

## **TOWARDS A DISCRETE COSMOLOGY 17/17: A FORMAL BASE FOR A DISCRETE COSMOLOGY**

[Links to papers in this series.](#)

All the articles in this series are aimed at proposing the construction of a formal basis for a discrete cosmology, based on a finite and discrete space and time. The articles in the series can be read in any order, although there are cross-references between them.

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**Abstract.**-This last paper of the series proposes the consideration of a set of formal elements to initiate a discussion on the foundations of a discrete cosmology. The main elements of this set will be the Principle of Directional Evolution and a short number of theorems and corollaries formally deduced from it. Taking into account the inconsistency of one of the fundamental axioms of the infinitist mathematical language of current cosmology (the Axiom of Infinity), the proposed consideration is formally justified. This paper 17, and with it this series of articles, ends with a list of the possible advantages of a finitist and discrete cosmology, compatible with all the empirical evidence about the observable universe, and oriented towards a more physical than mathematical interpretation of the great mysteries of contemporary physics.

**Keywords:** Theorem 5.4 of Identity, Principle of Inertia, Principle of Consistency, Theorem of Formal Dependence, discrete paradigm, CALMs

### **17.1 An inductive principle for a discrete cosmology**

Let us begin by recalling that in a finite and discrete universe there would be indivisible units of space and time. Although they have received different names, here we have proposed to call them respectively qseats (discrete space units) and qbeats (discrete time units). Let us also remember that in the precedent articles of this series of articles an inductive principles of the maximum empirical evidence was formulated: the Principle (5.1) of Directional Evolution:

*The universe always evolves in the same direction of increasing its entropy.*

This inevitable degradative evolution towards a final of maximum isotropic cold is compatible with the local and temporal appearance of ordered systems (minerals, for example) and of organized (teleological) systems, such as living beings. These are systems that maintain exchanges (physical and/or chemical) with their environment, and in such a way that the overall isotropic balance of both (system/environment) is always positive, in the direction indicated by the Principle of Directional Evolution. This fact should deserve the utmost consideration in any scientific cosmology. At the moment this is not the case.

## 17.2 A formal core for a discrete cosmology

As with other inductive principles, it is surprising the amount of information packed in the Principle of Directional Evolution. Information that can be extracted by successive applications of the basic laws of logic and basic logic inferences. Among (surely many) others, the following results follow almost immediately from the Principle of Directional Evolution (in this case also making use of the inconsistency of the actual infinity demonstrated in the paper 3 and in [4]):

- **Theorem 5.3 of the Consistent Universe:** *The universe evolves under the control of a unique set of invariant and consistent physical laws.*
- **Corollary 5.5 of the Universal Physical Laws:** *The laws of physics apply to all regions of space and time.*
- **Theorem 5.5 of the Formal Dependence:** *No concept defines itself; no statement proves itself; no physical object is the cause of itself; and no cause is the cause of itself.*
- **Theorem 5.6 of the Discrete Reference Frames:** *The laws of physics are the same in all discrete reference frames.*
- **Theorem 5.9 of the Indivisible Units:** *There is an indivisible minimum of space (time) of which all space (time) intervals are an integer multiple.*
- **Corollary 5.6 of the Discrete Threshold:** *The laws of physics do not apply in spaces smaller than the indivisible unit of space nor in times smaller than the indivisible unit of time, both being of non-zero extension (duration).*
- **Theorem 5.10 of Adjacency:** *No space exists between any*

*two successive qseats, and no time elapses between two successive qbeats.*

- **Corollary 5.11 of the Finite Space and Time:** *Every space interval (or time interval) is finite and can only be divided into an integer number of adjacent qseats (qbeats), or into an integer number of adjacent parts, each an integer multiple of a qseat (qbeat).*
- **Theorem 5.1 of the Canonical Changes:** *Every change is either a canonical change of a discrete sequence of canonical changes.*
- **Theorem 5.2 of Change:** *Canonical changes are impossible in the spacetime continuum.*
- **Theorem 7.1 of the Uncompletable Regress:** *Any recursive sequence  $S$  of proofs, definitions or causes in which there is a last element to be proved (defined, caused) and each element has an immediate predecessor that proves (defines or causes) it, is uncompletable.*
- **Theorem 7.2 of the First Element:** *A consistent sequence in which there is a last element and each element has an immediate predecessor is a complete totality only if it has a first element.*
- **Theorem 8.1 of the Discrete Motion:** *The continuum densely ordered spacetime cannot be used to model uniform motion.*
- **subTheorem 8.1 of Physical Space and Time:** *The indivisible units of space and time are physical, and then real and absolute.*
- **Theorem 5.4 of Identity:** *All particles of the same type have the same properties and behave the same way under the same conditions.*
- **Corollary 9.1 of Composed Identity:** *The Theorem 5.4 of Identity also applies to any combination of elementary particles, as atoms or molecules or even more complex particles, provided that the combinations are identical.*
- **Theorem 9.2 of the Arrow of Time:** *In a consistent universe the joint evolution of any system and its environment is always in the same direction of increasing its entropy.*
- **Theorem 9.3 of the Discrete History:** *The continuum densely ordered time cannot be used to model the history of physical objects.*

- **Theorem 10.1 of Abstract Points:** *In the spacetime continuum, the points of space have neither size nor shape, and the instants of time have not duration.*

Among others, the above formal results could be the initial building blocks for the design of a new finite and discrete model of the observable universe.

### 17.3 Preinertia: completing a mechanical principle

Preinertia was introduced in the article 7 of this series. It is a universal property of all physical objects, including photons. A property that has so far gone unnoticed by physics, although physics makes continuous (implicit, or best unconscious) use of it. And it is not an irrelevant property: it is nothing less than the reason why it is impossible to detect the absolute motion of a reference frame within that reference frame, i.e. with the only aid of the objects of that frame, including the photons produced in that frame (see the article 7 in this series of articles, and the corresponding chapters in [3]). Let us recall, then, that:

*A physical object is said preinertial if it inherits the relative velocity vector of the reference frame where it is set in motion.*

In the aforementioned article 7 of this series of articles it was proved (making use of the speed of light as the universal constant  $c$ ) that all physical objects are preinertial:

**Theorem 6.1 of Preinertia:** *Every physical object inherits in one of its vector components the relative velocity vector of the reference system where it is set in motion, provided that the resulting speed does not exceed the possible maximum limit.*

On the other hand, there is the most overwhelming empirical evidence for preinertia, it is the reason why we fall exactly below the place where we jump vertically (don't forget that the Earth moves at 367 km/s in the galactic direction  $(264.4, 48.4) \pm (0.3, 0.5)$  [2]). Such overwhelming empirical evidence and its predictable relation to inertia (yet to be established) point to the convenience of including Theorem 6.1 of Preinertia in the statement of the Principle of

Inertia. An inclusion, on the other hand, very simple and straightforward:

**Principle of Inertia:** *Every physical object is preinertial and remains at rest or moves at a constant uniform velocity, unless an external force acts upon it.*

### 17.4 CALM, a suggestion to start with

Naturally, everything remains to be done in the design of a new finite and discrete model for the observable universe. The above results only indicate a few things that should be taken into account in such a design. With the same guiding intention, in this series of articles we have considered the structure and operation of CALMs (cellular automata like models), essentially finite, discrete models that have been well known for several decades. Some of the advantages of this type of models could be the following:

1. Physics would no longer be dependent of an arbitrary mathematical axiom (the Axiom of Infinity), which could be inconsistent in accord with Hilbert's machine argument (paper 3) and several others [4].
2. The still unresolved problem of change, perhaps the most basic problem in physics (although completely forgotten by physics and metaphysics), may finally be solved.
3. All the oddities of relativity could be only apparent, as the refractive deformation of a rod partially submerged in water [3]. Furthermore, the conversion factor between the geometry of a CALM and the geometry of the continuum is precisely the relativistic Lorentz factor.
4. Nothing can last a time less than one qbeat nor move a distance less than one qseat. In a discrete model there is a maximum speed of one qseat per qbeat. That could be the speed of light in the vacuum, though not necessarily.
5. The Second Principle of relativity would not be necessary because in a discrete spacetime there is an insurmountable velocity of one qseat per qbeat.
6. Unlike points and instants, the discrete units of space and time (qseats and qbeats) are full of physical meaning.
7. CALMs are much more simple than the spacetime continuum: between any two points of the spacetime continuum infinitely

many other points exist, while the number of qseats in the whole visible universe would be finite ( $\approx 7.64 \times 10^{184}$  if they were cubes of a Planck's volume).

8. Once replaced the spacetime continuum by a discrete space and time, quantum field theory (QFT) resembles the logic and functioning of a CALM.
9. Motion has not to be referred to abstract reference frames but to the actual fabric of space (although for practical reasons we could also make use of symbolic reference frames).
10. The entanglement of space and time in the spacetime continuum finds a natural explanation within the logic of CALMs functioning.
11. Quantum entanglement and quantum non-locality could be a natural consequence of CALMs synchronized way of functioning.
12. The flow of time and its irreversible arrow, enigmatic from the perspective of the spacetime continuum, is naturally explained in CALM terms.
13. The slippery concept of *now* could also be easily explained in CALM terms.
14. The incessant quantum activity of free space in QFT could be better explained in CALM terms than it is in the spacetime continuum.
15. Although QFT seems to be complete, the spacetime continuum it makes use of could be inappropriate. If that were the case, realist theories (and then the common sense in science) could recover its lost validity.
16. General relativity and QFT would have a new discrete opportunity to meet each other [1].
17. While points and instants of the spacetime continuum are primitive concepts devoid of physical meaning, and then hard to link with physical reality, qseats and qbeats are plenty of physical significance.
18. All known physical objects and magnitudes, just except spacetime, are discrete, with indivisible units. In CALMs there is no exception, space and time are also discrete.
19. In the analog models of nature, extent and shape loss their physical meaning at the elementary particle level. This meaning could be found within the discrete spacetime of CALMs.

20. Since each variable defining the state of a qseat is updated at each successive qbeat, qseats can vibrate in multiple forms. And these vibrations could be the fundamental cause of the particle/wave duality in QFT.
21. Certain qseat states could have organizing effects and then could give rise to emergent objects and properties.
22. Observers, instruments and observed objects would form part, all of them, of the same CALM. Their current mutual interactions would determine their irreversible future.

But the most interesting consequences are probably not in the above list, but in the minds of some of its readers.

## Bibliographic references

- [1] J. Ambjorn, J. Jurkiewicz, and R. Loll. El universo cuántico autoorganizado. *Investigación y Ciencia*, 384:20–27, 2008.
- [2] Cameron Gibelyou and Dragan Huterer. Dipoles in the sky. *Monthly Notices of the Royal Astronomical Society*, 427(3):1994–2021, Nov 2012.
- [3] Antonio León. *Apparent relativity*. Self edition in KDP, 2022.
- [4] Antonio León. *Infinity put to the test*. Self edition in KDP. Printed at amazon.com. [Free pdf](#), 2023 (2021).
- [5] H. Reeves, M. Cazenave, P. Solié, K. Pribram, H. F. Etter, and M. L. von Franz. *La sincronicidad. ¿Existe un orden acausal?* Editorial Gedisa, Barcelona, 1987.
- [6] Steven Strogatz. *SYNC. The Emerging Science of Spontaneous Order*. Penguin Books, London, 2004.