^{-3}$  would put this mechanism under strong tension.

## 9. Observationally falsifiable predictions

### 9.1 — The “dark flow” as proper orbital motion

Kashlinsky et al. (2008, 2009) detected a coherent flow of galaxy clusters (“dark flow”) of 600–1000 km/s, not explained by standard  $\Lambda$ CDM. This flow is reinterpreted as the proper orbital motion of our node within the arm of the parent galaxy. Using the radius of the parent galaxy and that orbital velocity, the resulting period is:

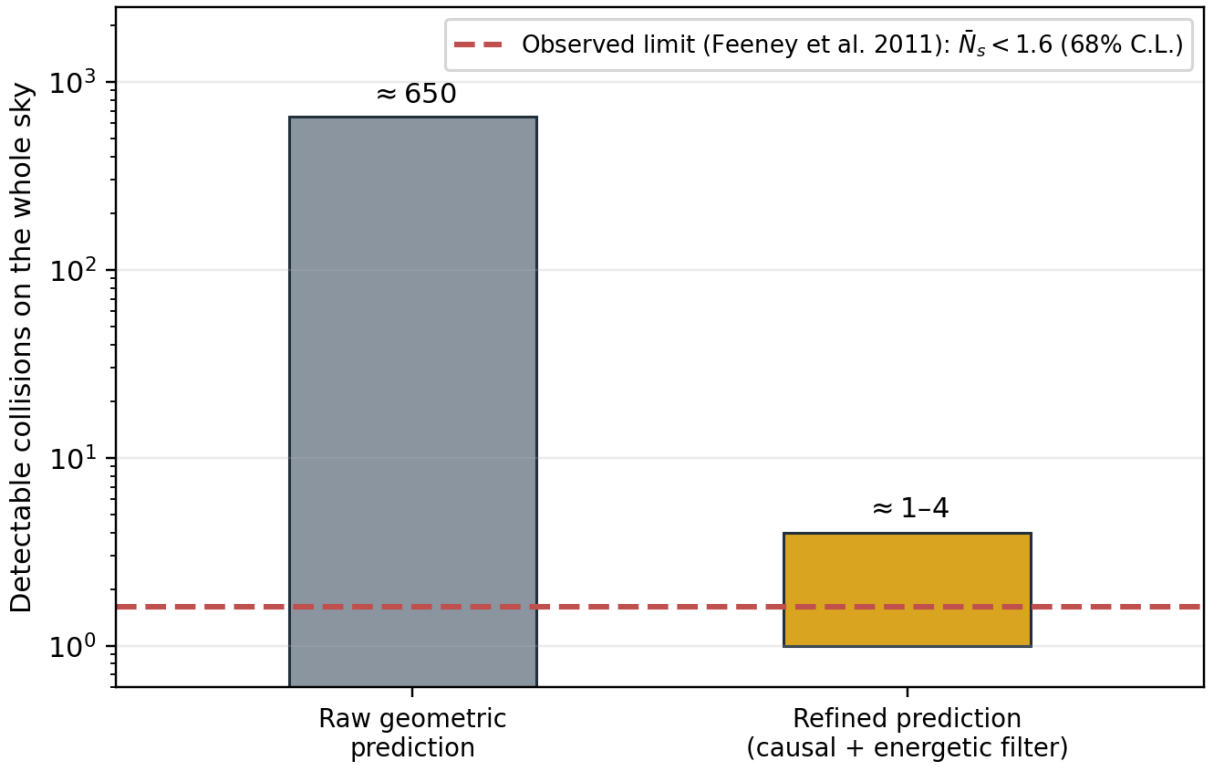
$$T = 2\pi R_{\text{parent}}/v \approx 0.9\text{--}2.2 \times 10^7 \text{ billion years } (\approx 10^{16} \text{ years})$$

that is, since the Big Bang only about a millionth ( $\approx 10^{-6}$ ) of an orbital turn has been completed — consistent with the absence of detectable orbital-curvature effects to date.

### 9.2 — Collisions between bubble universes in the CMB

With  $N \approx 10^8$  nodes packed in the golden region (packing factor  $\approx 0.74$ ) and our node  $\approx 10\times$  larger than the average, the pure geometric overlap predicts  $\approx 650$  neighbouring universes in contact with ours. The actual observation (Feeney, Johnson, Mortlock & Peiris, Phys. Rev. Lett. 107, 071301, 2011, WMAP 7-year data) found no collision signal, establishing an upper limit:

$$N_s < 1.6 \text{ detectable collisions over the whole sky (68\% C.L.)}$$



**Figure 5.** The raw geometric prediction (650) exceeds the observational limit; applying the standard causal/energetic filter of bubble-collision theory (Aguirre & Johnson), the refined prediction ( $\approx 1\text{--}4$ ) is consistent with the real limit.

**Falsifiable prediction:** applying the causal filter (collision within our past light cone, before recombination) and the energetic filter (vacuum-tension difference above the detection threshold) to the 650 geometric neighbours, the number of detectable collisions must be of the same order as the limit already observed. Future polarization data (full Planck, LiteBIRD, CMB-S4) that reveal dozens of collision discs, or that rule out even 1–2

candidates, would put the model under serious tension or refute it.

### 9.3 — Consequence of the generational conjecture for the collision count

Under the conjecture of Section 8.1, the  $\approx 650$  geometric neighbours split into stable nodes (bubbles) and unstable ones (debris). Only the former can leave a disc in the CMB, so the expected number of detectable collisions becomes  $N \approx 650 \cdot f_{\text{stable}} \cdot f_{\text{causal}} \cdot f_{\text{energetic}}$ . The observational limit  $N_s < 1.6$  then bounds the product of the three factors:  $f_{\text{stable}} \cdot f_{\text{causal}} \cdot f_{\text{energetic}} \lesssim 1.6/650 \approx 2.5 \times 10^{-3}$ . This is a constraint, not yet a prediction. The conjecture becomes falsifiable if  $f_{\text{stable}}$  can be computed independently from the arm dynamics: a value far above that bound would refute it.

## 10. Acknowledged limitations of the model

Following the standard of epistemological honesty of any rigorous speculative model, four limitations are explicitly identified and addressed:

### 10.1 — Redefinition of $M_c$ as a universal constant of the collapse

$M_c$  does not designate a single core of the parent galaxy, but the final state of each of the  $\approx 10^8$  independent local collapses that occur in the golden region. At any point where  $Q \approx 0.71$  is met, the local gas starts the collapse chain described in Sections 5–6, reaching the same universal condition of quantum parity ( $M_c = m_p$ ,  $R = 1.44d$ ) in every node, with a compression factor from the ambient halo density ( $\approx 10^{-36} \text{ kg/m}^3$ ) up to the Planck critical density of the order of  $10^{133}$ .

### 10.2 — Origin of the parent galaxy

It is explicitly declared as a limit of the model: the ultimate origin of the parent galaxy lies beyond its reach, just as standard cosmology does not explain the origin of the initial singularity. As the most probable background hypothesis, an eternal-past substrate is postulated (along the lines of Linde’s eternal inflation), acknowledging that not even this hypothesis fully avoids the question: the Borde–Guth–Vilenkin theorem (2003) proves that an eternally expanding space-time cannot extend infinitely into the past. Under the generational conjecture of Section 8.1, the parent structure is enriched by the debris of earlier unstable generations, but this shifts the question back rather than closing it: those generations also need a beginning, and the Borde–Guth–Vilenkin argument applies to the chain.

### 10.3 — Age-size mechanism (developed in Section 8)

Resolved through the relation  $R(t) = k \cdot t$ : our universe is larger than the average because it is older, not because of an uncaused exception.

### 10.4 — Second falsifiable prediction (developed in Section 9.2)

The model now has two independent observational fronts — dark flow and bubble collisions in the CMB — instead of just one.

## 11. Summary of model parameters

| Parameter                                              | Value                                                                        |
|--------------------------------------------------------|------------------------------------------------------------------------------|
| Base scale $d = 4 \cdot \ell_p$                        | $6.465 \times 10^{-35} \text{ m}$                                            |
| Parity radius $R = 1.44 \cdot d$                       | $9.309 \times 10^{-35} \text{ m}$                                            |
| Ratio $R/r_s$                                          | $\approx 2.88$                                                               |
| Local orbital velocity                                 | $\approx 0.59c$                                                              |
| Winding time / arm turns                               | $\approx 21 \ t_p / \approx 8.0 \text{ turns}$                               |
| Toomre parameter $Q$                                   | $\approx 0.71$                                                               |
| Total mass of the parent galaxy / gas mass per node    | $\approx 5.4 \times 10^{50} \text{ kg} / \leq 8.5 \times 10^{41} \text{ kg}$ |
| Bounce density and radius ( $\rho_c, a_b$ )            | $5.16 \times 10^{96} \text{ kg/m}^3 ; 3.4 \times 10^{-19} \text{ m}$         |
| Number of node-universes, $N$                          | $\approx 10^8$                                                               |
| Number of arms, $m$                                    | $\approx 4$                                                                  |
| Radius of the parent galaxy                            | $\approx 5\text{--}7 \times 10^{12} \text{ light-years}$                     |
| Golden region                                          | $1.3\text{--}2.6 \times 10^{12} \text{ light-years}$                         |
| Macro orbital velocity (dark flow)                     | $600\text{--}1000 \text{ km/s}$                                              |
| Predicted CMB collisions (refined / raw)               | $\approx 1\text{--}4 / \approx 650$                                          |
| Observational limit on collisions (Feeney et al. 2011) | $N_s < 1.6$                                                                  |

### Note on the use of AI tools

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### References

- Aguirre, A. & Johnson, M. C. (2011). A Status report on the observability of cosmic bubble collisions. Rept. Prog. Phys. 74, 074901.
- Borde, A., Guth, A. H., & Vilenkin, A. (2003). Inflationary spacetimes are not past-complete. Phys. Rev. Lett. 90, 151301.
- Feeney, S. M., Johnson, M. C., Mortlock, D. J., & Peiris, H. V. (2011). First Observational Tests of Eternal Inflation. Phys. Rev. Lett. 107, 071301.
- Kashlinsky, A., Atrio-Barandela, F., Kocevski, D. & Ebeling, H. (2008). A measurement of large-scale peculiar velocities of clusters of galaxies: results and cosmological implications. Astrophys. J. Lett. 686, L49.
- Kashlinsky, A., Atrio-Barandela, F., Kocevski, D. & Ebeling, H. (2009). A measurement of large-scale peculiar velocities of clusters of galaxies: technical details. Astrophys. J. 691, 1479.
- Linde, A. (1986). Eternally existing self-reproducing chaotic inflationary universe. Phys. Lett. B 175, 395–400.
- Wilson-Ewing, E. (2013). The matter bounce scenario in loop quantum cosmology. JCAP 1303, 026.
- Toomre, A. (1964). On the gravitational stability of a disk of stars. Astrophys. J. 139, 1217–1238.