Tagma (order) Ermeas TrisMegistos

Science advances the Mysteries

Abstract. The Mystic Rites must evolve, just as science demonstrably evolves, since the Mysteries are not dogmatic states that judge, as in the case of Galileo Galilei, who would have been condemned to death for daring to claim the self-evident—that the Earth is a planet and revolves around the star Sun (he recanted to save himself, yet in the end exclaimed “E pur si muove”—“And yet it moves”). Plato, in his allegory of the cave, taught that human beings, chained in the depths of a cave, see only the shadows of the false reality projected upon the wall by a fire burning behind them. Trapped within the cave, they cannot perceive the brilliance of the Sun nor the majesty of Nature. The Tagma (Order) Ermeas TrisMegistos accepts everything that may develop and strengthen its Mystic Rites. The purpose of this work is to present the current image of the inner course of the Order, which is founded both upon the modern scientific position and conception of the universe, and upon the esoteric Pythagorean philosophy.

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Introduction

The Mysteries of the Tagma (Order) Ermeas TrisMegistos imitate Cosmogenesis, so that the appropriate conditions may manifest for the creation of the spiritual human being.
For this reason, a concise summary of the creation of the universe according to modern cosmology will first be presented, in order to establish the scientific foundation and basis of the theurgic Rituals of the Tagma (Order) Ermeas TrisMegistos.

Some of the earliest stages of the universe's development remain theoretical. The theories that attempt to describe them rest upon assumptions without experimental proof—that is, they are speculative theories. Therefore, the reader is invited to comprehend the general concepts rather than dwell on the narrow interpretation of the terms.

All the scientific information of this work has been drawn from scientific sources and does not in any way constitute the intellectual property of the authors. Consequently, no references are provided for the scientific positions herein; further information regarding these positions may be found in a multitude of scientific treatises, many of which are freely available on the internet.

The creation of the universe unfolded in epochs (periods). The reader may follow, schematically, the unfolding of these epochs in Diagram 1, presented below. Additionally, the reader may find a concise interpretation of the terms used in the appendix that follows this work.

Standard Cosmological Model

When the equations of General Relativity are extended backward in time, they lead to what is known as the Standard Cosmological Model. It is the most widely accepted model within the scientific community, though it presents unresolved problems.

Initial singularity

At the ideal limit t = 0 arises what is called the ***initial singularity***—the point at which General Relativity ceases to apply: spacetime can no longer be extended beyond this limit, and physical quantities tend toward infinite values. This singularity does not correspond to an actual point of infinite density but represents the theoretical boundary of breakdown of the Standard Cosmological Model.

Planck epoch

(~from t>0 to t=10^{-43}”)

Scientific hypotheses suggest that during this epoch the universe did not possess classical spacetime but rather a ***proto-spacetime***, a quantum spacetime manifesting as quantum foam filled with extreme fluctuations. The geometry of space was not yet well-defined and is described in terms of pre-geometry, that is, a primordial state preceding the emergence of smooth spacetime structure. Under these conditions, the total ***energy*** of the universe was concentrated at extreme densities, while all interactions are thought to have been unified into ***one fundamental force***. The exact physics of this epoch remains unknown.

Grand unification epoch

(~from t=10^{-43}” to t=10^{-32}”)

After the Planck epoch, the universe did not remain static: the immense energy density curved ***spacetime*** (which had by then acquired its classical 3 + 1-dimensional form) and, according to the equations of General Relativity, inevitably expanded. As temperature dropped below the Planck scale, ***gravity*** separated first from the one fundamental force. The mechanism of this separation belongs to the still-incomplete physics of quantum gravity. Thus, at the beginning of the grand unification epoch two interactions existed: ***gravity*** and the ***grand unified force*** (strong + electroweak).

False vacuum

(~from t=10^{-43}” to t=10^{-36}”)

According to modern understanding, during this early phase of the grand unification epoch the universe was in a metastable false ***vacuum state*** of extremely high but nearly constant energy density. However, this vacuum state remained unstable. The transition of the false vacuum to a more stable configuration of lower energy density—whether through quantum tunnelling fluctuations or slow roll of the corresponding field—triggered ***cosmic inflation***.

Cosmic inflation

(~from t=10^{-36}” to t=10^{-32}”)

The most widely accepted mechanism today is Starobinsky (R^2) inflation, in which the nearly constant energy density of the false vacuum renders gravity repulsive (negative pressure), causing exponential expansion of space. This phase lasted for an infinitesimal duration but was sufficient for space to expand incomprehensibly: proportionally, an initial scale comparable to half the width of a DNA molecule (~10^{-9} m) could, after inflation, correspond to a size on the order of ten light-years (~10^{14} km).

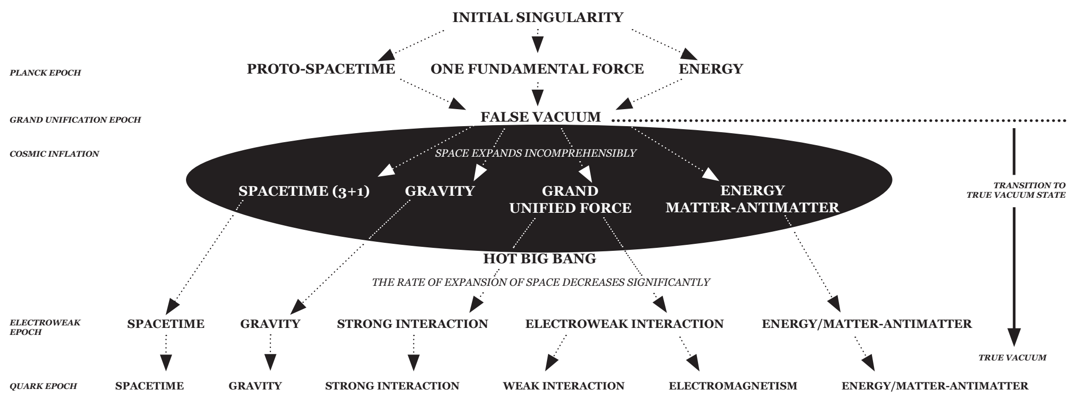


Diagram 1: *The standard cosmological model.*

During the grand unification epoch, the universe was filled with an ultra-hot plasma of particles and antiparticles (electrons–positrons, quarks–antiquarks, etc.) continuously created and annihilated. Through a yet-unknown mechanism (baryogenesis), ***matter*** prevailed over ***antimatter***. Particles had not yet acquired mass, while ***energy*** manifested through fluctuations of quantum fields and through high-energy radiation from annihilations. Hence, the fundamental elements of this epoch are: ***spacetime, gravity, the grand unified force, and energy / matter–antimatter***.

Hot Big Bang
(~t=10^{-32}”)

At the end of cosmic inflation, the energy of the false vacuum decayed and transformed into a hot plasma of particles and radiation. This process, known as *reheating*, abruptly increased the temperature of the universe—the first and only time such an increase occurred—and initiated the ***Hot Big Bang.***

Electroweak epoch
(~from t=10^{-32}” to t=10^{-12}”)

Spacetime continued to expand at a decelerating rate while temperature steadily decreased. The cosmic system had already transitioned to a new level of equilibrium, because the grand unified force had separated into two distinct interactions: the ***strong*** and the ***electroweak***.

Gravity persisted, and ***matter*** existed in a state of quark–gluon plasma, before particles acquired mass. The Higgs field existed, but its mean value was still zero, and photons had not yet fully decoupled to function as independent carriers of the electromagnetic force. By the end of this epoch, the universe transitioned into a *true vacuum state*.

Therefore, during this period, the following five elements existed: ***spacetime, energy / matter–antimatter, gravity, electroweak interaction, and strong interaction.***

Quark epoch
(~from t=10^{-12}” to t=10^{-6}”)

As ***spacetime*** expanded, temperature continued to fall, interrupting the temporary equilibrium of the system once again. The system transitioned into a more stable state in which the electroweak interaction divided into two distinct forces: the ***weak interaction*** and electromagnetism.

Gravity and the ***strong force*** remained, while ***matter*** acquired *mass* and photons assumed their independent role as carriers of the electromagnetic interaction. However, atomic nuclei had not yet formed, and matter existed as a quark–gluon plasma, where quarks, antiquarks, and gluons moved freely. Hence, during this period, the following six elements existed: ***spacetime, energy / matter–antimatter, gravity, strong interaction, weak interaction, and electromagnetism.***

Later epochs

After the quark epoch, the main developments in the universe no longer concern the separation of fundamental interactions but rather the *transitions of matter* into *increasingly stable and complex structures*: from hadrons and atomic nuclei to atoms, and subsequently to stars and galaxies.

The fundamental interactions—gravity, strong, weak, and electromagnetic—remain stable, while spacetime continues its cosmic expansion. Initially, expansion was decelerating due to the gravitational dominance of matter; however, when the universe reached an age of roughly 7–8 billion years, the rate of expansion became accelerating.

At every stage, the temperature of the universe continually decreased, reaching today a value of 2.73 K above absolute zero. Under these conditions, the production of new matter–antimatter pairs on cosmological scales is no longer possible, as energy is insufficient. The key milestones of the later epochs are as follows:

Between ***2 and 20 minutes*** after the Hot Big Bang, the first light ***nuclei*** formed. Antimatter, having mostly annihilated within the first seconds, now appeared only through spontaneous creation of particle–antiparticle pairs that annihilated almost immediately.

About ***370 000 years*** after the Hot Big Bang, ***light*** emerged from the opaque plasma of matter and radiation (matter–radiation decoupling). The first ***atoms*** formed.

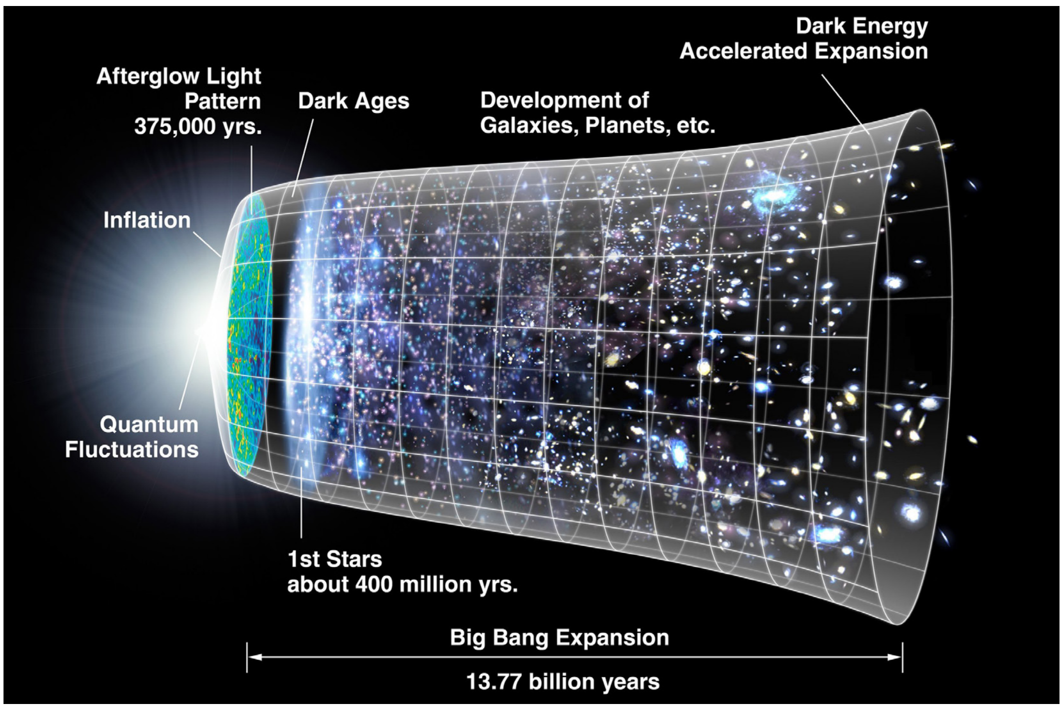
Within the first millions of years after decoupling, the universe's radiation cooled and photons shifted toward the red spectrum, becoming invisible to the human eye. The universe then had no stars or galaxies and was literally dark—this period, lasting until roughly ***150 million years*** after the Hot Big Bang, is known as the ***cosmic dark ages***.

Around ***150–200 million years*** after the Hot Big Bang, the first ***stars*** formed, marking the end of the cosmic dark ages.

When the universe was about ***7–8 billion years*** old, its expansion began to accelerate due to the dominance of ***dark energy***, which today accounts for roughly 70% of the total energy density of the universe.

Our ***solar system*** formed approximately ***9.2 billion years*** after the Hot Big Bang, with the ***Earth*** forming slightly later ***(~9.25–9.3 billion years)***.

Around ***9.8–10 billion years*** after the Hot Big Bang, when the Earth was several hundred million years old, the first traces of ***living matter*** appeared.



NASA/WMAP Science Team - Original version: NASA; modified by Cherkash

New physics

Beyond the Standard Cosmological Model, there exist several more recent theoretical frameworks which, although not yet widely adopted, attempt to explain the origin of the universe and its earliest epochs based on physical models at the frontier of scientific research. Two of these, both consistent with contemporary physics and particularly resonant with Pythagorean philosophy, are outlined below.

Informational cosmology

Modern approaches to informational cosmology propose that ***information*** constitutes a fundamental physical quantity, comparable to energy or mass. This view is associated with Landauer's principle, according to which the processing or erasure of information entails an unavoidable *energetic cost*, and with John Archibald Wheeler's notion that *"it from bit"*—that everything arises from information.

Within this framework, Fisher information has been proposed as the measure governing the emergence of physical laws, while the principle of extreme physical information states that *every physical system evolves in such a way as to minimise information loss. All physical phenomena—from cosmology to biology—can thus be viewed as manifestations of a universal process of maximising information through natural channels.*

Within this interpretative context, two forms of information are distinguished:
- ***Visible information***, that is, measurable and accessible information, such as statistical distributions of particles or cosmological observations.
- ***Hidden information,*** which exists but is not locally observable, being encoded in non-local quantum correlations (entanglement) or in holographic surfaces, as exemplified by the black hole information paradox.

In informational cosmology, the initial singularity of the Standard Model is replaced by a fundamental informational state: t***he informational vacuum or quantum nothingness***.

In this pre-geometric phase, there is as yet no classical space, time, matter, or forces—only *pure information*, a substrate of instantaneous correlations without a physical background. Within this informational vacuum, countless *temporary couplings between hidden and visible information* continually arise, yet they immediately collapse as *fluctuation noise*. ***The universe "begins" with a single informational fluctuation that did not collapse:*** a spontaneous disturbance of the informational field that stabilised the coupling of hidden and visible information and gave rise to the *first informational event* (bit event). This primordial event—a fundamental "yes/no," a quantum flip—marks the birth of the first stable correlation, the first form of quantum entanglement, from which the structure of *spacetime* gradually emerges as both mathematical and physical representation of information itself.

Accordingly, the geometry and curvature of spacetime *encode the distribution of information*: space is the "shadow" of information situated at the boundaries of the universe, while time may be regarded as the ordered sequence of computational steps in the evolution of that information.

Energy is the measurable manifestation of information—its degree of order or stability—when information acquires resilient discrete states capable of being transmitted through space and time, thereby inducing change and organising spacetime, interactions, and matter.

The *one fundamental force*, in informational cosmology, is not initially defined as a physical interaction but as the underlying law of stabilisation and transmission of informational correlations. In this pre-geometric phase, where no particles or fields yet exist, force expresses the rule by which hidden information couples with visible information, forming stable informational events (bit events). With the emergence of spacetime from information, this unified mechanism gradually differentiates into the four known fundamental interactions of physics.

As Nobel laureate Anton Zeilinger stated: "What I believe—but cannot prove—is that quantum physics requires us to abandon the distinction between information and reality.”

Ekpyrotic universe

The ekpyrotic model of Cosmogenesis is based on String Theory. Specifically, it posits that the universe is a ***brane of four dimensions*** (three spatial and one temporal) situated within a *five-dimensional bulk* (four spatial + one temporal). Initially, the brane that would become our universe is called the ***visible brane***, while another four-dimensional brane, the ***hidden brane***, also exists. In addition, within the bulk there may exist a ***bulk brane***, which either detaches from the hidden brane or pre-exists within the bulk.

According to the model, the bulk brane moves slowly through the bulk toward the visible brane and eventually collides with it, producing what we perceive as the ***Big Bang***. In the ekpyrotic framework, the Big Bang is not an initial singularity of infinite density and temperature but the moment of collision between the bulk brane and the visible brane. The energy released in this collision is finite, creating the conditions necessary for the beginning of cosmic evolution.

Immediately after the collision, its outcome transforms into a hot plasma of radiation and matter—the onset of the Hot Big Bang. At this stage, the universe enters directly into high-temperature conditions below the grand unification scale, meaning that it begins closer to the electroweak epoch than to a conventional grand unification epoch.

From that point onward, Cosmogenesis proceeds according to the standard cosmological model. Ultimately, when the universe reaches a vacuum state, the same scenario may recur through a new collision after an exponentially long duration. Thus, the universe is cyclic and recurring, continually reborn ***“from the fire”*** (ekpyrosis).

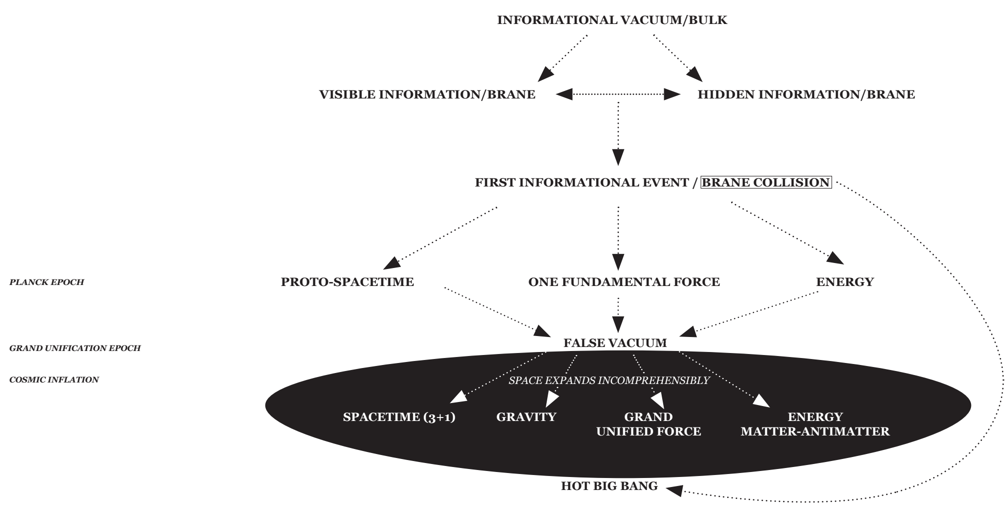
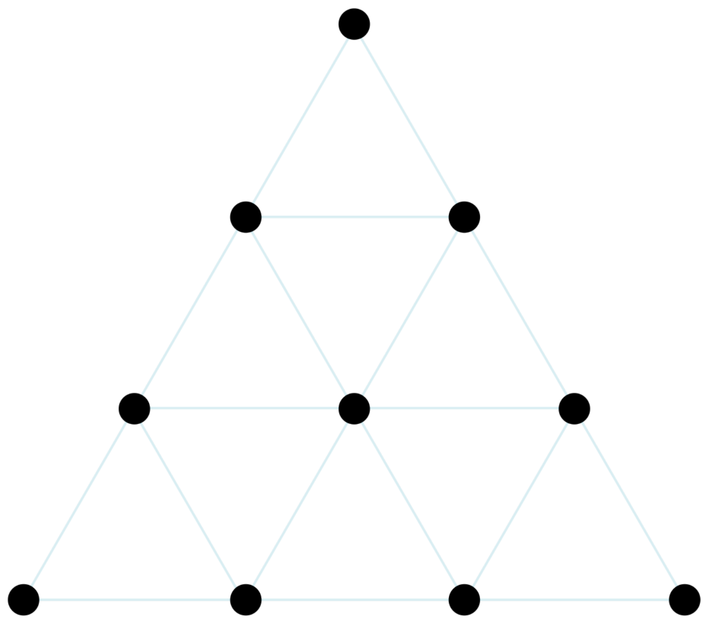


Diagram 2: By *combining the standard cosmological model with the two new physical theories, the above diagram is obtained. After the grand unification epoch the universe evolves according to the standard cosmological model.*



Tetraktys

Ananke (Necessity)

The cosmological epochs differ from one another due to successive phase transitions, during which the state of the quantum vacuum—the fundamental ground state of the fields—changes, leading the universe to new levels of equilibrium. These processes constitute internal dynamical evolution and do not require any external intervention. The only principle that could account for this fact is the existence of the intrinsic “Ananke” (necessity). “Ananke” represents the reason why the universe evolves in the specific manner described above. Every phase transition, every new particle, every interaction, and even spacetime itself exist because “Ananke” has ordained them to be so.

In *Plato’s Republic*, the goddess “Ananke” is depicted holding upon her knees an adamantine spindle, by which she determines all the revolutions of the celestial bodies. Likewise, in the *Symposium*, Plato writes that before Eros reigned among the divine principles, only “Ananke” ruled, and that everything occurred under her dominion.

Pythagorean philosophy

Pythagoras himself, in establishing his initiatic path, combined different forms of knowledge to achieve the best possible result. For this reason, the *mystic* development of the initial periods of Cosmogenesis will be based, on the one hand, upon scientific theories which have neither experimental confirmation nor experimental refutation, and, on the other hand, upon the philosophy of the Pythagorean esoteric path, which is expressed through the ***Tetractys*** and upon which all the Mystic Activities of the Tagma (Order) Ermeas TrisMegistos are founded.

Specifically, the scientific basis is provided by the combination of the standard cosmological model and informational cosmology, since the ekpyrotic model does not include the Planck epoch, cosmic inflation, or the electroweak epoch—stages of Cosmogenesis that are of great significance for the Pythagorean philosophy and for the Ritual Activities of the Tagma (Order) Ermeas TrisMegistos.

Mēdén (not Monad/not One/μη Eν)

In the philosophy of the Tagma (Order) Ermeas TrisMegistos, there exists a state prior to the informational vacuum or the initial singularity, a state which no scientific theory can approach, and within which there is not even the potential for information. The Tagma (Order) Ermeas TrisMegistos designates this state with the term ***"Mēdén=not Monad/not One (Mη Eν)"***, and regards it as utterly inconceivable to the human intellect; for this reason, it is not symbolised anywhere.

Monad (One/Eν)

As noted above, all the different prevailing scientific theories concerning the initial periods of the universe, as presented earlier, are in accord with "Ananke". For this reason, the Tagma (Order) Ermeas TrisMegistos regards "Ananke" as the "*manifested Mēdén*" and assigns to it the term ***"Monad (One/Eν)"***, which corresponds to the scientific term informational vacuum, or initial singularity. "Ananke" both is and contains everything, and governs whatever is manifested in the course of the Cosmogenesis.

Dyad

According to the theory of informational cosmology, the stabilisation of the correlation between the two forms of information—visible and hidden—led to Cosmogenesis. The existence of the ***Dyad*** also appears in Pythagorean philosophy, and the Tagma (Order) Ermeas TrisMegistos places the scientific concepts or states visible information – hidden information on the *second level* of the Tetractys.

Hidden information is regarded as *potentially unlimited*, since it represents all possible correlations that have not yet become manifest. Visible information, on the other hand, is always *finite*.

In the mystic path, the Initiate is called to *experience* the visible information of the Mysteries, and by attuning to them, to *reduce* their entropy and *move toward the source of all things* (at the initial singularity, entropy is practically almost zero, while at the level of Mēdén=not Monad it is absolutely zero). Consequently, even though the visible information presented in the Mystic Activities increases, the Initiate uses less of it, because in order to experience the level corresponding to lower entropy, less information is required. *That is, a smaller amount of utilised information suffices to describe fully the initiatic course*.

The experience of visible information by the Initiates occurs through the properties of the Planck epoch, the grand unification epoch, and the Quintessence (explained below). Practically, through the Mysteries, the Initiates ascend to a higher level with lower entropy, in which they fully possess its properties (the visible information of that level). This results in an increased possibility for potential creation. In other words, the initiatic path leads to the level *where visible information explains everything, and hidden information can potentially create everything*.

Hidden and visible information are *interdependent*. They may, within the Mysteries, be conceived as two distinct symbols, two distinct points within the Tetractys, yet in reality they possess a *single essence*. All because "Ananke" decreed it so.

Quintessence

Between the second and third level of the Tetractys—that is, at the level of the first informational event—there is a *mystic position* which is not symbolised in the Tetractys (by convention and not by nature in the Pythagorean initiatic path), yet it is important for the Pythagorean Mysteries. It is *the point from which all the Ritual Activities of the Order spring*.

The Tagma (Order) Ermeas TrisMegistos defines this point as ***“Quintessence”***. It is the point that represents the minimal unit of visible information, which is a necessary condition for the subsequent development of the Cosmogenesis, and therefore the “Whole” of the execution of the Ritual Activities.

At this point, *information can be experienced and used Ritually*, always under the ordinance of “Ananke”. According to informational cosmology, it is the point where hidden information is “necessitated” to manifest, creating the first correlation—that is, the first bit of the universe—always under the ordinance of “Ananke”. Whatever is performed within the Pythagorean Order springs from the Quintessence, which is symbolised in different ways depending on the initiatic degree.

At Quintessence, the Tagma (Order) Ermeas TrisMegistos places the ***Spiritual World***, where the ***Celestial Fellowship*** resides. The properties of this point are expressed in different ways in all the subsequent epochs of the Cosmogenesis and are the following:

QUINTESSENCE

GNOSIS/KNOWLEDGE

DIVINE PLAN

CONSCIOUSNESS

HYGEIA/HEALTH

ACTIVE IMAGINATION

COMMUNICATION

COMMUNION

Triad

Scientific theories state that from the informational vacuum, or from the ideal limit of the initial singularity, the fundamental structures emerge: proto-spacetime as a pre-geometric substrate, the one fundamental force, and energy as dynamical content (Planck epoch).

In the Pythagorean Tetractys, this epoch of the Cosmogenesis is symbolised at the third level, that is, at its three points. The Order places at this epoch the ***Properties of Manifestation of the Spiritual World***, which are used by the Celestial Fellowship.

The Pythagorean Mysteries are performed *transcendently* at this level. It is the level of the ***Created/Creating Creation***. The performer of the Rite ascends Ritually to this level and performs her/his mystic work, *attuned to the properties of the Created/Creating Creation*. The properties of the states that are manifested in this epoch of the Cosmogenesis—apart from the scientific properties referred to in the appendix—and which are employed both by the Celestial Fellowship and by the performer of the Ritual, are as follows:

PROTO-SPACETIME	**ONE FUNDAMENTAL FORCE**	**ENERGY**
SYNCHRONICITY	THE EXISTENCE OF TIME BROUGHT THE “BEFORE” & THE “AFTER” AND THEREFORE THE LAW OF CAUSE-EFFECT/ACTION-REACTION	EROS
FRAMING	RHYTHM	POWER
MNEMOSYNE	COMPUTATION	HARMONY
BEAUTY	WILL	
	EXPANSION	

Whoever possesses these Properties ***cannot use them by directing them wherever she or he wishes or desires***. In this epoch, the Properties function unaffected by *Desire*, since the *Psychism* has not yet been created.

Tetrad

With the grand unification epoch and the stage of cosmic inflation, we pass into the ***Created Creation***. During the inconceivable expansion of space, the ***Astral World*** is also created.

According to scientific theory, from the one fundamental force gravity separates first and the grand unified force remains, while, due to the decrease of energy density, the continuous creation and annihilation of matter–antimatter particle pairs becomes possible. In the Pythagorean Tetractys, this epoch of the Cosmogenesis is symbolised at the fourth level, that is, at its four points, which reveal the ***four Pythagorean Elements***. The Order places in this epoch ***the Properties of the Created Creation***, which the Celestial Fellowship uses (in addition to the properties of manifestation of the Spiritual World). *The entities of the Astral World* and their actions are not the subject of the present work; however, it would be good for the reader to bear their existence in mind, because *they too use the Properties of the Created Creation.*

The Pythagorean Mysteries are performed *earthly* at this level, with the aim of receiving the energy of ***Transmutation*** and of ascending toward the smaller amount of utilised visible information, as mentioned above. The performer of the Rite *transmits, Ritually, the charge* to the participating members so that they may achieve their *Transmutation* at this level as well. According to the Tagma (Order) Ermeas TrisMegistos, ***the Rites do not purify, but charge the members*** so that, *through their own action*, they may move in the direction of less utilised visible information. The properties of the elements that are manifested in this epoch of the Cosmogenesis, apart from the scientific properties referred to in the appendix and in the previous epoch, are the following:

SPACETIME	**GRAVITY**	**GRAND UNIFIED FORCE**	**ENERGY MATTER-ANTIMATTER**
SYNCHRONICITY WHICH FRAMES THE INCARNATION AND THE LIFE IN THE ASTRAL WORLD	IT IS AND AT THE SAME TIME CREATES THE FIELD WHICH GIVES DIRECTION	ATTRACTION-REPULSION	PASSION
CONSCIOUS-UNCONSCIOUS	PATH	INSTINCTS-REFLEXES	INSPIRATION
EMOTIONAL PATTERN	LOGIC	ACCEPTANCE	INTUITION
MEMORY	TRANSCENDENCE	EMOTION	IMAGINATION
ELEMENT: **EARTH**	FRIENDSHIP	DESIRE	ELEMENT: **FIRE**
	ELEMENT: **AIR**	ELEMENT: **WATER**	

The members of the Pythagorean Tagma (Order) Ermeas TrisMegistos, through the Rites, aim to *attune themselves with "Ananke", being charged with the Properties of the elements/epochs that created the Cosmos*. Through the experience of the flow of "Ananke", they come into contact both with the *Properties of the Spiritual World* and with *the Celestial Fellowship*, which is their Guide.

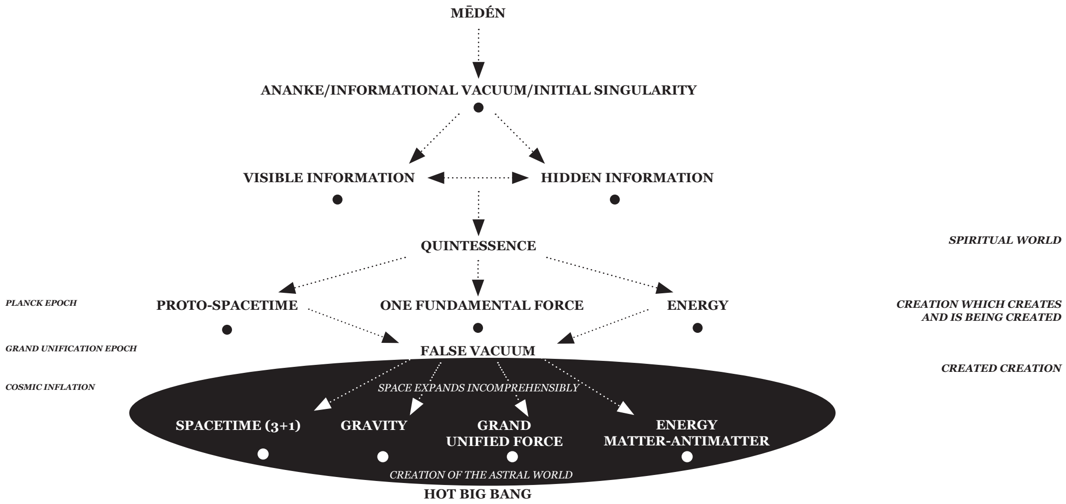


Diagram 3: *The mystic development of the initial epochs of the Cosmogenesis based on the standard cosmological model, informational cosmology and the philosophy of the Pythagorean initiatic path, which is presented by the Tetractys.*

Appendix of scientific terms

Antimatter: A form of matter composed of antiparticles that correspond to each particle of matter. Antiparticles have the same mass and the same internal properties (spin, statistics) as the corresponding particles, but opposite electric charge and opposite certain quantum numbers. When a particle meets its corresponding antiparticle, they interact and annihilate, converting their mass into energy, usually in the form of high-energy photons (or other particles, as the case may be).

Bit (binary digit): The smallest unit of information, which can take only two discrete values: 0 or 1.

Bosons: Subatomic particles with integer spin (0, 1, 2, ...). They may have positive, negative, or zero electric charge. Some bosons are elementary—such as photons, gluons, W^+, W^-, Z^0, and the Higgs boson—and act as carriers of fundamental interactions or properties. There are also composite bosons, such as mesons, which consist of a quark and an antiquark.

Brane: In String Theory, a brane is a dynamical physical object that generalises the notion of a point-like particle (0-brane), a one-dimensional string (1-brane), or a two-dimensional membrane (2-brane) to objects of arbitrary dimension p (p-branes). Branes can propagate in spacetime following the rules of quantum mechanics and interact with fields. They are characterised by tension (energy per unit volume) and may carry additional attributes such as charge.

Classical correlation: The relation of dependence between two or more variables or systems that is fully described by joint probabilities. In classical physics such correlations may be deterministic (fully specified) or statistical (probabilistic), but are always explained in terms of common causes and classical probabilities. In classical correlation, the values of the variables exist independently and are merely statistically related. In quantum correlation, values do not exist prior to measurement, since only the composite system has a well-defined state.

Color charge: An internal quantum number that characterises quarks and gluons and determines the way they interact through the strong force. It has nothing to do with optical colour but is used as a metaphor: quarks are considered to have three types of colour (conventionally called red, green, blue), while antiquarks have the corresponding anti-colours. Just as electric charges are associated with the electromagnetic interaction, colours are associated with the strong interaction. Observable states (e.g., protons and neutrons) are colour-neutral, i.e., they combine colours so that they cancel.

Coupling of information: The process by which two different forms of information—the hidden (potential, unmanifest) and the visible (manifest, observable)—are linked either temporarily or stably. In the informational vacuum the couplings are, as a rule, instantaneous and unstable (fluctuations), whereas the first stable coupling of hidden and visible information constitutes the first informational event, from which proto-spacetime emerges and Cosmogenesis begins.

Dark energy: In cosmology, the unknown form of energy that permeates the universe uniformly and is responsible for the observed accelerated expansion. It does not interact with matter or radiation except through gravity and constitutes about 70% of the total energy density of the universe. Its nature remains unknown; models describe it either as a constant property of spacetime (cosmological constant) or as a dynamical field that varies with time.

e (elementary electric charge): Denotes the fundamental unit of electric charge in nature. It is the magnitude of the charge carried by the proton (positive) and the electron (negative). All electric charges in nature appear as integer multiples or fractional parts of this elementary charge, as is the case with quarks.

Electromagnetic interaction: The fundamental interaction between particles that carry electric charge, manifesting as electrical and magnetic phenomena. It is the dominant interaction that determines the structure and chemistry of atoms and molecules, as well as most properties of ordinary matter. In the Standard Model of particle physics, the electromagnetic interaction is mediated by the photon.

Electroweak interaction: The unified theoretical description of two of the four fundamental interactions of nature: the electromagnetic and the weak. At the extremely high temperatures of early cosmology (electroweak epoch), the two forces are described as a single interaction. At lower energies, via the Higgs mechanism, this symmetry spontaneously "breaks," and the unified interaction appears as two separate ones: the electromagnetic and the weak. The theory was experimentally confirmed by the discovery of the W^+, W^-, and Z^0 bosons.

Energy: A fundamental physical quantity expressing the ability of a system to perform work or to cause change. Energy manifests in many forms—kinetic, potential, thermal, electromagnetic, or chemical—and it can be converted from one form to another without being lost. According to the theory of relativity, mass is a form of energy and can be converted into it, and vice versa ($E = mc^2$).

Entropy: In thermodynamics and statistical mechanics, entropy is the measure of the number of microstates corresponding to a given macrostate of a system. In information theory, the entropy of a system is defined as the expected amount of information that is missing from an observer to determine fully the actual microstate of the system, given its macroscopic description. That is, it expresses the observer's uncertainty about which of the possible microstates is the actual one. The smaller the information entropy, the more visible information the observer possesses about the system; the larger it is, the more hidden information remains inaccessible to the observer. Interpretively, entropy may be regarded as a measure of the observer's uncertainty and is linked to the quantity of hidden information that would have to be revealed for the full specification of the system's microstate. According to the second law of thermodynamics, in a closed system entropy cannot decrease spontaneously, but only remain constant or increase, unless there is external intervention or exceedingly improbable statistical fluctuations.

Fermions: Elementary or composite particles that cannot occupy the same quantum state two or more at the same time. They have half-integer spin (1/2, 3/2, ...). The elementary fermions of the Standard Model are the quarks and the leptons (such as the electron and the neutrino), while examples of composite fermions are the proton and the neutron.

False vacuum: A metastable vacuum state that is locally stable but is not the fundamental state of minimum energy density (the true vacuum). It may persist for very long periods, but there is a probability that it will spontaneously decay to the true vacuum through quantum fluctuations—a process known as false-vacuum decay.

First informational event: The primordial moment in which, within the informational vacuum, a spontaneous fluctuation leads to the emergence of the first stable visible information (first bit). This minimal unit of information constitutes the necessary beginning for the subsequent evolution of the universe, since from it arise proto-spacetime, energy, and the one fundamental force.

General Relativity: The theory of gravitation that describes gravity as the curvature of spacetime caused by mass and energy, unifying the geometry of space and time with the dynamics of matter.

Gluons: Elementary bosons with spin 1, massless and electrically neutral, which are the carriers of the strong interaction in Quantum Chromodynamics (QCD). They mediate the interactions between quarks by carrying a kind of charge called colour. Because of colour, gluons interact not only with quarks but also with one another.

Grand unified force: In theoretical physics, the hypothetical fundamental interaction that results from the unification of the strong nuclear, weak, and electromagnetic forces into a single interaction. Gravity is not included in this unification. Its description is based on Grand Unified Theories (GUTs), which are believed to have been valid during the grand unification epoch of cosmology.

Gravity: Observed macroscopically as the mutual attraction between bodies possessing mass or energy. In General Relativity, it is not described as a conventional force but as the result of the curvature of spacetime caused by the distribution of mass, energy, and momentum. Bodies move freely along trajectories that follow the natural "flow" of curved spacetime. These trajectories do not merely minimise distance but correspond to the paths along which the body experiences the maximum possible proper time—that is, the longest "clock time" measured by the observer during their motion from one event to another.

Hadrons: Composite particles composed of quarks and held together by the strong interaction. Examples of hadrons are the proton and the neutron, the basic constituents of the atomic nucleus.

Higgs boson: The elementary carrier particle (quantum) of the Higgs field. It is a boson with spin 0. Its role is to confirm the mechanism by which fundamental particles acquire mass through their interaction with the Higgs field.

Higgs field: A fundamental quantum field that extends throughout the universe and is associated with the Higgs boson. Its existence explains the mechanism by which elementary particles acquire mass.

Hidden information: Information that has not yet manifested or is not directly accessible to the observer. It corresponds to the microscopic, unmanifested states of a system that remain beyond the level of observation. It is considered potentially infinite, since however many manifestations become visible, an unlimited background of hidden information always remains.

Information: The quantitative property that allows prediction with greater accuracy than chance. Every physical process that is not entirely random, and every observable pattern in any medium, carries some amount of information. Information depends on the observer or the measuring instrument; thus it constitutes a subject-centred approach to reality. It satisfies the following axioms:
(1) an event with 100% probability yields no information;
(2) the smaller the probability of an event, the more information it yields;
(3) the information of two independent events is additive.

Consequently, information may be interpreted as the quantification of the degree of "surprise" of an outcome and is measured in bits. In informational cosmology, information is a fundamental entity, divided into visible information (which has already manifested and is observable) and hidden information (which remains unmanifest and potential).

Informational vacuum: In informational cosmology, the pre-geometric state prior to the appearance of spacetime, matter, and forces. It is not an "empty space" but an immaterial substrate of pure information, in which only instantaneous and unstable couplings between hidden and visible information exist. Most collapse immediately (fluctuation noise), until one stabilises and produces the first informational event—the beginning of visible reality.

Initial singularity: In cosmology, the hypothetical state of the universe at time $t = 0$, where the density of matter and the curvature of spacetime tend to infinity according to the equations of General Relativity. In this ideal mathematical state the known physical laws cease to be valid, rendering the description of the universe incomplete. The initial singularity is not considered today to be a physical reality, but an indication that a theory of quantum gravity is required to describe the primordial conditions before, or during, the Planck epoch.

Internal energy: In thermodynamics, the total energy contained within a system due to the microscopic motions (kinetic energy) and interactions (potential energy) of its constituent particles. It includes thermal energy, binding energy, and other forms of microscopic energy, but does not include the kinetic and potential energy of the system as a whole relative to its environment.

Leptons: Elementary fermions with spin 1/2 that are not affected by the strong interaction. They have mass (very small in neutrinos) and may be electrically charged or neutral. Examples are the electron (charged) and the electron neutrino (neutral).

Matter: Anything composed of quarks and leptons. It is distinguished from phenomena such as electromagnetic radiation (light) and other forms of energy. Matter and energy are equivalent and can be converted into each other according to the relation $E = mc^2$. In the Standard Model of particle physics, the notion of "matter" is not fundamental but descriptive, since the fundamental level consists of the elementary particles and their fields.

Matter–radiation decoupling: The period during which the universe cooled sufficiently for atoms to form and photons to cease interacting continuously with matter, with the result that they propagated freely (Cosmic Microwave Background).

Neutron: A subatomic particle with zero electric charge and a mass slightly greater than that of the proton. It consists of three quarks and, together with the proton, forms atomic nuclei. Outside the nucleus it is unstable and decays via the weak interaction.

Non-useful energy: The portion of internal energy equal to the product of temperature and entropy that cannot be delivered as useful work. It appears as an unavoidable loss due to the second law of thermodynamics.

Non-useful work: The part of the work that is produced or absorbed in a real (irreversible) process and cannot be converted into useful work because of losses associated with the increase of entropy.

One fundamental force: In cosmology, the initial interaction believed to have prevailed in the universe during the Planck epoch, when the four known fundamental forces—gravity, strong, weak, and electromagnetic—had not yet separated. Under these extreme energy conditions all interactions are considered to have been unified in a single field, which, as the universe cooled and evolved, successively "broke" into separate forces through phase transitions.

Phase transition: The change of a system from one macroscopic equilibrium state (phase) to another when some external parameter—such as temperature or pressure—changes. Classic examples are the melting of ice or the evaporation of water. In cosmology, a phase transition refers to the separation of fundamental interactions at lower energy scales, as the universe cooled after the Planck epoch.

Photon: An elementary particle with spin 1, zero mass, and zero charge, which acts as the carrier of the electromagnetic interaction. All forms of electromagnetic radiation, such as light, radio waves, and microwaves, are composed of photons. It always moves at the speed of light in vacuum and has no distinct antiparticle, since it is simultaneously particle and antiparticle.

Planck scale: The physical limit of lengths, times, and energies where quantum fluctuations of spacetime become dominant. At this scale a complete theory of quantum gravity is expected to be required, since classical descriptions of spacetime break down.

Plasma: One of the four fundamental physical states of matter (along with solid, liquid, and gas). It is characterised by the presence of free charged particles, such as ions and electrons, and by their collective behaviour under the influence of electric and magnetic fields. It is the most abundant form of matter in the universe, being found in stars and in interstellar space.

Pre-geometry: In theoretical cosmology, the hypothetical phase before the appearance of spacetime, where the usual geometric concepts of space and time do not yet exist and reality is described by more fundamental structures or correlations. Within informational cosmology, pre-geometry coincides with the informational vacuum.

Proton: A subatomic particle with positive electric charge (+1e) and a mass approximately equal to that of the neutron. It consists of three quarks (two up and one down) and belongs to the baryons. Together with the neutron, it forms atomic nuclei and is stable in nature.

Proto-spacetime: The primordial form of spacetime that emerges from the pre-geometric phase after the first informational event, and before it acquires the classical properties described by General Relativity. In this phase, the concepts of space and time are not yet clearly distinct but manifest through quantum fluctuations and uncertainties (quantum foam). Proto-spacetime thus constitutes the transitional stage between the informational vacuum and fully formed spacetime.

Quantum: The smallest, indivisible amount of a physical property or quantity that can participate in a physical interaction.

Quantum correlation: When two quantum systems are connected in such a way that knowledge of one provides information about the other in a manner that cannot be explained classically. A characteristic example is quantum entanglement.

Quantum entanglement: The non-classical state of two or more quantum systems in which their states are interlinked so that the overall state cannot be expressed as a product of the parts. Measurements on one subsystem directly affect the description of the other.

Quantum field: In theoretical physics, a physical entity that extends throughout spacetime and describes the probability of existence and the interactions of particles. Each type of elementary particle corresponds to a quantum field (e.g., the electromagnetic field for photons, the electron field for electrons). Excitations of these fields appear as particles, while their interactions are described by Quantum Field Theory.

Quantum Field Theory: The theoretical framework that describes particles as quantised excitations of fields and unifies quantum mechanics with the theory of Special Relativity, forming the basis of modern elementary-particle physics.

Quantum foam: The hypothetical, foamy microstructure of spacetime at the Planck scale, where, due to intense quantum fluctuations, spacetime ceases to be smooth and exhibits continual random variation in its geometry and topology.

Quantum mechanics: The fundamental theory that describes physical phenomena at atomic and subatomic scales, based on the wave–particle dual nature of matter, the quantisation of physical quantities, and the probabilistic character of measurements.

Quarks: Elementary fermions with spin 1/2 that constitute the building blocks of hadrons such as protons and neutrons. They have mass, fractional electric charge (+2⁄3e or −1⁄3e), and properties such as colour, through which they interact via the strong force.

Reheating: The phase that follows the end of cosmic inflation, in which the energy of the inflaton field (or false vacuum) is converted into particles and radiation, with the result that the universe acquires high temperature and the evolution of the Hot Big Bang begins.

Second law of thermodynamics: States that heat cannot flow spontaneously from a cold to a hot body without the production of work by an external factor (Clausius formulation). Equivalently, the entropy of a closed system that evolves spontaneously cannot decrease, but only remain constant or increase (Boltzmann formulation). In statistical mechanics there is, in principle, a non-zero probability of temporary local decreases of entropy, but in macroscopic systems it is negligible. In modern cosmology it is considered that the universe started from a state of very low entropy; consequently, its entropy increases continually until it approaches a final state of thermodynamic equilibrium (heat death).

Spacetime: The four-dimensional continuum that results from joining the three dimensions of space with the one dimension of time into a single mathematical model. In the theory of relativity, spacetime is not a passive background but a dynamical entity whose curvature determines the motion of matter and energy.

Spin: An intrinsic, quantum form of angular momentum possessed by all elementary particles, composite particles, and atoms, independent of any motion or rotation in space.

Special Relativity: The physical theory formulated by Albert Einstein in 1905 that describes the laws of nature for all inertial frames of reference (i.e., those that are not accelerating). The theory unifies space and time into a single four-dimensional continuum—spacetime—and establishes that the laws of physics and the speed of light are the same for all observers regardless of their motion.

String Theory: A theoretical unification framework of the fundamental forces according to which elementary particles are not point-like but one-dimensional vibrating strings, whose different modes of vibration correspond to different particles.

Strong interaction: The fundamental force of nature which, through the exchange of gluons, binds quarks together into protons, neutrons, and other hadrons. It also acts between protons and neutrons, holding them within the atomic nucleus and ensuring its cohesion despite the electrostatic repulsion of the protons.

Thermodynamic equilibrium: The state of a system in which there are no net flows of matter or energy within the system or between the system and its environment. The system is in thermal, mechanical, and chemical equilibrium: its temperature is uniform and stable, its pressure balanced, and its chemical composition unchanged. In this state the system undergoes no macroscopic change and has no tendency to change.

True vacuum: In Quantum Field Theory, it is the vacuum state with the absolutely minimum possible energy density, i.e., the most stable possible state of the field. In this state there is no possibility of any further transition to a configuration of lower energy.

Useful energy (or free energy): The part of a system's internal energy that can be converted into useful work under given conditions. It is calculated by subtracting from the total energy the portion that is bound by entropy (non-useful energy).

Useful work: The maximum work that can be produced by a system as it passes from an initial to a final state, under given conditions. This quantity is limited by the increase of entropy: the greater the entropy production in a process, the smaller the available useful work. Equivalently, useful work is the part of internal energy that can be converted into mechanical or other useful work, while the remainder is necessarily released as heat due to the increase of entropy. The concept is directly connected with the useful energy (free energy) of a system, i.e., the portion of the total energy that is available for doing work when thermodynamic constraints are taken into account.

Vacuum state: In Quantum Field Theory, the vacuum state (or quantum vacuum) is the quantum state with the lowest possible energy density. It is not a simple “empty space” but is characterised by quantum fluctuations of the fields, which appear as fleeting creations and annihilations of virtual particles.

Virtual particles: In Quantum Field Theory, virtual particles are the temporary, unobservable excitations of quantum fields that appear at intermediate stages of interactions. They are not real particles that are detected directly, but mathematical entities that describe the exchange of energy and momentum. Although they do not belong to the spectrum of physical states, they have measurable consequences, such as the forces between charged particles, or the quantum corrections to energy levels.

Visible information: Information that has already manifested and is available to the observer or the measuring instrument. It corresponds to the macroscopic, observable properties of a system and constitutes the part of the total information that has become “visible” or measurable, and is therefore finite.

Weak interaction: One of the four fundamental forces of nature. It is responsible for β-decay and, more generally, for particle transformations that change “flavour,” such as proton into neutron. It plays a decisive role in the initiation of nuclear fusion in stars, as it permits the conversion of protons into neutrons. In fission it is not the mechanism that splits the nucleus, but it may appear indirectly in the radioactive decays of the fission products.