The Hopes and Limits of Physical Cosmology of the 'Post-Inflationary' Intellectual Age

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Abbreviations:

BBN - Big Bang Nucleosynthesis
CBR - Cosmic Background Radiation
CDM - Cold Dark Matter
CMB - Cosmic Microwave Background
CMBR - Cosmic Microwave Background Radiation
FL - Friedmann-Lemaître theory/model
FLRW - Friedmann-Lemaître-Robertson-Walker model
GTR - General Theory of Relativity
GUT - Grand Unified Theory
QFT - Quantum Field Theory
QGT - Quantum Gravity Theory
SAP - Strong Anthropic Principle
STR - Special Theory of Relativity
TOE - Theory Of Everything

1. Introduction

Cosmology, from the Greek *κόσμος*, kosmos, 'world', and *λογος*, which in this case means 'science', is the study of the origin, evolution, and fate of the universe. *Physical cosmology* is the scientific study of the origin, evolution, large-scale structures and dynamics, and ultimate fate of the universe, as well as of the scientific laws that govern them. *Religious* or *mythological cosmology* is a set of beliefs based on the historical, mythological, religious, and esoteric literature and traditions of our predecessors. Strictly speaking, mythological cosmology differs from religious mythology. The former is characterized by popular myths and tales centered around a group of deities, from which one or few of them may be or not more important than the other ones. The latter is defined by popular stories gravitating around one creative god or even goddess (as in the case of *Shakta* form of Shivaism, which venerates Kali, *qua* mother of the world, or as in the case of the ancient henotheistic religions from *Graecia Magna*, which venerated goddesses of fertility).
Classical physics, which is the physics that was accepted until 1900, is defined by its adherence to Newtonian gravity, Maxwell's equations, the laws of thermodynamics. Also, it is based on General Theory of Relativity (GTR).
Modern physics is dominated by the Big Bang theory, and by the inflationary models of the Universe, which try to reconcile General Theory of Relativity (GTR) with Quantum Field Theory (QFT). Still, the highest *desideratum* of physical cosmology would be the completion of a coherent and realistic Quantum Gravity Theory (QGT).
Nowadays, cosmology has become one of the most prospective divisions of physics, interesting scientists from various areas of research.
After an important hiatus, the philosophers seem to provide again valuable advice to the professionals of the positive sciences. This does not happen because philosophy realized something like an ontological leap —because I think that such a motion should be lethal to a science that, by itself, is essentially ontology. This happens because the newest discoveries from the field of cosmology, quantum mechanics, astronomy and non-Euclidean geometries produced new models of physical reality, whose pretensions to completeness — in most of the cases — and whose hopes to achieve truthfulness necessitated an extensive metaphysical and logical analysis.
I want to make a short theoretical inquiry in the field of cosmology, discussing the similarities and differences between the concepts and the oppositions of ancient

cosmologies and of modern cosmologies, in order to find out how similar or different they are.
I hope that this small study will create an overall image about the evolution in time of cosmology, emphasizing the identities and dissimilarities between ancient cosmologies, which were unscientific, and physical cosmologies.
To this purpose, I will present the main features of the most relevant ancient cosmologies. Taking into account this comparison of cosmologies I will try to highlight the degree of speculation and unscientific reasoning that is shared both by ancient and by physical cosmologies.
Ultimately, the impossibility to test and confirm completely any cosmological theory, a fact which is caused by the immensity in space and time of the specific object of study of cosmology, the Universe, makes that both ancient and modern cosmologies to be essentially unable to provide us well confirmed answers to the core questions related to the birth, evolution and the destiny of the Universe.
In the best case, cosmology is able to provide empirically supported answers for the problems concerning the local Universe or to specify that some properties of matter which are seen within our particle horizon *must* define the rest of the Universe.
The first metaphysical thoughts, as those of the pre-classical Greek philosophers, were, more or less, proto-scientific cosmologies. They were intended to be scientific, especially because the positive sciences were not yet created, but they lacked the modern concept of scientific experiment. Due to the relatively early moment in the history of humankind when they were born, even pseudo-scientific theories as those of Empedocles still preserved some mythological elements. A discrete mythological and traditional mark echoed until the classical Greek antiquity, where Plato's dialogue about nature, *Timaios*, was centered around the demiurg, while cosmological conception of Aristotle had a slight theistic flavour as well.
Only beginning with Nicolaus Copernicus and his Copernican revolution in science we will speak about physical cosmologies, which are scientific, being based on observations and experiments. Several mythological names and religious concepts are still engaged in modern and post-modern cosmologies, but without having any impact on cosmological theories, which remain essentially physical. Especially the Greek and the Roman names of the deities are excellent choices for baptizing celestial bodies and cosmic phenomena, while certain religious notions, as Hindu concepts of *sharga*, the cosmic cycle, *pralaya*, the cosmic dissolution or Big Crunch, resemble some of the concepts employed by current cosmology and physics. The same may be said about the theory of the three *gunas* (a.k.a types of particles which constitute the soul) from the *Vedic* school *Samkhya-Yoga* (where *tamas* gives the mass, being the human tendency to rest and the ignorant part of the soul, *rajas* gives the energy, and *sattva* gives the wisdom and the lightness).

In other words, ancient cosmologies were absorbed by their modern and contemporary counterparts. The similarities between non-scientific and scientific cosmologies are only formal and methodological. Formally, all European cosmologies respect the rules of bivalent logic. Methodologically, all of them appeal to inferences, deductions and inductions, comparisons and hypotheses, all of them use as medium a natural language to communicate their ideas; the formal language of mathematics is specific to post-modern cosmology. Still, the difference in content is enormous. Mythological and religious cosmologies work with prejudices and unproved ideas, which are used as axioms, as there are the eternity of the world (Aristotle), the existence of at least one god who created nature (all ancient mythological cosmologies, Hinduism, Shivaism, the Abrahamic traditions, Plato, Nordic cosmologies, the Gnostics), the centrality of the Earth — a fact that place them in opposition with the Copernican Principle (mythological cosmologies, Aristotle, the Abrahamic traditions, the Gnostics). Physical cosmologies are based on evidential reasoning, observations, experiments and confirmations.

Within my paper I tried to underline the fact that philosophy collaborates with sciences in the specific field of cosmology. Both science and philosophy are instantiated within the encompassing matrix of history. As you will see reading my thesis, the cosmological theories are improved over time, becoming more complex and better justified. These features are shared by all the products of human culture, and sciences and philosophy subscribe to the same tendency to increase their complexity in time. Ancient cosmologies were simpler, but less convincing scientifically than their more recent counterparts. Though, must be added that their unsatisfactory scientific level is a label given to them by contemporary culture. Ancients belonged to an age where belief, *doxa*, played the same role with that one played by science, *épistème*, for the citizens born after Copernican revolution. Ancient cosmologies were structurally unable to satisfy the requirements desired for physical cosmologies.

The oldest civilizations generated the first cosmologies, which were purely mythological. Afterwards, the next cosmologies were religious, and only finally they become scientific. Cosmologies reflecting different stages of cultural development have coexisted with each other. This phenomenon still happens. This is possible because ancient civilizations preserved their creation myths, while newer civilizations produced their own different myths. Egyptian mythological cosmology predated Abrahamic cosmologies, which, at their turn, were prior to physical cosmologies. Hindu religious cosmology, although was created before Egyptian cosmology, represented a higher level of civilization, but because of the huge distances between the two cultures Hindu cosmology didn't have any impact on Egyptian cosmology. Also, Scandinavian cosmology was mainly mythological, and it was still popular in North Europe in an age when the rest of the continent subscribed to Abrahamic cosmology, and long after the elaboration of first scientific cosmologies, as Aristotelian Universe, Aristarchean Universe or

Ptolemaic model. Even nowadays, primitive tribes from Amazonia, Africa and Indonesia believe in mythological cosmological scenarios, which correspond to earliest stages of culture.

In the part of my work in which I will speak about the main ancient cosmologies, I have selected four of them, which were considered as being the most suited for portraying mythical cosmologies from the dawn of civilization.

I have chosen Hindu religious cosmology, Egyptian mythological cosmology, Eleatic proto-scientific and pseudo-religious cosmology, and Aristotelian proto-scientific cosmology to provide a panoramic view about ancient cosmologies due to their theoretical features.

More exactly, Egyptian mythological cosmology was a defining doctrine for all mythological cosmologies, from Sumer to Scandinavian mythologies. Also, I think that Egyptian mythological cosmology contains surprising plot elements in its cosmogony, which give it a retroactive and fortunate scientific legitimacy. And last, but not least, Egyptian mythological cosmology was expressed socially as a polytheistic solar religion, although the Egyptian astronomy placed the Earth in the centre of the world.

I picked also Hindu religious cosmology due to its countless cultural merits. Hindu religious cosmology, which is very similar with Buddhist and Jain cosmologies, is the best example for a cosmology germinated within the frames of a polytheistic ancestral religion, which was firstly recorded as a collection of devotional hymns, *Vedas*. Hindu cosmic chronology is the most realistic from all chronologies produced until one century ago. Only recently, in the light of the latest astronomical observations, the Indian calendar of cosmic *yugas* was slightly infirmed, while the theory about cosmic cycles still needs to be analyzed. Hindu religious cosmology has also the quality of being the first theory which spoke about the concept of Multiverse, a subject that would remain untouched until Aristotle, in *De caelo*, denied the existence of other heavens:

> 'Then it is not possible that any simple body should be outside the heaven. But, if no simple body, neither can any mixed body be there: for the presence of the simple body is involved in the presence of the mixture. Further, neither can any body come into that place: for it will do so either naturally or unnaturally, and will be either simple or composite; so that the same argument will apply, since it makes no difference whether the question is 'does A exist?' or 'could A come to exist?' From our arguments then it is evident not only that there is not, but also that there could never come to be, any bodily mass whatever outside the circumference. The world as a whole, therefore, includes all its appropriate matter, which is, as we saw, natural perceptible body. So that neither are there now, nor have there ever been, nor can there ever be formed more heavens than one, but this heaven of ours is one and unique and complete.'[1]

[1]Aristotle - *De Caelo* (*On the heavens*), part IX, http://classics.mit.edu/Aristotle/heavens.1.i.html

I also selected Eleatic proto-scientific and pseudo-religious cosmology, more precisely, the theory of Being of Parmenides from Elea, as it was expressed in his poem, *On nature*, due the scientific concepts which were engaged in his ontological discourse, even in the absence of an adequate observation of the *kosmos*, and of any elements characteristic of modern cosmology:

> 'Where, then, it has its farthest boundary, it is complete on every side, equally poised from the centre in every direction, like the mass of a rounded sphere; for it cannot be greater or smaller in one place than in another.'[2]

The metaphysical and non-mythological nature of cosmology of Parmenides made it a perfect choice for a special kind of transitional cosmology, which isn't neither religious, nor mythological, due to its lack of strong traditional elements and popular prejudices, but which is also not scientific, because it does not use the tools and criteria for truth of the experimental sciences. Nonetheless, a diffuse theism still may be detected within the lines of his work — there are two occurrences of the word 'goddess' within the entire poem, *On nature* — though this traditional feature is less present than in Plato's dialogues, for instance.

My fourth and last choice regarding ancient cosmologies was Aristotelian Universe. The Aristotelian Universe represents the first detailed description of physical reality, which inspired the geocentric system of Ptolemy and was the dominant astronomic model during the European Middle Ages, until the Copernican revolution. Aristotelian cosmology describes extensively the local Universe, using a series of mathematical and physical concepts, as well as theories of Empedocles and Plato. Still, the most important characteristic of this proto-scientific cosmology is its appeal to the astronomical observations, and its reliance on mathematical computations. Despite of this, the cosmological assumptions and some important conclusions are erroneous, the cosmological model being a geocentric and eternal Universe. Though, Aristotelian Universe remains the most long-standing theory about cosmos due to the slow scientific progress made during the Middle Ages.

In the part of my paper focused on the presentation of the most relevant scientific or physical cosmologies I have chosen to speak about Big Bang cosmology and Multiverse cosmology.

The Big Bang theory is the prevailing cosmological model about the early history of the Universe. It was first developed by the Belgian physicist and theologian Georges Lemaitre, in 1927, while the mathematical expression of the theory was realized by Alexandr Friedmann. The theory won the confrontation with the most popular cosmological model within the academic world, the Steady state theory. The Big Bang theory is a solution of Einstein's field equations of General Theory of Relativity.

[2]Parmenides - *On nature*, VIII, 40-45, translated by John Burnet, 1892.

The theory of Big Bang was parametrized by ΛCDM (*Lambda* Cold Dark Matter) model, where the Universe contains a cosmological constant (the energy of the vacuum or a source of negative pressure), Λ, and Cold Dark Matter. The latter is supposed to be instrumental in structure formation, currently having an essential role in maintaining the big baryonic structures, the clusters of galaxies and galaxies, while representing about a quarter of the total amount of mass of the Universe. CDM is also important to differentiate a small galaxy from stray groups of stars, because it is found in large quantities within the galaxies, whose formation was seeded by CDM.
Lambda Cold Dark Matter model, and implicitly, Big Bang theory, manages to explain the existence and structure of the Cosmic Microwave Background (CMB), the large-scale structure in the distribution of galaxies, the abundances of hydrogen, helium, and lithium, and the accelerating expansion of the Universe observed in the light from distant galaxies and *supernovae*.
The structure formation was possible only if matter had a certain density, which remained approximately constant during the cosmic epochs, requirement which is known as flatness problem. More precisely, the current density of matter and energy from the Universe seems to be fine-tuned to a certain value, called critical density. The current value of the density affects the curvature of the Universe, and hence its shape. This value suggests a flat Universe and it is very close to the critical value. Even a slight deviation from the critical value would create a totally different cosmic landscape. Normally, the total density cann't be preserved at the same level during the cosmic time, problem that could be solved only adopting the inflationary model of the Universe.
The Cosmic Microwave Background Radiation (CMBR) reveals a homogeneity and an isotropy defining the Universe at its largest length-scales, features which may be explained only if the cosmic matter and radiation were in thermal equilibrium in the moment of decoupling. If the Universe had macrocosmic scales immediately after the Big Bang, that means that most of its regions weren't in causal contact, then the approximative uniformity of the Cosmic Microwave Background would be inexplicable. This is the so-called horizon problem, and is also solved by the introduction of inflation.
Also, the cosmic inflation sends us to a Multiverse landscape. In consequence, I can say that the Big Bang theory is the most complex and exhaustive scientific theory.
The last part of the chapter dedicated to the main physical or scientific cosmologies is dedicated to the so-called Multiverse cosmology due to its enormous theoretical implications, as well as due its deductibility from the inflationary cosmological theories. In their turn, the inflationary cosmological theories enforce the Big Bang theory.
Therefore, was necessary to complete the theoretical perspective sketching the most important elements of the Multiverse cosmologies.

I hope that my paper will create an overall image about cosmology. I analyze, in the section 'A comparison between the ancient and modern cosmologies', the similarities and oppositions between the two main types of cosmological theories. Also, I explain separately the ancient and the scientific cosmologies, making their differences and agreements explicit, in order to find out how different or similar they are, and to find out how cosmology was, and still is, intertwined with philosophy.

2.0 Ancient cosmologies

From ancient times, humans have been interested by the organization and the evolution of the Universe. But because they did not have the appropriate scientific means, all the theories regarding the creation of the world, its structure and its subsequent fate were based on imagination, having largely a mythical content. Their only practical value was that they responded to the human need of finding satisfactory answers to questions about our purpose in the world, the reasons of our existence and the nature of the *kosmos* that contains us, questions that still occupy us today.

Presumably, this universal and timeless desire of our species to learn everything about the world, even if this implied a region of the existence substantially larger than the space inhabited or accessible to us, determined the *quasi*-similar phenomenology of all the religious myths, including those ones that explained the creation of the Universe. I am tempted to believe that the similarities between religions of humankind was not necessarily determined by the archetypes advanced by Carl Gustav Jung, but rather that the inherent and general-specific propensity of humans to inquire about the prime causes of the world and about its ultimate meaning were the factors that conditioned the similar form and content of all religious tales, no matter their geographical area of the people that produced them or the historical epoch to which they belonged.

Chronologically speaking, the first cosmological systems of humanity were the *mythological* and *religious cosmologies*. They explained the origin, evolution and the fate of the Universe in terms of religious myths, which usually involved deities. Therefore, the aboriginal cosmological and cosmogonic projections of humanity represented *anthropocentric* and *anthropomorphic* views over the world. The entire *kosmos* had a distinctive human mark. The explanations provided by these early cosmologies were not scientific.

Man was used as a pattern for the creation of the material world, and this makes the ancient mythological cosmologies *anthropomorphic* in the literal sense of the word. Both Yama, the god of death from Hinduism, and Ymir, the first man from the Nordic mythology, functioned cosmogonically as initial *macro-anthropic* humans, which represented the material causes of the entire physical Universe.

All these ancient cosmologies used superstitions and assumptions about the world for constituting themselves as theories about the Universe. At least Hindu cosmology, although it was the oldest, has the merit of being the most similar to

modern cosmologies of the Multiverse; it also advanced the most realistic time-scales for the cycles of these subordinate Universes. The evolution of matter, although it was not yet asserted in the period of *Vedas*, was wonderfully paralleled by the theory of reincarnation, *metensomatosis*, which basically mirrors the materialistic ideas of evolutionism, transferring them to the realm of spirit.

Only beginning with Nicolaus Copernicus, the cosmological theories became scientific, starting to rely on observations and calculations. In consequence, only after astronomy separated itself from astrology, and the logic of common sense or the rhetorical power of persuasion ceased to be acceptable, *physical cosmologies* started to flourish and we may speak about cosmological systems endowed with a real explanatory power.

Basically, from the dawn of human civilization until now, we had an impressive sequence of cosmological interpretations of reality: Hindu cosmology, Jain cosmology, Babylonian cosmology, Eleatic cosmology (the first cosmology that belonged to an European culture), Biblical cosmology, the atomist infinite Universe of Anaxagoras and Epicurus, Pythagorean Universe, Stoic Universe, Aristotelian Universe, Aristarchean Universe, Ptolemaic geocentric system, Medieval Universe, Multiversal cosmology of Fakhr al-din al-Razi, Maragha school's geocentric models, Copernican Universe, Tychonic system, Bruno's cosmology, Keplerian heliocentric Universe, static Newtonian cosmology, Cartesian *vortex* Universe, Einstein's Universe with a cosmological constant, De Sitter Universe, Friedmann Universe of spherical space, Friedmann Universe of hyperbolic space, Dirac large numbers hypothesis, Einstein-De Sitter Universe, Friedmann-Lamaitre model (FL-model), Oscillating Universe, Eddington's cosmology, Milne Universe of kinematic relativity, Friedmann-Lemaitre/Robertson-Walker class of models (FLR or FLRW-models), Steady state expanding, Ambiplasma model, Brans-Dicke theory, Cosmic inflation, Eternal inflation of a Multiverse, the cyclic model of Steinhardt and Turok, the cyclic model of Baum and Frampton, and so forth.

Of course, starting with Isaac Newton, we are speaking about *physical cosmologies*, and the methods engaged to research the Universe were improved ever since. The introduction of the telescopes was the most important factor that enhanced dramatically the quality of the astronomical observations. Practically, the biggest quantity of cosmological systems was produced in the last century, while the last fifty years were the most prolific in the whole history of science.

The first reflections about the structure, origins and evolution of the Universe were performed within the theoretical frameworks of Greek and Hindu philosophies. The ancient ontology and cosmology treated these matters extensively, but without using the modern method of scientific research to provide data for their ideas. Actually, in the case of the Eastern metaphysics, for instance, the spoken legacy of their ancestors, together with the revelation, the testimony of sensory perception and inference were the fourth sources of truth

and knowledge. Therefore, the concept of the scientific experiment was not yet introduced.
Also, all the systems of thinking from *Graecia Magna* were concerned with metaphysical issues, and less with moral philosophy, logic, philosophy of language or aesthetics. Actually, all these branches of philosophy did not really exist until until Plato started to write dialogues about a large range of philosophical themes and topics, and until Aristotle founded, in his *Organon*, the theoretical field of logic, classifying also philosophy in physics, ethics and logic. Only starting with classical Greek philosophy this discipline began to have different areas of interest than the traditional metaphysical ones. Before Socrates philosophy was essentially the natural philosophy of the pre-socratic philosophers. The pre-socratic philosophers were called *physiologoi*, natural philosophers. During pre-classical period philosophy was centered toward nature. Socrates and Plato changed for a while the main area of interest of philosophy toward man and society, while maintaining in the same time a vivid interest for the philosophy of nature. Aristotle produced the first scheme of philosophy, as a disciplinary science, interested in man and his society (ethics), in the forms of thinking and the correct ways of reasoning (logic), and the nature (physics).
With the passing of time, philosophy began to grow, leading to ethics, aesthetics, moral philosophy, philosophy of culture and philosophy of language. And for the confusion to be complete, as long as new sciences were created, such as biology, chemistry, mathematics, logic, the social sciences, each of them determined apparition of a corresponding philosophical domain dedicated to the research specific to the aforementioned science. Nowadays, even logic has a correspondent in the philosophy of logic. Moreover, epistemology was designed as a theory of scientific methodology in general, and it represented and still represents a distinct branch of philosophy.
In these conditions it should not be strange that Aristotle, who just witnessed the division of the alleged unitary theoretical field of philosophy due to the works of his teacher, Plato, used recurrently the expression 'prime philosophy' with regard to metaphysics, that represented the exclusive area of interest of the Eleatic school, Heraclitus, Thales, Anaxagoras or Empedocles. 'Prime philosophy' was the term used by Aristotle to denote the study of the 'being as being' or the study of the general categories of existence. The prime philosophy is basically the ontology, a major branch of metaphysics, which even after the development of physics, cosmology, psychology, theology, social sciences, economy and political sciences remains essentially philosophical.
One of the inherent characteristics of the metaphysical nature of ancient philosophy, in general, — the *dharm*ic philosophies of Indian subcontinent were all metaphysics — was that each of the systems that composed it, had as its aim the explanation of the world. In other words, all the ancient systems of thinkings generated cosmological theories and cosmogonic scenarios. The theory of substance (ontology) instead may be secondary or extremely fantastic, as is the

case with the doctrine of *Spherus* of Empedocles. The essential idea of this system was the existence of a macrocosmic and antithetic process that constitutes the entire physical reality, and whose components were in consequence less significant than the cosmological explanation allowed by the doctrine. The scarcity of the paleo-chemistry conceived by Empedocles, which reduced the natural elements to four species (fire, air, water and fire) and two governing principles (Love and Strife), wasn't able to give us a realistic image about the cosmogonic processes that shape the world.

I think that even the more modern *Process and Reality* of Whitehead was, first of all, a process metaphysics, that means, a process cosmology and a process ontology, hence it represented an antithetic interpretation of reality, as a continuous becoming of the cosmic entities, which instead were not realistically defined, while the process itself, as a dynamic whole, had a bigger, although debatable concreteness.

I assume that ancient humanity paid tribute to the damaging idea that the commonsensical beliefs must understand the deepest secrets of the Universe and that a healthy intellect ought to be able to apprehend the entire cosmological schemata. This was possible because the ancient societies did not have scientists, and the domain of natural science, in particular, was almost vacuous. The lack of scientific data was substituted by the most popular beliefs. These were species of subjective and historical truths that were prior to the scientific truth encouraged by Newton.

Consequently, a coherent philosophical system, as that one of Parmenides, respects only the criterion of the coherence theory of truth, and it represents a way of establishing the truthfulness of a theory or statement which was very common in antiquity:

> 'The first, namely, that It is, and that it is impossible for anything not to be, is the way of conviction, for truth is its companion.The other, namely, that It is not, and that something must needs not be, - that, I tell thee, is a wholly untrustworthy path. For you cannot know what is not - that is impossible - nor utter it;'[3]

Basically, the same issue is raised by contemporary cosmologies, that usually satisfy the criterion of being not self-contradictory, but that are in all the cases defective regarding the truth-correspondence criterion, especially in explaining the history of the early Universe.[4] In other words, the lack of empirical support, which marked the first cosmologies of the ancient philosophers, is perpetuated into contemporary cosmology, most of the systems having what Ellis calls 'satisfactory structure' and 'intrinsic explanatory power', but lacking the 'observational and experimental support', at least with respect to the core theses

[3]Parmenides - *On nature*, II, 1-10, translated by John Burnet, 1892.
[4]v. also Ellis, George F. R. - *Issues in Philosophy of Cosmology*, p.33.

that are heavily involved in explaining *cosmogenesis,* the future evolution of the Universe, or both.
As I said before, only beginning with the classical Greek thinkers, philosophy started to divide itself into branches, a cultural phenomenon that did not help the development of metaphysics, but which anticipated the birth of the positive sciences.
After the medieval stasis caused by the interference of religion in philosophical and scientific matters, and also by many other factors — an epoch in which philosophy was reduced to the role of a handmaiden of theology, *ancilla theologicae*, and was known under the label of '*theosophy*' — the European scholars introduced the concept of experiment and initiated a series of new positive sciences, many of them taking the place played by natural philosophy in the past.
Thus, sciences as chemistry — which was created from the ashes of alchemy —, geology or physics — the latter being classified as one of the subordinate disciplines of philosophy by Aristotle — were founded. Of course, the science of physics was still known under the name '*natural philosophy*', but this domain of knowledge already gained a specific scope and method, while people engaged in this area were basically the first experimental and mathematical physicists.
Theology, in its quality of the doctrine of the Christian supreme god, was separated for good from philosophy, while the main concepts of ontology and cosmology started to be employed in the newly recognized field of empirical physics. First, we may speak about so-called classical physics, afterwards about modern physics.
In parallel with the development of physics — natural philosophy — some intellectuals continued the metaphysical tradition of the previous centuries, limiting their activity to a strictly theoretical approach of the central metaphysical questions, concerning God, nature and the spirit. These metaphysicians were the authors of some of the greatest metaphysical systems. Here I may mention names as Fichte, Schelling and Hegel. I can say that the emergence of physics as a nominally and factually independent science, classical physics at the beginning, discouraged almost completely the traditional way of philosophizing, which had its roots in the theory of Being of Parmenides.
The cultural trend of emancipation of physics from the originating trunk of metaphysics was opened by the activities of certain polymaths as Bacon, Descartes, Leibniz, Newton, Galilei, Kepler and Huygens, whose interests exceeded by far the specialized field of natural philosophy.
The first scientific theories about the world appear in Renaissance, and they were improved in the following centuries. Currently, cosmology is a well established theoretical field, and its theories are a mixture of physical facts and philosophical speculations. Basically, all the major cosmological theories, taking in account the difficulty of their area of research and the relative scarcity of the empirical proofs, use massively philosophical ideas to complete their scenarios. In most cases, the

philosophical components of the theories treat the crucial mechanisms and moments of the evolution of Universe, as the early epoch of quantum gravity, the period prior to the Big Bang, the cosmic inflation or present explicative heuristic concepts as Multiverse or as the actual or realized infinity of spacetime, and so on. All ideas concerning the very early Universe are speculative. No accelerator experiments have yet probed energies of sufficient magnitude to provide any experimental insight into the behavior of matter at the energy levels that prevailed during this period. Basically, cosmological models as string theory, cosmic inflation and ekpyrotic Universe represent alternate scenarios of the history of infant Universe. The cosmogonic mechanisms employed by these theories use assumptions, which are essentially philosophical. Ekpyrotic Universe, for instance, hypothesizes that the beginning of our Universe was not determined by a singularity, as in Big Bang model. Our Universe was created due to the collisions of two four-dimensional worlds (time being the fourth dimension), located on an encompassing five-dimensional spacetime. This assumption is consistent with the late chronology of the Universe described by the actual structure of CMB, by the current density of matter of the Universe, by the homogeneity of the Universe, and so forth. Philosophically speaking, this kind of reasoning is an *a posteriori* inference. This is an instance in which we depart from an empirically confirmed fact, the Universe as it is today, and we use alternate conditions conducive to this physical state. Different scenarios lead to the same conclusion, but is clear that *at most* one of them may be true. Cosmology becomes prodigious, a fact that didn't change the history of the Universe, but which *may* be able to modify our knowledge about it. In the worst case, the plurality of the cosmological scenarios will provide an epistemological progress. In the best case, it will give us a correct chronology of our Universe.

Although cosmology ceased to be a branch of metaphysics and hence of philosophy — moreover, in antiquity cosmology represented the complete space of interest of philosophy together with ontology — it still works with a tremendous amount of philosophical concepts.

2.1 Hindu cosmology

The oldest cosmology of humankind was Hindu cosmology, and it has the quality to be the religious cosmology that resembles modern cosmologies the most. Hindu cosmology describes the world as an eternal cycle. The Universes are created and destroyed continuously, and the time scales advanced by this ancient theory for the lifespans of the Universes are immense, being more realistic than any other unscientific cosmology. The duration of a cosmic cycle, *sharga*, is about 4.320.000.000 years, period which represents a day from the life of the mythical creator deity, Brahma. At the end of a Day of Brahma, labeled also *kalpa*, the entire material Universe is destroyed, and the world enters the age of *pralaya*, the cosmic dissolution. *Pralaya*, called metaphorically the Night of Brahma, has an equal length with a *kalpa*. According to one of the four holy writings of Hinduism, *Rig Veda*, the world is generated from the cosmic egg, as an effect of the creative action of Brahma, it is preserved to exist by the activity of Vishnu, and it is periodically destroyed and reproduced under the action of Shiva. Of course, Hindu cosmological schemata are predominantly mythological and the knowledge about the physical properties of the Universe is limited, and it is substituted by naive assertions, which are common to the ancient philosophies and cosmologies, in general.

For example, the Universe is covered by seven shells: earth, water, fire, air, sky, the total energy, the false ego, while the factors of the cyclical destruction are fire, water and wind. Although the destruction of the entire Universe due to the wind or water is far for being realistic, *Vedic* cosmology, presented also in *Padma Purana*, has the merit of giving a approximatively correct image of reality, speaking about phenomenal continents (*lokas*), planets and even about different species of sentient beings.

The cycles of the Universes from Hinduism are eternal and the Universes are numerically infinite at any given time, a fact that rises philosophical and scientific issues. The actual numerical infinity of the Universes composing the Multiverse is unverifiable empirically, while, intellectually, it can be only imagined or uttered. A complete representation of numerical infinity is impossible. The eternity of the cycles generates the question 'how is possible that something to exist forever?'. To this question some thinkers, as Aristotle, answered saying that the circular circumterrestrial motion of the celestial spheres indicates the eternity of the world because a natural circular motion feeds itself. Hindu cosmology didn't have any pseudo-scientific argument for the eternity of the cycles.

Though, these issues are not significantly different from those of modern physical cosmologies, seeming that a common problem of all cosmological models is the spatial, temporal and numerical infinity of the Universe(s).
The Day of Brahma or *kalpa* equals with 1000 of *mahayugas*. A *mahayuga* is a complete subordinate cycle of successive cosmic epochs, whose timespan either decreases, or increases, according to the motion of our solar system around a central unseen star. The idea of the existence of a celestial body that determines the whole local cosmic structure composed by our sun and his planets to move around it was extremely innovative and near to reality.
Also, the contemporary concept of Multiverse was inherent in the idea of an innumerable quantity of Universes that exists at any given time. According with some *Puranas*, the infinity of Universes extends at micro-physical level. Speaking in the language of the metaphysical categories of the contemporary philosophy, here we have an instance of so-called microcosmic transcendence:

> 'To the macrocosmic transcendence there corresponds the microcosmic transcendence, equally spectacular, which determined the apparition of a special discipline, the philosophy of microphysics.'[5]

Basically, the quantum level becomes a world on its own, this being an idea specific to the *dharmic* metaphysics of Hinduism and Buddhism, and which was approached in the Western word only within the frames of science fiction literature.
Although Hindu religious cosmology was already infirmed by the most recent discoveries regarding the age of our Universe (the age of our solar system, instead, is about 4.568 billion years, close to the value of a Hindu cosmic cycle) this ancient model of physical reality remains the most realistic from all the cosmological systems that were created before the introduction of the empirical sciences and before the development of modern astronomy and modern cosmology.

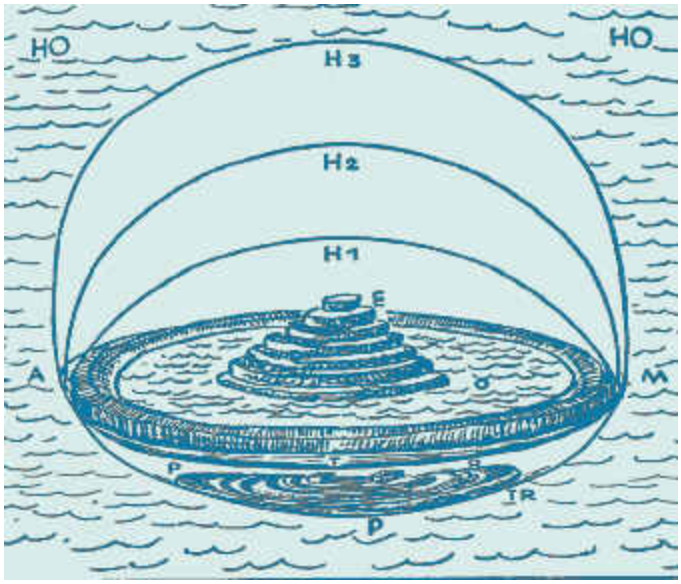
[5]Surdu, Alexandru - *Speculative thinking*, p.135, Paideia Publishing House, Bucharest, 2000.

2.2 Egyptian cosmology

Egyptian cosmology was mostly mythological, and partially inspired by the Assyro-Babylonian cosmology, partially determined by the natural processes which were experienced by the ancient Egyptians, some of them being specific to their country, as the yearly cycles of Nile, some of them being universal for any human observer, as the motion in the sky of the sun and of the planets. Since the ancient Egyptians were polytheists and they deified the celestial bodies, it was extremely important for them to compute accurately the moments of emergence of their gods and goddesses. This was one of the most significant causes of the development of astronomy and of cosmogonic myths by the Egyptian civilization. The movement on the sky of the brightest stars was useful for navigation on the seas, while the astronomical objects of our own solar system played a religious and cosmological function.

A logical consequence of the immortality of the immanent central gods of the Egyptian pantheon was the eternity of the Universe. The bodies of the gods composed the physical world. The gods were immortal, hence the world was also eternal. On the other hand, the multi-layered structure of reality, influenced by Babylonian mythology, depicted the world, with its earths and heavens, as being spatially finite. Still, the Universe before its creation was a spatially infinite chaos, that meaning that only the places inhabited by humans, spirits of the deceased and gods were spatially finite. The god of creation, Atum or Ra, was the ontological and cosmological result of an imbalance between the primordial pairs of deities, which composed so-called Ogdoad.

The first god himself, Atum, was a creation of Nu, the initial liquid void, and hence any comparison with Christian cosmogonic myths would be meaningless. Nu was the deification of the primordial watery abyss. The ancient Egyptians envisaged the oceanic abyss of Nu as surrounding a bubble in which the sphere of life is encapsulated. Nu is the source of all that appears in a differentiated world, encompassing all aspects of divine and earthly existence.



The primeval waters may be compared with the spacetime foam of the Planck era, while the ripples formed on the ancestral waters may be paralleled with the strings from super-string theory or with thermal fluctuations from the inflationary cosmologies. The male gods which composed the primary Ogdoad were represented as frogs, while the female deities were represented as snakes. The Egyptian cosmogonies varied by city within the ancient kingdom of Khem, and, consequently, the myths slightly differed one to another in places like Hermopolis, Heliopolis, Memphis, Thebes. If somebody will really want to make a comparison between Egyptian mythological cosmologies and modern quantum physics, he or she would need to associate the snake-shaped goddesses with the waves, and the frog-shaped gods with the particles. But I think that this would be too much even for a time when cosmologies are more literary than the science fiction books.
Atum, the god of creation, conceived the pair of deities Shu, the god of air or atmosphere, and Tefnut, the goddess of humidity or water:

> 'Shu is the atmosphere, his creation produced a dry, empty space in the midst of the universal ocean, within which all life exist.'[6]

An analogy between the water-surrounded Earth and the bubble Universes of the inflationary theory is not hard to be realized, although would be quite unlikely to sustain that Egyptians made scientific assumptions about the beginning of the world. And since the newly established Universe needed material items where they did not existed before, Shu and Tefnut gave birth to further deities:

[6]Allen, P. James - *Middle Egyptian: An Introduction to the Language and Culture of Hyerogliphs*, p. 176, Cambridge University Press, 2010.

> 'These are Geb, the earth, and Nut, the sky. [...] Together they define the physical structure and the limits of the created world.'[7]

The descendants of Geb and Nut are the primary forces of life: Osiris and Isis, Seth and Nephtys. The process of creation is completed with the birth of sun, Horus, the offspring of Osiris and Isis.
Though the Egyptian cosmology appeals to mythological names and trivial metaphors for explaining creation, as many commentators noticed, the Egyptian myths of genesis are not as far from reality as is the solar disc far from earth:

> 'Although is explained in generational terms, the Heliopolitan view of the creation is therefore less a step-by-step account than a kind of Egyptian Big Bang, in which all creation happened at once, in the moment when Atum evolved in the world, and time itself began.'[8]

[7] *Ibidem*, p. 176.
[8] *Ibidem*, pp. 177-178.

2.3 Eleatic cosmology

The most important Eleatic philosopher was Parmenides, whose cosmology described a monistic and static world, which excluded the void. Though, Parmenides admitted the existence of void because the Universe had a spherical shape, and hence a finite size. Parmenides had the merit of being the first real cosmologist of the European culture, although his system does not have too many adepts nowadays.
Parmenides used the notion of temporal infinity or eternity, *Aeternitas*, when he described Being — an idiosyncratic way to denote the Universe — qualifying it as unborn and imperishable. Also, the Being was spherical, homogeneous, unique and concentrating in itself the totality of existence:

> 'On this path there are a multitude of indications that what-is, being non-generated, is also imperishable, whole, of a single kind, immovable and complete. Nor was it once, nor will it be, since it is, now, all together, one and continuous.'[9]

At the same time, the sphere, being a closed geometrical body, was automatically finite, a fact that was in concordance with an universal idea of Greek antiquity whereby a limited or closed space is perfect, while a boundless or open space is imperfect, a conclusion sustained especially by the Pythagorean school.
Asserting that the Being is immovable, Parmenides wanted to say that the physical world lacks any becoming or process of change. Motion is just one of the instances of change, the change of place, and hence the property of immobility attributed to his Being by Parmenides ought to be understood rather as immutability or unchangeability.
Also, depicting the world as homogeneous, Parmenides generated an ample diachronic echo within the confines of Greek culture. Empedocles, Heraclitus and the atomist philosophers formulated philosophies that clearly opposed that one of Parmenides.
It is obvious that homogeneity was derived from the unchangeability of Being, which did not allow that different material parts or areas subjected to

[9]Parmenides - *On nature (Pery Physis), The way of objectivity (Aletheia)*, VIII, 1-5, translated by John Burnet, 1892.

transformation to exist within the cosmic body. The rejection of void within the complete and bounded structure of Universe was the main ontological claim, since the acceptance of void would let open the door to change, either from existence to non-existence, either vice versa:

> 'Where, then, it has its farthest boundary, it is complete on every side, equally poised from the centre in every direction, like the mass of a rounded sphere; for it cannot be greater or smaller in one place than in another. For there is nothing which is not that could keep it from reaching out equally, nor is it possible that there should be more of what is in this place and less in that, since it is all inviolable.'[10]

Therefore, Parmenides adopted the doctrine of an eternal and static Universe. Of course, its eternity was not determined by a continuous sequence of cycles, as in some of contemporary cosmologies, but by an unrealistic state of changelessness.

[10] *Ibidem*, VIII, 40-45, translated by John Burnet, 1892.

2.4 Aristotelian cosmology

Although Aristotelian cosmology had a great impact in Middle Ages, the heliocentric model of the Universe of Nicolaus Copernicus transformed Aristotelian cosmology in a simple discipline of study at the Renaissance universities and deprived it by its longstanding pretensions of truthfulness. Still, Aristotelian system had a big success during Greek antiquity, and influenced cosmological models as the heliocentric Aristarchean Universe or the geocentric model of Ptolemy.

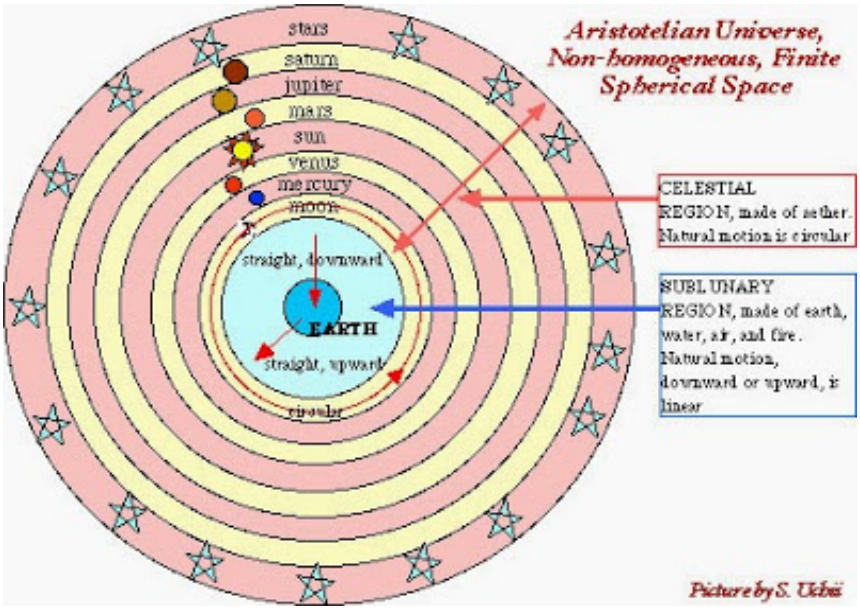
Essentially, the world described by Aristotle in *Physics*, *Metaphysics* and *De Caelo* is a complex system of concentric spheres, having the Earth in the centre and the stars at the periphery, in the outermost heaven. His geocentric system was inspired by the mathematical models of Eudoxus, a pupil of Plato, and they were firstly enunciated by Aristotle in *Metaphysics*.

The cosmological system of Aristotle departed from the prejudice that the Earth is located in the core of the creation and, consequently, that the place in which we are contained represents a privileged *locus* of nature. This is in explicit conflict with the Copernican Principle, according to which there does not exist a special place within the confines of Universe. Virtually any celestial body able to host an astronomical observer will create the illusion of centrality.

Also, the system of Aristotle subscribed to the commonsensical preconception that the Earth is static, while all other astronomical objects of the Universe are in motion around the Earth. Aristotle conceived 47 to 55 celestial concentric spheres, starting from the innermost sphere of Moon, ending to the upper sphere of the so-called fixed stars. All the planets and stars were contained in some sphere, which was made from the same material, the aether.

Aristotle depicted a very scarce chemistry, because he stated, following the train of thought of Empedocles, that there exist only five elements: earth, water, air, fire and aether. The first four were the material bricks of the sublunar world, while aether, called by the late medieval scholars *quintessence*, was the only element that composed the heavens. Both the celestial bodies: Earth's moon, the inner planets, the Sun, the outer planets (only Jupiter and Saturn were discovered until that time), the stars *and* their spheres were supposed to be made from aether. During the Middle Ages people started to believe that a small quantity of the heavenly substance, the aether, is dispersed within terrestrial sphere. The irony makes that Earth's atmosphere really contains traces of the most abundant baryonic components of the universal matter, hydrogen and

helium, elements that are also predominant within the inter-planetar space, and which also make most of the mass of Sun and of the giant planets, but this is a simple coincidence. Of course, the medieval speculation related to aether was completely alien to Aristotle.
The elements were located within the frames of the Universe in accordance with their density. The heaviest elements stood at the bottom of the Universe, Earth's surface, they being naturally attracted by the lowest place from the world, the center of the Earth. The lightest elements, air and fire, occupied the space located immediately above the Earth's surface, the atmosphere. The earthly elements had a sort of physical properties, as temperature and humidity. According to the distribution of these secondary characteristics, the elements were able to be transmuted one into another, and finally all the terrestrial elements were attracted by the centre of the Universe. Only the aether, being a heavenly substance, did not share any property with the terrestrial elements, constituting instead entirely the celestial space.
Each of the spherical layers of the Universe, Earth being itself spherical, was in direct contact with its neighbouring shells. That meant that Earth interacted directly only with the Selenic sphere. Every celestial sphere described a rotational motion around its nearest lower sphere. The celestial spheres were thus nested one into another, only the outermost layer, that one of the fixed stars, was not encompassed by a bigger shell.



All the spheres were moved by their corresponding unmoved mover. The intelligible principle of these orbital velocities was a sort of immanent necessity of circumterrestrial motion which permeated the heavenly matter:

> '[...] bringing about motion without being itself in motion, a celestial unmoved mover is a perpetually active and disembodied intellect.'[11]

All the descriptions given by Aristotle are more likely poetic, in the same way in which the principle of Love united the different elements of nature under the form of *Spherus* in the case of the cosmology of Empedocles. These local mechanical causes acted as coordinators of their respective orbs.

Only the unmoved mover of the sphere of the fixed stars *knew* the reasons underlying all the subsequent circular motions from the Universe, not being confined to its own sphere. I think that Aristotelian Universe was influenced by the Pythagorean aritmosophy, which gave a big importance to the mathematical entities. In consequence, a possible interpretation of the mysterious intelligible nature of the unmoved movers of all celestial spheres would be that they expressed the rotational period and the direction plus speed (velocity) of their corresponding shells. In other words, the unmoved movers may be understood as being mathematical parameters and not celestial beings or archons, as they were later reinterpreted by the Gnostics. Basically, the information which is stored in the shells is the same with its mechanical expression. The preordained harmony of the rotational speeds of the celestial spheres is intrinsic to the spheres themselves. The circumterrestrial motions of these spheres express a intelligible pattern. The Universe is self-reliant and autonomous in its mechanical functioning.

I think that this strange relation between the unmoved movers and their corresponding shells may be better explained by Aristotle's theory of the four causes. The formal cause, which represents the rational pattern of something (in this case of the celestial dynamics) consists in the onion-like structure of the Universe, with shells that are encased into another. The material cause consists in *prima materia* of the astral bodies, which for Aristotle seemed to be the hypothesized aether. The efficient cause(s) of the cosmic eternal circular motions are the unmoved movers themselves, while the final cause will be resultant celestial harmony of the Universe.

Although the Aristotelian Universe may be easier understood now, after thousands of reactions to his cosmology, some of them explicit, some of them implicit, were given, it is quite obvious that his system fails to explain the birth of the material world. In other words, Aristotelian Universe lacks a real cosmogony, Aristotle asserts the eternal movement of the spheres. The eternity of their movement is guaranteed by their circularity, and the arguments provided by Aristotle in this direction are odd, although they are consistent with his line of thinking.

More precisely, in the sublunar world, which is dominated by the mixture of the four terrestrial elements, the physical bodies have the natural tendency to go

[11] Aristotle - *Metaphysics, Gamma* 7, 1072, IRI Publishing House, Bucharest, 1999.

either down, to the centre of Earth, as is the case with the heaviest elements, earth and water, either up, in the atmosphere, as is the case with so-called 'exhalations' of the Earth, air and fire. In all these instances the motions are rectilinear, and not circular. Also, the motions of the bodies on the surface of Earth are done in straight lines, from left to right or to right to left, and this is stated as a common mark of all the objects from the sublunar world. These motions are always temporary, since we have a finite distance between the highest point of the atmosphere located immediately beneath the Selenic sphere and the centre of the Earth. Also, all the distances from different places located on Earth's surface are finite, the motion of a body will take a definite time, unless it will become a perpetual circular motion around the Earth, but then it will cease to be a rectilinear motion.

The circular motion is eternal, having the property of feeding itself. He sustains that because we do not have any privileged point on circle's circumference, any circular motion must be caused by the entire structure that describes it. This explains the vanishing nature of the unmoved movers, which seem to be dispersed within the heavenly substance of the shells, in the same way in which the data are stored in a liquid crystal. The rectilinear motions instead are essentially finite and non-self-reliant, they being paradigmatic for the sublunar world. Is admirable that somebody thought at the Universe as would be an autonomous mechanical clock long time before the invention of the first mechanical clock. Still, I would be tempted to consider Aristotle's arguments regarding the motion of the spheres as being rather mathematical than physical. In the absence of a real chemistry is hard to subscribe to the first great atheist cosmology. The appeal to modern chemistry and thermonuclear physics would be necessary to explain how the simplest elements generated the most complex ones, while aggregates of hydrogen and helium (in most of the cases) have bound gravitationally other celestial bodies.

Aristotle failed to provide a cosmogony for his cosmological system because he considered that the world does not have beginning and end. Current cosmological theories depict at most the eternity of the cosmic cycles, but nobody dares anymore to believe that our Universe was not generated. Although it was significantly different, Aristotle's Universe did not diverge completely from Eleatic paradigm.

2.5 Conclusions about ancient cosmologies

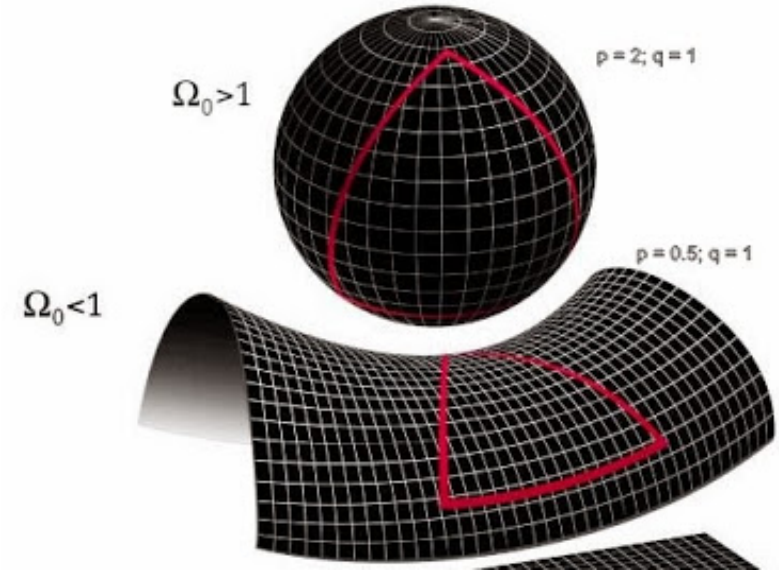
One of the few advantages possessed by so-called 'prime philosophy' was that if and when the philosophers have chosen to investigate a metaphysical issue, and not the stylistic quality of *Mahabharata* or of Homer's *Odyssey*, they had an extremely generous theoretical space for their intellectual and speculative maneuvers due to the novelty of this science. Consequently, I can say that the first cosmological systems represented in the clearest and the most complete way the entire set of methods that are more or less engaged in modern cosmology, although their weight varies depending on the explicative system.
The oldest and the most elementary philosophical and scientific tricks are logical and rhetoric subterfuges. Parmenides fell in his own trap, the trap of logical-linguistic paradoxes, when he asserted that only Being can be, and we can say nothing about non-Being, not even that non-Being does not exist:

> 'The first, namely, that *It is*, and that is is impossible for anything not to be [...] The other, namely, *It is not*, and that something must needs not be [...] For you cannot know what is not - that is impossible - nor utter it.'[12]

Indeed, what is without ontological reality, the nothingness, is completely different from what exists. It does not exist. The difference between something and nothing is more radical than the difference between matter and void. Although Parmenides used the thesis of homogeneity of Being to reject the existence of void, he definitely lost sight of the possibility of contrasting nothingness with all conceivable extensive items, including the void. Thus, to illustrate the non-existence of non-Being, Parmenides used linguistic arguments and fell wildly in the hole of the logical-linguistic paradoxes, which are, in fact, purely linguistic. The solution of Wittgenstein, from the preface of his *Tractatus Logico-Philosophicus*, which suggests us to keep the silence in matters concerning what can not be said, looks like the best remedy for understanding the negative definition of Parmenides' Being. Indeed, the Eleatic metaphysician had difficulties to tell us what *not* is Being. Of course, once we say something about a thing, even if its attributed properties are negative, we treat it, at least grammatically

[12]Parmenides - *On nature*, II, 1-10, translated by John Burnet, 1892.

and logically, as existing. In other words, the simple fact of saying or thinking about the non-existence of a thing gives it linguistic and mental existence. That thing receives thus a linguistic reality, it becomes a linguistic fact.
Parmenides confused nothingness — the ontological void — with the physical void — or vacuum. Still, we can say that precisely because he tried to deny the existence of the cosmic void, of what *It is not*, Parmenides managed to affirm it.



Let's forget the real values of the current density of matter and energy, and the real symbols for the current and critical densities. Let's remember that Wittgenstein defined the world as being the totality of the states of affairs:

> '1.2 The world divides into facts'[13]

and also:

> '2.04 The totality of existent atomic facts is the world.'[14]

I suggest to watch the pictures from above as alternate representations of the totality of the possible state of affairs. In other words, look at them as would be worlds located in the logical space of possibilities, worlds which may be, although just some of them really exist. In this case, the number of the actual state of affairs is restricted to one because we are speaking about the totality of these states, which has to be only one. For Parmenides, only the spherical world existed. For us, none of these. Let's consider '1' as being the symbol of true, and any other number (as '2' or '0.5') as the symbol of false. Let's consider 'p' and 'q'

[13]Wittgenstein, Ludwig - *Tractatus Logico-Philosophicus*, p. 23, 1922.
[14]*Ibidem*, p. 28.

as standing for properties necessary for the existence of Universe (world), as some kind of cosmological parameters. Density is anyway a cosmological parameter. That means that the sphere and the saddle have the same truth-values for p and q, 0 for p, and 1 for q. Hence, the *a priori* sense of the totality of the possible states of affairs is confined to Mpq = (0,1,0,0), which is the matrix of converse nonimplication, symbolized as 'M':

> '(FTFF) (p,q) ,, ,, q and not-p [q.¬p]'.[15]

Only if 0 implies 1 the formula will be true. M01 is the only proposition with an (*a priori)* sense, while M11, M10, M00 are (philosophical) non-senses. According to the logical form of converse nonimplication the alternative of a flat Universe (M11) is rejected.
Hence, only the state of affairs with the form Mpq, where p = 0, and q = 1 enters in the composition of the logical form of the world. Still, is not necessary that a world with the form M01 to exist. This is just possible. A knower called Parmenides considered that the world is spherical, and, let's assume, he had the empirical right to say that M01 is true. Even if M01 itself would had been false, Parmenides still would have the right to say something about M01, namely, that it is false, because only M01-type of propositions have sense. This doesn't mean that all of them will become actual (M01', which is saddle-like shaped, cann't be true in the same time with M01).
But can Parmenides say something about something which was cut in the image from above, something which isn't represented by a converse nonimplication? It seems that he did so, because he said that:

> 'For you cannot know what is not - that is impossible - nor utter it.'[16]

In other words, what 'It is not' or 'non-Being' are for Parmenides false propositions, hence propositions with a truth-value. Thus Parmenides stated something which contradicted the definition of Being — the linguistic existence of non-Being. But Wittgenstein considered that only the propositions of the natural sciences may have a sense, and a discourse about what doesn't exist could not be a subject of the natural sciences. The latter will be termed as a non-sense. For Wittgenstein, all the statements which don't have a sense cann't have a truth-value:

> '[...] but a proposition without a sense corresponds nothing at all, for it signifies no thing (true-value) whose properties are called 'true' or 'false'; the verb of the propositions is not 'is true' or 'is false' [...] but that which 'is true' must already contain a verb'.[17]

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[15] *Ibidem,* prop. 5.101, p. 56.
[16] Parmenides- *On nature*, II, 5-10, translation by John Burnet, 1982.
[17] Wittgenstein, Ludwig - *Tractatus Logico-Philosophicus*, prop. 4. 063, pp. 43-44, 1922.

Plato used the rhetoric subterfuge of the dialectics to confront contradictory beliefs for the purpose of generating true conclusions. Often, he inserted subjective and unconfirmed premises or he opposed false beliefs. Using mythological stories — mythologems — to complete or sustain his inductions, Plato appealed at *argumentum ad verecundiam*. The mythologems, *muthologēma*, were used either as warrants or justifications of truth, either as elements of the inferences, in the same way in which theorems operate in geometry.

The myths of Eros and of two Aphrodites, celestial and communal, were used in *Symposium* to indicate the different steps taken by humans for knowing the prototype of Beauty. Intermediate steps were required, and each of them was illustrated with a corresponding deity. The fable of Gyges, from *Politeia*, had the role of describing a situation in which a man was no more subjected to the social control. Hence, a special situation needed a surrealistic scenario. Chariot allegory, from *Phaedrus*, speaks about the posthumous destination of the human souls, and implies names of gods as Zeus, in a Pagan anticipation of the late Christian myths. The soul is compared with a chariot, which is easier to be controlled by the virtuous mortals and by the gods. In the same dialogue, Plato originates some of the edge mental states of humans in a divine influence: love is owed to Aphrodite, prophecy to Apollo, the mystic rites to Dyonysos, poetry to muses. In *Timaios*, the Demiurg was used as a principle of becoming and efficient cause (craftsman) of the world. The myth of cave from *Politeia* was probably invented by Plato in the purpose of underlining the cognitive differences between humans and to present his theory of Ideas in a better light. Also, this myth is a true *PowerPoint* presentation of Plato's epistemology.

Aristotle inherited from his teacher, Plato, the tendency to construct his own principles of cosmology and ontology, and only afterwards to analyze the various issues from all sides. All the conclusions which were recalcitrant to his already proclaimed principles were rejected. The case of circular motion, in its alleged quality of dynamic expression of eternity, was one instance in which Aristotle gave us the illusion of a demonstration. Because no part located on the circumference of a rotating sphere of Aristotelian Universe could be considered the cause of this motion, he inferred that circular motion, having the property of feeding itself, is a natural consequence of an eternal Universe.

In accordance with the psychological type and personality of the metaphysician, as well as with his personal background, the philosophical system described the becoming of the world — or on the contrary, its immutability, as in the case of Being of Parmenides — in a psychologically and socio-culturally determined manner. Quoting G.W.F. Hegel, 'Every man is the son of his time', and I can say that the work of the ancient philosophers was strongly influenced by the historical context in which they lived, shaping their personalities and limiting their apparent incommensurable quantity of choices of their intellectual expressions.

In the first place, the majority of the philosophical systems anterior to the twentieth century appeared either within a favorable intellectual climate, as the age of *Graecia Magna*, Roman Empire, Renaissance, the age of the rationalists, the period of the German romantic period, the American economic boom or within certain philosophical schools as: Eleatic school, Pytagorean school, Plato's *Academos*, Aristotle's *Lyceum*, Alexandrian schools, etc. The philosophers emerged on the stage of history in pairs or clusters: Parmenides, Zeno and Melissus in Elea, Socrates, Plato, Aristotle in Athens (without mentioning that Cratylus, the pupil of Heraclitus from Efes, was the first teacher of Plato), Plotinus, Porphyry, Iamblichus in Alexandria and Rome, Descartes, Malebranche, Spinoza, Leibniz as rationalists in continental Europe or Hegel, Fichte, Schelling, Jacobi and Kant as idealists in the German states.

In the second place, the works of the metaphysicians which lived in the same period or which belonged to the same school of thought or to the same philosophical doctrine were closely related.[18] Their ideas completed each other or continued the topics of their contemporaries, colleagues and mentors. Zeno reacted to Parmenides, Plato developed some of the ideas of Socrates, but was contradicted by Aristotle. Plotinus reawakened the interest of his contemporaries for classic Greek philosophy, and the same purposes were shared by his disciples. Spinoza, Leibniz and Descartes inspired each other, living in the same epoch. Hegel was heavily influenced by Kant, Fichte and Schelling, the last one considering Hegel as a pupil of himself, although Hegel was older than Schelling by five years.

Still, the advantage of the philosophers of antiquity, metaphysicians par excellence, was the fact that they had the opportunity to say almost anything that did not contradict the laws of logic or perceptible reality. Of course, this made even thinkers as Aristotle to sustain a geocentric theory, but on the other hand, we can easily see that basically the same patterns of reasoning were implied in the first cosmologies of our culture.

The first cosmologists, as well as the current ones, played with the same pairs of essential concepts: 'practical - theoretic', 'real - unreal', 'existence - non-existence', 'existence - transcendence', 'matter - void', 'spirit - matter', 'form - matter', 'material - immaterial', 'finite - infinite', 'eternal - temporary', 'unique - multiple', 'whole - part', 'absolute - relative', 'absolute - contingent', 'necessary - possible', 'potential - actual', 'necessary - impossible, 'possible - impossible', 'order - chaos', 'universal - particular', 'cause - effect', 'active - passive', 'direct - indirect', 'complete - incomplete', 'independent - dependent', 'mean - scope', 'homogeneous - inhomogeneous', 'motion - rest', 'heavy - light', 'warm - cold',

[18]I made this additional specification because, for instance, although Plato and Aristotle worked within the same philosophical school for a certain amount of time, Plato's *Academos*, it was a sharp difference between their ideologies. Thus, if Plato was on objective idealist, Aristotle was a sort of ancient realist, the father of logic, and a true forerunner of Kant, being, at his turn, a metaphysician of nature, of morality and of art.

'dry - wet', 'coarse - subtle', 'air - aether', 'stable - unstable', 'bound - unbound', 'particle - wave', 'position - momentum', 'complementarity - opposition', 'divisible - indivisible', 'simple - complex', 'continuous - discrete', 'divergent - convergent', 'odd - even', 'positive - negative', 'true - false', 'subject - object', 'concept - object', 'terrestrial - celestial', 'sensible - intelligible', 'microcosmos - macrocosmos', 'identity - difference', 'interior - exterior', 'superior - inferior', 'superordinate - subordinate', 'superstructure - infrastructure', 'maximum - minimum', 'substance - attributes', 'quality - quantity', 'organic - inorganic', 'light - dark', 'genesis - destruction', 'past - future', 'beginning - end'.
Also, they used often inductions and deductions for their conclusions, they compared collected data, they used hypotheses when the data were insufficient to draw a conclusion.
More or less, the same requirements, like the appeal to logical consistency, coherence, usefulness for the rest of the science, openness for further improvements, were used in the dawn of our culture as well as in the present days' cosmologies to legitimate a theory. Anyway, almost the entire science of antiquity was based on belief, *doxa*. The cosmological explanations were accepted by the polytheist and henotheist religions, while Greek, Roman and Persian medicine adopted the doctrine of the four humors, whose proportion in the human body determined the temperaments and propensities of the individuals to a certain type of disease. Each humor corresponded to a natural element, and had physical properties. The permutations between elements and properties were essentially the same to those from Aristotelian Universe, i.e, air was warm and wet, fire was warm and dry, etc. This is the sense in which ancient cosmologies must be understood as open to the rest of the knowledge. Still, the most important criteria for the modern empirical science were non-existent during antiquity. The ancient pseudo-science is not related to the concepts of experiment, observation, verifiability, confirmation.
The fundamental concepts are the same, the methodology is similar because the structure of our mind remained unchanged — moreover, I assume that the laws of our logic are universal in a sense more powerful than can be suggested by the use of the word. I must admit that my view is not shared by everybody, although I didn't find compelling arguments for this alleged relativity of logic:

> 'A problem that arises then is, What determines what is possible? For example, what about the laws of logic themselves? Are they inviolable in considering all possibilities? We cannot answer, for we have no access to this multitude of postulated worlds.'[19]

The only place where the laws of logic may be constantly violated would be a quantum world.
Also, for a theory to be successful, it had to pass almost the same type of conditions. Nowadays it is impossible for a hermit to modify the basis of the

[19]Ellis, George F. R. - *Issues in the Philosophy of Cosmology*, p. 41.

positive sciences because he would be unable to use the same technical vocabulary as the scientists. He will succeed to do so only if he has the intellectual property of the concepts and of the words employed in his discourse. The case of Georges Lemaitre, priest and astronomer, cannot work as a counterexample, precisely because he was a scientists in things concerning the science, and a clergyman in things concerning religion, as he said repeatedly. The modern science of contemporaneity is neither theological, nor rhetorical or juridical. The way of speech does not change the truth-values of the sentences, and this happens in good part because human knowledge reached borders located far beyond medieval science. Our knowledge received objectivity: the scientific data can validate themselves, they do not need the approval of a theological or traditional authority. On the contrary, all the political authorities of the actual states are interested that progresses to be made, no matter their ideological convictions.

Greek mythology reflected humans' place in the Universe, being thus in total opposition to the medieval philosophy of Europe. Though Greek cosmology was more realistic than the Christian explanation of the world and of its creation, it was not based on empirical facts. Only the sensory perception and the most commonsensical inferences were used during Greek antiquity. Their metaphysical systems, fed by a prodigious mythology, were modest in matters concerning the place of humans within the world. Still, these metaphysical systems were predominantly subjective, and the elements of the modern empiric science were extremely scarce. Although the Greek *kosmos* was anthropomorphous, and the gods themselves were anthropomorphous, Greek mythology gave to humans a small place in the economy of Universe. Especially the after-life, as well as in Egyptian mythology, was sombre, limiting most of the people to the state of a shadow. The metaphysical systems were centered around the main cosmogonic and cosmological themes: Thales, which established water as the principle of all things, Parmenides, which denied the change, Empedocles, which elaborated a cosmological theory where the natural elements and the cosmic forces were the only actors, Heraclitus, which considered that everything is in a continuous becoming, or even Aristotle, with his geocentric, rotational and eternal system of concentric spheres, have given little significance to the humans.

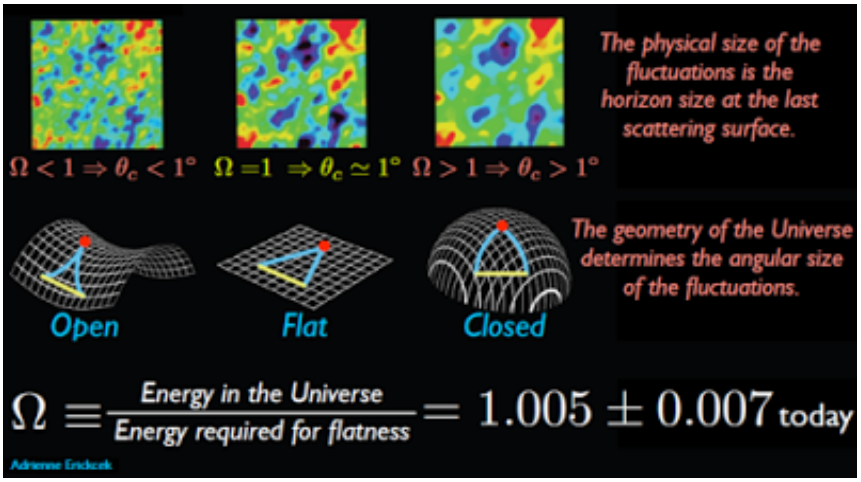
Therefore, despite of the similarities between them and us consisting in the general object of research and in their fundamental vocabularies, the cosmological systems of the distant past differed radically from those ones of the present.

Although modern cosmologies have the pretension and the means to be more realistic, and eventually to be claimed as true, the complexity of the matter which we shall explore exposes them to almost the same degree of fallibility as their ancient counterparts. More or less, we contemplate the same helplessness in the front of the immensity of the world to which we belong.

3.1 Big Bang Cosmology

The Big Bang model is explanatorily and empirically the best supported cosmological theory. The Big Bang model uses a Friedmann-Lemaitre-Robertson-Walker metric of spacetime. This metric describes a homogeneous and isotropic Universe, hence it is in complete accordance with the cosmological principle. Also, this mathematical model of the physical reality is available both for an expanding or for a contracting Universe. Basically, FLRW metric constitutes a solution to Einstein's field equations.
The texture of Cosmic Microwave Background (CMB) is one of the best confirmations of the homogeneity and of the isotropy of the Universe, as it is depicted by Friedmann-Lemaitre-Robertson-Walker metric. The symmetry properties of the Universe hold statistically at large scales. When we are analyzing clusters of galaxies, the distribution of matter within the component galaxies or the relative positions of the clusters themselves is less important, because we can see that they populate uniformly the sky, without any preferential direction. The spacetime geometry of the Universe is determined by energy densities described by General Relativity. The general form of the metric follows from the geometric properties of homogeneity and isotropy; Einstein's field equations are needed to derive the scale factor of the Universe as a function of time, and to allow FLRW as a solution to the field equations. A *strictly* FLRW-model does not describe non-microcosmic material contents, as clusters of galaxies or even small asteroids, because any of these objects are heavier than a typical part of the Universe — the latter being a lower density space, where the matter consists in dispersed atoms of hydrogen. FLRW-model is used as a first approximation to the evolution of the Universe because it is simple to calculate, and the more realistic models that compute the bigger concentrations of matter from the Universe are added onto the FLRW-models as extensions.
Actually, FLRW theories imply three different type of Universes, classified accordingly with the type of curvature and with the matter density of each of them: open, flat and closed. The open Universes are those with a negative curvature and have a saddle-like shape, the flat Universes are approximatively Euclidean and have null curvature, while the closed Universes are spherical and

they have a positive curvature. Of course, the so-called flat Universes are not really flat (in spacetime), but spatially flat.

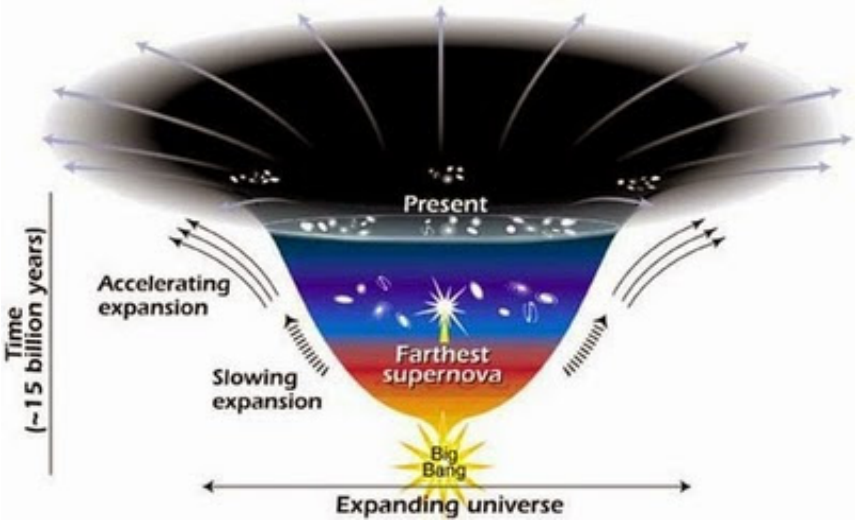


The theory of Big Bang was parametrized by ΛCDM (*Lambda* Cold Dark Matter) model, where the Universe contains a cosmological constant (the energy of the vacuum or a source of negative pressure), Λ, and Cold Dark Matter. The latter is supposed to be instrumental in structure formation, currently having an essential role in maintaining the big baryonic structures such as clusters of galaxies and galaxies, while representing about a quarter of the total amount of mass of the Universe. CDM is also important to differentiate a small galaxy from stray groups of stars, because it is found in large quantities within the galaxies, whose formation was seeded by CDM.

Lambda Cold Dark Matter model, and implicitly, Big Bang theory, manage to explain the existence and structure of the Cosmic Microwave Background, the large-scale structure in the distribution of galaxies, the abundances of hydrogen, helium, and lithium, and the accelerating expansion of the Universe observed in the light from distant galaxies and *supernovae*.

The first theory of Big Bang was conceived by Georges Lemaitre and Alexandr Friedmann. Friedmann derived the Friedmann equations from the equations of General Relativity, opening thus the path for the possibility of an expanding Universe, which contradicted the static model sustained by Einstein. The theoretical foundations of Big Bang theory were established by Lemaitre, but over the decades the initial theory was modified. The discovery of Cosmic Microwave Background in 1964 transformed Big Bang theory in the dominant academical preference for most of the cosmologists. The model of eternal inflation of Andrei Linde is the most famous cosmological theory that was elaborated on the basis of Friedmann-Lemaitre model. The Big Bang theory is also considered as the Standard Model of cosmology.

The central idea of Big Bang is that the Universe is expanding, and it is not in a steady state, as the most of the scientists believed before Friedmann and Lemaitre published their results.

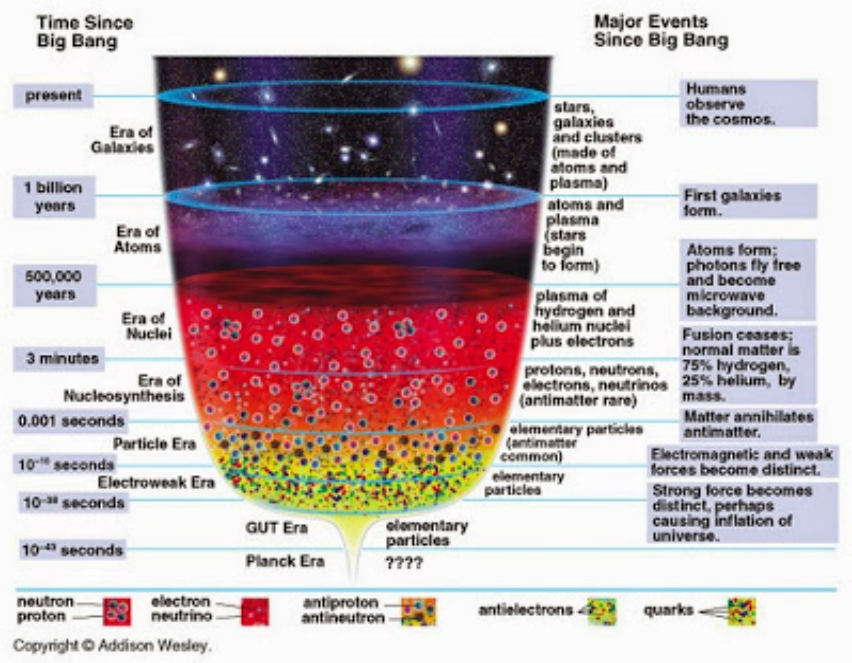


According to Big Bang theory, the Universe has began 13.798 billion years ago, originating itself from a gravitational *singularity*. The cosmic epochs that followed this moment were: Planck Epoch, Grand Unification Epoch, Electroweak Epoch, Reheating Epoch, Hadron Epoch, Lepton Epoch, Photon Epoch, Matter Epoch, Dark Energy Epoch.

It is assumed that during the first cosmic era, the so-called *Planck Epoch*, the temperatures were so high that the four fundamental forces of the present Universe were one unified force. Initially, the matter didn't exist due to the extremely high temperature. The entire Universe was a small packet of plasma, and spacetime expanded at 'ultrarelativistic' speeds. The matter and radiation were not yet decoupled. Because of the extremely small scale of the Universe, Quantum Gravity is the most suitable theory to describe the phenomena of the Planck Epoch. Still, this period of the early Universe is poorly understood. The scientists are not yet able to say how the four fundamental forces of nature were unified, and what determined them to break apart, giving birth to the world as we know it today.

Grand Unification Epoch was the cosmic era that followed immediately after Planck Epoch. Then the temperatures were still extremely high, while only the gravity became separated from the other three fundamental forces. The latter were still unified, being known as electronuclear force. During Grand Unification Epoch the masses were extremely small. At the end of this period the strong nuclear force separated itself from the other two non-differentiated fundamental forces. During Grand Unification Epoch it is supposed that baryogenesis took place, and hence the number of the baryons exceeded the number of the anti-baryons. This period hosted the initiation of cosmic inflation.

The next period was the *Electroweak Epoch*. It is assumed that during this period the Universe contained a hot and dense plasma of quarks, antiquarks and gluons. *The Inflationary Epoch* is an overlapping cosmic age which started at the end of Grand Unification Epoch, but whose end was not yet clearly confined. Most likely that the Inflationary Epoch ended in the middle of the Electroweak Epoch. The inflation was generated by a hypothetical field called inflaton field. It seems that a phase transition that marked the end of Grand Unification Epoch and the beginning of Electroweak Epoch generated a scalar field named by physicists inflaton field. This field was the effect of an energy state lower than that of the Grand Unification Epoch, and determined an exponential expansion of the fabric of spacetime at a speed faster than the speed of light. In this way, previously inhomogeneous particles and anti-particles that populated the Universe were redistributed in homogeneous patterns within the increasing volume of the Universe. The Inflationary Epoch was defined by colder temperatures. The Inflationary period ended when Reheating took place.



The Reheating Epoch is the age of *baryogenesis*, when the Universe returned to the temperatures previous to the inflationary epoch. The huge potential energy of the inflation field suddenly decayed and filled the Universe with elementary particles and radiation. During Reheating, photons, gluons and quarks were formed, but in a plasma state. Quarks and anti-quarks began to annihilate each other. However, for reasons not yet figured out, the mutual destruction of quarks and anti-quarks ended with a surplus of quarks. Because of this discrepancy stars, planets, and human beings exist today. This was also the time when *all* four fundamental forces were separated.

The Reheating Era was succeeded by the *Particle Era*, during which the first particles were created, hadrons and leptons, as an effect of the lower temperatures.
As the Universe continued to cool, new particles were formed out of pre-existing ones. This early formation phase is called the Big Bang Nucleosynthesis (BBN). Firstly, we speak about *Hadron Epoch* when the Universe was dominated by hadrons. The quarks and anti-quarks formed during the previous period combined each other creating the first hadrons, respectively, the first anti-hadrons. The matter and the anti-matter were in a state of thermal equilibrium. But, as an effect of the decreasing temperatures, new pairs of hadrons and anti-hadrons weren't produced anymore. Just a small residue of hadrons remained and the cosmic landscape started to be dominated by leptons. Then we enter in *Lepton Epoch*. During this sub-epoch, leptons and their anti-matter pairs (positrons) remained in thermal equilibrium as long as the temperatures allowed it. When the temperatures decreased significantly the leptons and anti-leptons began to annihilate each other, and only a small residue of leptons was preserved. The next cosmic period is *Photon Era*. This was the cosmic period during which photons dominated the energy of the Universe. It started at the end of the Lepton Epoch. Nucleosythesis occurred in the beginning of Photon Era and consisted in the formation of nuclei of other than those of the lightest isotope of hydrogen, protium. During this era, deuterium, helium, and small quantities of lithium, berylium and tritium were formed. The last two decayed in lithium and helium, respectively. The era was characterized by the existence of a hot and dense plasma of nuclei, electrons and photons. The Photon Era was a dark age of the early history of our Universe because the photons were intercepted by the free electrons and protons.
As the Universe continued to cool off, more and more ions were formed. Expansion caused radiation to lose more energy than matter so that after a while, matter (nuclei) particles exceeded massless particles (photons). About 70.000 years after the Big Bang, radiation and matter were about equal in density, shortly thereafter matter began to dominate. This is the moment the *Matter Era* began. During this period, Cold Dark Matter dominated, facilitating gravitational collapse to amplify the tiny inhomogeneities left by cosmic inflation, and making thus dense regions denser and rarefied regions more rarefied. Pre-inflation quantum fluctuations were amplified by inflation generating post-inflationary overdensities. These overdensities represented the seeds for the later structure formation. Around these seeds, dark matter started to concentrate long before the decoupling between radiation and the baryonic matter. Thus was created the infrastructure for the future baryonic structures that populate the space between the cosmic voids.
For the next 310.000 years, the Universe continued to expand and cool off, but was still fiery hot and dark. Any visible light was immediately scattered by collisions with the ubiquitous electrons and protons. Eventually, the Universe

cooled to the point that the formation of neutral hydrogen was energetically favored. The electrons begin to get captured by the ions forming atoms which were electrically neutral. This process is known as 'recombination'. At about 380.000 years of cooling, photons decoupled from matter and began to travel through the spaces between the atoms which now 'bind' the electrons in their orbits. The freed photons constituted the Cosmic Microwave Background Radiation. The Universe had become transparent. The first structures began to form. These small clumps of matter grew in size as their gravity attracted other, nearby matter. The process of structure formation continued in time with the creation of first galaxies, made from the lightest elements. From the material spread by the most massive of stars from the primeval galaxies - the first *supernovae* - were created the late stars with their subsequent planets. All of them were contained in bigger galaxies. In time, the galaxies aggregated in larger structures, clusters of galaxies, superclusters, walls and filaments.

Dark Energy Era began after Matter Era, when the Universe was about 9.8 billion years old. As other forms of the matter dropped to very low concentrations, the dark energy started to dominate the energy density of the Universe. Dark energy is an intrinsic property of space. The first property of the empty space discovered by Einstein is that it is possible for more space to come into existence. One version of Einstein's Gravity Theory, the version that contains a cosmological constant, makes a second prediction: 'empty space' can possess its own energy. Because this energy is a property of space itself, it would not be diluted as space expands. As more space comes into existence, more of this energy would appear. As a result, this form of energy would cause the Universe to expand faster.

Big Bang has become the main cosmological model of present physics, and it has the quality of explaining the most important cosmological phenomena: the abundance of the light elements in the Universe, the existence and structure of Cosmic Microwave Background Radiation, the large-scale structure in the distribution of galaxies, the accelerating expansion of the Universe observed in the light from distant galaxies, and *supernovae*.

The lightest elements, hydrogen and helium, were and are the most abundant elements in the Universe because they were produced in the primeval nucleosynthesis, the so-called Big Bang nucleosythesis, while the heavier elements were generated later, due to the stellar nucleosythesis. The Big Bang cosmological model allows us to explain the actual ratio between the astronomical metals and the first elements because it describes convincingly Big Bang Nucleosynthesis, as an event that happened as a consequence of the lower temperatures from the Universe of the Photon era. Then were created deuterium, tritium, helium, lithium and berylium, the only isotopes and elements that were not the byproducts of the stellar evolution. Their ancient abundance, when these elements represented the entire stock of baryonic matter, explains their current ratio, when hydrogen and helium continue to be the predominant elements in nature.

The structure and the very existence of Cosmic Microwave Background Radiation may be explained only within the theoretical frame provided by the Big Bang model. The photons that began to circulate freely through space, as an effect of recombination between ions and electrons, and which were scattered due to the decoupling from matter, gave to this relic radiation its approximately homogeneous structure.

The structure formation is also excellently explained by Big Bang model. The initial thermic perturbations were amplified by the decrease in temperature and by inflation, while in the post-inflationary period the Cold Dark Matter was gravitationally attracted by the resultant overdensities, creating the seeds for the future baryonic structures. The latter started to form after recombination, and the denser dark matter halos attracted higher quantities of neutral atoms. In time, these structures grew in size, and due to gravity, which become operational after decoupling, the bigger baryonic aggregates attracted larger quantities of matter.

Finally, the accelerating expansion of the Universe is explained as an effect of the continuously decreasing density of matter, while the dark energy, in its quality of an inherent dynamic property of spacetime itself, remains constant, but whose power relative to that of matter and gravity increases determining the accelerated expansion of the Universe.

The Universe's expansion rate was decelerating until about 5 billion years ago due to the gravitational attraction of the matter content of the Universe, after which time the expansion began accelerating. This happened because the matter ceased to be the dominant force in the Universe, its density being diminished gradually. In order to explain the acceleration physicists have postulated the existence of dark energy which appears in the simplest theoretical models as a cosmological constant.

3.2 Multiverse Cosmology

One of the issues raised by the uniqueness of the object of study of cosmology is the fact that we can not discover new laws of physics, available for a different, but similar object. Even the idea that possible twin Universes, contemporary, causally disconnected or cyclic, do exist, does not guarantee that observing them we deal with different physical laws, and in any case, these laws will forever be concealed to us, taking in account our confinement to our own Universe. Consequently, an interaction between our Universe and another bubble Universe would pass more likely unnoticed by us and definitely would not help us to understand the physical laws of the respective Universe.

Our sense of reality is so weak that we can not rule out the possibility that our world is contained in the ergo-sphere of a huge black hole or that it was exposed to special initial conditions, a fact that would explain the debatable strangeness of the temporal asymmetry of our Universe, where the events seem to flow only in one direction, from the past to the future, contrary to the fundamental physical laws, that are time symmetric.[20]

Of course, the main counter-argument would be that the temporal symmetry is a property of microcosmic systems, not of macroscopic matter. Once the matter structures in stable compounds, as a consequence of the decreasing temperatures and densities, the arrow of time starts to become uni-directional. The lifespan of the larger baryonic structures is big enough to be relevant, and the arrow of time cannot be reverted anymore.

Anyway, the fact that the FLRW-model describes accurately the nature of Universe ceases to be so clear if we extend the borders of the physical Universe far beyond its natural limits, and, consequently, we call in the game concepts like 'Multiverse'. More precisely, a group of contemporary Universes will not necessarily be distributed in a homogeneous and isotropic pattern. In other words, we cannot know — and we may even conceive recalcitrant encompassing scenarios — whether the Universe is globally depicted by FLRW-model or not. These recalcitrant scenarios can be imagined because the Universe may exhibit clear non-uniformities at supra-Universal length scales, both inhomogeneities and anisotropies. These scales will correspond either to spatial scales larger than the Universe itself, as the alleged vacuum between Universes or as the ensemble of all Universes (Multiverse), or they will correspond just to hyper-volumes exterior

[20] v. also Ellis, George F. R. - *Issues in the Philosophy of Cosmology*, p. 32.

to it, or to some special 'intertwined' cases when the trajectory of our own Universe intersects with that one of a different Universe.
All these examples designate instances when the cosmological paradigms of FLRW do not hold anymore, at least *prima facie*. But, in fact, these principles extend non-empirically the content of the notion of Universe.
According also to Ellis, Kirchner and Stoeger, *Multiverses and Physical Cosmology*, when we speak about Universe we mean the entire domain of existence, and hence, if we assume the existence of many-worlds, then their complete ensemble (the Multiverse) will represent the updated version of Universe. If we admit the existence of other Universes, their actual union will not correspond to an inductive inference from local to global in the sense meant by FLRW, but will signify instead that the FLRW-model will be discarded, at least at extra-Universe scales. It would be very unlikely that the physical laws of the other bubble Universes are the same; and anyway this will be something that can be only conjectured, as well as their very existence.
In conclusion, if we admit the existence of numerically different Universes alongside our own Universe, we have the same heuristic liberty to assume that at least one of them harbours different laws of nature. Anyway, the distribution of these Universes within the encompassing frames of the Multiverse cannot be homogeneous, and neither their motion isotropic according with the inflationary cosmological scenarios for the Multiverse, where the Universes are nucleated at different times at aleatory places within the Multiverse-vacuum or even they can be nucleated from a previously emerged Universe.
Of course, this failed uniformity of the ensemble does not necessarily imply that its parts (bubbles, cells) will behave the same because we have one example, our Universe, in which the cosmological principle holds. If the Multiverse is the product of inflation, and logically speaking the Multiverse's idea leads here, then we *may* assume the existence of a higher structure that will contain the Multiverse, and we arrive to the first Kantian cosmological antinomy. More precisely, we shall have the tendency to extend indefinitely the cosmic hierarchy, although we do not have any proof that the group of all Universes is infinite. Though, the contradictory thesis will be equally unprovable. We will not have any reason to stop our counting of the Universes — named by now Multiverses — at increasingly higher orders of magnitude, but neither any chance to achieve the highest mathematical and dynamical limit and to bound this structure somehow. Of course, these are logical considerations; while the cosmological models of a Multiverse, as the highest cosmological structure, are more philosophical than empirical. The things *may* also be smaller than an ensemble of Multiverses, but definitely they can not be smaller than our Universe.
Andrei Linde's chaotic inflation sustains the idea of a set of FLRW-like Universes. Here an inflaton field drives inflation and leads to the production of an indefinite quantity of causally disconnected Universes:

> 'This kind of scenario suggests [...] a really existing ensemble of many very different FLRW-like regions of a larger Universe. However, these proposals rely on extrapolations of presently known physics to realms far beyond where its reliability is assured. They also employ inflaton potentials which as yet have no connection to the particle physics we know at lower energies.'[21]

But, as I said before, we lack anyway observational proof for such a cosmological model. The possibility that these Universes are generated in an infinite number is invoked by Ellis as an additional problem.
Anyway, the idea of meta or super-Universal non-uniformities that may discard FLRW-model of reality is debatable, depending mainly on accepting the concept of a Multiverse. The inflationary theories are structurally open to scenarios that involve many-worlds:

> 'It is hard to build models of inflation that do not lead to a Multiverse. It is not impossible, so I think there is still certainly research that needs to be done. But most models of inflation do lead to a Multiverse, and evidence for inflation will be pushing us in the direction of taking [the idea of a] Multiverse seriously.'[22]

The bubble Universe model presupposes that different spacetime regions decayed at different moments to true vacuum states, generating bubble or baby Universes, causally disconnected and governed by different physical laws in accordance with the huge space of possibilities given by the cosmological parameters. Certain numbers that describe the properties of the Universe as: expansion rate, curvature, dark energy may differ from one Universe to another and determine particular laws for these Universes.
Here is a clear contrast between claiming that the observable Universe respects more or less the theoretical constrains specified by FLRW-model, and the extension of this fact to a global claim regarding *all* of spacetime. The former plays a fundamental role in evidential reasoning in contemporary cosmology, whereas the latter is disconnected from empirical research by its nature. Of course, we can not rule out the possibility that the spacetime of our Universe plus an indefinite vacuum from which it emerged to represent the entire reality. Though, the simple appeal to inflation gives room to Multiverse's interpretations, fact that relativizes the intended global FLRW-model. Still, we are living here, in our Universe, and this seems that will be available for our entire lifespan.
FLRW-models of Universe, now associated with inflation, met a series of explanatory difficulties. At the beginning it was not clear at all why the initial singularity spawned the Universe as we know it. This cosmological theory, in its bare formulation, required an improbable initial state characterized by a high homogeneity of the particles, although separated regions were causally

[21]Ellis, George F. R., Kirchner, U., Stoeger, W. R. - *Multiverse and Physical Cosmology,* p. 24.
[22]Guth, Alan - *The Inflationary Universe*, Perseus Books, 1997, p. 56.

disconnected, while the initial value of the Hubble constant had to be extremely fine tuned.
Additional problems marked this cosmological scenario, the most important from them being related to structure formation, from atoms to galaxies. More precisely, the amplitude of the thermal perturbations that constituted the seeds for the future baryonic and *luxonic* aggregates, the galaxies and the clusters of galaxies (the latter being essentially the walls and the filaments of matter) is 9 degrees of magnitude smaller than should have to be in order to allow the development of the material Universe. Also, the thermal fluctuations had to be coherent at super-horizon lengths scales, a fact that was not the case according with FLRW-model.
This is why, in the year 1980, Alan Guth introduced the inflationary phase from the early Universe. His research firstly appeared in the journal *Physical Review*, with the title: *The Inflationary Universe: A Possible Solution to the Horizon and Flatness Problems*. Thus, a temporary phase, that took place extremely soon after Big Bang, explains both the horizon problem and the actual mass density and shape of the Universe. Inflation addresses successfully precisely the problems that affected the first version of the Standard Model, and hence what was characterized by the Standard Model alone as being improbable becomes normal when we try to explain our Universe using Standard Model in conjunction with inflation.

3.3 Conclusions about modern cosmologies

I analyzed the most important cosmological theories and sub-theories, describing their main features and trying to identify their main theoretical and practical problems.
I approached one of the strangest subjects of a very strange science, namely the Multiverse, a cosmological heuristic concept that implies recurrently, both spatially, numerically and temporally, the concept of infinity.
It is impossible for us to hope that we shall succeed someday to know positively whether our Universe is the only one or we live in a Multiverse, or to appreciate empirically if the current Universe belongs to a cycle of expansions and collapses or it is a completely novel emergence of matter, antimatter and radiation in the domain of existence.
It is unlikely that we will ever know whether the Universe is eternal or streamed from a singularity. From our point of view both branches of interpretation lead to an unverifiable explanation, hence they can not be checked experimentally, but both are logically possible. Anyway, these questions belong already to the field of metaphysics and philosophy of science, and they are essentially the same as those ones raised by the ancient philosophers:

> 'Is not clear in the end which is philosophically preferable: a singularity or eternal existence. That decision will depend on what criteria of desirability one uses.'[23]

According to eternal inflation models, (infinity of) the false vacuum generates the finite spacetime in which we live. Ellis said:

> 'If the proposal is the evolution from a previous eternal state, Minkowski space for example, then why did that come into existence, and why did the expansion of the Universe as a bubble from that vacuum start when it did, rather than at some previous time in the pre-existent eternity?'[24]

Therefore, the sudden beginning of the Universe, and hence of the causal or proper (space)time cannot be otherwise than arbitrary. We cannot see any internal logic of eternity to cancel itself and to generate the finite spacetime in which we live. Logically speaking, we cannot identify any reason for why the lack of order and causality, which is the pre-cosmic indeterminate eternity, will give

[23]Ellis, George F. R. - *Issues in Philosophy of Cosmology*, p. 29
[24]*Ibidem*, p. 29.

birth to order and causality. As you know, the main meaning of the Greek word *'kosmos'* is 'order'. Actually, the state of world before the apparition of the Universe cannot hide in itself any kind of reason like the Hindu *rita* or the Greek *logos*. Though, physically speaking, we still may conceive cosmological models that should explain how an Universe is nucleated by a false or metastable vacuum.
The model of a cyclic Universe, where there was neither an absolute beginning or an absolute emergence of spacetime, makes the impression that it would be able to overcome these issues, superposing the physical notion of spacetime with the philosophical *and* physical notion of eternity. But I think that the model of the cyclic Universe, although *prima facie* fixes the problems raised by the spacetime singularity, produces greater issues, even though they are mainly philosophical.
The model of eternal (chaotic) inflation of Andrei Linde does not need any beginning in time for the Multiverse, while Universes like ours, that are hospitable to life, would be probabilistically enabled to exist in more than one instance. As a matter of fact, since the time passed until the alleged nucleation of our bubble-Universe was infinite, we have all the reasons to believe that similar Universes were already created and collapsed an uncountable number of times before.
Still, the spatial infinite is not so obvious, and we do not have any proof that our mathematical constructions of infinity have physical reality:

> 'Infinitely large space-sections at the macro-level raise problems as indicated by Hilbert, and leads to the infinite duplication of life and all events. We may assume space extends forever in Euclidean geometry and in many cosmological models, but we can never prove that any realised 3-space in the real universe continues in this way — it is an untestable concept, and the real spatial geometry of the universe is almost certainly not Euclidean. Thus Euclidean space is an abstraction that is probably not physically real.'[25]

And also the alleged shape of our Universe, inferred from the approximative value of its curvature, k, indicates that:

> 'The best current data from CBR and other observations indeed suggest k = +1, implying closed space sections for the best-fit FL-model.'[26]

On the the hand, eternity seems to be a bigger *conundrum* than spatial infinity. Maybe that Ellis provided the answer regarding the problem of temporal infinity in the following phrase, and this interpretation appears to be reinforced by a slightly different species of common sense, the intellectual's — or perhaps speculative — common sense:

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[25] *Ibidem*, p. 47.
[26] *Ibidem*, p. 47.

> 'Even attempting to prove [...] future infinite is problematic (we cannot for example guarantee the properties of the vacuum into the infinite future — it might decay into a state corresponding to a negative effective cosmological constant).'[27]

Actually, this may be a valuable proposal, that the temporally symmetric and essentially barren of events pre-cosmic period generated suddenly spacetime, and hence the first Universe(s), as an effect of a state modification of the pre-existing vacuum. Consequently, this phenomenon may be reverted, and the Universe may be erased by a new modification of the state of the vacuum. Indeed, everything that had a beginning may end, in this case the end may be produced by the reversal of the generative process.
Logically speaking, if we start to double the already existing background infinity with a subsequent infinity of contents at a certain time — infinity of the Multiverse — or at any given time, then we should have the right to extend as much as we would like the cardinality of the Multiverse, because what will result will be *as well* an infinity of Universes. Would be like recreating algebra in the field of physics. The same is said by Ellis when he analyzes the perspective of an infinity of Universes constituting an ensemble:

> 'Suppose for example that we identify corresponding times in the models in an ensemble and then assume that all values of the density parameter and the cosmological constant occur at each spatial point at that time. Because these values lie in the real number *continuum*, this is a doubly uncountably infinite set of models.'[28]

The paradox is obvious, even ignoring the technical issues generated by the ontological impossibility of the structured matter to be found in an infinite quantity, since the principle of individuation of every bit of matter, luxonic or bradyonic, lays precisely in its mathematical differentiations. All the chemical elements are individuated by numerical reports. The proton numbers differentiate the elements, while the neutron numbers give the isotopes. Also, the odd numbers of quarks make the hadrons. The shells and subshells of the electronic clouds of the chemical elements have an even number of available orbitals. Everything seems to be a matter of quantity. Infinity is not a properly differentiated quantity: you can differentiate one million from one billion, but you can not distinguish between infinite and infinite in the physical sense, when the numbers which are counted stand for real quantities which will never be *effectively* infinite. You can express the spatial infinity in various units of measurement of length, like feet, miles, AU, parsecs, light-years, but the final result will be expressed in an continuously growing number, though always

[27] *Ibidem*, p. 48.
[28] *Ibidem*, p. 48.

countable. Actually, we cannot differentiate two physical infinities because we are not able to effectively perceive a single infinity.
Of course, you can say that the divergent series of odd natural numbers is infinite and has an equal cardinality with the divergent series of even natural numbers, while both of these series have a smaller cardinality than the series of natural numbers, which is, at its turn, infinite. Moreover, intuitively, you can assert that the series of the natural numbers contains without rest the sum of the subsequent series of the odd natural numbers and of the even natural numbers, and hence that it is as an union of both. But not all the members of these series have a name, although we established relations of inclusion and of mediated equality (union and intersection) between them (even numbers + odd numbers = natural numbers). Therefore, not all the constituents of the series of natural numbers, or even more if you want, not all the numbers of the *continuum* have a proper name. Or, even if they have a proper name, they do not have a specific or assigned position alongside the real line of the numbers. For example, nobody had computed yet the entire spectrum of decimals for Π, but we know that this sequence is infinite, moreover, we know that the 'missing numbers' are reiterations of the first ten natural numbers, just that we do not know their order, and we will never be able to know the complete sequence of these decimals.
I may use to support the idea of the physical impossibility of infinite, at least in its spatial hypostasis, the statement of the astronomer Gustav Tammann:

> 'Yes, of course. It is a purely mathematical question.' [...] 'No, it is not purely mathematical, because you can easily have a function of time in mathematics with a discontinuity. It goes from a finite value to infinity, but you cannot have that in a physical system. The universe cannot suddenly go from a finite size to infinity. That would require infinite velocities which is impossible.'[29]

If we analyze the infinity from its numerical perspective, assuming an infinity of Universes — like in eternal inflation — or hypothesizing the infinity of the Multiverses, we will succumb to an illustrated variant of Cantor's theorem. The natural numbers are infinite, but still they are included by the series of the real numbers — the so-called numbers of *continuum* — and they have a smaller cardinality. Yet, both are infinite.
I identify one of the problems as being humans' tendency to project their own mathematical laws to the outer world. It appears that many of the cosmological models that accept any spacetime infinity — in other words, any other infinity than the all-inclusive vacuum — fall in a sort of modern Platonism, which anyway is not so uncommon for contemporary physicists or philosophers. Why? Because any model of reality that deals with subsequent and determinate concepts of infinity — like spacetimes from the model of eternal inflation — duplicates the ontology of the infinities. Though, at least the notion of an all-inclusive vacuum,

[29]Høg, Erik - *Astrosociology - Interview about an infinite Universe*, p. 128.

as an empty space for all physical possibilities, should be conceived as being infinite as long as the possibilities of existence are virtually infinite. Still, they will never be fully accomplished. Physically, this idea corresponds to the concept of true vacuum, as the lowest natural energy state.
Intuitively, we do not have any problem in thinking that nothingness is eternal. The questions about eternity of nothingness arise because I, as *res cogitans*, seem to have a sort of existence, without mentioning that I belong to a material world. In other words, the thinking process itself discards the actuality of nothingness.
I think that the *essentiality* — and, obversely, the concrete non-existence — of the mathematical infinite series of numbers does not pose a problem since they do not have physical reality.
Furthermore, I gave several technical details of the main scenarios of reality with the goal to clarify the understanding of the most important concepts of physical cosmology. The key cosmogonic period remains the early Universe, from the Planck Epoch until nucleosythesis. I hope that my description, excepting the fact that it offered some insights in the main current cosmological models, was able to provide the desired philosophical investigation of the capital matters of concern. I underlined the crucial role played by metaphysics and logic in a highly speculative field of physical cosmology. I tried to collect some of the most relevant statements of the physicists, mathematicians and philosophers of science regarding the core topics and issues of physical cosmology, trying to indicate that the space of mathematical possibilities must be adapted and adjusted accordingly with the physical probabilities and with the logical laws of the intellect.
Related to the laws of logics, I would like to quote Ellis:

> 'Universes where physics is not well-described by mathematics; with different logic; Universes ruled by local deities; allowing magic as in the Harry Potter series of books; with no laws of physics at all?'[30]

I would say that this 'extreme variation of possibilities for Universes', alternative which is in accordance with the Strong Anthropic Principle (SAP), *all that is possible, happens*, goes too far. I do not think that the laws of logic may be violated, excepting the case of a quantum world. However, the principle of sufficient reason should be able to survive in any conceivable world. The alleged lack of the laws of physics should be translated as 'a completely different set of laws'. On the other hand, the speculative logic did not do the same, even in a more traditional and Christian way, when it proposed principles that are perfect for explaining the mystic trance?
My intention was to illustrate the improvements that were made in the field of cosmology and to suggest that the explanatory power of several contemporary theories from physical cosmology may recommend them as the best candidates

[30]Ellis, George F. R. - *Issues in Philosophy of Cosmology*, p. 43.

for the *status quo* of a definitive or complete model of the Universe. I think that the model of cosmic inflation of Alan Guth is one of the strongest and the most appealing cosmological theories, especially because it completes the FLRW-model. I assume also that the inflationary scenarios have a bigger explanatory power in general, and the issues faced by the FLRW-model in its singlet form and presented above are typical for the dependence of the actual cosmological theories to the concept of cosmic inflation.

The current tendency is that the prevailing cosmological models of reality, which are mainly speculative, to be reconciled and supported by observations before they are accepted by the scientific community. Usually, a theory reaches its maturity when, once generally confirmed, it is subjected to an extensive observational analysis.[31] I want to emphasize the idea that contemporary physical cosmology is characterized lately by the healthy habit of interpreting scientifically the physical reality, and in consequence, the initial geometrical models of the Universe were discarded. The frozen eternal shape of the Universe with a homogeneous structure was substituted by inflationary and more dynamic models of the world. I think that the ontology of Parmenides, although it was unscientific, represented a perfect example of a geometric cosmological model. The absence of becoming, and hence of any fundamental transformational process, make me to consider this metaphysical system as an excellent example of a geometric cosmology. The subsequent daily natural processes still took place in the three-dimensional world, and even if Parmenides' mind would deny them any concreteness, the testimony of the senses should convince him to accept them anyway, as a sum of the foreground constitutive processes of reality.

Nowadays we have the tools to investigate reality both empirically and philosophically, but still the problems that define the specific epistemic *corpus* of physical cosmology belong to a special category, and achieving a global perspective over spacetime is practically impossible, taking into account the special nature of the object of concern of this science.

[31] v. Ellis, George F. R. - *Issues in Philosophy of Cosmology*, p. 33.

4. A comparison between ancient cosmologies and modern cosmologies

In final, I would like to stress the identities and differences between the concepts and oppositions of the ancient and modern cosmologies. Thus I hope to succeed to point out the progress in time of cosmology.

I may say that the differences between *ancient cosmologies* and *modern cosmologies* are substantial. *Scientific value* and *complexity* are the most important differences between them. On the other hand, their *appeal to heuristic concepts*, their *use of philosophical explanations*, and the *binary categorical scheme*, used both by ancient European cosmologies and modern cosmologies, are their cardinal common features.

The main difference between ancient and modern cosmologies was their *scientific value*. If the former were dependent by the culture which produced them, the latter are self-relying. As an effect, ancient cosmologies were unscientific, while modern cosmologies are scientific. Another important difference between the two main types of cosmologies may be derived from the *complexity* of modern cosmologies in contrast with the simplicity of ancient cosmologies. More precisely, physical cosmologies make appeal to notions from various positive sciences, while ancient cosmologies hardly differentiated themselves from their cultural background.

The first identity between ancient and modern cosmologies is that both make *use of heuristic and functional concepts*. Still, if physics and cosmology use these notions to denote unknown phenomena and natural forces, ancient cosmologies used these concepts in a completely speculative way. Modern cosmologies use these heuristic concepts to complete their equations, to fill some gaps in their conclusions. They have an empiric basis for them. Concepts like 'dark energy', 'dark matter', 'axions', 'gravitons', 'inflatons'', brown dwarfs', 'strings', 'magnetic monopoles', 'wormholes', 'techniquarks', 'Planck length' belong to this category. Mythological and religious cosmologies only assumed the existence of certain substances, states of matter, elementary particles, and so on. Ancient philosophers gave them names as: quintessence, *ousia (*Aristotle), atoms (Leucippus and Democritus in Greece, Jain and *Carvaka* schools in India, which called them *anu*), *apeiron* (Anaximandros), *Spherus* (Empedocles), *trigunas* (*Samkhya-Yoga* and Hinduism):

> 'The advances which have taken place in the field of physical sciences and the light which this has thrown on the structure of matter and the nature of physical phenomena has now placed us in a position to be able to gain a faint glimpse into the essential nature of the *Gunas*.' [...] 'If we analyse the flux of physical phenomena around us in the light of modern scientific knowledge we shall find three principles of a fundamental character underlying these phenomena. These three principles which ultimately determine the nature of every phenomenon are all connected with motion and may be called different aspects of motion. It is very difficult to express these principles by means of single words, for no words with a sufficiently comprehensive meaning are known, but for want of better words we may call them: (1) vibration which involves rhythmic motion of particles, (2) mobility which involves non-rhythmic motion of particles with transference of energy, (3) inertia which involves relative position of particles.'[32]

All these notions do not have empirical confirmation. They were introduced to improve a metaphysical doctrine whose cosmological consequences weren't related to observations and verified physical facts. Greek cosmologies (Thales, Anaximandros, the Eleatic school, Empedocles, the atomists, Pythagoreans, Heraclitus, Plato, Aristotle) conceived heuristic concepts to explain the Universe without the empirical means of current days. Indian cosmologies, instead, created their own heuristic concepts to complete and to justify their psychologies and soteriologies. Cosmologies gave frameworks to their esoteric theories. The heuristic notions of Indian metaphysics suffered by the same defect as their Greek counterparts, namely, the lack of empirical confirmation.

Another identity between ancient and modern cosmologies was the fact that both of them *use philosophical arguments* to explain the very early history of the Universe. Many of the concepts used in physics are speculative by nature, being the products of previous philosophical inquiries. Actually, the speculative theories preceded in most cases the physical discoveries, they just being confirmed by experiments and observations. I can say that without the presence of antecedent speculative ideas for many of the major novelties of the positive sciences, their progress would had been inconceivable or, at best, substantially different. These ideas populate profusely the scientific nomenclature of the natural sciences, physics and astronomy being the best examples in this direction. Inflationary model of the Universe is maybe the most illustrious speculative theory that was adopted by cosmologists. Thus, rather functional than empirical concepts associated with inflation, such as 'dark energy', 'dark matter', inflaton', 'inflation field' received core places within the most recent cosmological systems. Besides, the notion of 'dark energy' has became the new Holy Grail of physics; around this yet purely theoretical and heuristic concept gravitate all the reasonable explanations of the Universe, the aforementioned concept being essential for

[32]Taimni, I. K. - *The Science of Yoga*, The Teosophical Publishing House, Adyar, Chennai, India - Wheaton, IL, USA, pp. 157-158.

reconciling our astronomical observations of the celestial dynamics with any decent theory about the evolution of the Universe. If 'dark matter' seems to be crucial for understanding and justifying the cosmic stability at the local length scales, notions like 'inflaton' or 'inflaton field' are instrumental for realizing what happened at the quantum level at the beginning of time. In the past, the same functional role, confined in explaining the motions of the celestial bodies on the sky and the attraction of the falling objects to the ground, was played by the concept of 'gravitation' of Newton. In the meantime, the universality of this force was confirmed by the observation of other solar systems, of the behaviour of the matter from Milky Way and from different galaxies, noticing the tendency of the galaxies to aggregate in clusters, and even by the slightly faster flow of time in the extra-terrestrial space. Ekpyrotic model of the Universe hypothesizes that the Universe was created due to the collisions of two four-dimensional worlds, located on an encompassing five-dimensional spacetime. Philosophically speaking, this kind of reasoning is an *a posteriori* inference. This is an instance in which we depart from an empirically confirmed fact, the Universe as it is today, and we use alternate conditions conducive to this physical state. Due to this model, heuristic concepts as 'the fifth macroscopic dimension of spacetime' and 'Multiverse' became familiar to the vocabularies of cosmologists.

The typical dichotomous way of thinking of Europeans seemed to be useful for their researches, although its absolutization was not always prolific. For instance, if the pair 'positive-negative' was essential in physics and chemistry, concepts as 'white holes', in their qualities of hypothetical couples of the indirectly proved 'black holes', looked to be rather hilarious.

A common denominator of ancient European cosmologies and modern cosmologies is their *binary categorical scheme*, which defined the European culture beginning from the so-called classical Greek period. This dichotomous thinking, based on so-called conceptual discrimination, always separated 'objective' from 'subjective'. Finally, this attitude led to the constitution of the empirical sciences on the Old Continent. Aristotle, who founded the science of logic in his *Organon*, represented the most famous example of an European thinker which used abundantly the dual reasoning. He wrote down the rules of the two-valued logic. Aristotelian logic became the official model of thinking in the next centuries, and it still has a paradigmatic function. In the Indian subcontinent, where the conception about *advaita*, non-duality, of the *Vedic* school of *Mimamsa* paralled the Buddhist doctrine of the vacuum-like nature of existence, *sunya*, the positive sciences were imported by the Englishmen.

Regarding the differences between the old cosmologies and physical cosmologies, I have to say that the former were fundamentally *unscientific*. They were either *mythological*, as the Babylonian cosmology, the Egyptian cosmology, the Greek cosmology, either *religious* as the Hindu cosmology, Jain cosmology, Buddhist cosmology, Biblical cosmology. Some models exhibited a real independence from their cultural background, a fact that made them irreligious. Still, their

delimitation from the usually polytheistic culture where they flourished did not make them scientific. In the best case, the irreligious cosmologies of antiquity may be considered proto-scientific. To this category belong cosmological theories as: the Eleatic cosmology, the atomist Universe of Anaxagoras, Leuccipus, Democritus and Epicurus, the Pythagorean Universe, the Stoic Universe, Aristotelian Universe, Aristarchean Universe, Ptolemaic model.

Between the latest models of antiquity and the first scientific cosmological theories we have a series of intermediate cosmologies. Here I must mention the Multiversal cosmology of Fakhr al-Din al-Razi, the geocentric model of Maragha school, or the Scandinavian cosmology. Although the Nordic cosmology was older, to this conclusion contributing its completely mythological nature, a fact which places it on the same level of civilization with the oldest cosmologies of antiquity, it became known across the entire continent only in the Middle Ages, after the writing of *Eddas*. In other words, the medieval models did not represent a different category of cosmological systems; they are individuated by the period in which they were created.

Starting with Nicolaus Copernicus we are speaking about *physical* or *scientific cosmologies*. The cosmological models were based on careful and regular observations, computations and, beginning with Galileo Galilei, the astronomical research was dramatically improved by the use of telescopes. Physical cosmologies enunciate cosmological theories sustained and determined by the observations and experiments. Physical cosmology is a branch of modern empirical science. Here I must mention theories as: Giordano Bruno's cosmology, Keplerian Universe, the static Newtonian Universe, Cartesian *vortex* Universe, Einstein's Universe (governed by the *General Relativity*), De Sitter Universe, MacMillan Universe, the three types of Friedmann Universes (with positive, negative and null curvature), the theory of Big Bang, the oscillating Universe, FLRW class of models, Steady-state Universe, Brans-Dicke theory, the cosmic inflation of Alan Guth, the eternal inflation of Andrei Linde, and so forth.

One of the main features of the mystical and religious cosmologies of the past millenia is that they were enunciated within the theoretical frames of an encompassing culture, which usually gave to all its subsequent intellectual expressions its specific mark. Both the Hindu or the ancient Greek cosmologies were heavily influenced by their polytheist religions and mythologies. Moreover, many of the cosmological scenarios were written especially for the purpose of sustaining the already accredited mythological tales about gods or about the *genesis* of the *kosmos* itself. Even a less traditionalist philosopher as Plato used a lot of religious pagan myths in the same way in which a modern mathematician would use a theorem. For both, the appeal to these cultural items was helpful, facilitating the understanding of certain topics. For both, their corresponding cultural items were taken for granted, no one of them doubted about the truthfulness of their myths or theorems. Plato recurred often to some religious myths during his dialogues. He did so to expose in a clearer way his arguments,

taking into account the fact that his Greek audience was extremely familiar with the cosmogonic myths and with deities as Eros, Aphrodite, Prometheus, and so on. Also, some events, like the creation of the world by Zeus or the quality of his brother, Hades, as shepherd of the dead's souls, were considered as undeniably true, hence they were used in the demonstrations performed by Plato's *alter ego*, Socrates. In *Phaedrus* (237 a9, 241 e8) the word *muthos* is used to name 'the rhetorical exercise which Socrates carries out' (*Brisson* 1998, 144), but this seems to be a loose usage of the word.

The great advantage of the contemporary physicists is that their science does not need to appeal to a transcendent personal force to explain the creation of the world or to infuse meaning in human existence. Therefore, all *Weltanschauungen* of the modern positive sciences follow only their inner logic. They do not need to reconcile themselves with a bigger cultural paradigm generated by the tradition or by politics. Science has become an aim in itself, independent of its practical applications. We currently do not have an *Empireus* as a common denominator for all traditionalist cosmologies of the classic age of Greek civilization. On the contrary, we are not fully convinced by what our researches have shown us: *i.e*, it is not necessary that the Milky Way to be our host galaxy; the thermal uniformity of Cosmic Background Radiation could be explained alternatively by the fact that we live in a multiply connected and hence relatively small Universe, a fact that also implies that many of the images from the sky may be mirrored, and so on.

The only aim of the modern science is the truth, and probably that the only real problems of the modern positive sciences, which are essentially empirical, is that their results are limited by the vastness of their object of study, being quite clear that not even a more advanced civilization could not achieve a complete knowledge about the history of Universe, and much less about its real size.

Despite its speculative elements, modern physics is heavily indebted to the empirical methods of scientific research, and its cosmological theories have to respect the following requirements:

> '1. *Satisfactory structure*: (a) internal consistency, (b) simplicity, and (c) aesthetic appeal ('beauty' or 'elegance').2. *Intrinsic explanatory power*: (a) logical tightness, (b) broad scope (of the theory), and (c) probability (of the theory or model) with respect to some well-defined measure;3. *Extrinsic explanatory power*: (a) connectedness to rest of the science, (b) extendability - providing a basis for the further development;4. *Observational and experimental support*, in terms of (a) testability [...]; and (b) confirmation: the extend to which the theory is supported by such tests as have been made.'[33]

Some of these conditions involve the *validity* of the inferences and of the statements which are made within the theoretical frameworks of a given cosmological model, like internal consistency, simplicity, logical tightness. Other

[33]Ellis, George F. R. - *Issues in the Philosophy of Cosmology*, p. 33.

requirements entail the *absolute scientific value* of the theory itself, meaning its ability to provide a reliable system of ideas, feature that is ensured by the scope of the theory, by its degree of probability, but especially by its testability and by its actual confirmation. Also, are requirements that call for the *relative scientific value* of the theory, namely its connectedness with the rest of the science, and its extendability, hence its openness for further improvements. The latter should be characteristic to all the scientific systems since the contingent conditions with which we deal in Universe rarely allow us to give definitive solutions to the matters that concern the natural sciences.

Speaking about the higher *complexity* of modern cosmologies, I must affirm the multi-layered nature of scientific cosmology, which is found in opposition with the popular and essentially speculative and imaginary character of ancient cosmologies. Taking in account the complexity and the difficulty of the cosmological puzzles, which practically can not be solved without making a generous appeal to all the areas of physics, and without speaking about the necessity of having an extensive knowledge of chemistry, astronomy, geometry, is quite clear that nobody is capable to offer us definitive answers by generating an exhaustive cosmological model.

In the peculiar realm of cosmology, the conjunction of the positive sciences, particularly of physics, with philosophy — and even with pure intuition in some cases — seems to be the only way to elaborate an intelligible and coherent model of reality.

All the explanations of the beginning of Universe, due to their high degree of uncertainty, imply mainly a speculative approach of this age, and really scientific scenarios may be invoked only afterward, when the quantity of our data related to the evolution of Universe becomes considerably bigger, and when, consequently, we could use the classical tools of experimental sciences to investigate these subsequent cosmological stages.

In other words, cosmogony appears to be rather confined or attached to metaphysics, in the same way in which mythology makes sense nowadays only within the canonical frames of theology or of philosophy of religion. Only cosmology which describes the evolution of the Universe after baryogenesis may be disputed more or less equally between the positive sciences and metaphysics. Cosmology of the very early Universe is highly speculative, and only starting with the early Universe the percent of the scientific concepts and explanations increases. The chronology of the very young Universe possesses a speculative nature, as well as ancient cosmologies, in general. Though, the latter were almost completely unscientific, and philosophical speculation was combined and even occulted by pure imagination. Cosmological models as string theory, cosmic inflation and ekpyrotic Universe represent alternate scenarios for the history of infant Universe. The cosmogonic mechanisms employed by these theories use assumptions, which are essentially philosophical.

The cosmological answers provided by a theory would vary proportionally with its theoretical functions and its type of approach:

> 'The scope we envisage for our cosmological theory shapes the questions we seek to answer. The cosmological philosophical base become more or less dominant in shaping our theory according with more or less ambitious explanatory aims in terms of all physics, geometry, and underlying fundamental causation.'[34]

For example, as in the situation of Konopka's, Markopoulou's and Smolin's *Quantum Graphity*, the scientific collective was more concerned with the algebraic, geometrical and mathematical physical issues than with the overall cosmological landscape — especially because their explanation of the history of early Universe concerned the emergence of the four-dimensional geometry of spacetime from a higher dimensional initial quantum gravity state:

> 'Seeing in this way may be helpful, because it may allow us to attack the problem of the emergence of spacetime in the low temperature phase with tools from statistical physics'[35]

or

> 'Thus the model shows the horizon problem may be avoided if geometry is emergent.'[36]

Despite its explicative power regarding the horizon problem and the structure of CMB, meaning that the model has proven to be useful in giving a plausible alternative to the inflationary theory of Universe, the so-called '*geometrogenesis*' of the Canadian threesome of researchers is based on its algebraic and geometrical apparatus, while cosmological consequences are just some welcomed happenings. More precisely, *Quantum Graphity* proposed that the Universe has cooled from a high temperature phase, and the 4-D geometry of spacetime is a property of the low temperature stage. The 4-D spacetime is encased, as a honeycomb in fluid honey, in a higher dimensional spacetime. The fundamental degree of freedom of the matter particles and photons was higher in the hot era, when the spacetime was defined by an extreme inter-connectivity of the particles. Then, like in Photon Era of the inflationary models, photons interacted continuously with electrons and ions, and the entire Universe was in causal contact, a fact which explains the uniformity of Cosmic Microwave Background, a relic radiation which coats the whole space. The weaker inter-connectivity and simpler geometry of the patterns of matter particles which make the actual Universe hide an eloquent cosmic background, which suggests a more complex

[34]I*bidem*, p. 34.
[35]Konopka, T., Markopoulou, F., Smolin, L. - *Quantum Graphity*, p .2.
[36]*Ibidem*, p. 12.

topology of the Universe. Still, the structures made now by the particles are stable, a fact that was not possible in the era of pure probabilities.
Also, the theories of the multiple-connected (relatively) small Universes seem to tackle the cosmological topics from an astronomical and geometrical perspective, for them being less important the cosmogonic scenarios of the respective Universes. For instance, a *Poincaré dodecahedral space* does not exclude the cosmological thesis of inflation, although the weak positive curvature of the Universe implies a finite space and implicitly sets strong constrains on inflationary models:

> 'It is possible to build 'low scale' inflationary Universes in which inflation phase ends more quickly than it does in general inflationary modes, leading to a detectable space curvature.'[37]

But a wet cat is still a cat, hence the theory, though centered around the theme of an multiply-connected Universe, is still in principle able to satisfy the physical requirements of cosmology. The model of Luminet's *Poincaré dodecahedral space* does not seem to be compatible with the *Quantum Gravity* theory:

> 'Perhaps the most fundamental challenge is to link the present day topology of space to a quantum origin, since general relativity does not allow for topological changes during the course of cosmic evolution. A [theory of quantum] gravity could allow us to address the problem, but there is currently no indication about how such a unified theory might actually describe the emergence of multiply-connected spaces.'[38]

Therefore, the various models of reality are different according to their scopes and to their type of scientific approach. In consequence, the degree of philosophical, physical or mathematical inputs may vary according with the nature of a cosmological theory. *Quantum Graphity* seems to be influenced by non-Euclidean geometries and by lattice algebra, while *Poincaré dodecahedral space* of Luminet is an observational theory that tries to reconcile some surprisingly convenient astronomical data with a geometrical influenced idea about the intertwined shape and small size of the Universe.
But every kind of approach and perimeter belonging to a higher theory supposes the differentiated use of a certain positive science or even the appeal to the speculative tools of metaphysics, that plays an apparently unexpected role in these extremely realistic matters. Actually, since the theory of *Quantum Mechanics* tried to describe the microcosmic phenomena, while the *General Theory of Relativity* and the *Special Theory of Relativity* render the macrocosmic phenomena, we already witnessed the possibility — maybe even the circumstantial necessity — that the main physical theories to specialize

[37]Luminet, Jean-Pierre - *A cosmic hall of mirrors*, p .7.
[38]*Ibidem*, p. 7.

themselves in a way adapted to their respective object of interest. Conversely, the major methodologies and sciences involved in the cosmological inquiries play distinct roles in the epistemic drama of understanding everything about everything. Also, certain approaches exhibit themselves as being more suited for certain cosmic epochs:

> 'The study of expansion of the Universe and structure formation from nucleosynthesis to the present days is essential and well-informed. The philosophical stance adapted is minimal and highly plausible. The understanding of physical processes at earlier times, back to quantum gravity, is less well-founded. The philosophical stance is more significant and more debatable. Developments in quantum gravity era are highly speculative; the philosophical position adopted is dominant because the experimental and observational limits on theory are lacking.'[39]

It is easier for the scientists to figure out what happened in the Universe after recombination, when there the first neutral atoms were produced. Therefore, cosmological theories are sustained by our current scientific observations. The very early history of our Universe, instead, is clouded in the darkness of the unknown. The physical conditions characteristic to that period cann't be reproduced in our laboratories, and hence we may, at best, only approximate what occurred in the history of the infant Universe. This is why the philosophical ideas, the metaphysical arguments and, in some degree, the logical deductions, play a significantly bigger role in elaborating the cosmological theories about the very early Universe.

I conclude saying that philosophy remains an essential ingredient of cosmological theories. It retains a special relation with cosmology since the dawn of culture. First cosmologies were based on imagination, superficial observations of nature and naive speculations, as was the case with mythological cosmologies. More elaborated mythological cosmologies (Egypt, ancient Greece) and religious cosmologies appealed both at imagination, speculations and philosophical concepts. Scientific cosmologies are based on observations, experiments, and only secondarily on philosophical concepts and metaphysical speculations. The qualitative evolution in time of cosmology is obvious. The same process is available for science and philosophy. Consequently, when you make history of culture, you must make equally history of science and history of philosophy. Though, the situation of philosophy is a special one, philosophy being a science which interferes with all other particular sciences, and even with arts, as in the case of aesthetics and philosophy of art. Moreover, during antiquity philosophy stood in the place of physics and cosmology, and, automatically, making history of ancient philosophy, you will make history of ancient sciences. Basically, the almost complete overlapping relation between science and philosophy ends only when classical physics is founded, and when what was until then called philosophy

[39]Ellis, George F. R. - *Issues in the Philosophy of Cosmology*, p. 34.

of nature becomes a historical name for physics. Philosophy and sciences grow within the frames of history in an organic way, each improvement representing a necessary step. Each of these steps are connected to the previous and to the following ones. This linear, but possessing an inherent necessity, diachronic evolution of ideas is placed by Hegel in the core of his system:

> 'I maintain that the succession of philosophical systems in history is the same as their succession in the logical derivation of the categories of the Idea.'[40]

Especially because of his universalized dialectics I consider that Hegelian system is the most suited to create an adequate image about the evolution in time of cosmology. Still, for Hegel scientific knowledge is concerned with the finite objects and phenomena, and only philosophy has as its content the infinite, which is the universal spirit. He considered that philosophy belonged to a higher level of natural dialectics than scientific knowledge. History, in all its instances, as history of science and history of philosophy, is the external manifestation or 'the life of universal spirit'. Science is subordinated to philosophy, the only one which is able to say something about the universal spirit, which is the Hegelian expression for the cosmic process. Hegel's premises are debatable because he assumes that the process must be eternal, and positive sciences are constitutionally unable to deal with infinite objects. Hegelian system is an onto-theology, and the macrocosmic dynamics describes a pantheistic religious view. From a Hegelian perspective, the perpetual becoming of God, *in* and *as* nature, denotes the supreme truth. Therefore, the antithetical relations between consecutive theses, whose oppositions are solved in synthesis — which stand as theses of new antithetical cycles — naturally evolve towards the knowledge of God. The entire process prior to the perfect self-knowledge of nature is realized by God as well. Because Hegelian system is an absolute idealism, God is the one which knows himself *via* self-consciousness and *qua* nature.

But in reality things are different, science is superior to philosophy, and this relation may be observed examining the results of the most important cosmological scenarios. Science and philosophy started with personified cosmological principles and natural elements, they continued by creating a relation between humans and these personified forces, and finished by describing the whole cosmic process through the means of scientific concepts, confirmed by observations or only hypothesized. In the last third of the path to truth — the stage of physical cosmologies — the contribution of philosophy was significantly decreased. The destiny of philosophy is to be completely abandoned when humans' knowledge about Universe will become absolute. This is clear enough that is not necessary to ask somebody as Hegel to be sure about it. Self-referential cosmological perspectives, as those suggested in his strictly

[40]Hegel, G. W. F. - *Lectures of History of Philosophy*, *Introduction*, p. 38.

philosophical manner by Hegel, through which the universal spirit supposedly speaks, are impossible anyway because nobody has the absolute knowledge. Probably that a super-civilization will be the only rational community for which philosophical speculations will become useless. This is the tendency in the evolution of sciences, no matter we will reach the *apex* or knowledge or not. I must admit that even we consider philosophy as being just a winter jacket for the human culture, philosophy shares with science, and hence with cosmology, the binary categorical scheme of thinking. In this sense I may say that philosophy is virtually reducible to logic. That means that this reduction will happen when the humans will gain an exhaustive knowledge about Universe. This reduction will not take place as long as philosophical arguments and heuristic concepts are still needed in fields of physics and cosmology. Heuristic concepts having as common denominator the adjective 'dark' and, in general, any hypothesized notion used by modern physics are not fundamentally scientifical, they are genuinely philosophical.

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