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Article

Geometric Reinterpretation of FLRW Cosmology: A Crystallographic Holography and Absorptive Framework Independent of Temporal Dynamics

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Abstract

This work introduces a novel conceptual framework that integrates crystallographic visualization techniques with cosmological geometry. Specifically, we reinterpret the crystallo-graphic holography of three-dimensional crystal structures onto a two-dimensional plane within the three-dimensional spatial sector of the Friedmann–Lemaître–Robertson–Walker (FLRW) metric, formulated following the Landau–Lifshitz approach. Within this framework, the surface of a four-dimensional hypermanifold (a 4D sphere) is conceptually interpreted as exhibiting topological features analogous to the "inside–outside" structure of a Klein bottle. This geometrical perspective provides a foundation for analyzing the mass–energy budget of the Universe as determined by the Planck's mission. We examine the present mass–energy composition—including the relative contributions of visible matter (baryonic), and dark energy identified with the zero-point field (ZPF)—within a differential geometric setting. These components are ultimately represented through a crystallographic holography–based formulation of the Planck observational mass–energy budget.

Keywords: differential geometry; cosmology; Planck's mission; crystallographic holography; friedmann–lemaître–robertson–walker metric

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1. Introduction

Foundational research in cosmology and gravity has increasingly exposed the conceptual limits of standard spacetime models and their role in early-universe physics. George F. R. Ellis has highlighted the geometric assumptions and interpretive constraints of FLRW cosmology (Ellis, 2014), motivating alternative formulations of gravity such as the geometric and topological approaches developed by Kirill Krasnov, which shift emphasis from metric variables to connections (Krasnov, 2011). In parallel, Carlo Rovelli has advanced relational and time-independent formulations of physics that challenge the notion of fundamental time (Rovelli, 2004; 2018). These conceptual developments are closely connected to the physics of early-universe phase transitions (Guth et al., 1980; Witten, 1984), which are tied to symmetry breaking at high energies and may have generated topological defects such as monopoles, cosmic strings, or domain walls (Kibble, 1980). Although such transitions occurred when the universe was opaque to light, their consequences—ranging from relic particles to primordial gravitational waves—may still leave observable imprints on the present universe. **About the author:** Former docent at the Faculty of Economics, Tallinn Technical University, Estonia; Independent researcher. Docent is an Eastern European academic title equivalent to Associate Professor in the USA. Residence: Nygårdsvej, 10, 2s., Nr.13, 2100 Østerbro, Copenhagen, Denmark, E-Mail: mjoosep@gmail.com.

Recent findings from the James Webb Space Telescope are prompting a major reassessment of cosmic evelution. The predictions of the Big Bang model, once thought to provide a comprehensive framework for cosmic evolution, are now in question. Observations from James Webb have revealed

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inconsistencies that reconsider the fundamental assumptions of Lambda-CDM, particularly regarding galaxy formation, structure, and the nature of dark matter and dark energy. These groundbreaking discoveries necessitate a paradigm shift in cosmology, prompting the search for new models that better align with empirical data.

The construction of the Standard Model as a whole was long consided to be complete, yet recent findings challenge its sufficiency in describing fundamental physics. Experimenters continue searching for phenomena that would contradict the Standard Model, while theorists propose extensions in hopes of uncovering new physics, no definitive results have emerged—until now.

The latest discoveries from the James Webb Space Telescope suggest that our fundamental understanding of the universe, including the Standard Model's connection to cosmology, may be flawed. Observations have unveiled anomalies that cannot be explained within existing frameworks, casting doubt on long-held assumptions. The long-standing attempts to unify quantum mechanics and cosmic evolution into a "theory of everything" have yielded no promising results, and now even the foundational Lambda-CDM model and Big Bang predictions are being questioned. Without a clear theoretical direction, physicists are waiting for new experimental guidance, yet Webb's findings indicate that the expected "New Physics" might not be an extension of current models but rather a fundamental revision of our understanding of space, time, and the evolution of the universe. Cosmology, once a science of precision and vast datasets, now finds itself at a crossroads, requiring a radical rethinking of its core principles.

Amid these paradigm-shifting revelations from Webb, it is worth considering how earlier missions, such as the Planck Collaboration, can contribute to amendments in our cosmological models and offer a new perspective on the interpretation of past precision measurements.

The Planck Collaboration has already taken the detailed space-time structure into account. The European Planck satellite, launched in May 2009, completed its scheduled sky survey by November 2010. The mission continued until the liquid helium cooling the detectors was exhausted, with Helium-3 cooling for the high-frequency receiver running out in January 2012, and Helium-4 cooling for the low-frequency instrument following soon after. The instrument outperformed the American WMAP, launched in 2001, with better angular resolution, higher sensitivity, and a wider frequency range. Naturally, researchers eagerly awaited the announcement of Planck's cosmological results. Some astrophysical findings had already been published, revealing fascinating discoveries such as giant barriers of hot gas connecting galaxy clusters. A major cosmological data release was scheduled for 2013.

One of the most striking results concerns the cosmic recipe of the universe. Ordinary matter—protons, atomic nuclei, and electrons—accounts for only **5%** of the total space in the current universe. In addition to ordinary matter, the universe also contains relic neutrinos—about 300 neutrinos of all types per cubic centimeter. Their contribution to the total energy (mass) of the universe is small, given their low masses, and certainly does not exceed **3%**. However, the remaining **95%** of the universe's energy and matter has long been a mystery.

To introduce a scenario that emphasizes the geometric relationships among cosmological objects—relationships inferred from observational phenomena commonly attributed to dark matter—we adopt a revised terminology aimed at improving clarity and accessibility for a broader audience. In this context, what is traditionally referred to as dark matter is occasionally described as dark or hidden matter, a choice intended to ease comprehension without altering the underlying physical meaning. Likewise, dark energy is presented as a background energy field, or zero-point-field (ZPF), particularly when discussing the mathematical framework of our static-space scenario as formulated within the LL/FLRW metric. These terminological and conceptual adjustments are designed to support a more intuitive understanding of the Universe's composition while facilitating discussion of its evolution and large-scale structure.

The reader may initially perceive the following discussion as a straightforward exploration of well-known concepts. However, the novel approach of linking two existing categories through the crystallographic mapping of a four-dimensional hyper manifold onto a three-dimensional surface

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has, to my knowledge, never been explored by any researcher. Moreover, no prior studies have interpreted **Figure 1** using crystallographic holography terminology.

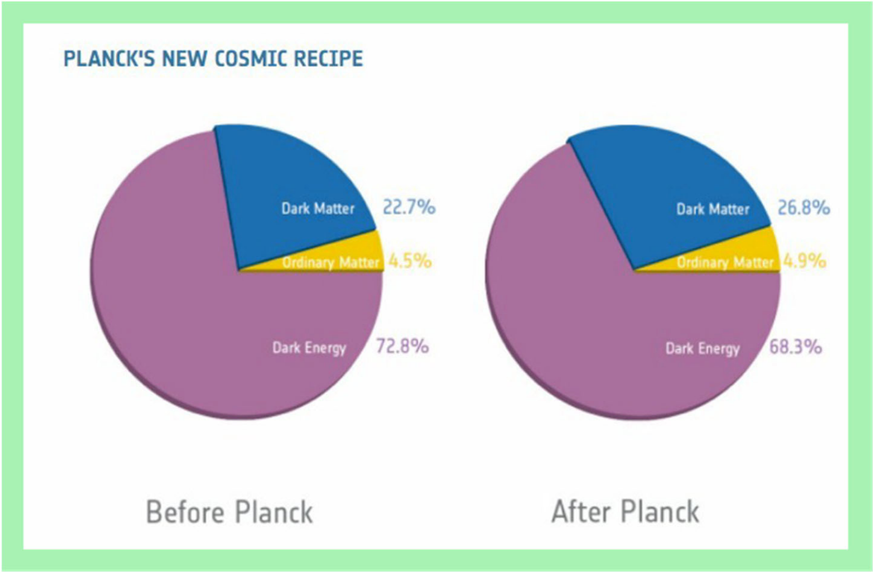

Figure 1. https://sci.esa.int/web/planck/-/51557-planck-new-cosmic-recipe.

The concept illustrated in **Figure 1** is far more profound than it may seem. Our analysis leads to the prediction that the universe has already completed the full cycle of development, following a specific framework derived from **Le Sage's Theory** (18th century) in terms of the graviton background energy field (Danilatos, 2020, invokes and reexamins Le Sage–type pushing gravity and graviton absorption coefficient k extremely carefully.)

Regarding the Figure 1, we read: "*Planck's high-precision cosmic microwave background map has allowed scientists to extract the most refined values yet of the Universe's ingredients. Normal matter that makes up stars and galaxies contributes just* ***4.9%*** *of the Universe's mass/energy inventory. Dark or hidden matter (quantum, ed.), which is detected indirectly by its graviton influence on nearby matter, occupies* ***26.8%****, while dark energy, a mysterious force thought to be responsible for accelerating the space capture of the Universe, accounts for* ***68.3%***", accessed online 26/07/2022.

If we consider perspectives—such as the alternative geometric interpretation of Big Bang model and the questionable predictions of the SM regarding the inflationary phase—the Le Sage's coefficient κ during the so-called primary inflation, as determined by the LL/FLRW metric framework developed here, the k must be estimated to be around $\infty \approx 10^{110}$. However, contemporary insights and empirical data, particularly the Planck cosmic recipe, indicate that the present-day background energy absorption coefficient κ' is approximately 0.12457 (cf. Mullat, 2022).

As the universe continues expanding at a constant acceleration, our speculative model suggests that it will eventually reach a state of thermal and dynamic exhaustion—its ultimate "death"—once the energy density of the hypothetical ether (interpreted here as dark energy or the background gravitational field) falls to a critical threshold of $\kappa^* \approx 0.087626$. At that point, the baryonic matter of the universe will remain intact but will be shrouded in darkness (with all visible light sources having vanished), occupying one-third of the total volume of the three-dimensional manifold S^3. The remaining two-thirds of the space will be filled by traditionally identified as dark or hidden (surrounding matter). Meanwhile, the background energy field (ZPF) as mentioned earlier, will be completely depleted. As a consequence, Le Sage's pushing gravity forces should also disappear.

1.1. Roadmap

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The structure of the paper is organized as follows.

Section 1 introduces the conceptual motivation for the work and situates it within current tensions in cosmology, particularly those arising from Planck mission results and recent James Webb Space Telescope observations. The section emphasizes the need for alternative geometric interpretations of cosmological data that do not rely fundamentally on temporal dynamics.

SubSection 1.7 develops the geometric **interpretation of dark matter** using the Klein bottle analogy. This discussion explains the apparent invisibility of dark matter as a consequence of topological separation within a higher-dimensional embedding space, rather than as a failure of particle detection. The Klein bottle is employed strictly as a geometric visualization tool to illustrate "inside–outside" duality in crystallographic coordinates.

Section 2 (Preliminaries) establishes the methodological and conceptual foundations of the analysis. Occam's Razor is adopted as a guiding principle, motivating the deliberate elimination of explicit time dependence. Background material from crystallography, differential geometry, and the Friedmann–Lemaître–Robertson–Walker (FLRW) spatial-slice formalism in the Landau–Lifshitz framework is reviewed.

Section 3 introduces crystallographic holography in its simplest setting by mapping the two-dimensional spherical surface S^2 onto the Euclidean plane $\mathcal{E}^2$. This section serves as a pedagogical preparation for the higher-dimensional constructions that follow.

Section 4 generalizes the crystallographic holography to a four-dimensional hyper-manifold $\mathcal{R}^4$, mapping its three-dimensional surface S^3 onto Euclidean space $\mathcal{E}^3$. The crystallographic Landau–Lifshitz (LL/FLRW) spatial metric is derived explicitly, and cosmological volumes are computed in holography coordinates. This section provides the geometric basis for interpreting the Planck cosmic mass–energy budget.

Section 5 applies the crystallographic LL/FLRW framework to the observed composition of the Universe. By redefining velocity and acceleration in purely geometric terms—expressed as percentage change per megaparsec rather than as time derivatives—the Planck 2013 cosmic recipe emerges as a consistency condition of the model. The agreement with observational data is emphasized as a validation of the geometric framework rather than as a prediction.

Section 6 (Concluding Remarks) summarizes the main results and highlights the model-dependence of cosmological mass–energy budgets. It argues that the crystallographic LL/FLRW approach, combined with monotonic systems theory, provides a flexible alternative to standard ΛCDM interpretations and is potentially better aligned with recent JWST observations.

Section 7 is devoted to the **reinterpretation of the Hubble constant** within the crystallographic LL/FLRW framework. Here, the Hubble parameter is treated not as a fundamental time-based constant but as an emergent, geometry-dependent quantity derived from percentage-based expansion rates in holography space. This section explores the implications of a non-monotonic Hubble profile and discusses how accelerated and decelerated expansion phases arise naturally without invoking conventional temporal dynamics.

Section 8 provides a **philosophical and pedagogical synthesis**, aimed at a broader audience. It offers an intuitive explanation of dark-energy dynamics and zero-point-field depletion within the κ-scaled absorption framework, emphasizing conceptual simplicity over technical formalism. This section situates the model within a minimalist scientific philosophy, clarifies its epistemological assumptions, and explains how dark energy evolution can be understood without invoking additional physical entities or high-rank tensor structures.

Taken together, Sections 2–6 demonstrate that the Universe's observed mass–energy budget, can be coherently interpreted as consequences of crystallographic geometry applied to FLRW spatial slices—without reliance on fundamental time or supplementary dynamical postulates.

1.2. Redefining Gravitational Potential Energy

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• The Newtonian stellar background field vortex velocity formula was used as a scalar indicator of gravitational potential energy. The model suggested that a zero-point-field (ZPF) underwent a phase transition into baryonic matter and dark (or hidden) matter when a critical energy threshold (Λ) was reached.

1. 3 Mathematical Formulation of Universe Genesis

• The critical transition occurred when the gravitational potential energy at the initial slice, charecterized by the radius $\rho_0^0 \approx 0$ give rise to the Universe's centrum and satisfied the condition $-\mu_\kappa \cdot \frac{M_0}{\rho_0^0} \leq -\Lambda$, where μ_κ is a gravitational constant inspired by Danilatos (2020), and Λ denotes the zero-point field ZPF phase transition threshold accociated with formation of matter M_0. This formulation, which is initially singular at $\rho_0^0 \approx 0$, can be rewritten as $-\mu_\kappa \cdot M_0 + \Lambda \cdot \rho_0^0 \leq 0$, removing the singularity. This reformulation led to an interpretation of universe formation—or creation events—as the sequential layering process. In this picture FLRW three-dimensional (3D) spatial slices or volumes ("bubbles"), charcterized by radii $0 \approx \rho_0^0 < \rho_0^1 < \rho_1^1 < \rho_1^2 < \ldots < \rho_i^j < \rho_i^{j+1} < \ldots$ with corresponding three-sphere volumes $0 \approx V.S_0^3 < V.S_1^3 < \ldots V.S_i^3 < \ldots$ are succesfully generated and embedded within the ZPF. These discrete layers collectively describe the dynamical genesis of the Universe.

1. 4 Proposed Formulation

•Within the framework of *Pushing Gravity*, and by analogy with the Beer–Lambert law of absorption, we introduce an absorption parameter κ. The addmissible absorbtions κ lie within an interval approximately given by $(\infty \approx \kappa_0 > \ldots \kappa' = 0.12457 > \ldots \kappa^* \approx 0.087626]$. The calibration parameters λ and Λ define the governing $\Gamma(\rho, \kappa) = -\kappa \cdot V.S^3(\rho) + \Lambda \cdot \rho^\lambda \leq 0$ limitation, which we refer to concisely as the Γ - condition ('<') or equation ('='). In this context $V.S^3(\rho)$ denotes the volume of the three-sphere S^3 with radius ρ. The Γ-condition highlights a decrete sequence of $\Gamma(\rho_i^j, \kappa_i) < 0$, ${}^{0}_{0}, {}^{1}_{0}, {}^{2}_{0}, \ldots {}^{j}_{i}, {}^{j+1}_{i}$ …, which can be interrpreted as a cosmological genesys process driven by successive absorbtions κ_i of the Universe's zero-point-field (ZPF) energy. Sequence κ_i converges such that $\lim_{j \to \infty} \Gamma(\rho_i^j, \kappa_i) \to \Gamma(\rho_i, \kappa_i) = 0$ indicating an asymptotic stabilization of reaching the Γ-equation status.

1.5. Consistency with Current Composition of the Universe

• The model was calibrated using Planck Mission cosmic recipe data, yielding $(\kappa = 0.12457,\ \lambda = 0.83751,\ \Lambda = 0.91499)$.

•These values are consistent with the Planck's new recipe (budget) composition:

4.9% baryonic (visible) matter,

26.8% dark or hidden matter (lynguistic shift of terminilogy),

68.3% background energy field (**ZPF**) for $\kappa' = 0.12457$.

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• There do not exists net positive (only for complex) solutions of Γ-equation for $\kappa < \kappa^* = 0.087626$. The κ^* is called the *"death or terminal phase"* of the Universe.

1.6. Implications for Cosmology

• The paper outlined a Hubble-independent approach (Mullat, 2022) to measuring cosmological distances, arguing that the Hubble constant may evolve over time rather than remain truly constant.

1.7. The Dark Matter, the Klein Bottle, and the Geometry of Space

The persistent failure to directly detect dark matter may be understood through a geometric analogy. Consider two observers walking on the surface of a transparent, glass-made Klein bottle embedded in a four-dimensional super manifold $\mathcal{R}^4$. One of them, for simplicity "**DM**", is "inside" the bottle, while the other "**VM**" is "outside." Although they can see each other, they have no interaction opportunities. Only by embedding the bottle in $\mathcal{R}^4$ do such interaction opportunities arise. Until then, the separation persists—not in ordinary distance, but in topology, cf. Galloway, et al., 2022, Opoku, 2026.

A similar situation arises when describing the observable universe from the perspective of an observer located at the origin, $\rho = 0$. The spatial domain accessible to observation can be divided into two regions, $0 \le \rho < 1$ and $1 \le \rho < \infty$, which appear disconnected despite being related through a Klein bottle coordinate mapping. Such a mapping in line with crystallographic holography is defined by $r(\rho) = \dfrac{2\cdot\rho}{1+\rho^2}$, under which the coordinate r increases from $r = 0$ to $r = 1$ as ρ runs from 0 to 1, and then decreases from $r = 1$ back toward $r = 0$ as ρ extends from 1 to infinity. As a consequence, two observers located at widely separated positions ρ' and ρ'', with $\rho' << \rho''$, may nevertheless share the same crystallographic coordinate, satisfying $r(\rho') = r(\rho'')$. Despite this apparent coincidence, they remain deprived of interaction opportunities, much like two individuals on the bottle—one inside and one outside—for whom the condition $r' = r''$ does not guarantee interaction. Although no interaction opportunities exist within three-dimensional space $\mathcal{E}^3$, interaction becomes possible through higher-dimensional embedding. Indeed, when the bottle is embedded in $\mathcal{R}^4$, the additional dimension allows the "neck" of the bottle to pass through itself without self-intersection.

By analogy, observers in our universe cannot access dark matter through any known local interaction channels within $\mathcal{E}^3$, yet they can infer its existence through gravitational effects arising in a four-dimensional space $\mathcal{R}^4$. In this framework, the additional coordinate may be represented as a line connecting the poles of a four-sphere, from the North Pole $N = (0,0,0,+1)$ to the South Pole $S = (0,0,0,-1)$. Dark matter, while hidden along this fourth coordinate, nevertheless curves spacetime and influences the motion of visible/baryonic matter.

Thus, the absence of direct detection of (DM) dark matter need not be interpreted as evidence of its nonexistence, but rather as a manifestation of the geometric and topological structure of the universe. In this framework, visible (baryonic or VM) matter is confined to the "outside" of the bottle, fully embedded within the familiar three-dimensional spatial manifold accessible to electromagnetic and nuclear interactions. Dark matter, by contrast, occupies a topologically distinct region—effectively "inside" the bottle— that is globally connected yet locally inaccessible to observers confined to 3D Euclidian space ($\mathcal{E}^3$).

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An instructive analogy is provided by observers moving on different regions of the bottle. Although the "inside" and "outside" are part of a single, continuous global geometry, observers constrained to one region cannot directly interact with those on the other through local, non-gravitational means. No exchange of light or particles is possible; nevertheless, gravitational influence transcends this topological separation, allowing matter residing outside the observers' immediate dimensional domain to imprint itself dynamically.

In this sense, dark matter is not merely an undetected physical substance but a geometric consequence of spatial topology and dimensional confinement. Its apparent invisibility arises not from exotic particle properties alone, but from the fundamental limits imposed by the topology of space and the observational horizon of 3-dimensional physics.

2. Preliminaries

We will work based on Occam's Razor—a principle with roots tracing back to Aristotle. It is a foundational methodological guideline of parsimony, which advises: "*Do not multiply entities beyond necessity" or "Do not introduce new entities unless absolutely required*." This heuristic serves as a guiding framework in both philosophy and science, favoring simplicity over complexity in the construction of theoretical models. Although not a strict rule, Occam's Razor promotes the elimination of superfluous assumptions and discourages unnecessarily elaborate constructs unless there is compelling evidence for their inclusion. (Accessed online, 05.04.2025, https://www.britannica.com/topic/Occams-razor)

We reaffirmed our commitment to this principle by treating time as irrelevant in the scenario that follows, while simultaneously describing a sequence of %-expanding configurations of Universe and introducing a κ-scale—a form of parametric temperature, whether one chooses to call it that or not, analogous to a time scale.

To us, reality appears as a multitude of faces, each reflecting distinct speculations—speculations that can be true and false at the same time. Our model, as presented, does not lack falsifiability or physical foundations. On the contrary, we provide derivations that are directly connected to observable phenomena. The model's predictive power lies in its unconventional approach to temporal dynamics: rather than relying on the conventional time parameter, it derives the energy absorption coefficient as the key to scaling the Universe's composition. All of these "allegied predictions" are framed within the holography of FLRW spatial slice geometry.

In our context, this principle informs a deliberate attempt to reduce theoretical overhead. Specifically, we are choosing to abandon the use of high-rank tensors, explicit time coordinates, and external physical laws such as gravity, which, while potentially relevant in certain broader frameworks, are not strictly necessary for the conceptual scope of our analysis. Instead, we focus exclusively on the standard quadratic forms of differential geometry, which provide a rich but parsimonious mathematical language to describe curvature, structure, and spatial relationships within our system. These quadratic forms—often manifesting as metrics on smooth manifolds—allow us to capture essential geometric and topological features without resorting to the full machinery of more complex physical theories.

By adhering to this minimalist approach, we aim to clarify the intrinsic geometric structure of the problem at hand, stripping away potentially obfuscating layers and emphasizing only those mathematical tools that are essential for a precise and elegant description. This aligns with the deeper scientific tradition of seeking conceptual economy—a hallmark of theories that not only describe reality effectively but do so with elegance and explanatory power.

2. 1. Crystallography

In crystallography, various holographys are used to create spatial images of crystals under study, allowing for detailed visualization of their symmetry elements, lattice orientation, and limiting faces. These holographys are fundamental tools for interpreting the geometric and symmetrical properties of crystalline structures. One of the most commonly used methods is the gnomo-

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stereographic holography, which combines aspects of both gnomonic and crystallographic techniques.

The gnomon is a scientific instrument historically used to measure the position of the sun by casting a shadow on a horizontal plane. This principle is adapted in stereography to represent directions and orientations in three-dimensional space. In constructing a crystal holography, the crystal is conceptually placed at the center of a spherical surface. Its faces and edges are extended outward until they intersect with this imaginary sphere. In a crystallographic holography, these intersections are then golographed onto a two-dimensional plane, typically along lines extending from a point on the sphere (often the North Pole) to a holography plane tangent to the South Pole. In this method, the faces of the crystal appear as circular arcs, and the edges appear as points, capturing angular relationships and symmetries accurately without significant distortion.

However, for a more intuitive and visual understanding of the crystal's geometry and symmetry relationships, crystallographers often use gnomo-stereographic holography. This method differs in that it projects the normals (perpendiculars) to the crystal faces, rather than the faces themselves. Consequently, the orientations of these face normals are mapped onto the surface of the sphere and then golographed onto a plane. In this approach, the faces are represented as points, corresponding to their orientation, while edges become arcs that connect these points, representing angular relationships between adjacent faces. This form of holography is particularly useful for analyzing the angular symmetry, pole figures, and the distribution of crystallographic directions in space.

Crystallography, at its core, is the study of the atomic arrangement within crystals and the symmetrical patterns they form. These holographys serve as essential visualization tools in this science, enabling crystallographers to interpret complex three-dimensional structures and their symmetries in a two-dimensional format, facilitating analysis, classification, and prediction of crystal behavior and properties.

2.2. *Friedmann–Lemaître–Robertson–Walker Spatial Slice Metric: A Universe in Symmetry*

In the grand narrative of modern cosmology, there exists a powerful idea—simple in symmetry, profound in implication—that describes the very shape and fate of the universe. This idea is encoded in a geometric construct known as the FLRW metric, a mathematical expression that captures the large-distance structure of space and time.

The story begins in the early 20th century, as physicists and mathematicians grappled with the implications of Einstein's general theory of relativity. Einstein had revolutionized our understanding of gravity, recasting it not as a force but as a curvature of spacetime itself. But while his equations were majestic, they were also immensely complex. To extract cosmic-distance predictions, simplifications were needed—assumptions about the universe as a whole.

Enter Alexander Friedmann, a Russian physicist and mathematician. In 1922, Friedmann took Einstein's equations and boldly applied them to an idealized universe—one that is homogeneous (the same in every location) and isotropic (the same in every direction). These assumptions, radical in their elegance, allowed him to derive solutions that described not a static cosmos, as Einstein had hoped, but a dynamic one—expanding or contracting, driven by its own matter and energy content.

Shortly after, Georges Lemaître, a Belgian priest and physicist, independently arrived at a similar solution. He proposed what would later be called the "primeval atom" or the "Big Bang" theory. Lemaître wasn't just echoing Friedmann's math—he went further, connecting the expanding universe to astronomical observations, such as the redshift of galaxies. This wasn't just a speculative model; it was a model grounded in the observable cosmos.

Years later, in the United States and the United Kingdom, Howard P. Robertson and Arthur Geoffrey Walker formalized and extended this framework, expressing the metric in a form that could accommodate different possible curvatures of space: positive, negative, or flat. Their collective work led to the formulation of what we now call the FLRW metric—a mathematical description of a path-connected universe that, while continuous and traversable, is not necessarily simply connected, meaning it might possess topological quirks such as holes or loops.

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At its heart, the FLRW metric assumes that the universe, on the largest distances, can be treated as smooth and symmetric. With these geometric assumptions, the metric reduces Einstein's field equations to a more manageable form, resulting in the Friedmann equations—differential equations that describe how the distance factor of the universe evolves over time.

These equations are the backbone of the conceptual framework of Cosmology, often called the Lambda-CDM model (where Lambda represents dark energy and CDM stands for cold dark matter). While this model has successfully explained a wide array of cosmological observations—such as the cosmic microwave background, the formation of large-distance structures, and the accelerating expansion of the universe—recent discoveries from the James Webb Space Telescope have led some astronomers to question its completeness or validity.

Today, the FLRW metric is more than a mathematical convenience—it is a gateway to understanding our universe's past, present, and future. It connects theoretical physics to observational astronomy, and the insights of four scientists from diverse backgrounds and nations now stand together at the foundation of cosmological science.

Whether referred to as Friedmann, FRW, FL, or FLRW, the metric is a testament to the power of symmetry, geometry, and international collaboration in unraveling the deepest mysteries of the cosmos. It teaches us that even the most abstract equations can reveal truths about the stars, galaxies, and the very nature of space and time itself.

2.3. *Synthesis of Crystallography and FLRW Spatial Slice*

First, we describe the observational limitations and the inferred large-distance homogeneity and isotropy of the Universe. The finite speed of light imposes an observational horizon, such that we perceive distant cosmic structures not as they are now, but as they were when their light first began traveling toward us. Despite this, the large-distance structure of the observable Universe, as supported by cosmic microwave background measurements and galaxy surveys, appears statistically homogeneous (uniform across space) and isotropic (uniform in all directions). These empirical findings align with the Copernican Principle, which asserts that no spatial location in the Universe is privileged—a conceptual extension of Copernicus's original insight that the Earth does not occupy a central, special position.

This foundational principle provides the logical basis for modeling the Universe with the Friedmann–Lemaître–Robertson–Walker (FLRW) metric, a solution to Einstein's field equations under the assumption of large-distance symmetry. Among the clearest formulations of this approach is found in "The Classical Theory of Fields" by Landau and Lifshitz, 3rd Revised English Edition, 1971, particularly Chapter 12, paragraph 107, expression 107.7. There, a closed, isotropic model is presented, in which the Universe possesses constant positive curvature—a geometric framework that directly yields the FLRW metric in its closed-form expression.

What we propose here is a novel synthesis: the FLRW metric, interpreted through the lens of Landau and Lifshitz's field theory, can be understood as a crystallographic holography of cosmological geometry, much like the crystallographic and gnomo-stereographic methods used in crystallography to represent complex three-dimensional forms on a two-dimensional surface. In crystallography, these holographys are employed to encode the symmetrical properties and orientations of crystal structures in an idealized, often spherical space. Analogously, the FLRW metric can be viewed as a mapping of the Universe's large-distance structure, golographed from a higher-dimensional manifold governed by its curvature and symmetry properties onto a coordinate framework suitable for cosmological analysis.

Just as crystallographic holographys reveal the symmetry operations and spatial constraints inherent in crystal lattices, the FLRW metric—particularly in its closed form—captures the curvature-induced topology and symmetry constraints of the Universe as a manifold. The Landau–Lifshitz formulation, built within the rigorous language of differential geometry and classical field theory, provides the mathematical apparatus for interpreting the metric tensor as a field over a curved

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spacetime manifold, akin to how crystallographers interpret the lattice vectors and face normals as golographed features on a spherical representation.

Thus, in this interpretation, the Copernican homogeneity and isotropy correspond to the space-group symmetries in stereography; the FLRW geometry corresponds to the unit cell or Bravais Lattice in momentum space; and the Landau–Lifshitz cosmological metric acts as the mapping function—a field-theoretic, differential-geometric analog to the gnomonic holographys of crystallography. The FLRW manifold is, therefore, not just a mathematical abstraction but a cosmic lattice, golographed into observable coordinates through the symmetry conditions dictated by general relativity.

In this framework, cosmology borrows tools from the geometry of matter, transforming the Universe itself into a macro-crystal of spacetime—a coherent, self-similar structure that obeys symmetry principles at all observable distances. The connection between crystallographic methods and relativistic cosmology, when interpreted through Landau and Lifshitz's field-theoretic formulation, opens the door to new analogies and mathematical tools for understanding the geometry of the Universe—not merely as a solution space to Einstein's equations, but as a structured holography, shaped by symmetry, topology, and the fields that bind them.

Landau and Lifshitz incorporate these principles into their cosmological framework. They assume that, at a sufficiently large distance, the Universe obeys these symmetries, naturally leading to a spatial metric expressed in terms of a radial coordinate r that measures distances on a three-dimensional sphere S^3:

$$dl^3 = \left(1 - \frac{r^2}{a^2}\right)^{-1} \cdot dr^2 + r^2 \cdot \left[\sin^2(\theta) \cdot d\varphi^2 + d\theta^2\right] \qquad (1)$$

This metric explicitly reflects the assumed homogeneity and isotropy, ensuring that all points and directions in space are equivalent. It provides a geometric foundation for modeling a closed universe, consistent with the fundamental assumptions of cosmology.

The metric depends on the curvature radius a, where the r can vary from 0 to a, and where φ and θ are in the intervals $[0 \le \varphi \le 2\pi]$ and $[0 \le \theta \le \pi]$. It turns out that the quadratic metric (1) can be considered as a crystallographic holography of the surface $\mathcal{S}^3$ of the four-dimensional hyper-manifold $\mathcal{R}^4$ onto the flat Euclidean space $\mathcal{E}^3$. Indeed, the substitution $r = \dfrac{r_1}{1 + \dfrac{r_1^2}{4 \cdot a}}$ for $0 \le r_1 \le a$ lead to

$$dl^3 = \left(1 + \frac{r_1^2}{4 \cdot a^2}\right)^{-2} \cdot \left(dr_1^2 + r_1^2 \cdot d\theta^2 + r_1^2 \cdot \sin^2\theta \cdot d\varphi^2\right) . \qquad (2)$$

According to LL's intention, at every point of a 3-dimensional manifold $\mathcal{S}^3$ it would locally be Euclidean but curved for far away distances.

By making the substitution $r_1 = 2 \cdot a \cdot \rho$ the LL/FLRW spatial metric in equation (2) can be transformed into the crystallographic metric:

$$dl^3 = \frac{4}{\left(1 + \rho^2\right)^2} \left[d\rho^2 + \rho^2\left(\sin^2(\theta) d\varphi^2 + d\theta^2\right)\right] \text{ for } a = 1 . \qquad (3)$$

The reader can verify this by substituting $r = \dfrac{2 \cdot \rho}{1 + \rho^2}$ into equation (1), which leads directly to metric (3) matching its derivation in Section 4, and corresponds to metric (4). This demonstrates that

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the LL/FLRW metric represents a crystallographic holography of the 4D hyper-manifold $\mathcal{R}^4$ onto the Euclidean 3D space $\mathcal{E}^3$. For heuristic purposes, the Klein bottle's non-orientable topology may be recalled here in terms of "inside" and "outside" regions represented as two overlapping domains within the crystallographic interval $[0 \le \rho = 1 < \infty)$. These domains can be visualized as interpenetrating regions distributed along the boundary $\rho = 1$, overlapping at all points $(\mathcal{E}_x, \mathcal{E}_y, \mathcal{E}_z)$ equidistant from the common center $(0,0,0)$. Each region is associated with an effective volume of π^2, emphasizing the topological equivalence of the domains and the lack of a globally well-defined interior–exterior distinction.

3. Crystallographic Holography of Two-Dimensional Surface

We will proceed with a very short illustration of what is well known as crystallo-graphic holography. Let the $\mathcal{S}^2$ manifold geometry correspond to $x^2 + y^2 + z^2 = 1$ of curvature radius 1. The North Pole corresponds to the point $N = (0, 0, +1)$, and the South Pole is denoted by $S = (0, 0, -1)$. Conceive Euclidian plain $\mathcal{E}^2$ intersecting the origin $O = (0, 0, 0)$ perpendicular to the z-axis. We can project a line from N through $(x, y, z) \in \mathcal{S}^2$, which will intersect the plain at a distance ρ from the origin O. Using $\mathcal{S}^2$ geometry it can be verified that $d^2 + z^2 = 1$ what yields $d^2 = (1 - z)(1 + z)$.

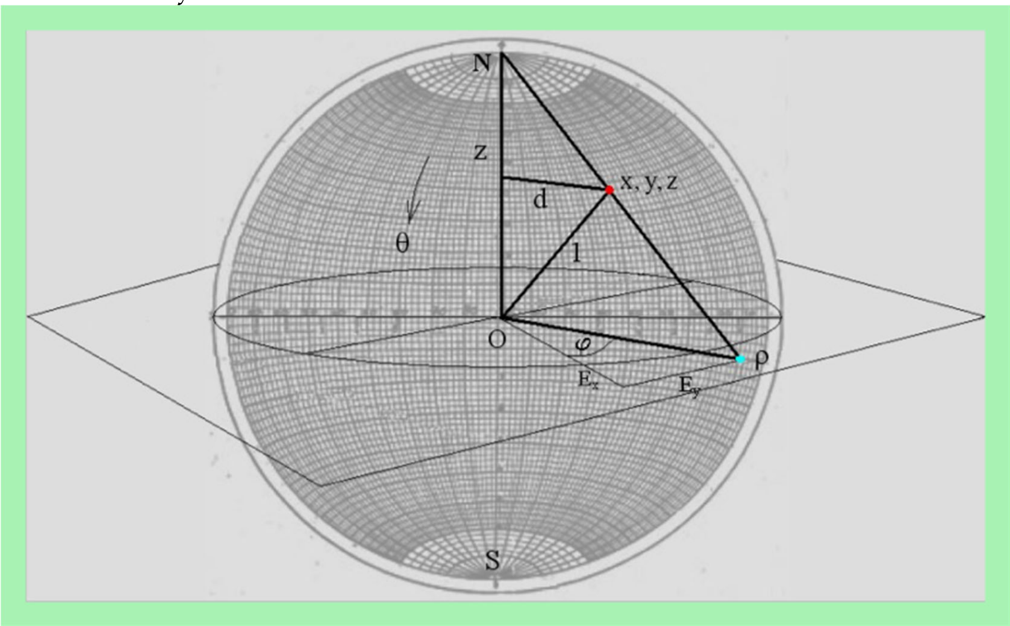

Figure 2. Surface $\mathcal{S}^2$ of the manifold $\mathcal{R}^3$ crystallographic holography at Euclidian Plane $\mathcal{E}^2$.

Now convert $\frac{d}{\rho} = \frac{1 - z}{1}$ into $d^2 = \rho^2 (1 - z)^2$. For latter d^2's these d^2 yield $z = \frac{-1 + \rho^2}{1 + \rho^2}$, $d = \frac{2 \cdot \rho}{1 + \rho^2}$ what match up a 3-fold crystallographic holography, given by mapping $\left(\frac{2\cdot\rho}{1+\rho^2}\times\cos(\varphi);\frac{2\cdot\rho}{1+\rho^2}\times\sin(\varphi);\frac{-1+\rho^2}{1+\rho^2}\right)$ of two variable functions as a diffeomorphism $S^2\to\mathscr{E}^2$ into Euclidian coordinates $(\mathscr{E}_x,\mathscr{E}_y)$ on the plain $\mathscr{E}^2$: $(\mathscr{E}_x,\mathscr{E}_y)=(\rho\cos(\varphi),\rho\sin(\varphi))$, $0\le\varphi\le 2\cdot\pi$, $0\le\rho<\infty$.

Let us finally find the metric of our crystallographic holography drawn by Figure 2. The partial derivatives of the holography/diffeomorphism represent the Jacobin matrix J. The transpose of the matrix J is thus given by three functions of two variables:

$$J^T=\begin{Vmatrix}2\cdot\frac{1-\rho^2}{(1+\rho^2)^2}\cdot\cos(\varphi); & 2\cdot\frac{1-\rho^2}{(1+\rho^2)^2}\cdot\sin(\varphi); & \frac{4\cdot\rho}{(1+\rho^2)^2}\\ -\frac{2\cdot\rho}{1+\rho^2}\cdot\sin(\varphi); & \frac{2\cdot\rho}{1+\rho^2}\cdot\cos(\varphi); & 0\end{Vmatrix}$$

.

Consequently, provided by Скляренко (2008), the metric tensor $G_{i,j}=J^T\times J$ yields $g_{i,j}dx^i dx^j=\frac{4}{(1+\rho^2)^2}\begin{pmatrix}d\rho & 0\\ 0 & \rho^2 d\varphi\end{pmatrix}$. Herby, in our S^2 crystallographic topology $\mathscr{E}^2$ the rod element $dl^2=\frac{4}{(1+\rho^2)^2}\left(d\rho^2+\rho^2 d\varphi^2\right)$ is represented on Figure 2. We will refer later to substitution $r=\frac{2\cdot\rho}{1+\rho^2}$ representing the "*inverse*" part of the diffeomorphism of $S^2\to\mathscr{E}^2$ or $S^3\to\mathscr{E}^3$ crystallographic holographys, where dl^2 denotes the metric in the Euclidian plain $\mathscr{E}^2$. This means that it will be possible to refer to manifolds $S^3(r)\equiv S^3\left(\frac{2\cdot\rho}{1+\rho^2}\right)$, which are now given as a function of ρ radius coordinate, and not of the radius r but as a holography radius ρ onto the Euclidean manifold $\mathscr{E}^3$, Figure 2.

4. Crystallographic Holography of Three-Dimensional Surface

Unfortunately only a few people can conceive a four-dimensional hyper-manifold $\mathscr{R}^4$. However, the aforementioned process can be applied to a S^3-dimensional surface of the $\mathscr{R}^4$ dimensional hyper-manifold. Around the North Pole $N=(0,0,0,+1)$ as a reference system center, try to envision drawing an imaginary $S^3(r)$ manifold given by polar coordinates of radius r, $0\le r\le 1$. Our $S^3(r)$ manifold is of a fixed curvature of radius 1. Proceed in similar way already described above for an ordinary manifold $\mathcal{R}^3$ encircling point N until the whole $\mathcal{S}^3$ surface of the $\mathcal{R}^4$ hyper-manifold is inflated.

Given at cosmological distances, the S^3 surface of four-dimensional hyper-manifold $\Re^4$, the space S^3 purported to be homogeneously inflated with energy and matter and is completely isotropic. The generic metric derivation, that meets these conditions, will be considered below only in case of closed model with positive curvature ≈ 1.

$$x^2 + y^2 + z^2 + r^2 = 1$$

$$x^2 + y^2 + z^2 \le r^2 \le 1$$

These equations represent so-called closed space manifolds $\mathcal{S}^3(r)$ of curvature one on the surface enclosing four-dimensional hyper-hyper-manifold $\mathcal{R}^4$.

The spherical coordinates x, y, z are related to the $\mathcal{E}^3$ coordinates by $\varphi = \tan^{-1}\left(\frac{y}{x}\right)$, $\theta = \cos^{-1}\left(\frac{z}{r}\right)$, where $r = \sqrt{x^2 + y^2 + z^2}$.

$x = r \cdot \cos(\varphi) \cdot \sin(\theta)$,

$y = r \cdot \sin(\varphi) \cdot \sin(\theta)$,

$z = r \cdot \cos(\theta)$, where

$0 \le r < 1$, $0 \le \varphi \le 2 \cdot \pi$,

and $0 \le \theta \le \pi$,

Given that a crystallographic diffeomorphism $S^3 \to \mathcal{E}^3$ maps S^3 into a quadruple of three-variable functions $\left(\mathcal{E}_x = \rho\cos(\varphi)\sin(\theta),\ \mathcal{E}_y = \rho\sin(\varphi)\sin(\theta),\ \mathcal{E}_z = \rho\cos(\theta)\right)$ defined in spherical coordinates, where $0 \le \rho < \infty$, $0 \le \varphi \le 2 \cdot \pi$, and $0 \le \theta \le \pi$, the crystallographic holography of S^3 from the North Pole $N = (0,0,0,+1)$) identifies $\mathcal{R}^4$ with the hyperplane through the origin $O = (0, 0, 0, 0)$) perpendicular to the line connecting N with South Pole $S = (0,0,0,-1)$:

$$\left(\frac{2\cdot\rho}{1+\rho^2}\times\cos(\varphi)\cdot\sin(\theta); \frac{2\cdot\rho}{1+\rho^2}\times\sin(\varphi)\cdot\sin(\theta); \frac{2\cdot\rho}{1+\rho^2}\times\cos(\theta); \frac{-1+\rho^2}{\rho^2+1}\right).$$

The partial derivatives of the holography/diffeomorphism represent the Jacobin matrix J, whereby its transpose J^T is given as follows:

$$J^T = \left\|\begin{matrix} 2\frac{1-\rho^2}{\left(1+\rho^2\right)^2}\cdot\cos(\varphi)\sin(\theta) & 2\frac{1-\rho^2}{\left(1+\rho^2\right)^2}\cdot\sin(\varphi)\sin(\theta & 2\frac{1-\rho^2}{\left(1+\rho^2\right)^2}\cdot\cos(\theta & \frac{4\cdot\rho}{\left(1+\rho^2\right)^2} \\ -\frac{2\cdot\rho}{1+\rho^2}\cdot\sin(\varphi)\sin(\theta) & \frac{2\cdot\rho}{1+\rho^2}\cdot\cos(\varphi)\sin(\theta) & 0 & 0 \end{matrix}\right\|$$

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$$\left\| \begin{matrix} \frac{2\cdot\rho}{1+\rho^2}\cdot\cos(\varphi)\cos(\theta) & \frac{2\cdot\rho}{1+\rho^2}\cdot\sin(\varphi)\cos(\theta) & -\frac{2\cdot\rho}{1+\rho^2}\cdot\sin(\theta) & 0 \end{matrix} \right\|$$

Consequently, Gram Matrix metric tensor $G_{i,j} = J^T \times J$ yields

$$g_{i,j}dx^i dx^j = \frac{4}{\left(1+\rho^2\right)^2} \times \left\| \begin{matrix} d\rho & 0 & 0 \\ 0 & \rho^2 \sin^2(\theta) d\varphi & 0 \\ 0 & 0 & \rho^2 d\theta \end{matrix} \right\|$$

, which leads to rod element given by:

$$dl^3 = \frac{4}{\left(1+\rho^2\right)^2}\left[d\rho^2 + \rho^2\left(\sin^2(\theta)d\varphi^2 + d\theta^2\right)\right]. \quad (4)$$

4.1. Foundation of Planck Satellite Data in Terms of Crystallographic Holography

Before approaching this issue, it is necessary to start calculating the volume of 3-dimensional regions in our 3-dimensional Euclidean plane $\mathscr{E}^3$. It is easy to verify that the volume of the entire space is equal to $\lim S^3(\rho)$ as $\rho \to \infty$, namely $S^3(\infty) = 2\cdot\pi^2$. Now it remains for us to calculate which part in percentage is the volume $V.S^3(\rho)$ in relation to $2\cdot\pi^2$. The following mathematical sequence is reduced to the following chain of formulas.

We know that in flat $\mathscr{E}^3$ topology, the volume rod dl^3 is equal to $dx\cdot dy\cdot dz$, whereas the rod length is given by $dl^2 = dx^2 + dy^2 + dz^2$. Applying the same rule to the previous flat expression for dl^2, we obtain volume rod $dV = dl^3$ as $dV = \sqrt{\det g}\cdot d\rho d\varphi d\theta$:

$$g_{i,j}dx^i dx^j = 8\cdot\frac{\rho^2 d\rho\cdot\sin(\theta)d\theta\cdot d\varphi}{\left(1+\rho^2\right)^3}$$

$$8\int_0^{2\pi}\int_0^{\pi}\int_0^{\rho}\frac{\xi^2 d\xi\cdot\sin(\theta)d\theta\cdot d\varphi}{\left(1+\xi^2\right)^3}$$

within a coordinate triple: $0 \le \rho < \infty$, $0 \le \theta \le \pi$ and $0 \le \varphi \le 2\pi$. Hereby the expression in the form of integral represents the space volume $V.S^3(\rho)$ of a hyper-manifold $S^3(\rho)$ with a radius ρ.

The *radius* $r = \frac{2\cdot\rho}{1+\rho^2}$ can be interpreted as a new dimension, implying that the space volume is proportional to Euclidian space $\mathscr{E}^3$ at nearby distances. Taking the integral into account, we derive the expression of the volume:

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$$V.S^3(\rho) = 4\pi \cdot \frac{-\rho + \tan^{-1}(\rho) + \tan^{-1}(\rho)\cdot\rho^4 + \rho^3 + 2\cdot\tan^{-1}(\rho)\cdot\rho^2}{\left(1+\rho^2\right)^2}.$$

After accounting for the sub-expression $\tan^{-1}(\rho)$, we obtain

$$V.S^3(\rho) = 4\pi \cdot \frac{\left(1+\rho^4+2\cdot\rho^2\right)}{\left(1+\rho^2\right)^2}\cdot\tan^{-1}(\rho) + 4\pi\cdot\frac{-\rho+\rho^3}{\left(1+\rho^2\right)^2}.$$

Finally, we arrive at $V.S^3(\rho) = 4\pi\cdot\left(\tan^{-1}(\rho) + \rho\cdot\frac{-1+\rho^2}{\left(1+\rho^2\right)^2}\right)$.

To interpret the crystallographic holography in order to confirm to the matter composition put forward by the Planck Mission 2013 satellite data it is necessary to establish the share of the volume $V.S^3(\rho)$ with respect to the entire volume $S^3(\infty) = 2\cdot\pi^2$. Indeed, while the share $V\%.S^3(\rho) = \frac{2}{\pi}\left(\tan^{-1}(\rho) + \rho\frac{-1+\rho^2}{\left(1+\rho^2\right)^2}\right)$, the $V\%.S^3(\infty) = 1$. (5)

The proicents leads to two distinct (figurative) divisions, which may be intuitively described as an "*inside*" and an "*outside*" illustrated by a Klein bottle. Here, the Klein bottle (KB) is used only as a visual aid appealing to geometric intuition and carries no topological or mathematical significance in the formal model. These two divisions correspond to two different "*bubbles*": $V\%.S^3(\rho_0) = 0.268$, for $\rho_0 = 0.675545$, and $V\%.S^3(\rho_1) = 0.951$ for $\rho_1 = 3.069028$ as listed in Table 1. One can verify that the first ("inside") corresponds to dark Ω_{DM}, while the second ("outside") corresponds to baryonic Ω_{VM} bubbles respectively. The associated angular domains are $0 \le \varphi \le 2\pi$, $0 \le \theta \le \pi$.

Ω_{DM} :	Ω_{DE} :	Ω_{VM} :
$V\%.S^3(\rho)=0.268$	$V\%.S^3(\rho_1)-V\%.S^3(\rho_0)=0.683$	$V\%.S^3(\infty)-V\%.S^3(\rho_1)=0.049$
$0<\rho<\rho_0=$	$\rho_0<\rho<\rho_1=$	$\rho_1\le\rho<\infty=3.969027963$
0.675545953	3.969027963	$\frac{\Omega_{DM}}{\Omega_{VM}}=5.47$

Table 1. Crystallographic holograpy composition: Ω_{DM} —dark or hidden matter%, Ω_{DE} —dark energy or zero-point-field%, Ω_{VM} —visible or baryonic matter%,—the relative amount 5.47 of dark mater per unit of visible matter.

We argue that on the absorption scale $(\infty \approx \kappa_0 > ...\kappa' = 0.12457 > ... > \kappa^* \approx 0.087626]$, the value $\kappa' \approx 0.12457$ corresponds to the present Planck mass–energy budget. Although this value was not derived independently and represents calibrated value of the parameter, the parameter nevertheless has predictive power. Indeed, decreasing $\infty \to \kappa$ predicts its eventual thermal death ($\kappa \to \kappa^*$), where $\kappa^* \approx 0.087626$. In contrast, approaching the Big Bang along $k \to \infty$, the ratio $\Omega_{\text{DM}}/\Omega_{\text{VM}}$ of dark mater per unit of visible matter rises to approximately $1.4 \cdot 10^9$ at $\kappa \approx 10^3$, showing that dark matter overwhelmingly dominated baryonic matter near the Big Bang.

It remains for us once again to pay attention to the connection between the metric space, which is a crystallographic holography, and the original (pre-image) defined by the Landau-Lifshitz metric (1). As already noticed, in metric (1), there seem to be two bubbles extending along the coordinate r when moving along r from zero to 1, and in the opposite direction from 1 to zero. This movement along the coordinate r will be clear from the substitution $r = \dfrac{2 \cdot \rho}{1+\rho^2}$ when moving along the coordinate ρ within the crystallographic interval $[0 \le \rho < \infty)$. In crystallographic holography, as said, these two bubbles are clearly separated by the transition boundary when $r = 1$. In metric (1), however, these two bubbles are hyper-imposed on each other and each of which has a volume of π^2.

In order to be convinced of the above, we need to calculate the volume of the three-dimensional manifold $V.\mathcal{S}^3(r)$, which extends in metric (1) in the interval $[0, r)$. Indeed

$$V.\mathcal{S}^3(r) = \int_0^{2\pi} \int_0^{\pi} \int_0^{r} \frac{\xi^2 d\xi \cdot \sin(\theta) d\theta d\varphi}{\sqrt{1-\xi^2}} = 2 \cdot \pi \cdot \left(\sin^{-1}(r) - r \cdot \sqrt{1-r^2} \right).$$

$$\frac{V.\mathcal{S}^3\left(r_0 = \dfrac{2 \cdot \rho_0}{1+\rho_0^2} \right)}{2 \cdot \pi^2} = 0.268, \text{ and } \frac{V.\mathcal{S}^3\left(r_1 = \dfrac{2 \cdot \rho_1}{1+\rho_1^2} \right)}{2 \cdot \pi^2} = 0.049.$$

For $\rho_0 = 0.675545953$ and for $\rho_1 = 3.069027963$. These ρ's values originate from the postulate of so called zero-point-field (ZPF) phase transitionin to baryonic and dark matter (Mullat, 2022): illustration on Figure 2.

4.2. *Analysis of the Cosmic Recipe of the Universe*

We are now in a position to present a set of calculations that describe the dynamics of the Universe's expansion speed and the acceleration of its size. To this end, we define the following functions in terms of the crystallographic radial coordinate ρ:

- Velocity %-function: $$v\%(\rho) = \frac{2}{\pi} \frac{d}{d\rho} \left(\tan^{-1}(\rho) + \rho \cdot \frac{-1+\rho^2}{\left(1+\rho^2\right)^2} \right). \quad (6)$$
- Acceleration %-function: $$a\%(\rho) = \frac{2}{\pi} \frac{d^2}{d\rho^2} \left(\tan^{-1}(\rho) + \rho \cdot \frac{-1+\rho^2}{\left(1+\rho^2\right)^2} \right). \quad (7)$$

It has been theoretically established above that the current state of the Universe corresponds to two roots of the $\Gamma(\rho, \kappa) = 0$ equation:

"inside the Klein bottle"—the dark (or hidden) matter radius—$\rho_0 = 0.675545953$,

"outside the Klein bottle"—the visual (or baryonic) matter radius— $\rho_1 = 3.069027963$.

Let us define a new function: $vol\%(r) = \frac{1}{\pi} \cdot \left(\sin^{-1}(r) - r \cdot \sqrt{1-r^2} \right)$.

Now, applying the substitution $r = \frac{2 \cdot \rho}{1+\rho^2}$, we obtain just testing that:

- $vol\%(r_0) = 26.8\%$,
- $vol\%(r_1) = 4.9\%$, and
- $100\% - [vol\%(r_0) + vol\%(r_1)] = 68.3\%$

,

which correspond not only closely but exactly to the observed Planck mission mass-energy badget.

These values underscore the significant dependence of observational interpretation on the underlying our theoretical framework. The stereographic Landau-Lifshitz (LL) metric offers an alternative geometric perspective for understanding cosmic evolution. It is now well-established that the Universe is undergoing accelerated expansion—a phenomenon first discovered through supernova measurements by Saul Perlmutter, Brian P. Schmidt, and Adam G. Riess, who were awarded the 2011 Nobel Prize in Physics for this work.

4.3. Visualization of the Universe Mass-Energy Dynamics

Before delving into the core of our discussion, it is important to clarify a potential source of misunderstanding regarding the motivation behind the subject at hand. A foundational principle in cosmology asserts that any valid model must be capable of making predictions across a time scale. This principle underpinned the success of classical mechanics and, later, Einstein's general theory of relativity—especially in addressing anomalies such as Mercury's orbital motion. In these traditional frameworks, time is an indispensable parameter.

By contrast, our approach does not rely on time in the conventional sense. Although this may appear to some as a critical limitation, our objective is not to track motion through time, but rather to predict the composition (the so-called mass–energy budget) of the Universe near the Big Bang and during its terminal phase. This is accomplished through a speculative framework based on the absorption of potential energy from a hypothetical Primary Background Field, or zero-point-field (ZPF).

In our model, dark and visible matter volumes $S^3.V(\rho)$ with radii ρ_0=0.67534217 and ρ_1 =3.069027963 arise via crystallographic holography. We treat the Hubble constant not as a fundamental constant but as a parameter $H(\rho)$ describing the formation rate of these volumes. Since absolute sizes are unknown, we work with percentage changes and volume accelerations on a relative %-scale.

Planck mass–energy data indicate a substantial excess of dark over visible matter, motivating calibration of H using the dark matter volume rate $S^3.V(\rho)$ for the current absorption coefficient **κ = 0.12457**. A proportionality factor α is chosen such that $\alpha \cdot H(\rho_0)$=73. The coefficient **κ** is treated as an interval scale parameter rather than a time-dependent variable, representing phases of energy absorption by dark and visible matter. It reflects a phase transition from an initial gravitational field to a mixed matter state, during which gravitational entropy decreases while mixture entropy increases, making the universe increasingly transparent to energy absorption. In this sense, **κ** plays a role analogous to time, allowing hypothetical but logical predictions without explicit temporal evolution. This scenario expresses in terms of Hubble notation—highlighting our analogy of cosmic

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expansion. At this stage, referred to as the 'fatal outcome' in our model, the composition of the Universe undergoes a dramatic shift: visible matter becomes invisible, comprising only 33%, while the dark matter comes to dominate with a 67% share.

4.3.1. Prediction Power Illustration

As indicated, the central parameter in the presented model is the parameter **κ**, which represents the rate of energy absorption from the zero-point field (ZPF). Using observational constraints from the Planck Mission, we calibrated this parameter to reproduce the observed mass–energy composition of the universe: **4.9%** visible (baryonic) matter, **26.8%** dark matter, and **68.3%** dark energy**.** The calibration yields the value **κ=0.12457.** This value can be interpreted as a critical point dividing the **κ** scale into two regions (**κ**-time future and **κ**-time past):

- **κ < 0.12457** – indicating a trajectory toward the terminal phase of cosmic evolution.
- **κ > 0.12457** – corresponding to evolution in the opposite direction, effectively approaching the initial conditions of the **Big Bang**.
- the **maximum of expansion rate velocity**, and both the **maximum positive acceleration** and its **minimum (negative) acceleration rates**, corresponding to a phase of **deceleration in the cosmic expansion**. The model yields the values: **velocity%=0.4250418 acceleration%=−0.47545094**

These values indicate a **reduction in the acceleration of cosmic expansion**. Within this framework, the theoretical model offers a novel interpretation of the distinct expansion behaviors of **baryonic matter** and **dark (hidden) matter**. Specifically: **Baryonic matter** continues to expand, but its expansion rate is **decelerating**. **Dark (quantum) matter**, by contrast, expands with **positive acceleration**. This dichotomy is consistent with observational results reported by Saul Perlmutter and collaborators regarding cosmic expansion measurements. Moreover, reg. the visible universe:

"Scientists have long held that the universe is expanding at an ever-increasing rate, driven by a mysterious but measurable force known as dark energy. Now, a new study might upend that idea, suggesting the universe's expansion is actually slowing down—and that dark energy is diminishing, rather than stable." Smithsonian magazine, accessed 27.02.2026:

https://www.smithsonianmag.com/smart-news/the-universes-expansion-may-be-slowing-down-not-speeding-up-new-research-suggests-180987660/

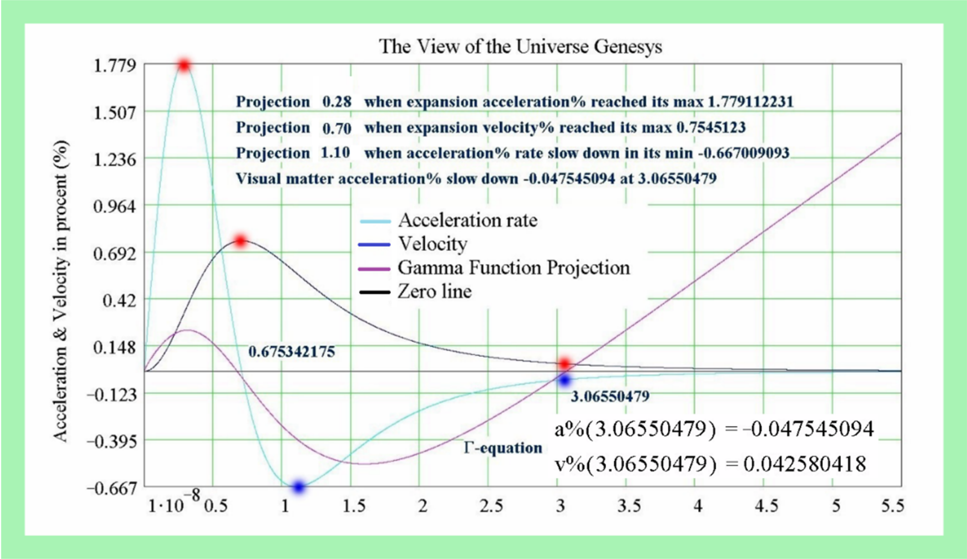

Figure 3.

Figure 3 illustrates the dynamics of the universe's volume $V.S^3(\rho)$ expansion's rate $V\%.S^3(\rho)$ on the procent (%) scale—expression (5)—together with expressions (6) and (7), which describe the velocity and accelaration rates: the **velocity rate** $v\%(\rho)$ and the **acceleration rate** $a\%(\rho)$ as functions of the **crystallographic holography coordinate** ρ. The figure highlights several important points in the model dynamics. In particular it represents a situation in which the parameter **κ** acts as a player capable of predicting the its value at which a point on the graph will be reached. To determine this value, the crystallographic coordinate **ϱ** must be substituted into the Γ-equation corresponding to the points where the extrema occur: the maximum of the velocity rate $v\%(\rho^{v}_{max})$; the maximum of the acceleration rate $a\%(\rho^{a}_{max})$, and the minimum of $a\%(\rho^{a}_{min})$. The resulting equations are then solved for **κ**.

Our calculations yield the following quantitative results:

1. **Maximum of** $a\%(\rho^{a}_{max})$ at ρ^{a}_{max} **=0.28700001**, the value **1.779112231** is reached when $\Gamma(\rho^{a}_{max}, \kappa) = 0$ with respect to **κ**, yielding **κ=0.46804363**;

2. **Minimum of** $a\%(\rho^{a}_{min})$ at ρ^{a}_{min} **=1.10400001**, the value **−0.667009093** is reached when $\Gamma(\rho^{a}_{min}, \kappa) = 0$ with respect to **κ**, yielding **κ=0.089495335**;

3. **Maximum of** $v\%(\rho^{v}_{max})$ at ρ^{v}_{max} **=0.70700001**, the value **0.7545123** is reached when $\Gamma(\rho^{v}_{max}, \kappa) = 0$ with respect to **κ**, yielding **κ=0.118852923**.

From these results, the following conclusions may be drawn. In case 1) if the absorption coefficient according to Planck is taken as **κ=0.12457** the event corresponding to **κ=0.46804363** lies at a value greater than the Planck reference and may therefore be interpreted as belonging to an earlier cosmological epoch, closer to the Big Bang. In case 2), the event associated with **κ=0.089495335** lies below the Planck reference value and may be interpreted as occurring in the future, toward the ultimate thermodynamic fate of the universe. In case 3), the event corresponding to **κ=0.118852923**, associated with the maximum relative expansion velocity of the universe, lies sufficiently close to the present Planck reference state of mass–energy budget to suggest that it will occur *relatively soon* on our cosmological **κ**-time scale.

This speculative interpretation of dynamic expansion—along with the increasing and decreasing acceleration—may seem ambitious, but it is conceptually straightforward and does not rely on advanced computational methods. This simplicity, as promised at the outset, is central to our proposed framework.

What follows is a truly intriguing and bold concept with deep philosophical and scientific implications. We hope it will be more accessible to a wider audience, especially those not well versed in advanced cosmology or philosophical theory. The text preserves the core ideas of the article while making it flow more smoothly, cutting down on technical jargon, and emphasizing the novelty of our thoughts.

5. Alternative Vision of the Universe: Creation, Expansion, and the Echo of the Infinite

Our stimulating idea endorses an alternative picture of the Big Bang. We propose that the expansion of the Universe is not simply about space stretching—but rather a grand phase transition, a shift that created both visible and dark matter. This transition emerged from a deeper, four-dimensional energy field we call the Primary zero-point-field (ZPF)—a kind of fundamental background energy, invisible yet foundational.

This creation process wasn't explosive. Instead, it unfolded through a sequence of evolving three-dimensional "slices" of space—mathematical shapes known as three dimensional (3D) manifolds ($S^3_0, S^3_1, \dots$, and so on)—each one larger than the last. These manifolds reflect, or are " golographed " from, the 4D ZPF and help us understand the growth of the Universe using the Friedmann–Lemaître–Robertson–Walker (FLRW) metric's spatial slices—a standard geometry in cosmological models that describes the large-distance structure of space and time.

In this view, the so-called "Big Bang" wasn't a Bang at all. Our first postulate is that after their creation, the visible and dark matter were essentially at rest—no initial explosion, just emergence.

Our second postulate deals with the energy exchange between the Universe and the ZPF. While the Universe continues to expand, its ability to absorb energy from the ZPF gradually decreases. In simpler terms: the larger the Universe gets, the less it draws from this infinite source. We describe this behavior through a property we call the average absorption coefficient, denoted by κ, which declines as expansion progresses.

Philosophically, this idea echoes Spinoza's radical notion: that God is not the creator of the Universe, but rather that the Universe is God itself—everything that exists is a manifestation of this one infinite substance. While such thinking has historically clashed with mainstream religious views, we find a bridge in the ideas of the Danish philosopher Søren Kierkegaard, especially his concept of synthesis—the idea that apparent opposites can exist together in a deeper unity.

This leads us to our core equation, the Γ-equation, expressed as: $\Gamma(\rho,\kappa)=0$. Solving this equation allows us to describe a new kind of cosmic distance—one that exists beyond time as we know it. It doesn't track the motion of objects through space, like in Newtonian or Einsteinian models. Instead, it maps the structure of the Universe itself—its division into components, their genesis, and their evolution.

Ultimately, this framework lets us envision both the beginning and the end—the creation and the eventual death—of the Universe, not as a timeline of events, but as a dynamic interplay of existence and energy rooted in a deeper, unseen dimension.

6. Concluding Remark

Crucially, the observed Planck mission cosmic recipe (baryonic matter: **4.9%**, dark matter: **26.8%**, and dark energy: **68.3%**) depends on how data is interpreted within a theoretical framework. The Landau-Lifshitz (LL) Stereo-Graphical metric space provides an alternative geometric structure for understanding the universe's evolution (Figure 4). Unlike the conventional spatial FLRW interpretation, which constrains observations to fit within its assumed framework, the LL/FLRW approach offers a more adaptable perspective, making it better suited to accommodate recent JWST discoveries.

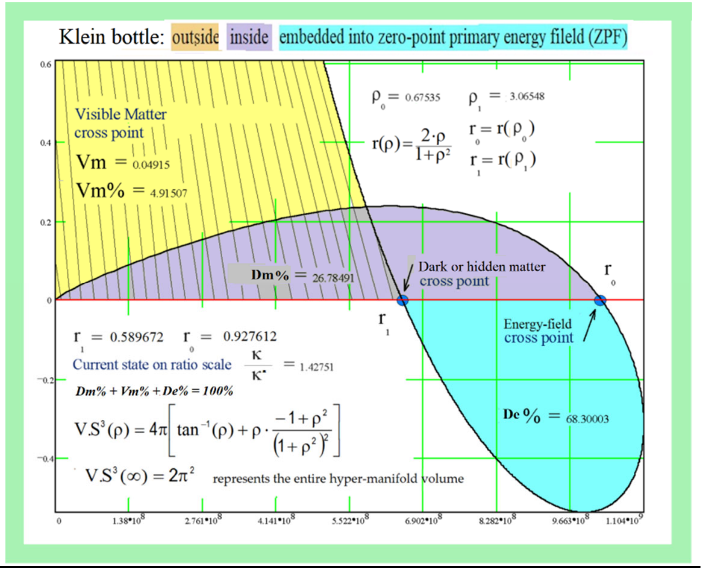

Figure 4. Planck Mission data S^3 holography of hyper-manifold $\mathcal{R}^4$ at Plane $\mathcal{E}^3$.

In light of these challenges, alternative approaches—such as a crystallographic holograpy interpretation of the Friedmann–Lemaître–Robertson–Walker (FLRW) metric space, combined with the author's Monotonic Systems theory (Mullat, 1976–1977)—may provide a more comprehensive account of cosmic dynamics. We contend that viewing cosmological time as an extrapolated coordinate rather than a directly observable quantity constitutes a philosophically legitimate critique, one that aligns with longstanding concerns in both general relativity and quantum gravity.

The novelty of current approach lies primarily in a shift of perspective. Rather than focusing on what is traditionally expected of cosmological theories—namely, the prediction of the motion of material bodies in space—we concentrate on the structural origin of the Universe itself. However, some of the remarks enclosed with the manuscript reflect a common criticism, specifically the absence of a detailed treatment of matter dynamics and of an explicit κ-time parameter governing such dynamics. In our view, these issues are not central to the objectives of the present article. Accordingly, the work does not address the dynamical evolution of individual cosmological objects, but instead focuses on the entity and geometric structure from which the Universe arises.

The article offers a description of the Universe's global structure and its large-scale evolution, including phenomena that may remain invisible beyond the limits of present observational horizons. Mathematics plays a central role in this analysis, serving as a bridge between two well-established frameworks: crystallographic visualization methods and the Friedmann–Lemaître–Robertson–Walker (FLRW) metric. We argue for a structural identity between these two categories, drawing in part on observations by Landau and Lifshitz in The Classical Theory of Fields as they relate to cosmology.

This perspective would not, in our view, merit presentation—particularly given its mathematical content—unless it were grounded in empirical observation and supported by established theoretical considerations; relevant observational indications include, for example, the statistical comparison of angular diameter distances between quasar pairs reported in Mullat and Noble (2022, https://www.datalaundering.com/download/Fundamental-RG.pdf, "An Experiment Comparing Angular Diameter Distances Between Pairs of Quasars", ISBN-13 9789403674216, accessed 09.03.2026), although the detailed analysis lies beyond the scope of current presentation.

It is widely accepted in the literature, and frequently emphasized in lectures by leading cosmologists, that the observable Universe is not only expanding but doing so at an accelerating rate. This accelerated expansion emerges naturally from the mathematical framework developed in the manuscript. Within this framework, the Big Bang is not interpreted as an explosion, but rather as a rapid phase transition. This transition is associated with the Hubble constant (more appropriately treated as a parameter than a true constant) and with Newton's gravitational constant $G \equiv \mu_k$, which is likewise interpreted parametrically.

From this perspective, recent observations—such as the presence of apparently very old galaxies at high redshift revealed by the James Webb Space Telescope—are no longer paradoxical. In a phase-transition framework, successive transitions may occur that are not ordered as a conventional temporal sequence. Early stages of such a sequence may already correspond to states containing well-formed galaxies, contrary to expectations derived from standard cosmological narratives.

Acknowledgement: The mathematical derivation that originally motivated this article—now obsolete—was first presented at the seminar of M. A. Aizerman, È. M. Braverman, and L. I. Rozonoèr in Moscow in 1973. Earlier versions of the derivation are available on various public-domain platforms (e.g., ResearchGate). The present work eliminates outdated elements and substantially advances the original formulation by introducing a new interpretation. It should therefore be regarded as an independent publication, as less than one third of the earlier material has been incorporated.

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