# Could the universe be a massive elastic 3D-lattice and ordinary matter consist of topological singularities?

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ABSTRACT

One fundamental problem of modern physics is the search for a *theory of everything* able to explain the nature of space-time, what matter is and how matter interacts. There are various propositions, as *Grand Unified Theory, Quantum Gravity, Supersymmetry, String and Superstring Theories, and M-Theory*. However, none of them is able to consistently explain *at the present and same time* electromagnetism, relativity, gravitation, quantum physics and observed elementary particles.
Here, it is suggested that Universe could be *a massive elastic 3D-lattice*, and that fundamental building blocks of Ordinary Matter could consist of *topological singularities of this lattice*, namely diverse dislocation loops and disclination loops. We find, for an isotropic elastic lattice obeying Newton's law, with specific assumptions on its elastic properties, that the behaviours of this lattice and of its topological defects display "all" known physics, unifying electromagnetism, relativity, gravitation and quantum physics, and resolving some longstanding questions of modern cosmology. Moreover, studying lattices with axial symmetries, represented by *"colored" cubic 3D-lattices*, one can identify a lattice structure whose topological defect loops coincide with the complex zoology of elementary particles, which could open a promising field of research.

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## 1. Introduction

Since the 19[th] century, physicists have attempted to develop unified field theories [1], which would consist of a single coherent theoretical framework able to account for several fundamental forces of nature. For instance:

- *Grand Unified Theory* [2] merges electromagnetic, weak and strong interaction forces,
- *Quantum Gravity* [3], *Loop Quantum Gravity* [4] and *String Theories* attempt to describe the quantum properties of gravity,
- *Supersymmetry* [5-10] proposes an extension of the space-time symmetry relating the two classes of

elementary particles, bosons and fermions,

- *String and Superstring Theories* [11-18] are theoretical frameworks incorporating gravity in which point-like particles are replaced by one-dimensional strings, whose quantum states describe all types of observed elementary particles,

- *M-Theory* [19-27] is a unifying theory of five different versions of string theories, with the surprising property that extra dimensions are required for its consistency.

Many physicists believe now that *11-dimensional M-theory* is the theory of everything. However, there is no widespread consensus on this issue and, at present, there is no candidate theory able to calculate the fine structure constant or the mass of the electron. Particle physicists expect that the outcome of the ongoing experiments – search for new particles at the large particle accelerators and search for dark matter – are needed to provide further input for a theory of everything.

In a recent theoretical work [28], edited as an e-book freely accessible on Internet, we suggest that Universe could be *a massive elastic 3D-lattice* with specific elastic properties, described using Euler's coordinates in an absolute reference frame, and that fundamental building blocks of Ordinary Matter could consist of *topological singularities of this lattice* (namely vacancy and interstitial edge dislocation loops, mixed dislocation loops and screw and edge disclination loops). We demonstrate that interactions of these singularities via the various generalized lattice deformation fields obey to a single formalism reflecting at the same time Maxwell's equations, special relativity, gravitation, and quantum physics. Moreover, considering an isotropic cubic lattice with axial symmetries, elementary and composed topological singularities can be found, which coincide with the known elementary particles of the standard model.

In this letter, only main steps and principal results of theory [28] are summarized as succinctly as possible.

## 1. Description of lattice deformation

In book [29], we show that Euler's coordinates are very powerful for describing solid lattices deformation. Using vectorial notations of the tensors allows a very detailed description of strong *distorsions* (deformations and rotations) and *contorsions* (torsions and flexions) of a lattice. Adding physical properties of the lattice (Newton's law, first and second principles of thermodynamics), this theory allows one to write the complete set of equations describing the lattice space-time behaviour, and to introduce lattice phenomenological properties, such as elasticity, anelasticity, plasticity, self-diffusion and structural transformations.

## 2. Description of lattice topological singularities

Description of lattice topological singularities, such as *dislocations*, *disclinations* and *dispirations*, was initiated by Volterra's idea of macroscopic defects in 1907 [30]. This domain has shown a quick development during twentieth century [31]. Lattice dislocation theory started in 1934 [32-35], and lattice dislocations were observed in metals using electron microscopes in 1956 [36-37]. Disclinations were observed in 1904 [38] and described in 1922 [39].

Generally, one uses differential geometries to describe the lattice topological singularities. This was initiated in the 1950's years [40-43], and formalized by Kröner in detail in 1960 [44]. But the use of differential geometries is very complicated, due to a mathematical formulation similar to that of general relativity [45], and also when one has to introduce lattice defects other than dislocations, as intrinsic or extrinsic point defects, or disclinations [46].

In book [29], we develop a novel approach to lattice topological singularities, based on a rigorous formulation of the concept of *"deformation charge"* in Euler's coordinates: *dislocation charges*, representing the lattice plastic distorsions (rotations and deformations), and *disclination charges*, representing the lattice plastic contorsions (torsions and flexions).

These charges appear as *strings* or *membranes* inside the 3D-lattice. They naturally satisfy Maxwell's equations, their energy satisfies the famous Einstein equation $E_0 = M_0 c^2$ and they present relativistic dynamics. On the other hand, the long range perturbations of the lattice by localized topological singularities can be completely resumed by two vectorial fields and one scalar field: *the vectorial local rotation field* $\vec{\omega}$, related to the electrical field, *the vectorial curvature field* $\vec{\chi}$ and *the scalar expansion field* $\tau$, related both to the gravitational field. It is not the first time that analogies between deformation theory and other physics theories are found [44-48], but none of these analogies were as fully exploited as in [29].

## 3. The cosmological lattice and its Newton's equation

In [28], we were able to find a particular 3D-lattice, called the *cosmological lattice*, containing loop topological singularities, with a chosen *elastic distorsion free energy,* expressed *per volume unit*

$$F^{def} = -K_0 \tau + K_1 \tau^2 + K_2 \sum_i (\vec{\alpha}_i^{el})^2 + 2K_3 (\vec{\omega}^{el})^2 \tag{1}$$

where $\tau$ is *the scalar volume expansion*, $\vec{\alpha}_i^{el}$ *the elastic shear strain tensor*, $\vec{\omega}^{el}$ *the elastic local rotation vector*, and $K_0, K_1, K_2, K_3$ are *the elastic modules*.

The lattice dynamics in Euler's coordinates is then obtained as *a localized Newton's equation*

$$nm \frac{d\vec{\phi}}{dt} = -2\left(K_2 + K_3\right) \overrightarrow{\mathrm{rot}}\, \vec{\omega}^{el} + \left(\frac{4}{3} K_2 + 2K_1\right) \overrightarrow{\mathrm{grad}}\, \tau + \overrightarrow{\mathrm{grad}}\, F^{def} + 2K_2 \vec{\lambda} \tag{2}$$

where $\vec{\phi}$ is *the lattice velocity*, $m$ *the inertial mass* of the lattice cell, $n = n_0 \, \mathrm{e}^{-\tau}$ *the density* of lattice cells, and $\vec{\lambda}$ is *the flexion charge density* due to the topological singularities inside the lattice.

Under the conjectures

$$K_3 = K_0 > 0 \quad ; \quad 0 < K_1 << K_0 \quad ; \quad 0 < K_2 << K_0 \tag{3}$$

Newton's equation (2) becomes the fundamental equation allowing one to unify electromagnetism, relativity, gravitation, and quantum physics.

In this cosmological lattice, only *circularly polarized transversal waves* can propagate, which is well consistent with light propagation by photons. When scalar expansion of the lattice is smaller than a critical value $\tau_{0cr}$, *longitudinal waves* disappear and are replaced by *local perturbations of expansion* $\tau$ corresponding to gravitational perturbations.

Transversal waves are non-dispersively curved by gradients of the scalar gravitational field $\tau$ generated by localized topological singularities, and can even disappear in *«black holes».*

Moreover, a finite lattice can also present cosmological expansion and/or contraction, with all the properties described by modern cosmology, as *Big-Bang*, *inflation*, *accelerated expansion,* and even *contraction* and *Big-Bounce*. Origin of *the «dark energy»* postulated to explain the observed accelerated expansion is here simply explained by the balance of elastic and kinetic energies stored in the lattice.

## 4. Maxwell's equations and special relativity

From rotational part of Newton's equation (2), all Maxwell's equations of electromagnetism are deduced, including the constitutive relations between electromagnetic fields and the electrical charges and currents. In the frame of these equations, "*magnetic monopoles"* do not exist, but new "*vectorial electrical charges"* could.

The elastic and kinetic energies stored inside the lattice by moving loop topological singularities can also be calculated, which allows to show that dynamics of these singularities satisfy precisely special relativity. For example, calculation of the electrical field energy of the electron (electron corresponds to an interstitial edge dislocation loop associated with a screw disclination loop) allows to simply explain the paradox of electron energy [49]. The cosmological lattice can be considered as *an «aether»* allowing to physically understand the dilatation of time, the contraction of length, the Michelson-Morley experiment, the Doppler-Fizeau effects, and the twin paradox of special relativity.

## 5. Gravitation, general relativity, cosmology and weak interaction

With Newton's equation (2), we also have access to the gravitational properties of the loop singularities, which seem more or less identical to gravitational properties described by Einstein's gravitation. For instance, time and lengths for a local observer situated inside the lattice and himself constituted from lattice topological singularities are affected by the local gravitational field $\tau$ in the same way as in general relativity. This leads to invariant Maxwell's equations for him, who then perceives the light speed as a perfect constant, while the light speed strongly varies with the local scalar expansion $\tau$ if measured by an imaginary external observer situated in the absolute space-time frame.

Some differences with *Schwarzschild metric* of general relativity only appear at very short distances of a localized topological singularity, leading for instance to different characteristics of black holes radii: the radii of photon and of Schwarzschild spheres become identical and equal to $R_{Schwarzschild} = 2GM / c^2$, when the radius where the falling observer's time seems to become infinite disappears (in fact it becomes equal to zero).

Moreover, the edge dislocation loops present *a curvature charge* responsible for a curvature of the lattice, which can be assimilated to *a small curvature gravitational mass*, positive or negative following the interstitial or vacancy nature of the loop (corresponding respectively to matter and antimatter), which adds to the inertial mass of the edge dislocation loops to form its total gravitational mass. This curvature charge concept is completely new, as it *does not appear* in general relativity, in quantum physics or in standard model of elementary particles. It leads to a surprising negative gravitational property *(antigravity)* of the interstitial edge dislocation loop (corresponding to *the electron neutrino*), when all the other topological loops present normal gravitational property, even the vacancy edge dislocation loop (corresponding to *the electron antineutrino*).

This curvature charge is also responsible for several unexplained properties in physics, such as *the small asymmetry existing between matter and antimatter* (based respectively on interstitial and vacancy edge dislocation loops), the disappearance of antimatter during the cosmological evolution of the universe and *the «dark matter»* which is necessary to explain the gravitational properties of galaxies (dark matter corresponds here to a sea of repulsive neutrinos in which galaxies are immerged).

Moreover, the curvature charge is responsible for a very short distance coupling interaction between an edge dislocation loop and a screw disclination loop, which matches very well *the weak interaction of standard model* of particle physics and its behaviors.

Finally, the gravitational behaviours of the different topological singularities allow one to propose a very satisfactory model for *the cosmological evolution of the matter and antimatter* inside the universe. For example, the galaxies formation can be attributed to *a precipitation phase transition*, when the disappearance of antimatter can be attributed to *a coalescing process* of the anti-matter inside the newly formed galaxies, leading to the formation of enormous antimatter black holes in the galaxies centres. In this frame, phenomena as *Hubble's expansion*, *galaxies redshift* and *cosmological background radiation cooling* also find very simple explanations.

## 6. Photons, quantum physics and particles spin

With a *quantification conjecture* $E = \hbar\omega$ *of the energy*, we show that circularly polarized transversal wave packets present all the properties of *photons* (zero mass, non-zero momentum, non-locality, wave-particle duality, entanglement and decoherence).

Moreover, with Newton's equation (2) we demonstrate that dynamical gravitational perturbations (lattice local expansion fluctuations) are always associated with moving topological singularities when $\tau < \tau_{0cr}$. The *Schrödinger equation* of quantum physics is then directly deduced from the Newton's equation, giving for the first time a simple physical meaning to the quantum wave function, as *the amplitude and the phase of local gravitational fluctuations* associated to moving singularities. This allows simple explanations of the probabilistic interpretation of wave function and of *Heisenberg's incertitude principle*.

Applying Newton's equation in the case of two coupled topological singularities, we also find simple physical explanations for *bosons*, *fermions*, and *Pauli's exclusion principle*.

Finally, we prove that a static solution for the expansion does not exist in the heart of a loop topological singularity, which implies to find a dynamical solution corresponding to a quantified rotation of the loop around one radius (in fact *a quantum spin of the loop*). The arguments of the pioneers of quantum physics assuming that the equatorial velocity of a charge rotation is too large by comparison with the light speed is here swept away by the fact that the local gravitational expansion at the vicinity of the loop heart is so high that light speed is much higher than equatorial velocity.

## 7. Standard model of elementary particles and strong interaction

All properties described above are independent of the exact microscopic structure of the 3D-lattice, granted that this one is isotropic and satisfies Newton's equation (2), and that its elastic modules obey relations (3).

However, assuming *a cubic lattice with axial properties*, resulting in special layout and rotation properties of lattice planes (imaginarily «colored» in red, green and blue), we can define loop topological singularities with properties similar to all the elementary particles, *leptons and quarks*, of the first family of standard model, as well as loops similar to *intermediate bosons*. Moreover, an interaction force acts between loops corresponding to the quarks, due to *a "colored" lattice-stacking fault*, presenting precisely the asymptotical behaviour of *the strong force of the standard model*. This force is also related to other two-colored loops presenting properties corresponding to those of *the gluons* of standard model.

In order to take into account the three families of particles of the standard model, we find that a more complicated structure of the edge dislocation loops, formed as doublets of edge disclination loops, could produce *two or three supplementary families of leptons and quarks*. In fact, the real structure of the lattice can still be discussed, which could open a promising field of research.

More hypothetical consequences can also be imagined in the frame of the cosmological lattice and its loop singularities *[28]*, such as the existence of *supersymmetric* topological loops, *exotic* leptons, stable macroscopic expansion fluctuations leading to *a multiverse theory*, and stable microscopic expansion fluctuations leading to new quasi-particles (*gravitons*).

## Conclusion

It is remarkable that the description, using Euler's coordinates in an absolute space-time frame, of *a massive elastic "colored" cubic 3D-lattice containing loop topological singularities* and having particular elastic properties allows one to find all observed natural phenomena.

In fact, the theory described in [28] and summarized here is not yet completed, as there remain several questions without answers, as for example the exact nature of the «colored» 3D-lattice and its relation with the Higgs field postulated in standard model, the detailed rotation mechanisms of the topological loops and the reason for spin values of 1/2 or 1, and still several other unsolved problems detailed in [28].

However, it appears that this theory is the first and only *(i)* to combine all known physics in a very simple manner, unifying electromagnetism, relativity, gravitation and quantum physics, *(ii)* to give a simple meaning to the local space-time and the quantum behavior of topological singularities, *(iii)* to propose the existence of a new scalar curvature charge leading to an explanation for the asymmetry observed between matter and anti-matter and its consequences, and *(iv)* to propose simple explanations to well-known problems of modern cosmology and of standard model of elementary particles.

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