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Cosmological Inconstant, Supernovae 1a and Decelerating Expansion

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Abstract

In 1998, two groups of astronomers, one led by Saul Perlmutter and the other by Brian Schmidt, set out to determine the deceleration—and hence the total mass/energy—of the universe by measuring the recession speeds of type la supernovae (SN1a), came to an unexpected conclusion: ever since the universe was about 7 billion years old, its expansion rate has not been decelerating. Instead, the expansion rate has been speeding up. To justify this acceleration, they suggested that the universe does have a mysterious dark energy and they have emerged from oblivion the cosmological constant, positive this time, which is consistent with the image of an inflationary universe. To explain the observed dimming of high-redshift SN1a they have bet essentially on their distance revised upwards. We consider that an accelerated expansion leads right to a "dark energy catastrophe" (*i.e.*, the chasm between the current cosmological vacuum density value of 10 GeV/m^3 and the vacuum energy density proposed by quantum field theory of ~10^{122} GeV/m^3). We suppose rather that the universe knows a slowdown expansion under the positive pressure of a dark energy, otherwise called a variable cosmological constant. The dark luminosity of the latter would be that of a "tired light" which has lost energy with distance. As for the low brilliance of SN1a, it is explained by two physical processes: The first relates to their intrinsic brightness—supposedly do not vary over time—which would depend on the chemical conditions which change with the temporal evolution; the second would concern their apparent luminosity. Besides the serious arguments already known, we strongly propose that their luminosity continually fades by interactions with cosmic magnetic fields, like the earthly PVLAS experiment which loses much more laser photons than expected by crossing a magnetic field. It goes in the sense of a "tired light" which has lost energy with distance, and therefore, a decelerated expansion of the universe. Moreover, we propose the "centrist" principle to complete the hypothesis of the cosmological principle of homogeneity and isotropy considered verified. Without denying the Copernican principle, he is opposed to a "spatial" theoretical construction which accelerates the world towards infinity. The centrist principle gives a "temporal" and privileged vision which tends to demonstrate the deceleration of expansion.

Keywords

Variable Cosmological Constant, SN1a, Dark Energy Catastrophe, Theory of Relation, Deceleration of the Expansion, PVLAS Experiment, Tired Light, Centrist Principle

1. Introduction

The aim of this paper is to propose the earthly experience *Polarizzazione del Vuoto con LASer* (PVLAS) [1] [2] amalgamated to the radiation of the SN1a, and show that it corroborates the interpretation of the theory of Relation according to which the observation of the distant SN1a leads to a deceleration of the expansion and a variable cosmological constant.

We consider that the light of the SN1a loses its brightness through the intergalactic magnetic fields, in the same way that the laser of the earthly PVLAS experiment loses photons by going through a magnetic field. This experiment tends to demonstrate that the weakening of the apparent luminosity of the SN1a is due to a physical process rather than a distance to revise upward as required by the theory of inflation. This physical process is added to some of the main propositions already known in opposition to the acceleration of the expansion. It leans toward a very low density of matter and a flat universe, in accordance with the results of the weighing of clusters of galaxies and those from the cosmic microwave background (CMB). It implies a deceleration of the expansion and appeals to a "variable" cosmological constant which derives from the theory of Relation of which we present some aspects. The basic assumption of this new theory excludes the original phase of exponential growth of the cosmic inflation. Rather, it appeals to a relativistic big bang [3] [4], stemming from a previous universe, with a primeval dark energy with a density of at least 10^{60} times greater than the current vacuum energy, whose high temperature "substance" would quickly have begun to disintegrate into ordinary matter and dark matter, decay that would have continued during the history of the universe, especially with each broken symmetry, whenever the forces of interaction between particles change their nature. The "full" initial quantum becomes the quantum vacuum of space through a variable cosmological constant, which is nothing else than the dark energy which is transformed into common and dark matter. In this way, the "dark energy catastrophe" is stemmed and the reconciliation between particle physicists and cosmologists takes place.

But in order to demonstrate the deceleration of the universe, the paper also proposes a "centrist principle" which would coexist with the Copernican principle. The centrist-quantum vision reinforces the whole edifice of knowledge of the big bang. The concept of the center of the world reappears and the center is brought back to the rank of a privileged coordinate system. This quantum center gives rise to a cosmological time which does not separate from the space of expansion. The arrow of time generates epochs which are separated by temporal lengths. Each epoch has a different coordinate system because temperature and density change from epoch to epoch. The Copernican-relativist vision where the center is reduced to the rank of any coordinate system only applies to an era in itself. That is what made think that the theory of relativity is primarily a local theory and not a global one.

The second section presents the prevailing theory of inflation which is, in physical cosmology, a theory of exponential expansion of space in the early universe. The third section presents the distant Type 1a supernovae whose observations indicated in 1998 the unexpected result that the universe appears to be undergoing accelerated expansion. The fourth section introduces the "dark energy catastrophe" which is the disagreement as much as 120 orders of magnitude between the small observed value of the cosmological constant and the theoretical large value of vacuum energy density suggested by quantum field theory. The fifth section describes a variable cosmological constant within the framework of the theory of Relation. The sixth section shows two ways to explain the low luminosity of SN1a: greater distance and physical process. The seventh section, in order to explain the weakening of the apparent luminosity of SN1a, suggests comparing the laser of the terrestrial experiment PVLAS which loses photons by crossing a magnetic field to the rays of SN1a which lose their luminosity by interactions with cosmic magnetic fields. The eighth section proposes a "centrist principle" intended to demonstrate the deceleration of the universe. It would oppose the Copernican principle while coexisting with it.

2. Inflationary Scenarios

Before discussing the theory of inflation currently prevailing, let us mention that the cosmology, which exists hardly since the XXth century, grounded on the laws of physics as we know them, and on the observations done from the smallest to the largest scales, has made up the standard model. This one is an archeology of the universe by the thought which goes back up to the big bang, and which appears as an apotheosis of physics. However, in the late 70, some pieces fit together very poorly in the puzzle of the standard big bang theory. For example, observations show that on a large scale the matter is widely distributed in a rather homogeneous way. How then to understand the formation of large structures (clusters of galaxies, superclusters), which show an extreme heterogeneity of the universe today? The physical process at the origin of the small density fluctuations was missing. There were also the riddles of a very flat universe, broken symmetries and magnetic monopoles [5].

In 1980, a new hypothesis, issuing from particle theory, claimed its ability to solve these conundrums, while preserving the success of the standard theory.

The universe would have known very early in the cosmic chronology a dazzling phase of expansion, the inflation [6] [7]. One can imagine there are several tens of billions of years, a universe whose energy was carried by a field, which was perched away from its minimum energy state. Because of its negative pressure, the field drove an enormous burst of inflationary expansion. The space, driven by something akin to the current dark energy, would have dilated with a gigantic factor, say 10^{100} [8]. Then, some 10^{-35} sec later, as the field slid down its potential energy bowl, the burst of expansion ended, and the field released its trapped energy to the production of ordinary matter and radiation. For many billions of years, these familiar constituents of the universe exerted an ordinary attractive gravitational pull that slowed the spatial expansion. But as the universe grew and thinned out, the gravitational pull diminished. About 7 billion years ago, ordinary gravitational attraction became weak enough for the gravitational repulsion of the universe's cosmological constant to become dominant, and since then the rate of spatial expansion has been continually increasing [9].

After twenty years of works, the inflationary universe scenario was able to make macroscopic random fluctuations of energy, inevitable at the quantum scale. With this theory, the most infinitesimal initial irregularities in the distribution of energy can be grown enormously and create future centers of condensation of matter. These will in turn become the seeds from which the matter will gradually be structured on scales larger and larger.

Despite this sketch of cosmic evolution, at the end of the XXth century, views on inflation had failed in forming a definitive scenario. Some astrophysicists were ready to raise arms and declare false the theory of inflation (and even the big bang). Most of the astronomers who had measured the mass of distant clusters of galaxies were convinced that matter represented only 20% - 40% of the critical density of the universe, and that the latter should be close to the critical density that makes it flat but could not find the remaining 80% - 60% [10].

3. Supernovae 1a

In 1998, a revolution took place in the world of the cosmology. The astronomers of the Supernova Cosmology Project and of the High-z Supernova Search Team announced that the rate of the cosmic expansion accelerates instead of slowing down [11]. The astronomers used old stars thermonuclear explosions—SN1a—to measure the rate of expansion of the universe. They expected to measure a deceleration of the expansion, slowed by the gravitational force attraction of the matter content of the universe. They were stunned to notice that the recession of galaxies, instead of slowing down as the universe grows older, seems to accelerate.

This announcement was consistent with measurements from previous studies, which evaluated the density of matter at 27%, of which the largest part (~22%) comes from the dark matter, still unknown but which exerts a gravitational influence on observable galaxies [12]. Once this value was determined, researchers had only to consider the contributions of Cobe satellite and Boomerang balloon

[13], and of course the theoretical framework of the big bang's models. These stipulate that the sum of the three cosmological parameters [density of matter, noted Ω_M (baryonic matter + dark matter), density of curvature, noted Ω_K and the density of dark energy which takes the role of the cosmological constant, noted Ω_Λ] must be equal to unity for critical density universe ($\Omega = 1$). However, the results of Boomerang have fixed the density curve. Its value is null.

The meticulous analysis of the data led the astronomers to argue so: the recession velocity of a supernova depends on the difference between the gravitational attraction of ordinary matter and the gravitational pull of the dark energy from the cosmological constant; taking the density of matter, whether visible or invisible, equals to about 27% of the critical density, they concluded that the accelerated expansion they had demonstrated could be explained by a push towards outside due to a cosmological constant which dark energy contribute about 73% of the critical density.

These two combined values bring the total density of mass/energy of the universe to exactly the 100% value predicted by the inflationary cosmology! [6] [14]. Measurements of SN1a and the theory of inflation were complementary and confirmed themselves mutually, independently.

4. The "Dark Energy Catastrophe"

However, the concordance of all the experiments which conducts to a space almost flat, ever expanding, startled more than a cosmologist. At the dawn of the XXIth century, astrophysicists discover that all their theories are based only on observation of visible 5% of the total energy and 95% of the universe are completely foreign to them. This does not prevent them from continuing to build their theoretical edifice. If the experimental indications of a non-zero value for the cosmological constant come not only from the SN1a, but also of independent measures on the fluctuations of cosmic background radiation, what is its value?

The acceleration is very slow, which tells us that the value of the vacuum energy, though nonzero, is extremely tiny. The theoretical problem with the observed vacuum energy is that it is far smaller than anyone would estimate. According to particle theorists estimates, energy should be much bigger. But if it was, it would justly not be able to lead to this acceleration of SN1a so difficult to measure. With a huge energy, the universe would have collapsed long ago (if negative) or quickly expanded into the great void (if positive). That is what we call the "dark energy catastrophe".

Thus, these fascinating measures also present a significant enigma. At this is added the challenge of revealing the nature of dark energy, characterized by the cosmological constant.

The vacuum energy is precisely the favorite candidate but effectively, if so, the quantum physicists would prefer to see it multiplied by at least 10^{60} so that this vision of the cosmos suits to the standard model of the physics of particles [15]. Several models are possible, but the predicted value in most cases is 10^{122} times above the limits prescribed by astronomical observation. The cosmological constant is comparable to the inverse square of a length. For the physicists of the infinitesimal, this length is interpreted as the distance scale at which the gravitational effects due to the vacuum energy become manifest on the geometry of space-time. They consider that this scale is the Planck length, or 10^{-33} cm. For the astronomers, the cosmological constant is a force of cosmic repulsion which affects the rate of expansion on the scale of the radius of the observable universe, which is 10^{28} cm. The ratio of both lengths is 10^{61}, which is the square root of 10^{122}.

The vacuum of the physicists is full of energy. Its energy fluctuations give birth to pairs of particles. During the history of the universe, whenever the interaction forces between particles change their nature, thus in every symmetry breaking, the vacuum cashed energy. Today, the vacuum energy, which constitutes the essence of the cosmological constant, should be much larger than the value predicted by the cosmologists.

The observed SN1a seem to say that these remaining two thirds of the critical density seem to exist in the form of a mysterious "dark energy" and to bolster up the inflationnaire cosmology. But their rate of acceleration may mean that the contribution of dark energy to the critical density is about 73%, two-thirds which miss so that the universe is flat, as predicted by the inflation theory, nevertheless this last one, as well as the model of particles or strings, have to explain why the universe's vacuum energy is as small as we know it must be. Their best models of unification, expected to make correct predictions in the field of elementary particles, lead to some absurd cosmological consequences, and they have no answer to this problem [16]. Thus, for theoretical physicists, the hope of reconciling their models and those of their colleagues' cosmologists flew away. Some physicists believe that there is no true explanation.

The so-called theories of quintessence were born to dissipate this conception: the cosmological constant is replaced by a variable field during the time, very high in the phases of the early universe, in agreement with the calculations of physicists, but falls very low during the cosmic evolution, according to the value measured by astronomers today. The quintessence field would evolve naturally towards an "attractor" conferring it a low value, regardless of its original value. Physicists consider that many different initial conditions would lead to a similar universe—the one which is precisely observed! But these theories require extra dimensions [8] [17].

Even if astronomers and cosmologists are probably right about the low predicted value of vacuum energy, and that it belongs especially to particle physicists of better understand the theories of unification and the true nature of the vacuum energy, we estimate that both groups are conceptually wrong. Physicists are deluded into believing that, if there was great energy at the beginning, there should be still a great energy today. On the other hand, cosmologists are mistaken in believing that the vacuum energy was always the same, almost zero. For them, there is no real empty vacuum in nature: constantly, particles are created and annilihated virtually, what explains the presence of energy. To be connected to this low density of the vacuum energy which has never changed, they need a constant energy density that models the presence of a permanent cosmological constant.

In fact, if astronomers take the observations of supernovae and the microwave background and apply the theory of general relativity to them, they have a universe that corresponds to the magic omega number of 1; if particle physicists apply quantum theory to them, they get an answer that is about 122 orders of magnitude higher. Unraveling all this gibberish amounts in fact to tackling the problem of reconciling the physics of the immensely large-general relativity—and that of the infinitely small-quantum mechanics. The dark energy catastrophe is for the moment this abyss between the value of the density of the current cosmological vacuum which is worth 10 GeV/m^3 (or ~10 protons/m^3) and the energy density of the vacuum proposed by the quantum field theory which is ~10^{122} GeV/m^3 (~10^{122} protons/m^3).

5. A Variable Cosmological Constant within the Framework of the Theory of Relation

According to the theory of Relation, the force of gravity is not a force independent of the force of expansion. The two structures in our theory, the expansion structure and the condensation structure, represent the force of expansion and the force of gravity. Except that they are directly linked, one is engendering the other; the colossal energy of the force of expansion generating the force of gravity. It is the energy of the big bang that is transformed over the time of expansion into matter as we know it. There is not a coincidence infinitely improbable (and yet accidentally close to an infinite fraction near a point of equilibrium) between the immeasurable energy released at the time of universe creation and gravity, there is a natural transformation of energy (that of the cosmological constant which is also called dark energy) into matter. The fact that the expanding universe seems forever in a chaotic state of maximum entropy, and the fact that there are low entropy structures is not a big mystery; it is simply the transformation of the electromagnetic (em) energy of the big bang, which is continuously transformed into frozen matter, into gravitational energy. This is why the universe is decelerating.

A) Scenario of the theory of Relation

The question to know why the density of energy is so tiny finds answer within the framework of the theory of Relation [10]. This new theory uses a "cosmological inconstant", or a variable cosmological constant, which means a variable density energy during the cosmological time. It does not require the presence of extra dimensions: the universe has two complementary and interpenetrated structures and four dimensions (one of time and three of space). The structure of the condensation has the aspect of the Einstein's gravific space-time and electromagnetic matter, whereas the structure of the expansion has some aspects of the Lorentz-Maxwell's flat em spacetime and ordinary matter.

Since the big bang, the em structure of the expansion—with the variable cosmological constant—is in decline, having abandoned his energy for the benefit of the increasing structure of the condensation, positive and gravitational. Throughout cosmological time, a perpetual annihilation of the negative energy-mass is transformed into a continual creation of positive energy-mass. The first structure of condensation represents the positive solution of Dirac's equation of energy, while the second structure of expansion express its negative energy solution which was eliminated by a mathematical trick [15] [18].

The negative energy-mass is assimilated to the cosmological constant or the dark energy. The variable density of dark energy takes the form of a variable cosmological constant directly related to the full energy that will become the minimal energy of vacuum. We can say that it starts with the energy of particle physicists, with 10^{120}, and leads to the almost zero energy of the astronomers, that is ~10^{0}.

Through the "principle of Compensation", the lost negative energy is transformed into positive energy [19]. Permanently, real positive particles (not virtual) are created, and all do not disappear (those corresponding to positive energy), hence the presence of a growing positive matter and a weakening vacuum energy. The principle says that the decreasing of the negative em energy-mass during the expansion induces a proportional and opposite increasing positive gravitational energy-mass. The em wave of spacetime is supported by an inhomogeneous vacuum filled of "minimal" negative energy perpetually in interaction with positive matter.

B) General characteristics of the theory of Relation

1) With the theory of Relation, it is not the dark matter which dominated from the beginning but an expansive dark energy. How does this anti-gravity manifest in the theory of Relation? It is as early as the big bang related to the density of the "full quantum" which existed in the earliest moments of the universe. This dark energy varies over time, hence the term "variable cosmological constant". The repulsive action of the full energy launches the universe starts in its infancy, between 10^{-35} and 10^{-32} sec, in a crazy phase of annihilation of dark energy and creation of ordinary and dark matter. Its huge negative dark energy is so transformed into positive energy/mass. It is at the same time energy, negative cosmological constant and arrow of time, because it creates space-time and matter. It is associated with the topological defects of the space bound to the various broken symmetries that the universe has experimented in the past. Dark energy empties its energy to reach the today's "quantum vacuum" or the cosmological "vacuum energy", which reconciles the particle physicist and the cosmologist.

2) The structure of expansion goes with dark energy. Globally, into the theory of Relation, our complex universe is dual: positive and negative. The negative part, which is a universe by itself, disintegrates, and "creates" our actual positive universe. The Compensation principle asserts that the permanent loss of nega-

tive energy of the expanding em wavelength of spacetime induces the positive gravific spacetime matter. Flat em spacetime can yield induced gravity to ordinary matter. Gravific spacetime matter produced by the expansion can flatten the em spacetime. The deep meaning of the Compensation principle is that when there is less em mass/charge repulsive force in the structure of expansion—going forward with the arrow of cosmological time—there is more mass/matter attractive force in the other structure [3] [19].

This said, according to general relativity, even in the absence of particles, the universe can carry energy known as vacuum energy, this energy has a physical consequence: it stretches or shrinks space. The positive vacuum energy accelerates the expansion of the universe, while the negative energy makes it collapse [20]. We do not contest this classification, but in the theory of Relation the positive vacuum energy and the negative vacuum energy have another meaning. The first structure of condensation represents the positive solution of Dirac's equation of energy, while the second structure of expansion express its negative energy solution [15]. (Let us say that in the expression $E = \pm mc^2$, $E = +mc^2$ represents the positive energy, while $E = -mc^2$ represents the negative energy. $E = -mc^2$ is considered just as a virtual energy, which is wrong, in our view).

So, in our theory, the negative vacuum energy means dark energy also known as cosmological constant, while the positive vacuum energy means the structure of condensation, with the positive matter which augments and the space which shrinks. It is the inverse of Einstein's classification.

3) The cosmological constant provokes the expansion of space and at the same time its positive pressure exerted inwards slows down its expansion. This is not the positive pressure that induced deceleration but the transformation of negative dark energy into positive ordinary energy that produces an "attractive" force of gravity. The repulsive force of gravity of the primeval universe is a colossal negative energy which would result from the presumable big crunch of a pre-universe. From 10^{-35} sec, we can say that full dark energy had brutally begun its transformation into "white" energy of the primordial vacuum.

The total energy of matter increases as the universe expands. Similarly, the total energy of the graviton increases with decelerated expansion of the universe because it takes energy to the cosmological constant. With the expansion of the universe, the loss of energy of photons becomes directly observable, because their wavelength lengthens—they undergo a redshift—and the more the wavelength of the photon lengthens, the less it has some energy.

Microwave photons of cosmic background radiation are thus redshifted during nearly fourteen billion years, which explains their long wavelength (in the field of the microwaves) and low temperature. In this sense, we have a "tired" dark energy, and the gravitons would have extracted some energy from the disintegrated dark energy. In short, as the expansion of the universe decelerates dark energy's negative cosmological constant gives energy to the gravitation of the positive matter, while the graviton takes energy to matter and radiation [9].

4) There is a transformation of the negative energy (the em spacetime wave, or

dark energy, namely the cosmological constant) into positive energy (ordinary matter + dark matter), and we have a gravitation (energy/mass) which increases with the cosmological time of expansion. The matter increases, so the total energy related to mass of the particle varies. There is creation of particles and therefore of energy/mass. (This does not violate the principle of equivalence: the "proper energy" of the particles is equal to their rest mass). What does not remain constant is the global mass which grows with the expansion. So, if R_U, t_o and M^o is the radius, the time and the mass of our universe:

$$R_U = t_o c = GM^o / c^2 \quad (1)$$

R_U, and M^o increase with time. The global mass continues to enlarge because the disintegration of the pre-universe after the big bang is not yet finished [3] [19] [21].

5) What is the contribution of dark energy to the critical density in the theoretical framework of the theory of Relation? The full dark energy transformed into white vacuum energy, born in about 10^{-32} sec after the big bang has left imprints on the CMB in the form of tiny density fluctuations resulting from small variations in temperature (the order of 0.001%) of this radiation. By scrutinizing these tiny fluctuations in temperature with telescopes perched on balloons or satellites (in particular, the WMAP satellite launched by NASA in 2001 [22]), astronomers have inferred that the amount of dark energy that was responsible for more than two thirds of the critical density. In addition to this evaluation of the density of energy, independently, physicists have determined the density of matter (visible and dark) of the universe. The apparent size of heterogeneities of the cosmic background on the bottom of the sky is partially determined by the overall geometry of the slice of space which separates us from it. This apparent size provides an indirect measure of the total density of the universe, and it appears that the quantities of dark and ordinary matter account for less than a third of the found value [9] [10].

Conscientious French researchers declared that to explain that the universe is Euclidian, such as was predicted by the WMAP satellite, we do not need the hypothesis of dark energy and that the density of matter, alone, is sufficient. It is however necessary to put the hand on this missing matter. This claim does not correspond to the theory of inflation [6]. In its framework, the concordance of the experiments is consistent with a very low-density matter and the apparent abnormal recession of SN1a led to a positive cosmological constant, sign of an accelerated expansion [23]. Its theoretical framework is consistent with the results of weighing of clusters, deriving from the study of the cosmic microwave background: an energy density of 73% and a matter density of 27%. This gives

$$73\% + 27\% = 100\% \quad (2)$$

and involves a constant density of dark energy, that is to say a positive cosmological constant, during time, since at least 6 billion years.

Nevertheless, it seems to us that the inflation does not correspond to the theory of Relation, no more than a universe dominated by matter that would sound the death knell of dark energy. In the relationary cosmology, there is a negative "variable" cosmological "constant", in which dark energy density is reduced in favor of the density of matter consistent with the results of weighing galaxy clusters. We obtain

$$\underset{\text{Dark energy}}{(73\% - 20\%)} + \underset{\text{Ordinary and dark matter}}{(27\% + 20\%)} = 100\% \tag{3}$$

This expression means that the energy without mass (without positive mass) of the cosmological constant that contributes about 73% of the critical density would decrease over time towards 50%. What is lost of the immaterial dark energy becomes mass, joins the 27% coming from ordinary and dark matter, and keep the positive matter growing bigger. This compensatory balance maintains constantly the total mass/energy of the universe at the full 100%. Such a process implies a continuous creation of matter throughout the cosmological time, translates a slowing down expansion and explains a variable cosmological constant (~73% → ~50%) which continues to fill the missing mass (~27% → ~50%).

Dark energy in the framework of the theory of Relation—with a variable cosmological constant with a maximum of dark energy at the beginning and a minimum of matter/mass—can not only reconcile the model of physicists but also resolves the same endemic difficulties that claims to solve the positive cosmological constant.

For example, the presence of a negative cosmological constant equal to about 73% of the critical mass allows, as well than a positive constant, to settle an annoying paradox: the present universe is very heterogeneous if one judge by the distribution of matter, nevertheless the expansion seems perfectly uniform in all directions. By using both constants, the contradiction disappears with an energy distributed in a homogeneous way and which would govern the expansion... Except that, in parallel, the dark energy of the positive constant carries back into the past the beginning of the cosmic expansion. If its value was large enough it could even repel it to infinity (big bang eliminated). Whereas dark energy of the variable negative constant can back up until Planck's time and space time and space, starting from the vacuum energy of the cosmologists to the full energy of the physicists [3] [21]. The Compensation principle reveals a hidden, evolutionary, variable symmetry which explains the above value but close to the zero of the current cosmological constant [19].

6. Distances on the Rise or Physical Process to Explain the Low Luminosity of the SN1a?

To explain the low brightness of distant SN1a, scientists had two choices: either a physical process weakened their radiation, or their distance should be revised upwards.

In 1998, the results of the weighing of galaxy clusters, those from the study of cosmic microwave background and the latter resulting from the observation of distant SN1a, formed parts of a cosmic puzzle which matched to present the image of a nearly flat universe with a matter, whether dark or ordinary, which represented only ~27% of the critical density of the universe. Two international teams clamored that the luminosity of distant SN1a were 25% weaker than their close colleagues [11] [24]. When we observe such a supernova in another galaxy, it is enough to compare its visible magnitude with its intrinsic magnitude (brightness if is next to us) to know its distance. By decomposing through a spectrograph the light of those stars taken by the expansion of the universe, astronomers determine the redshift, and consequently their receding velocity. These two values, bound by the expansion which depends itself on the contents of the universe, showed a redshift higher upper to the predictions. Astronomers were quick to conclude that they are more distant than previously expected: it was a matter of distance [25] [26].

The results on supernovae gibe with the inflationary cosmology. Everything was held so that the expansion accelerates through a positive cosmological constant. Although the case appears heard for most astronomers, it seems problematic if not erroneous. The astronomers had considered *a priori* that the luminosity of SN1a is almost always the same: 5 billion times the Sun. But is the intrinsic magnitude of SN1a really constant?

This one is indeed known only due to the explosion models developed by astrophysicists. However, some mechanisms ruling the explosion are still misunderstood and some features of these models are still unprecise, what could modify the fragile value of the intrinsic magnitude that they predict. It is unclear, for example, if the explosion is due to a deflagration propagating slower than sound or to a supersonic boom. Such an uncertainty incites certain cosmological theories to postulate a variation of the constants of the nature, of which the constant of gravitation, although no observation or experiment showed some variation of G. A variable cosmological constant would be, however, more likely to change the value of the energy (and hence of the intrinsic magnitude) released by a supernova. Indeed, this energy depends among others on the reaction speed of some elements synthesized during the explosion such the nickel. If the cosmological constant, or the density of dark energy, does not have the same value at the instant of the supernova as it does today (contrary to what is usually assumed), the reaction rate and the chemical composition involving nickel would not be those envisaged by astrophysicists. There would be an evolution of the system overtime and the measures of luminosity of supernovae would then be corrected.

On the other hand, the result of the observations of the satellite XMM-Newton of Agency's European Space X-ray observatory (ESA) around 2003-2004 implies a decelerating expansion and excludes a distance in the increase to explain the excessive paleness of distant supernovae 1a [27] [28]. This is consistent with the theory of Relation.

Within the framework of the theory of the inflation, the concordance of the experiments goes in the direction of a very low matter density and the apparent abnormal recession of SN1a led to a positive cosmological constant. The choice of a physical process that weakens the radiation of supernovae was quickly dismissed and astronomers opted for the scenario of an accelerated dark energy which would have taken the upper hand during the second half of the history of the universe. This scenario is difficult to check, unless we observe clusters of galaxies today and in the past when the universe was only half its current age. Indeed, in a world dominated by this strange energy which accelerates expansion, clusters would have a very hard time forming. Galaxies too far apart would not even be able to assemble. Very early in the history of such a universe, no more clusters of galaxies would form. Those we see today would have been formed in the distant past. The question to be answered to determine the existence of dark energy was simple: yes or no, were clusters of galaxies formed in the second half of the life in the universe? It turns out that the XMM-Newton has returned data about the nature of the universe indicating that the universe must be a high-density environment, in clear contradiction to the "concordance model" relying on the theory of inflation. In a survey of distant clusters of galaxies, the results of the satellite revealed that today's clusters of galaxies are superior to those present in the universe around seven thousand million years ago. Such a measure logically inclines toward a decelerated expansion.

For his part, the American astrophysicist Bradley Schaefer obtained a result of the relation distance/luminosity which determines an inconstancy of the density of dark energy [29]. His idea was to use some gamma ray bursts (GRBs) as distance indicators which would mark out the distant Universe. Hundreds of times brighter than supernovae, GRBs can indeed be detected at distances much greater than these. So they would probe the dynamics of the expansion in an age of the universe very old and still poorly known. In this purpose, he began to analyze gamma-ray bursts detected by satellites Swift and Hete 2. Schaefer said he established the distance of 52 GRBs to about 12.8 billion light years. He compared the intrinsic intensity of the 52 gamma flashes with the intensity seen from Earth, determined their distance and established a relationship between this one and their luminosity. He found that the bursts to the same distances as the distant supernovae are fainter and therefore further that if the current expansion of the universe was decelerating, thus confirming the acceleration recorded using SN1a. In contrast, the most distant bursts at distances much greater than those where SN1a can be observed with present techniques seem rather more brilliant and therefore closer than expected if the acceleration was due to a cosmological constant. Since the brightness of 52 GRBs measured until the borders of the universe is too intense for the accelerating expansion is due to the cosmological constant, Schaefer concluded that the density of dark energy, instead of being constant, had to vary.

This finding does not seem to stand out from the current framework of accelerated expansion and from increase of distance to explain the low luminosity of the distant SN1a [30] [31]. The fact remains that astronomers know—while acknowledging not knowing enough about the secrets of exploding supernovae to be sure of their luminosity—that the synthesis of heavy elements in stars was different in the past from what it is today. It is therefore likely that the bursts due to the older stars have had at their disposal a larger reservoir of energy at that time. Ultimately, if the most distant bursts are the brightest, this is due rather to the evolution of objects that are at the origin than to the expansion.

Let us underline that Jayant V. Narlikar showed at the beginning of the years two thousand that the observed SNIa explosions, that were looking fainter than their luminosity in the Einstein-deSitter model, could be explained by the presence in galaxies of a certain type of dusts, forming needles. The absorption of light by the inter-galactic metallic dust would extinguishe radiation travelling over long distances. The galactic dusts would be produced by condensation of iron rejected by previous generations of supernovae. Explanation which has the merit of being based on facts, since laboratory experiments show that indeed this type of condensation produces needle-shaped [32] [33].

If the question of the absorption of light by the metallic dust ejected from the explosions of supernovae is generally ignored in the standard approach, which of a process of "tired light" which would weaken the luminosity is completely ruled out. The tired light is a theory proposed by Albert Einstein to reconcile its hypothesis of static universe with the observation of the expansion of the universe. Einstein had emitted the hypothesis that light could, for an unspecified reason, lose energy in proportion to the distance traveled, hence the name of "tired light". The term was coined by Richard Tolman—as an interpretation of Georges Lemaître and Edwin Hubble who believed that the cosmic redshift was caused by the stretching of light waves as they travel in the expanding space. Fritz Zwicky in 1929 suggested, as an alternative explanation to an expansion which derived from the observation of a redshift proportional to the distance of the galaxies, that the shift was caused by photons which gradually lose energy with the distance, probably because of the resistance to the gravitational field between the source and the detector [34]. Obviously, the ideas of Einstein and Zwicky, in a supposed static universe, were quickly ruled out.

With the theory of Relation, a form of "tired light" is indistinguishable from the assumption of a decelerated expansion of the universe with a variable cosmological constant. We are talking about the presently undetectable radiation of dark energy. Note that the tired light of this theory has nothing to do with the traditional model of light tired of the static universe in irreconcilable contradiction with the expanding universe. In the case of primeval photons, the tired light is also connected to the expansion of the universe. Today the distribution of these photons presents a blackbody spectrum from the hot and dense phase experienced by the early universe. Due to the expansion, of a thermal imbalance with a temperature that decreases with cosmic time, the blackbody spectrum of CMB observed by the COBE satellite in early 1990 is similar but not identical to that of the recombination, approximately 380 000 years after the big bang. The photons during the expansion would have lost energy (collected elsewhere), changed frequency without being deformed, as evolve the cells of a living body between the early youth and the advanced age [19] [35].

6.1. The Effect of Dark Matter on the Expansion of the Universe

According to most cosmologists, dark matter, which contributes about 24% - 25% of the content of the universe, has coexisted since the big bang with ordinary matter (4% - 5%) and dark energy (72% - 70%). They postulated that even before the epoch of radiation, and in later epochs, dark matter was the dominant species [36]. It gathered the cosmic structures and held them together. The more dark matter there is, the more gravity there is. Gravity keeps galaxies relatively close together and objects in them should be brighter because they are closer. In the case of a slowing of the expansion, one expects to find that the most distant supernovae are a little brighter than their close sisters. When 16 supernovae from the *High-z Supernova Search Team*, added to the 42 from the *Supernova Cosmology Project* (SCP) were detected at distances amounting to billions of light-years, their luminosity was not stronger but, on the contrary, 25% lower than that of their close counterparts. To explain this phenomenon, the scientists deduced that the speed of expansion was increasing: the expansion of the universe was accelerating.

The theory of Relation does not share the vision of an accelerating expansion under the pressure of a dark energy and dark matter preponderant from the origin of the history of the universe. We have previously suggested that there was almost no dark matter at the beginning of the universe [3] [19], that it appeared gradually in the cosmos, and we have tried to understand the nature of this major constituent of the universe [37] [38]. We assume that there was much less dark matter a few billion light years ago. Gravity therefore bound planets, stars and galaxies less strongly. The latter were more distant from each other and the objects in them must have been less bright because they are more distant. The latter were further apart from each other and the objects in them must have been less bright because they are more distant. In the case of an expansion at a steady rate, the remote SN1a discovered should be less bright than expected. This was the case. This suggests that they are closer and that the expansion is decelerating.

6.2. Acceleration of Expansion beyond a Reasonable Doubt; Rejection of Physical Processes That Can Explain the Pallor of SN1a

To determine simultaneously the distance at which a luminous object is and its speed of distance, it is necessary to know the luminous intensity of the emitted waves, called intrinsic luminosity, and to compare them with the received waves, called apparent luminosity. The latter decreases as the square of the distance from the source. As for the speed of distance, it is determined by the wavelengths received and their shift is due to the Doppler effect. Until the observation of type 1a supernovae about 9 billion light-years away at the edge of the universe, everything seemed normal: the more distant a supernova was, the weaker its luminosity was following a roughly linear curve. In the case of a slowing down of the expansion, we should have noticed that the most distant supernovae were a little more luminous than their close counterparts. In other words, these supernovae should have been a little less far away than if the expansion had kept a constant pace and appear comparatively brighter. The opposite was the surprise, the brightness was 25% lower. Astronomers concluded that they must be further away, as if the universe had stretched a little further than expected, and that the expansion was accelerating.

Two physical processes that could have caused this decline in apparent luminosity were quickly ruled out.

First process: a part of this light would have been absorbed on its way by matter in the form of gas or dust.

This explanation was dismissed by saying that, since these dusts absorb more blue light than red light, these supernovae should have had an "excess of red", which was not the case.

However, we mentioned Narlikar in section 6 who explains this non-excess of red by the presence of an interstellar metallic dust in the shape of a needle capable of absorbing all wavelengths. If one considers the absorption by the inter-galactic metallic dust which weakens radiation travelling over long distances, then the observed faintness of the extra-galactic SN1a can be explained in the framework of the Einstein-deSitter model, without any dark energy. Non-exotic metallic dust, since it was produced by laboratory experiments [32] [33].

Second process: supernovae were less luminous in the past than they are today.

The astronomers also ruled out this hypothesis, because the lack of luminosity remains the same, whether the supernova is old or not.

Let us recall that Henrietta Leavitt's cepheids were also intended to play the role of "standard candle", and that they had to be split into several classes with different properties. Even if nature makes classes of stars, it does not make two identical supernovae. We know that the first supernovae were of a different chemical composition from the following ones since the generations of stars had not yet succeeded one another to manufacture the heavy elements. This suggests a non-uniformity of SN1a; intrinsic luminosities whose absolute magnitude varies according to properties. How can they say that the supernovae of the past with a different composition from the following are the same as those of now?

In order to find out what could stretch space in this way, Einstein's cosmological constant was unearthed, which allows, mathematically, to introduce into space a negative pressure force that accelerates the expansion. This positive constant calls for a huge constant—in the form of dark energy—which would imply that the universe would have expanded so fast that no structure at all could have formed. In fact, general relativity applied to supernova observations and cosmic microwave background leads to an almost zero value. The existence of galaxies seems to accommodate this limit. For its part, quantum theory also requires a huge cosmological constant. The limits it predicts for accelerating the expansion and obtaining galaxies are of the order of 120 orders of magnitude greater than the value calculated by general relativity.

This prediction, already qualified as the worst prediction ever made by a scientific theory, indicates that something remains deeply misunderstood. This model of the big bang, which is that of a "preposterous universe", must be revised in its foundations. Hence the theory of Relation.

7. Supernovae and Pvlas Experiment

Aside from negative pressure dark energy, there are astrophysical processes that could affect the measurements and explain why distant supernovae have been observed to be fainter than what is expected in a matter dominated universe [39]. We are discussing here a less exposed argument, although touched upon, the PVLAS experiment [1] [2]. This is a physical process supported by an earthly experiment likely to explain the dimming of the apparent luminosity of SN1a. The general idea is that the latter lose their luminosity through interactions with cosmic magnetic fields, just as the laser of the PVLAS experiment loses photons when crossing a magnetic field [40] [41] [42].

On one hand, we have the Italian physicists of the PVLAS experience who studied in 2000, in a laser device, the way a magnetic field affects the propagation of a beam of "polarized light". The waves of this type of light oscillate on the same plane, characterized by an angle. Theoretical models predict a slight modification of this angle, because a small number of photons are deflected by the magnetic field and disappear from the beam. Except that the variation that the Italian physicists observed was ten thousand times greater than expected. They spent the next five years to verify this result, so much the stakes were potentially important. They acquired in 2006 the certainty that the strange phenomenon they had observed at the beginning of the millennium is not the result of a bias.

On the other hand, we can briefly say that supernova has roughly the volume of the Earth, the mass of the Sun and luminosity five billion times that of this last one. And therefore, one can easily conceive that the light emitted by a SN1a can be as brilliant and coherent than the laser, if not more.

Laser light has special and exceptional qualities which rank it in a separate category. At first, this light is extremely intense: much more than the Sun. It is monochromatic and pure, that is to say of a single color and the same energy for all the photons of the beam. It is temporally and spatially "coherent" because the time interval between the passage of a crest of a wave and that of the next is always the same. Finally, it is directive: the laser beam is very narrow and spreads very little. The SN1a constitute, despite differences, the candidate who can best resemble the laser light [43] [44].

In 1916, Einstein remarked that an electron located in a low energy level can absorb a quantized energy $h\nu$ and jump into an upper level; if the same energy

$h\nu$ is then received by the atom, it cannot be any more absorbed because the electron is already in the high energy level; Einstein then anticipated that the atom will behave as if it still wanted to absorb this energy: as it could not do, the excited electron will return to the fundamental state by emitting the energy $h\nu$: we say that this energy is stimulated—the total energy emitted by the atom is thus $h\nu$ not captured + $h\nu$ stimulated = $2h\nu$ [45] [46] [47]. We can compare a SN1a, which corresponds to the explosion of a white dwarf star after the accretion of matter and wave carrying the energy $nh\nu$ extracted from a close giant star, to an atomic system with "scales" of energy.

The SN1a form a relatively homogeneous class of objects, both in their mechanisms of explosion and in their spectroscopic and photometric observed characteristics. Their standardisable character authorizes to use them to build a diagram of Hubble permitting the determination of the cosmological parameters [48]. Due to the low dispersion of their maximum of luminosity in the spectral band B and their important luminosity which allows observing them at very high-redshifts, they have become the "standard candles" to measure great distances and constrain the cosmological parameters. Their maximum luminosity presents 40% dispersal, which is still largely homogeneous. Like laser, which is a macroscopic quantum object, a SN1a emits photons which have almost all the same wavelength, are almost all in phase, move all according to parallel paths. Their luminous waves are waves where the radiation emitted by atoms is synchronized between them [49] [50].

The light from supernovae, assimilated to a laser beam, suggests a supernova-amplifier of em waves based on stimulated emission, which would cross through cosmic magnetic fields by losing some energy-luminosity, like the PLVAS lasers [51]. The radiation of the supernovae which inevitably passes through the magnetic fields of galaxy clusters, stars, and interstellar space, gives up photons, which would be transformed into dark matter. The brightness of an em energy that loses photons and frequency in the long run, without its speed of light being affected, can only wane.

We would so obtain, corroborated by the PVLAS experiment, a kind of tired light that weakens the brightness of supernovae. If the most distant supernovae are fainter than expected, this would come from the fact that, at such distances, losses of luminosity by "tired energy" were able to finally be detected. And this observational bias could constitute a method to establish a distance-luminosity relation in the distant universe, predict a change in the density of dark energy and play a crucial role in the determination of the constancy or not of the density of dark energy.

Since the confirmation of the experience PVLAS, physicists have been particularly obsessed with the creation of axions in order to demonstrate the existence of dark matter. Is it the fear of a bad incidence on their conclusions that prevented the astronomers from imagining that a similar physical process can weaken the luminosity of the "cosmic probes"?

8. The "Centrist" Cosmological Principle and the Deceleration of the Expansion of the Universe

The cosmological principle states that all points and directions in the universe are more and less equivalent, and thus that the universe is, at least on large scales, homogeneous and isotropic. Given the cosmological principle, the Copernican principle concludes that there is no center of the universe [52]. Adopted by the theory of relativity, and then became the cornerstone of the building of the standard big bang, the Copernican cosmological principle leads—in agreement with the interpretation of contemporary astronomers—to the acceleration of the expansion of the universe.

The theory of Relation finds that the cosmological principle suffers from incompletion, and it is this insufficiency which led, in our opinion, to the blunder of the acceleration of the expansion of the universe. Karl Popper criticized the cosmological principle on the grounds that it makes "our lack of knowledge a principle of knowing something". According to him, cosmological principles were dogmas that should not have been proposed [53]. Recent findings have suggested that violations of the cosmological principle exist in the universe [54]. Evidence from galaxy clusters [55], quasars [56], type Ia supernovae [57] and anisotropies in the cosmic microwave background (temperature fluctuations and variations in the densities) suggests that isotropy is violated on large scales. A number of observations have been reported to be in violations of homogeneity of the cosmic microwave background over cosmological scales [58]. It is not the purpose of this section to debate whether the expansion could have been anisotropic—occurring in some preferred directions and allowing contraction in another direction—or inhomogeneous with some regions denser than others.

8.1. The "Centrist" Principle

Instead, the theory of Relation proposes to include a "centrist principle" into the cosmological principle, in addition to the Copernican principle. This principle can be confused with a new geocentrism that Physics has been striving to reject since Copernicus. In fact, it translates a neo-geocentrism: our representation of the universe cannot avoid, in order to be coherent, to include a privileged center from where the history of the world originates.

The existence of the universe is subordinated to the existence of a Word (*i.e.*, a generator of things) in this universe. This Word is the original center of the universe, namely the big bang, an extremely condensed state that has been expanding for about fifteen billion years. This privileged central point gave birth to all the points of the universe. It is quite relative, if not false, that every point in the universe is central and gives birth to the universe.

Unlike the Copernican principle, which uses a spatial length (or "spatial space") with an everywhere simultaneous factitious time, the centrist cosmological principle leads to the deceleration of the expansion of the universe. If astronomers had remembered that into space "seeing far means seeing early", they would have been aware of using a temporal length with acceleration to the past, to the beginning. And that the reversal towards us, towards the direction of expansion, towards "here and now" of the current epoch means a slowdown of the expansion of the universe.

8.2. The "Centrist" Cosmological Principle and Temporal Length

The temporal length (or "temporal space") of theory of Relation is characterized by a space-time with an irreversible cosmological time during expansion. The "centrist" cosmological principle concerns the spherical symmetry around the point of the singular origin which will be called the big bang (but which is the point of Planck supposed to mark the origin of theoretical time at the first millionth of a second approximately after the creation event). Centrism therefore refers to the beginning of the universe which becomes the center of the observable and unobservable universe. The cosmos at different times keeps the same center evolving to form the arrow of expansion, so snapshots taken at different times look like different sized enlargements of earlier snapshots. We formulate the cosmological hypothesis that the observers of an epoch occupy a privileged position to observe the center of the universe. This assumption is called the *centrist principle*. It implies a cosmological history where the energy of electromagnetic radiation which resulted in the cosmic microwave background radiation must be taken into consideration; case discussed by the theory of Relation which questioned the expansion of the universe from a hot state of thermal equilibrium to the universe we observe today, about 15 billion years after the big bang. The theory of Relation uses an equation of the universe with an irreversible cosmological time that unites Planck's time with present time [3] [21].

With theory of Relation, the starting matter-energy of expansion is at the speed of light. Then the speed of expansion decreases as energy is transformed into matter. There is a rapid deceleration at first and then more and more slowly. Light always propagates at speed c but the wavelength increases and the frequency decreases to form the cosmic microwave background (CMB). Although energy transforms into matter throughout the expansion, the hypotheses of homogeneity and isotropy can be considered, even approximately, to be valid since the matter-energy density of the Planck era. Spacetime of the theory of Relation offers a spatio-temporal framework with stratified epochs of locked states. This supposes, for each of the overlapping epochs, the invariance of the laws in the displacements of each of the coordinate systems. Any point arbitrarily chosen at an epoch is equivalent to any other choice from the point of view of the fundamental laws of physics; all observers are Copernicans since they occupy no privileged place.

But by recentering the big bang point as the center of the world, these observers are no longer equally qualified to serve as the origin of the coordinate system since there would be a particular origin to which to compare the positions of other objects [59]. The observer at the origin of an electromagnetic space-time "sees" towards the future all the Copernican observers, who everywhere here and now "see" him at the very beginning. The finite speed of light means that we always look at the universe as it was in the past, rather than as it is in the present. According to the Copernican cosmological principle, "here and then" is the same as "there and then" (then meaning previously), which means that from any point in the present epoch time has the same past no matter the distance to the past. In this sense only, one can speak of temporal length for relativity. In the theory of Relation, "here and then" and its spatially opposite equivalent "there and then" imply a real temporal distance since the time of this spacetime has everything to do with the past, as advent and fading, in connection with the continuing succession to the past, and vice versa to the future [60].

This makes that the travel backward through expansion time goes from the currently estimated speed of the expansion to the speed of light of the beginning. There is an increase in speed going towards the beginning and the observed apparent brightness of SN1a, weaker than expected, only accentuates the acceleration towards the origin (assuming only the distance is involved). If, conversely, we position ourselves at the origin to follow the expansion towards the present epoch that is part of the horizon, we can only go from c towards the lower present speed by following the arrow of cosmological time. Thus interpreted, the pallor of the SN1a only accentuates this deceleration.

The centrist principle incorporates the concepts of isotropy and homogeneity of the cosmological principle. Like the Copernican principle, the centrist principle adopts the paradigm of the cosmological principle. The Copernican principle does not claim that the center does not exist, only that we are not there. From this principle, we should expect that we are not at the center of anything, much less some universal cataclysm. The centrist principle says that the center exists and that we can imagine being at the center: a special place, if only for the sole reason that it is unique.

Imagine being near the region of the early universe where the big bang happened and watching as it expands. By the cosmological principle, this volume must be completely representative of the universe as long as it is sufficiently large for true isotropy to prevail. In the beginning, the density and temperature were very high, and everything was in the state of electromagnetic radiation. This light at several billion degrees absolute was gradually transformed into matter, *i.e.*, elementary particles. The universe was opaque: radiation and matter were constantly exchanging energy. As the universe expanded, cooled and diluted, there came a time when radiation stopped interacting with matter and the universe became transparent. The universe was opaque: matter and radiation constantly exchanged energy. As the universe expanded, cooled, and rarefied, there came a point at which the matter ceased to interact with the radiation, and the universe became transparent. Since the decoupling, the cosmic radiation has evolved independent of the matter: these cosmic photons are neither created nor destroyed; they simply stream through space in all directions. They constitute a cosmic background radiation (CBR) as a relic from a hot, dense phase in the early history of the universe. The CBR provides evidence for the big bang, can tell us about the conditions in the very early universe and is also the best evidence we have that the picture adheres to the cosmological principle. A truly homogeneous and isotropic big bang should produce a relic cosmic background that is a perfect blackbody in all directions, excluding any possible interactions with matter lying between its distant source and our radio antennas [61].

According to the centrist principle, temporal space is isotropic and homogeneous. We can imagine the expansion of the universe as an arrow of time [62] [63] made up of epoch-points in the direction of the future (line in the direction of movement). The density of matter changes with time, and the space of this arrow (it constitutes the radius of the universe) has asymmetries since it does not remain identical to itself if a translation or a rotation is carried out. The existence of homogeneous and isotropic spaces defines a class of privileged, central and fundamental observers, those whose universe line straddles this arrow of time at all points. These observers are a mathematical and theoretical construction, and their existence is necessary insofar as they define and measure the theoretical reference time of this temporal arrow, called cosmological time. In theory of Relation, the measured cosmological time depends on the state of motion of the expansion of the universe. Any observer will have to determine his movement in relation to these central observers.

Allow us the following technical remark. As each point represents an epoch, the matter remains isotropic and homogeneous for this point-epoch. The line of spatial space of this point is perpendicular to the line of the universe constituted by the arrow of time which runs from the past to the future: such a space for a particular epoch is Copernican, has symmetries since it remains identical to itself if a translation or a rotation is done. Relativity applies for each era in particular: the density of matter is the same at all points, no observer occupies a privileged position in space and a theoretical cosmic time of reference makes it possible to measure the movement of one observer in relation to another.

The centrist cosmological principle is therefore a generalization of the universe as a whole from the non-Copernican point of view: any creature or observer at the beginning occupies the privileged place in the universe. The reappearance of the concept of the center of the world leads to that of its limits: our universe is not infinite and with the deceleration of expansion the universe is heading towards a tipping point, towards a big crunch.

8.3. The "Copernican" Cosmological Principle and Spatial Length

The cosmological assumption that we do not occupy a privileged position in space is called the *Copernican principle* [64]. According to this principle, space is isotropic and homogeneous. The density of matter is therefore the same at all points but may possibly change over time. Such a space therefore has symmetries since it remains identical to itself if one performs a translation or a rotation.

According to the Copernican cosmological principle of the theory of relativity, "here and now" is the same as "there and now". This means that time has the same present whatever the distance, which implies that time does not express becoming or the past and has the appearance of duration, that is to say that it has an aspect of conservation, permanence, and stability. We can speak here of a spatial distance since the time of this space-time has nothing to do with the continuous succession. The time of this space-time is perfectly reversible just like this space-time itself.

The Copernican principle is a cornerstone of general relativity and much of astronomy: not only do we not live in a special part of the universe, but there are no special parts of the universe—everything is the same everywhere. There is equivalence between "here and now" and "there and now"; equivalence between "here and then" and "there and then". The observers are spatially opposed but the time is the same, as if it did not exist, which means that the speed of the expansion goes from ~0 to $\sim c$, towards the horizon, towards infinity. If we reverse the positions, we cannot go from $\sim c$ to 0. We go from ~0 to $\sim c$ again and always since "here and now" is the same as "there and now". It is a spatial space directed from all sides towards the infinity of the horizon: if, in addition, an excessive pallor is added to the SN1a, this only further confirms the acceleration of the expansion of the universe towards the big freeze.

8.4. Einstein and the Copernican Cosmological Principle of Homogeneity and Isotropy

The cosmological principle of homogeneity and isotropy, in accordance with the Copernican principle, was implicitly formulated by Albert Einstein in 1917 when he was looking for solutions to the equations of general relativity describing the universe considered as static. The observations were limited to the Milky Way because no object located in our galaxy had been identified as such. It has the consequence that Man does not occupy a privileged position in the spatially homogeneous universe; that is to say that his general appearance does not depend on the position of the observer.

After much trial and error—de Sitter, Friedmann, Lemaître and the proof of expansion by Hubble in the late 1920s—Einstein presents in his 1945 memoir entitled *On the Cosmological Problem* (appendix to the second edition of *The Meaning of Relativity*) [65], the conception of a uniform distribution of matter on a very large scale in the universe and the explanation by general relativity of an isotropic recession of the galaxies, in agreement with all the relativist cosmologists of the time and in good understanding with the investigation of Hubble and its successors.

In fact, the Copernican cosmological principle concerns spatial space. But as far as temporal space is concerned, Einstein quickly understood the difficulty of a cosmic history and a singular origin that we will call big bang. He never considered the case where the energy of radiation should be taken into consideration, a case that has since been discussed by cosmologists who wonder about the structure of the early universe. For the creator of the theory of general relativity, this singular origin (big bang) is a mirage which results from the fact that one unduly extends the domain of validity of spatial space to the domain of temporal space, because, beyond a certain density of matter-energy, the hypotheses of homogeneity and isotropy can no longer be considered, even approximately, as valid.

8.5. The Big Bang and the Centrist Principle

In keeping with the theory of Relation, the Copernican cosmological principle is unacceptable with regard to the dynamic theory of the big bang. This principle implies that the spacetime of relativity and the spacetime of the big bang theory are interchangeable concepts when they are not. And therein lays the physical flaw: they respond to specifically different realities, since one can conceive of a space-time whose reversible time is a perpetual "now", whether here or there at the other end of the world, and a space-time whose arrow of time going from cause to effect is irreversible. This arrow of time is due to the initial conditions: the universe began in a state of low entropy and the arrow is determined by the inexorable increase in entropy, an increase which is observed in all macroscopic occurrences. What provides a past and a future for the universe is that it began in a state of low entropy; it makes the past distinct from the future. The cosmic time of general relativity has nothing to do with the cosmological time of the big bang that we find in the formula of the theory of Relation.

Above, we imagined being near the region of the early universe where the big bang occurred and watching its expansion. Observations indicate that the universe has many special epoch-points in the arrow of time and evolves with cosmological time. The universe of our epoch is filled with numberless galaxies, organized into huge structures stretching over millions of parsecs. The galactic spectra provided redshifts giving the information that the galaxies were nearly all receding. There is a systematic increase of redshift with distance and nearly all cosmologists agree that the data present support for the interpretation that the major contribution to the redshifts of distant objects is the cosmological redshift due to the expansion of space itself. From the centrist principle, we should expect that we are at the center of everything, even more of a universal bang, unlike the Copernican principle that we are not at the center of anything, much less some universal explosion. The Hubble flow, *i.e.* the overall motion of galaxies away from one another, due to the general expansion of the universe is quite clearly consistent with the cosmological principle [61]. Only by appealing to the cosmological principle can we affirm that the same laws of physics discovered on Earth also apply to distant galaxies, and that all objects, regardless of the temporal or spatial distance separates, are composed of the same fundamental substances that we find on Earth and in its vicinity.

The Copernican cosmological principle theoretically leads in relativity to the equivalence during expansion between temporal length and spatial length. But this equivalence is in fact only valid for the spatial length that leads to the spatial infinity since the temporal length to the past means nothing given that this time is both a "now" without change and a change without time direction. Einstein distinguished well between spatial space and temporal space but preferred to consider the latter as a mirage without reality, which is a mistake. The other fault comes from current cosmologists who wanted to be more Einsteinian than Einstein himself by no longer distinguishing the difference between spatial space and temporal space. They employed the "*perfect*" Copernican cosmological principle which implies that temporal space is the equivalent of spatial space [66]. They stated that the universe is identical to itself in each of its points and at all epochs, a different hypothesis from Einstein's cosmological principle which states that all points in the universe possess the same properties at a given epoch. In our opinion, this double aberration which perverts the cosmological principle constitutes the major contemporary cosmological error.

8.6. The Expansion of the Universe: One Foot on the Accelerator, One Foot on the Brake

Here we are again with a center, no longer of the Earth or the Milky Way, but of the universe. This suggests a privileged direction. Which? Undoubtedly, that of the irreversible arrow of cosmological time which points from the past towards the future during the expansion. And this "temporal" cosmology undeniably presupposes a "centrist" cosmological principle. One can have the vision of a central and privileged observer using an "irreversible" space-time which opposes an observer who uses a "reversible" space-time where "here and there" always have the same "now": "spatial" cosmology which uses the Copernican principle is not equivalent to "temporal" cosmology which uses the centrist principle.

When spatially opposed observers of an epoch, for whom reversible cosmic time is the same for all, claim to have the same past, they fall straight on the arrow of the single time that crosses all epochs and defines the entire observable universe. The irreversibility of this central arrow, as shown by the basic equation of the theory of Relation [3] [21] is inscribed at all levels, from the simplest of quantum objects—the hydrogen atom—to the universe itself, born of an entropic explosion. One then no longer flounders in the Copernican principle which has become synonymous with the cosmological principle; one has the obligation to graft the centrist principle as well to the cosmological principle so that irreversibility has a fundamental meaning within physics.

The centrist principle rehabilitates the standard cosmological model from before 1998 which predicted a deceleration. The expansion that decelerates from the original center towards us means that one could explain the unexpected pallor of the distant SN1a compared to the brightness of the closer SN1a simply because the former are closer to the center with a higher speed, and that the second are closer to us with a lower speed. A drop in speed coming towards us would explain the difference in brilliance. The experimental discovery in 1998 of the acceleration of the expansion of the universe by dint to the observation of distant supernovae was precipitated and erroneous because cosmologists speak of an expansion which they are at the same time unable to describe correctly since they do not make a distinction between "spatial space" and "temporal space". They do not know if it is a spatial expansion towards infinity or a temporal ascent towards the origin.

All in all, here we are with an expansion of the universe which has, in accordance with interpretations of the cosmological principle, both one foot on the accelerator and one foot on the brake, like Schrödinger's cat in a state at the same time dead and alive. One of the predictions of the basic equation of the theory of Relation is that the expansion of the universe can only decelerate.

9. Discussion and Conclusions

Since its discovery during the late 90's, the dimming of distant SNIa apparent luminosity has been mostly ascribed to the influence of a mysterious dark energy component. The discovery was able to confirm the ideas of inflation and the acceleration of the expansion. Cosmology has achieved its inflationary version of a standard model, called the "cosmic concordance", within the strongly tested framework of the hot big bang model. However, in this paper we argue that the official declaration of the astronomers in 1998, to the effect that the expansion of the universe accelerates, was precipitated and erroneous. Furthermore, a drawback to their conclusion: The dark energy component or a positive cosmological constant represents, in the current "concordance" model, about 73% of the energy density of the universe. Nevertheless, a cosmological constant is usually interpreted as the vacuum energy and current particle physics cannot explain such an amplitude approaching zero. No theoretical model, not even the most modern, such as supersymmetry or string theory, is able to explain the presence of this mysterious dark energy in the amount that our observations require. On the other hand, if dark energy were the size that theories predict, the universe would have expanded with such a fantastic velocity that it would have prevented the existence of everything we know in our cosmos. This negative pressure fluid remains a serious weakness known as the cosmological constant problem. We dubbed it the "dark energy catastrophe" [23] [30] [31] [64].

We propose the theory of Relation with a variable cosmological constant, which explains the early universe as well as the state of the current universe, and which leads to a deceleration of the expansion, what has the merit to resolve the paradox of the cosmological constant. The expansion of the universe is so likened to a positive pressure and to a negative cosmological constant. It has decelerated steadily throughout cosmological time due to the presence of dark energy that varies down in favor of a matter/mass which does not stop growing since the beginning.

The accelerated cosmic expansion of the universe is mostly based on the apparent faintness of the distant SN1a. Two means were available to explain the wanness: revise the distance on the rise, which means acceleration, and the physical process which means a deceleration. The astronomers hurried to accredit the distance on the rise which was consistent with the theory of inflation.

They have disregarded arguments brought by several physicists-theorists and experimentalists (XXM-Newton) that foster physical processes.

We subject an argument susceptible to explain by a physical process the decline of the visible luminosity of SN1a. It is about the PVLAS experiment which revealed a loss of intensity of the luminosity of laser radiation in a magnetic field. Further to this experiment, physicists have struggled to discover the mysterious particle of the dark matter which would explain the loss of photons. They seemed to be obsessed by this single issue, without even considering that light from distant quasars and supernovae could also lose brightness when it passes through the inevitable cosmic magnetic fields. If the loss of photons experience PVLAS was ten thousand times greater than expected, and if it is appropriated to compare this laser experience with the radiation of SN1a, we can therefore hardly doubt that this is a physical process of "tired light" which increases the redshift, weakens the apparent brightness of SN1a, what indicates a deceleration of the expansion which excludes the increase in distance.

We bring the philosophical "centrist" assumption. It is opposed to the philosophical Copernican assumption which postulates that there is no privileged point of view in the universe. The Copernican principle has spawned the cosmological principle of isotropy and homogeneity, which has never been tested, on which is built the big bang edifice and is based relativity. The resulting interpretation leads to negative pressure dark energy or a positive cosmological constant, implying the worst prediction in physics: the discrepancy of ~122 orders of magnitude between the energy density of the vacuum observed by astronomers and that predicted from the calculation of particle physicists. We think it is necessary to consider a centrist principle that coexists with the Copernican principle, in order to include the arrow of irreversible time of expansion that marks the history of our universe. A Copernican observer from any point of a particular epoch uses reversible cosmic time that gives all the space to a spatial space directed towards the horizon (towards the future). One of the aspects of this time implies that physical causality ignores any dissymmetry between future and past, any distinction between "cause" and "effect". This same Copernican observer becomes a "centrist" observer when he gives way to a temporal space that uses an irreversible cosmological time that accelerates through all epochs towards the original radial center. (This going back in time corresponds to the contraction phase while the opposite, the current expansion phase, is our reality).

Relativity has contributed a great deal by clarifying that the change in mass depends on the relative magnitudes of space and time; that time is a sequence of events which follow one another in a determined place, like a succession, in space, of points on a line. But it has obscured a great deal by accustoming us to consider as an illusion the idea that time is a succession of states which embrace the universe; to estimate, like a geocentric point of view of the Middle Ages, the world which, in its duration, would be composed of a continuous succession of locked epochs, like slices, as if the history of events were stratified. The instantaneous events of each epoch form a state, or a stratum. The "now" epoch represents one of these strata extending through the history of the universe. The ordered succession of these strata forms the whole of reality [67]. It is partly the interpretation of the succession of events of spatial order with a relative and local time (which we do not reject), to the detriment of a succession of events of temporal order with a universal time, which has led to the scientific catastrophe of our time.

This is why the theoretical model of the theory of Relation proposes an irreversible spacetime resulting from the original quantum universe and whose course of cosmological time—with a history, a past directed towards the future—flows until the current epoch. Irreversibility, entropy and temperature are related to the direction of the arrow of this time. Now such an expansion which originates from a hot state of electromagnetic radiation can only gradually transform its light into matter, which elucidates the mystery of dark energy, and slow down. To see far is to see early.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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