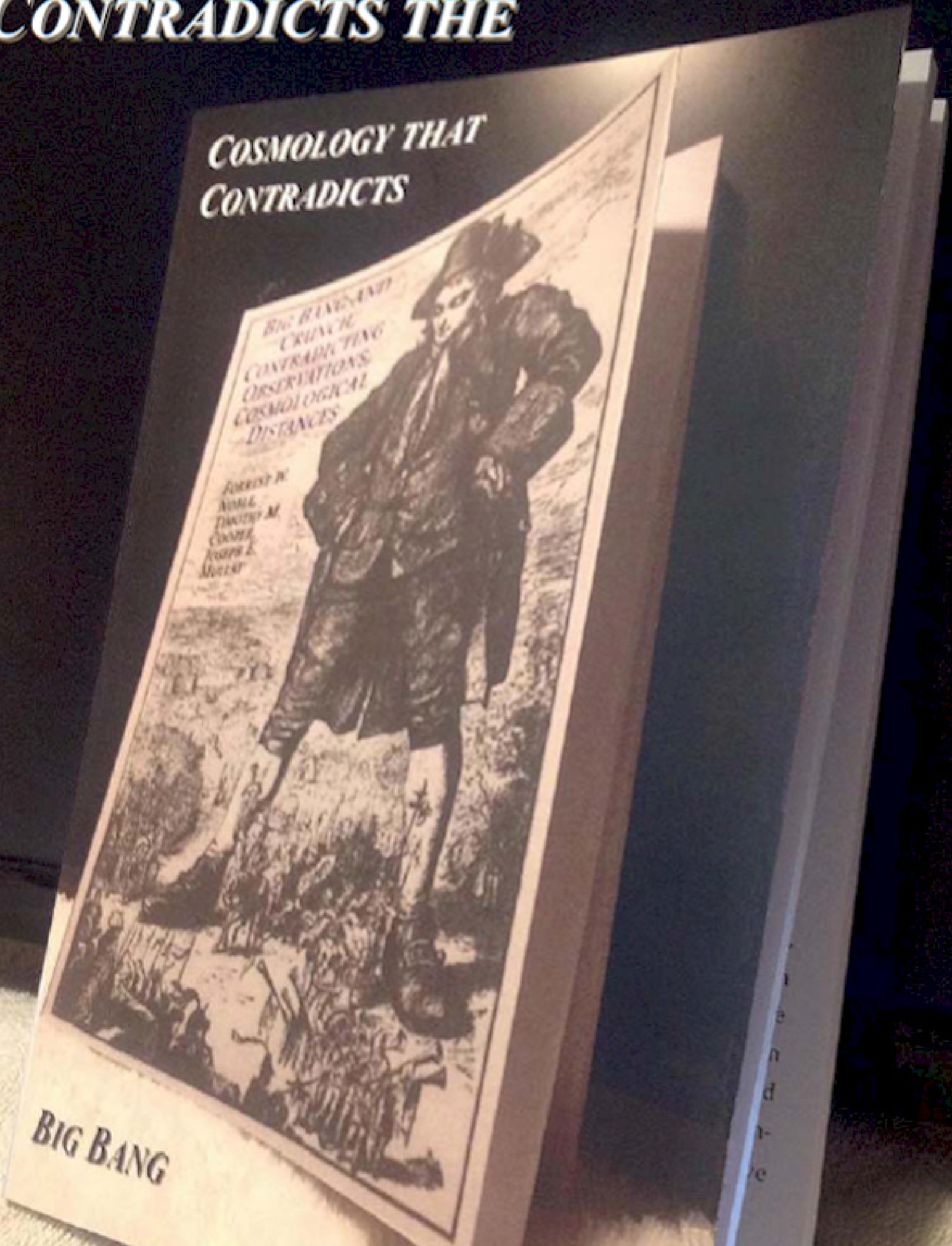
COSMOLOGY THAT CONTRADICTS THE



BIG BANG THEORY

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THE BIG BANG AND THE BIG CRUNCH
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Luke Mastin

OBSERVATIONS THAT SEEM TO CONTRADICT THE BIG BANG MODEL WHILE AT THE SAME TIME SUPPORT AN ALTERNATIVE COSMOLOGY

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HUBBLE-INDEPENDENT PROCEDURE CALCULATING DISTANCES TO COSMOLOGICAL OBJECTS

Joseph E. Mullat

AN EXPERIMENT COMPARING ANGULAR DIAMETER DISTANCES BETWEEN PAIRS OF QUASARS

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COSMOLOGY THAT CONTRADICTS THE BIG BANG THEORY

The Standard and The Alternative Cosmological Models, Distances Calculation to Galaxies without Hubble Constant, An Experiment comparing angular Diameter Distances

For the alternative cosmological models discussed in the book, distances to galaxies are calculated without using the Hubble constant. Initially, in the present and in the future, a new space in the form of a quantum vacuum and matter will arise independently in the Universe as a result of parallel and simultaneous gravitational interaction, forming a new quantum vacuum and visible matter. The average energy density in the Universe decreases, new regions appear, previously being hidden under the quantum transition from the hypothetical Background Gravitational Field. When a minimum (average critical energy density) is reached, the gravitational transition to quantum vacuum and visible matter will begin to decrease its acceleration. We recreated the inflationary phase of the Universe based on the postulate of decreasing density. An experiment was also carried out to compare the angular diameters of the distances between pairs of quasars according to data from open access.

Unlike all known geometric models of the Euclidean metric space, the gravitational transition of the Background Gravitation Field into matter, respectively, would presumably occur in the metric space of the stereographic projection into the three-dimensional surface of the four-dimensional manifold. It doesn't matter how we describe energy-field, calling it ether, gravitons, or vice versa, converting it back into the ether or energy-field. It should be clear to everyone that this renaming does not change the essence of the gravitational transition.

About the Authors

Pantheory Research Organization. Forrest Noble Director: Our published research papers to date relate to theoretical cosmology and related theoretical physics. Most of this work promotes alternative explanations and equations contrary to dark energy, dark matter, Inflation and Big Bang cosmology in general.

Forrest W. Noble

One of Tim's interests in the contrarian theory herein is that it contradicts major aspects of most theories in modern physics yet it cannot be disproved by observations to date based upon alternative interpretations of them. Tim is a stress engineer in the aerospace industry and has a Master's degree in Systems Engineering.

Timothy M. Cooper

Joseph Emmanuel Mullat currently works as Independent Researcher. Joseph does research in Game Theory, Public Economics, Optimal Taxation, Data Analysis and Cosmology. The most recent publication is 'On the Possibility of Describing Events in Cosmology at the Scale of Average Relativistic Density of Matter'.

Joseph E. Mullat

Σ Π

Critical Views, credits from Public Domain

It seems to me (ie., for the writer of this critical lines, which follows; the source will not be disclosed, ed.) that Scientists "invent" some concepts in order to prevent their old ideas becoming untenable. Dark Matter and Dark Energy are "inventions" that highlight the errors in current theory, they just do not really exist, and a modification to current theory is required to "fix this up". For instance "dark matter" is supposed to be 80% of all the matter in the Universe. What it is telling me (author of these current lines, ed.) is current theories of Gravitation and the Big Bang are out by nearly an order of magnitude. You can "keep" the current theory only if you "balance the books" using a "huge fudge factor". The real problem is quantum entanglement has not been introduced into theories of cosmology yet and that is where the problem is. Space-time is not primary to the Universe and it is the pre-existing geometry that is "real". It illustrates just how little science knows and how reactionary it is to any change. There are plenty of theoretical solutions to this problem but the "elephant in the room" is there is a reluctance to commit to primary research in the areas that will cause real change because change is going to hurt a large number of established reputations. Therefore the question "What was first: The Dark or the Visible matter", the answer is there can only be one form of matter. Too many people are watching Star Wars and have turned to the "Dark Side" for answers and are not keeping a weather eye on their instruments. If they finally find "the elephant", they will be attacked and savaged by those who have their pensions to protect.

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"In the beginning, there was nothing. Well, not quite nothing—more of a Nothing with Potential. A nothingness in which packets of energy fleeted in and out of existence, popping into oblivion as quickly as they appeared. One of these fluctuations had just enough energy to take off. It inflated wildly out of control—one moment infinitesimally small, moments later light-years across. All of space and time was created in that instant, and as that energy slowed, it cooled and froze into matter—protons and neutrons and photons. This baby Universe kept expanding, over billions of years, and those particles coalesced into stars and planets and eventually humans." Source unknown

PREFACE

Cosmological phenomena are not exactly a subject of physical science as many might think. We cannot perform experiments on the Universe. In contrast, physics is a science, where researchers can conduct experiments on various natural phenomena that can be reproduced by others in a laboratory. In cosmology, we can only look at the skies and speculate what stands behind the light reaching our telescopes. [1]

We can predict the location of planets and stars at closer distances by applying classical Newtonian mechanics, when we use the ordering of the events on the time scale. Still, cosmology relies on numerous pictures of the Universe, aiming to shed some light on phenomena at far away distances. Of course, researchers can verify the correctness of the mathematical reasoning performed by their colleagues, but this does not bring them closer to the truth hidden in the vast expanses of the Universe.

The dark matter is an example of such speculation that is inherent in the study of the Universe. Cosmologists call something that cannot be explained as dark matter, and have even introduced the concept of dark energy. Yet, despite these many assumptions and speculations, cosmology is very interesting and useful, even if it is not an experimental sci-

[1] Disney, M. J., "The Case Against Cosmology," Physics and Astronomy, Cardiff University, Cardiff CF24 3YB, Wales, UK.

ence. Remember Aristarchus, who with his primitive tools needed only common sense and the knowledge of trigonometry to calculate the distance from the Earth to the Sun with great accuracy, using only the dimensions of the Earth's shadow projected onto the Moon's surface. Aristarchus from Samos, fl. c.310 BC — c.230 BC, was a Greek astronomer and mathematician of the Alexandrian school. It is said that he was the first to propose the heliocentric theory of the Universe.

As cosmologists also speculate about the origins of the Universe, they posit neither existence of some point prior to which neither time nor space existed, and refer to it as singularity problem of time. Space has a density of energy, which largely determines the dynamics of cosmic objects and the Universe as a whole. Given these many assumptions, it is reasonable to speculate about the Universe dynamics, as many researchers claim that it is expanding and its density of energy is decreasing.

Space and time despite the speculations still are subjects of physical science and are defined in general terms, by presently accepted theory, as fundamental structures for coordinating objects and their states: a relationship system that reflects the coordination of coexisting objects (distance, orientation etc.), together form space, and a relationship system that determines the consistency of successive states or phenomena of flow-series events, ordering, preferences, etc., together accordingly form time. The space in which we live—the usual three-dimensional space—is a physical object bounded by a certain set of parameters, the change of which over time is described by dynamic systems.

It seems that the mathematical apparatus of dynamic systems is quite sufficient for solving problems associated with the motion of matter in the Universe. Indeed, *"Theories in physics are not at all hypotheses, they are not just supported by more or less numerous facts. Theories should have consistent math, such as topology. If the physical theory does not obey the topology, it is incorrect. Topology lays the foundation for physics, not vice versa,"* (Public Domain, Researchgate 2019). However, the theory of space, based on the topological principles of General Relativity (GR), brought problems related to space and time, perhaps, to a dead end, both in cosmic dynamics systems and in the attempts to form a quantum theory of gravity. In such a situation, there naturally arises the need for alternative approaches to the description of reality. Unfortunately, the choice of alternative paths is somewhat limited, and if such a path is indicated, one must first understand the situation, what it looks like at present, and then try to determine any contradictions between the observations and theory. Finally, try to offer something new, even if it is not as perfect as hoped, for example to deviate from the quest to explain all the reality and settle for an insight of a lesser magnitude. This is our motive for narratives offered to a thoughtful reader.

In the first narrative, a modern view of cosmological reality is given, as it is taken from a standard perspective. The obvious sign of the standard view is the concentration of activity, not in solving some physical problem or better explaining observed reality, but in discussing the options of “falling into black holes”, “parallel worlds”, discussing the possibility of getting into the past, and the like. All of these ideas lead to great science fiction but highly questionable science.

There are also many alternative cosmologies to the Big Bang model. Most of these are unknown to mainstream theorists since professional theorists proposed few of them. Indeed, most of them can be considered steady-state theories, meaning that the observable universe would look generally the same everywhere in time and therefore would be much older, or could even be infinite in age and size. Most of such models have a different explanation for galactic redshifts. One of these theories is discussed in some detail in the second narrative, as well as an extensive redshift comparison of calculated distances in the latter part of the book in both the third and fourth narratives.

In the second narrative, based on factual material, a thoughtful reader will become familiar with a number of contradictions and paradoxes of the standard model of the Universe. Many researchers and theorists, in order to explain the paradoxes, try to expand the mathematical apparatus to the point of absurdity using various paradoxical mathematical constructions. Indeed, in many cases it is possible. However, it is far from common sense, which people have long used to form a theory, contemplate and explain reality.

As stated above, there have been many other similar hypotheses (e.g., tired light) like this since Fritz Zwicky first proposed most famous one in 1929. Zwicky suggested that if photons lose energy over great distances through collisions with other particles in a regular way, the more distant objects would appear redder closer ones. The spectral lines of the elements that produced the initial light would become longer because of these collisions and therefore shifted toward the red spectrum, redshifted from where they started. Aside from the tired light proposal, the regional differences in redshift remain unexplained and of the few who know of it, many of those believe the effect is too prevalent to be a coincidence. Indeed, too much of the aging idea is no longer endorsed by any theorists and nearly all astronomers would scoff at the conclusions drawn in the above view of present theory, and because the logic solely fails in light of present day observations.

Today nearly all astronomers would say that this hypothesis of tired light was worse than just unsatisfactory; they would say that it has been disproved because of the observed time dilation, the slowing of time causing an event to last longer. This is most noticeable concerning dying stars called type 1a supernova. All this type of supernova have a similar light and time profile whereby the duration of their great brightness only lasts a few days, very close to the same amount of time for relatively close events. Then after peaking, this great brightness steadily dies off in just a few days. It has been shown by a great number of these observations that the farther away these supernovae explode based upon their redshift, the longer the event lasts from our perspective. All observations occur in other galaxies since only a few per millennium are thought to occur in our galaxy. These observations are consistent with the expansion of space whereby wavelengths twice as long would last twice as long since there is nearly the same number of wavelengths per event.

Too much of the above paragraph is no longer endorsed by any theorists and nearly all astronomers would scoff at the conclusions drawn in the above paragraph in light of present theory, and because the logic solely in this paragraph fails in light of present day observations. The proposed abbreviated paragraph is shown below. This is the reason why most astronomers believe that tired light has been disproved. But this is not the end of the tired light story concerning logic.

There are other versions of tired light theory, however, that can accommodate time dilation. One such hypothesis involves the interaction of light with the ether as it travels. The surrounding ether would accordingly absorb some of the EM radiation's energy while stretching it out because of some resistance to the flow of EM radiation. This would explain what is being observed concerning both redshifts and time dilation but would get little consideration from astronomers if the word ether were used. Instead one might use the words background-field, which could mean either a physical or energy omni-present background field in all of space, which could carry and dilate EM radiation.

Upon research one might see still other tired light versions, which also can explain time dilation. For aged-light theory time dilation must be logically explained for any astronomer or student to read further since all have been familiarized with it via related education.

But the theory of the aging of light, presented by the bulk of astronomers, does not require radical additions to the existing physical laws. It was assumed that in intergalactic space there are some particles that, interacting with light, take some of the light energy. In the vast majority of massive objects, these particles are larger than others.

Using this idea, astronomers, as mentioned above, explain the differences in redshift values as follows: light passing through galaxies with a denser cluster of particles encounters more of these particles, and therefore, light loses more energy than light that does not passes through regions of galaxies with lower density. Thus, a larger redshift will be observed in the spectrum of light crossing obstacles (areas with denser clusters of the galactic background), and this will lead to different values of the Hubble constant. In making such arguments, astronomers are thus referring to additional evidence for their theories, which has been obtained from experiments with objects with low redshift.

We will specify a few versions that cannot be disproved by time dilation. In the first version light interacts with a space medium similar to the old idea of luminiferous ether. As light becomes older with distance, it accordingly could be called "tired," a tired light hypothesis. The farther light would travel through this ether the more the light would stretch out its wavelengths redshifting it. The word *ether* is no longer popular so new versions of it have been called the zero-point-field, quantum foam, gravitons, the Higgs particle and field, and many other theorized entities like background energy field. Visual" matter is real. However, the *dark matter* that we will refer to as "hidden vacuum" is not. Hidden vacuum cannot interact with light.

In short, among astronomers, in particular among amateurs, redshifts are explained in terms of a non-expanding universe, in which the behavior of light differs from the idea accepted by most scientists. Astronomers in this small community believe that the model of a non-expanding universe provides more accurate and realistic astronomical data than the standard model of an expanding universe. This old model cannot explain the large difference in the values obtained when calculating the Hubble constant. According to this small community of astronomers, high redshifts may be a global feature of the universe. The universe may well be static, and therefore the need for a theory of the Big Bang simply disappears.

The next hypothesis is known to be valid but not thought to be the cause of the redshifting of galactic light. It is known as gravitational redshifting. Gravity is known to bend the path of light, called gravitational lensing. If we measure the spectrum of light emanating from a star located near the disk of our Sun, then the redshift in it will be greater than in the case of a star located in a remote region of the sky. Such measurements can only be made during a total solar eclipse, when stars close to the solar disk become visible in the dark. It is necessary to take into account that we are dealing here with a gravitational redshift, which manifests itself when light passes near the Sun. Gravitational redshifts also occur in a straight line such as from us on Earth to the sun center. For instance the central solar light is slightly more redshifted than the sun's light away from its center, proportional to its distance from the center.

The gravitational redshift considered cannot have such large values for light coming from deep space, since the gravitational effect from a distance is negligible, ed. The resistance of light to gravitational influence could not by itself explain galactic redshifting in spite the farther light travels through the universe the more gravitational resistance it would encounter. However, the bending of light through its travels might also redshift it by stretching it. These possibilities usually are not considered as tired light hypotheses but the similarity would be that older, and therefore longer traveling light, would or could be gravitationally redshifted. And there are other versions of old light redshifting that are lesser known and therefore not mentioned here.

The point of this old-light hypothesis is that there are other possible, logical explanations for galactic redshifts other than expanding space. The question being, is the principle of expanding space logical? Readers should realize that the entire Big Bang (BB) model is supported by the premise of expanding space. Another explanation for galactic redshift is valid for the entire BB theory, including its formula for distance calculations falls, since that too was formulated by this premise. And what causes space to expand? Research that question on the Internet. You will find the most common answer is a very poor one. “Space can expand due to “dark energy” and can contract due to “dark matter.” What does it mean that space can expand? We want to know how and why space expands.

And what are *dark matter* and *dark energy* anyway? You will see that no satisfying answers follow these research questions. The expansion of space, *dark energy* and *dark matter* are all unknown, or even if any of them really exist at all. And these three elements are foundation pillars of the Big Bang model, now called the Lambda cold dark matter model. Still roughly 99% of all astronomers and cosmology theorists believe in both dark matter and dark energy.

The fourth foundation pillar of the model is called Inflation, which seemingly is an untestable hypothesis. With all four of the foundation pillars of the theory still unknown hypotheses, what is the likelihood the theory is correct and will remain standing after the James Webb goes up and tests some of its major propositions? One proposition that can be tested then is that galaxy groups and clusters at the farthest distances will contain only young galaxies. If instead galaxy groups or clusters look the same as local groups and clusters, the same as the Hubble Deep Field photograph, the Big Bang model will likely begin to fall because of its present age limitation, 13.8 billion years. There are a number of other serious problems with the Big Bang model, the more well-known of these are discussed in the second narrative in the middle of the book.

One of the problems in cosmology to be discussed in the narrative four is the problem of quasars. Quasars are defined as very massive extremely remote celestial objects presently thought to be at the centers of Active Galactic Nuclei. They emit exceptionally large amounts of EM radiation and typically have a star-like appearance in a telescope. Their brightness overpowers the other parts of the galaxy so no separate redshift for the galaxy can be observed, if it were different from the quasar. Present theory holds that quasars contain massive black holes and may represent a stage in the evolution of some galaxies.

Quasars would seem to be an even greater problem for steady-state cosmologies, which will be later discussed. The Big Bang model asserts that the universe has evolved and that quasars and large radio galaxies are a good example of this. Both appear to preferentially exist at distances in common. But for now we will continue to discuss the characteristics of quasars. So their existence and distribution is believed to fit the evolution of the universe according to the Big Bang model.

One of the most striking features of quasars is that their redshifts are very high compared to those galaxies in our vicinity. This is because quasars have an average distance and centrally cluster at redshifts around $z = 1.7$, with a somewhat normal average range between about $z = 0.1$ to redshifts around $z = 2.5$, with a seemingly normal fall-off thereafter to a present maximum redshift of about $z = 5$, after which little or none can be found. This limit could be because of their relative focus problem to be explained. Quasars are thought to originate from the centers of galactic black holes in some of the largest elliptical galaxies, usually in clusters from which a pair of oppositely emitting polar jets emanate. These jets are almost laser-like in that their directional focuses which are very narrow. The very few of these galactic jets that are closely focused in our direct we observe as quasars, by definition, because of their tremendous relative brightness to other galaxies at the same calculated distances. According to most theorists, mainstream or otherwise, all quasars are believed to come from the centers of what are now commonly called active-galactic-nuclei (AGN's).

While quasar redshifts in our vicinity have an average redshift of about 0.067, some of the redshifts of the most distant quasars are close to a redshift of 5.00. If we accept, like most astronomers, that redshifts are the indicators of quasar distances then quasars would be some of the most distant objects in the observable Universe. And if these redshift calculated distances are correct then these quasars are emitting millions of times more energy than galaxies of their similar type, size, and distances. Taking into account the mainstream distance formula called the Hubble formula, galaxies with a redshift of more than 1.00 accordingly should allegedly be moving away from us at the speed of light, and quasars with a redshift of 4.00 should be moving away from us at 4 times the speed of light. This is explained by the BB model that when the quasar's light that we are now observing was close enough to us that the light could now reach us, but now new light from an equally distant quasar would be beyond the possibility of its light ever getting to us because accordingly the expansion of space, the mainstream model, expands away from us at four times the speed of light for such quasars at these distances and therefore could never reach us again.

It turns out that now we have to scold Albert Einstein? Or are the initial conditions of the problem wrong and the redshift is the mathematical equivalent of processes, of which we have little idea? Mathematics is not mistaken, but it does not give an actual understanding of the processes that are taking place. For example, mathematicians have long proven the existence of additional dimensions of space, while modern science cannot find them.

If quasar-calculated redshifts are accepted as caused by the ordinary expansion of space, the distances indicated are very great, but additional analysis has shown that their surrounding energy emission and energy densities are inexplicable for such distances. On the other hand, if their distances calculated by their redshifts are wrong, there are no mainstream accepted hypotheses about the mechanism which quasar might produce redshifts. But there are other relatively simple non-mainstream hypotheses to explain them. The famous astronomer Halton Arp was most famous for such a proposal, which was a major aspect and promotion of his fruitful, distinguished, but controversial career. Several other prominent astronomers and theorists concurred with his findings based upon the observations and reasoning he presented. By his telescopic observations, and of others, he proposed that most, or nearly all quasars are much closer than their redshifts might indicate. But he and his few followers, some well known, together, were generally dismissed by the mainstream. This is because one of the foundation pillars of modern astronomy and cosmology is the Hubble formula, and the belief that it correctly calculates galactic distances based upon there observed redshifts. Harp's observations, and similar observations by other astronomer, were asserted to be only optical illusions, coincidental, or other seemingly possible explanations. Still his few remaining proponents still make the same assertions concerning the anomalous distances of quasars.

Halton Arp suggested that most or all quasars have an intrinsic redshift to them. This would mean that something is happening inside or immediately surrounding the galaxy, which would create the extent of the observed redshift from our perspective. But what mechanism might that be? There have been several proposals but maybe the simplest logical mechanism would be gravitational redshifting discussed in the paragraphs above. The theory in the second narrative made such a proposal not discussed in this book. It asserts that because the elliptical galaxies producing the quasar, usually in the center of a cluster, are often the largest galaxies of the cluster, therefore their gravity would be very strong. Their galactic core and central galactic black hole would likely have a very strong gravitational influence on light being produced by them. A black hole will prevent any light from escaping it inside its event horizon, but if the galactic black hole is strong enough to redshift its surroundings outside its event horizon, as explained above, this redshifting effect is readily observed as we observed from our sun's light described above. But how much would these quasar-producing Active Galactic Nuclei (AGN) redshift the EM radiation they produce? In the theory of the second narrative this quantity is easily calculated. Looking at a distribution chart of these quasars concerning their redshifts, called a histogram, it can be readily seen that it is very similar to a natural curve, a distribution formula in statistics.

Although all of these AGN galaxies are many times greater in size than the Milky Way, some are still much larger and more condensed than others. In the same way some of them could be only slightly gravitationally redshifted while others gravitationally redshifted to the maximum. If the assumption is made that quasars are instead distributed evenly like other galaxies, then one can calculate the maximum proposed gravitational redshift that the AGN's are producing. This maximum redshift is calculated to be about $z = 1.3$, and progressively decreases thereafter down to only a slight gravitational redshift close to zero. The range of this redshifting calculates to about z (the redshift)$= 2.6$. Add on top of this a normal distribution of these quasar galaxies based upon regularly distributed distances of the volumes they occupy, we come very close to the observed distribution of quasars, of course their distances would then become normally distributed as all other galaxies. For the furthest outliers beyond a redshift of 3, there are additional reasons why this most distant small group of outlying quasar distances could be under-calculated as explained in both the second and third narrative. Also many now believe that the same active galactic nuclei the produce quasars and the same ones that produce high-energy radio galaxies, but we can't see the quasars inside most of them if they are not facing us directly.

There are primarily two major reasons why mainstream astronomers do not want to consider the possibility that quasars are intrinsically redshifted. The first is because it would complicate the picture of the universe in that galactic redshifts would not necessarily be the sole indicator of distances in some cases. If not they would have little else to go by concerning these object's distances. However, in the third narrative of this book in case the energy density surrounding quasars might be determined, if at all possible in at least one or more cases, then, their distances can still be calculated using unique proposal as explained in the third narrative. But secondly, such a contrary determined alternative proposals would be an indicator that the Big Bang model is wrong, since on the bases of the discovery of quasars and radio-galaxies and according to similar but novel Big Bang expansion phenomenon, the universe would have been different in the past as the Big Bang model proposes. Taking these alternative proposals under consideration there would be less supporting evidence for the Big Bang model in general.

Thus, both of the alternatives available within the conventional astronomical theory face serious difficulties. If the redshift is assumed to be the usual Doppler effect due to spatial absorption, as well as spatial expansion, then the indicated distances are so huge that other properties of quasars, especially energy radiation, are inexplicable. If the redshift is not connected, or is not completely related to the speed of movement, we do have, perhaps, in the third narrative a reliable gravitational transition hypothesis about the mechanism, which produces it.

Indeed, in the third narrative, we proceed with the application of our scheme to the matter creation phenomenon. We discuss the possibility of expanding the space given a gravitational transition sequence of high energy cells $A, B, C, \ldots$. Any effect of this transition upon the cells in the surrounding area is then measured a posteriori. Thus, we can arrange conceivable experiments with a tiny piece of matter, using Newton's gravitational potential, taking gravity as a function responsible for the effect of high-energy cells on a piece of surrounding space. In this context, the high energy cells would refer to the likelihood of gravitational transition emerging from the oblivion as a phenomenon of matter. In the same manner it will be possible to determine whether the transition would have positive or negative effects on sequence in progress. However, this would necessitate changing somehow the gravitational transition (inclusion/exclusion) procedure and establishing how the change incurred would be evaluated.

Here it should be emphasized that this is precisely our proposal on the possibility of using the apparatus of combinatorial mathematics anywhere not yet used in topology. In fact, as our analysis of the distance to galaxies shows, we use in the third narrative the so-called apparatus of Monotone Systems borrowed from game theory and data analysis. Although the idea of Monotonic Systems implementation in highly diverse research fields of cosmology may seem unexpected, the use of stable/steady lists or topologies of Monotone System *credentials* (in particular case the Newton potential functions) provides a unifying perspective for conceivable experiments in calculating distances to galaxies. This is particularly beneficial when employing monotonic mappings producing so called fixed points, (Γ-equation) which preserve stability or equilibrium of lists/topologies of credentials despite the credentials' dynamic nature.

Newton gravitation potential is just an example that represents high-energy cells with the inverse monotone property. When a hole/bubble under the action of the "stream" of a new matter expands/inflates, the gravitation potential outside the bubble increases because the total bubble's mass increases at a higher rate, even though *"the energy density"* of matter at each point inside the bubble decreases. We can thus construct once again our fixed-point Γ-equation, finding the roots of the equation as stable points. This is particularly relevant for the so-called inflation stage of the Big Bang. The resulting equation might be parameterized by what is known in astrophysics as a relativistic energy density of energy. The density of energy, rather than time, might thus be the appropriate candidate for the scale like time-line events. Such a scale could be employed to perform our fixed point "experiments" on the Universe via geometrical modeling. Its solution exists even when the radius of topology equals zero—the point on our high energy cells scale at which density of energy is infinite. This parameter provides the opportunity to investigate the topology of the monotone systems apparatus of the Universe while the density decreases on its energy density scale from very high/extreme values to lower ones.

In conclusion, while making the connection between our Cosmological Speculation and the implementation of the monotone apparatus in the third narrative, it is important to note that the architecture of the apparatus is always nested. Really, while the high energy cells grow or decrease, the fixed points shrink in a way akin to a nested structure of subsets in the set theory sense. The solutions of our mathematical Γ-equation lead exactly to similar nested phenomena of topology when applying the General Relativity theory given by a metrical quadratic form as a rod upon the 3-dimensional Euclidian space lying on the 4-dimensional hyper globe surface.

Paying attention to the front cover of our book, it is quite possible that our thoughtful reader will understand what we mean when we talk about the nested structure of the monotonous system. Indeed, on the front cover one book is embedded in the other, and the other in turn is embedded in the third, and so on.

We must emphasize here that our nested structure established from the third narrative monotone apparatus, as roots of our fixed point equation, coincide with Planck Mission measurements of the composition of the Universe with incredible precision. They predict almost $\approx 0.005\%$ to $\approx 0.01\%$ precision the composition of *dark*, *visible matter* and *energy-field* in the Universe. Thus, given that the equation must be calibrated a priori using some parameters, the question is what kind of phenomenon has been created first on the energy density scale—the dark or the visible matter? Our mathematical speculation suggests that the "dark matter"—"hidden vacuum" or whatever is hiding behind this mathematical phenomenon—was allegedly created first. Contrary to presently assumed, almost infinite density, it had a density of a soup in the so-called initial inflation phase of the Big Bang.

It is also thought that the Universe, according to the inflation pillar, was born in the first 10^{-36} s of this process, based on Standard Model. Still, whether the Big Bang ever took place, or whether the density decreased to some level is irrelevant to our discussion, as our results indicate that the "visible matter" emerged "later" on the density scale, accompanying the "dark-matter." This was the best interpretation we can make from the nested structure of Monotonic System with the high-energy cells in the form of Newtonian potential functions. Although it is pure speculation, the calculations that lead to such a conclusion might be interesting to follow. That was the reason for introducing the Monotone Phenomena of the Universe.

THE BIG BANG AND THE BIG CRUNCH

Designed by Luke Mastin, credits *

Introduction

Most scientists now believe that we live in a finite expanding universe which has not existed forever, and that all the matter, energy and space in the universe was once squeezed into an infinitesimally small volume, which erupted in a cataclysmic "explosion" which has become known as the Big Bang.

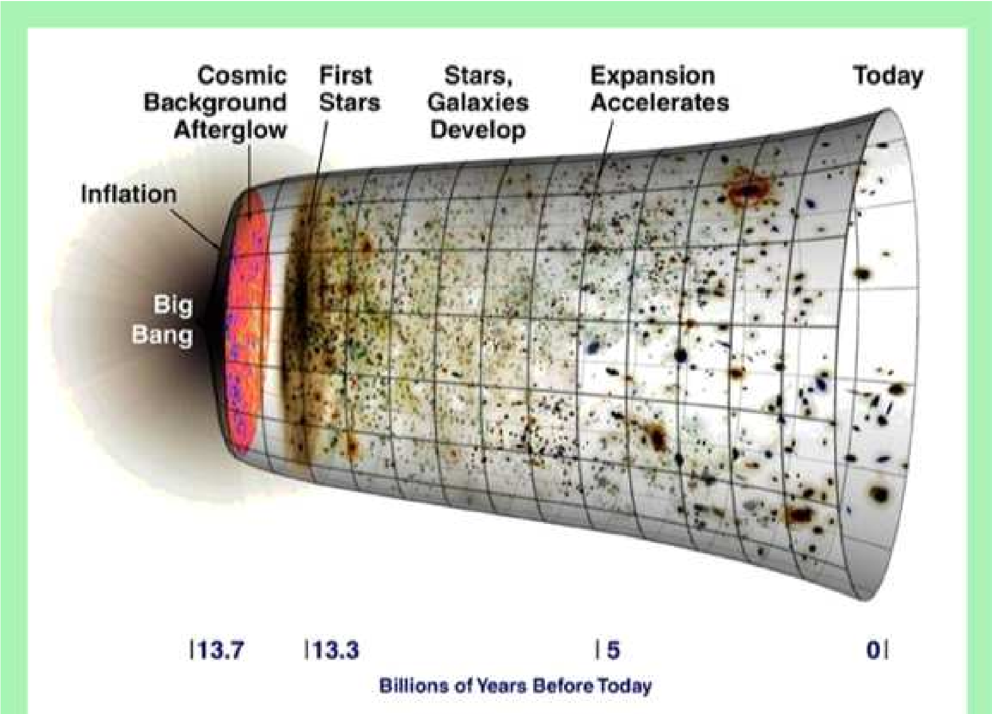
Thus, space, time, energy and matter all came into being at an infinitely dense, infinitely hot gravitational singularity, and began expanding everywhere at once. Current best estimates are that this occurred some 13.7 billion years ago, although you may sometimes see estimates of anywhere between 11 and 18 billion years.

The Big Bang is usually considered to be a theory of the birth of the universe, although technically it does not exactly describe the origin of the universe, but rather attempts to explain how the universe developed from a very tiny, dense state into what it is today. It is just a model to convey what happened and not a description of an actual explosion, and the Big Bang was neither Big (in the beginning the universe was incomparably smaller than the size of a single proton), nor a Bang (it was more of a snap or a sudden inflation).

In fact, “explosion” is really just an often-used analogy and is slightly misleading in that it conveys the image that the Big Bang was triggered in some way at some particular centre. In reality, however, the same pattern of expansion would be observed from anywhere in the uni-

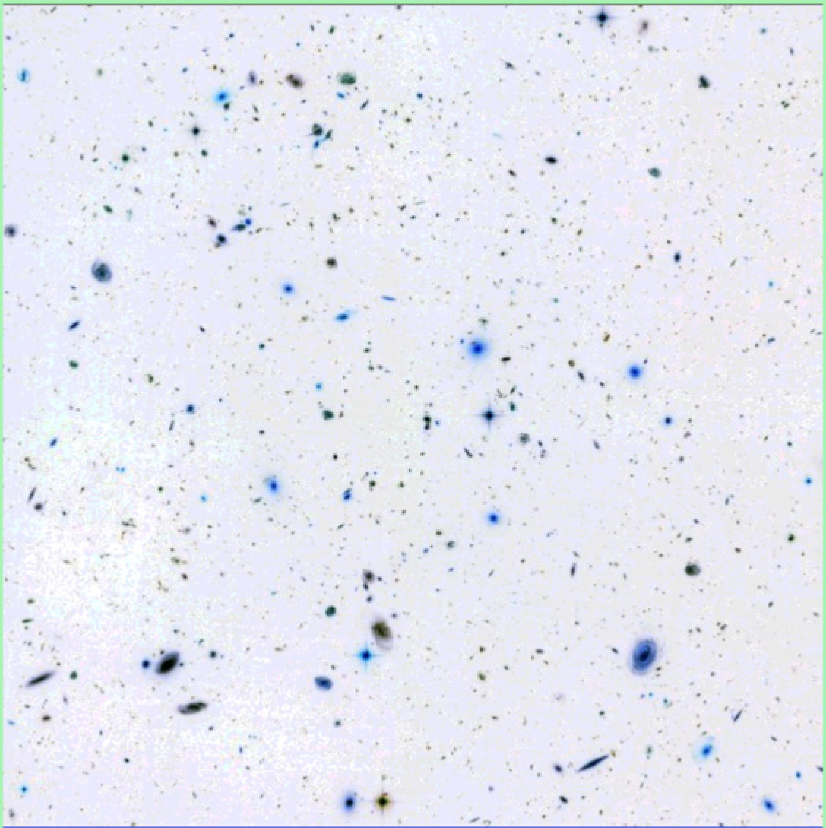
* http://www.physicsoftheuniverse.com/topics_bigbang.html, lukem@lukemastin.com

verse, so there is no particular location in our present universe which could claim to be the origin. It really describes a very rapid expansion or stretching of space itself rather than an explosion in pre-existing space. Perhaps a better analogy sometimes used to describe the even expansion of galaxies throughout the universe is that of raisins baked in a cake becoming more distant from each other as the cake rises and expands, or alternatively of a balloon inflating.



The Big Bang and the expansion of the universe

Neither does it attempt to explain what initiated the creation of the universe, or what came before the Big Bang, or even what lies outside the universe. All of this is generally considered to be outside the remit of physics, and more the concern of philosophy. Given that time and space as we understand it began with the Big Bang, the phase "before the Big Bang" is as meaningless as "north of the North Pole".



The cosmological principle is supported by pictures of different parts of the universe by the Hubble Space Telescope

Therefore, to those who claim that the very idea of a Big Bang violates the First Law of Thermodynamics (also known as the Law of Conservation of Energy) that matter and energy cannot be created or destroyed, proponents respond that the Big Bang does not address the creation of the universe, only its evolution, and that, as the laws of science break down anyway as we approach the creation of the universe, there is no reason to believe that the First Law of Thermodynamics would apply.

The Second Law of Thermodynamics, on the other hand, lends theoretical (albeit inconclusive) support to the idea of a finite universe originating in a Big Bang type event. If disorder and entropy in the universe as a whole is constantly increasing until it reaches thermodynamic equilibrium, as the Law suggests, then it follows that the universe cannot have existed forever, otherwise it would have reached its equilibrium end state an infinite time ago, our Sun would have exhausted its fuel reserves and died long ago, and the constant cycle of death and rebirth of stars would have ground to a halt after an eternity of dissipation of energy, losses of material to black holes, etc.

The Big Bang model rests on two main theoretical pillars: the General Theory of Relativity (Albert Einstein's generalization of Sir Isaac Newton's original theory of gravity) and the Cosmological Principle (the assumption that the matter in the universe is uniformly distributed on the large scales, that the universe is homogeneous and isotropic).

By the English astronomer Fred Hoyle incidentally coined the phrase The Big Bang (during a radio broadcast in 1949 as a derisive description of a theory with which he disagrees) is now considered by most scientists as the most likely scenario of the birth of the universe. However, this has not always been the case, as the following discussion illustrates.

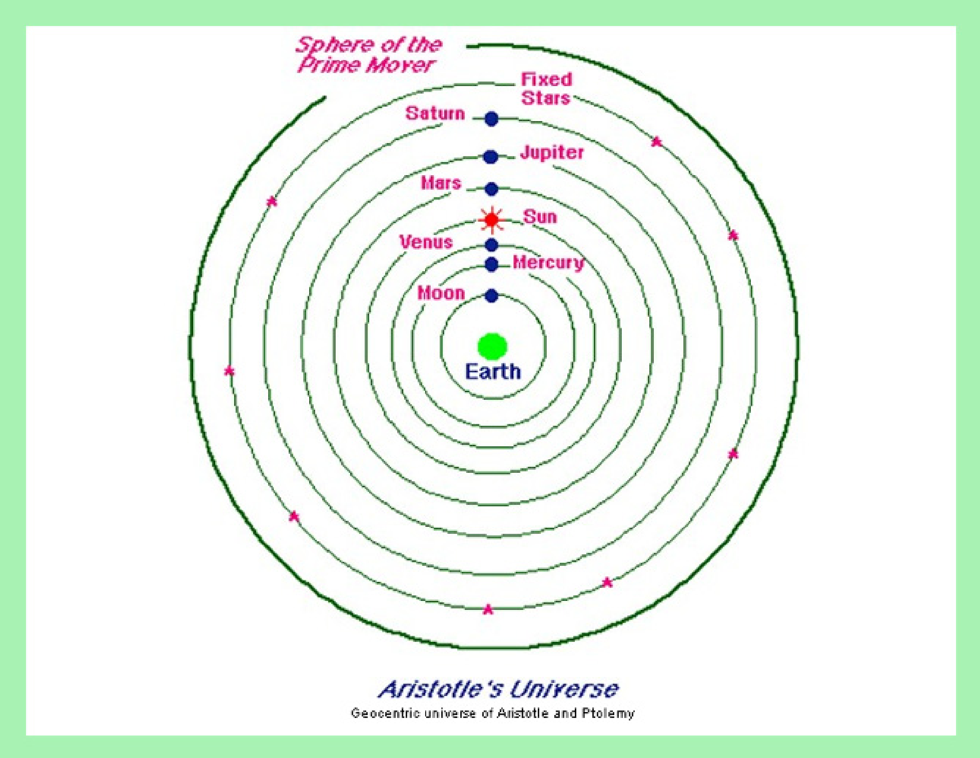
The Expanding Universe and the Hubble's Law

When Albert Einstein was formulating his ground-breaking theory of gravity in the early 20th Century, at a time when astronomers only really knew of the existence of our own galaxy, he necessarily used the simplifying assumption that the universe has the same gross properties in all parts, and that it looks roughly the same in every direction wherever in the universe an observer happens to be located. Like Sir Isaac Newton two hundred years before him, he assumed an infinite, static or "steady state" universe, with its stars suspended essentially motionless in a vast void.

However, when Einstein tried to apply his General Theory of Relativity to the universe as a whole, he realized that space-time as whole must be warped and curved back on itself, which in itself would cause matter to move, shrinking uncontrollably under its own gravity. Thus, as early as 1917, Einstein and others realized that the equations of general relativity did not describe a static universe. However, he never quite came to terms with the idea of a dynamic, finite universe, and so he posited a mysterious counteracting force of cosmic repulsion (which he called the "cosmological constant") in order to maintain a stable, static universe. Adding additional and arbitrary terms to a theory is not something that scientists do lightly, and many people argued that it was an artificial and arbitrary construct and at best a stop-gap solution.

As we have noted, up until that time, the assumption of a static universe had always been taken for granted. To put things into perspective, for most of history (see the section on Cosmological Theories Through History), it had been taken for granted that the static earth was the centre of the entire universe, as Aristotle and Ptolemy had described. It was only in the mid-16th Century that Nicolaus Copernicus showed that we were not the centre of the universe at all (or even of the Solar System for that matter!). It was as late as the beginning of the 20th Century that Jacobus Kapteyn's observations first suggested that the Sun was at the centre of a spinning galaxy of stars making up the Milky Way. Then, in 1917, humanity suffered a further blow to its pride when Curtis Shapely revealed that we were not even the centre of the galaxy, merely part of some unremarkable suburb of the Milky Way (although it was still assumed that the Milky Way was all there was).

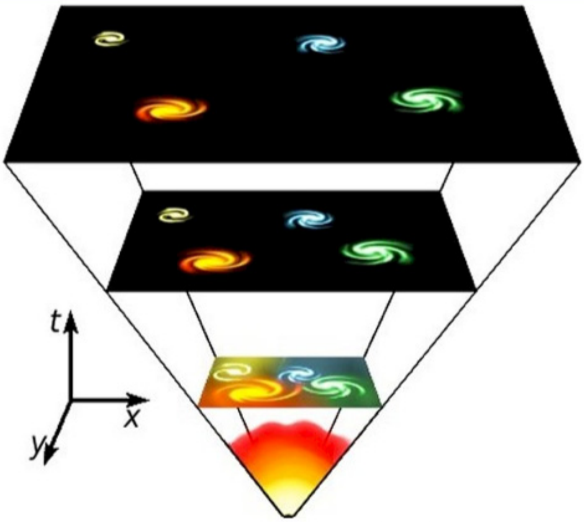
Some years later, in 1925, the American astronomer Edwin Hubble stunned the scientific community by demonstrating that there was more to the universe than just our Milky Way galaxy and that there were in fact many separate islands of stars - thousands, perhaps millions of them, and many of them huge distances away from our own.



Then, in 1929, Hubble announced a further dramatic discovery, which completely turned astronomy on its ear. With the benefit of improved telescopes, Hubble started to notice that the light coming from these galaxies was shifted a little towards the red end of the spectrum due to the Doppler effect (known as "redshift"), which indicated that the galaxies were moving away from us. After a detailed analysis of the redshifts of a special class of stars called Cepheids (which have specific properties making them useful as "standard candles" or distance markers), Hubble concluded that the galaxies and clusters of galaxies were in fact flying apart from each other at great speed, and that the universe was therefore definitively growing in size. In effect, all the galaxies we see are slightly red in colour due to redshift.

Hubble showed that, in our expanding universe, every galaxy is rushing away from us with a speed which is in direct proportion to its distance, known as Hubble's Law, so that a galaxy that is twice as far away as another is receding twice as fast, one ten times as far away if receding ten times as fast, etc. The law is usually stated as $v = H_0D$, where v is the velocity of recession, D is the distance of the galaxy from the observer and H_0 is the Hubble constant which links them. The exact value of the Hubble constant itself has long been the subject of much controversy: Hubble's initial estimates were of the order of approximately 500 kilometres per second per megaparsec (equivalent to about 160 km/sec/million light years); the most recent best estimates, with the benefit of the Hubble Telescope and the WMAP probe, is around 72 kilometres per second per megaparsec. (It should perhaps be pointed out that the Hubble constant is technically a parameter, not a constant, because it will actually change over long periods of time.)

This expansion, usually referred to as the "metric expansion" of space, is a "broad-brush effect" in that individual galaxies themselves are not expanding, but the clusters of galaxies into which the matter of the universe has become divided are becoming more widely separated and more thinly spread throughout space. Thus, the universe is not expanding "outwards" into pre-existing space; space itself is expanding, defined by the relative separation of parts of the universe. Returning to the image of the expanding universe as a balloon inflating, if tiny dots are painted on the balloon to represent galaxies, then as the balloon expands so the distance between the dots increases, and the further apart the dots the faster they move apart. Another analogy often used (and maybe even clearer) is that of a raisin cake expanding as it bakes, so that the raisins (galaxies) gradually all move away from each other.



Artists impression of the metric expansion of the universe

In such an expansion, then, the universe continues to look more or less the same from every galaxy, so the fact that we see all the galaxies receding from us does not necessarily mean that we are at the very centre of the universe: observers in all other galaxies would also see all the other galaxies flying away according to the same law, and the pattern of galactic dispersal would appear very much the same from anywhere in the cosmos.

The old model of a static universe, which had served since Sir Isaac Newton, was thus proved to be incontrovertibly false, but Hubble's discovery did more than just show that the universe was changing over time. If the galaxies were flying apart, then clearly, at some earlier time, the universe was smaller than at present. Following back logically, like a movie played in reverse, it must ultimately have had some beginning when it was very tiny indeed, an idea which gave rise to the theory of the Big Bang. Although now almost universally accepted, everyone did not immediately welcome this theory of the beginnings of the universe, and several strands of corroborating evidence were needed, as we will see in the following sections.

In the face of Hubble's evidence, Einstein was also forced to abandon his idea of a force of cosmic repulsion, calling it the "biggest blunder" he had ever made. But others, notably the Russian physicist Alexander Friedmann and the Belgian priest and physicist Georges Lemaître, had already used Einstein's own theory of prove that the universe was in fact in motion, either contracting or expanding. It is now recognized that Einstein's description of gravity as the curvature of space-time in his General Theory of Relativity was actually one of the first indications of a universe which had grown out of much humbler beginnings.

And, as we will see later, Einstein's "biggest blunder" may actually turn out to have been one of his most prescient predictions.

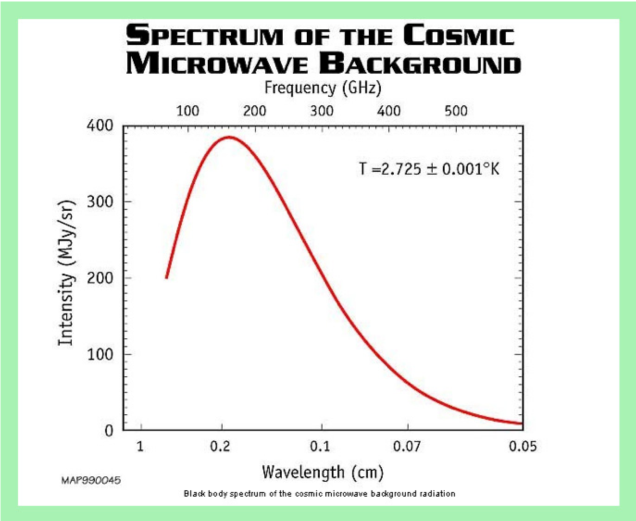
Cosmic Background Radiation

The Ukrainian- use American physicist George Gamow was the first to realize that, because the universe is all there is, the huge heat from a hot Big Bang could not dissipate in the same way as the heat from a regular explosion and therefore it must still be around today.

Gamow's research students, Ralph Alpher and Robert Herman, moreover, argued in 1948 that, because the Big Bang effectively happened everywhere simultaneously, that energy should be equally spread as cosmic microwave background radiation (or CMB for short) throughout the universe.

This radiation was emitted approximately 300,000 years after the Big Bang, before which time space was so hot that protons and electrons existed only as free ions, making the universe opaque to radiation. It should be visible today because, after this time, when temperatures fell to below about 3,000°K, ionized hydrogen and helium atoms were able to capture electrons, thus neutralizing their electric charge (known as "recombination"), and the universe finally became transparent to light.

In 1965, Arno Penzias and Robert Wilson, two young employees at Bell Telephone Laboratories in New Jersey, discovered, albeit by accident, just this. The mysterious microwave static they picked up on their microwave antenna seemed to be coming equally from every direction in the sky, and eventually they realized that this microwave radiation (which has a temperature of about -270°C, marginally above absolute zero, and the coldest thing found in nature) must indeed be the "after-glow" of the Big Bang. Penzias and Wilson received the 1978 Nobel Prize in Physics for their discovery (although, strangely, Gamow's contribution was never recognized).



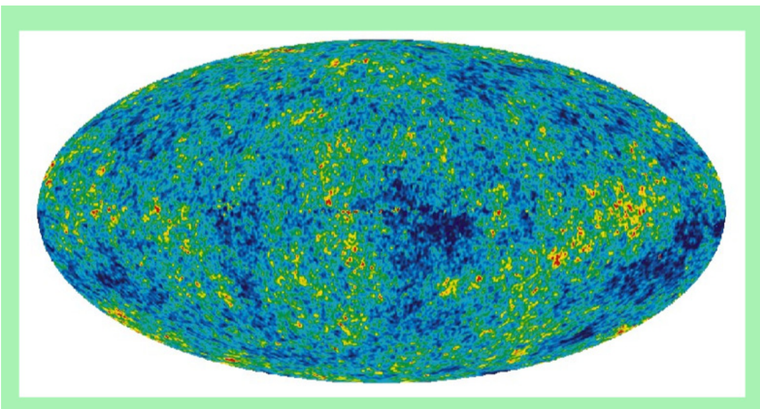
It was later confirmed that the intensity of these microwaves at different wavelengths traces out a "black body" or "thermal" curve, consistent with radiation that has been brought into balance with its environment - just what would be expected if they were indeed a relic of an early hot "fireball" stage. This discovery, perhaps the most important cosmological discovery since Edwin Hubble had shown that we live in an expanding universe, was powerful evidence that our universe had indeed begun in a hot, dense state and had been growing and cooling ever since.

The same photons that were around in the early stages of the Big Bang, then, have been propagating ever since, though growing fainter and less energetic as they fill a larger and larger universe. So ubiquitous is this cosmic microwave background radiation that, even though each cubic centimetre contains just 300 photons of it, in total it makes up 99%

of all the photons in the universe (the remaining 1% being in starlight). It has been estimated that 1% of the “snow” which appears on a TV screen tuned between stations is attributable to cosmic background radiation!

In view of the importance of cosmic microwave background radiation to the Big Bang model of the universe (no other model has explained CMB quite so neatly), efforts were redoubled in an attempt to definitively prove the connection, first in the form of the Cosmic Background Explorer (COBE) satellite in 1989, and then the Wilkinson Microwave Anisotropy Probe (WMAP) in 2001. Both probes have confirmed the predicted data with increasing accuracy, as well as providing the most detailed picture we have of how the universe looked soon after the Big Bang, and establishing the age of the universe with much greater accuracy at 13.7 billion years.

Another indirect indication that the universe began with a Big Bang is wrapped up in the very fact that the night sky we see from Earth is black. Olbers’ Paradox, named after the 19th Century German astronomer, Heinrich Wilhelm Olbers, who was one of the first to start to think of the universe as a whole. Olbers (who definitively stated the problem in 1823, although several others, dating back to the time of Newton, had previously posed similar ideas in various ways) asked why, if the universe was studded with billion upon billions of stars, the night sky was not completely lit up with the light from all these stars.



The answer (first pointed out, interestingly enough, by the author Edgar Allen Poe in 1848) lies in the fact that the light from the more distant stars, in fact from the majority of the objects in the universe, has still to reach us. The only stars and galaxies we see are those close enough that their light has taken less than the 13.7 billion years since the Big Bang to reach us. For the same reason, the most distant objects visible (those recorded with sensitive equipment like the Hubble Space Telescope) appear to consist of much younger galaxies, only recently formed, or consisting mainly of glowing diffuse gas not yet fragmented into stars.

Another apparent paradox is the question of why, given that the universe started off as much hotter than the centre of the hottest star, all the primordial nuclei of hydrogen were not instantly transmuted into the tightly-bound and ultra-stable nuclei of iron (the final state of fusion process). In that case, no long-lived stars could ever have existed in our present universe as all the available fuel would have been used up in the initial fireball, and the universe as we know it would have been a non-starter. In fact, the ultra-hot conditions of the first few minutes of the expansion only lasted long enough to turn about 23% of the hydrogen into helium and tiny traces of lithium. It turns out that even the oldest objects in the universe contain about 23-24% of helium, and this confirms calculations which predict that hydrogen and helium are the only elements which would be created prolifically in a Big Bang event.

Dark Matter

The simple Big Bang theory is, however, not without its potential problems, and some aspects require further investigation and explanation. One such problem is the rather unfortunate fact that about 85-95% of the matter, which is predicted, to exist in the universe appears to be invisible or otherwise unaccounted for!

The evenness of the cosmic microwave background radiation (the afterglow of the initial Big Bang) suggests that the matter emitted from the Big Bang should have been spread around very smoothly. But we know that the universe is in fact clumpy, with clusters of galaxies and great voids of empty space in between. Actually, in 1992, NASA's Cosmic Background Explorer (COBE) satellite did discover some variations or ripples in the brightness of the afterglow, which probably resulted from a period about 450,000 years after the Big Bang, when some parts of the universe became just a few thousandths of a per cent denser than others. These barely noticeable clumps of matter grew to become bigger clumps due to the cumulative effects of gravity, and the denser regions (the "seeds" of structure) became ever denser over time, leading to the great clusters of galaxies we see today.

However, the modelling of this theory revealed that the 13.7 billion years which has elapsed since the Big Bang is actually nowhere near long enough for the huge structures of today's universe to have developed, by the gradual process of gravity and increasing density, out of the tiny imperfections and clumps indicated by the COBE satellite. This could only have happened if there was, and/or is, much more matter in the universe than our current estimates of the matter tied up in visible stars. This has led to speculation about so-called "dark matter", an unknown substance which emits no light, heat, radio waves, nor any other kind of radiation (thus making extremely hard to detect).

The idea of dark matter, though, goes back much further than that. The stars in spiral galaxies like our own Milky Way whirl about the galactic centre, prevented from flying off into intergalactic space by gravity. However, calculations of the speed of the whirling, dating back to work by maverick astronomer Fritz Zwicky in the 1930s, suggest that the galaxy is actually spinning much faster than it theoretically should be in order to maintain its current equilibrium. Zwicky hypothesized that the only way this could occur was if galaxies, ours and all the others, actually contained much more matter (he estimated at least ten times as much) as is visible in stars, spread reasonably evenly throughout the galaxy.

Zwicky's observations were backed up by more accurate data gathered by Vera Rubin in the 1960s, and by Jim Peebles and Jerry Ostricker in the 1970s. Rubin noted that stars right out near the edge of the galaxy were orbiting around the galactic centre at the same speed as stars much closer in, whereas in our solar system, for example, the innermost planets orbit much faster than those further out. (Other more recent studies have shown that even hydrogen gas out on the fringes of the galaxy is still orbiting just as fast as the inner stars). It therefore appeared as though the force of gravity did NOT get weaker the further a star was from the centre of the galaxy, which flew in the face of all that was known about gravity. The only explanation was that some unseen and undetected mass (i.e. dark matter) was causing the increased rotation.

Thus, it appears that around 85% of the mass making up galaxies must be composed of an unknown, invisible substance, which came to be known as dark matter. This is almost exactly the factor of additional matter required by the models to allow the structures we see in today’s universe to have developed from the ripples in the cosmic microwave background radiation discovered by the COBE satellite, as mentioned above. This dark matter makes up an even greater proportion of the small dwarf galaxies that can be found orbiting larger galaxies, including our own, and the same thing also applies on a larger scale to entire clusters of galaxies, millions of light years across, which would also need to contain many more times more material than we can see in order to hold together.

Ring of dark matter in the galaxy cluster Cl 0024+17

More recent studies, using modern gravitational lensing techniques, have added further confirmations, if any were needed, and have allowed the creation of a kind of "map" of dark matter which shows how galaxies and clusters of stars tend to form around, and within, the largest blobs of dark matter, which forms a kind of all-pervading halo around the visible objects of the universe. In this way, Carlos Frenk has produced a dramatic 3D simulation of the dark matter throughout the whole visible universe, showing what he calls the "skeleton" of the universe, or the "scaffolding" around which galaxies and clusters of galaxies have formed. It seems that everything we know is ultimately dependent on dark matter - without dark matter there would be no galaxies; without galaxies there would be no stars; without stars there would be no planets, and therefore no life.

The problem is that dark matter, whatever it may be, is invisible and extremely hard to detect. It is affected by gravity, but not by any of the other fundamental forces; it has no electrical charge; it does not seem to stick or clump together but floats freely; and it passes through atoms of normal matter without any kind of interference we can detect. In fact, it appears not even to interact with itself: colliding galaxies have been observed, where the normal matter of the two galaxies re-coalesces together as expected, but the dark matter just keep on going along its original path regardless. Its existence and properties can only be inferred from its gravitational effects on visible matter, radiation, and the large-scale structure of the universe.

So, despite its apparent ubiquity, no-one really knows what dark matter is, and astronomers are using a variety of technique, including gravitational lensing, to try to spot where such matter might lie. Among the possible candidates are so-called MACHOs (short for MAssive Compact Halo Objects), such as small brown and black dwarf stars, cold unattached planets, comet-like lumps of frozen hydrogen, tiny black holes, and possibly even mini dark galaxies. Other candidates for baryonic dark matter include cold and warm gas, bound to galaxy groups, but too cool to be visible or even detectable.

Scientists are also investigating other kinds of non-baryonic exotic particles, including WIMPs (short for Weakly Interacting Massive Particles), hypothetical super-symmetrical particles which may be all around us but which pass through normal matter without stopping and without interacting in any way. Experiments to look for WIMPs are being carried out in highly-shielded, super-cooled facilities deep down in rocky mines where other interfering cosmic rays cannot penetrate.

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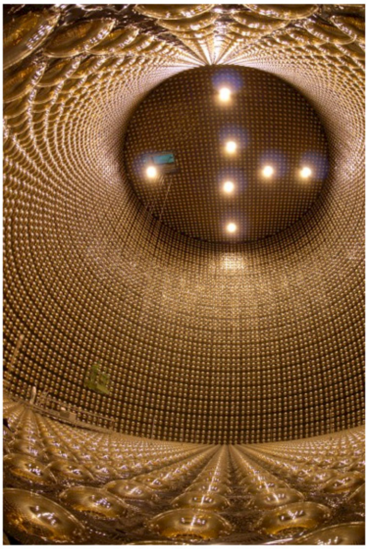
Super-Kamiokande, a neutrino observatory in the city of Hida, Gifu Prefecture, Japan

Another category of non-baryonic exotic particle, neutrinos, may represent another possibility. Neutrinos are tiny elementary particles which have no electric charge and hardly interact at all with ordinary atoms, and which mysteriously may even move faster than the speed of light. It is hypothesized that they could have come into existence during the first second after the Big Bang as part of the reaction with the photons that were created at that time, and it is calculated that there could be hundreds of millions of them for every atom in the universe, with millions of them passing through you and I and everything around us every second. So, even if each neutrino weighed a hundred-millionth as much as an atom, they could theoretically still be the dominant, if unseen, matter in the universe.

Cosmic Inflation

Another conundrum thrown up by the basic Big Bang theory is how to explain the relative homogeneity and evenness of the temperature of the cosmic microwave background radiation. How did large-scale structures such as galaxies and clusters of galaxies develop out of what should have been a rather boringly amorphous and featureless fireball?

This would appear to be in direct violation of the Second Law of Thermodynamics, which describes an inexorable tendency towards entropy and uniformity and away from patterns and structures. If our universe had started out completely smooth, then it should have continued that way, and the universe today would contain nothing more than thinly spread dark matter along with less than one atom per cubic meter of hydrogen and helium gas, with no sign of the texture and complexity we see around us (stars, galaxies, a multitude of elements, life).

However, even very slight irregularities in the early phases of expansion would have become amplified as slightly dense patches are affected by additional gravity until they condensed into self-contained structures held together by their own gravity. Galaxies crashed and merged and cannibalised their neighbours, and larger scale structures like clusters and super-clusters formed by a continuing process of gravitational aggregation working on these newly formed galaxies.

Heat tends to travel from a hot body to a cold one so that the temperatures of both bodies eventually even out (a result of the Second Law of Thermodynamics itself), like hot coffee in a cold cup. The microwave background radiation discovered by Arno Penzias and Robert Wilson in the 1960s appeared to be extremely uniform throughout the observable universe, with almost no variance. But if, as the evidence suggests, the last time the cosmic background radiation had any contact with matter was about 450,000 years after the Big Bang (by which time the universe had cooled to around 3,000°C), then this presents a paradox, because the universe at that time would already have had a diameter of around 90 million light years, and just not enough time would have elapsed for radiation or heat to have flown around the whole universe and equalized itself, and the horizons could never have actually been in causal contact with each other (known as the "horizon problem").

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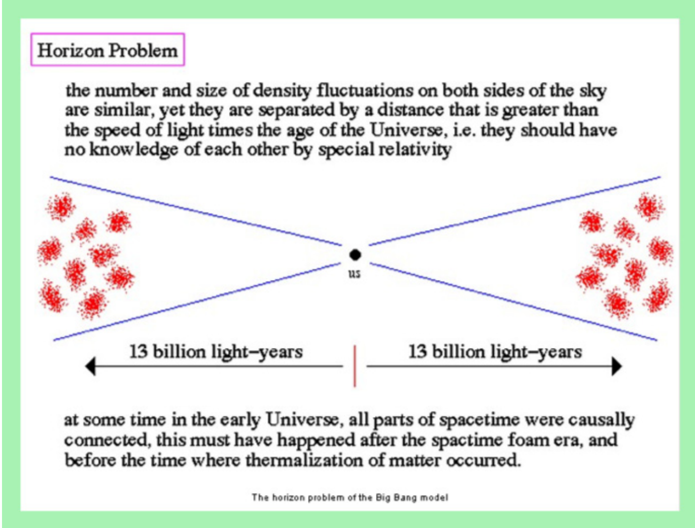
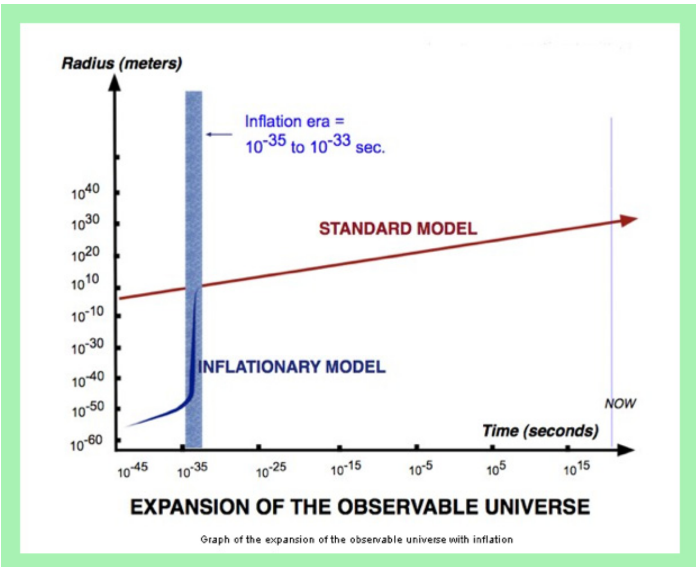


The horizon problem of the Big Bang model

So, in theory, there actually ought to be even more variation today than there is. That is, unless the very early universe was in fact much smaller than the models were predicting. The most widely accepted theory as to how this might have been possible is known as cosmic inflation, which was first proposed in 1980 by the American physicist Alan Guth, developed out of Steven Weinberg's Electro weak Theory and Grand Unified Theory.



Graph of the expansion of the observable universe with inflation

As we will see, the addition of inflation to the Big Bang model claimed to solve the horizon problem, as well as one or two other potential problems that had been identified with the standard Big Bang theory, such as the “flatness problem” (why the density of matter in the universe appears “fine-tuned” to be very close to the critical value at which space is perfectly flat rather than a non-Euclidean hyperbolic or spherical shape) and the “magnetic monopole problem” (why the magnetic monopoles which theory suggests should have been produced in the high temperatures of the early universe appear not to have persisted to the present day).

Cosmic inflation is the idea that the very early universe went through a period of accelerated, exponential expansion during the first 10^{-35} of a second before settling down to the more sedate rate of expansion we are still experiencing, so that all of the observable universe originated in a small (indeed, microscopic) causally-connected region.

Although the universe has been expanding since the initial Big Bang, inflation refers to the hypothesis that, for a very short time, the universe expanded at a sharply INCREASING rate, rather than at the decreasing rate it followed before inflation and has followed since. By some calculations, inflation increased the size of the universe by a factor of around 10^{26} during that tiny fraction (far less than a trillionth) of a second, expanding it from smaller than the size of a proton to about the size of a grapefruit.

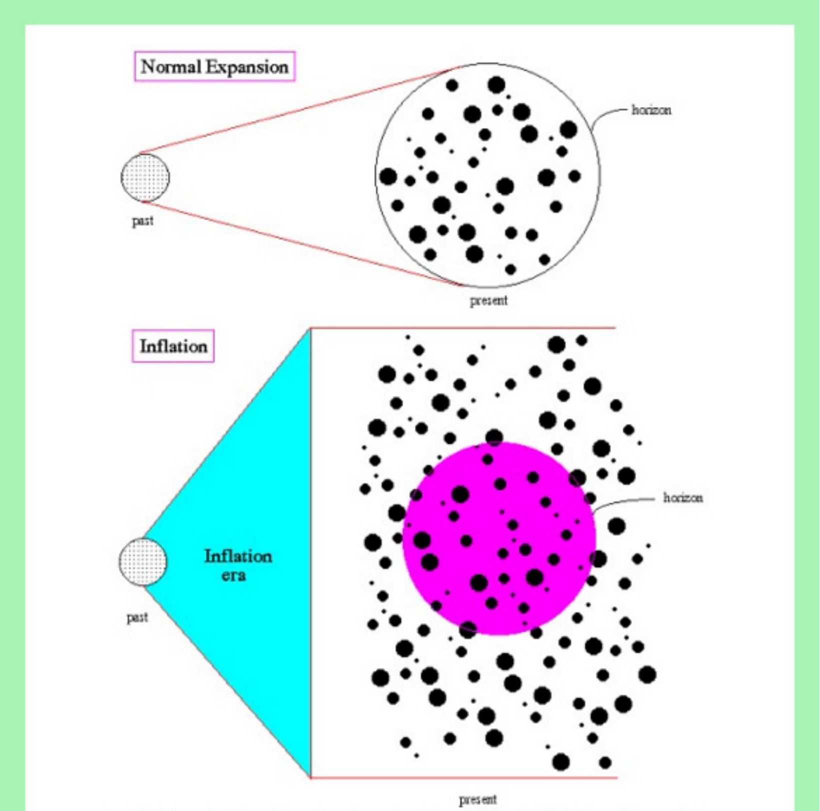
Technically, the expansion during this period of inflation (and even the somewhat slower expansion which succeeded it) proceeded faster than the speed of light. To explain how this is possible (the speed of light being supposedly the maximum speed it is possible to travel), an analogy may help. If two airplanes are flying directly away from each other at their maximum speed of, say, 500 kilometres per hour, they are actually flying apart at 1,000 kilometres per hour even though neither individual plane is exceeding 500km per hour. Thus, "expansion", in terms of the expanding universe, is not the same thing as "travel".

It is still not clear to scientists, however, exactly what caused the inflationary phase, the best guess being some kind of a negative "vacuum energy density" (or positive "vacuum pressure") triggered by the separation of the strong nuclear force from the other elementary forces at this time. It is hypothesized that this separation caused a kind of symmetry breaking or phase transition (analogous to the phase transition when water turns to ice), which left the universe in a highly unstable state with much more energy than it would otherwise have had, causing a sharp outward anti gravitational effect, smoothing out most of the irregularities in the existing matter and creating vast quantities of particles in a very short time.

This theory allows for some kind of very slight unevenness (so-called quantum fluctuations) on a sub-atomic scale at a very early stage in the growth of the universe, which provided starting points for the large-scale structures we see in today's universe. This suggests the rather bizarre possibility that sub-microscopic seeds may actually have spawned the largest structures in the universe, the great clusters of galaxies.

Guth hypothesized that the reason why the universe appears to be flat is because it is actually fantastically big (in the same way that the spherical Earth appears flat to those on its surface), and that the observable universe is actually only a very small part of the actual universe. In fact, Guth's calculations suggest that the entire universe may be at least 10^{23} times bigger than the size of the observable universe (the part within the horizon, that we are able, at least in principle, to see), roughly equal to the ratio of the size of the observable universe to the planet Earth. Thus, although the observable universe may appear to be effectively flat, the entire universe may be completely different in nature. Also, although an enormous number of magnetic monopoles could well have arisen in the inflationary early universe, the chances of actually observing even one magnetic monopole are infinitesimally small in a universe of such immense size.

Thus, the incredibly vast and fast expansion of the universe caused by inflation "solved" both Robert Dickes flatness problem and Guth's own monopole problem. But it also solved the horizon problem: according to the inflation theory, the universe blew up so quickly that there was no time for the essential homogeneity to be broken, and the universe after inflation would therefore have been very uniform, even though the parts of it were not still in touch with each other.



Under inflation, the observable universe is merely a tiny part of the whole that lies within our horizon

In an attempt to prove the inflation theory, the Cosmic Background Explorer (COBE) probe was launched in 1992, and its initial results confirmed almost exactly the amount of variation in the cosmic microwave background radiation that was predicted by inflationary theory. In 2003, the Wilkinson Microwave Anisotropy Probe (WMAP) demonstrated the existence of these non-uniformities with even greater precision. As recently as 2014, astronomers at the Harvard-Smithsonian Centre for Astrophysics announced that they had detected and mapped "gravitational waves" within the cosmic microwave background radiation, providing further strong evidence for inflation (and for the Big Bang itself), although further peer review of these new findings are still ongoing.

Guth's theory has been very influential, even if he himself could find no way to end inflation so that stars and galaxies could form (known the "graceful exit" problem), and he considered his own theory something of a failure because of this. There have been many other refinements and revisions since Guth's original model, such as the "new inflationary model" of Russian physicist Andrei Linde, who had been working on an inflation theory independently (as had Paul Steinhardt and Andreas Albrecht). This new model hypothesized a slow (as opposed to Guth's fast) breaking of symmetry, and the creation of many "bubble universes" (just one of which contains our own observable universe). A later proposal by Linde, known as the "chaotic inflationary model", hypothesized that a "spin-0 field" rather than any kind of phase transition caused the repulsive antigravity effect as Guth had thought.

Linde's work, and that of fellow Russian Alex Vilenkin, has also given rise to the idea of "eternal inflation", where the inflation as a whole actually never stops, but small localized energy discharges within the overall energy field - almost like sparks of static electricity, but on a cosmic scale - create small points of matter in the form of tiny particles. Such a process may represent the birth of a new universe, such as our own. Beginning in this way with what we have called a Big Bang, this new universe then itself proceeds to expand, although at a much slower rate than the continuing inflation outside of it. The rest of space outside of that universe is still full of undercharged energy, still expanding at enormous speed, and new universes, new Big Bangs, are occurring all the time.

The theory of cosmic inflation, then, supports the scenario in which our universe is just one among many parallel universes in a multiverse. As we will see in later sections, some corroborating evidence for such a scenario also arises from work on dark energy, on super string theory and on quantum theory. However, the idea of a hypothetical multiverse, which we can never see or prove, is anathema to many physicists, and many critics still remain.

Timeline of the Big Bang

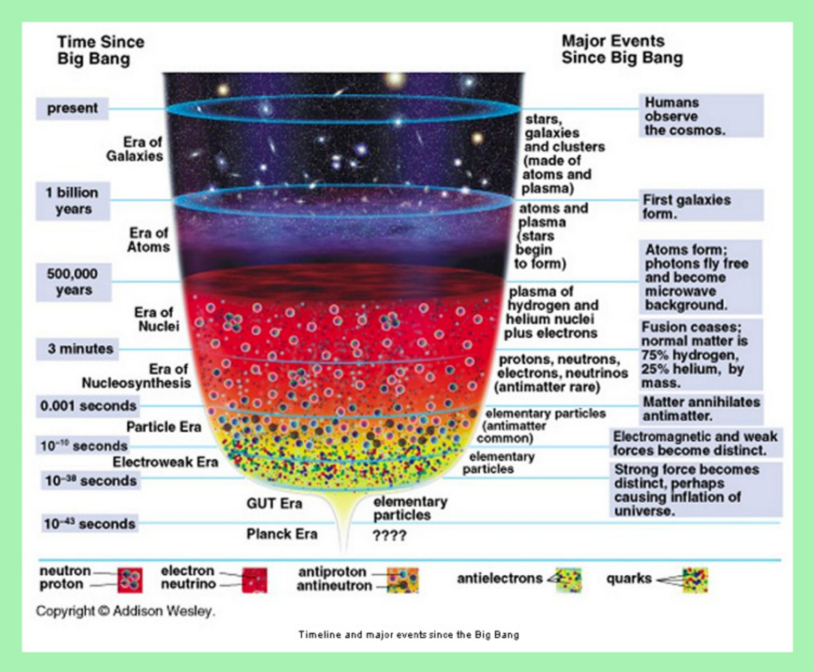
Since the Big Bang, 13.7 billion years ago, the universe has passed through many different phases or epochs. Due to the extreme conditions and the violence of its very early stages, it arguably saw more activity and change during the first second than in all the billions of years since.

From our current understanding of how the Big Bang might have progressed, taking into account theories about inflation, Grand Unification, etc, we can put together an approximate timeline as follows:

- Planck Epoch (or Planck Era), from zero to approximately 10^{-43}seconds (1 Planck Time):This is the closest that current physics can get to the absolute beginning of time, and very little can be known about this period. General relativity proposes a gravitational singularity before this time (although even that may break down due to quantum effects), and it is hypothesized that the four fundamental forces (electromagnetism, weak nuclear force, strong nuclear force and gravity) all have the same strength, and are possibly even unified into one fundamental force, held together by a perfect symmetry which some have likened to a sharpened pencil standing on its point (i.e. too symmetrical to last). At this point, the universe spans a region of only 10^{-35} meters (1 Planck Length), and has a temperature of over 10^{32}°C (the Planck Temperature).

- Grand Unification Epoch, from 10^{-43} seconds to 10^{-36} seconds: The force of gravity separates from the other fundamental forces (which remain unified), and the earliest elementary particles (and antiparticles) begin to be created.
- Inflationary Epoch, from 10^{-36} seconds to 10^{-32} seconds: Triggered by the separation of the strong nuclear force, the universe undergoes an extremely rapid exponential expansion, known as cosmic inflation. The linear dimensions of the early universe increases during this period of a tiny fraction of a second by a factor of at least 10^{26} to around 10 centimetres (about the size of a grapefruit). The elementary particles remaining from the Grand Unification Epoch (a hot, dense quark-gluon plasma, sometimes known as "quark soup") become distributed very thinly across the universe.
- Electro weak Epoch, from 10^{-36} seconds to 10^{-12} seconds: As the strong nuclear force separates from the other two, particle interactions create large numbers of exotic particles, including W and Z bosons and Higgs bosons (the Higgs field slows particles down and confers mass on them, allowing a universe made entirely out of radiation to support things that have mass).
- Quark Epoch, from 10^{-12} seconds to 10^{-6} seconds: Quarks, electrons and neutrinos form in large numbers as the universe cools off to below 10 quadrillion degrees, and the four fundamental forces assume their present forms. Quarks and anti quarks annihilate each other upon contact, but, in a process known as baryogenesis, a surplus of quarks (about one for every billion pairs) survives, which will ultimately combine to form matter.
- Hadron Epoch, from 10^{-6} seconds to 1 second: The temperature of the universe cools to about a trillion degrees, cool enough to allow quarks to combine to form hadrons (like protons and neutrons).Electrons colliding with protons in the extreme conditions of the Hadron Epoch fuse to form neutrons and give off massless neutrinos, which continue to travel freely through space today, at or

near to the speed of light. Some neutrons and neutrinos re-combine into new proton-electron pairs. The only rules governing all this apparently random combining and re-combining are that the overall charge and energy (including mass-energy) be conserved



Timeline and major events since the Big Bang

- Lepton Epoch, from 1 second to 3 minutes: After the majority (but not all) of hadrons and anti hadrons annihilate each other at the end of the Hadron Epoch, leptons (such as electrons) and anti leptons (such as positrons) dominate the mass of the universe. As electrons and positrons collide and annihilate each other, energy in the form of photons is freed up, and colliding photons in turn create more electron-positron pairs. Nucleo synthesis, from 3 minutes to 20 minutes: The temperature of the universe falls to the point (about a billion degrees) where atomic nuclei can begin to form as protons and neutrons combine through nuclear fusion to form the nuclei of the simple elements of hydrogen, helium and lithium. After about 20 minutes, the temperature and density of the universe has fallen to the point where nuclear fusion cannot continue.

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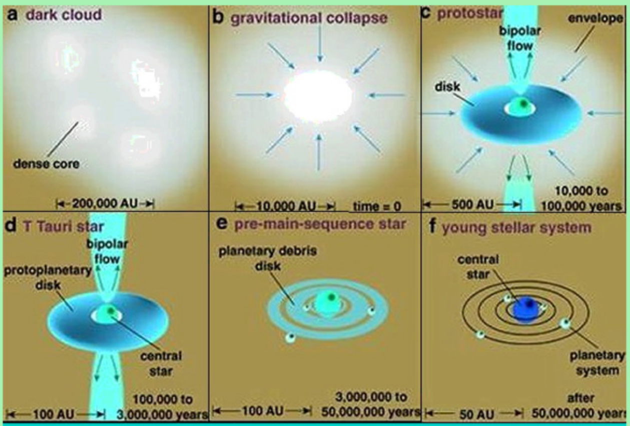
- Photon Epoch (or Radiation Domination), from 3 minutes to 240,000 years: During this long period of gradual cooling, the universe is filled with plasma, a hot, opaque soup of atomic nuclei and electrons. After most of the leptons and anti leptons had annihilated each other at the end of the Lepton Epoch, the energy of the universe is dominated by photons, which continue to interact frequently with the charged protons, electrons and nuclei.
- Recombination/Decoupling, from 240,000 to 300,000 years: As the temperature of the universe falls to around 3,000 degrees (about the same heat as the surface of the Sun) and its density also continues to fall, ionized hydrogen and helium atoms capture electrons (known as "recombination"), thus neutralizing their electric charge. With the electrons now bound to atoms, the universe finally becomes transparent to light, making this the earliest epoch observable today. It also releases the photons in the universe which have up till this time been interacting with electrons and protons in an opaque photon-baryon fluid (known as "decoupling"), and these photons (the same ones we see in today's cosmic background radiation) can now travel freely. By the end of this period, the universe consists of a fog of about 75% hydrogen and 25% helium, with just traces of lithium.
- Dark Age (or Dark Era), from 300,000 to 150 million years: The period after the formation of the first atoms and before the first stars is sometimes referred to as the Dark Age. Although photons exist, the universe at this time is literally dark, with no stars having formed to give off light. With only very diffuse matter remaining, activity in the universe has tailed off dramatically, with very low energy levels and very large time scales. Little of note happens during this period, and mysterious "dark matter" dominates the universe.

- Reionization, 150 million to 1 billion years: The first quasars form from gravitational collapse, and the intense radiation they emit reionizes the surrounding universe, the second of two major phase changes of hydrogen gas in the universe (the first being the Recombination period). From this point on, most of the universe goes from being neutral back to being composed of ionized plasma.
- Star and Galaxy Formation, 300 - 500 million years onwards: Gravity amplifies slight irregularities in the density of the primordial gas and pockets of gas become more and more dense, even as the universe continues to expand rapidly. These small, dense clouds of cosmic gas start to collapse under their own gravity, becoming hot enough to trigger nuclear fusion reactions between hydrogen atoms, creating the very first stars. The first stars are short-lived super massive stars, a hundred or so times the mass of our Sun, known as Population III (or "metal-free") stars. Eventually Population II and then Population I stars also begin to form from the material from previous rounds of star-making. Larger stars burn out quickly and explode in massive supernova events, their ashes going to form subsequent generations of stars. Large volumes of matter collapse to form galaxies and gravitational attraction pulls galaxies towards each other to form groups, clusters and super clusters.



The process of star formation

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- Solar System Formation, 8.5 - 9 billion years: Our Sun is a late-generation star, incorporating the debris from many generations of earlier stars, and it and the Solar System around it form roughly 4.5 to 5 billion years ago (8.5 to 9 billion years after the Big Bang).
- Today, 13.7 billion years: The expansion of the universe and recycling of star materials into new stars continues.

Accelerating Universe and the Dark Energy

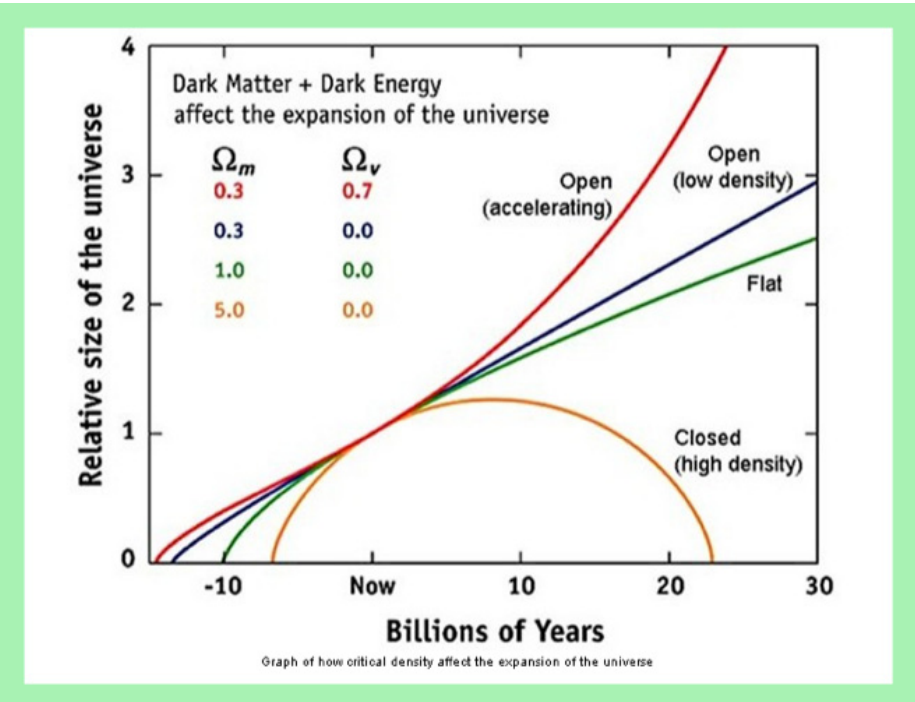
Like dark matter, cosmic inflation (even if it is not actually proven beyond all doubt) is now usually seen as part of the standard Big Bang theory, and to some extent the two additional concepts rescue the Big Bang theory from being completely untenable. However, other potential problems still remain.

The universe has continued to expand since the Big Bang, albeit at a slower rate since the period of inflation, while at the same time the gravity of all the matter in the universe is working to slow down and eventually reverse the expansion. Two main possibilities therefore present themselves: either the universe contains sufficient matter (known as the "critical mass") for its gravity to reverse the expansion, causing the universe to collapse back to what has become known as the “Big Crunch”, a kind of mirror image of the initial Big Bang; or it contains insufficient matter and it will go on expanding forever.

According to General Relativity, the density parameter, Omega, which is defined as the average density of the universe divided by the critical density (i.e. that required for the universe to have zero curvature) is related to the curvature of space. If Omega equals 1, then the curvature is zero and the universe is flat; if Omega is greater than 1, then there is positive curvature, indicating a closed or spherical universe; if Omega is less than 1, then there is negative curvature, suggesting an open or saddle-shaped universe.

The cosmic inflation model hypothesizes an Omega of exactly 1, so that the universe is in fact balanced on a knife's edge between the two extreme possibilities. In that case, it will continue expanding, but gradually slowing down all the time, finally running out of steam only in the infinite future. For this to occur, though, the universe must contain exactly the critical mass of matter, which current calculations suggest should be about five atoms per cubic metre (equivalent to about $5 \times 10^{-30} g/cm^3$).

This perhaps sounds like a tiny amount (indeed it is much closer to a perfect vacuum than has even been achieved by scientists on Earth), but the actual universe is, on average, much emptier still, with around 0.2 atoms per cubic meter, taking into account visible stars and diffuse gas between galaxies. Even including dark matter in the calculations, all the matter in the universe, both visible and dark, only amounts to about a quarter of the required critical mass, suggesting a continuously expanding universe.

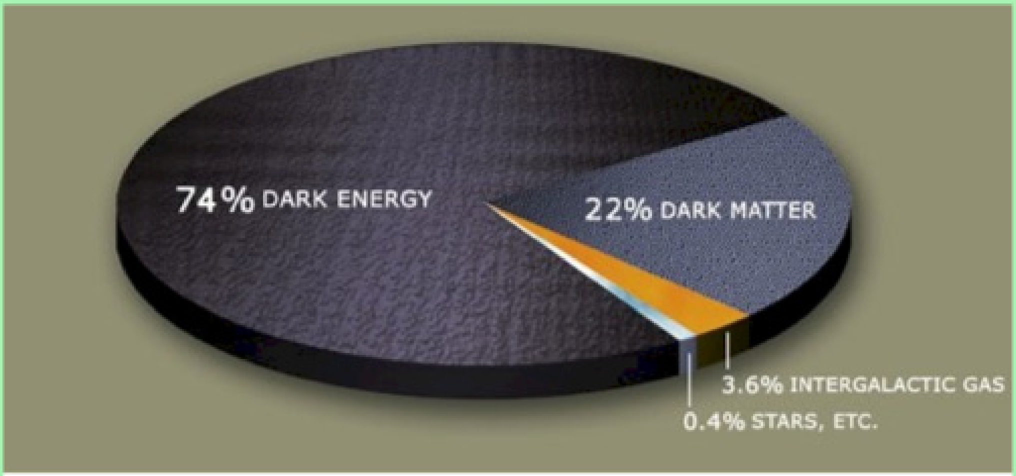


Graph of how critical density affect the expansion of the universe

However, in 1998, two separate teams of astronomers observing distant type 1a supernovas (one led by the American Saul Perlmutter and the other by the Australians Nick Suntzeff and Brian Schmidt) made parallel discoveries which threw the scientific community into disarray, and which also has important implications for the expanding universe and its critical mass. The faintness of the supernova explosions seemed to indicate that they were actually further away from the Earth than had been expected, suggesting that the universe’s expansion had actually speeded up (not slowed) since the stars exploded. Contrary to all expectations, therefore, the expansion of the universe actually seems to be significantly speeding up - we live in an accelerating universe!

The only thing that could be accelerating the expansion (i.e. more than countering the braking force of the mutual gravitational pull of the galaxies) is space itself, suggesting that perhaps it is not empty after all but contains some strange “dark energy” or “antigravity” currently unknown to science. Thus, even what appears to be a complete vacuum actually contains energy in some currently unknown way. In fact, initial calculations (backed up by more recent research such as that on the growth of galaxy clusters by NASA's Chandra x-ray space telescope and that on binary galaxies by Christian Marinoni and Adeline Buzzi of the University of Provence) suggest that fully 73 - 74% of the universe consists of this dark energy.

If 74% of the total mass of the universe consists of dark energy, and about 26% of the remaining actual matter (representing about 22% of the total) is dark matter (see the section on Dark Matter for more discussion of this), then this suggests that only around 4% of the universe consists of what we think of as "normal", everyday, atom-based matter such as stars, intergalactic gas, etc. As of 2013, based on cosmic microwave background radiation data from the Planck satellite, the latest figures are closer to 68%, 27% and 5% respectively. Nowadays, this is generally accepted as the "standard model" of the make-up of the universe. So, for all our advances in physics and astronomy, it appears that we can still only see, account for and explain a small proportion of the totality of the universe, a sobering thought indeed.



Estimated distribution of dark energy, dark matter and normal matter in the universe

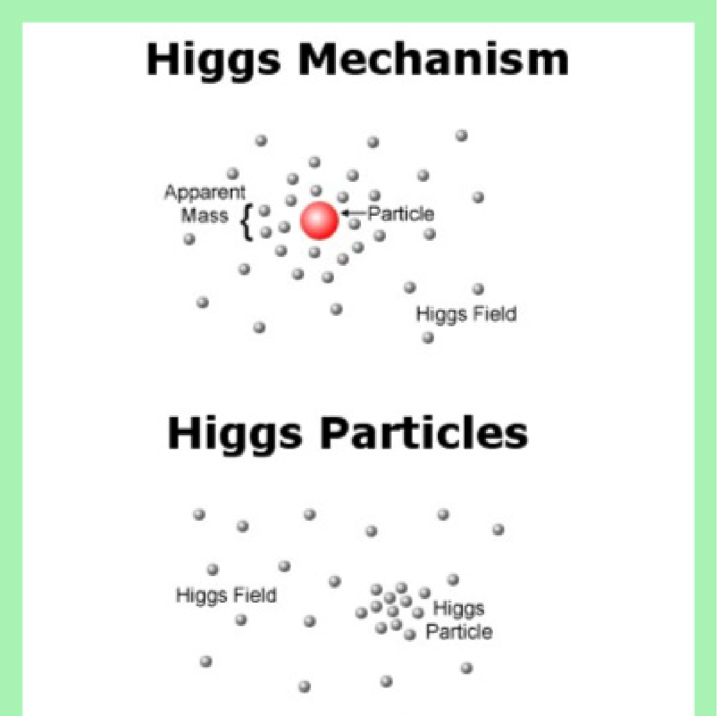
Incorporating dark energy into our model of the universe would neatly account for the "missing" three-quarters of the universe required to cause the observed acceleration in the revised Big Bang theory. It also makes the map of the early universe produced by the WMAP probe fit well with the currently observed universe. Carlos Frenk's beautiful 3D computer models of the universe resemble remarkably closely the actual observed forms in the real universe (taking dark matter and dark energy into account), even if they convince not all scientists. Alternative theories, such as Mordehai Milgrom's idea of "variable gravity", are as yet poorly developed and would have the effect of radically modifying all of physics from Newton onwards. So dark energy remains the most widely accepted option.

Further corroboration of some kind of energy operating in the apparent vacuum of space comes from the Casimir effect, named after the 1948 experiments of Dutch physicists Hendrik Casimir and Dirk Polder. This shows how smooth uncharged metallic plates can move due to energy fluctuations in the vacuum of empty space, and it is hypothesized that dark energy, generated somehow by space itself, may be a similar kind of vacuum fluctuation.

Unfortunately, like dark matter, we still do not know exactly what this dark energy is, how it is generated or how it operates. It appears to produce some kind of a negative pressure, which is distributed relatively homogeneously in space, and thereby exerts a kind of cosmic repulsion on the universe, driving the galaxies ever further apart. As the space between the galaxies inexorably widens, the effects of dark energy appears to increase, suggesting that the universe is likely to continue expanding forever, although it seems to have little or no influence within the galaxies and clusters of galaxies themselves, where gravity is the dominant force.

Although no-one has any idea of what dark energy may actually be, it appears to be unsettlingly similar to the force of cosmic repulsion or "cosmological constant" discarded by Einstein back in 1929 (as mentioned in the section on The Expanding Universe and Hubble's Law), and this remains the most likely contender, even if its specific properties and effects are still under intense discussion. The size of the cosmological constant needed to describe the accelerating expansion of our current universe is very small indeed, around 10^{-122} in Planck units. Indeed, the very closeness of this to zero (without it actually being zero) has worried many scientists. But even a tiny change to this value would result in a very different universe indeed, and one in which life, and even the stars and galaxies we take for granted, could not have existed.

Perhaps equally worrying is the colossal mismatch between the infinitesimally small magnitude of dark energy, and the value predicted by quantum theory, our best theory of the very small, as to the energy present in apparently empty space. The theoretical value of dark energy is over 10^{120} times smaller than this, what some scientists have called the worst failure of a prediction in the history of science! Some scientists have taken some comfort about the unexpectedly small size of dark energy in the idea that ours is just one universe in an unimaginably huge multiverse. Out of a potentially infinite number of parallel universes, each with slightly different properties and dark energy profiles, it is not so unlikely that ours just happens to be one with a dark energy that allows for the development of stars and even life, an example of the anthropic principle.



Representation of the Higgs mechanism and particle

There has been some speculation that dark energy may be connected to the still little understood Higgs field. According to the theoretical work of the English physicist Peter Higgs and others in the 1960s, the vacuum of space is actually permeated by what has become known as a Higgs field. It is the interactions with this field that gives the other elementary particles their mass, as it stops them from flying off at the speed of light by clustering around them and impeding their progress.

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Excitations of the Higgs field form particles known as Higgs bosons, an essential component of the current Standard Model of particle physics. Up until 2012, though, such a particle remained entirely theoretical and unproven. But experiments in 2012, at the Large Hadron Collider at CERN, were finally able to create and isolate a particle which gives every indication of being the elusive Higgs boson, although more detailed tests are still ongoing.

Another possible candidate for dark energy arises from the theoretical work on super symmetry, which effectively doubles the number of elementary particles in the current Standard Model with the postulation of massive unknown "super-partners" for each particle, whose spin differs by ½. Yet other candidates are so-called "quintessence" and so-called "phantom energy", although these ideas are essentially still at the hypothesis stage.

Neither is it clear whether the effects of dark energy are constant or changing over time, although research using data from the Hubble Space Telescope suggests that it was already at work boosting the expansion of the universe as much as nine billion years ago.

Antimatter

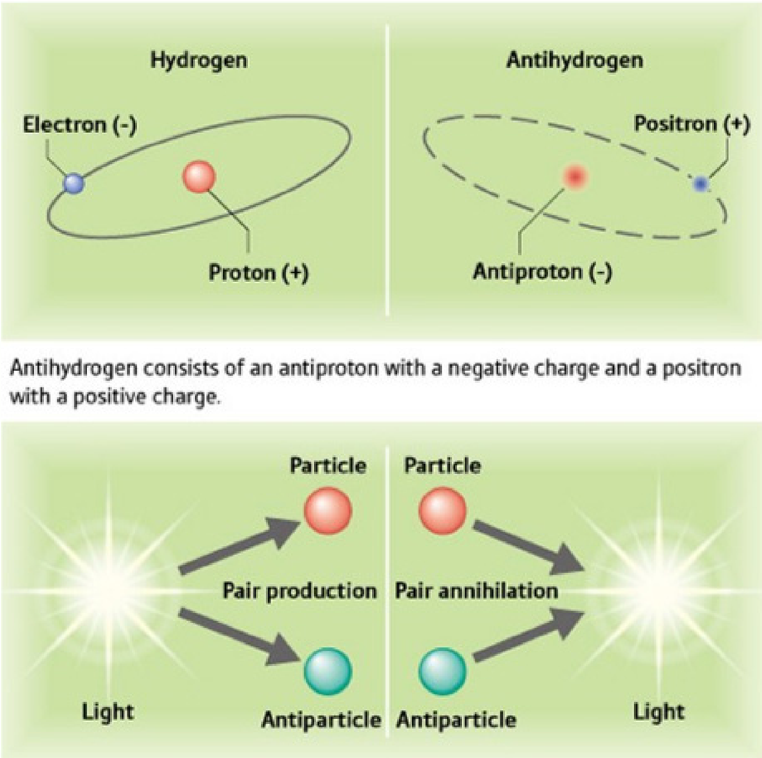
Another area, which perhaps needs some additional explanation, is the concept of antimatter, and why our universe consists almost entirely of matter and hardly any antimatter. According to theory, the Big Bang should have produced matter and antimatter in equal quantities. Thus, for every quark produced in the early stages of the Big Bang, there would also have been an anti quark; for every electron, a positron (the antiparticle of the electron); etc. The apparent asymmetry of matter and antimatter in the visible universe is one of the greatest unsolved problems in physics.

The British physicist Paul Dirac first predicted the existence of antimatter in 1928. For each of his theoretical equations, there appeared to exist another associated solution, with all the properties reversed, which did not seem to physically exist in the known universe. This antimatter, then, is the “mirror image” of matter, and the antiparticles of which it is composed are the mirror images of normal particles, being the same size but having opposite electrical charge.

Dirac’s equations also predicted that, if enough energy could be concentrated, an anti electron (always accompanied by an electron in order to preserve the overall electrical charge) could in theory be produced where none had existed before! In 1933, Carl Anderson successfully demonstrated the appearance of this hypothetical anti electron (which he called the positron), and definitively showed that matter could in fact be created in the laboratory in a controlled experiment. With the development of super-high-acceleration machines after World War II, other particles (such as protons and neutrons) and their respective antiparticles were created, and even stored in magnetic “bottles”.

However, when matter and antimatter meet, they completely annihilate each other in a brilliant flash of light produced by extremely high-energy gamma photons. This explosive annihilation mirrors the huge energy required to produce the matter-antimatter pairs in the first place.

For example, the high-energy cosmic rays, which regularly impact the Earth’s atmosphere, produce minute quantities of antimatter in the resulting particle jets, which are immediately annihilated by contact with nearby matter. The tiny quantities of antimatter, which scientists have managed to create in the laboratory, have always been accompanied by an equal quantity of normal matter, and the two tend to cancel each other out almost immediately. While it is technically possible that substantial amounts of antimatter do exist somewhere in the universe, isolated in some way from normal matter, no substantial quantities of antimatter have actually been discovered. Which begs the question of why this huge apparent imbalance exists, and why all matter and anti-matter did not just annihilate each other completely very early in the history of the universe (and therefore, ultimately, why we are here at all!)



Antihydrogen consists of an antiproton with a negative charge and a positron with a positive charge.

Particle and antiparticle pairs are produced from light. Conversely, upon collision of a particle and an antiparticle, pair annihilation occurs to produce light. On annihilation of an antiproton and a proton or a neutron, several π-mesons are released in the first step.

Pair production and pair annihilation of hydrogen and antihydrogen particles

It is assumed that, very early in the life of the universe, in a process known as baryogenesis, massive numbers of particles and antiparticles were created and did in fact annihilate each other. The cosmic microwave background radiation, which pervades the universe today, represents the remains of the energy produced by this wholesale annihilation of the matched particle-antiparticle pairs. But a small imbalance remained, in the form of an excess of matter, of the order of one extra matter particle per billion matter-antimatter particle pairs. It has been calculated that this apparently tiny imbalance in the early universe would be sufficient to make up the amount of matter presently observable in the universe.

In 1966, the Russian physicist Andrei Sakharov outlined three conditions necessary for a matter-antimatter imbalance to be possible: first, protons must decay, but so slowly that for all the protons in the Earth, fewer than a bread crumb's worth should have decayed so far; second, there must be specific constraints on the way in which the universe has cooled after the Big Bang; and third, there must be a measurable difference between matter and antimatter.

James Cronin and Val Fitch won the Nobel Prize in the 1960s for their work on a particle called the kaon, which showed that particles and their antiparticles might not in fact be exact opposites, and it does seem possible that kaons might actually live longer than anti kaons, but it is still far from clear whether this could account for the triumph of matter over antimatter in the universe.

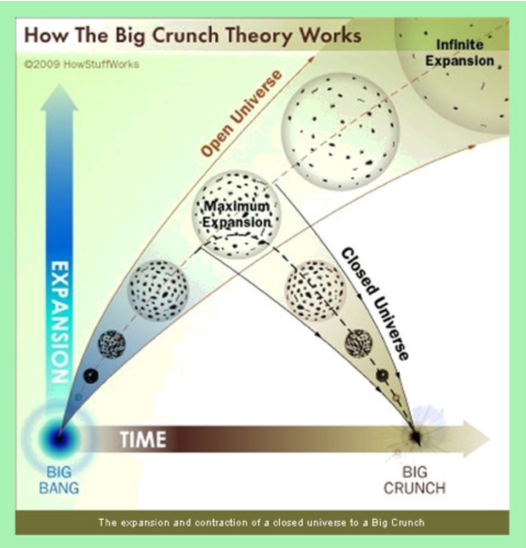
The Big Crunch, the Big Freeze and the Big Rip

Clearly, further advances in fundamental physics are required before it will be possible to know the ultimate fate of the universe with any level of certainty. However, scientists generally agree that this fate will depend on three things: the universe's overall shape or geometry, on how much dark energy it contains, and on the so-called "equation of state" (which essentially determines how the density of the dark energy responds to the expansion of the universe).

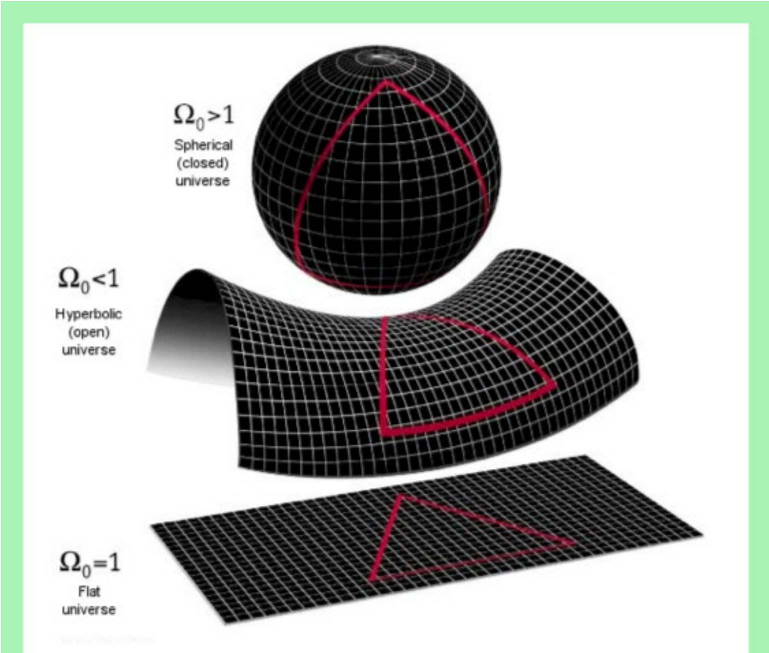
If the geometry of the universe is "closed" (like the surface of a sphere), then there are two main possibilities, as has been mentioned in the section on Accelerating Universe and Dark Energy. If the universe has a large amount of dark energy (as recent findings suggest it may well have), then the expansion of the universe could theoretically continue forever. If, however, the universe lacks the repulsive effect of dark energy, then gravity will eventually stop the expansion of the universe and it will start to contract until all the matter in the universe collapses to a final singularity, a mirror image of the Big Bang known as the "Big Crunch", somewhere in the region of a hundred billion years from now.

Models of a collapsing universe of this kind suggest that, at first, the universe would shrink more or less evenly, because, on a gross scale, matter is reasonably consistently distributed. At first, the rate of contraction would be slow, but the pace would gradually pick up. As the temperature begins to increase exponentially, stars would explode and vaporize, and eventually atoms and even nuclei would break apart in a reverse performance of the early stages after the Big Bang.

As the universe becomes compacted into a very small volume, any slight irregularities will become ever more magnified and, in the final stages, the collapse will probably be wildly chaotic, and gravity and the warping of space-time will vary immensely depending on the direction the singularity is approached by an in-falling body. According to some predictions, very close to the singularity, the warp age of space-time will become so violent and chaotic that space and time will actually "shatter" into "droplets" and all current concepts of time, distance and direction will become meaningless.



This model offers intriguing possibilities of an oscillating or cyclic universe (or "Big Bounce"), where the Big Crunch is succeeded by the Big Bang of a new universe, and so on, potentially ad infinitum. However, in the light of recent findings in the 1990s (such as the evidence for an accelerating universe described previously), this is no longer considered the most likely outcome.



Possible shapes of the universe (closed, open and flat)

If, on the other hand, the geometry of space is "open" (negatively curved like the surface of a saddle), or even "flat", the possibilities are very different. Even without dark energy, a negatively curved universe would continue expanding forever, with gravity barely slowing the rate of expansion. With dark energy thrown into the equation, the expansion not only continues but also accelerates, and just how things develop depends on the properties of the dark energy itself, which remain largely unknown to us.

One possibility is where the acceleration caused by dark energy increases without limit, with the dark energy eventually becoming so strong that it completely overwhelms the effects of the gravitational, electromagnetic and weak nuclear forces. Known as the "Big Rip", this would result in galaxies, stars and eventually even atoms themselves being literally torn apart, with the universe as we know it ending dramatically in an unusual kind of gravitational singularity within the relatively short time horizon of just 35 - 50 billion years.

Perhaps the most likely possibility, however, based on current knowledge, is a long, slow decline known as the "Big Freeze" (or the "Big Chill" or "Heat Death"). In this scenario, the universe continues expanding and gradually "runs down" to a state of zero thermodynamic free energy in which it is unable to sustain motion or life. Eventually, over a time scale of 10^{14} (a hundred trillion) years or more, it would reach a state of maximum entropy at a temperature of very close to absolute zero, where the universe simply becomes too cold to sustain life, and all that would remain are burned-out stars, cold dead planets and black holes.

What happens after that is even more speculative but, eventually, even the atoms making up the remaining matter would start to degrade and disintegrate, as protons and neutrons decay into positrons and electrons, which over time would collide and annihilate each other. Depending on the rate of expansion of the universe at that time, it is possible that some electrons and positrons may form bizarre atoms billions of light years in size, known as positronium, with the distant particles orbiting around each other so slowly it would take a million years for them to move a single centimetre. After perhaps 10^{116} years, even the positronium will have collapsed and the particles annihilated each other.

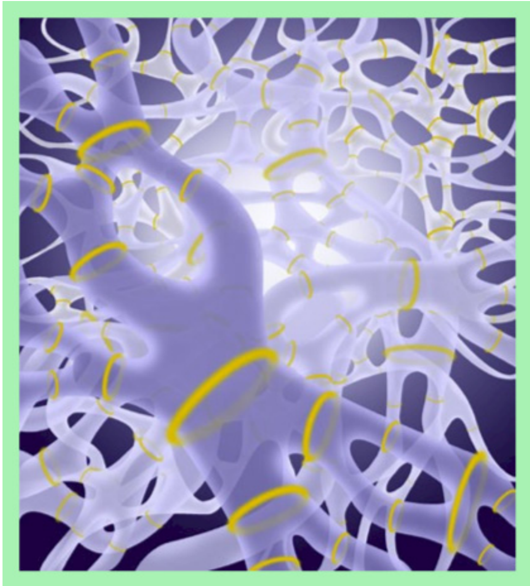
In this way, all matter would slowly evaporate away as a feeble energy, leaving only black holes, ever more widely dispersed as the universe continues to expand. The black holes themselves would break down eventually, slowly leaking away "Hawking radiation", until, after 10^{200} years, the universe will exist as just empty space and weak radiation at a temperature infinitesimally above absolute zero. At the end of the universe, time itself will lose all meaning, as there will be no events of any kind, and therefore no frame of reference to indicate the passage of time or even its direction.

Interestingly, recent analyses from the WMAP satellite and the Cosmic Background Imager, seem to be confirming other recent observations indicating that the universe is in fact flat (as opposed to closed or open). These experiments have revealed hot and cold spots with a size range of approximately one degree across, which, according to current theory, would be indicative of a flat universe.

To fully understand Superstrings and Quantum Gravity

To fully understand questions like where the universe came from, why the Big Bang occurred 13.7 billion years ago and what, if anything, existed before it, we need to better understand singularities like those in black holes and the singularity which marked the birth of the universe itself.

In order to achieve that, most scientists agree that a “quantum theory of gravity” (also known as "quantum gravity" or "unification" or the “theory of everything”) is needed, which combines the General Theory of Relativity (our current best theory of the very large) and quantum theory (our current best theory of the very small). These may seem like fundamentally incompatible concepts, and even Einstein, who devoted most of the latter part of his life to unification, came up short. But attempts are nevertheless continuing on several fronts to find just such a synthesis.

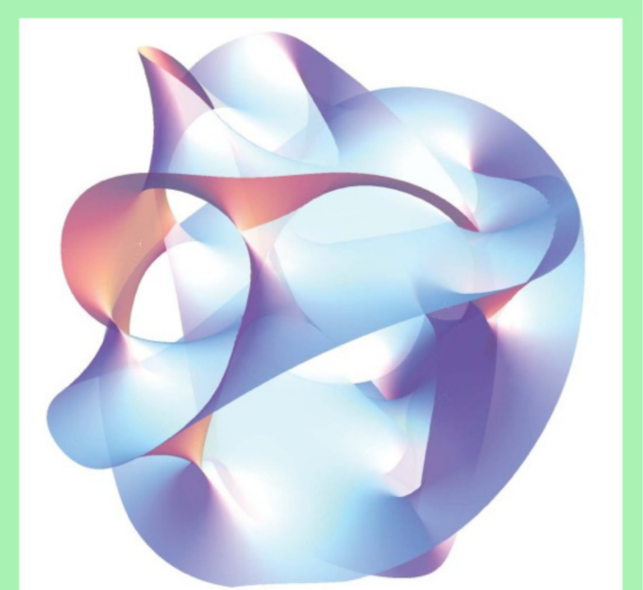


In the 1970s, the strongest candidate for a unified theory was probably “supergravity”, a field theory combining the principles of super symmetry and general relativity. But, although the approach appeared promising, it soon became apparent that the calculations involved were so long and difficult that it may never be provable. Around 1984, however, largely in response to a ground-breaking paper by Michael Green and John Schwarz, there was a remarkable change of opinion in the world of theoretical physics in favour of string theory (or, more specifically, Theory), a paradigm shift sometimes referred to as the "First Superstring Revolution".

Gabriele Veneziano, Leonard Susskind and others as a result of work had first been posited in the late 1960s the String theory. It views the basic building blocks of matter not as point-like particles but as unimaginably small one-dimensional vibrating “strings” of energy, which have length but no other dimension, like infinitely thin pieces of string or twine. A string may be open (i.e. have ends) or closed (i.e. joined up in loops), and the history of a string over time is represented by a two-dimensional strip (for open strings) or tube (for closed strings).

There might seem to be an inconsistency between the idea of a universe composed of strings and the point-like particles we actually observe in experiments. However, this is because the strings are so tiny that we cannot resolve their shape, even with our best technology, so that they just appear to us as tiny featureless points, like the difference between a speck of dust seen with the naked eye and under a microscope. To give some idea of the scales involved, a string is as small compared to an electron as a mouse is to the whole Solar System (around 20 order of magnitude smaller).

But the real beauty of string theory is that it looks on everything in the universe, all matter and all forces as well, as being made up of one single ingredient. Strings are composed of super-concentrated mass-energy which vibrate like a violin strings, with each distinct vibration mode corresponding to a fundamental particle (such as an electron or a photon, etc). The dividing or joining together of strings represents the emission or absorption of one particle by another, and the forces acting on particles correspond to other strings linking the particle strings in a complex "web".



3-D projection of a multi-dimensional Calabi-Yao manifold

According to string theory, then, the universe is a kind of symphony and the laws of physics are its harmonies. The vibrations of strings, however, occur in a ten-dimensional world, with each one-dimensional point in our ordinary space actually consisting of a complicated geometrical structure in six dimensions, all wrapped up on the scale of the Planck length (the smallest distance or size about which anything can be known, approximately 1.6×10^{-35} metres). The vibratory quality of these tiny threads of energy is what replaces particles and fields in the quantum description of the universe. The strength of the vibrations is what we see in the world as mass, and the patterns of vibrations are the fundamental forces.

The speculation on incorporating additional dimensions into space-time goes back to the ideas of the Polish physicist Theodor Kaluza in 1919 and, independently, the Swedish physicist Oscar Klein in 1926. They asked why it was not possible that electromagnetism could be unified with gravity in a notional five-dimensional universe, or that perhaps the electromagnetic force may relate to some curvature in a fifth dimension, just as gravity is due to curvature in four-dimensional space-time, as demonstrated by Einstein's General Theory of Relativity. In fact, string theory started out as a theory in an unbelievable 26 dimensions, and was reduced to the 10 dimensional theory known as superstring theory (shorthand for "supersymmetric string theory") after the discovery of a symmetrical mathematical object called a "Calabi-Yao shape".

General Relativity, which implicitly interprets gravity as curvature in four-dimensional space-time, is built in to the basic precepts of superstring theory in a way that may be consistent with quantum mechanics, and so it is hoped that the long-sought synthesis between gravity and quantum theory will naturally emerge. In fact, over ten dimensions (in which all but the four we are familiar with are "curled up" into tiny strings with diameters on the order of the Planck scale), it may even be possible that all the fundamental forces in nature can be accommodated into one "theory of everything", known as quantum gravity.

Superstring theory may also go some way towards explaining another problem, which has dogged physicists for years: why gravity is so very weak compared to the other fundamental forces. If strings, which are too small for us to see or measure, incorporate other dimensions, then it has been posited that perhaps the effects of gravity can only be felt in their entirety at the level of higher dimensions, which we cannot perceive. However, the very fact that strings are too small for us to see (and probably too small for us to EVER see) have led some to question whether string theory is science at all, or whether it falls into the realm of philosophy.

The validation of superstring theory, though, is all in the mathematics, and it remains frustratingly abstract and theoretical, particularly as we are clearly not able to actually observe such tiny objects, nor to clearly visualize the multi-dimensional aspects. Moreover, at least five different and competing superstring theories have developed, none of which are conclusive, however elegant. Since Ed Whitten's contribution to the field in 1995, though, there is some evidence that the inclusion of an eleventh dimension might be able to reconcile these competing theories, to show them as being just five different way of looking at the same thing. It might also make superstring theory consistent with supergravity theory (which had been largely disregarded since the early 1980s).

With the additional eleventh dimension, the fundamental building block of the universe was therefore no longer a string but a “membrane” or “brane”, leading to the theory's designation as “membrane theory” or “M-Theory”, first described by M-Theory pioneer Bert Ovrut in 2001. It soon became clear, though, that the new eleventh dimension was, if anything, even stranger than the other special dimensions of superstring theory, being infinitely long but only 10^{-23} metres wide, so that it theoretically exists at less than a trillionth of a millimetre from every point in our three-dimensional world but is totally insensible to us.

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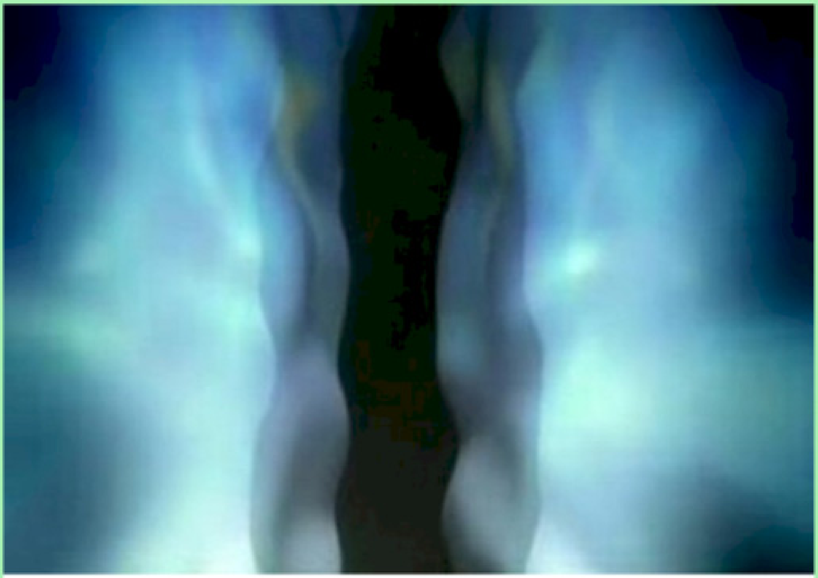


Artists visualization of rippling membranes

M-Theory and the incorporation of an eleventh dimension is also consistent with the existence of a multiverse, a convenient but ultimately improvable solution to many of the more intransigent problems in theoretical physics. For example, if the membranes move and ripple, as it is supposed they do, then events like singularities (and the Big Bang itself) can be visualized as the result of chance collisions between rippling, wave-like membranes, with the initial Big Bang of our universe being just one of many in the constant encounters between membranes in parallel universes.

This vision of the eleventh dimension suggests a much more violent and active place than the early visualizations of membranes serenely floating in space. It also suggests that time can in fact be followed back though the initial singularity of the Big Bang of the universe we know to the parallel universes, which gave rise to it (in what is sometimes described as the "Big Splat"), a possible solution to an intractable problem which has dogged physicists since the Big Bang theory was first mooted. This all conjures up the rather unsettling idea of an infinite number of universes, potentially each with different laws of physics, of which ours is just a single insignificant member, part of an endless multiverse, where Big Bangs are taking place all the time.

But the existence of parallel universes seems to provide plausible solutions to most of the outstanding problems with the theory. For example, some physicists (notably Lisa Randall) believe that M-theory may explain the apparent weakness of the force of gravity in our universe, if the strings that we experience as gravity (known as gravitons) are not open-ended strings which are tied down to our three-dimensional membrane or universe (as are the strings of particles and other forces), but self-contained closed loops of string which are therefore free to escape into other dimensions we are not able to experience. Or, alternatively, if we are only experiencing small leaks of the full force from other nearby membranes (and other universes).

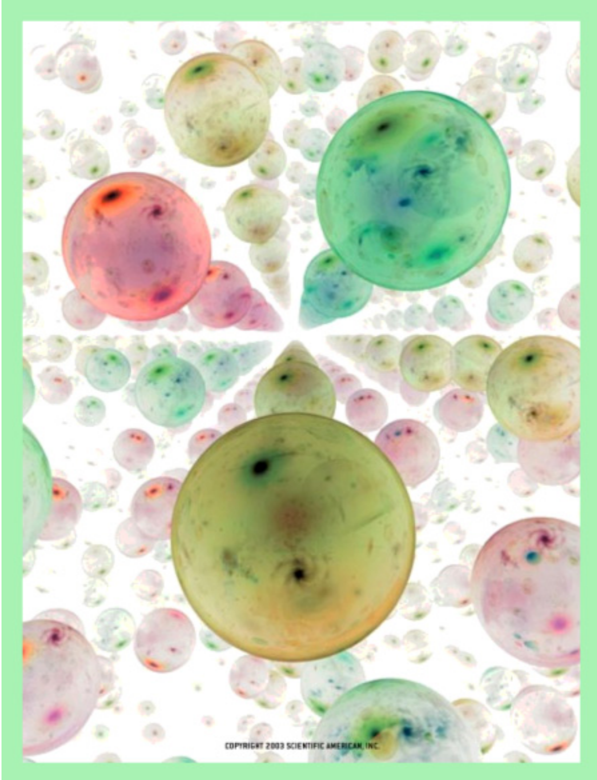
Superstring theory (and its off-shoot, M-Theory), though, is by no means the only candidate for a "theory of everything" which is being pursued. Indeed, some physicists think that it has been a disaster for science, taking many of the best brains off on a wild goose chase. Other approaches include "loop quantum gravity" (in which space is represented by a network structure called a "spin network", and particles are woven and braided together out of Planck lengths of space, evolving over time in discrete steps), "causal dynamical triangulation" (a background independent approach which attempts to show how the space-time fabric itself evolves), "causal sets" (an approach which assumes that space-time is fundamentally discrete and that space-time events are related by a partial order) and even a recent one called “An Exceptionally Simple Theory of Everything”.

Conclusion

The theory of the Big Bang, as modified by the inclusion of dark matter, cosmic inflation and dark energy, is still the best explanation we have for the origin of the universe. However, there are still gaps and inconsistencies in our knowledge, and perhaps the nagging suspicion that the more we learn and the more questions we answer, the more there is to learn and the more new questions arise.

Since the 1980s, steps have been taken towards a “quantum theory of gravity”, such as the theory of super strings mentioned in the previous section, steps which many physicist believe are necessary before we can advance any further in our understanding of the universe. However, the mathematics involved is hugely complicated, the tiny scale is inherently unobservable, and it is difficult to tell just how much progress is actually being made, and how much of the enthusiasm being shown is merely due to the elegance and the compelling apparent “rightness” of the theory.

It is apparent, though, that the laws of physics and the fundamental forces that have led to the creation of the universe as we know it (with all the complexity of stars and galaxies, a complex and interactive periodic table of elements, intelligent life, etc), are extremely sensitive to any change. For example, even a relatively slight difference in the ratio of the strength of the strong force holding atoms together to the force of gravity(about 10^{38}) would result in a much shorter or longer life for stars and much less favourable conditions for complex evolution, quickly leading to a featureless, sterile universe. If the very small mass difference between neutrons and protons (about one part in a thousand) were changed by only a factor of two, then the abundance of elements in the universe would be radically different from that observed today.



For some, the extent of these apparent coincidences and "fine tuning" have led them to attribute it to the hand of God and so-called “intelligent design”. Others have invoked the “anthropic principle” that this universe appears to be fine-tuned for life, specifically human life, and therefore could not be any other way (if it were, then would not be here to observe it).

As for the oft-posed question of what was there before the Big Bang - why there is Something rather than Nothing - physics as it stands has no answer, and such a question is considered effectively meaningless by most physicists. If matter, space and time all came into being with the singularity we call the Big Bang, then so did the concerns of physics, they argue, and any discussion of what came before is therefore an exercise in metaphysics and philosophy, not physics. If pressed, most scientists would probably have to answer: “As far as we know, nothing”.

New work on eleven dimensional superstring theory and M-theory, though, is suggesting plausible answers to even this audacious question. Among other ideas, it is hypothesized that the universe that we inhabit is just one of a potentially infinite number of parallel universes (the "multiverse"), some of which may have the same physical laws and fundamental forces but fine-tuned slightly differently, and some of which may have an entirely different set of laws and forces. What we think of as the Big Bang was just one of many collisions between rippling membranes in the eleventh dimension, and merely the result of two parallel universes momentarily coming together.

Others, like the Ukraine-born American physicist Alexander Vilenkin, claim that such extravagant theories are not needed to explain how Something came out of Nothing, and that quantum theory, and more specifically the concept of quantum tunnelling and the virtual particles that pop into existence apparently out of nothing as a result of the uncertainty principle (see the sections on Quantum Theory and the Uncertainty Principle for more details), are quite sufficient to explain how the universe first came into being.

Σ Π

Observations that Seem to Contradict the Big Bang Model While at the Same Time Support an Alternative Cosmology *

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Abstract

This research paper summarizes many very distant observations made by many groups of astronomers over a number of years, primarily utilizing the Hubble Space Telescope (HST) and ground radio astronomy observations, observations which are thought to contradict or question the standard Big Bang (BB) and Lambda Cold Dark Matter (LCDM) models, along with a listing and discussion of generally known and lesser-know problems with Big Bang cosmology. Also presented is an alternative cosmology and arguments contending support for this alternative model where the standard BB model seems to be deficient.

Keywords: Alternative Cosmology, Big Bang Problems, Contradicting astronomical observations,

Introduction

The purpose of this paper is to illustrate that there have been many observations that appear to contradict the standard Lambda Cold Dark Matter (LCDM) model but, for the same reasons, seem to support alternative cosmologies. This paper is timed to increase awareness of alternatives to the BB and LCDM models so that its predictions and expectations can be compared to observations produced by the new long-baseline radio telescope Atacama Array in Chile and the James Webb Space Telescope (JWST) when it is successfully operating. For this reason the authors herein offer a particular cosmology that they believe will fit past and future observations much better than any other cos-

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mology currently available. The observations in question are, for the most part, distant observations made by the Hubble Space Telescope (HST), the Spitzer Space Telescope (SST), and long-baseline radio telescope arrays. Some of these observatories, like the HST, have operated for decades and have made the same high-quality observations that can be made with them today.

The alternative cosmology being presented herein is called the "Pan Theory" and is preferred by the authors to explain the observations being presented for two reasons: it requires no ad hoc hypotheses like the standard BB model (Inflation, dark matter, and dark energy), and it is believed to be better supported by observational evidence presented here and elsewhere.

1. Discussion

The discussions of this paper will center on a list of perceived "problems" with BB cosmology**,** and for some of these problems we have presented listed observations that exemplify these problems. The list is given below to quickly introduce the reader to the scope of this paper's arguments. Following the list, each problem is discussed in turn, describing why it is a continuing problem with the BB model and why certain alternative cosmologies would not share these same problems.

The list of Big Bang problems to be considered are as follows:

(1.1) The Horizon Problem
(1.2) The Flatness Problem
(1.3) The Density Problem
(1.4) Galaxy Emergence and Universe structure Formation Problem
(1.5) The Anachronistic Galaxy Problem
(1.6) The Anachronistic Black Hole Problem
(1.7) The Metallicity Problem
(1.8) The Gravity Problem
(1.9) The Distance/ Brightness Problem

1.1 The Horizon Problem

Although this problem is believed by theorists to be somewhat "mitigated" by the Inflation hypothesis, theoretical problems still remain as will be explained. From cosmic microwave background data, background radiation temperatures vary no more than 0.01% in all directions from us; any patterns in this variance describe differences of a very low order of magnitude. This homogeneity is mirrored in the appearance of galaxies in all directions. Roughly, this was/ is the basis of the horizon problem.

Arguments: In a BB scenario, these regions of the cosmos could never have been in direct contact with one another after the beginning of the universe, so how could these uniformities of temperatures and galaxy appearances exist at opposite ends (i.e. horizons) of observation? Ad hoc explanations to fit the BB theory to the facts ended up collectively making up the Inflation hypotheses proposing superluminal universal expansion immediately following the BB. This superluminal expansion allowed the size of the actual universe to well exceed the size of the observable universe, which would act to homogenize conditions both by dilution (spreading a set amount of matter over a very large volume) and isolation (where any outlier mass concentrations would become likely to be far away from observable volumes).

This homogenization accordingly led to the universe we observe today. As matter did not exist during the Inflation period, this expansion must have carried with it some form of energy that later condensed into the basic units of matter. The fundamental energies that we know of today—those unrelated to the energy of relative motion — are forms of electromagnetic radiation that involve wavelengths, Zero Point energy, or hypothetical dark energy. Wavelengths involved in the superluminal expansion of space would seemingly "stretch out" beyond recognition or dissipate during a rapid expansion of space, and the energy carried by electromagnetic radiation is a function of its wavelength. Hyperinflation could therefore logically lead to comparative energy deficits.

Other horizon problems concern the matter of what actually was expanding during inflation. If it was only space, then initial conditions could never have mixed (since they would be spatially getting farther away from each other; one can't mix things by separating them) and caramelized into homogeneity outside of the diffusion of observation, which would mean that our vantage point is not necessarily mundane (the assumption of banality) and therefore our observations cannot be considered average. This would effectively eliminate cosmology as a meaningful study into the nature of things beyond the observable universe altogether, as the assumption that our observations are not particularly special are fundamental to being able to draw general conclusions from them. If anything else expanded and multiplied during the inflationary period, then there would be new creation from nothing, which is explicitly not permitted by the assumptions of the BB theory.

Another general criticism of Inflation is that the theoretical physics used to explain it are functionally "invented" and have no counterpart in observed reality. These physics can therefore never be tested, and newer physics can always be invented and proposed if the other models fail to explain a particular phenomenon. Valid hypotheses must be testable. The Inflation hypotheses are untestable speculation that can only claim observational support by its own implications.

Why the Alternative Model Better Explains these Observations

The Pan Theory might be described as a type of quasi-steady-state model (but not infinite) and as such lacks a horizon problem. (From this point forward, we will not use the quasi-steady-state term to describe this model so as not to confuse it with the prior quasi-state model of

Hoyle, Narlikar, Belinger, et. al. identified by that name.) No steady-state model would have a horizon problem since there would be a constant density in the universe, with no Inflation. The Pan Theory model is not an eternal universe model, but the universe would be a great deal older than conventional cosmology asserts and therefore there would be much more time for the universe to homogenize and evolve into the vast and complicated structures we observe today. If energy travels at the speed of light but the universe functionally expands much more slowly, then there can be sufficient energy transfer over time to ensure homogeneity and support the assumption that our observations are indeed representative of the way things are in the observable universe as a whole.

Additionally, by not requiring new physics, the Pan Theory can be rather easily tested: if we continue building better telescopes and seeing further away and keep seeing the same sorts of galaxies that we have been seeing so far, galaxies that interact in ways we would predict modern galaxies to, then that lends support to a steady-state theory. If, on the other hand, with better telescopes like the JWST and the Atacama Array, we start seeing phase shifts, seeing only small, young-appearing blue galaxies at the farthest observable distances or, perhaps, nothing at all, then these observations would contradict all steady-state theories with no chance of them being salvaged on an *ad hoc* basis.

1.2 The Flatness Problem

According to observations and the predictions of General Relativity, the amount of matter in the observable universe is greater than one tenth but less than ten times the critical density needed to stop the predicted expansion of the universe. This two-orders-of-magnitude range of matter density, and an equivalent ranging energy density, leads the topology of the universe to be "very nearly flat." With the changing density of an expanding universe, why should the density today—which, again, should not be a special point in time if we are to reliably make predictions off of our observations—be so close to the critical density? Also substantial variation from this critical density would, according to General Relativity, deform space in such a way that it should be observable. There seems to be no curvature of the observable universe which would indicate we are close to the critical density; this is the continuing flatness problem.

As with the horizon problem, the inflation hypothesis was also invented to help explain the flatness problem. According to this hypothesis the critical density of the universe just after the BB was theoretically close to the critical density, then stayed about the same during Inflation, and has decreased little since then. This seems illogical because as space expands, and the gravitational influence of a given mass diminishes over a greater volume, one would expect the critical density near collapse would change while the actual density of the universe would decrease. The differing ratios between density and critical density would result in the topology being different from time to time, even if the rates of change between the ratios were small. That would make the current observation of "very nearly flat" a special case, which means we are extraordinarily lucky to see it at this point. If we are extraordinarily lucky to see it, general conclusions we draw from it must naturally come under question because the assumption of banality is violated. If something is being created from nothing to maintain the observed density this is also a theoretical problem as explained concerning the Horizon problem, and the physics of the Inflation hypotheses.

Why the alternative model better explains these observations: Steady-state models lack a flatness problem also as they all propose that the density of the universe has always been effectively constant. The Pan Theory proposes a very slow decrease in the size of existing matter combined with the 'creation' of 'new' matter from the decrement, which leads to a constant matter density. While explained in more detail below, it can be readily described using the analogy, that after countless eons an object of static volume and mass could be split in half repeatedly: the numbers of objects increase, and the volume and mass of each object decreases, but the total mass, density, and volume of the system remains constant. From the viewpoint of slowly shrinking yardsticks, the total system appears to be getting bigger. As such, although space would appear to be expanding, instead matter and scales of measurement would very slowly be getting smaller. This would explain the observed redshifts of galaxies and other cosmic entities from our perspective.

1.3 The Density Problem

The density problem is similar to the flatness problem, but has proven resistant to being explained by Inflation. Based on the standard model of an expanding universe and the volume of a sphere, when the universe was half its present age (and diameter), it would have been eight times denser with matter, primarily observable as galaxies. At a quarter its age (and diameter), it would have been 64 times more dense compared to now, based upon a relatively constant rate of expansion since that time. An even larger difference would be observable if expansion were accelerating. These are not small differences. Since the HST has detected galaxies from calculated distances of ~13.2 billion years ago in a ~13.8 billion year old universe, such great differences in densities should be observable if the standard model were valid. Inflation hypotheses cannot change this since expansion has accordingly continued at observed rates after Inflation ended. But deep-field studies have not observed greater densities.

Indeed, we appear to see the opposite: observed galactic density decreases the farther away (and back in time) one looks. The presently accepted explanation for why this is so is summarized in this excerpt from an astronomy website (Springbob, 2003).

Why does the density of galaxies seem to steadily fall off with distance on large scale galactic maps?

The short answer is that it's harder to see things that are farther away. So while we can see almost all the galaxies nearby, we can only see the very brightest ones far away. This effect overwhelms everything else, and is responsible for the density of galaxies in those maps dropping off at large distances. So if you look at one of those maps, you can imagine that there are actually many more galaxies on the outskirts, but we just can't see them.

The above is true, but smaller, less luminous galaxies cannot explain the comparative paucity of galaxies in the universe around seven billion years ago when, as stated above, matter and galaxies should be about eight times denser, as well as more galaxy mergers should be observable. Adjusting for estimates of the opacity of the intergalactic medium, there still should have been many times as many bright-enough galaxies, as they do not take billions of years to form based upon present observations of the most distant galaxies. These observations instead appear to indicate that the density of galaxies falls off with distance; that the universe was *less* dense in the past than it is now.

Another common answer is that astronomers cannot easily measure density with only a telescope. Angular separations inside telescopes cannot be used to measure the mass inside any significant volume. This explanation is also valid, but also dodges the question since there's no reason to assume that bright stars in the past were of appreciably different mass than they are now, nor alter the appearance of a photograph like the Hubble Ultra Deep field, a collective of hundreds of the most distant galaxies that appears the same as a local photograph of such a collective. Still another explanation invokes Inflation mechanics and suggests that the further back one looks the more that dark energy— the force proposed for causing Inflation in some models—would push galaxies farther apart. Both proposals ignore that regardless of expansion rates at any given point in time, if the universe has been expanding steadily for more than 13 billion years, from a denser past, then this greater density should be detectable from large-scale galaxy surveys. Even if the average galaxy in the past may have been smaller and relatively farther apart from each other, there should have been more of them—corrected for intergalactic medium opacity—than now. This is not what is being observed.

Another answer suggests that by the standard model most galaxies would not have formed yet. This is logical on its face, though the Earth's four-billion year history up to now being almost a third of the entire universe's age—and with Sol not even being a first-generation star—seems to suggest that galaxies would need to have formed comparatively quickly to be consistent with a universe of only 13.8 billion years. Additionally, by the standard model, the most distant galaxies should be young, blue immature galaxies that have not yet differentiated. Instead, astronomical observations find, at twelve billion light years' distance, some galaxies they identify as large spiral and elliptical galaxies functionally identical to the Milky Way, without the greater star production which might be expected if interstellar hydrogen densities were indeed greater.

Why the alternative model explains these observations: steady-state models, true to their name, predict a roughly constant galactic density that leads to a decreasing observed galactic density following the inverse square law of illumination and any effects of the opacity of the intergalactic medium. This appears to be exactly what is being observed, which is contrary to what would normally be expected with the BB model as described above. Most previous steady-state models, however, lack an origin and invoke infinity; the Pan Theory instead posits an age of the universe so great that the observable universe is effectively uniform and steady-state whilst avoiding the quandary of simply 'having always been.'

Although decreasing galactic densities looking backward in time contradict the BB model, it supports the Pan Theory in that galaxies in the past would have been of equal density, but space in the past would appear to us as being larger than it really was because of the diminution of matter resulting in our changing scales of measurement.

1.4 The Galaxy Formation Problem

The non-uniformities that would be produced by an expanding universe—either by inflation or expansion alone—do not seem to be sufficient to allow enough time for galaxies, clusters, webs of galaxies, and all of the intergalactic structures that have been observed, to have formed within the limited time allowed by the BB model. Due to the nature of expansion, all of these structures would effectively have to form *in situations* with limited opportunity for mutual influence and self-ordering. Based upon the rate of assumed universal expansion, gravitational attraction would be too slow to form galaxies if expansion resulted in a reasonable level of turbulence.

As such, "the question of how the large-scale structure of the universe could have come into being has been a major unsolved problem in cosmology" (Trefil, p. 63, Daily Galaxy, 2010, Problems in Cosmology, 2012). To explain this problem, theorists have been compelled to look at a theoretical period before one millisecond after the BB to form hypotheses explaining the observable existence of galactic and intergalactic-scale structures by one means or another. To be blunt, this is pure theory with no counterpart in immediately observable reality or any means to test the theory except by computer modeling, and the weakness of validation-by-model is that if the model is incorrect, it can be tweaked until it is "correct." Even then, there is always the risk that new structures—such as the Large Quasar Group four billion light-years across discovered using the HST in 2013 (Klotz, 2013)—was observed which required fine-tuned model addendums, in a continuing process of fine-tuning and changes in fine tuning, but with continuous surprises rather than predictive power.

Why the alternative model better explains these observations: The Pan Theory proposes a much older universe which provides ample billions (or even trillions) of years to form the large scale structures of the universe that we can now observe, but does not involve the philosophical problems of a temporally infinite universe as do most other steady-state models.

1.5 The Anachronistic Galaxy Problem

This may be the most obvious problem with the Big Bang model at this time since there have been a great many observations by many different groups of astronomers that have come to the conclusion that some of the most distant galaxies appear to be very old and mature, rather than young appearing as the Big Bang model would require. This is exemplified by the sampling of such observations shown below.

In a universe 13.8 billion years old, it stands to reason that the most distant and therefore first-to-form galaxies should be young galaxies: small, with young blue mostly first-generation stars within them. This is not what has been observed, and as such constitutes the greatest weakness of the BB model. There have been many large, old-appearing galaxies at the farthest distances that we have been able to see, observed many times by several different groups of astronomers. Some appear to be filled with old, red stars; others appear to be large spirals and elliptical, like the Milky Way and our surrounding galaxies.

Observations in Support of Statements

1.5.1 Old Galaxies Observed Ten Billion Light Years Away by the Ultra-Deep Survey

The purpose of the Ultra-Deep Survey (UDS), “an image containing over 100,000 galaxies over an area four times the size of the full moon,” (Massey, 2008) was to “allow astronomers to look back in time over 10 billion years, producing images of galaxies in the Universe's infancy.” Doctor Foucaud of the UDS project said first that “our ultra-deep image allows us to look back and observe galaxies evolving at different stages in cosmic history, all the way back to just 1 billion years after the Big Bang," and then "we see galaxies 10 times the mass of the Milky Way already in place at very early epochs.”

Further analysis of the UDS had surprising results, paraphrased below:

The distant galaxies identified are considered elderly because they are rich in old, red stars, not because the light from these systems has taken up to 10 billion years to reach Earth. They are seen as they appeared in the very early Universe, just four billion years after the Big Bang. The presence of such fully-evolved red-appearing galaxies so early in the life of the cosmos is hard to explain and has been a major puzzle to astronomers studying how galaxies form and evolve. (University of Nottingham, 2008).

For fairness, dark matter was invoked to explain how these ancient galaxies could have evolved into supermassive modern ones, but this leaves unanswered the question of how they became supermassive so quickly at the beginning stages of the universe and at the same time appear so “elderly” in the first place.

1.5.2 Massive Distant Galaxies Observed in the HST's Ultra Deep Field

Similar to the UDS, the Ultra Deep Field was an effort to use the HST to detect distant galaxies and then follow up observations with the Spitzer Space Telescope and the European Southern Observatory Very Large Telescope (USO VLT). One galaxy, HUDF-JD2, was seen "as the universe was only about 800 million years old" (Britt, 2005). Nahram Mobasher of the European Space Agency had this to say about it: "It made about eight times more mass in terms of stars than are found in our own Milky Way today, and then, just as suddenly, it stopped forming new stars. It appears to have grown old prematurely."

The article reporting this goes on to say**:** The leading theory of galaxy formation holds that small galaxies merged to gradually form larger ones. But the newfound galaxy is so massive at such an early epoch that astronomers now think that at least some galaxies formed more quickly in a monolithic manner.

What would be a large galaxy today would be phenomenally huge in the early days of an expanding universe, having to form rapidly *in site* rather than coalescing from smaller galaxies. Whether it would have had time to do either is questionable under the BB model.

1.5.3 Very Distant Red Galaxies Challenge Theory

The Spitzer Space Telescope discovered four extremely red galaxies. Jiasheng Huang of the Harvard-Smithsonian Center for Astrophysics, lead author on the discovery, said "We've had to go to extremes to get the models to match our observations" (Aguilar, 2011); the authors here note that this is a dangerous statement to make since it is suggestive of having to force models to fit data. An article reporting on this discovery explains:

Galaxies can be very red for several reasons. They might be very dusty. They might contain many old, red stars. Or they might be very distant, in which case the expansion of the universe stretches their light to longer wavelengths and hence redder colors (a process known as redshifting). All three reasons seem to apply to the newfound galaxies. All four galaxies are grouped near each other and appear to be physically associated, rather than being a chance line-up. Due to their great distance, we see them as they were only a billion years after the Big Bang - an era when the first galaxies formed (Aguilar, 2011).

In terms of probability, it seems unlikely that these ultra-red galaxies should exist at all at these great distances and therefore unsurprising that current computer models had to be forced to the data in an attempt to provide explanations. If more of these galaxies are observed (as expected and predicted by the Pan Theory), then they must accordingly be more common, and 'extremes' of a model are insufficient to explain them, since such 'extremes' should be either non-existent or very rare.

1.5.4 Distant Anachronistic Galaxy Cluster Contradicts Theory

A group of scientists used the USO VLT, the XMM-Newton telescope, and the Chandra X-Ray observatory to analyze the CL J1449-0856 galaxy cluster and stated that its "properties imply that this structure could be the most distant, mature cluster known to date and that X-ray luminous, elliptical-dominated clusters are already forming at substantially earlier epochs than previously known" (Gobat, 2010). In their conclusions, they state:

Our results show that visualized clusters with detectable X-ray emission and a fully established early-type galaxy content were already in place at z > 2, when the Universe was only ~3 GYR old. While it took us several years of observations to confirm this structure, upcoming facilities like JWST and future X-ray observatories should be able of routinely find and study similar clusters, unveiling their thermodynamic and kinematics structure in detail. The census of z > 2 structures similar to CL J1449+0856 will subject the assumed Gaussianity of the primordial density field to a critical check.

As continuously more of these mature galactic clusters are detected in a theoretically young universe—and, most importantly, if they are detected farther away—then this would even more strongly contradict the BB model.

1.5.5 Most Distant Galaxy Cluster Contradicts Theory

A research team lead by Andrew Newman confirmed "that JKCS 041 is a rich cluster and derive a redshift z=1.80 via the spectroscopic identification of 19 member galaxies, of which 15 are quiescent" (Newman, 2014). This indicates a large, ancient galactic cluster past the peak of its star-forming period.

There were other notable observations:

- "We construct[ed] high-quality composite spectra of the quiescent cluster members that reveal prominent Balmer and metallic absorption lines." Young, early-generation stars (as should be expected in young, early-generation galaxies) should not have notable metallicity.

- "We find no statistically significant difference in the mass/radius relation or in the radial mass profiles of the quiescent cluster members compared to their field counterparts." Galaxies in clusters are expected to be larger than isolated galaxies, due to their increased opportunity to coalesce. This does not seem to be the case here; both cluster and field galaxies grew at the same rate.

It must be noted that as-yet unobserved Population III stars have been hypothesized to explain metallicity, but there is currently no explanation for galaxy clustering not leading to larger galaxies. Again, the large number of mature, quiescent galaxies at approximately 9.9 billion light years away emphasizes the limited amount of time available for this to occur, and therefore such observations remain anomalous.

Why the alternative model explains these observations without contradiction: For the Pan Theory and other steady state models, old-appearing galaxies at increasingly greater distances are not only predicted but are expected and required by these models since the portion of old appearing galaxies would accordingly have been about the same portion throughout the observable universe. Such theories can immediately explain observations such as the above since they match predictions. On the other hand, if we observe a 'hard limit' that we cannot see beyond, and at these distances observe no old appearing galaxies, but only small, blue, young appearing galaxies as in BB predictions, then seemingly all these alternative models would be discredited and disproven, as would the Pan Theory.

1.6 The Anachronistic Supermassive Black Hole Problem

According to the BB model, black holes form from matter within a galaxy and grow alongside it: the bigger the galaxy gets, the bigger the central black hole. Very large black holes in extremely distant galaxies is akin to the problem of Milky Way-sized (and larger) galaxies being observed near the theoretical beginning of the universe. The Milky Way itself is theorized to be approximately twelve billion years old, for comparison's sake.

1.6.1 Particularly, Submillimeter Array observations of 4C60.07 "now suggest that such colossal black holes were common even 12 billion years ago, when the universe was only 1.7 billion years old and galaxies were just beginning to form" (Aguilar, 2008). One of the galaxies seems quiescent, the other active; both "are about the size of the Milky Way." As can be seen, such observations extend the anachronistic galaxy problem.

Why the alternative model explains these observations: For all cosmologies proposing a much older universe than the standard BB model, large black holes should be found equally in large distant galaxies as well as local ones, which is what is being observed.

1.7 The Metallicity Problem

Metals—are characterized in astronomy as being anything heavier than hydrogen and helium. Anything other than hydrogen can be produced by nuclear fusion inside of stars. Late-generation stars are made up of the Ejecta of earlier generation stars that underwent nova and supernovae processes that expelled these heavier elements into interstellar space. Logically, this means that early-generation stars should be metal poor, and the hypothesized Population III stars (first generation stars) are theoretically metal-free, as suits the first stars in the universe. Stars should become more metallic—in other words, their metallicity should increase—the later they form. Therefore, distant galaxies, being part of a younger universe and an earlier generation, should have stars of lower metallicity than today.

1.7.1 The quasar SDSS J1148+5251 is "hyperluminous" and resides within "a high metallicity galaxy in the early universe" (Galliano). A redshift of 6.42 would make this quasar, by the Hubble equation, about 13.4 billion years old. This means that the quasar and galaxy can be, at most, 400 million years old, which is the average lifetime of a large metal-producing star. However, "various metal tracers, like the [FeIII], [MgII], and [CII] lines, as well as the large amount of CO and dust emission, indicate a nearly solar metallicity." The Sun is a Population I star about 4.5 billion years old; its metallicity should not resemble that of a quasar at almost the beginning of the universe.

The quasar's dust content and metallicity can therefore only be explained conventionally by a huge population of supermassive, short-lived stars and almost "instantaneous" recycling. The researchers also estimated that "previous studies overestimated the star formation rate [of this galaxy] by a factor of 3-4."

Why the alternative model explains these observations: For steady-state models such as the Pan Theory, the metallicity of distant galaxies, on an average, should be the same as those found in local ones. According to these models no matter how near or far one would look s back in time there should be galaxies of all ages, points in their evolution, and metallicity – which is what is being confirmed by observations such as this one. The difficulty of such observations of metallicity at these great distances will remain a problem in their observation, regardless of the model being considered.

1.8 The Gravity Problem

For a long time now it has been known that the Milky Way and its surrounding dwarf galaxies present anomalies that cannot be accurately explained by computer modeling. In a resent study it was confirmed that the dwarf galaxies surrounding the Milky Way appear "preferentially distributed and orbit within a common plane" (now being called the Magellanic Plane)

1.8.1 (Pawlowski, 2014) around a "vast polar structure (VPOS)… globular clusters and stellar and gaseous streams appear to preferentially align with the VPOS too." M31 appears to have a similar satellite system, "and aligned systems of satellites and stellar streams are also being discovered around more distant galaxies." This is "a challenge for the standard Λ-cold dark matter cosmological model" because it is "incompatible with the planar VPOS." In short, most objects around the Milky Way orbit in the same direction and in a roughly-aligned plane, but because the dark matter halos that galaxies should form from are first-order isotropic, there should be no preferred orientation within them. Likewise, the distribution of sub-halos is also isentropic so if there are follower galaxies, they should be widely distributed and moving in random directions.

Pawlowski *et al* essentially performed a Monte Carlo simulation using the standard cosmological model(s) to try to replicate the ordered structures seen around the Milky Way and M31: the structures could be flukes. However, the models predicted far more random systems and reduced the likelihood of 'vast structures' to a very low order of probability. Pawlowski then went on to suggest that these satellite galaxies are tidal dwarf galaxies caused by galactic collision debris, which would have to have a signature on the Local Group scale, and says that he "discovered that the non-satellite galaxies in the Local Group are confined to two thin and symmetric planes" (Pawlowski, date unknown). Professor Pavel Kroupa, a co-author of the paper, went further: "There's a very serious conflict, and the repercussion is **we do not seem to have the correct theory of gravity**" (bold added) (Luntz, 2014).

Why the alternative model better explains these observations: The Pan Gravity model predicts galaxy formation and similar rotation curves for spiral galaxies by way of simple vortex mechanics in such cases where the majority of mass is not centrally located. To do this, it proposes a kind of "curved momentum" (not unlike the alleged lines of warped space but using Euclidean geometry) for stars in spiral galaxies so that an extra gravitational force inward would not be needed to maintain the higher stellar velocities that have been observed. It also hypothesizes admittedly *ad hoc* electromagnetic influences that could produce spiral galactic bars, and mechanisms that could explain a wall of tidal galaxies perpendicular to a large spiral like the Milky Way. Alternative galaxy-formation models and gravity theory involving outside-the-box explanations, such as the Pan gravity theory, might also be considered (if experimenters are aware of such a theory and of its details) and investigated as a possibility if known models of galaxy formation have failed, as indicated by the above related observations and attempted computer modeling using presently accepted theory.

About the Pan Gravity model: The Pan Gravity model is a mechanical 'pushing gravity' model with similarities to Newton's Pushing Gravity model, in his second edition of *Optics* (1717). Unlike his first explanation, he proposed a mechanical pushing ether explanation of gravity whereby the ether would get progressively thinner (less dense) when approaching celestial bodies (wikipedia, Mechanical explanations of gravity, Newton, Static Pressure). A similar explanation is proposed by the Pan Gravity model.

1.9 The Distance/ Brightness Problem

The conventionally accepted method of calculating cosmological distances involves redshifts and is based upon the Hubble formula. The results tend to result in Type 1a supernovae—generally considered to be equivalent to standard candles concerning their relatively constant brightnesses—being brighter or dimmer than expected and thus resulting in a parabolic curve of brightnesses vs. redshifts. This unexpected result was thought to necessitate the proposal dark energy.

It should also be noted that if one is using the wrong equations to calculated distances and brightnesses, one would come to the wrong conclusion concerning the appearances of cosmic entities in the past. The conclusion that cosmic entities in general were different in the past could be totally wrong for this reason. This was one of the two conclusions that put the Big Bang model into prominence. The other conclusion was that the cosmic microwave background radiation and its uniformity could be best explained by the Big Bang epoch of Recombination, rather than steady-state explanations of the time.

The problem comes from the belief that the Hubble distance formula, also called the Hubble Law, calculates distances correctly based upon redshifts. Based upon Hubble calculations type 1a supernova as standard candles do not act as one would expect from them—their luminosity does not diminish as expected with distance—increasingly complex models that can only be justified mathematically, and even then the mathematics can be, and have been adjusted to account for newer observations. This is not necessarily a bad thing; despite Occam's Razor. There is nothing that says that the cosmos must operate in the simplest possible way. However, these models are evangelized with the ring of truth, which ignores that they are models: as Korzybski said, "the map is not the territory." Models, as assumption-based analytical predictors of future observations, should be as pragmatically simple as necessary to make predictions. Continuous adjustment to them is generally indicative of some flaw that some different model with a different context would explain more simply**:** the complex helical planetary movements from a geocentric model simplify to ellipses in a heliocentric model, for example. Truth value aside, the *ad hoc* adjustment (and some would say foundation) of current models leave room for other models with better predictive power, if they exist and are available.

Why the alternative model explains these observations: As related to the present authors' previous paper: *The Pan Theory proposes new formulas for calculating cosmic distances and brightnesses based upon slowly shrinking matter rather than an expanding universe*.

The Pan Theory proposed a complete replacement of the Hubble formula and has added an additional brightness formula based upon the theory, the results being very well-supported by observations of type 1a supernova. The Hubble formula is based upon the tenets of an expanding universe. These alternative equations were derived instead from the diminution of matter concept and in the authors' previous paper, as indicated below, which matched observations of supernova very well without the need for hypothetical dark energy.

1.9.1 The alternative distance equation was/is proposed to replace the existing Hubble formula directly below (Noble, Cooper 2014):

$$r_H = \frac{v}{H_0} = \frac{\beta \cdot c}{H_0} = \left[\frac{(z+1)^2 - 1}{((z+1)^2 + 1}\right] \cdot \frac{c}{H_0}$$

The new proposed formula is linear and was derived based upon the Pan Theory premise, the diminution of matter:

$$r_1 = 21.946 \cdot \log_{10}\left[0.5 \cdot \left((z+1)^{0.5} - 1\right) + 1\right] \cdot (z+1)^{0.5} \cdot P_0 \text{, where}$$

r_1 is distance, z is the observed redshift, *and* constant $P_0 = 1{,}958.3$

Based upon the rate of the diminution of matter an additional formula is needed to calculate brightnesses, since matter would appear to have been larger and brighter in the past. The Brightness Enhancement factor ΔL is calculated below, which is based upon the diminution of matter going forward in time resulting in larger matter in the past producing brighter stars than there distances would otherwise indicate based solely on the inverse square law of light:

$$\Delta L = 2.512 \cdot \log_{10}\left[\left[\left((z+1)^{(0.5t)} - 1\right) \cdot (0.5t) + 1\right] \cdot (z+1)\right] \text{, where}$$

ΔL is the calculated brightness addendum factor, z is the observed redshift. Time

$$t = 9.9661 \cdot \log_{10} \cdot \left[(z+1)^{0.5}\right]$$

represents the calculated quantitative timeframe, based upon the rate of the diminution of matter in "doubling periods or circles," that is a function of the observed redshifted wavelengths.

The alternative cosmology is based upon the changing scale of matter (matter diminution) so the formulas are linear and the results at great distances, very different. This proposal succeeded in forming the distance/brightness trend line to an approximate constant resulting in a straight-line graph, as would be expected from a standard candle without dark energy (Noble, Cooper 2014). This does not require invoking any phenomena that cannot be either directly observed or immediately disproved: as the diminution rate is constant and all mathematical operations in the model have explicit mechanical explanations, it cannot be 'tweaked' to force flatness. The mathematics of the alternative model are, for the most part, simpler and its assumptions involve the diminution of matter rather than the expansion of space. From a relative perspective they might be considered the same thing, but the ramifications of each result in different mathematical formulations and implications.

2. Summaries of the Above Problems

The Horizon, Galaxy Formation, Anachronistic Black Hole, Metallicity, and Gravity Problems all relate to the limited age of the universe (13.8G years) required by the Hubble formula concerning the BB model. Any cosmology of a much older universe would not have these same problems.

The Flatness and Density Problems are common to all cosmological models that do not propose a steady-state condition of the universe. Steady-state or quasi-steady-state models would not have these problems.

The Gravity Problem relates to any cosmology like the BB model that proposes the standard model of gravity, with or without dark matter. Cosmologies that can explain galaxy formation as presently observed, along with galaxy rotation curves, whether right or wrong, would not have this problem.

The Distance/Brightness Problem occurs in expanding universe models like the BB and Hoyle's steady-state models, or any other model that uses the Hubble formula to calculate distances and brightnesses. The problem shows up as unexpected brightnesses and sizes of distant cosmic entities. The researchers and authors of this paper believe that so far only the Pan Theory has, from its basic tenets, derived the correct distance and brightness formulations and therefore is the only model able to correctly calculate distances, brightnesses, and angular sizes of galaxies and other cosmological objects accurately, especially at the greatest distances.

3. Explaining of the Pan Theory

The Pan Theory is a type of **steady-state theory** which proposes that, as far as we could ever observe, a constant cosmological density, and that **the universe as a whole is much older** than is currently thought. Unlike most previous steady-state models, the Pan Theory does not propose that the universe is of infinite age or size; there was a beginning point in time prior to which the question of 'what happened before' would not be a valid question (much like the initial version of the BB model). The universe would be a much simpler place.

It is a scale-changing theory that proposes that rather than space expanding, matter very slowly gets smaller over time. Matter would decrease in size about 1/1000 part every 8 million years. This is a similar perspective to expanding space since space would appear to be expanding from our perspective. This slow decrease in the size of matter is accordingly enough to explain the observed redshift of galaxies and other cosmic entities.

It is also a single-force theory evidenced by the particle spin of fermions. Particle spin would be real, in this model, not just angular momentums as in present theory. **It is an ether model** involving a universal medium (a physical background field) believed to be evidenced by the Zero Point Field. EM radiation would be density waves of ether particles. Electro-magnetism would be explained by ether flow similar to Maxwell's ether model, and a pushing theory of gravity also based upon ether flow, with its own equations explaining stellar velocities in the discs of spiral galaxies, there being no need for the existence of non-baryonic dark matter, excepting as non-matter ether particulates.

The authors submit the Pan Theory for consideration based upon the evidence submitted above and observations in general, with the understanding that reality always trumps theory. If its predictions are not borne out or, more importantly, specified counter-evidence comes to light, then it would be fundamentally in jeopardy of being disproved as would any model continuously contradicted by evidence, such as the BB model, and not worthy of consideration or continued support.

Certain aspects of the Pan Theory are presently considered controversial, such as **pushing gravity** rather than the warped space of General Relativity and dark matter. **It proposes the diminution of matter** resulting in ~~a~~ the changing scale of measurement, rather than the expansion of space, and **proposes real waves in an etherial background field** rather than pure energy waves or probability waves of Quantum Theory. Two of these controversial tenets will now be discussed.

3.1 Proposing a new Ether

As mentioned above, the Pan Theory is an ether model. There have been a number of proposals on an ongoing basis, explaining and/or proposing a “new ether” (Mingst, 1997; Wikipedia, 2014, Superfluid Vac.; Scientific American, June 2014; Spacetime Superfluid).

The Pan Theory proposes the following**:**

A background ether-like field of particles forms into coiled strings (3 dimensional) of like particles. There is only one fundamental particle that makes up everything, including matter and ether field particles, all of reality. Space is the volume the matter and the ether occupy without any other meaning to it. These particles are called

Pan (as in “everything”), which are hypothesized to be much smaller than either proposed dark matter particles or Higgs particles. Pressure differentials within Pan fields explain both gravity and magnetism.

Electromagnetic radiation and De Broglie waves are explained as physical, mechanical waves in the Pan field ether (encompassing the local hidden variables of quantum theory in what De Broglie called pilot waves), carrying discrete collections of Pan (which Planck called quanta) and we call photons. This explains the coexistence of particles and waves in the quantum realm, and would simplify this aspect of quantum theory to simple pilot-wave theory. The ether field waves produced by orbiting atomic electrons would be EM radiation, and the much higher frequency, very-short field waves produced by spin and momentum of atomic and molecular particles we call matter waves, or De Broglie waves. Both accordingly would simply be density waves of varying intensities and frequencies traveling within the ether. If this interpretation of quantum theory were valid and accepted, the applied physics of quantum mechanics, with its proven predictive power, would not necessarily need to change, and quantum mechanics could be considered mechanical rather than "mystical."

This ether would encompass the entire universe and would be comprised of ether particulates within it. It would have relative motions and flows to it. We partly observe it as the Zero Point Field. It would be a preferred reference frame. Other present-day theoretical/ hypothetical background fields are the microwave background, the Higgs field, dark matter, dark energy, gravitons, quantum foam, etc.. Any background reference frame could theoretically negate special relativity. If so the effects of special relativity would be replaced by Lorentz transforms, whose formulations are the same as special relativity but would be based on ether physics as Lorentz proposed. Like quantum mechanics, many of the concepts and predictions of special relativity and its mechanics would not necessarily need to change.

Within the realm where the proposed pushing gravity works similarly enough to pulling gravity that currently forms the foundation of physics, Pan Gravity theory would have no application difference. Because Pan Gravity is pushing and mechanical, and involves field pressure differences and flows, it is not irrotational and leads to vortices being produced, at both galactic and atomic scales. These vortices accordingly produce tangential accelerations as well as radial ones, but the tangential components are most recognizable at interstellar scales. These tangential accelerations, along with gravity mechanics, accordingly would explain the increased orbital velocities of spiral galaxy disk stars, and increased velocities observed concerning orbiting galaxies in a cluster, mostly in the same galactic plane.

3.1.1 Additional possible empirical support for this new ether comes from physical experimentation by Harris and Bush. Their experiments with mechanical, macroscopic oil droplets bouncing on water produced evidence of pilot waves, confirming previous work by Couder, and stable quantized orbits (Harris, 2014). As Bush explained, "this is a classical system that exhibits behavior that people previously thought was exclusive to the quantum realm, and we can say why" (Wolchover, 2014). Couder's previous experiments demonstrated that a combination of a bouncing droplet, the primary waves that it rides, and the pilot waves it generates can replicate the famous double-slit experiment (Couder, 2006). All of this shows that what used to be considered purely quantum mechanical phenomena can be produced and explained by macro-mechanics. This is not evidence of physical ether waves, admittedly, but it does lend credence to the Pan Theory (and De Broglie theory), or any concept or theory explaining quantum phenomena in terms of macroscopic mechanics. It was the asserted impossibility of physical waves to exist in the absence of a background field that lead the De Broglie theory to be discarded completely in preference for the Copenhagen interpretation.

3.2 Proposing a Single Force Theory

The Pan Theory is a single-force theory that is inherently mechanical: this single force is an unwinding force innate to matter, observable as the particle spin of fermions. This is the sole force which would be the singular cause of both time and motion in the entire universe. This 'unwinding and concurrent rewinding' is the cause of individual Pan forming into spring-like stands which eventually lead them to *mechanically link* to themselves (in a looped form). As these loops self engage they begin to spin because of their innate unwinding requirement, but not all of the loops that form are stable. Some have a tendency to spin apart, while others, because of their configuration, lengths, and type of attachments, stabilize. This process explains stable, unstable, and virtual particles. Such spinning spring-shaped looped particles when forced together during the great force involved in stellar fusion processes, can describe nuclear bonds within matter (the Strong, Weak, and Strong nuclear force), and when spins are opposite explain matter/antimatter annihilation, which in this model only involves particle-form destruction rather than substance destruction. In the case of nuclear bonds, the bonds are actual physical, mechanical connections of the nucleons with each other.

These springs engage each other mechanically upon stellar fusion of nuclei, and produce a spring-stretching resistance force when attempts are made to separate nucleons. When these connections are broken, the springs physically break violently much like strong macroscopic springs do when they rupture.

Therefore, the single force aspect of Pan Theory would explain the Strong, the Weak, and the Strong nuclear forces as simply mechanical connections of nucleons resisting separation. Gravity and Electromagnetism are explained by differences in field ether pressures produced by matter and Ferro-magnetic materials, resulting in ether flow that we have perceived as forces. The warped space of General Relativity would be explained instead as pressure differentials in a background ether field. The equations of Newtonian gravity and General Relativity or their applications, are changed to explain rotation curves of spiral galaxies, galaxies in a cluster, and the additional bending observed concerning gravitational lensing, as an additional bending diffraction, without the need for dark matter to explain anything. All effects presently explained by dark matter would instead be explained by a flowing ether caused by ether density variations, and where no unobservable dark matter would be needed.

3.3 Predictions, With Similarities and Differences to Other Models

The Pan Theory is based on the long-documented and widely accepted correlation between the distance to cosmological entities and the observed red-shift of their spectra. But unlike the standard model, space is not expanding (though, if matter shrinks, space would certainly appear to be expanding). Redshifts rather than being created by expanding space and stretching EM radiation were created by larger atoms in past timeframes where time ticked more slowly. Both aspects would produce redshifted, longer wavelengths of light from our perspective, from a far distant time frame. From this viewpoint, different equations were derived which match observations very much better than the Hubble formula, without the need for any ad hoc hypothesis like dark energy (Noble, Cooper 2014).

In terms of observations, what the Pan Theory predicts is that galaxies in the distant past should appear unexpectedly bright, condensed, and that the average observed size of objects should appear to decrease the farther back in time one looks, using the Hubble formula to calculate distances. Since distances are accordingly underestimated using the Hubble formula, the angular size of galaxies will appear to be unexpectedly small at the farthest distances, by many factors, but would appear to be unexpectedly brighter because they would be calculated to be much closer than they really are based upon Hubble formula calculations. Using the alternative formulations above in 1.9, instead galaxies in all timeframes should appear to be the same variations of size and brightnesses that we see close by.

The Pan Theory proposes that Black Holes are not vacuous singularities but are instead a more dense form of matter comprised of highly compressed ether particles, more dense than neutron stars. They, along with the background ether field, are accordingly the creators of all the matter in the universe, with minor possible exceptions. In terms of operation, the Pan Theory proposes that 'new' matter is being created surrounding Black Holes similar to the 'C field' (creation field, Hoyle) creation processes maybe similar to those proposed by the quasi-steady state theory, or otherwise created by the forces at the base, surrounding, and within galactic and stellar black-hole jets.

Like Halton Arp's original proposal, the Pan Theory hypothesizes that black holes can spin off pieces of themselves which eventually will produce a new galaxy, although it is not a theory requirement. The atomic particles of electrons, positrons, and protons are accordingly created by the above processes, with no Big Bang or original creation process. Anti-protons are theorized to be short-lived particles like free neutrons, unless their spin is somehow continuously reinforced. The lack of antimatter in the observable universe is explained by antimatter being mechanically unlikely to remain stable in the first place (particularly anti-protons) —going against the unwinding force inherent to Pan—and having a much shorter half-life.

As collections of individual Pan become smaller in size, they become longer in length, and eventually spin off pieces of themselves, or are pared off by particle interactions, the pieces again becoming part of the background ether. This would partly explain the zero-point-field, with more original matter-creating processes being involved. Phenomena such as virtual particles and hypothetical quantum foam would be explained as temporary combinations of Pan that mechanically engage and disengage. In effect, quantum phenomenon that are currently described as 'simply happening' without cause, would have almost classical mechanical explanations as to how they occur; for the most part, stochastic quantum mechanical equations would remain as an accurate description as to the frequency these phenomena will occur, as well as many other successful phenomenological equations of Quantum Mechanics.

One of the alleged philosophical weaknesses of most steady-state cosmologies was that they lacked initial conditions, invoking infinity forwards and backwards in time. Prior to the BB this was more-or-less accepted almost as a matter of faith, but the BB model did have the advantages of more reasonably explaining the observations of the time and proposing a beginning to an finite universe. Likewise, the Pan Theory similarly proposes an initial condition: at some point in the distant past, there was but one single Pan Particle which contained all of the matter and volume of the entire universe. Yet, relatively speaking, this original Pan would accordingly have been identical in every way excepting its relative size, to every other single Pan which makes up all matter today. The difference between this and the conventional universal mono-block of the BB model, in essence, is that if one had a set of 'magical scales' to measure the matter of the initial state in BB cosmology the mono-block would have been extremely massive, while the Initial Pan, to coin a term, would have been smaller than an electron: any measurement system has to be relative to the units that make it up, and even electrons would accordingly be made of huge numbers of Pan. This perspective of the Pan Theory involves an additional "simple" theory of relativity, involving the relativity of the size of matter to time. Matter and space would have been relatively larger, velocities would appear to have been greater, and time would appear to have been slower in past time frames.

This, and the diminution and progressive increase in the numbers of this first Initial Pan, establish the foundation for the rest of the Pan Theory's cosmology, although there are different possibilities concerning exact details of Pan mechanics. The rate of this diminution and number of "doubling cycles" dictates the age of the universe, and the diminution itself affects the observed size of matter, masses, and times concerning distant observations. One of the principal authors of this paper has calculated that the maximum rate of the proportional loss of size in atomic matter is approximately 1/1000th part every eight million years. This small amount accordingly explains the redshifting of cosmic entities. Hence, every eight billion years (note that diminution is continuous and therefore must use an exponential function rather than a linear one) an atom has half the volume and substance it once possessed and, overall, there are twice as many Pan in the cosmos than there was about 8 billion year ago (which is a reduction in diameter of about.794 (1 over the cube root of 3) about every 8 billion years. From this, it is clear that the Pan Theory predicts a far greater age for the universe than conventional BB models. Indeed, the age could be 'functionally' infinite since there is no effective way to estimate the bounds of the cosmos beyond the observable universe. Unlike previous steady-state theories an initial state and beginning is proposed; no infinities would exist in the Pan Theory. It would be a model whereby we are "lost" in both time and space.

One important difference between the expansive and diminutive interpretations of observations is that in the Pan Theory, galaxies do appear to be moving away from each other but new galaxies will eventually form in the spaces so opened up, resulting in a relatively steady-state appearance and densities. While galaxies are moving away from each other, they are only doing so at a relatively minor pace. Mutual gravitational attraction causing the formation of cosmological structures such as galactic superclusters and filaments, the same as in the standard model, but there would have been a much greater amount of time for such galactic structures to form. Large voids may be created in this model by a number of hypothetical occurrences such as burned out or exploding galaxies, and again there is much more time available for their formation. As matter would slowly radiate outward from a starting point such an exploding galactic core, or a dissipating burned out galaxy, new galaxies would form from this outward moving matter leaving large expanding voids as the origin of an ancient galactic parent.

4. Conclusions

It is the opinion of the authors that the merit of any theory can be judged on the summation of reasonable criteria: We propose four in our short summation.

1. A theoretical model should be able to explain all observations and predict the outcome of experiments over time, with a minimum of ad hoc additions or adjustments.
2. Within its scope, a theoretical model should be able to make predictions agreed upon by a consensus of its practitioners, rather than many different practitioners proposing different predictions and outcomes.
3. New observations and analysis should tend to confirm the model, rather than requiring the model to be regularly adjusted.
4. One or more methods to disprove the model should be agreed upon and proposed by a consensus of its practitioners.

Considering both the conventional BB model and the proposed Pan Theory model under these considerations, it appears to the authors that the Pan Theory could have some distinct advantages over the BB model in places where the BB model is demonstrably weak. It can be argued that the BB model has *ad hoc* alterations and additions due to regular observational contradictions of the model. But on the other hand the same observations that seem to contradict the BB model support the Pan Theory. In observation and natural experiment, then, radio astronomy often sees the farthest. Future observations of the most distant galaxies by radio telescopes, especially by extremely capable and newer ones such as the James Webb Space Telescope or the ATACOMA array, have the potential to confirm or deny the Pan Theory, other cosmologies proposing an older or infinite age universe, or the BB model.

Three observations, in particular, could make the distinction of validity:

1. **Galactic density:** an expanding universe should have evidence other than red-shifting. The galactic density of past epochs should be able to determine whether the universe is expanding or whether matter is getting smaller and 'filling in the gaps.' In an expanding universe, past epochs should have had galaxies more densely packed than they are now. In the Pan Theory, density should remain roughly constant no matter what epoch is observed, although density would appear to have been less since distances would appear to have been relatively greater in the past.

2. **The Dark Ages epoch:** according to the BB model, there should be a horizon beyond which we can observe no galaxies because there are no galaxies for us to observe, since they had not formed yet. This should also be a relatively hard limit; before it in time there should be the beginning luminous galaxies and after it nothing, rather than a weakening in luminosity until there is eventually nothing, as that would suggest some other possible factors, such as the imperfect transparency of the intergalactic medium, being responsible. The Pan Theory instead expects a gradual weakening in luminosity until the opacity of intergalactic hydrogen and dust establish a 'foggy' horizon.

3. **Galactic evolution:** the composition and structure of early-epoch galaxies will be a deciding factor between the BB and steady state models. The very first galaxies should not be large, well-ordered elliptical or spiral galaxies with a wide range of Population I stars with high metal-

licities. They should be small, blue galaxies of Population III stars. The Pan Theory, alternatively, expects some galaxies to be mature-looking and complex no matter how far back in time one looks until they are finally obscured by the dust horizon.

One of the biggest problems for those proposing the Pan Theory is that BB practitioners are using different formulas for calculating distances and brightnesses and therefore would be expected, according to the Pan Theory, to misinterpret distant galaxies as being smaller, denser, and brighter than what they really were.

Observations along these lines are already causing uncertainty amongst practitioners, as can be seen from the reference observations listed below. The authors expect that these challenging observations to the BB model, will continue in greater numbers as new telescopes of all types identify even more distant cosmological entities, a portion of which will continue to appear old. They further predict that the BB model may be seriously questioned—in terms of an active search for an alternate model—within three years following the proper placement and functioning of the James Webb Space Telescope, if the trend in observations holds true. Before an attempt is made to add an additional hypothesis to the Big Bang model to greatly increase the age of the BB universe based upon contradicting observations, it is hoped that the Pan Theory may be better known by that time and considered an alternative possibility. In the meantime, it is hoped that the theory may become known for its many different predictions, and in particular that of continuous anomalous observations of large, old appearing galaxies at ever increasing distances and that its distance and brightness equations will be tested and confirmed by many others, as it was by the authors concerning hundreds of type 1a supernova in their prior research.

Further Explanations

For any cosmology when one is first exposed to the theory, despite all explanations given, there will always be many possible remaining unanswered questions that cannot all be thought of, addressed, or answered in a single paper. All readers are encouraged to ask the authors questions concerning any and all remaining questions they may have regarding this paper or related theory.

Responses

Please contact the author Forrest Noble at pantheory.org@gmail.com. He will be very happy to answer any questions, consider corrections, and comments. If you are interested in testing the equations on page 98, have new or different insights, or need additional explanations concerning this paper or the alternative cosmological model, the authors are willing to discuss this.

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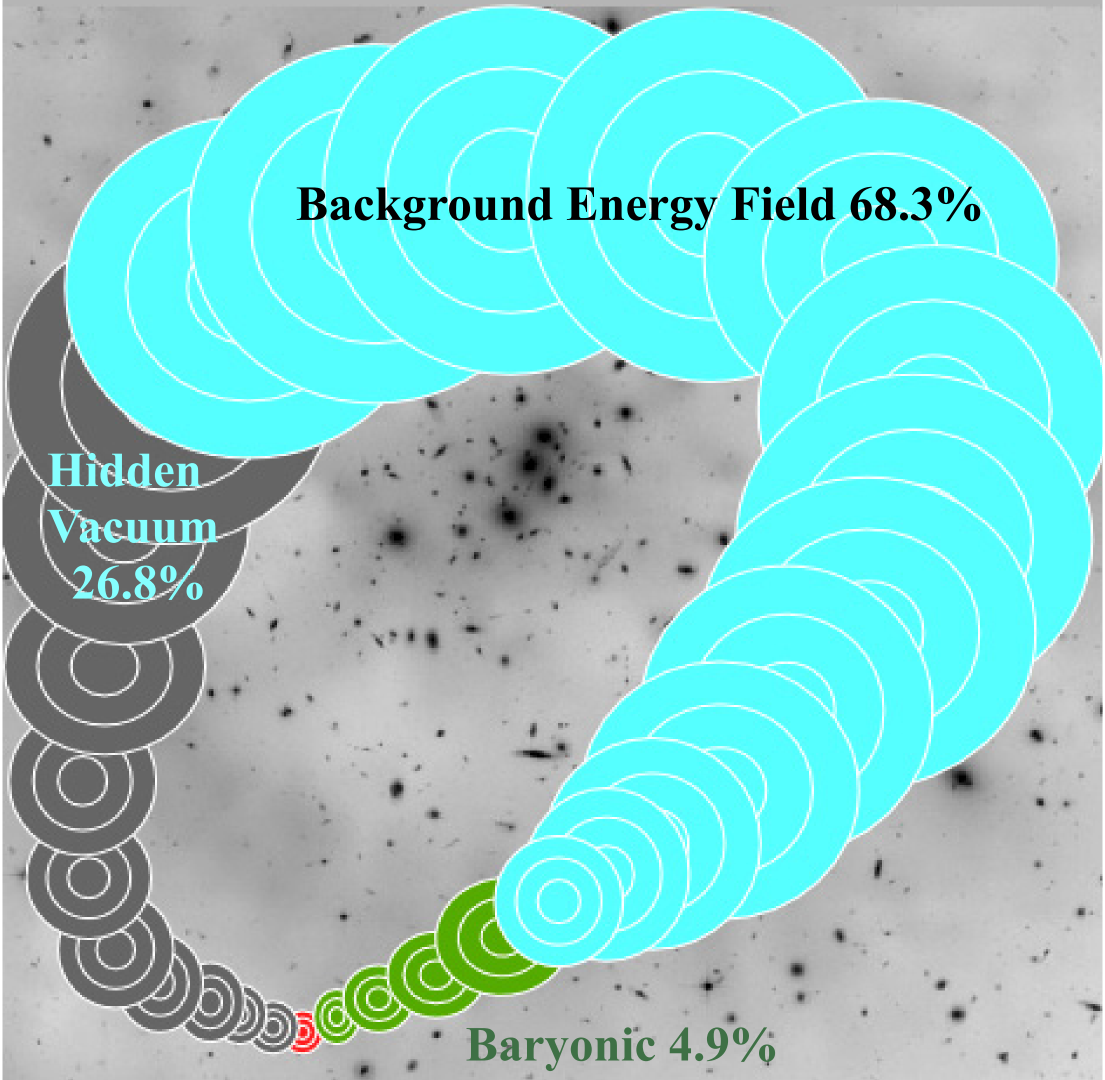

The Puzzle of Planck Mission

HUBBLE-INDEPENDENT PROCEDURE CALCULATING DISTANCES TO COSMOLOGICAL OBJECTS

J. E. Mullat *

Abstract. Our findings confirm Planck's satellite data on the composition of the Universe, based on which some predictions were made regarding the dynamics of the Universe in its past and future. On the same basis, a new procedure was developed for calculating distances to galaxies without the use of Hubble's constant. Then, the procedure for calculating distances was compared with the luminosity distances and the Hubble's law diagram, as well as with an alternative method for calculating distances linearly dependent on the redshift. Luminosity and Hubble's law distances for comparative analysis were found in the NASA/IPAC Extragalactic Database (NED), which is operated by the Jet Propulsion Laboratory, California Institute of Technology, under contract with the National Aeronautics and Space Administration. *"NASA/IPAC Extragalactic Database (NED) is a master list of extragalactic objects for which cross-identifications of names have been established, accurate positions and redshifts entered to the extent possible, and some basic data collected."* The results contradict rather than support the use of the Standard Cosmological Model.

Keywords: *Universe Composition; Quantum Vacuum; Red Shift; Visible/Baryonic Matter; Background Energy-Field*

1. INTRODUCTION

As far as the laws of mathematics refer to reality, they are not certain, and as far as they are certain, they do not refer to reality. Albert Einstein

The essence of this story is that our Universe could have formed from the gravitational—"background energy-field", which is considered as a qualitatively new form of matter. The gravity of the energy field is the fundamental basis of the world, generating vacuum voids and various anti-vacuum elementary baryonic particles. This leads to the fact that so-called gravitons continuously appear and disappear in it. If the strength of the gravitational field exceeds a certain level, gravitons can undergo a phase transition and turn into real particles.

From this point of view, the entire universe was filled with energy-field in a stationary but excited energy state, much higher than the current one. This state of matter is called *energy-field*, which has tremen-

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dous potential, but latent energy. As a result of a quantum leap, it passed into another, less excited state—*quantum vacuum*, then into baryonic matter, and then all of its energy was spent on the formation of the visible Universe. In this case, the quantum jump presumably comes from a strongly super-cooled symmetric phase below absolute zero. The result was an exponentially fast inflation of the universe. Before the quantum transition, the potential energy of the energy-field was incredibly high, but after that it turns out to be less.

During the quantum transition of the energy-field from one state to another the newly created space breaks simultaneously neither isotropically nor homogeneously up into quantum voids of vacuum and baryonic, i.e., visible matter in the form of quasars, galactic clusters, jets, flux, etc. The volume of the Universe becomes such that its distant parts turn out after inflation to be completely disconnected (Zeldovich et al., 1982), and each part of it will develop in its own way. Some will expand indefinitely, some will pulsate, some will contract and re-enter a state of high-energy; then restart new quantum transition again and generate new galaxies again. The newly created space in the inflation phase is very similar to the Big Bang, but it is not, because the newly created matter will be at rest but not in the state of an expanding ball.

Like raisins in dough, additional pockets of matter began to appear continuously in the dough, gradually layering the growing and created new dough. Simultaneously and in parallel in all the places around the Universe the energy loss of atoms in the dough were accelerated as the radius of the space filled with matter increased. We can thus assume that in space, as in a puff cake, the voids of the vacuum were gradually filled—the more vacuum was engaged in matter creation, the more energy from the outside came to the formation of new matter. The average energy density of the new space, however, decreased due to the loss of energy by atoms although the more energy as a whole was accumulated in due to the new space filled with matter.

The quantum transition of energy-field into matter can be explained by the assumption that first matter was formed with atomic distances inside the atoms of matter with a large extent. Electron's further from the nucleus are held weaker by the nucleus, and thus can be removed by spending less energy. Thus, the dynamics of EM energy can be expressed using the formulas of quantum mechanics, assuming that the release of energy of atoms was initially small, and then the release of energy from atoms (atoms aged) gradually increased as new spatial voids layered. Consequently, light waves coming to us from the distant past should be shifted towards the red side of the visible spectrum.

It is also known that the primary heterogeneous in the *phase transition* of one form of matter to another sometimes lead to secondary heterogeneous in the secondary matter that is formed. Thus, we can then assume that, taking into account a contradictory, perhaps provocative hypothesis about the *gravitational transition* (Caldwell et al., 2005) of matter accompanying this transition by adopting a postulate of newly created particles of matter, which can be physically associated with different internal/intrinsic redshifts of areas of the same atoms that are formed simultaneously. The last statement, probably, justifies, Halton Arp (1966), assertion about the possibility of physical coexistence of cosmological objects with various redshifts in physical vicinity from each other inside so-called peculiar Arp's Galaxies.

As noted by Larry Abbott (1988), regarding Standard ΛCDM Model, cf. Bradley & Ostlie (2007) or Keel (2007), *"According to theory, the constant, which measures the energy of the vacuum, should be much greater than it is. An understanding of the disagreement could revolutionize fundamental physics"*. For the novel Γ-equation distance calculation, based on hypothesis of a gravitational transition of *energy-field* into *quantum vacuum* and *baryonic matter*, we use a similar Λ-constant, however, with only three parameters including Λ. In these somewhat novel terms of space dynamics in the Universe, we are comparing the Γ-equation calculations regarding the distances +over/–under estimates. In connection with this, the space-layering postulate is a fundamental element of the Γ-equation. We use the parameter μ of the average energy density of space, which must, by this assumption, constantly decrease.

One may wonder how the expanding postulate fits galaxies having the spectroscopic blue-shifted lines, such as the Andromeda galaxy. Is the light from Andromeda coming from the future? This paradox from the expanding perspective can be explained that astronomers cannot observe the effect of space expanding in neighboring galaxies. Instead, astronomers observe the relativistic Doppler effect, which dominates the expansion effect. This explanation of the redshift/blueshift indicates the dual nature, cf. Gupta (2018), of the parameter $1+z$. Most astronomers believe that Doppler effect is the correct answer, because they observe galaxies in the neighborhood. Few others rightly emphasize that the Doppler effect is not the correct answer, which has nothing to do with the reality, in particular when applied to cosmological objects located far away, thus having high cosmological redshift values.

Beyond a Reasonable Doubt, modern cosmology is undergoing a significant shift since many renowned scientists participate in revision of the general theory of relativity of space and time (Jones & Lambourne 2004; Copeland, Sami & Tsujikawa 2006; Gradenwitz 2018). The departure from the SM and the accepted view of the origin of Universe is driven by the realization that the theoretical predictions based on universal gravitation laws do not correspond to observations at a large scale, i.e. at cosmological distances and locations. The distant parts of the Universe, which we could observe on a large scale, for centuries, however, had, on average, a homogeneous and isotropic structure. Encoded in cosmology according to the Copernican principle, parameters such as energy density, brightness, etc. should be the same at all points and in all distant directions. The laws of gravity, provided that the Principle presumably corresponds to reality, will cause an unimpeded contraction of matter. In contrast, according to Adam Riess et al. (1998), Saul Perlmutter et al. (1999), gravity is not slowing down but actually speeding up the expansion with acceleration [i]. Indeed, many researchers are arguing that observations do not confirm the expansion (Lerner, Falomo & Scarpa 2014; Lerner 2018). Some others, including J.G. von Brzeski (2018), are trying to disprove the expansion theory in general. While our goal is not to challenge conflicting or odious views, in this study we still look at the evolution of the universe from an *"expansion / growth"* perspective. In contrast to the SM, growth is postulated simultaneously with the disappearance of the *energy-field* regions due to the creation of a new static space, which, in turn, experiences a decrease in energy density. Our initiative shows that this growth of the newly created static space is manifested through the quantum vacuum as primary and baryonic matter as secondary, both of which pass through a gravitational transition from an unknown energy-field or ether, called also the zero point-field, quantum foam, gravitons, etc., into new space composition of growing three-dimensional spheres—manifolds S^3.

Hence, we hypothesize that a new space must emerge as soon as the space stable state has been established, since the old space composition violates the Γ-equation stable state criterion; cf. a) Mullat (1995), definition 2, p. 202. Based on this premise, the previous stable state violates itself, resulting in the creation of *"new space"*. This newly created space—a manifold in space—on average, as a whole, achieves a lower *"density of energy"* μ compared to that of the previous state. This violation arises due to such as latent *"gravitational energy forces"*, or any other energy form, induced into the manifold, providing a theoretical foundation for a stable states evolution as the dynamics of the Γ-equation roots. For this reason, in accord with the postulate of space layering, the declining density μ not only serves as an indicator of space creation, but also allows the time scale component of the space-time metric tensor—typically established by the t parameter—to be replaced by μ. While this is a far-reaching and highly unconventional assumption, it promotes a more diverse perspective on the dynamics of the space and energy evolution in the Universe. In view of the aforementioned assumption, the time variable in the time-space tensor will be omitted from all further considerations.

According to the NASA statement about the acceleration of visible Universe, for any alleged observer located at any point in the Universe and at any local time schedule in the past, the growth was slower than it is today. This statement by NASA invisibly hides the fact that the solutions of Γ-equation do not contradict NASA predictions about the dynamics of the universe in general. Yet, the math shows that Hubble constant is not a constant at all. In the past, perhaps, the value of Hubble constant was much lower than it is now, and it will be increasing in future. The question arises: what astronomers call dark matter (hereinafter—the quantum vacuum or something else—vacuum or matter), explains the contradictory characteristic features of the dynamics of baryonic matter, does such a Hubble constant refer to a quantum vacuum? Making this supposition, we found that, in the death phase, when the energy-field of the Universe will be almost exhausted, the dynamics of quantum vacuum in terms of *Dark Hubble Constant* will change its nature—the acceleration of the quantum vacuum area size will slow down. In contrast, the baryonic matter will still continue to expand its occupied area with acceleration by growing as usual the area extent and dimension with acceleration, like a window or bubble amid energy-field.

It was simple, to calibrate the Γ-equation of quantum vacuum and baryonic matter, as well as energy-field composition manifested by the equation, in order to match the 2013 Plank Mission satellite data. By solving the Γ-equation, it was possible to achieve 100% of exact co-occurrence between the obtained percentages of baryonic matter and quantum vacuum (dark matter) in their proportions to the background energy field and the latest data (Ade et al. 2013; Francis 2013; Clavin 2015). Second, our space/energy gravitational transition model supported the BB inflation phase. Theoretical foundations show that solely the quantum vacuum, cf. Tentanen 2019, first inflated three-dimensional manifolds S^3 embedded in the globe $\Re^4$. Third, it is predicted that, after the inflation phase, as the manifolds S^3 expanded, its average energy density μ decreased, while volume-growth accelerated. This prediction was supported by the Γ-equation, the roots of which confirm that the manifolds initially expanded more slowly when the energy density was high.

Drawing upon the study pertaining to average density of energy parameter μ, it was possible to subject NED distances to a series of linear and non-linear transformation into a certain interval of densities. This interval confirmed with very high degree of reliability that it is feasible to describe the events in space with density μ by establishing a match to a number of distances to extragalactic objects collected in NED database[1]. We further posited a critical value κ of the density at which the gravitational/energy-field will be exhausted. We denote this event as the origin of density scale, i.e. the *"moment"* when the globe $\Re^4$ would allegedly collapse into *"standstill"* composition with critical density state. The Standard cosmological Model also supports a very high likelihood of such an event. We also confirmed some of NASA statements regarding the past evolution of the Universe.

Before we proceed with our analysis, we wish to outline the structure of this study, which is presented in 8 sections, including introduction—Section I. The section II might be helpful for understanding the mathematical foundation of our technique. In Section III, we present plausible/preliminary exercises by describing hypothetical energy-field undergoing a gravitational transition into quantum vacuum and baryonic matter on the basis of our geometric model. Applying initially the postulate of the gravitational transition of energy-field at distances almost equal to the Planck wall, in Section IV, the growth of space further on is a consequence of the postulate that is associated with a triplet of real parameters Λ, λ and μ in the form of a Γ-equation. We proceed further in Section IV dedicating our efforts to the energy density scale con-

[1] https://ned.ipac.caltech.edu/classic/forms/byname.html (accessed 29.06.2018).

struction, which is achieved by fine-tuning or calibrating latter triplet with regard to the current mass-energy composition of the Universe. In section V—the results—we consolidate the roots of the **Γ**-equation with the data pertaining to cosmological observations of 15000 Extraterrestrial objects collected into **NED** data[2]. Table 2-4 and Figure 5 present the data analysis summary. After the discussion in section VI, we provide some concluding remarks in Section VII. In Section VIII, we present mathematical derivation of three-dimensional series of manifolds S^3, which, in accordance with our initial hypothesis, are inflated with space. We illustrate in the Appendix the gravitational transition of energy-field by presenting our stereographical projection of the series S^3 of manifolds into Euclidian static space E^3. It should be noted that our model confirms rather than disproves the NASA statements of Universe dynamics, which are based on the past and current observations.

In conclusion, we should note that part of the material in our study, including Figure 1, as well as all the conclusions in the Appendix that led to our theoretical **Γ**-equation including our own mathematical derivation, which according to the result corresponds exactly to the metric of space, not so well-known in the literature (§108, p.336, *"Classical Theory of the Field"*, Landau & Lifshitz 1971, English edition), have already been published in the public domain, b) Mullat (1971).

2. Preliminaries

Suppose we pointed our telescope toward some portion of three-dimensional sky on which we superimposed a grid cell. By analyzing the characteristics of the light ray reaching us, we would allegedly be able to estimate the *number* of photons, electrons, and all atoms of various types of matter, including galaxies, in those particular moments when the ray was emitted. Once the process is complete, we can focus

2 Received the data with kind permission from Ian Steer.

the same telescope on some other part of the sky. Assuming that the Copernican Principle is true, we can expect to obtain similar results when observing parts of the Universe at the same distance from our observation point in any direction. Such *measurements* will be particularly useful when the observations made are incompatible with Newton's dynamics—i.e. the measurements made at cosmological distances. In this scenario, the key challenge is to compare the energy densities of space measured at nearby and faraway distances as indicators of the layering dynamics of space and matter in the Universe. This type of measurements at cosmological distances can allow events to be described by the average energy density μ using the reciprocal relationships of events on the energy density scale.

By analogy with the postulate of the aging of atoms, it would be instructive to make the following remark from the barmaid standpoint. We often see a sheet of paper burn out. If you start burning the sheet somewhere in the center, you will see that the front of fire will gradually spread out from the center, covering new areas, turning these areas into ash. By observing the combustion process somewhere inside the ash, it will be possible to measure the temperature of the gradually cooling ash and, on the basis of this measurement, determine how far away from the observer certain cells of the ash are.

Yet another barmaid remark is also useful. Indeed, on Earth nuclear physicists can similarly determine the age of a material by noting the average number of atoms that have undergone radioactive decay. Using this approach, geologists can establish the age of a rock by observing unstable atoms undergoing a decay, recording the half of the atoms still present in the rock and comparing samples that have undergone the decay—referred to as radioactive half-life. Let us assume that we are able to count not only the average number of atoms undergoing the decay, but establish an exact number of atoms belonging, for example, to an Sn isotope in a rock. Let us further assume that we can do so with a high accuracy by taking into account every single atom remaining after the decay. Clearly, we cannot perform such an experiment. However, we can establish the *quasi-number* of atoms remaining after the decay as some *quasi-events* equivalent to the age of the rock under observation. By examining different parameters characterizing the rock, such as size, temperature, etc. We can establish the *quasi-velocity* of these parameters by noting the number of atoms that have not yet undergone decay. In the same vein, we can establish the *quasi-events* in the Universe without recourse to the clock.

Returning to the earlier discussion on the observation of different parts of the Universe, we can also assume that the energy density μ of various particles (photons, electrons, neutrinos, galaxies, etc.) established through the observation of a nearby grid cell differs from that taken at faraway distances. We can now assert that, at nearby distances, the density in the grid cell is lower than that in the same cell when superimposed on parts of the Universe at faraway distances, representing their state at some point in the past. This assumption is in line with the Hubble's law rather than it contradicts the law. Thus, we can detect the age dynamics of the Universe using *energy densities* in these two locations, since regions with lower energy density (at nearby distances) have emerged during later events than similar areas characterized by greater density (at far away distances). Consequently, our aim is to emphasize that the energy density μ of energy can be chosen as an indicator of events in static space. Such an approach permits establishing the origin of time, whereby the density denotes time point $t = 0$ by $\mu >> 0$. Similarly, it will be possible to establish the future and the past on this scale, thus investigating the evolution of the Universe in terms of *energy density* instead of events on time scale.

Matter exists in four fundamental states—solid, liquid, gas and plasma—and can undergo a phase transition from one state to another. At normal atmospheric pressure, water is in solid state (ice) at temperatures below $0^{\circ}C$, whereby the liquid state symmetry transforms into crystal symmetry. In this context, it is noteworthy that a liquid can be cooled below its freezing point (known as super-cooling) without it becoming solid. Thus, when undergoing a phase transition to ice, water cooled below $0^{\circ}C$ can release latent heat (Murphy & Koop 2005). The same concept can be applied to gravitational energy, or whatever it is, as *"matter"* super-cooled under absolute zero ($0^{\circ}K$). This line of reasoning might prompt the conclusion that, in the Universe, a gravitational transition of super-cooled *"gravitational field"* into space occurred, releasing an extensive amount of latent heat. The space released by transition expands; however, elsewhere at the globe surface, a latent *gravitational/energy-field transition* might take place simultaneously.

Three-dimensional coordinates can be used to measure the ice floe linearly. Yet, the volume of water is usually expressed in liters, rather than in cubic meters, etc. Speaking, for *Creatures* in the form of ice crystals, the water undergoing a phase transition is supposedly invisible, as they can neither observe nor measure phenomena pertaining to liquid matter. They can, however, feel the latent heat or space creation effects. From the mathematical perspective, the quantum vacuum, the gravitational, or whatever energy form we choose to consider, the energy can undergo a gravitational transition from zero to a positive measure state. Being rooted in the theory of Probability, measure is a means of assigning a numerical value to every space volume that allows examining the union of volumes as a sum of their individual measures. The space or mass of matter is an example of such a measure.

In contemporary cosmology, as previously noted, the Universe do not correspond to Copernican Principle of a homogenous and isotropic space presumably characterized by uniform distribution of galaxies at each point and in all directions, etc. The Principle, however, acknowledges the universality of laws of physics. These laws are applicable in the Universe with the same precision because there is no point of reference (although any point within the Universe could be used for this purpose). It is correct to recall a two-dimensional surface for flat *Creatures*, like that chosen by Einstein (1916), implying that flat *Creatures* cannot imagine a three-dimensional world by walking on the flat surface of a manifold. This analogy seemingly suggests that we as three-dimensional *Creatures "inhabit"* a three-dimensional static space. In this space, we are still observing a three-dimensional unbounded Euclidian space E^3, being inside of a bounded manifold $S^3(r)$ of radius r, $0 \le r \le 1$, embedded into four-dimensional closed hyper-globe $\Re^4$ of curvature radius 1. All manifold points, idealizing the Copernican Principle, are equal in all directions, without a center or a terminal point. However, our view also accounts for departures (as shown in Zeldovich, Einasto, & Shandarin 1982) from the Principle, which as an absolute can never be realized in nature. Indeed, it is well known as already noted the primary anomalies in material undergoing phase or gravitational transition might result in secondary anomalies following the transition phase.

In the theory of choice, topology and some branches of social science, the emphasis is being made on the so-called Closer Operator, Pfaltz (2015). In this study, the closer operator is represented by constant Λ in Γ-equation to ensure new space creation dynamic. The constant Λ indicates the similar fixed-point stability of layering manifolds S^3, representing potential level Λ of the expected gravitational transition of the manifestation of energy-field. It seems that the Closer Operator mathematics introduces a novel idea in explaining the origin of the Universe.

To be more specific, our three-dimensional manifold of curvature radius $R = 1$—we prefer to denote it as a closed topology, i.e. a manifold S^3—comprises of a kind of energy-field that is not accessible to existing measuring instruments (akin to the *crystal creatures* not being able to use liquid measuring system in their solid world). As a result of some accident, at a given point within S^3, occurs energy-field gravitational transition into a seed lump of another form of space, which represents a transition of a 0-measure to a positive one. We emphasize that the lump of space formed from potential energy-field embedding the lump must preserve the stable or fixed point dynamic while undergoing rapid inflation from zero and progressing further, *like a hole growth* within energy-field similar to the discussions presented by Linde (1983a, 1984b). In short, the lump of space has to be in a dynamic Γ-equation with energy-field. The Γ-equation view on space dynamics is an alternative to SM, where the manifold curvature radius $R >> 0$ is time-dependent. In contrast, the curvature $R = 1$ considered here is constant. By making this assumption, we do not violate any mathematical foundations and do not try to dispute the postulates of rational science. Our goal is an alternative to the SM in order to give a reasonable interpretation of the paradoxes of astronomical observations.

The space creation singularity problem—the initial inflation phase, Guth (1997), of the Big Bang—has not yet been addressed. We argue that the singularity does not exist because our Γ-equation permits a zero solution. We thus postulate that, starting from a state described by the zero solution, the space suddenly inflates the infinitesimally small hole by seed of quantum vacuum in gravitational transition into static space from the aforementioned energy-field. The seed size might be not more of a size of a Planck wall. According to this view, when a *"lump of space"* emerges, it will impose an additional pressure on the previously allegedly *"super cooled gravitational energy"*, thereby causing an additional *inflating effect*. We further assume that this would give rise to additional space creation, akin to an *"avalanche"* rolling down the hill and gaining mass (and thus weight) due to *"potential gravitational energy of super-cooled energy-field."* According to our Γ-equation, the avalanche of the space creation has to remain in a dynamically stable condition. This assumption confirms that the gravitational transition of energy-field into quantum vacuum starts suddenly and will continue to progress if the *super-cooled energy* is of incredibly high energy density. After all, once the avalanche has occurred, it will govern the space creation inside the manifold. However, a *friable globe* cannot roll down a slope forever, as it would eventually crumble into pieces. While the *snow-globe dynamic* is just a barmaid-physics illustration of the space evolution, it is useful for depicting its initial and terminal state.

3. THE MODEL

In the continuation of our narrative, we combine some points to talk about the essence of the gravitational transition model in our understanding. Apparently, the reader could more smoothly follow our cosmological apparatus, which prompted us to more accurately disclose details that may remain intellectual speculations unless something similar does not reveal itself as a reality. In science, it is important, in which direction to move, so as not to be at an impasse. Mathematically, everything is in order here, since we will have rich computational capabilities and will be able to formulate a sufficient number of non-trivial predictions.

3.1. Pedagogical preface.

Consider a field W of high-energy environment consisting of 5 items $W = \{\alpha_1, \alpha_2, ..., \alpha_5\}$ or gravitons. There is no need to refer to these main ingredients $W = \{-5, -1, -1, -5, -1\}$ in any other way than, for example, to cells, particles, etc. Negative numbers conceal a latent energy below absolute zero or status of cells indicating that the high energy-field gravitational transition of the cells into space is potentially available. Positive values will indicate the fact of the gravitational transition into matter. Using these 5 cells, one can arrange subsets or compositions of cells where the process of transition completed, for example, 4 of which will be $X_{5,1} = \{5,1\}$, $X_{1,1,5} = \{1,1,5\}$, $X_1 = \{1\}$, $X_{5,5} = \{5,5\}$, etc. So, $|X_{5,1}| = 2$, in $|X_{1,1,5}| = 3$, $|X_1| = 1$, $|X_{5,5}| = 2$ point at digits of gravitons. Let's talk about, e.g., some high-energy indicators $\pi(\alpha, X) = \alpha \cdot |X|^{-1}$ of the gravitational transition into space cells. Numerical values $\pi(\alpha, X)$ are defined within indicated subsets X of cells. The negative index $u = \pi(\alpha, X)$, as a parameter in the form of threshold u may indicate enormous energy level when the latent energy is turning into positive value by supposition. In particular, $u = -\frac{1}{3}$ will indicate soon some phase transition constant, e.g., gravitational potential force or pressure, temperature threshold etc. Negative index points that transition is impossible but latent. Positive values will point at inverse situation – transition is potentially available. So, the potential gravitational transitions events with our high-energy cells may arrange the following lists:

$$\{\pi(\alpha, X_{5,1}\} = \{-\tfrac{5}{2}, -\tfrac{1}{2}\}, \{\pi(\alpha, X_{1,1,5}\} = \{-\tfrac{1}{3}, -\tfrac{1}{3}, -\tfrac{5}{3}\},$$
$$\{\pi(\alpha, X_1\} = \{-\tfrac{1}{1}\}, \ \{\pi(\alpha, X_{5,5}\} = \{-\tfrac{5}{2}, -\tfrac{5}{2}\}.$$

Given a list $\{\pi(\alpha, X)\}$, we consider the value $F(X) = \min_{\alpha\in X} \pi(\alpha, X)$ on each X. Turns out that $F(X_{5,1}) = -\frac{5}{2}$, $F(X_{1,1,5}) = -\frac{5}{3}$, $F(X_1) = -\frac{1}{1}$, $F(X_{5,5}) = -\frac{5}{2}$. In standard notation we can consider a kernel subset X^*, which satisfy a condition: $X^* = \arg\max_{X\subset W} F(X)$, where the subset X^* deliver the function $F(X)$ global maximum – the **min/max** problem.

Until now we have considered only 4 compositions. What if we look at a space bubble W or sphere of cells in the form of a 3-dimentional room, which e.g., consists of a 10^{215} cells. Then the number of gravitational transition subsets $X \subseteq W$ under consideration will be equal to $2^{10^{215}}$. Now our task at first glance will be *mission impossible* to find a kernel among all such a subsets on which the minimum of the function $F(X)$ is reached. However, the problem is solved simply.

Let us illustrate the solution on the example of our 5 cells $W = \{-5, -1, -1, -5, -1\}$. First, we need to arrange the cells $W = \{-5, -1, -1, -5, -1\}$ in descending order of α-numbers in brackets in the form $\langle W\rangle = \langle -1, -1, -1, -5, -5\rangle$. Then we will move along $\langle W\rangle$ from the left to right, examining the cells while moving along the arranged list of compositions $X_1, X_{1,1}, X_{1,1,1}, X_{1,1,1,5}, X_{1,1,1,5,5}$. We attach the cells one by one to each composition in the sequence, keeping in mind that the attached cell is undergoing a phase transition, until we fill in the whole composition $\langle W\rangle$. Consequentially, while moving to the right, the potential (or latent) gravitation energy indicators $F(X_1), F(X_{1,1}), F(X_{1,1,1}), F(X_{1,1,1,5}), F(X_{1,1,1,5,5})$ corresponding to the sequence $\langle -\frac{1}{1}, -\frac{1}{2}, -\frac{1}{3}, -\frac{5}{4}, -\frac{5}{5} \rangle$ are considered. The local maximum $u = -\frac{1}{3}$ is reached on the composition $X_{1,1,1}$, which is the solution to our problem of phase transition among all the 32 compositions. As promised, it is obvious now that an exactly the same algorithm among all the compositions in the bubble W of the size equal to $2^{10^{215}}$ works *"perfectly."*

Without prejudice to what has been said, looking ahead, we would like to note that in our cosmological model reg. distances calculations to galaxies there are similar functions $\{-\pi(\alpha, X)\}$, i.e. functions that increase (as negative) in accord of X growth: for example, the function of Newtonian gravitational potential function $-G\frac{M}{r(X)}$. The X is an interior set while $\overline{X}$ is the outside set: $X \cup \overline{X} = W$, $r(X)$ denotes the radius of X. The kernel X^* in our pedagogical nomenclature will then be, once again, where the function $F(X) = \max_{\alpha \in X} \pi(\alpha, X)$ reaches its maximum, cf., Mullat 1971.

3.2. General considerations

So, let a certain field (e.g. Gravitational energy-field) W be given in which the field folds can pass from one state to another. It does not make a difference at first what these states are. It is important that there are two states, two phases from which the high-energy cells W are folded. Each cell can be in two states—matter and energy, i.e. the cells can transit from the energy to matter and back.

Since this view on the field W is taken for something real or reasonable, it is very natural to consider the set 2^W of all subsets or high-energy cells W in which the gravitational transition can happen, and let them be subsets of cells acting as cells compositions $X \in 2^W$, $X \subseteq W$. Such an abstraction in the notation represents the most common standard in set theory.

However, not being an experienced high-energy physicist and having no idea how a high-energy gravitational transition takes place, it can still be assumed that all cells $x \in X$ represent a potential transition from latent gravitational energy states to a materialized state, while all those cells $\overline{x} \in \overline{X}$ that are in a state of potential transition as some candidates are only labeled as such. The set $\overline{X}$ is the part of W unfilled by cells from X. Shortly speaking $X \cup \overline{X} = W$ or $\overline{X} = W \setminus X$.

Now we need to say a few words about what we are going to consider for the compositions of cells X. In theory of measure we consider some *"good"* subsets of cells that can be measured: such as having mass measured by weight in kg^1, volumes in m^3 or liquids in lt^1 or galloons of gas, energy density in $j\_s \text{ per } kg$, etc. The starting point of the theory of measure is the probability theory. We not accidentally talking about probability, since it is very natural to link the high-energy gravitational transition of any cell $\alpha \in W$ with the certain *"quantum probability"* $\pi(\alpha, X)$ that the gravitational transition will occur as a subject of the transition itself. Note that the probability estimates $\pi(\alpha, X)$ may be defined on W but inside X. That is, we consider a set or a family of parametric functions $\{\pi(\alpha, X) : X \subseteq W\}$ consisting of $2^{|W|}$ individual functions dependent on a parameter X in the form of a subset of cells in the aggregated high-energy medium of measurable cells W. It is possible that some kind of quantum effects can play a role here, since this is about probability.

Now, we reached the most important point. Suppose that in the aggregated high-energy-field W the cells are characterized by a certain distribution functions $f(\alpha)$, $\alpha \in W$, or whatever we want to interpret these functions. These functions may be some initial force acting in the cell α like temperature, pressure, etc. We cannot imagine or say more, but the following phenomenon is important. For example, we can associate this function with some estimate (not with the probability but a gravitational transition process itself), for example, by setting $\pi(\alpha, X) = \dfrac{f(\alpha)}{|X|}$, where $|X|$ it is weight, volume, etc., which aggregate cells X. We can also supposedly associate this function with some threshold u when the gravitational transition occurs. Such functions can be constructed in order to satisfy many conditions but one mandatory condition, which is characterized by the so-called monotonicity property. Indeed, suppose we consider two subsets of cells L, G such that $L \subseteq G$, then the following monotonicity property should hold: $\pi(\alpha, L) \leq \pi(\alpha, G)$ for all $\alpha \in L$.

Finally, we meet the main assumption. Based on the proposed scheme for any set of cells $X \subseteq W$, we have a certain probability function on the anti-gravitons $\bar{x} \notin X$ that are outside X of the indicated by using the function $\pi(\bar{x}, X)$ of the probability of a gravitational transition in an outside cell $\bar{x}$. Suppose that the gravitational transition is determined by a certain threshold value u of the function $\pi(\bar{x}, X)$, namely: in the set X the gravitational transition can take place only if $\pi(\underline{x}, X) \geq u$, while for $\bar{x}$ out of X, it can be $\pi(\bar{x}, X) \geq u$ either $\pi(\bar{x}, X) \leq u$, in the latter case the transition cannot take place. A similar view on gravitational transitions gives rise to the display of subsets in two equivalent aggregate compositions of cells W:

$$V_u(X) = \{\alpha \in W | \pi(\alpha, X) \geq u\}, \text{ or } V_u(X) = \{\alpha \in W | -\pi(\alpha, X) \leq -u\}.$$

In theories, speaking of mappings, we always are interested in the so-called fixed points, (i.e. fixed point theorem of Brauwer). In our case, we will also be interested in fixed points of mapping $V(X)$, i.e. such subsets X of cells of the field:

$$V_u(X) = X. \Leftarrow \Gamma\text{-equation}$$

Given a sequence $X_0, X_1, \ldots X_i, \ldots$ such that $V_u(X) = \lim_{i \to \infty} X_i$, $X = X_0$. $X_0 \subset X_1 \subset, \ldots$ it is simple to figure out what these fixed points $V_u(X)$ of mappings are. Perhaps $V_u(X)$ is a state of space or the high-energy state of the field when the phase or gravitational transition process stopped, etc. We claim that **Γ**-equation in our cosmological model devoted to distances calculation to galaxies corresponds to a fixed point in terms we just have been described. For some researches this terminology in choice theory represents so called closer operator $V_u(X)$ performed on X.

3.3. *Summary*

The fairy tale that we have just told is irrelevant to reality, but it can become one if we can formulate what a high level energy-field W might be, for example, it could be a cylinder, a globe, a surface of a globe, etc. In our findings calculating of the distances to galaxies we were able to define the field W as a stereographic projection of the diverse surface $\mathcal{S}^3$ of the globe $\mathcal{R}^4$. Functions $\pi(\alpha, X)$ were chosen as the potential energy $-\frac{G \cdot \mathcal{E}}{c^2 \cdot \rho^\lambda} = -\frac{\mathcal{E}_{\text{rel}}}{\rho^\lambda}$ like the gravitational potential, where the radius ρ of the Universe was given in terms of the stereographic projection of Landay-Lifshitz metric space, which is actually an Euclidean space E^3. A separate element outside our visible Universe can be interpreted as an element of energy-field, undergoing a potential gravitational transition into atoms, or whatever high level energy baryonic particle like leptons, neutrinos, etc., when the high energy cell undergoes a gravitational transition into cells α of baryonic matter. The parameter threshold u at which the gravitational transition presumably occurs is set to a constant Λ. However, above, until now, the parameter was defined as a variable u. This contradiction is simply solved by introducing an energy density μ parameter of the cell α. Now it's clear which parameter Λ or μ—the threshold parameter or the energy density parameter—should be a variable parameter and which should become a constant.

Of course, more natural is to set the energy density μ as a variable parameter leaving some constant value behind Λ. The μ parameter will make it possible to find the total energy $\mathcal{E}_{\text{rel}} = \mu \cdot V.\mathcal{S}^3(\rho)$ of the hyper-manifold $\mathcal{S}^3(\rho)$; mathematical derivation in the Appendix. This is an important decision, since it allows building an energy density scale μ using some extents of the redshift z. However, when performing simulations by trial and error with the NED database, it would be prudent to replace the μ parameter by a decay function $\mu \approx 1 - \left(\frac{1}{2}\right)^Z$.

4. THE TALE OF THE SPACE CREATION

Our knowledge of the Universe is limited by the horizon of observations. This horizon is determined by the speed of light, whereby we can only observe those areas of the Universe from which the light has already reached us. Hence, we do not see the objects in their present state, but rather in the one in which they were at the time of the emission when the ray of light has reached us at the moment of observation. In view of the foregoing, it is assumed that the universe can be described in terms of some geometry, the main characteristic of which is the distance r to some point in the universe, regardless of whether the ray of light has reached the point or where the point is located.

Conceive a globe; say $r = 1$ m in radius and some black paint. Suppose that the black paint is a space under creation undergoing a gravitational transition from some latent energy-field. Choose any point at the globe surface and draw a circle of radius r around the point, e.g. encircle the point as the North Pole N. Then paint the circle inside this perimeter with black paint. Increase the radius r and draw a larger circle around the N point and once again cover the newly created area with black paint. Repeat this process until you reach the opposite side—the south S pole of the globe $\mathcal{R}^3$. The entire globe $\mathcal{R}^3$ is now black.

4.1. Stereo-graphical projection of two-dimensional surface

We will proceed first with a very short illustration of what is well known as stereographical projection. Let the $\boldsymbol{S}^2$ manifold corresponds to $x^2 + y^2 + z^2 = 1$ of curvature radius 1. The North Pole corresponds to the point $N = (0, 0, 1)$, and the South Pole is denoted by $S = (0, 0, -1)$. Conceive Euclidian plain E^2 intersecting the origin $O = (0,0,0)$ perpendicular to the z-axis. We can project a line from N through $(x, y, z) \in \boldsymbol{S}^2$, which will intersect the plain at a distance ρ from the origin O. Using $\boldsymbol{S^2}$ geometry it can be verified that $d^2 + z^2 = 1$ what yields $d^2 = (1-z)(1+z)$. Now convert $\frac{d}{\rho} = \frac{1-z}{1}$ into $d^2 = \rho^2(1-z)^2$. For latter d's these d^2 yield $z = \frac{-1+\rho^2}{1+\rho^2}$, $d = \frac{2\cdot\rho}{1+\rho^2}$, which correspond to a stereographical projection, given by threefold projection/mapping $\left(\frac{2\cdot\rho}{1+\rho^2}\times\cos(\varphi); \frac{2\cdot\rho}{1+\rho^2}\times\sin(\varphi); \frac{-1+\rho^2}{1+\rho^2}\right)$ of two variable functions as a diffeomorphism $S^2 \to E^2$ into coordinates (E_x, E_y) on Euclidian plain E^2: $(E_x, E_y) = (\rho\cos(\varphi), \rho\sin(\varphi))$, $0 \le \varphi \le 2\cdot\pi$, $0 \le \rho < \infty$.

Let us finally find the metric of our stereographical projection drawn by Figure 1. The partial derivatives of the projection/diffeomorphism represent the Jacobin matrix J. The transpose of the matrix J is thus given by three functions of two variables:

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

Consequently, the Gram Matrix as the static space metric tensor

$G = J^T \times J$ yields $G = \frac{4}{(1+\rho^2)^2}\begin{pmatrix} 1 & 0 \\ 0 & \rho^2 \end{pmatrix}$ provided by Скляренко (2008).

Herby, our $\boldsymbol{S^2}$ stereographical projection on Figure 1 is represented by $dl^2 = \frac{4}{(1+\rho^2)^2}\left(d\rho^2 + \rho^2 d\varphi^2\right)$. We will refer later to substitution $r = \frac{2\cdot\rho}{1+\rho^2}$ representing the inverse part of the diffeomorphism of $\boldsymbol{S^2} \to E^2$ or $\boldsymbol{S^3} \to E^3$ stereographic projections, where dl^2 denotes the metric in the Euclidian plain E^2. This means that it will be possible to refer to manifolds $\mathcal{S}^3(r) \equiv \mathcal{S}^3\left(\frac{2 \cdot \rho}{1+\rho^2}\right)$, which are now given as a function of ρ radius coordinate, and not of the radius r but as a projection radius ρ onto the Euclidean manifold, Figure 1.

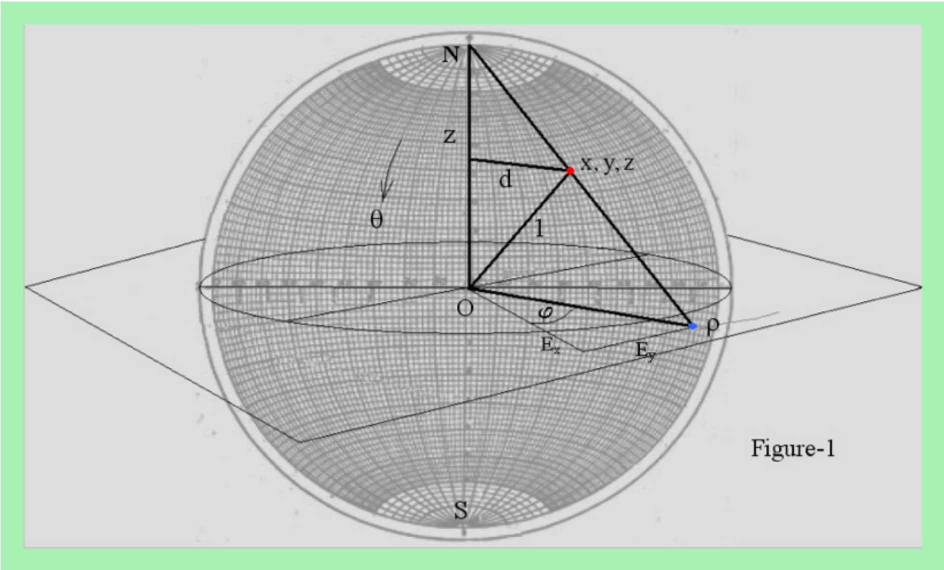


Figure 1: Stereographical Projection of the globe $\mathcal{R}^3$ surface $\mathcal{S}^2$ at Euclidian Plane E^2

4.2. Stereographical projection of three-dimensional surface

Unfortunately only a few people can conceive a four-dimensional hyper-manifold. However, the aforementioned process can be applied to a $\mathcal{S}^3$-dimensional manifold of the $\mathcal{R}^4$ dimensional globe. Around the North Pole as a reference system center, try to envision drawing an imaginary $\mathcal{S}^3(r)$ manifold given by polar coordinates of radius r, $0 \le r \le 1$. Our $\mathcal{S}^3(r)$ manifold is of a fixed curvature of radius 1. Fill $\mathcal{S}^3(r)$ with black paint—it will certainly take much more effort to fill this manifold. Proceed in similar way already described above for an ordinary globe $\mathcal{R}^3$ encircling point N until the whole S^3 surface of the $\mathcal{R}^4$ globe is inflated with black paint. Suppose that the black paint has density and that the painting process with very small radius r was triggered at the North Pole by some phenomena related to the energy-field gravitational transition. Assume further that the energy density of painting is linearly decreasing with the radius r keeping the curvature equal to 1. Moreover, suppose that outside the $S^3(\mathrm{r})$ manifold, the painting process on its boundary is governed by gravitational potential energy threshold level Λ like a gravitational transition of gravitational/energy-field at freezing level $-\Lambda^{\circ}\mathrm{K}$ depending on of the whole $S^3(\mathrm{r})$ manifold. We posit that the potential energy of the black paint at the boundary of $S^3(\mathrm{r})$ manifold is proportional to the total energy $\mathcal{E}$ of but the $S^3(\mathrm{r})$ is an inverse function of the radius r. Thus, the total energy $\mathcal{E}$ within our $S^3(\mathrm{r})$ manifold will be growing on average, i.e. following our supposition like painting creation at the freezing point $-\Lambda^{\circ}\mathrm{K}$, in proportion of order higher than the radius r of encircled area. Thus, in accord with the earlier assumption that the energy density of space will linearly decrease with r, the painting process of space creation, cannot be terminated or arrested because it should reach a fixed point status representing, as above, the so called closer operator which will manifest itself as a series of layering $S^3(\mathrm{r})$ manifolds.

In view of the last assumptions, the cosmic growth is governed by the energy density parameter μ of growing $S^3(\mathrm{r})$ manifolds inside energy-field region. We assert, however, that the space or matter creation will nevertheless stop at some critical density κ when the energy-field outside the $S^3(\mathrm{r})$ manifold is be exhausted, and the manifolds S^3 inflated by space will completely enclose the globe $\mathcal{R}^4$. While the aim of this exercise was to emphasize the importance of density μ of energy in the Universe, it is advisable to examine more technical details next.

4.2.1 Mathematical derivation

At cosmological distances, the space purported to be homogeneously inflated with space energy and matter and is completely isotropic. The generic metric that meets these conditions is given by $\boldsymbol{S^3}$ manifold of four-dimensional globe $\boldsymbol{\mathcal{R}^4}$. In the derivation below, we will consider only the case of closed model with positive curvature ≈ 1.

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

These equations represent so-called closed space manifolds $\boldsymbol{S^3}(r)$ of curvature 1 on the surface enclosing four-dimensional hyper-globe $\Re^4$.

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

$x = r \cdot \cos(\varphi) \cdot \sin(\theta)$,
$y = r \cdot \sin(\varphi) \cdot \sin(\theta)$, $z = r \cdot \cos(\theta)$,
where $0 \le r < 1$, $0 \le \varphi \le 2 \cdot \pi$, and $0 \le \theta \le \pi$,

The stereographical projection $\boldsymbol{S^3}$ from North Pole $(0, 0, 0, 1)$ intersecting $\boldsymbol{\mathcal{R}^4}$ at the origin $O = (0, 0, 0, 0)$ perpendicular to line connecting N with S-Pole is given by a quadruple of three variable functions (recall the tale 3.4 of space creation) as a diffeomorphism/mapping of $\boldsymbol{S^3}$ into Euclidian E^3 related to $\left(E_x = \rho\cos(\varphi)\sin(\theta), E_y = \rho\sin(\varphi)\sin(\theta), E_z = \rho\cos(\theta)\right)$ — spherical coordinates, where $0 \le \rho < \infty$, $0 \le \varphi \le 2 \cdot \pi$, and $0 \le \theta \le \pi$.

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

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

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

Consequently, Gram Matrix as the space metric tensor $G = J^T \times J$ yields

$$G = \frac{4}{(1+\rho^2)^2} \left\| \begin{matrix} 1 & 0 & 0 \\ 0 & \rho^2\sin^2(\theta) & 0 \\ 0 & 0 & \rho^2 \end{matrix} \right\|,$$

which leads to the metric rod $dl^2 = \dfrac{4}{(1+\rho^2)^2}\left[d\rho^2 + \rho^2\left(\sin^2(\theta)d\varphi^2 + d\theta^2\right)\right]$.

We know that in flat E^3 topology, the rod volume dl^3 is equal to $dx\cdot dy\cdot dz$, whereas the rod length is given by $dl^2 = dx^2 + dy^2 + dz^2$. Applying the same rule to the previous flat expression for dl^2, we obtain

$$dl^3 = 8\cdot\frac{\rho^2 d\rho\cdot\sin(\theta)d\theta\cdot d\varphi}{(1+\rho^2)^3},$$

within a coordinate triple: $0 \le \rho < \infty$, $0 \le \theta \le \pi$ and $0 \le \varphi \le 2\pi$. Hereby the expression

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

in the form of integral represents the space volume $V.\boldsymbol{S}^3(\rho)$ of a hyper-manifold $\boldsymbol{S}^3(\rho)$ with a radius ρ.

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

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

5. THE Γ-EQUATION

In formulating speculations similar to, cf. a) Mullat (1995), using the Γ-equation describing the current mass-energy composition in the Universe, our aim is to identify some stable states embedded into the four-dimensional hyper-globe $\mathcal{R}^4$ of a curvature radius 1 given by $x^2 + y^2 + z^2 + r^2 = 1$ as topologies among three-dimensional ordinary manifolds $\mathcal{S}^3(r)$ of radius r, $0 \le r \le 1$, $x^2 + y^2 + z^2 \le r^2$.

The Copernican Principle, as an ideal attribute, can be assigned with two-dimensional surface $\mathcal{S}^2$ of a three-dimensional globe $\mathcal{R}^3$. Extending the Principle to the manifold $\mathcal{S}^3$ enclosing a hyper-globe $\mathcal{R}^4$, we preserve the same ideal properties. Therefore, stereographic $\mathcal{S}^3(\rho_0)$, $\mathcal{S}^3(\rho_1)$ embedded into hyper-globe $\mathcal{R}^4$ corresponds to the Principle idealizing homogeneity and isotropy of the Universe. Before proceeding further with the analysis, we will present a hypothetical situation based on the assumption that the Copernican Principle is an ideal absolute.

We assume that closed three-dimensional stereographic $\mathcal{S}^3(\rho)$ manifolds of radius ρ, $0 \le \rho \le \infty$, are surrounded by energy-field within the globe $\mathcal{R}^4$ of curvature radius 1. It should be reiterated that the observer does not necessarily have to be placed at the North Pole of $\Re^4$. However, we shall adopt $(0,0,0)$ in $\mathcal{S}^3(\rho)$ as the stereographic reference system origin O, while allowing the observer to be positioned at any point within the manifold $\mathcal{S}^3(\rho)$. Such representation, however, ignores explanations of some known observational anomalies, such as super-void areas in Cosmos, local zones with higher and lower density of matter, etc. as anomalies in gravitational transitions of energy-field into quantum vacuum and baryonic matter.

According to Newton's laws, if a mass M of radius r hypothetically converges into a zero point O, the potential energy of a gravitational field at a distance r from O equals $-G\frac{M}{r}$, where $G = 6.67384^{-11}$ $m^3kg^{-1}s^{-2}$ is the gravitational constant. We can further hypothesize the process of gravitational transition, which occurs within the manifold $S^3(r)$—that is, at a distance r from some origin O. It is plausible to speculate that, at a distance r from the origin O, the energy-field gravitational transition takes place if the potential gravitational field intensity is strong enough—e.g. below the value of an universal constant Λ, i.e. at $-G\frac{M}{r} \leq -\Lambda$. The energy-field space and baryonic matter creation, according to our speculative postulate, is thus determined by a Γ-equation $-G \cdot M + \Lambda \cdot r = 0$. As previously noted, once the process of space or matter creation begins, it cannot cease or be arrested because by supposition a fixed point equilibrium should be reached, i.e. an increase in the mass M used in solving the Γ-equation in fact is increasing in a higher order than the increase in radius r needed for the mass M to be stipulated by the Γ-equation solution.

In the context of the gravitational constant G and the speed of light constant c may be omitted. Indeed, these parameters can be instead incorporated into the energy density μ, referring henceforth to energy $\mathcal{E}$ as $\mathcal{E}_{rel}$. Here, with respect to the manifold, the numerical values of energy $\mathcal{E}_{rel}$ are of key importance. Whether we refer to it as energy or by any other nomenclature is irrelevant for our theoretical purposes, as the gravitational constant G and speed of light c, as said, can be the built-in by the scale of Joule per kg. of the energy density parameter μ.

Let us now turn attention to the potential energy level on the manifold that forms the three-dimensional vectors (x, y, z) denoting manifold $\boldsymbol{S}^3$. In fact, these vectors represent the level of potential energy at the distance r from the centum of the manifold $\boldsymbol{S}^3(r)$ of radius r. As already emphasized by our speculative postulate, the space-energy composition undergoes gravitational transition, which allegedly occurs on the three-dimensional manifold embedded into the four-dimensional hyper-globe denoted by $\boldsymbol{\mathcal{R}}^4$. Moreover, we introduce a parameter λ, allegedly representing a fine-tuning or calibrating parameter of the energy-field defined by Newton's formula. It features in the *"potential energy"* $-\frac{G \cdot \mathcal{E}}{c^2 \cdot r^\lambda}$ or $-\frac{\mathcal{E}_{rel}}{r^\lambda}$ modified, what being said, as in MOND model, Milgrom (1983). In accordance with the Speculation on the space-energy composition, transition occurs at the energy level equal to $-\Lambda$ representing some universal constant, as discussed above. Thus, the gravitational transition occurs by violating the Γ-equation $-\frac{\mathcal{E}_{rel}(r)}{r^\lambda} + \Lambda = 0$, where $\mathcal{E}_{rel}(r)$ corresponds to the energy $\mathcal{E}_{rel}$ of the manifold $\boldsymbol{S}^3(r)$. This equation describes the stable set applied to the space-energy composition. In the subsequent analyses, we will replace $\mathcal{E}_{rel}$ by its energy $\mathcal{E}_{rel} = V.\boldsymbol{S}^3(r) \cdot \mu$ of a manifold $\boldsymbol{S}^3(r)$ or total energy of a hole or bubble within an allegedly layering/inflating energy-field, where $V.\boldsymbol{S}^3(r)$ signifies the total volume of $\boldsymbol{S}^3(r)$. Note that we previously referred to the parameter μ as a average energy density. Hence, the product of μ and volume $V.\boldsymbol{S}^3(r)$ corresponds to $\mathcal{E}_{rel}$—energy of the manifold $\boldsymbol{S}^3(r)$ under inflation. The parameter μ is of purely theoretical relevance, as it can neither be observed nor measured. Consequently, the Γ-equation might be rewritten in the form $-V.\boldsymbol{S}^3(r) \cdot \mu + \Lambda \cdot r^\lambda = 0$. In Section 7, we provide mathematical derivation of the equation upon our hyper-spherical manifold.

In accordance with Γ-equation the surface rod dl^2 of three-dimensional manifold $\boldsymbol{S}^3(r)$, $0 \le r < 1$, $0 \le \varphi \le 2\pi$, $0 \le \theta \le \pi$ yields a stereographical projection of $\boldsymbol{S}^3(r)$ given by

$$dl^2 = \frac{4}{\left(1+\rho^2\right)^2}\left[d\rho^2 + \rho^2\left(\sin^2\theta \cdot d\varphi^2 + d\theta^2\right)\right], \text{ where } r = \frac{2\cdot\rho}{1+\rho^2} \text{ and}$$

$0 \le \rho < \infty$, which guarantees that the manifold is mapped into a flat E^3 topology at nearby distances like a stereographical projection of S^3 from North Pole into Euclidian static space E^3. Hereby, the rod of the stereographical volume is defined by $dl^3 = \frac{8\cdot\rho^2}{\left(1+\rho^2\right)^3} d\rho \cdot \sin(\theta) d\theta \cdot d\varphi$, $0 \le \rho < \infty$, $0 \le \varphi \le 2\pi$ and $0 \le \theta \le \pi$. Consequently, the expression

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

represents the volume of radius ρ of hyper-manifold $\boldsymbol{S}^3(\rho)$ of ρ-*"radius"*. Taking the integral into account, we obtain:

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

It thus can be easily verified that $V.S^3(\infty) = 2\pi^2$ represents the entire hyper-manifold volume. Hence, with regard to the Γ-equation, the equation can now be rewritten as:

$$\Gamma(\mu,\rho) = -4\pi\cdot\left[\tan^{-1}(\rho) + \rho\cdot\frac{-1+\rho^2}{\left(1+\rho^2\right)^2}\right]\cdot\mu + \Lambda\cdot\rho^{\lambda} = 0.$$

In order to calibrate Γ-equation, which must be taken as speculative, the roots must be accurately aligned with the latest Plank Mission data of the mass-energy composition in the Universe. In fact, Γ-equation can almost always be solved for two roots, where $\rho_0 < \rho_1$. The case with one root $\rho_0 = \rho_1$, as well as that described by $\rho_S = 0$, exists as well, as do those including no roots at all.

5.1. Layering Dynamics of the Universe

We established the *"layering dynamics"* of the universe as a hypothesis of gravitational transition exploiting a nomenclature of energy-field transition into quantum vacuum and baryonic matter without use of GR and time line as a sequence of 3-dimentianal surfaces/manifolds $\boldsymbol{S}^3$ of 4-dimentional globe $\boldsymbol{\mathcal{R}}^4$. The dl^2 -s represent a stereographical projection of $\boldsymbol{S}^3$ with curvature 1 into Euclidian E^3 flat space; cf. Landau and Lifshitz, *"The Classical Theory of Fields"*, §107, p.348. The two roots ρ-s, ρ_0 and ρ_1 must resolve the Γ-equation:

$$\Gamma(\mu,\rho) = -4\pi \cdot \left[\tan^{-1}(\rho) + \rho \cdot \frac{-1+\rho^2}{\left(1+\rho^2\right)^2} \right] \cdot \mu + \Lambda \cdot \rho^{\lambda} = 0,$$

The roots $\rho_0(\mu)$ and $\rho_1(\mu)$ are exponential functions supporting the Universe growth with acceleration depending on average energy density μ while μ is linearly decreasing in semi-interval

$$\left(\begin{array}{l} \text{Planck Era} \to \mu \approx 10^{12} \geq \ldots \geq \mu \approx 10^{3} \leftarrow \text{the Dark Ages Phase}, \mu \approx 0.12457 \\ \leftarrow \text{Current phase of Universe} \geq\geq \mu \approx 0.08727 \leftarrow \text{Final Death Phase} \end{array} \right].$$

Nothing can stop us from moving the $\mu \to \infty$ in such a way as to diminish the size of quantum vacuum or space bubble $\boldsymbol{S}^3(\rho_0)$ by moving $\rho_0(\mu) \to 0$. This means that quantum vacuum bubble penetrates beyond the so-called Planck wall, with extent $\rho_0(\mu)$ smaller than the Planck constant $\hbar = 6.62606957 \cdot 10^{=34}$, can be included in our model.

By triple $\{ \mu = 0.12457, \lambda = 0.83751, \Lambda = 0.91499 \}$ we achieved the best match with Planck mission 2013 satellite data, i.e. matching 68.3% energy-field, 26.8% quantum vacuum and 4.9% baryonic matter using component function $\mathrm{sh}(\rho) = \frac{2}{\pi}\left[\tan^{-1}(\rho) + \rho \frac{-1+\rho^2}{\left(1+\rho^2\right)^2} \right]$. However, the capabilities of MathCad, which were used to calculate the table below, do not allow for technical reasons to calculate the solution of Γ-equation for $\mu > 10^{12}$.

This understanding brings about not only one but also two divisions of the same metric as two different solutions of the equation $sh(\rho_0) = 0.268$ for $\rho_0 = 0.675545953$, and $sh(\rho_1) = 0.951$ for $\rho_1 = 3.069027963$. One can check that for the quantum vacuum or for the **Qv**-, and the baryonic or normal **Vm**-matter bubbles respectively, $0 \le \varphi \le 2\pi$, $0 \le \theta \le \pi$:

Qv: *Quantum Vacuum*	**Be:** *Background Energy Field*	**Vm**: *Visual/Baryonic Matter*
$sh(\rho_0) = 0.268$	$sh(\rho_1) - sh(\rho_0) = 0.683$	$sh(\infty) - sh(\rho_1) = 0.049$
$0 \le \rho < \rho_0 =$ $= 0.675545953$	$\rho_0 \le \rho < \rho_1 =$ $= 3.069027963$	$\rho_1 \le \rho < \infty$

$\mu \approx 10^{12}$, Planck wall Epoch or Era of the Big Bang	$\mu \approx 10^{3}$, The Universe quantum vacuum Phase	$\mu \approx 0.12457$, Current Phase of the Universe	$\mu \approx 0.087267626$, The Death Phase of the Universe
Quantum Vacuum/Space Composition			
$sh(\rho_0)\% \approx$ $3.302832273 \cdot 10e-17$	$sh(\rho_0)\% \approx$ $\approx 0.000079175448461$	$sh(\rho_0)\% \approx$ ≈ 26.784557217	$sh(\rho_0)\% \approx$ ≈ 67.912846576
Background Energy-field Composition			
$sh(\rho_1)\% - sh(\rho_0)\% \approx$ $\approx 100\%$	$sh(\rho_1) - sh(\rho_0) \approx$ ≈ 99.9999208245515	$sh(\rho_1) - sh(\rho_0) \approx$ ≈ 68.300360425	$sh(\rho_1) - sh(\rho_0) \approx$ $\approx 0.00\%$
Visual or Baryonic Matter Composition			
$sh(\infty) - sh(\rho_1) \approx$ $\approx 0.00\%$	$sh(\infty) - sh(\rho_1) \approx$ $\approx 0.000000000000057$	$sh(\infty) - sh(\rho_1) \approx$ ≈ 4.914972357	$sh(\infty) - sh(\rho_1) \approx$ ≈ 32.087153424

Table 1: The function $sh(\rho)$ readily explains the static space dynamics

When the inflation time line in the Standard Model of the Big Bang began, column one defend our view that a positive root $\rho_0 \approx 0$ can be interpreted as infinitesimally small space volume of matter with radius $\rho_0 \approx 0$. As the SM inflation phase of the Big Bang developed further—

the second column—the emergence of baryonic matter was lagged behind the appearance of quantum vacuum. We can rephrase this speculation believing that in the inflation phase only the quantum or vacuum space prevailed.

Column 3 (http://sci.esa.int/planck/51557-planck-new-cosmic-recipe/, last visited 18/09/2021) of the table shows an attempt to compare the composition of energy-field, quantum vacuum and baryonic matter, with satellite data. Despite the fact that satellite data were obtained on the basis of the SM, the most suitable parameters Λ, λ and μ with great accuracy fit into our phase transfer model as the basis for calculating distances to galaxies. Last column shows the death phase, when $\rho_0 \approx \rho_1$: the energy-field source will be almost exhausted—both the quantum vacuum and baryonic matter bobbles will start to slow down their alleged acceleration of growth.

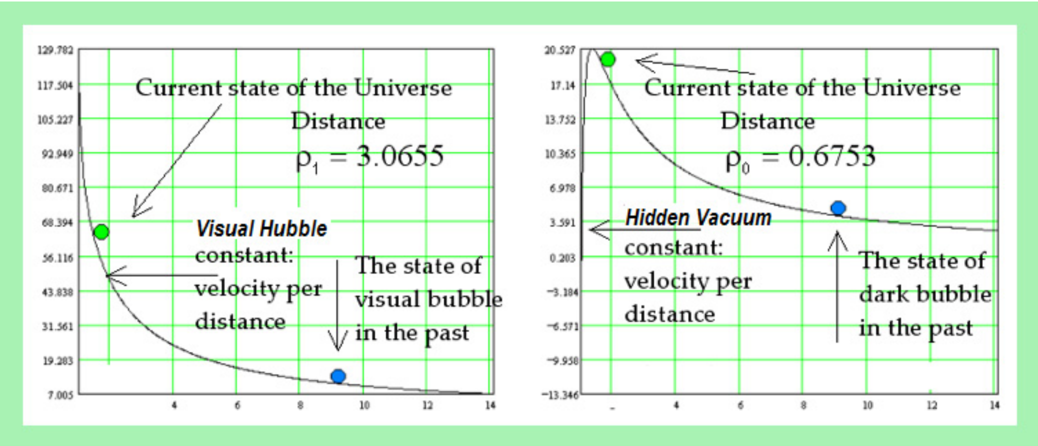


Fig. 2 and **Fig. 3:** Reveal the fundamental difference in the dynamics of quantum vacuum and baryonic matter highlighted in Table 1.

According to our analyses, which contradict the laws of gravity implying that the baryonic matter should start to contract, it allegedly continues to expand. This effect is readily apparent in the graphs depicted in Fig. 2 and Fig. 3. Indeed, they indicate that the baryonic matter creation velocity within the manifold $\boldsymbol{S}^3(\rho_1)$ continues to accelerate, whereby as the manifold inflated with space continues to increase in size, the average energy density also decreases. However, when the energy density reaches the vicinity of the critical value κ, the alleged quantum vacuum $\boldsymbol{S}^3(\rho_0)$ volume of quantum vacuum or space seem to be better aligned with the laws of gravity. Indeed, as shown in Figure 3, the creation of quantum vacuum does not stop although the acceleration completely stops before it becomes negative, that is, the growth of the radius of the quantum vacuum slows down, and the growth of its volume begins to slow down, respectively. So, in accordance with thermodynamic laws, in the vicinity of the critical value, as can be seen from Figure 3, the density of energy-field continues to decrease, but more slowly. We might thus conclude that the dynamics of the evolution of quantum vacuum and baryonic matter, accounting for the decreasing energy density, still corresponds to the known laws of physics.

5.2. Energy density scale construction

Parameters Λ, λ and μ represent a triplet in Γ-equation, where $-\Lambda$ is a mass-energy gravitational transition level, at which the transition occurs and which characterizes some speculative potential energy-field demarcation stripe on the scale inverse to radius ρ of the manifold $\boldsymbol{S}^3$. Similarly, λ is a tuning or calibrating parameter for the postulated potential energy of the gravitation field itself, and μ denotes our speculative density of the manifold. By introducing the curvature of the manifold $\boldsymbol{S}^3$ equal to 1, we have succeeded in calibrating the roots of the equation, which results in the following values for the aforementioned triplet: $\Lambda = 0.91499$, $\lambda = 0.83751$ and $\mu = 0.12457$. This parameter value set provides what being said the best fit to the Planck Mission Statement. It should be noted that we use a modified classical potential energy of gravitation field in the form of function $-\frac{\mathcal{E}_{\text{rel}}}{\rho^{\lambda}}$ that for $\lambda < 1$ declines more rapidly at nearby distances (i.e. when $0 < \rho \leq 1$) than for faraway distances (when $1 < \rho < \infty$).

Before we proceed further, it is necessary to establish the share of the volume $V.\boldsymbol{S}^3(\rho)$ with respect to the entire volume $V.\boldsymbol{S}^3(\infty)=2\pi^2$ in order to conform to the quantum vacuum and baryonic matter composition put forth by the Planck Mission satellite data. Indeed, the share equals $sh(\rho)=\frac{2}{\pi}\left[\tan^{-1}(\rho)+\rho\frac{-1+\rho^2}{\left(1+\rho^2\right)^2}\right]$. For the triplet given above, the roots $\rho_0=0.67535$ and $\rho_1=3.06548$ solve Γ-equation. It can, cf. Table 1, thus be verified that:

Quantum Vacuum / Space:	$Qv\% \mid sh(\rho_0)\approx 26.785\%$,
Background / Energy-Field:	$Be\% \mid sh(\rho_1)-sh(\rho_0)\approx 68.300\%$,
Visual / Baryonic Matter:	$Vm\% \mid sh(\infty)-sh(\rho_1)\approx 4.915\%$.

These percentages in Table 1, with regard to the Plank Mission Statement, allow us to refer to ∞ as the baryonic matter crossing/starting point, which terminates at ρ_1. We can also refer to ρ_0 as the energy-field starting point, whereby the energy-field terminates when it reaches ρ_1, while the quantum vacuum commences at 0 and ends at ρ_0. The inverse stereographical distance r_0-r_1 in r-reference system $r=\frac{2\cdot\rho}{(1+\rho^2)}$ denotes the energy-field width. From the above, it can be inferred that, while the percentages align with the Planck Mission Statement nearly perfectly, the roots ρ_0 and ρ_1 produce a good fit only when $\mu=0.12457$. Whatever this value μ of the energy density parameter represents or is interpreted to imply, the $\mu=0.12457$ points at an alleged current density state of the Universe.

It remains for us to pay attention to the connection between the metric space, which is a stereographic projection, and the original (pre-image) defined by the Landau-Lifshitz metric:

$dl^2=\frac{dr^2}{1-\left(\frac{r}{a}\right)^2}+r^2\cdot\left\{\sin^2(\theta)\cdot d\varphi^2+d\theta^2\right\}$. The metric depends on the curvature radius a, where the r can vary from 0 to a, and where φ

and θ are in the intervals $[0 \le \varphi \le 2\pi]$ and $[0 \le \theta \le \pi]$. In particular, we will work without any high rank tensors, time coordinate, laws of gravity, etc., focusing only on standard quadratic forms of differential geometry. The latter metric dl^2 was considered in "Classical Field Theory", Landau-Lifshitz, 3rd Revised English Edition, 1971, p. 336. As an exercise, the substitution $r = \dfrac{r_1}{1 + \dfrac{r_1^2}{4 \cdot a}}$ for $0 \le r_1 \le a$, according to the authors' intention would at every point of a 3-d manifold $\boldsymbol{S}^3$.

In Landau metric, there seems to be two bubbles extending along the coordinate r when moving along r from zero to 1, and in the opposite direction from 1 to zero. This movement along the coordinate r will be clear from the substitution $r = \dfrac{2 \cdot \rho}{1 + \rho^2}$ when moving along the coordinate ρ within the stereographic interval $[0 \le \rho < \infty)$. In stereographic projection, these two bubbles are clearly separated by the transition boundary when $r = 1$. However, these two bubbles are superimposed on each other, and each of which has a volume of π^2.

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

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

We can check that for dark $\rho_0 = 0.675545953$ and for normal matter $\rho_1 = 3.069027963$

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

5.3. Energy density scale of origin

The conclusion made here is based on the premise that, in line with our Speculation, the manifold composition must stop changing when the energy density declines below the threshold $\mu = 0.08727$. In this case, the quantum vacuum will *collapse into or be in contact* with the visible manifold when $\mu \approx 0.08727$ because $\rho_0 \approx \rho_1$. By implementing a ratio scale of density on the μ-axis as a ratio of density μ to somewhat critical density κ, i.e. $\frac{\mu}{\kappa}$, while moving from higher to lower density values, the roots should confirm, or at least not contradict, the currently accepted statements about the Universe dynamics.

Let us now introduce a scale that commences at the point corresponding to the critical density ratio $\frac{\mu}{\kappa} \approx 1$, $\kappa \approx 0.08727$. The manifold points on this scale at the ratio $\frac{\mu}{\kappa} \approx 1.42751$ as the current composition. In contrast, when very high values $\frac{\mu}{\kappa}$ are exceeded on the density scale, a small or infinitely small clump of quantum vacuum can suddenly undergo an initial gravitational transition from the zero solution $\rho_S = 0$ of our speculative Γ-equation, yielding $Hv\% \approx 3{,}30283 \cdot 10^{-17}\%$ of the quantum vacuum and $Vm\% \approx 0.00 \cdot 10^{-17}\%$ for the visual or baryonic matter. This fits well with the current postulate on the beginning of *"Dark Ages of the Universe"*, Trimble (1987), indicating that background energy-field $Be\% \approx 100\% - 0.00 \cdot 10^{-17}\%$ constitutes almost the entire manifold, as illustrated by Figure 7 in the Appendix. At the other end of the scale the alleged composition suggests $Vm\% \approx 32.67\%$ and $Hv\% \approx 67.33\%$, when density decreases, and thus starts approaching the critical level $\kappa \approx 0.08727$, the roots of the equation cease to exist.

The roots of our speculative Γ-equation do not contradict, but rather confirm the *"flatness problem"* $\Omega_0 \approx 1.0002 \pm 0.0026$ of the Universe on traditional density scale Ω, when it is outside the generally accepted critical density $\Omega \approx 1$, to expand forever, as was assumed in the Standard Model. Indeed, the similarly $\frac{\mu}{\kappa} \to 1$ with the last possibility for finding the roots of Γ-equation is reached when the width $\rho_0 - \rho_1$ of the energy-field will approach zero.

5.4. Redshifts transformation into energy density scale.

Invariance is one of the fundamental properties of the energy density scale (as well as any other scale), since it allows linear transformations to be implemented, supporting the theoretical construction irrespective of the chosen scale interval. Here, we will illustrate the invariance by a linear transformation of distances into the scale of average densities of space and matter substituting the resulting densities μ in the equation

$$\Gamma(\mu,\rho) = -4\pi \cdot \left[\tan^{-1}(\rho) + \rho \cdot \frac{-1+\rho^2}{(1+\rho^2)^2} \right] \cdot \mu + \Lambda \cdot \rho^{\lambda} = 0,$$

where $\Lambda = 0.91499$ and $\lambda = 0.83751$. In solving this equation with respect to distances ρ, we obtain a theoretical distribution of distances, which will be appropriately compared with the distances in the original *Mean (MpC)* column of NED data with 15000 records; cf. Table 4 below.

First we return to the question of the average density of energy in the Universe. As already noted, when estimating the energy density, it was relatively easy to take into account the *"independent distances"* given in +/- percentages of Table 3 of +over/–under estimates below. It was also comparatively straightforward to transform the distances into the light years time scale indicating the propagation of light through static space until light from extragalactic objects reaches the telescope of the observer. In making this connection, it was also plausible to accept that light from extragalactic objects, indicated by column *Mean (MpC*), was emitted at some point in the past, with such various moments of origin denoted as $[\tau_o, \tau_n]$ representing some interval determined by the closest and the farthest object in the column *Mean (MpC)*. On the other hand, we have repeatedly pointed out the theoretical possibility of describing events in static space by the energy density μ dynamics of energy distribution in the Universe. Thus, at this juncture, it should be clear that our reasoning leads to the emergence of a certain interval $[\mu_o, \mu_n]$ of average densities μ. Indeed, given that $\Lambda = 0.91499$ and $\lambda = 0.83751$, such an interval can be constructed, thus supporting our claim that average density can be used in place of the time scale events. These conditions result in obtaining solutions of Γ-equation that are reasonably matching with the +over/–under estimates in the *Mean (MpC)* column of Table 4.

To summarize the essence of calculating distances using Γ-equation, in accordance with the theory, it is necessary, what being said, to find a certain interval of energy densities $[\mu_o,...,\mu_n]$, which would allow us to calculate distances. We do not have any methodology for choosing such an interval. All that can be counted on is a trial and error method. Nevertheless, as the trial and error method shows, it turned out to be necessary to consider three intervals on redshifts scale separated by two milestone points: $z_1 = 0.0015$ and $z_2 = 0.011118$. As a result, we have the opportunity to combine calculations into one procedure for calculating distances, both for small, moderate and significant redshift values. A similar separation of z values is already known for long time since the Hubble law is very accurately fulfilled for the small z values of redshifts. However, for large values, the Hubble's law validity is in doubt. The reader will be able to verify this further by viewing the Table 2.

Using the trial and error method for interval calibration, as we said, it was possible to separate the interval of redshifts into three extents. Based on our knowledge that for the Dark Ages the energy density was $>> 0$ and for the Current Phase of the Universe the density is $\mu = 0.12457$ we succeeded in a rather satisfactory way. Indeed, given the redshift z in the interval $[z_o = 0 < ... < z_n = 10.99]$ we tried to estimate the density decrease in the form of $h(z) = 1 - \left(\frac{1}{2}\right)^z$ exponent's decay function in the following three cosmological redshifts extents:

$$[z_0 = 0 \leq z < z_1 = 0.0015 \leq z < z_2 = 0.11118 \leq z < z_n = 10.99].$$

In each extent we implemented a separate linear transformation of z's using linear functions:

$$\mu(z) = \begin{cases} 98.188007 \cdot h(z) + 0.16027 \text{ for } z \in Z_1 = [z_0 = 0 \le z < z_1], \\ 97.926578 \cdot h(z) + 0.42157 \text{ for } z \in Z_2 = [z_1 \le z < z_2], \\ 102.812981 \cdot h(z) + 0.53757 \text{ for } z \in Z_3 = [z_2 \le z < z_n = 10.99]. \end{cases}$$

As the experiments show, it was prudent to apply a smoothed function: $\bar{\mu}(z) = \tfrac{1}{3} \cdot (\mu(z - 0.0001) + \mu(z) + \mu(z + 0.0001))$.

Distance Calculation Procedure. It remains thus to solve the equation $\Gamma(\bar{\mu}(z), \rho) = 0$ for $\bar{\rho}(z)$ depending on $z \in Z_1, Z_2$ or $z \in Z_3$. Then, the estimated distance to an extraterrestrial object equals $\bar{\rho}(z) - \rho_1$, where $\rho_1 = 3.065505$. We can now put on trial the distance $\bar{\rho}(z) - \rho_1$ given in MpC against Hubble and modulus $m - M$ distances, and also put on trial $\bar{\rho}(z) - \rho_1$ with reg. to formula of Noble Forrest W. & Timothy M. Cooper, 2014, http://www.pantheory.org/HF.htm, accessed 21.08.2018).

6. Results

Our contemporary knowledge of the structure of the Universe extends to galaxies and quasars, which form groups and clusters of various categories of extragalactic objects. The entire Cosmos is permeated with radiation comprising of the infrared, visible, ultraviolet and X-ray radiation emitted by extragalactic objects, as well as neutrino fluxes. It also includes relict microwave and neutrino radiation, the occurrence of which is purported to be associated with the *Big-Bang* event that initiated the emergence or grows of the Universe.

The complexity of the Universe, which we are trying to understand, and whose visual particles we strive to control, inevitably results in difficulties in attempting to represent observations in the field of astronomy in a form that is understandable to a mathematician. We hope that our mathematical modeling succeeded in overcoming such challenges, as it permits similar language to be adopted by both the observer and the theoretical physicist. In creating this connection, we relied on the energy density μ parameter, developed in the previous section, which replaces the events in static space by energy dynamics of the Universe. It nonetheless explicates the distribution of matter and energy in the Universe that is acceptable to both mathematicians and physicists.

The energy density scale μ remains merely of theoretical value in spite of confirmation of the scale obtained by solving Γ-equation, for which we utilized the data sourced from NED distances in the form given by Table 2; cf. Astronomical Journal, 153:37 20 pp. (Steer et al. 2017). On the other hand, the scale μ explaining the dynamics of the Universe in alternative terms related to extragalactic objects can be interpreted as evidence supporting the reliability of our mathematical model, rather than pointing to its inconsistency.

6.1. NED Data

For the comparative analysis, in line with the approaches described in known literary sources, cosmic distances are traditionally calculated using: relativistic Doppler Effect formula with the Hubble constant H_0 or the formula for modulus $m - M$. However, Noble et al. distance, http://www.pantheory.org/HF.htm (accessed 21.08.2018) is different. It is noteworthy that in Table 2 by specifying the redshift z the distance to a cosmological object allows to be expressed in megaparsecs, also known as the MpC distance. It signifies the position to which the object should be repositioned in order to see it at an angle of 1″ second from the protozoan points of the Earth's orbit around the Sun.

Table 2: Intergalactic estimates: Representatives of Galaxies	Equa-tion	Hubble	F. Noble	M-Distance	Mean m - M	NED (MpC)	Window
MACS J0647.7+7015	9643.0	4046.1	25338.4	46410.6	47.8104	7415.3	Win1
GRB 060210	8897.1	3851.2	16999.0	29795.2	47.1553	6680.1	Win2
GRB 060526	8418.4	3768.6	14351.3	19561.4	45.9457	4946.3	Win3
GRB 030429	7799.9	3595.7	11917.0	20218.6	46.3504	5649.6	Win4
[HB89] 2345+000:BX0120	7326.2	3440.8	10468.6	16720.6	45.7164	4350.7	Win5
GRB 030226	6489.0	3228.8	8426.9	12372.6	45.1692	4465.3	Win6
COMBO-17 19434	5895.5	3093.4	7244.9	9358.4	44.6939	3568.7	Win7
COMBO-17 40328	5455.3	3053.1	6468.1	9351.9	44.7727	4036.4	Win8
COMBO-17 35663	5232.3	2949.9	6100.8	9031.7	44.6779	3957.9	Win9
SCP 06R12	4798.6	2769.1	5430.5	7450.9	44.2321	3476.1	Win10
GRB 000911	4469.3	2683.1	4954.9	6561.9	43.9983	3225.9	Win11
GSS 074_5532	4325.7	2629.8	4755.4	8202.0	44.2812	3836.4	Win12
[RSC2007] J123809.00+621847	4246.1	2601.4	4646.9	6592.2	44.0283	3295.2	Win13
XSS J18076+5937	4195.1	2601.8	4578.1	5980.3	43.8316	3053.7	Win14
GRB 071010B	4132.7	2551.1	4494.6	5828.2	43.7528	3013.9	Win15
CGCG 266-031	98.2	102.1	107.9	104.5	35.0596	102.0	Win184
UGC 11064	96.0	100.4	105.2	144.4	35.3321	103.7	Win185
ESO 573- G 014	93.5	97.6	102.3	114.8	35.0979	112.2	Win186
NGC 0232	90.0	92.9	98.0	104.9	34.9671	96.0	Win187
UGC 06363	86.2	88.9	93.4	169.5	35.0541	92.1	Win188
ESO 300- G 009	82.8	85.1	89.3	90.6	34.7375	88.7	Win189
NGC 3332	79.4	81.0	85.1	107.3	34.7433	82.6	Win190
NGC 3873	75.6	77.4	80.5	72.6	34.2727	71.3	Win191
UGC 00052	74.3	75.3	78.9	71.8	34.2273	70.6	Win192
ESO 478- G 006	71.4	71.0	75.2	73.8	34.3151	72.5	Win193
NGC 5490	68.5	68.2	71.7	78.0	34.2991	68.7	Win194
CGCG 141-044	67.0	66.0	69.8	70.5	34.1464	69.4	Win195
NGC 4495	65.7	65.0	68.1	64.2	34.0064	63.1	Win196
UGCA 036	63.7	62.4	65.7	64.4	33.9964	63.5	Win197
CGCG 308-009	61.9	60.1	63.3	64.5	34.0033	63.5	Win198
NGC 2258	58.4	56.0	58.9	59.0	33.8212	58.2	Win199
NGC 7408	46.8	47.6	50.4	49.0	33.4045	47.1	Win200

The data in Table 2 is collected on the basis of individual cosmological objects from NED sources. As far as we know, the NED database is provided by long-term observations conducted by astronomers, institutions, individual research groups, or private organizations interested in space depth research. The distances and the modulus are of interest for evaluating and comparing the theoretical methods. However, this still does not alleviate the bewildering and perplexing problems related to calculating distances to cosmological objects. According to NED, for galaxies or stars the distances are measured independently of redshifts. However, it seems to us that m – M modulus have been frequently used for this purpose, probably due to the challenges related to conducting independent measurements at the distant parts of the Universe.

When moving along the 15.000 lines in the MS *EXCEL* spreadsheet, the mean and median values of averages for 200 windows were calculated. Each window consists of 75 supernova records. Comparative results of distances are presented in Table 2. The entire table is available on request. We have chosen these windows for some technical reasons connected to MathCAD 5.0, which allows vector variables at most only with 200 components to solve equations by iteration method.

For comparison, an index of distance +over/–under estimates for these 200 windows was developed. To produce a normalized index, we divided average distances D_i obtained by a particular method by the average NED distance N_i in Mean (MpC) column and then subtracted one. The indices $\left(\frac{D_i}{N_i}-1\right)$, $i=\overline{1...200}$, of +over/–under estimates reflects the situation in Table 3 like a series of experiments have been conducted to determine whether the distances D_i are closer or further than the N_i distance shows. If the experiment shows a different results (more or less) equal number of times (closer or further), then it is considered that D_i is approximately balanced with an expected distance N_i. If it, also, almost always turns out that objects on trial are closer than (or farther than) N_i, then it is considered that the D_i distance, in contrast, is misbalanced with N_i.

It became clear for some astronomers, who postulate a link between intergalactic distance and the extent of redshift, observing the Universe on the basis of Hubble's law, that the calculations using the relativistic Doppler formula are not entirely correct. In order to examine this issue more closely, we calculated the mean and median +over/–under estimates of distances collected into Table 3 taken from 15.000 supernova records in NED database. Based on the information sourced from the database, using some H_0, we compared methods typically employed when calculating distances between the objects in the Universe. In Table 3, the Γ-equation column presents distances based on the μ scale, which we denoted as the energy density scale of space and matter.

Disbalance z>0.594	**29.4%**	**-21.7%**	**54.2%**	**121.1%**
Median z>0.594	**24.1%**	**-20.8%**	**31.2%**	**84.0%**
Deviation	0.14	0.07	0.51	0.98
Disbalance 0.594>=z>0.2178	**0.4%**	**-22.3%**	**1.7%**	**38.4%**
Median 0.594>=z>0.2178	**0.0%**	**-22.3%**	**1.7%**	**35.3%**
Deviation	0.09	0.07	0.10	0.18
Disbalance z<=0.2178	**0.8%**	**0.1%**	**5.3%**	**3.1%**
Median z<=0.2178	**0.1%**	**-1.3%**	**4.1%**	**1.7%**
Deviation	0.03	0.05	0.05	0.04
Table 3: Total Observation	Γ-equation	Hubble	Noble	Modulus

Closer scrutiny of the data presented in Table 3 reveals that, at lower, perhaps moderate, redshift values, i.e. for $0.594 \geq z > 0.2178$, there is reasonable agreement between the Γ-equation and Noble F. formula for the distances to cosmological objects. The quality of the computed distances is also compared by the alignment with the Doppler formula. However, for higher redshifts, i.e. for $z > 0.594$, discrepancies for Γ-equation with Doppler formula are evident, as well as in relation to the Modulus and the results based on the Noble et. al. theory both together. Although Noble F., and Modulus seems to overestimate independent distances, the Γ-equation provides similar overestimates for greater redshifts. In addition, according to the Doppler Effect calculations based on the Hubble constants chosen from the range starting at 66.375 up to 70, the discrepancies of underestimates exist both at moderate and higher redshifts. Indeed, Hubble's law produces obvious underestimation for both of these indicated extents of redshifts. However, according to Table 3, for the redshift values $z \le 0.2178$ pertaining to the cosmological objects *"in the vicinity"*, the Γ-equation predicted approx. the same magnitude of estimates relative to those yielded by luminosity distances. This prediction for galaxies in the nearest vicinity, as already noted, is often based that in the NED Database the estimates relay on modulus distance formula.

6.2. A Posteriors Experiment

The formulas of Hubble's law relativistic Doppler Effect in comparison to Γ-equation, are shown, F. Noble and Modulus distances, on Figure 4 — both in their original form and in a more elegant form.

Hubble Distance

$$\frac{(1+z)^2-1}{(1+z)^2+1}\cdot\frac{c}{H_0}$$

$$\tanh(\ln(1+z))\cdot\frac{c}{H_0}$$

Pan Distance $c = 299792.458$ **speed of light** $H_0 = 66.375$

$$21.2946\cdot\log\left[\frac{1}{2}\cdot\left[\left(\sqrt{1+z}\right)-1\right]+1\right]\cdot\left(\sqrt{1+z}\right)\cdot 1958.3$$

$$18110.607641\cdot\ln\left[\left(\frac{1+\sqrt{1+z}}{2}\right)^{\sqrt{1+z}}\right]$$

Modulus distance MpC

$$dist = \frac{10^{1+\frac{m-M}{5}}}{106}$$

Figure 4: The formulas for calculating distances to Cosmological Objects according to the methods known to the author of the study. The results yielded by applying these formulas are transferred into Table 4.

Table 4: For any astronomer, including amateurs, it will be easy to check our results if one tries to access the NED, https://ned.ipac.caltech.edu/forms/byname.html (accessed 12/19/2018), where one can find the redshift values for some extraterrestrial objects.

Γ-Eq.	Hubble	Noble	Modulus	Redshift	Extraterrestrial object
2171.9	1498.8	2197.6	2523.5	0.466082	3C 411
1701.3	1241.1	1715.1	1386.8	0.366090	3C 048
9237.2	3796.6	19714.9	24774.2	4.047950	GRB 060206
6697.3	3188.7	8887.9	13614.4	1.819000	3C 256
704.9	603.3	734.8	734.5	0.159492	3C 273
112.7	111.4	125.0	115.3	0.027514	NGC 4860
6057.2	3011.6	7550.3	11117.3	1.549480	GRB 051111
923.2	756.7	947.9	809.1	0.204885	LEDA 25177
103.7	102.2	114.4	102.8	0.025199	ARP 334
26.3	22.0	24.4	22.2	0.005380	ARP 152
24.9	20.1	22.2	16.4	0.004907	ARP 159
32.3	30.0	33.2	30.3	0.007331	NGC 0772
5218.3	2755.3	6078.4	8550.7	1.253328	GRB 020813
37.0	36.1	40.1	38.0	0.008836	NGC 3516
8.2	6.1	6.8	8.4	0.001491	NGC 5832
4151.6	2381.4	4519.9	5970.4	0.939227	AO 0235+164

3.1	**3.3**	**3.6**	**6.7**	**0.000804**	MESSIER 101
576.0	**507.7**	**608.0**	**542.0**	**0.132313**	LEDA 51975
78.5	**75.4**	**84.1**	**77.3**	**0.018529**	ARP 220
1.9	**1.2**	**1.3**	**1.2**	**0.000297**	NGC 4569
73.2	**69.6**	**77.5**	**66.7**	**0.017085**	3C 449
107.5	**106.1**	**118.9**	**66.7**	**0.026175**	NGC 7385
495.3	**445.5**	**527.8**	**515.2**	**0.115068**	PKS 2155-304
24.0	**18.9**	**20.9**	**16.5**	**0.004622**	NGC 4487
101.4	**99.8**	**111.7**	**16.5**	**0.024601**	NGC 1265
328.5	**309.9**	**358.9**	**342.0**	**0.078548**	IC 1101
6022.5	**3001.6**	**7483.7**	**11015.4**	**1.536089**	SDSS J1156+1911
138.0	**136.9**	**154.1**	**137.4**	**0.033903**	ESO 325- G 004
69.2	**65.1**	**72.5**	**66.4**	**0.015980**	ABELL 3627
71.1	**67.2**	**74.9**	**67.0**	**0.016506**	2MASS J04375556-0931094
52.5	**46.2**	**51.3**	**46.8**	**0.011313**	NGC 7714
95.2	**93.3**	**104.3**	**95.9**	**0.022980**	UGC 00014
9855.2	**3980.4**	**33262.1**	**68548.8**	**7.000383**	EGS-zs8-1
38.6	**38.1**	**42.3**	**28.2**	**0.009330**	NGC 7619
43.9	**44.9**	**49.8**	**45.5**	**0.010988**	NGC 5010
7414.9	**3371.7**	**10720.3**	**17139.6**	**2.189613**	UDFj 39546284
126.0	**124.9**	**140.4**	**130.0**	**0.030893**	Markarian 421
26.3	**22.0**	**24.4**	**22.2**	**0.005380**	NGC4486
31.1	**28.4**	**31.4**	**28.7**	**0.006940**	LEDA 36252
111.3	**109.9**	**123.3**	**113.8**	**0.027140**	PGC 6240
9444.0	**3848.2**	**22067.6**	**3848.2**	**4.546953**	Baby Boom
823.7	**688.0**	**850.9**	**863.0**	**0.184268**	ABELL 1689
1474.7	**1108.4**	**1488.8**	**1606.9**	**0.318843**	ABELL 1995
3198.2	**1991.8**	**3330.3**	**4130.5**	**0.698091**	MACS J0744.9+3927
1520.1	**1135.5**	**1533.9**	**1667.2**	**0.328288**	ZwCl 1358.1+6245
61.1	**56.1**	**62.3**	**57.0**	**0.013746**	Hydra Cluster
4293.8	**2434.8**	**4711.9**	**3597.5**	**0.978000**	SN 2001jm
2635.1	**1732.0**	**2693.2**	**3062.0**	**0.568000**	SN 2001iy
6054.1	**3010.7**	**7544.2**	**11117.3**	**1.548267**	HG 051111
23.0	**17.6**	**19.4**	**16.8**	**0.004283**	MESSIER 87
30.2	**27.2**	**30.2**	**27.5**	**0.006658**	ARP 274
110.56	**109.2**	**122.46**	**124.7**	**0.026959**	NGC 4039
9100.4	**3764.0**	**18499.1**	**33265.9**	**3.792285**	N4C 41+41.17
54.1	**48.1**	**53.4**	**45.5**	**0.011778**	ARP 333
9776.5	**3943.7**	**28892.1**	**5495.4**	**6,027000**	ABELL 383
22.6	**16.93**	**18.7**	**11.8**	**0.004130**	ESO 162G017
7255.1	**3332.2**	**10273.2**	**16218.1**	**2.099000**	4C +01.02
7470.4	**3385.2**	**10881.8**	**17458.2**	**2.222364**	PKS 0237-23
9402.6	**3837.5**	**21530.0**	**16069.4**	**4.432400**	PSS J0747+4434
7895.6	**3486.9**	**12246.7**	**10280.2**	**2.500000**	B3 0727+409
9765.1	**3943.2**	**28842.2**	**24660.4**	**6.016000**	SDSS J1306+0356
1369.3	**1044.5**	**1384.5**	**1224.6**	**0.297000**	H 1821+643
9882.6	**3994.8**	**35505.5**	**31915.4**	**7.507800**	z8 GND 5296
9907.3	**4010.8**	**38529.5**	**17298.2**	**8.200000**	GRB 090423
9942.1	**4050.9**	**50744.0**	**50118.7**	**11.09000**	GN-z11
25.0	**20.2**	**22.4**	**20.3**	**0.004937**	NGC3227
76.1	**72.5**	**81.1**	**74.5**	**0.017877**	NGC5548
2745.0	**1784.6**	**2814.3**	**2432.2**	**0.592800**	3C 345
9886.6	**3997.2**	**35915.4**	**31188.9**	**7.601068**	ABELL 1689-zD1
9926.1	**4027.2**	**42444.3**	**40738.0**	**9.110000**	MACS1149-JD1

6.3. Summary

Summing up all our efforts presented in this study, we can conclude that the distances calculated in accordance with the Hubble's law are the most severely underestimated in almost entire spectrum of redshifts. On the other hand, the deviations created by the Noble F. are an order of magnitude higher overestimates the greater are the redshift values even if they match quite satisfactory the NED Database for lower values. When measuring distances using the modulus for estimating luminosity distances, the largest deviations, even grater than Noble F., occur in the spectrum of high redshifts.

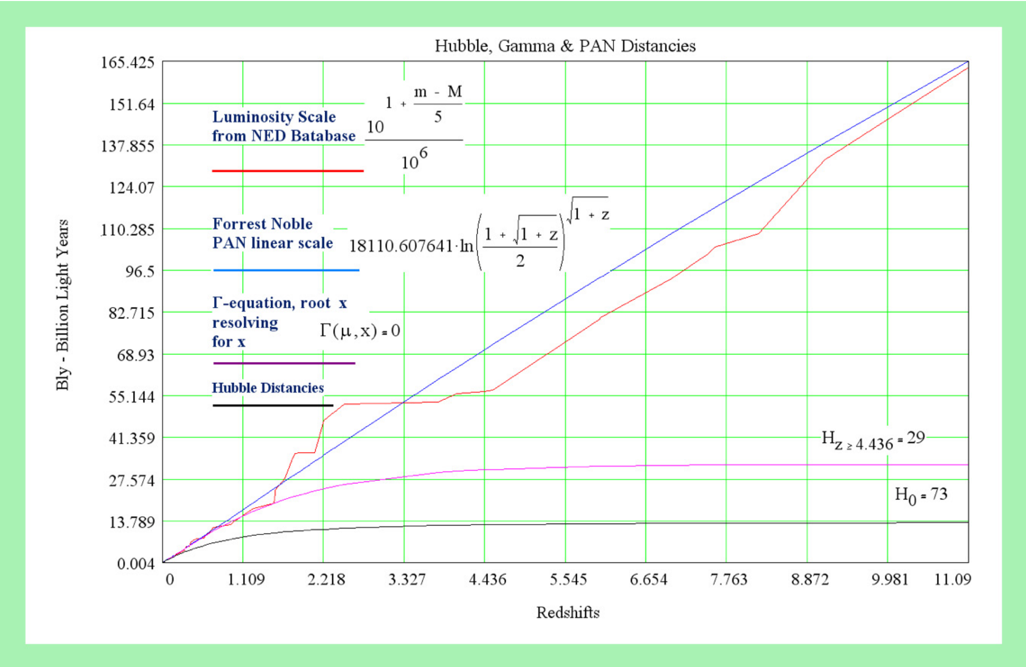


Figure 5: Based on cosmological redshifts z and modulus $m-M$ obtained from NED database. It is an image of the comparative analysis of distances calculated to cosmological objects on the basis of the formulas given above and Γ-equation procedure. The Luminosity, Noble F., Γ-eq., NED and Hubble traces are calculated using Table 2. Substituting into the Noble formula $z=1$, the distances are approximately consistent with the linear law: $\text{Linear Pan Formula}(z=1)\cdot z$.

It should be noted that the estimates obtained using the Γ-equation are more reasonable in the spectrum of moderate redshifts than the estimates obtained by all other methods. The observation of the position of the Γ-equation estimates on the Figure 5 amid Noble F., and NED Database distances, also with regard luminosity distance, indicates for us that the size of the universe does not correspond well enough to the Hubble's law. If we take into account the reasonableness of our mathematical model in this study the Universe seems for us to be also much larger in size than it is commonly believed. Such a discrepancy in the estimates may well be due to the fact that the luminosity of distant cosmological objects is much stronger than expected, and these distant objects emit, perhaps, much more energy. It is also noteworthy to emphasize that using the NED database it was possible to fine tune calculations and establish the most accurate estimates of the distances to cosmological objects by the Γ-equation. The tuning was achieved by dividing the redshifts interval into three extents introducing three average energy density functions separately in each extent as noted above**.**

In conclusion, it is also necessary to make, as we think, one important comment. We have repeatedly pointed to the Hubble's constant that this is not a constant at all, but most likely, a Hubble's variable H_0. If our thoughtful reader turns attention to the trace calculated by the rules of the Γ-equation, then one can see that this trace in Figure 5 is very similar to the Hubble's distances somewhere starting with the redshift values in the region higher than $z \approx 4.436$. The Hubble's trace occupy a shifted area along the y-axis but down by some interval. Now it is not difficult to figure out what will be the shift interval along the y-axis, which can match the Γ-equation trace into Hubble's trace by changing the constant H_0 for calculating distances using the formula:

$$\frac{(1+z)^2-1}{(1+z)^2+1}\cdot\frac{c}{H_0}\equiv \mathrm{tangh}(\ln(1+z))\cdot\frac{c}{H_0}\,.$$

Indeed, the current value of $H_0 = 73$, and c is the speed of light—the value 73 is taken from NED database. If we now replace the constant H_0 by $H_{z \geq 4.436} = 29$ (remembering that this is not a constant at all), then it turns out that the Hubble distance trace will very accurately fit our trace calculated according to the rules of the **Γ**-equation. However, we must separate the entire space of galaxies—if we may say so—into two regions—the so-called foreground galaxies with the red shift number with the boundary number no more than 4.436, and the background galaxies with the redshift number greater than 4.436. The indicated shift by 29 is valid only for background galaxies with a redshift of more than 4.436 and from which the light has reached us from the distant past. Now, again, it is not difficult to understand that if we take the number 29 for the Hubble's constant, then it will be a constant, which supposedly was in the distant past and which tells us, presumably, that in the distant past the growth of the Universe occurred more than two times slower than now.

From the foregoing, it is quite obvious to conclude that it is also fully consistent with Figure 2, that in the modern era, according to the forecast calculated according to the rules of the **Γ**-equation, in the future our universe will expand faster and faster. Everything that has been said here (we have already indicated this circumstance where it was appropriate) agrees with the fact that the size of our universe not only increases, but this growth also occurs with acceleration. However, as the dynamics of acceleration shows, in accordance with the **Γ**-equation—the **Γ**-trace in the past—the growth of the Universe, as well as the acceleration, both have been practically insignificant. Indeed, for large values of redshift in the displacement of distances along the y axis, the **Γ**-trace is almost parallel to the x axis of the redshift.

It is also appropriate to emphasize here that the **Γ**-equation is derived from the postulate of the gravitational transition of energy-field into quantum vacuum and baryonic matter. Therefore, the growth of the Universe by the rules of the Γ-equation is not an expansion in the sense of the standard cosmological model, i.e., Big Bang model, but a certain growth of the space domain of the Universe due to the narrowing of the energy-field region. That is, here we are dealing with a universe where the baryonic matter inside the universe is stable and does not move anywhere in contrast to what the Big Bang model supposedly predicts. So, the Γ-equation highlights the steady state Universe.

7. DISCUSSION

The aim of this investigation was to provide a reliable way for estimating cosmological distances. In our analysis, we started with the Space idealization assuming homogeneity and isotropy of the space; the so-called Copernican Principle was supposed to be valid. Isotropy implies absence of allocated directions (top, bottom and others), thereby postulating independence of the properties of bodies moving by inertia from the direction of their motion. Complete isotropy is inherent only in vacuum, as anisotropy in the distribution of the binding forces characterizes the structure of real bodies. They split in some directions better than in others if we observe the Universe in grid cells of 50-100 MpC in dimensions. In the same way, complete homogeneity, characteristic only of an abstract Euclidean space, is an idealization. The real space of material systems is inhomogeneous, as it differs in the metric and in the values of curvature, depending on the distribution of gravitating forces.

More often than not, numerous anomalies and paradoxes in cosmology suggest that in the context of Universe dynamics it is prudent for cosmologists to consider the average energy density scale rejecting thereby the space non-homogeneity while retaining the isotropy assumption. However, taking into account our postulate of the gravitational transition, which leads to the growth of space, the homogeneity of energy in space, in contrast, will thus supposedly manifest itself, demonstrating a decrease in energy density with the development of growing phenomena in the visible hemisphere. This speculative postulate, in spite of violation in reality the homogeneity assumption, may lead to correct understanding of space and matter dynamics in the depths of space if a distance to the observed extragalactic object is truly estimated by relying on the light, which was obviously emitted at some point in the past. If we also include the principle of a gravitational transition of energy-field into quantum vacuum and baryonic matter, we believe that we can arrive at a coherent picture of the Universe.

Testing a particular theory, the researcher constructs a hypothesis based on the verifiable facts or previously established theories and examines the obtained data in relation to this knowledge base. To test the gravitational transition assertion objectively, it is necessary to obtain valid data. Still, it is debatable whether available data is an objective basis for verifying the replacement of events on time line by the energy density scale parameter values instead. Referring to the doctrine of Ernst Mach's economy of thought, the kind of math we use is not important, but how the math predicts the reality is highly relevant. Guided by this premise, we confirmed the validity of employing the average density of energy as a parameter for describing the events in space.

In the context described above, when attempting to verify the correctness of a newly developed theory, a researcher should also take into account the reliability of the data used. In some cases, the theory can be verified by examining it through its own prism—a common strategy when observing the reality. This is not the case here, because the reliability of the data records reported by NED is not in doubt. On the other hand, if there were no high correlations between known methods for calculating distances, e.g. between the modulus or the alternative theory of Noble F., and if there was a clear degree of contradiction with respect to the Hubble's law, a comparative analysis of average density energy scale μ will not be worth the efforts—it will end where it started. The only objection that really matters is that we interpreted the data on the basis of the energy density scale μ using the hypothesis of gravitational transition of the energy-field into quantum vacuum and baryonic matter while the average density μ decreases with the evolution of the Universe. The transition hypothesis cannot be adequately confirmed without accepting the validity of the gravitational transition of energy-field on the basis observations. It is also clear that we are not in the position to provide evidence in support of this assertion.

8. CONCLUDING REMARKS

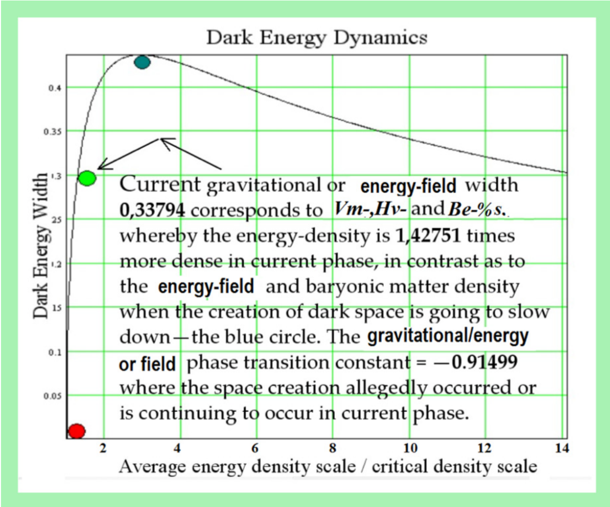
In this study, we presented a speculative equation describing the space and matter composition at the point of emergence from energy-field and as it continues to emerge. Calibrating the equation in accordance with the current mass-energy composition of the Universe allowed us to reach some speculative conclusions with regard to the energy dynamics in the Universe. We suggested treating the Big Bang as a sudden occurrence of freezing gravitational energy, or any other known or unknown type of energy, releasing latent heat. While this was a plausible line of reasoning, the math that can describe this process allowed us to explain the current composition of the Universe.

None of our speculations presented here fundamentally contradicts the latest views on the composition of the Universe in terms of the percentages of quantum vacuum and baryonic matter in proportion to the energy-field. Specifically, contradictions are avoided due to the calibration and by imposing the curvature relationship. Obviously, we eliminated the mathematical impossibility of Big Bang singularity problem of cosmic growth of the geometry from an alleged singularity $r \approx 0$. Instead, we focused on a series of holes/bobbles, represented as hyper-manifolds S^3 of radius $0 \le r \le 1$ enclosing the $\mathcal{R}^4$ hyper-globe by adopting radius of space curvature equal to 1. The latter eliminated any ambiguity in the outcomes pertaining to the quantum vacuum and baryonic matter fractions in proportion to the energy-field in case that the grid incorporated gravitational constant G and speed of light c into potential energy measurements, i.e., the case when the grid guarantees the correct output irrespective of the values adopted for G and c. We were interested in the composition of quantum vacuum, baryonic matter and energy-field, wherever these three components might be in reality. Subsuming the constant G and speed of light c under the energy density parameter μ also resulted in our calculation becoming transparent to the curvature of the space. That was the motivation behind the choice of curvature $\text{const} = 1$. Our speculative equation required fine-tuning or calibration of the so-called Λ-parameter of a speculative space-energy gravitational transition level, as well as the λ-parameter characterizing a modified potential energy-field. This allowed the optimal values to be determined, with respect to achieving the best tuning effect posited by the Planck Mission. Thus, the search for the roots of the equation depending on the average energy of density μ can have some predictive power, since the relative location of the root values in the current μ is almost 100% consistent with the latest Planck Mission Statement about the composition of space and matter in the Universe.

The next important assumption pertained to the energy density parameter μ of the emerging space and matter, to which we referred as an energy density. While acknowledging that the explanation offered for the NED data analysis findings requires more convincing arguments of equivalence of energy and space, we proceeded with our analyses by assuming that the energy density was aligned with the *"normal density"* of matter. The concept of density allowed us to interpret, as well as predict, the dynamics and *"quasi-velocity"* of the formation of a hole or a globe within space. It was also possible to make assertions that essentially coincide with the NASA statement that, in the past, the manifold expanded more slowly than it does presently. As our manifold implies, only a tiny globe of quantum vacuum solves the equation at the higher end of the energy density scale. At this extreme end of the density scale, the manifold comprised solely of energy-field, i.e., when the time $t \le 0$ since the baryonic matter radius suggested almost a zero solution. At the opposite (lower) extreme of the scale, approaching the critical value, in contrast to the baryonic matter, the quantum vacuum will allegedly start to diminish.

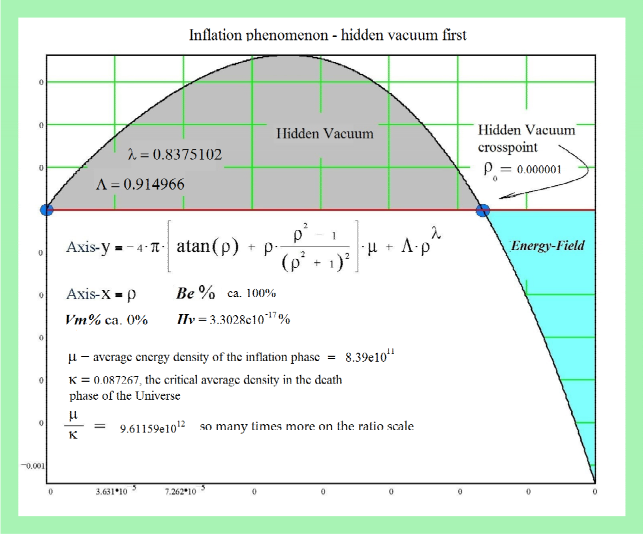
APPENDIX. ***The energy density scale effects***

Figure 6: Shows the dynamics of energy-field as a function of density.



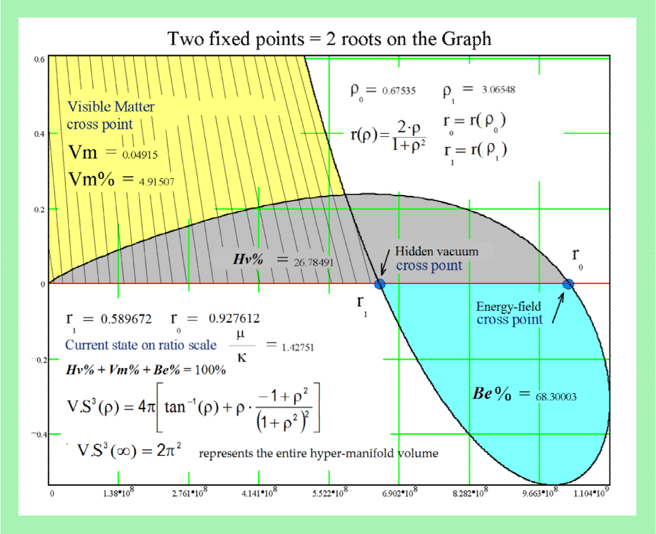
The scale of energy density on the x-axis extends from its critical ratio=1 and will continue to reflect the energy-field width as it shifts to the right. If one moves in the opposite direction (to the left), using the analogy implied by the proposed scale, the Figure 6 shows that the formation of quantum vacuum or matter precedes, cf. Carroll (2007), that of baryonic matter because the gap between the two forms increases. On the y-axis, when the inverse stereographical distance $r_1 - r_0 = 2 \cdot \left[\frac{\rho_1}{1+\rho_1^2} - \frac{\rho_0}{1+\rho_0^2} \right]$ reaches some point, it will stop increasing, thus closing the aforementioned gap. The reduction, as indicated in Figure 6, will be most pronounced in the energy density in vicinity of 1, where the red circle indicates the end of the evolution of the manifold—the moment of reaching the critical density κ. Thus, as indicated by the blue circle, at the much later stages of evolution, the gap between the baryonic matter and the quantum vacuum starts to close. The state of the manifold at the current stage—denoted by the green circle—is particularly relevant here, as it indicates the present state of the manifold that has already passed the turnaround point. When the gap started closing, the energy density was about three times greater than that at the present state.

Figure 7: Depicts the case of energy density exceeding a critical value $\kappa \approx 0.087267$ by more than $\approx 9.6115916 \cdot 10^{12}$ times. Quantum vacuum size $\rho_0 \approx 0.000001$



Based on the zero solution $\rho_s \approx 0 > 0$ of the equation, while moving to the right along the x-axis, the speculation states that a positive root $\rho_0 > 0$ can be interpreted as a creation of a small lump of quantum vacuum. We can paraphrase this statement, positing that the quantum vacuum was created first. As it preceded the baryonic matter creation—the inflation Bang of the Big Bang resulted in the emergence of the quantum vacuum only.

Figure 8: Two roots on opposite poles of S^3 geometry/bubble



The graphical illustration provided in Figure 8, denoting the link between the S^3 manifold and its stereographical projection into Euclidian topology E^3 inflated by quantum vacuum and baryonic matter with regard to energy-field, is the foundation for the study of the essence of all of our Speculations. On the x-axis, the radius r is given by an inverse stereographic mapping $r = \frac{2\rho}{1+\rho^2}$ while the y-axis corresponds to

$$\Gamma(\mu,\rho) = -4\pi \cdot \left[\tan^{-1}(\rho) + \rho \cdot \frac{-1+\rho^2}{\left(1+\rho^2\right)^2} \right] \cdot \mu + \Lambda \cdot \rho^{\lambda}.$$

The interval $[0 \le \rho \le 1]$ in r-coordinates corresponds to $[0 \le r \le 1]$, whereby the coordinate $r \to 0$ when moving further from 1 corresponds to $\rho \to \infty$. Thus, in the r-coordinate system used in Figure 8, presence of *double curves* on the x/y-axis for $\Gamma(\mu, \rho)$ makes sense.

Two roots (ρ_0, ρ_1) at which the formation of space and matter allegedly occurs solve the equation $\Gamma(\mu,\rho) = 0$. Hence, it can be seen that the graph shown in Figure 8 corresponds to the energy density $\mu = 0.12457$ supposedly representing the current state of the manifold S^3 . While passing through the area highlighted in gray, we we move r_0 from zero point $0 \to r_0$. In the ρ coordinate system increasing the ρ_0 upward: $0 \to \rho_0$, we are moving along the positive portion of $\Gamma(\mu, \rho)$, which corresponds to 26.8% of quantum vacuum in the Universe composition. Positive $\Gamma(\mu,\rho)$ values indicate the region in the manifold S^3 where the alleged formation of quantum vacuum and baryonic matter already occurred. Similarly, entering the region $\Gamma(\mu, \rho)$ denoting negative values (depicted in blue), we move through the energy-field, which accounts for about 68.3% of the total energy, and is sufficient for further evolution of the manifold. Reaching the radius r_1, we enter the region of baryonic matter, contributing about 4.9% to the Universe composition and moving away from $\rho_1 \le \rho \to \infty$. As depicted in Figure 8, at the radius r_1 and beyond, baryonic matter cannot be in contact with the energy-field in the coordinate system $\rho \in (0, \rho_1)$. However, as it can be seen, it is superimposed on the quantum vacuum at $0 \le r_1$. In conclusion, the scenario depicted in this Figure 8 should be understood as an attempt to visualize the current state in calibrating of the Universe according to the latest data yielded by the Planck Mission measurements.[ii]

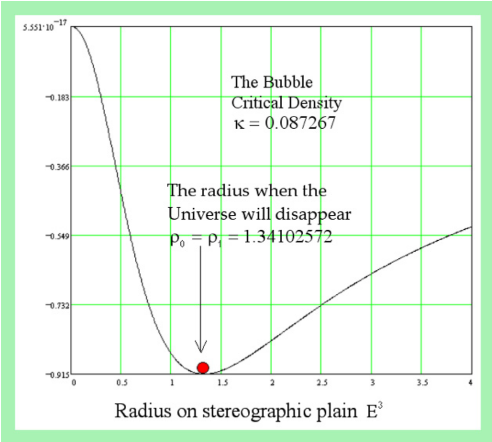


Figure 9: The potential energy governed by the radius starting point 0.

The case presented by the graph shows on the x-axis in the respective coordinate system ρ our speculative Γ-equation of space and matter creation allowed only a single root, $\rho_0 = \rho_1$. This is the *moment* after which the evolution of the manifold supposedly ceases, since the formation of the new space and matter will terminate upon reaching the critical density κ. At this last *energy-moment*, when the radius $\rho_0 = \rho_1 = 1.34102572$, as indicated by the solution of our Γ-equation, the energy density in the manifold will be critical, $\kappa \approx 0.087267$. The manifold in its current state is characterized by density $\mu = 0.12457$, which is, as already pointed above, 1.42751 times greater than the critical density κ at the scale with regard to the critical density starting point. The values of the critical potential energy $-\dfrac{V.S^3(\rho)}{\rho^\lambda}\kappa$ are depicted on the y-axis in Figure 9. In this graph, $V.S^3(\rho)$, equal to the volume of a manifold $S^3(\rho)$ of radius ρ, is multiplied be the critical density κ at which the potential energy reaches its minimum with respect to the critical condition—i.e. the level when only a single root of the Γ-equation exists.

Note that the manifold given by Γ-equation, in contrast to that usually adopted does not contain the time scale coordinate. Instead, we used the energy density parameter μ, which declines from very high values that are $96{,}115 \cdot 10^{11}$ times greater than κ. Then we attempt to shift the density towards the critical value $\kappa \approx 0.087267$. Replacing the evolution of the manifold given by Γ-equation by the energy density μ parameter is an exercise, due to the scale of *densities*, where declining values replicate the dynamics of space and matter creation within the manifold. Our exercise indicates that the density μ declines towards the current mass-energy composition; it accounts for the μ value pertaining to the current composition, which is at least 1.42751 times denser than $\kappa \approx 0.087267$.

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[i] Scientific Background on the Nobel Prize in Physics, **2011**. The accelerating universe. The Royal Swedish Academy of Sciences has as its aim to promote the sciences and strengthen their influence in society

[ii] Planck captures a portrait of the young Universe, revealing the earliest light. University of Cambridge (March **2013**), Retrieved 21 March 2013.

[iii] This was recognized early on by physicists and astronomers working in cosmology in the 1930s. The earliest Layman publication describing the details of this correspondence is Eddington, Arthur (**1933**). The Expanding Universe: Astronomy's 'Great Debate', 1900–1931. Cambridge University Press. (Reprint: ISBN 978-0-521-34976-5). Overview of products and scientific results – Table 9. Astronomy and Astrophysics, 1303, 5062. arXiv:1303.5062. Bibcode:2014A&A...571A...1P. doi:10.1051/0004-6361/201321529.

[iv] "...dark matter: An invisible, essentially collision-less component of matter that makes up about 25 percent of the energy density of the universe... it's a different kind of particle...something not yet observed in the laboratory..."

- While philosophy and physics may seem like polar opposites, they regularly address similar questions. Recently, physicists have revisited a modern philosophical topic with origins dating back over a century ago: the unreality of time. What if the passage of time were merely an illusion? Can a world without time make sense?
- While a world without the familiar passage of time may seem far-fetched, several renowned physicists, including string theory pioneer Ed Whitten and theorist Brian Greene, have recently embraced such an idea. A timeless reality may help reconcile the differences between quantum mechanics and relativity, but how can we make sense of such a world? If physics does indeed suggest that the flow of time is illusory, then philosophy may be able to shed light on such a strange notion.
- British philosopher J.M.E. McTaggart advanced this idea in **1908** in his paper titled “The Unreality of Time: http://en.wikisource.org/wiki/The_Unreality_of_Time,” last visited 17.07.2017. Philosophers widely consider his paper to be one of the most influential early examinations of this possibility. Looking through McTaggart’s philosophical lens, a reality without time becomes a little more intuitive and, in principle, possible.

A Tale of Two Times

- Several interpretations of McTaggart's argument against the reality of time have been put forth. The author's argument starts with a distinction about ordering events in time. The "A" series and "B" series of time form an integral part of McTaggart's argument, which is explicated below by using a historical event as an example.
- On July 20, **1969**, Apollo 11 became the first manned spacecraft to land on the Moon. For the purpose of this discussion, consider this event to represent an event during the present. Several days in the past (July 16), Apollo 11 lifted off the ground. Additionally, several days in the future, all of the mission astronauts will land back on Earth, safe and sound. Classifying an event as "several days prior" or "several days in the future" fits into the "A" series. With respect to the Moon landing, some events (e.g., Lincoln's assassination) are in the distant past, while others are in the distant future (e.g., the inauguration of President Obama), with numerous other events occurring somewhere in between.
- Under the "A" series, events flow from one classification (*i.e.* past, present and future) to another. On July 16th, the Moon landing would have the property of being in the future. The instant the Apollo 11 landed on the Moon, that event would be deemed as occurring in the present. After this moment, its classification changes to the past.
- The "B" series, however, does not classify events on this scale ranging from the distant past to the distant future. Instead, the "B" series orders events based on their relationship to other events. Under this ordering, Lincoln's assassination occurs *before* the Moon landing, and Obama's inauguration occurs *after* the Moon landing. This relational ordering seems to capture a different way of looking at time.

Two Times, One Contradiction

- Having made this distinction, McTaggart additionally argues that a fundamental series of time requires a change to take place. Under the "B" series, the way these events are ordered never changes. Obama's inauguration, for instance, will never change properties and occur before the Moon landing and vice versa. These relational properties are simply immutable.
- On the other hand, the "A" series does embody the change that we might expect from the flow of time. All events first have the property of being in the future, before becoming current events unfolding in the present. Afterwards, they drift into the past. Under the "A" series, time does have an objective flow, and true change does take place. In McTaggart's view (which is perhaps held by many others), this change is a necessary aspect of time.
- But herein lies the contradiction. If these events do change in this sense, they will have contradictory properties. McTaggart argues that an event cannot be simultaneously in the past, in the present, and in the future. As these properties are incompatible, the "A" series leads to a contradiction. Consequently, time, which requires change, does not truly exist. Welcome to the timeless reality!

Wait a Minute…

- Certainly, many philosophers and physicists still believe in the reality of time and have objected to McTaggart's argument. A number of fascinating caveats and counterexamples can be found elsewhere, such as http://plato.stanford.edu/entries/mctaggart/#UnrTim, last visited 17.07.2017. Nonetheless, McTaggart's work has influenced the approach to time that a number of philosophers have taken, some of whom were inspired by his work and have incorporated physics into their arguments.
- For instance, when Albert Einstein introduced the notion of special relativity, he seriously disrupted our "folk" conception of the flow of time. In special relativity, there is no absolute simultaneity of events. In one reference frame, two events may appear to take place simultaneously. An observer on a speeding rocket ship, however, may observe one event happening before the other. Neither observer is "right" in this situation; this is simply the weirdness that special relativity entails.
- Consequently, many philosophers have used special relativity as evidence refuting the presence of the "A" series of time. If absolute simultaneity does not exist, a statement that one event is "in the present" makes no sense. There is no absolute present that pervades the Universe under special relativity.
- Nonetheless, McTaggart's argument may help us better understand strange physics at the intersection of quantum mechanics and general relativity. In an attempt to reconcile these two theories, some well-known physicists have developed theories of quantum gravity implying that the world lacks time in a fundamental way.
- Brad Monton, a philosopher of physics at the University of Colorado Boulder, recently published a paper comparing McTaggart's philosophy with prominent theories in physics, including quantum gravity (http://philsci-archive.pitt.edu/4615, last visited 17.07.2017). During an interview, We asked him how some of the "timeless" ideas in quantum gravity compared to McTaggart's arguments.
  "They're on par with the radicalness," he said. "There's a lot of radicalness."
- Monton cautioned, however, that quantum gravity does not imply the absence of time that McTaggart may have had in mind. Physicist John Wheeler, as Monton notes, has postulated that time may not be a fundamental aspect of reality. However, this argument applies to extremely small distance scales only.
- Although some of these ideas pertaining to quantum gravity may be radical, several renowned physicists are seriously considering a reality without time at its core. If a quantum gravity theory that requires a radical conception of time emerges, McTaggart may help us better prepare for this new understanding of our world.
- As Monton writes in his paper: "As long as McTaggart's metaphysics is viable, then the answer to the physicists' queries is 'no' – they are free, from a philosophical perspective at least, to explore theories where time is unreal."
- Many quantum gravity theories remain speculative. Still, it is possible that timelessness may become a prominent feature in physics. In such a case, philosophers of science will hopefully help us wrap our heads around the implications.

An Experiment Comparing Angular Diameter Distances Between Pairs of Quasars

J. E. Mullat * and F. W. Noble **

Abstract. We discussed an experiment comparing the angular diameters of the distances between pairs of quasars based on data from publicly available sources. The evaluations were completed in terms of two new methods, which proved to be acceptable in their theoretical estimate of the comoving angular diameter compared to two independent datasets. It turned out to be possible to apply the Hubble diagram. The Hubble diagram was also used in a comoving manner; however, it underestimated the length of the angular diameter between quasars, while the first method overestimated. In barmaid language our technique performs +zoom while it performs -zoom at large distances with Hubble diagram. The best fit occurred with the second method. All of our conclusions were based on standard statistical reasoning that coincidence cannot be the result of chance, error, or other reason, but it reflects the fact that calculating the distance to a cosmological object is actually more difficult than most astronomers think.

Keywords: Redshift, Visible Matter, Quasars, Pair, Projection

1. Introduction

In astronomy one of the fundamental issues, which are understood by professional astronomers as well as by amateurs, is the determination of distances to cosmological objects (Czerny et al. 2018), such as galaxies, including individual stars, star clusters, radiation belts, quasars, jets, etc. For this purpose, along with the Hubble constant H_0, the relativistic Doppler effect is usually used. If used incorrectly, this leads astronomers to an erroneous estimate of the size of the Universe, but the size of the universe was always considered to be far greater than the distances we could ever see. For the truth of the statement it is necessary to adopt alternative postulates.

Most astronomers believe that Doppler effect is the correct answer, because astronomers as terrestrial observers are measuring distances to galaxies in the neighborhood. Few others rightly emphasize that the

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Doppler effect is not the correct answer, which has nothing to do with the reality, in particular when applied to cosmological objects located far away, thus having high redshift values. The Hubble law is very accurately fulfilled for the small z values of redshifts. However, for large values, the Hubble's law validity is in doubt.

The more difficult question is due to which courses the redshift occurs. Here we have no clear answer as in the first and in the second case. The issue of redshift is allegedly associated with the expansion of the universe. The expanding Universe model potentially has two flaws: first, the brightness of celestial objects can depend on many factors, not only on their distance. That is, the distances calculated from the apparent brightness of galaxies may be invalid. Secondly, it is quite possible that the redshift is completely unrelated to the speed of the galaxies. This premise is the purpose of all our discussions.

Hubble continued his research and came to a certain model of the expanding universe, which resulted in the Hubble's law. To explain it, we first recall that, according to the Big Bang model, the further the galaxy is from the epicenter of the explosion, the faster it moves. According to the Hubble's law, the rate of removal of galaxies from the terrestrial observer should be equal to the distance to the epicenter of the explosion, multiplied by a number called the Hubble constant. Using this law, astronomers calculate the distance to galaxies, based on the magnitude of the redshift, the origin of which is not completely clear to anyone. In general, astronomers decided to measure the Universe very simply. Find the velocity of galaxy, which depends on the redshift. Multiply the velocity by the redshift and divide the product by the Hubble constant. You will get the distance to any galaxy. In the same way, modern astronomers with the help of the Hubble constant calculate the size of the universe. The reciprocal of the Hubble constant has the meaning of the characteristic time of the expansion of the Universe at the current moment. This is where the feet of the Universe are growing. Hubble never believed in an expanding universe although one can find a great many websites making this statement.

Instead this is what he believed: On these, and other grounds, he (Edwin Hubble) was inclined, thus, to reject the Doppler-interpretation (galaxies moving away from each other and an expanding universe) of the redshifts and to regard the nebulae (galaxies) as stationary—and that an undiscovered reason for the observed redshift was probably responsible, **https://en.wikiquote.org/wiki/Edwin_Hubble**, last visited 4/27/2019. It was only much later that the expansion of space was proposed to explain redshifts. This made sense to most theorists in that if space could warp, according to Einstein, then it seemingly could expand or contract. A consensus explanation as to why space should expand has not immerged since the expansion of space hypothesis was proposed roughly 50 years ago.

For example, in 1929, the Hubble constant was equal to 500. In 1931, it was equal to 550. In 1936, it was 520 or 526. In 1950, it was 260, i.e. dropped significantly. In 1956, it fell even more: to 176 or 180. In 1958, it further decreased to 75, and in 1968 jumped to 98. In 1972, its value ranged from 50 to 130. Today, the Hubble constant is considered to be between 72.4 and 67.15 depending on the method being used for its calculation. All these changes allowed one astronomer to say with humor that it would be better to call the Hubble constant the Hubble variable, which is now considered likely by many. In other words, it is believed that the Hubble constant changes over time, but the term "constant" is justified by the fact that at any given moment in time the Hubble constant would accordingly be the same at all points in the Universe. [1]

Of course, all these changes over the decades can be explained by the fact that scientists improved their methods and the quality of calculations. But, the question arises: what kind of calculations? We repeat once again that no one can actually verify these calculations, because a *roulette* (even if it was a laser beam that could reach a neighboring gal-

[1] While writing these and some lines below, techn. Ed translated the content from the public domain **https://alexfl.ru/vechnoe/vechnoe_dopler.html**, accessed online 02.05.2021. The reason is that this site integrates well into the story from an alternative perspective.

axy) has not been invented yet. Also, even with regard to distances between galaxies; all this seems incomprehensible to many considering the rationale. If the Universe expands, according to the law of proportionality, evenly, then for what reason then would so many scientists get so many different values of distances based on the same proportions of the speeds of this expansion? It turns out that these proportions of expansion as such also do not exist.

2. General preliminary remarks

Today we have the technology to determine quasar distances, after many decades of study, because finally most mainstream astronomers realize that quasars are exactly the same thing as the centers of active galaxies, from which one of their bi-polar beams are faced in our direction. No astronomers have tried to measure these distances aside from the redshift of their polar beam because it would require special equipment to block out the polar beam to hopefully be able to measure the redshift of the galaxy itself rather than just the polar beam redshift. That being said, they would still be using the Hubble formula to calculate distances, which would be good enough for most quasars where they might be off by a factor of 20% rather than their present calculation errors, which at a redshift of $z = 2$ to 3 would be off by factor as much as three—underestimating distances.

Quasar pairs are a very interesting study concerning distances; the problem is that they are only called pairs because of their chance alignment from our perspective. They have, for the most part, different redshifts and different brightness. It is rare when pairs have about the same redshifts. These would interest astronomers the most. *"In 1979, astronomers at Arizona noticed that a pair of quasars, separated by only 6", and known collectively as The Twin Quasar (also known as Twin QSO, Double Quasar, SBS 0957+561, TXS 0957+561, Q0957+561 or QSO 0957+561 A/B), looked remarkably similar of about 17th magnitude, and they both have an equal redshift of 1.413.* If the pairs have about the same redshifts and brightness then they are probably close together but not at the Hubble calculated distances. Only few have the same redshift but different brightness. Mainstream astronomers would say that they are at the same distances from us and are likely close together, where we herby in the study would say that they are far apart in their distances based upon their different brightness, where we could estimate their different distances. Pairs with different redshift could also be very interesting in that those of different redshifts having the same brightness, could be very close to each other even though their redshifts indicate otherwise based upon the Hubble formula.

Quasars provide us with some of the worst distance indicators, based on the original problem proposed by Halton Arp about the distances between quasars, with which we agree. Although for quasars, the distances determined from the redshift indicators, as for galaxies, can be accurately calculated for some of them. However, for others, there will be little or no direct correlation between redshift and distances. A completely arbitrary estimate on our part with regard to distances will be such that 80% of the quasars are to some extent correct, and 20% will be completely unrelated to their redshifts, even if the correct distance formula is applied.

3. Visualization of the angular distance diameter

We turn to the analysis of data on distances to cosmological objects due to "blind glance" or a certain ideology of data evaluation. Blind glance has allowed us, without having special knowledge of observations, to discover some hidden patterns in the data available on the Internet. A clear understanding of what is at stake needs to be achieved. In our case, we are dealing with an observer for whom the object of observation is a pair of quasars. In the calculations, the Hubble law with a constant $H_0 = 70$ was chosen. You can use any method for calculating distances to cosmological objects as long as you take the length of the angular distance from the point of view of the observer.

The goal was to compare three methods of calculating distances to cosmological objects: 1)-st method, the postulate of the phase transition of energy into matter (Γ-method, Mullat, 2019, 1971-1976) was used, in the 2)-nd method, the so-called method according to the PAN theory (Noble and Cooper, 2014), and in the 3)-rd the Hubble's diagram. For this purpose, we have downloaded from public domain a number of articles (Kochanek et al. 1997; Zhdanov and Surdej, 2001; Hennawi et al 2010; Rogerson and Hall, 2012; Findlay et al. 2018), and compiled dataset a) with 133 pairs of quasars in total. Next, we have downloaded and compliled a dataset b) — a total of 129 pairs of quasars (Decarli et al. 2009; Farina et al. 2014; Sandrinelli et al. 2020). Judging by the borrowed observational data sets a) and b), it was acceptable to adjust the apparent angle $\theta \cdot (1 \pm \Delta\alpha\%)$ of the so-called comoving diameter by changing the scale of angular interval of a pair of quasars until the best approximation occurred. This approach made it possible to establish over- or under-estimate indices as percentages relative to data collected online.

We called diameter r as comoving in the FLRW metric of flat cosmology, that is, the θ'' angular diameter of $\frac{r}{1+z}$ coordinate comoving with the redshift z. *"Comoving distance factors out the expansion of the universe, giving a distance that does not change in time due to the expansion of space (though this may change due to other, local factors, such as the motion of a galaxy within a cluster)."* This assumption about the angular diameter of the visible distances from the position of an observer, placed at the point of observation of a pair of quasars at the opposite end, turns out to be useful.

We have also implemented brightness enhancement ΔL (as it seems to us a result of rather convincing reasoning regarding the scales of measuring distances both in the past and in present time intervals) into the PAN formula, Noble and Cooper, according thereby decreased the PAN distances. Instead of the distances calculated by all three methods, we introduced, in the result, the comoving angular diameter between quasars. Namely, we divided the distances by $1+z$ thereby also reducing the diameter as the redshift increased. That being said, it turned out to be possible to adjust the angular diameter scale interval in such a way that each of the methods, including the Hubble diagram, was best, one by one, and each allegedly with great accuracy estimates physical comoving angular diameters represented in datasets a) and b), Figure 1 and Figure 2.

Since in the past the brightness was apparently relatively brighter (or just like all dimensions and distances, and to the same extent that we might have seemed larger in the past due to a change in the measurement scale) then multiplying the distance by a factor of inverse brightness, we subtract the current scale of distance measurement. This means that we allow a return in time to the most distant parts of the Universe, which we can observe now. Using a barmaid argument, suppose that we can build a spaceship with an accurate odometer. After the spacecraft has moved from here to there, it will measure the distance and brightness calculated, as it were, in the previous time interval, which can be called the "real" distance. But these are not the distances that we would consider valid today based on our current distance criteria.

According to related paper (Noble and Cooper, 2014) concerning type 1a supernova, the distance formula of the 2)-nd method was very closely confirmed by these supernova observations and calculations. But the model requires two formulas for distance determination: One for measuring distance and the other for determining apparent brightness. Astronomers would have to use both formulas. The brightness formula is needed for corroboration of the distance formula based upon the inverse square law of light intensity to distances. Using a single formula to calculate distances can be exactly calculated, but corroboration and understanding of the calculated distances could never be based upon an expanding-universe model. This method, unlike the first one (Mullat, 2019), takes into account both brightness and luminosity as follows.

Proposed, **https://www.pantheory.org/hubble-formula/** method accessed online 03.24.2021, (Noble and Cooper, with minor technical amendments) can estimate distances to cosmological objects with moderate accuracy, that is, the NC formula:

$$\mathrm{nc(z)} = 18110.607641 \cdot \ln\left\{\left(\frac{1+\sqrt{1+z}}{2}\right)^{\sqrt{1+z}}\right\} \cdot \sqrt{\frac{1}{1+\Delta L}} \approx 4820.9 \cdot z \cdot \sqrt{\frac{1}{1+\Delta L}},$$

where, $\Delta L = \log\left\{\left[\left((1+z)^{\frac{t(z)}{2}} - 1\right) \cdot \frac{t(z)}{2} + 1\right] \cdot (1+z)^{10^{2/5}}\right\}$ and

$t(z) = 9.966 \cdot \sqrt{1+z}$.

So, using MATHCAD spreadsheets, the formula estimates distances to be approximately equal to $\mathrm{nc(z)}$ Mpc.

The factor for corroboration $\sqrt{\frac{1}{1+\Delta L}}$ appears here for simple reasons. Indeed, if for an object with a luminosity of L lumen and located at a distance, say ρ, from the observer, the luminosity of the latter is enhanced by a certain fraction of ΔL of the luminosity L, then the luminosity enhanced in this way will be equal to $L \cdot (1+\Delta L)$. Now, it remains only to find out what the distance r to the object with its original luminosity will be if the brightness for the observer is compared with the brightness of the object with enhanced luminosity, namely, the equality should then remain: $\frac{L}{r^2} = \frac{L \cdot (1+\Delta L)}{\rho^2}$: after all, $r = \rho \cdot \sqrt{\frac{1}{1+\Delta L}}$.
So, for quasar pairs, for instance, aside from their equal redshifts, their distance differences could be accurately estimated based upon their brightness differences. Therefore quasars that have the same redshifts could be very distant from each other, in some cases the dimmer of the two could be twice as far away. We can estimate distances based upon above indicated inverse square law of light up to a redshift of about $z \approx 3$.

Figure 1.

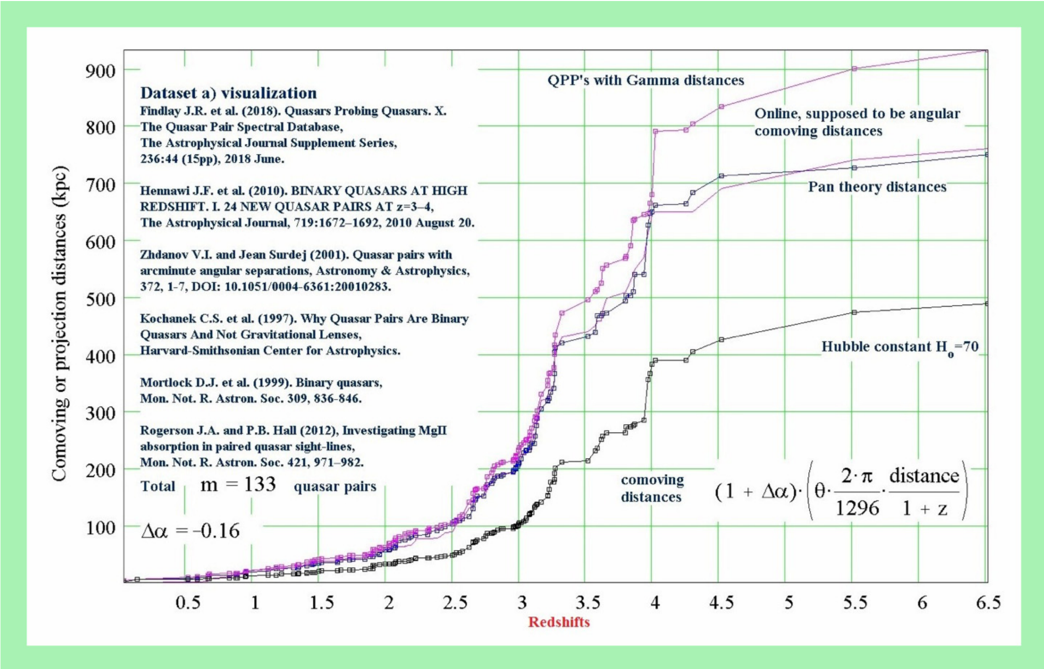

Figure 1 above visualize the dataset a) for $\Delta\alpha$=-16%, Figure 2 below for $\Delta\alpha$=-6%; dataset b). We have an overestimation at $\Delta\alpha$%<0 — at $\Delta\alpha$%>0; an underestimation. The situation $\Delta\alpha$=0% sets the angular diameter scale as kpc per second, (kpc)s^{-1}, which corresponds to the usual scale. The situation $\Delta\alpha$%<0 means that the scale is compressed; $\Delta\alpha$%>0 the opposite—the extension, until the minimum of standard deviation, both, for the applied distance calculation methods are reached. It is reasonable to take the $\pm\Delta\alpha$% value as indcator in percents of the deviation of theoretical distances in one or the other direction for the datasets a) and b) presented in Tables 1-2 below.

- overestimation, + underestimation

Zoom Δα	Gamma	Pan	Hubble
Dataset a)	-27.1%	-16.0%	44.0%
Deviation	34.9	16.4	88.3
Dataset b)	-24.5%	-6.0%	21.0%
Deviation	14.08	4.47	16.55

The figure 1 represents four traces (kpc, y-axis, redshifts, x-axis): a) Projection of quasar pairs using Gamma estimates (Mullat. 2019); b) Projection of quasar pairs found online (Findlay et al., 2018; Hennawi et al., 2010); c) Projection of quasar pairs, PAN theory (Noble, 2014); and d) Hubble original diagram distances: Hubble constant $H_0 = 70$. The figure 2 visualizes the data in similar way.

Figure 2.

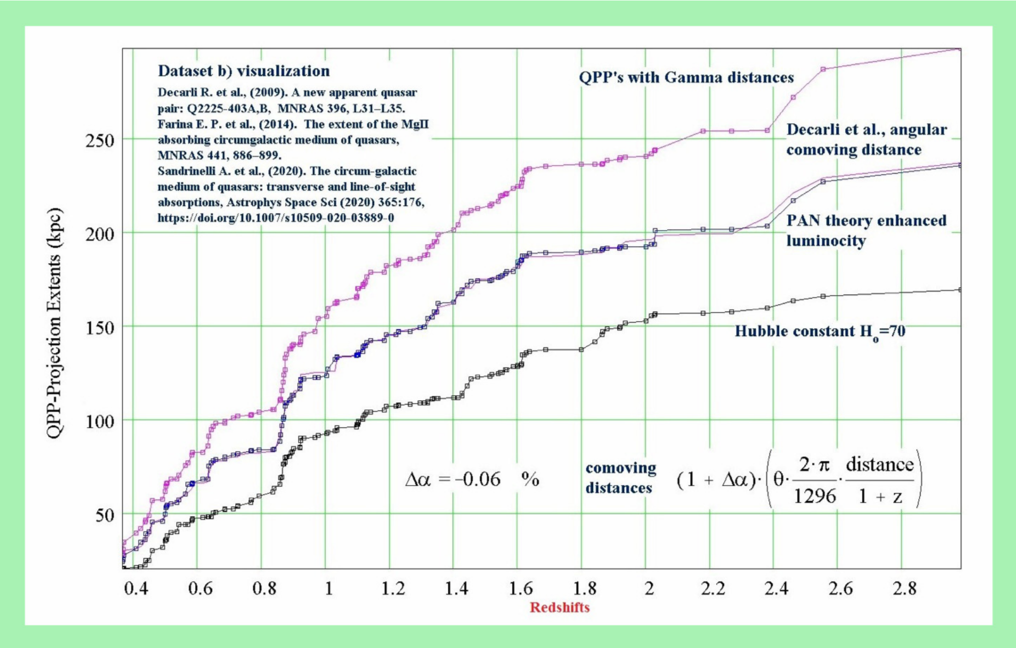

Table 1. Findlay et al., (2018). Quasars Probing Quasars. X. The Quasar Pair Spectral Database, The Astroph. Journal Supplement Series, 236:44 (15pp), **rows 1-54**; Hennawi et al., (2010). Binary Quasars at high redshifts, New Quasar Pairs at $z \approx 3 - 4$, The Astroph. Journal, 719:1672–1692, **rows 55-80**; Shdanov and Surdey (2001). Quasar pairs with arcminute angular separations, Article in Astronomy and Astrophysics, **rows 81-91**; Kochanek et al., (1997) and Mortlock et al., (1999). Why Quasar Pairs Are Binary Quasars, And Not Gravitational Lenses, Harvard-Smithsonian Center for Astrophysics, **rows 92-119**; Rogerson J. A. and P. B. Hall (2012). Investigating MgII absorption in paired quasar sight-lines, Mon. Not. R. Astron. Soc. 421, 971–982, **rows 120-133**.

A Note amended for our purposes. From left to right: 1) *column give the names of the foreground quasars*; 2) *the foreground quasar redshifts*; 3) *the on-sky angular separation between the pair in arc seconds"*; 4*) the physical, i.e., comoving transverse distance between the line of sight of the background quasar and the foreground quasar in pkpc*; 5) Estimates of pkpc using Gamma distance; 6) Estimates of pkpc using PAN distance; 7) Estimates of Hubble's diagram (pkpc); Differences between Findlay et al. and those: 8) in Gamma pkpc; 9) in PAN (pkpc); and 10) in Hubble's diagram (pkpc).

	Table 1 QSOfg	Zfg	M"	Proj. pkpc	G pkpc	PAN pkpc	HBL pkpc	G - Proj.	PAN - Proj.	HBL - Proj.
1	J003308.63–083222.19	3.038	27.54	216.00	237	218	105	21	2	-111
2	J012902.78+191824.46	2.680	25.80	210.00	232	205	105	22	-5	-105
3	J015415.22+032455.84	2.660	18.24	149.00	165	145	75	16	-4	-74
4	J022845.72–124643.92	1.733	41.28	358.00	400	323	201	42	-35	-157
5	J023229.05–100123.48	2.063	38.46	329.00	368	305	177	39	-24	-152
6	J031855.31–103040.30	2.226	58.92	498.00	556	468	263	58	-30	-235
7	J032926.40–134732.22	2.073	59.52	509.00	569	471	273	60	-38	-236
8	J033347.40–133928.44	2.230	30.78	260.00	290	244	137	30	-16	-123
9	J034952.34–110620.59	2.449	55.20	459.00	510	439	236	51	-20	-223
10	J090551.96+253003.35	3.325	24.66	188.00	204	194	89	16	6	-99
11	J090828.30+080313.18	2.390	23.10	193.00	215	184	100	22	-9	-93
12	J091800.77+153621.46	2.980	9.90	78.00	86	78	38	8	0	-40
13	J093240.91+400905.65	2.962	25.56	203.00	222	202	99	19	-1	-104
14	J093836.78+100905.34	2.504	22.56	187.00	207	179	95	20	-8	-92
15	J095503.57+614242.66	2.739	5.58	45.00	50	44	23	5	-1	-22
16	J095549.38+153838.11	0.830	6.18	48.00	51	41	32	3	-7	-16
17	J095629.72+243441.34	2.979	25.50	201.00	221	202	98	20	1	-103
18	J100205.70+462411.82	3.138	29.40	229.00	249	232	110	20	3	-119
19	J100253.37+341924.03	2.418	11.40	95.00	106	91	49	11	-4	-46
20	J100903.16–142104.27	2.033	59.70	511.00	572	472	276	61	-39	-235
21	J101853.24–160727.80	2.331	40.32	338.00	377	320	176	39	-18	-162
22	J102947.32+120817.11	2.820	23.94	192.00	212	190	95	20	-2	-97
23	J103109.37+375749.68	2.752	17.52	142.00	156	139	71	14	-3	-71
24	J103716.68+430915.57	2.676	29.34	239.00	264	233	120	25	-6	-119
25	J104314.33+143434.81	2.980	9.36	74.00	81	74	36	7	0	-38
26	J104339.12+010531.29	3.240	26.70	205.00	223	210	98	18	5	-107
27	J105202.95–103803.70	2.104	12.12	103.00	116	96	55	13	-7	-48
28	J105338.15–081623.66	2.192	30.72	260.00	291	244	138	31	-16	-122
29	J105354.90–100941.44	3.232	11.52	89.00	96	91	42	7	2	-47
30	J110402.08+132154.46	2.869	21.96	176.00	193	174	87	17	-2	-89
31	J110124.79–105645.12	2.579	18.48	152.00	168	147	77	16	-5	-75
32	J111820.36+044120.22	3.120	5.28	41.00	45	42	20	4	1	-21
33	J112032.04–095203.21	2.180	26.52	225.00	251	210	119	26	-15	-106
34	J112239.32+450618.54	3.590	29.16	216.00	232	228	101	16	12	-115
35	J112355.97–125040.73	2.965	54.48	431.00	473	431	211	42	0	-220
36	J112516.06+284057.59	2.845	25.26	203.00	223	200	100	20	-3	-103
37	J112839.64–144842.36	1.920	53.28	459.00	513	420	251	54	-39	-208
38	J112913.52+662039.13	2.807	24.84	200.00	220	197	99	20	-3	-101
39	J113820.28+203336.93	2.687	4.26	34.00	38	34	17	4	0	-17
40	J114443.59+102143.48	1.503	26.16	227.00	253	201	132	26	-26	-95
41	J115037.52+422421.01	2.883	24.66	197.00	216	195	97	19	-2	-100
42	J115222.15+271543.29	3.102	4.80	38.00	41	38	18	3	0	-20
43	J120032.34+491951.99	2.629	29.88	244.00	271	237	123	27	-7	-121
44	J121642.25+292537.97	2.532	10.68	88.00	98	85	45	10	-3	-43
45	J122900.87+422243.23	3.842	21.48	156.00	165	167	71	9	11	-85
46	J123055.78+184746.79	3.169	19.26	149.00	163	152	72	14	3	-77
47	J132728.77+271311.96	3.085	19.20	150.00	164	152	73	14	2	-77
48	J134221.26+215041.97	3.062	21.72	170.00	186	172	83	16	2	-87

49	J135456.96+494143.74	**3.126**	**10.50**	**82.00**	*89*	*83*	*39*	*7*	*1*	*-43*
50	J141457.24+242039.67	**3.576**	**26.64**	**198.00**	*213*	*208*	*92*	*15*	*10*	*-106*
51	J143622.50+424127.13	**3.000**	**7.44**	**59.00**	*64*	*59*	*29*	*5*	*0*	*-30*
52	J144225.30+625600.96	**3.271**	**29.40**	**226.00**	*245*	*231*	*108*	*19*	*5*	*-118*
53	J162413.70+183330.72	**2.763**	**23.58**	**190.00**	*210*	*187*	*95*	*20*	*-3*	*-95*
54	J214858.11–074033.28	**2.660**	**1.86**	**15.00**	*17*	*15*	*8*	*2*	*0*	*-7*
55	J0004-0844A	**2.998**	**4.40**	**35.00**	*38*	*35*	*17*	*3*	*0*	*-18*
56	J0829+2927A	**3.054**	**40.30**	**322.00**	*346*	*319*	*153*	*24*	*-3*	*-169*
57	J0956+2643A	**3.087**	**16.50**	**131.00**	*141*	*130*	*62*	*10*	*-1*	*-69*
58	J0959+1032A	**4.024**	**44.10**	**320.00**	*330*	*341*	*141*	*10*	*21*	*-179*
59	J1016+4040A	**2.996**	**68.20**	**548.00**	*590*	*540*	*263*	*42*	*-8*	*-285*
60	J1021+1112A	**3.805**	**7.60**	**56.00**	*59*	*59*	*25*	*3*	*3*	*-31*
61	J1053+5001A	**3.078**	**2.10**	**17.00**	*18*	*17*	*8*	*1*	*0*	*-9*
62	J1054+0215A	**3.984**	**88.30**	**644.00**	*664*	*684*	*285*	*20*	*40*	*-359*
63	J1116+4118A	**2.982**	**13.80**	**111.00**	*120*	*109*	*53*	*9*	*-2*	*-58*
64	J1118+0202A	**3.939**	**83.80**	**613.00**	*634*	*650*	*273*	*21*	*37*	*-340*
65	J1150+4659A	**3.005**	**34.90**	**280.00**	*301*	*276*	*134*	*21*	*-4*	*-146*
66	J1159+3426A	**3.135**	**51.20**	**405.00**	*435*	*404*	*192*	*30*	*-1*	*-213*
67	J1248+1957A	**3.872**	**64.80**	**477.00**	*495*	*503*	*213*	*18*	*26*	*-264*
68	J1251+2715A	**3.660**	**13.90**	**105.00**	*110*	*109*	*47*	*5*	*4*	*-58*
69	J1307+0422A	**3.021**	**8.20**	**66.00**	*71*	*65*	*31*	*5*	*-1*	*-35*
70	J1312+4616A	**3.971**	**85.70**	**625.00**	*646*	*664*	*277*	*21*	*39*	*-348*
71	J1353+4852A	**3.863**	**37.10**	**273.00**	*284*	*288*	*122*	*11*	*15*	*-151*
72	J1404+4005A	**3.999**	**47.30**	**344.00**	*355*	*366*	*152*	*11*	*22*	*-192*
73	J1414+3955A	**3.218**	**30.70**	**242.00**	*258*	*242*	*113*	*16*	*0*	*-129*
74	J1420+2831A	**4.305**	**10.90**	**77.00**	*78*	*84*	*33*	*1*	*7*	*-44*
75	J1439-0033A	**4.255**	**33.40**	**237.00**	*242*	*257*	*103*	*5*	*20*	*-134*
76	J1541+2702A	**3.623**	**6.40**	**48.00**	*51*	*50*	*22*	*3*	*2*	*-26*
77	J1546+5134A	**2.961**	**42.20**	**340.00**	*367*	*334*	*164*	*27*	*-6*	*-176*
78	J1622+0702A	**3.264**	**5.80**	**45.00**	*48*	*46*	*21*	*3*	*1*	*-24*
79	J1626+0904A	**3.632**	**52.70**	**398.00**	*417*	*412*	*181*	*19*	*14*	*-217*
80	J1630+1152A	**3.277**	**23.80**	**186.00**	*198*	*187*	*87*	*12*	*1*	*-99*
81	Q0053-3342A	**2.000**	**83.70**	**650.00**	*803*	*662*	*389*	*153*	*12*	*-261*
82	Q0107-0235	**0.958**	**77.50**	**570.00**	*680*	*540*	*405*	*110*	*-30*	*-165*
83	CTS-H26.12	**2.330**	**58.90**	**450.00**	*551*	*468*	*257*	*101*	*18*	*-193*
84	Q1310+4254A	**2.561**	**91.40**	**690.00**	*834*	*726*	*382*	*144*	*36*	*-308*
85	1WGA	**1.890**	**82.20**	**650.00**	*793*	*648*	*390*	*143*	*-2*	*-260*
86	1333.2+2604	**1.182**	**68.30**	**530.00**	*636*	*503*	*356*	*106*	*-27*	*-174*
87	Q2121-4642	**1.347**	**82.80**	**650.00**	*790*	*626*	*426*	*140*	*-24*	*-224*
88	Q2139-4433	**3.220**	**62.60**	**440.00**	*525*	*493*	*231*	*85*	*53*	*-209*
89	QSM1:35	**1.123**	**70.10**	**540.00**	*645*	*510*	*367*	*105*	*-30*	*-173*
90	1336.5+2804	**1.310**	**94.70**	**740.00**	*900*	*713*	*489*	*160*	*-27*	*-251*
91	HE_1104-1805	**2.320**	**3.10**	**24.00**	*29*	*25*	*14*	*5*	*1*	*-10*
92	HS_1216+5032	**1.450**	**9.10**	**78.00**	*88*	*70*	*46*	*10*	*-8*	*-32*
93	J-164313156	**0.590**	**2.30**	**16.00**	*16*	*13*	*11*	*0*	*-3*	*-5*
94	LBQS_1429{008	**2.080**	**5.10**	**42.00**	*49*	*40*	*23*	*7*	*-2*	*-19*
95	LBQS_2153-2056	**1.850**	**7.80**	**64.00**	*75*	*61*	*37*	*11*	*-3*	*-27*
96	MG_0023+171	**0.950**	**4.80**	**40.00**	*42*	*33*	*25*	*2*	*-7*	*-15*
97	MG_2016+112	**3.270**	**3.60**	**26.00**	*30*	*28*	*13*	*4*	*2*	*-13*
98	MGC_2214+3550	**0.880**	**3.00**	**26.00**	*26*	*20*	*16*	*0*	*-6*	*-10*

99	PKS_1145-071	**1.350**	**4.20**	**36.00**	*40*	*32*	*22*	*4*	*-4*	*-14*
100	Q_0151+048y	**1.910**	**3.30**	**28.00**	*32*	*26*	*16*	*4*	*-2*	*-12*
101	Q_0957+561	**1.410**	**6.10**	**52.00**	*59*	*46*	*31*	*7*	*-6*	*-21*
102	Q_1120+0195yy	**1.460**	**6.50**	**56.00**	*63*	*50*	*33*	*7*	*-6*	*-23*
103	Q_1343+2640	**2.030**	**9.50**	**78.00**	*91*	*75*	*44*	*13*	*-3*	*-34*
104	Q_1635+267	**1.960**	**3.80**	**32.00**	*37*	*30*	*18*	*5*	*-2*	*-14*
105	Q_2138-431	**1.640**	**4.50**	**38.00**	*44*	*35*	*22*	*6*	*-3*	*-16*
106	Q_2345+007	**2.150**	**7.30**	**58.00**	*69*	*58*	*33*	*11*	*0*	*-25*
107	Q-0101.823012	**0.890**	**17.00**	**132.00**	*145*	*116*	*88*	*13*	*-16*	*-44*
108	Q-015110448a	**1.910**	**3.30**	**28.00**	*32*	*26*	*16*	*4*	*-2*	*-12*
109	Q-112010195b	**1.470**	**6.50**	**55.00**	*63*	*50*	*33*	*8*	*-5*	*-22*
110	Q-120811011	**3.800**	**0.50**	**3.00**	*4*	*4*	*2*	*1*	*1*	*-1*
111	Q-134312640	**2.030**	**9.50**	**79.00**	*91*	*75*	*44*	*12*	*-4*	*-35*
112	Q-142920053	**2.080**	**5.10**	**42.00**	*49*	*40*	*23*	*7*	*-2*	*-19*
113	Q-16341267	**1.960**	**3.80**	**32.00**	*37*	*30*	*18*	*5*	*-2*	*-14*
114	Q-21382431	**1.640**	**4.50**	**38.00**	*44*	*35*	*22*	*6*	*-3*	*-16*
115	Q-215322056	**1.850**	**7.80**	**66.00**	*75*	*61*	*37*	*9*	*-5*	*-29*
116	Q-23451007	**2.150**	**7.30**	**61.00**	*69*	*58*	*33*	*8*	*-3*	*-28*
117	Q23540+1839	**1.666**	**96.20**	**760.00**	*933*	*750*	*474*	*173*	*-10*	*-286*
118	QJ_0240-343	**1.410**	**6.10**	**52.00**	*59*	*46*	*31*	*7*	*-6*	*-21*
119	RXJ_0911.4+0551	**2.800**	**3.10**	**24.00**	*27*	*25*	*12*	*3*	*1*	*-12*
120	Q1343+266	**0.520**	**9.50**	**58.95**	*62*	*51*	*43*	*3*	*-8*	*-16*
121	Q1343+267	**1.520**	**10.50**	**59.95**	*101*	*81*	*53*	*42*	*21*	*-7*
122	Q1343+268	**2.520**	**11.50**	**60.95**	*105*	*91*	*48*	*44*	*30*	*-12*
123	Q1343+269	**3.520**	**12.50**	**61.95**	*101*	*98*	*44*	*39*	*36*	*-18*
124	Q1343+270	**4.520**	**13.50**	**62.95**	*94*	*103*	*40*	*31*	*40*	*-23*
125	Q1343+271	**5.520**	**14.50**	**63.95**	*88*	*108*	*37*	*24*	*44*	*-27*
126	Q1343+272	**6.520**	**15.50**	**64.95**	*82*	*112*	*35*	*17*	*47*	*-30*
127	HS_1216+5032	**0.040**	**9.10**	**7.93**	*6*	*6*	*6*	*-2*	*-2*	*-2*
128	HS_1216+5032	**0.140**	**9.10**	**21.83**	*20*	*20*	*18*	*-2*	*-2*	*-4*
129	SDSS_J1029+2632	**0.670**	**1.77**	**10.53**	*13*	*11*	*9*	*3*	*0*	*-2*
130	SDSS_J1029+2632	**1.760**	**1.77**	**1.34**	*17*	*14*	*9*	*16*	*13*	*7*
131	SDSS_J1029+2632	**1.910**	**1.77**	**0.81**	*17*	*14*	*8*	*16*	*13*	*8*
132	J0904+1512	**1.220**	**1.13**	**0.52**	*11*	*8*	*6*	*10*	*8*	*5*
133	J1054+2733	**0.680**	**1.27**	**1.87**	*10*	*8*	*6*	*8*	*6*	*4*
		Rows 1-54 standard deviation, Fanomo et al.						**15.0**	**12.4**	**58.5**
		Rows 55-99 standard deviation, Hennawi et al.						**10.3**	**14.4**	**108.8**
		Rows 1-133, total standard deviation						**34.9**	**16.4**	**88.3**

Table 2. Sandrinelli et al. (2020). The circum-galactic medium of quasars: transverse and line-of-sight absorptions, Astrophysics Space Sci 365:176, **rows 1-14**; Farina et al. (2014). The extent of the MgII absorbing circumgalactic medium of quasars, MNRAS 441, 886–899, **rows 15-32**; Decarli R. at al. (2009). A new apparent quasar pair: Q2225-403A,B, MNRAS 396, L31–L35, **rows 33-52**; Farina E. P. (2012). Physical and Projected Pairs of Quasars, A Thesis submitted for the degree of Doctor of Philosophy, supervisor: A. Treves, co–supervisor: R. Falomo, **rows 53-129**.

	Table 2 ID	Zfg	Arc sec	Proj. (kpc)	G pkpc	PAN pkpc	HBL pkpc	G - Proj.	PAN - Proj.	HBL - Proj.
1	Sandr.1	**0.66**	**3.7**	**25**	*31*	*25*	*20*	*6*	*0*	*-5*
2	Sandr.2	**0.9**	**3.6**	**30**	*35*	*28*	*21*	*5*	*-2*	*-9*
3	Sandr.3	**0.88**	**28.6**	**221**	*272*	*217*	*166*	*51*	*-4*	*-55*
4	Sandr.4	**0.86**	**25.4**	**196**	*240*	*191*	*147*	*44*	*-5*	*-49*
5	Sandr.5	**1.13**	**28.9**	**237**	*298*	*236*	*169*	*61*	*-1*	*-68*
6	Sandr.6	**1.1**	**13.7**	**112**	*140*	*111*	*80*	*28*	*-1*	*-32*
7	Sandr.7	**0.84**	**27.3**	**208**	*255*	*203*	*157*	*47*	*-5*	*-51*
8	Sandr.8	**1.03**	**16.9**	**136**	*170*	*135*	*99*	*34*	*-1*	*-37*
9	Sandr.9	**0.98**	**19.0**	**151**	*188*	*149*	*111*	*37*	*-2*	*-40*
10	Sandr.10	**0.64**	**28.7**	**198**	*236*	*192*	*157*	*38*	*-6*	*-41*
11	Sandr.11	**1.12**	**27.9**	**229**	*287*	*227*	*163*	*58*	*-2*	*-66*
12	Sandr.12	**0.86**	**19.3**	**148**	*182*	*145*	*112*	*34*	*-3*	*-36*
13	Sandr.13	**0.77**	**6.3**	**47**	*57*	*45*	*36*	*10*	*-2*	*-11*
14	Sandr.14	**0.71**	**11.3**	**82**	*98*	*79*	*63*	*16*	*-3*	*-19*
15	Farin.1	**0.79**	**12.1**	**91**	*110*	*88*	*69*	*19*	*-3*	*-22*
16	Farin.2	**1.62**	**9.4**	**80**	*102*	*82*	*52*	*22*	*2*	*-28*
17	Farin.3	**1.12**	**21.4**	**175**	*220*	*174*	*125*	*45*	*-1*	*-50*
18	Farin.4	**1.32**	**22.2**	**186**	*236*	*187*	*128*	*50*	*1*	*-58*
19	Farin.5	**1**	**22.0**	**176**	*219*	*174*	*129*	*43*	*-2*	*-47*
20	Farin.6	**0.92**	**15.9**	**125**	*154*	*123*	*93*	*29*	*-2*	*-32*
21	Farin.7	**0.88**	**18.8**	**145**	*179*	*142*	*109*	*34*	*-3*	*-36*
22	Farin.8	**0.69**	**19.5**	**138**	*166*	*134*	*108*	*28*	*-4*	*-30*
23	Farin.9	**1.04**	**8.2**	**66**	*83*	*65*	*48*	*17*	*-1*	*-18*
24	Farin.10	**0.73**	**16.0**	**116**	*140*	*113*	*90*	*24*	*-3*	*-26*
25	Farin.11	**1.6**	**22.0**	**176**	*239*	*191*	*123*	*63*	*15*	*-53*
26	Farin.12	**1.19**	**17.8**	**147**	*186*	*147*	*104*	*39*	*0*	*-43*
27	Farin.13	**0.63**	**28.6**	**196**	*233*	*190*	*155*	*37*	*-6*	*-41*
28	Farin.14	**1.1**	**19.0**	**156**	*195*	*154*	*111*	*39*	*-2*	*-45*
29	Farin.15	**0.92**	**21.7**	**170**	*210*	*167*	*126*	*40*	*-3*	*-44*
30	Farin.16	**1.23**	**13.1**	**109**	*138*	*109*	*76*	*29*	*0*	*-33*
31	Farin.17	**0.87**	**23.7**	**183**	*224*	*179*	*137*	*41*	*-4*	*-46*
32	Farin.18	**1.43**	**23.6**	**199**	*254*	*202*	*135*	*55*	*3*	*-64*
33	Decar.1	**1.55**	**6.3**	**53**	*68*	*54*	*35*	*15*	*1*	*-18*
34	Decar.2	**2.03**	**7.7**	**64**	*83*	*68*	*40*	*19*	*4*	*-24*
35	Decar.3	**1.3**	**8.1**	**67**	*86*	*68*	*47*	*19*	*1*	*-20*
36	Decar.4	**1.44**	**9.8**	**82**	*106*	*84*	*56*	*24*	*2*	*-26*
37	Decar.5	**2.18**	**9.5**	**78**	*101*	*84*	*48*	*23*	*6*	*-30*
38	Decar.6	**1.34**	**6.6**	**55**	*70*	*56*	*38*	*15*	*1*	*-17*
39	Decar.7	**1.63**	**4.5**	**38**	*49*	*39*	*25*	*11*	*1*	*-13*
40	Decar.8	**1.14**	**3.8**	**31**	*39*	*31*	*22*	*8*	*0*	*-9*
41	Decar.9	**2.38**	**7.4**	**60**	*77*	*66*	*36*	*17*	*6*	*-24*
42	Decar.10	**2**	**3.9**	**32**	*42*	*35*	*20*	*10*	*3*	*-12*
43	Decar.11	**0.44**	**4.4**	**24**	*28*	*24*	*21*	*4*	*0*	*-3*
44	Decar.12	**1.31**	**9.9**	**83**	*105*	*83*	*57*	*22*	*0*	*-26*
45	Decar.13	**1.26**	**4.3**	**35**	*45*	*36*	*25*	*10*	*1*	*-10*
46	Decar.14	**1.33**	**9.3**	**78**	*99*	*79*	*54*	*21*	*1*	*-24*
47	Decar.15	**1.59**	**5.7**	**48**	*62*	*49*	*32*	*14*	*1*	*-16*
48	Decar.16	**1.52**	**8.9**	**75**	*96*	*77*	*50*	*21*	*2*	*-25*

49	Decar.17	0.65	8.0	55	66	54	44	11	-1	-11
50	Decar.18	0.89	7.9	61	75	60	46	14	-1	-15
51	Decar.19	1.86	7.5	63	81	66	40	18	3	-23
52	Decar.20	0.93	10.5	83	102	81	61	19	-2	-22
53	QQS01	1.62	16.9	143	183	147	94	40	4	-49
54	QQS02	1.92	21.0	176	226	185	111	50	9	-65
55	QQS03	1.64	16.0	135	174	139	89	39	4	-46
56	QQS04	0.51	9.6	58	68	57	48	10	-1	-10
57	QQS05	0.56	30.5	197	232	191	160	35	-6	-37
58	QQS06	2.03	8.5	71	91	75	44	20	4	-27
59	QQS07	1.61	9.4	79	102	82	52	23	3	-27
60	QQS08	1.13	21.4	175	221	174	125	46	-1	-50
61	QQS09	1.32	22.2	186	236	187	128	50	1	-58
62	QQS10	0.37	21.8	110	124	107	94	14	-3	-16
63	QQS11	1.01	22.0	176	220	174	129	44	-2	-47
64	QQS12	1.35	15.9	133	170	135	92	37	2	-41
65	QQS13	0.92	16.0	125	155	123	93	30	-2	-32
66	QQS14	0.41	32.7	177	201	172	149	24	-5	-28
67	QQS15	1.69	17.7	149	192	155	97	43	6	-52
68	QQS16	0.49	16.5	99	115	97	82	16	-2	-17
69	QQS17	0.86	25.1	192	237	189	145	45	-3	-47
70	QQS18	0.88	18.8	145	179	142	109	34	-3	-36
71	QQS19	0.69	19.4	137	165	134	108	28	-3	-29
72	QQS20	1.04	8.2	66	83	65	48	17	-1	-18
73	QQS21	0.73	16.0	115	140	113	90	25	-2	-25
74	QQS22	2.46	4.5	36	46	40	21	10	4	-15
75	QQS23	1.6	22.3	188	242	194	124	54	6	-64
76	QQS24	1.84	20.0	168	216	176	107	48	8	-61
77	QQS25	0.89	19.6	152	188	149	114	36	-3	-38
78	QQS26	0.42	29.3	162	185	157	136	23	-5	-26
79	QQS27	1.61	22.1	187	240	192	123	53	5	-64
80	QQS28	0.44	14.6	82	94	80	69	12	-2	-13
81	QQS29	1.18	17.8	147	186	147	104	39	0	-43
82	QQS30	0.5	9.3	56	66	55	47	10	-1	-9
83	QQS31	0.77	26.2	193	235	189	149	42	-4	-44
84	QQS32	0.54	15.0	94	111	92	77	17	-2	-17
85	QQS33	0.84	18.2	138	170	136	105	32	-2	-33
86	QQS34	1.35	18.6	156	199	157	107	43	1	-49
87	QQS35	0.54	21.8	138	162	134	113	24	-4	-25
88	QQS36	0.9	23.3	181	223	178	135	42	-3	-46
89	QQS37	0.57	18.7	122	144	118	98	22	-4	-24
90	QQS38	1.87	15.0	126	162	132	80	36	6	-46
91	QQS39	1.4	19.0	160	204	162	109	44	2	-51
92	QQS40	0.59	28.8	189	224	184	153	35	-5	-36
93	QQS41	1.51	5.3	45	57	46	30	12	1	-15
94	QQS42	1.54	14.7	124	159	127	83	35	3	-41
95	QQS43	1.1	17.2	140	176	139	101	36	-1	-39
96	QQS44	0.97	24.2	192	239	189	141	47	-3	-51
97	QQS45	1.1	13.6	111	139	110	80	28	-1	-31
98	QQS46	2.99	13.7	105	133	121	59	28	16	-46

99	QQS47	**0.45**	**32.7**	**187**	*215*	*182*	*156*	*28*	*-5*	*-31*
100	QQS48	**1.94**	**21.2**	**177**	*228*	*187*	*112*	*51*	*10*	*-65*
101	QQS49	**1.46**	**9.1**	**77**	*98*	*78*	*52*	*21*	*1*	*-25*
102	QQS50	**1.22**	**16.4**	**136**	*172*	*136*	*96*	*36*	*0*	*-40*
103	QQS51	**0.5**	**17.0**	**103**	*120*	*100*	*85*	*17*	*-3*	*-18*
104	QQS52	**0.37**	**23.5**	**120**	*135*	*116*	*102*	*15*	*-4*	*-18*
105	QQS53	**2.02**	**22.7**	**189**	*244*	*201*	*118*	*55*	*12*	*-71*
106	QQS55	**1.92**	**16.0**	**134**	*173*	*141*	*85*	*39*	*7*	*-49*
107	QQS56	**0.58**	**18.9**	**124**	*147*	*121*	*100*	*23*	*-3*	*-24*
108	QQS57	**1.12**	**20.8**	**170**	*214*	*169*	*122*	*44*	*-1*	*-48*
109	QQS58	**1.8**	**15.8**	**133**	*171*	*139*	*85*	*38*	*6*	*-48*
110	QQS59	**2.27**	**18.3**	**150**	*193*	*163*	*91*	*43*	*13*	*-59*
111	QQS60	**1.57**	**22.2**	**187**	*240*	*192*	*124*	*53*	*5*	*-63*
112	QQS61	**0.37**	**24.8**	**126**	*142*	*122*	*108*	*16*	*-4*	*-18*
113	QQS62	**1.56**	**11.7**	**98**	*127*	*101*	*66*	*29*	*3*	*-32*
114	QQS63	**0.62**	**20.3**	**137**	*163*	*133*	*109*	*26*	*-4*	*-28*
115	QQS64	**1.55**	**9.6**	**81**	*104*	*83*	*54*	*23*	*2*	*-27*
116	QQS65	**0.52**	**29.3**	**181**	*212*	*176*	*149*	*31*	*-5*	*-32*
117	QQS66	**1.48**	**16.9**	**142**	*182*	*145*	*96*	*40*	*3*	*-46*
118	QQS67	**0.64**	**28.6**	**195**	*234*	*190*	*156*	*39*	*-5*	*-39*
119	QQS68	**1.1**	**19.0**	**155**	*195*	*154*	*111*	*40*	*-1*	*-44*
120	QQS69	**0.5**	**20.5**	**125**	*146*	*122*	*103*	*21*	*-3*	*-22*
121	QQS70	**0.92**	**21.7**	**170**	*210*	*167*	*126*	*40*	*-3*	*-44*
122	QQS71	**1.88**	**9.5**	**80**	*103*	*84*	*51*	*23*	*4*	*-29*
123	QQS72	**2.55**	**20.8**	**167**	*213*	*185*	*97*	*46*	*18*	*-70*
124	QQS73	**1.23**	**13.1**	**108**	*138*	*109*	*76*	*30*	*1*	*-32*
125	QQS74	**0.87**	**23.7**	**182**	*225*	*179*	*137*	*43*	*-3*	*-45*
126	QQS75	**0.46**	**31.4**	**182**	*210*	*177*	*152*	*28*	*-5*	*-30*
127	QQS76	**0.58**	**8.3**	**54**	*64*	*53*	*44*	*10*	*-1*	*-10*
128	QQS77	**1.41**	**22.7**	**191**	*244*	*194*	*130*	*53*	*3*	*-61*
129	QQS78	**1.43**	**23.6**	**199**	*254*	*202*	*135*	*55*	*3*	*-64*
						Standard deviation		**14.1**	**4.474**	**16.55**

4. Discussion

Mainstream astronomy believes redshifts are a true indicator of distances for both galaxy and quasar distances. They are only quasar pairs from our perspective. But small minority like Halton Arp and others believe quasar redshifts are the poorest indicators of distances. Of course, any calculated distances between quasars, apart of galaxies, i.e., one from the other, are simply a pure fantasy since in reality they can be hundreds of millions of light years apart. Quasar pairs having the same redshifts from our perspective can be relatively close to each other, but if their brightness varies, one from the other, then their distances from us could be very different.

Unlike galaxies, if quasar-pair redshifts relate to their relative distances from us (which we believe they don't) then comoving their distances apart might have some value to it —otherwise it would be a waste of time. However, in estimating the real distances to pairs of quasars based on the comoving distances, the error range in our experiment was significantly reduced despite their significant redshifts. If we take this improvement in the calculations as a fact, then most of the quasars are much closer than their redshift could indicate by ΛCDM cosmology. Why are their redshifts so big? If this statement and question are correct, then our alternative theories must be a reasonable answer.

Astronomers that believe quasar redshifts are not proper indicators of their distances have attributed quasar redshifts to intrinsic mechanisms such as gravitational redshifts, long known to be valid in some cases but only to a small extent. In the last decade or so many realized what they believe to be a more likely intrinsic mechanism. This proposed mechanism would be unpopular for most astronomers and theorists because it proposes that the most powerful galactic jets *"move faster than the speed of light"* relative the galactic core, which ejects them. It has been maybe 30 years now since astronomers first claimed that some large galactic jets *"move faster than the speed of light."* Many astronomy papers from those times, and some from the present, have still claimed that by observation measurement some quasar jets can move up to five times the speed of light. In time, mainstream astronomy called all of these many observations as optical illusions, which they continue to do so up to this date, and provided the reasons why they thought so.

Indeed there is a difficulty here. For large values $z > 1$ of redshifts, the galaxy's receding speed will supposedly exceed the speed of light. The light is shifted to a longer wavelength (redshifted), we know this if e.g., a gas cloud is moving away from us, the speed can be calculated using the Doppler redshift formula for $z = \frac{\Delta\lambda}{\lambda}$:

$$v = c \cdot \frac{\Delta\lambda}{\lambda} = \left(3.0 \cdot 10^{8}\ \mathrm{m/s}\right) \cdot \left(\text{e.g.}, 0.3\ \mathrm{nm} / 656.3\ \mathrm{nm}\right) =$$
$$= \left(3.0 \cdot 10^{8}\ \mathrm{m/s}\right) \cdot \left(0.3 \cdot 10^{-9}\ \mathrm{m}\ 656.3 \cdot 10^{-9}\ \mathrm{m}\right) = 140{,}000\ \mathrm{m/s} = 140\ \mathrm{km/s}$$

However, taking e.g. $z > 1$ we get that $v > 306273.3\ \mathrm{km/s}$, what is impossible according to SRT. Peacock commented on this absurd delusion: Cosmological Physics: p.72: ...*it is common but misleading to convert a large redshift to a recession velocity using the special relativistic formula* $1 + z = \sqrt{\left(1 + \frac{v}{c}\right)^{+1} \cdot \left(1 - \frac{v}{c}\right)^{-1}}$. *Any such temptation should be avoided.* P.87: …*Nevertheless it is all too common to read the latest high-redshift quasar as "receding at 95% of the speed of light."* Therefore, astronomers believe that the Hubble diagram should be used in a relativistic form. In this case, one can improve the situation by excluding the speed of objects from consideration by applying the formula for distances $D = \tanh(\ln(1 + z)) \cdot \frac{c}{H_0}$. This formula implicitly contains Hubble's law, which was used in our calculations [2] and which can be successfully applied for moderate redshifts ignoring the fact that the formula significantly underestimates distances compared to data from available online sources.

Some authors (J. G. von Brzeski and V. von Brzeski, 2003) argue that this formula is a representation of the (hyperbolic) three-dimensional space of the Lobachevskian vacuum: a topologically pair-wise connected, non-compact cosmic ball (universe), of constant negative curvature $k = -1$. Paradoxical conclusion. However, in Brzeski's (2003) words the volume of space (and taking into account Lerner's et al., 2014,

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[2] The derivation of this form of distance formula is simple and we do not need to expose it here.

words: *"By contrast, in a static (non expanding) Universe, where the redshift is due to some physical process other than expansion (e.g., light-aging), the SB is expected to dim only by a factor* $(1+z)$*, or be strictly constant when AB magnitudes are used"*) the Universe will be grater and will contain more mass than we think. The universe has always existed. The space is as it is and is not expanding and will exist forever.

It is very difficult to say what is right and what is wrong here. However, for any metric of curved space, which we supposedly took into account in all our methods for calculating distances to cosmological objects using the angular diameter $\theta \cdot \frac{\text{distance}}{1+z}$ of objects in kiloparsecs as a comoving coordinate, all this significantly improved the estimates of the diameter and is consistent with data from borrowed articles. In connection with this improvement in the estimation of distances to cosmological objects, we argue that it is possible to accurately measure how much better or worse a particular method is: are the distances overestimated or underestimated in comparison with the available data from articles or the database. This is the essence of this experiment. Namely, it seems to us that we should not apply Hubble's law at high redshifts, but instead use alternative methods.

That being said, by searching alternative methods on public domain, we found, extending the list of paradoxes (Forrest and Cooper), that one amateur astronomer [3] derived different expansion rates of the universe based upon redshifts, when conducting measurements in different directions. He then drew attention to something even stranger: He discovered that the sky could be divided into two sets of directions. The first is a set of directions in which a lot of galaxies lie in front of more distant galaxies. The second is a set of directions in which distant galaxies are without galaxies in the foreground. We call the first group of

[3] We have not yet found a true identity and any references confirming these experiments. However, it seems convincing that our amateur has opened some hiding side of the reality.

directions in space—“region A”, the second group—“region B.” Our amateur astronomer discovered an amazing thing. If we confine ourselves to studying distant galaxies in region A, and only on the basis of these studies calculate the Hubble constant, then one constant value is obtained. If we do the same studies of region B, we get a completely different value of the constant. It turns out that the rate of expansion of the universe, according to these studies, varies depending on how and under what conditions we measure the redshifts coming from distant galaxies. If we measure them wherever there are galaxies in the foreground, there will be one result. If the foreground galaxies are missing, the result will be different. If the Universe is really expanding then how can foreground galaxies so influence the movement or redshifts of far distant galaxies behind them so as to indicate a different expansion constant?

Galaxies are at a great distance from each other, they cannot blow on each other as we blow on a balloon. Therefore, in the amateur astronomer words, it is logical to assume that the problem lies in the riddles of redshift. That’s exactly what the amateur astronomer was thinking. He suggested that the measured redshifts of distant galaxies, on which the standard Big Bang model of Cosmology is built, are not at all related to the expansion of the Universe. Rather, that they are caused by a completely different effect. He suggested that this effect is associated with the so-called mechanism of the aging of electromagnetic radiation, approaching us from afar. Historically such ideas have been called “tired light.”

Our amateur astronomer asserted that this redshifting of light (EM radiation) happens in accordance with accepted physical laws and is remarkably similar to many other phenomena of nature. In nature, always, if something moves, then there must be something else that prevents this movement. Such impeding forces also exist in outer space. The amateur astronomer believed that as light travels through the vast distances between galaxies, the effect of redshift begins to appear. This effect he associated with the hypothesis of aging (reducing the energy) of light. He believed that it turns out that light loses energy crossing the vast expanses of space in which there are certain forces that absorb light's energy, e.g., ether. The older the light crossing space, generally the more redshifted it becomes. Therefore, the redshift of galactic light would be proportional to the distance light travels rather than any other factor. After coming to this conclusion the amateur astronomer described the Universe as a non-expanding structure. Upon coming to this conclusion, galaxies would be more or less stationary.

The paradox with regions A and B, which are fundamentally different from the Big Bang model, can be explained based on the postulate of Mullat, 2016. The postulate asserts that starting from a state described by the singularity of the space the space suddenly inflates the infinitesimally small hole by seed of hidden vacuum in gravitational transition into static space from the aforementioned Background Energy-Field region. The seed size might be not more of a size of a Planck wall or even smaller beyond the wall. According to this perspective, when a "lump of space" emerges, it will impose an additional pressure on the previously allegedly "super cooled or latent gravitational energy", thereby causing an additional inflating effect. Like an "avalanche" rolling down a hill and gaining mass (and therefore weight) due to the "potential gravitational energy of a super-cooled or latent energy field," we also assume that inflating will create additional space.

Hereby, no BB explosion is assumed while the formation of new galaxies is consistent with the steady state theory. Creation of new areas of *dark matter* or *hidden vacuum* commencing Background Energy-Field, from which the galaxies will be then formed, is assumed by the postulate. If we then assume further that the energy density of the expanding three-dimensional globe or the manifold decreases as the radius of the globe of newly formed galaxies increases, then it is clear that the terrestrial observer will see exactly the picture pointed out by our amateur astronomer. If the front of the formation of galaxies passed the terrestrial observer somewhere 4 billion years ago and constantly moved 4 billion years up to dd., i.e., also further, as the radius of the globe grew, then the sphere of the terrestrial observer in terms of the density of newly created galaxies should indeed be divided into two hemispheres: one hemisphere with a lower density of matter (energy) and one with a higher density of matter. Therefore, it will not be surprising that astronomers will observe different Hubble constants depending on which side of the sky their telescopes are pointing.

5. Concluding remarks

In conclusion, the following comments can be made. Our experiment consisted of evaluating two new methods for calculating distances to cosmological objects by comparing these methods with the well-known formula for calculating distances using the Hubble diagram. To do this, we have collected data from publicly available sources at comoving diameter of pairs of quasars. Each apparent diameter has a visible angle in a spherical coordinate system measured in kpc per 1″.

It is a fact that we were able to very accurately compare the calculations with the Hubble diagram, in order to present measurements of pairs of quasars based on data taken online. It seems to us that we have proved the applicability of two new methods for calculating distances to cosmological objects. Still, it cannot be argued that the numerous positive theoretical results on estimating the distances to space objects using the Hubble law are unreliable. Nevertheless, calculations show that measurements of distances to cosmological objects can still lead to questionable scientific results in cosmology such as the Big Bang theory.

It all depends on the accuracy of the experiments in terms of distance estimates, especially to distant cosmological objects such as quasars. More often than not, one group of researchers presents conflicting measurements compared to another group of researchers. We also know of many questionable or unreliable observational data in cosmology, but this doubt relates more to standard deviation errors, which should indicate that the probability or errors should be very large. On the contrary, the probability of error is very small in our experiment. From all that has been said, only one conclusion can be drawn—the Doppler effect and Hubble's law are still very doubtful for calculating the distances to cosmological objects.

It is also important to emphasize that in the databases of astronomical observations there is always the Hubble diagram involved, either explicitly or implicitly, since these databases contain the velocities of objects calculated on the basis of the Doppler effect. Therefore, it is clear that by applying the Hubble Diagram to the projections that reflect the Hubble Diagram, we get the coincidence of the Hubble Diagram again with the Hubble diagram. From this point of view, the first two independent calculation methods can be trusted more, since only one parameter appears here—the redshift. This is the peculiarity of our experiment, which reveals the complexity of the situation with measuring distances to cosmological objects: Whether to use the Hubble diagram or follow the path of alternative methods for calculating distances to cosmological objects.

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POSTSCRIPT

Astronomers do not observe the entire universe, but what they observe was quite enough to propose reasonable conclusions that led to another perceptive of the standard Big Bang model. Addressing the thoughtful reader, and as such we took the reader for granted, it should be noted that in fact in our narratives there are proposed two opposing, but in many respects, similar points of view on the dynamics of matter in the universe.

So, in the second narration a theoretical model of the universe based on the ether was proposed. Whether ether, as we know, was believed to be non-existent in the Michelson–Morley experiment, it is not so important. More importantly, methodology was proposed for the creation of matter in the Universe from strings of Pan Particles comprising the ether. Again, it doesn't matter what the particles are. The number of particles doubles over a long, albeit gigantic period of time. At the same time as these particles are very slowly reducing in size, dimensionally they proportionally increase in their numbers maintaining the particle density relative to the space they encompass. In the same way and for the same reason matter very slowly reduces in its dimensions while it proportionally increases in its numbers. This approach allowed us to calculate the distance to galaxies on the basis of Euclidean geometry based on a very simple formula. Saying in short, in the second narrative it was postulated that the average density of the formed matter will be constant, which is allegedly confirmed by observations of the cosmic neighborhood, which is not so remote from us in the cosmological sense. The formula from second narrative for calculating the distances obtained on the basis of pan postulates was in the third narration compared with the already known methods as well as with the new method of calculation without the Hubble constant.

On the other hand, it should be clear that the incredibly slow reduction in the size of matter at any point in the universe at any time could be attributed to the expansion of space rather than a reduction in the size of matter, one being a relative perspective of the other. Figuratively speaking, it all somehow comes along with Jonathan Swift's book Gulliver's Travels where Gulliver sails to the land of Giants, enormous humans compared to the size of Gulliver. In the same way in astronomy and astrophysics when we "sail" to observe the most distant galaxies, us being the Lilliputians, we would be looking backwards in time into the land of the Giants. At the same time, neither the present day Lilliputians, nor the Giants in the past could notice changes in their size because they all use the same rods, meters, kilograms, etc., measuring sticks, which shrink in size in direct proportion to the passage of time. From a mathematical point of view, the situation can be represented in the form of an expanding metric of space, which is filled from a controversial ether or pan particle substance, or with new mass according to the postulate of gravitational transition from Background Energy-Field, both of which we have no direct knowledge of their existence or essence, aside from theory or hypothesis.

Discussing a possible approach in analyzing the creation of space in the third narration, our thoughtful reader will, perhaps, pay attention to some contradiction, namely: the energy density of the so-called *"hidden vacuum"* and visible or baryonic matter decreases while in the second the narration about the density of energy is presumably fixed. It seems that there is a fundamental difference in the approaches to the formation of matter. However, there is no contradiction. As before, the model in the third narrative considers the static universe in the same way as in the second narrative. For example, if we try to weight 1 kg. of metal in the form of a casting that has just come out of a blast furnace, the same kilogram again will still weight, since the metal is cooled or not cooled, exactly 1 kg. However, from the point of view of energy density (substance density), the same cooled kilogram of metal will weight less than the kilogram that was previously in a blast furnace. Consequently, from the point of view of the energy density of matter, it is quite reasonable to assume that the birth of a matter in the form of particles, atoms or pan particles occurred at a very high energy density of matter.

The density of the energy decreases, leaving the usual density of matter, which is observed by astronomers, still constant as described in the second and as in the third narration. While the universe develops on the basis of the postulate of the emergence of matter, it was assumed that matter arises as a result of a gravitational transition of Background Energy-Field, first into hidden vacuum and then accompanied by visible anti-vacuum or baryonic matter. Therefore it was irrelevant how we call the Background Energy-Field, calling the energy by ether, gravitons, or visa versa, changing the ether to Energy-Field. It should be clear to everyone that this renaming does not change neither the essence of the gravitational transition phenomena nor the phenomena of pan particles creation. Among other things, unlike well-known geometric models where all the events usually occur, it should be noted that in the third narrative the gravitational transition of Energy-Field into matter occur inside a three-dimensional Euclidean surface of a stereographic projection of a four-dimensional globe.

Justification of the proposed postulate about the gravitational origin of matter in the Universe was the subject of all our efforts in both the third and fourth narratives. We did not go into physical theories about the nature of the transition of the gravitational field into matter. Instead, it was simply stated that one form of matter transforms into another form - the Energy-Field of gravity transforms into dark and visible matter. Systems for measuring space occupied by matter in various forms are known to require different metric units, such as cubic meters, kilograms, lengths, and so on. etc .

Usually, to substantiate theories, physics requires laboratory experiments, which, for obvious reasons, cannot be carried out in cosmology. It is possible, however, to use existing databases or published literature to compare data tables against which different theoretical models could be compared. Here it turned out to be possible on three models to calculate the theoretical distances to cosmological objects from their redshift.

Although, as you know, some researchers, such as Halton Arp, consider redshift to be a bad indicator with which you can calculate distances. But so far we do not know exactly which indicators could be better than the redshift.

The second point that needs to be borne in mind is the coincidence of calculations obtained on the basis of various independent theories. So in the third narrative, we developed a method for calculating the distances to cosmological objects based on our postulate of a gravitational transition. This method was tuned on the basis of the NED database, in which many objects are allegedly supplied with distances independent of redshift.

In the fourth narrative, we tried to compare the method of calculation based on our postulate of the gravitational transition with the method of the so-called PAN theory. In addition, we also had the opportunity to compare distances based on the hypothesis of an expanding universe along the lines of the Big Bang phenomena with the standard Hubble diagram. It should also be noted here that the body of data, borrowed in the 4-narrative from literary sources available online to all interested, reflects the views of a narrow circle of researchers.

The result seems to us to be quite satisfactory. Thus, the calculation of distances to cosmological objects based on the postulate of the gravitational transition during the formation of matter practically leads to similar numerical values from the calculation of distances according to the PAN theory. The Hubble diagram, however, requires a lot of tweaking. Apparently, our experiment shows that the steady state model of the Universe is more realistic than the Big Bang model. If we turn to the contradictions described in the second narration as a contradiction of the horizon and the contradictions pointed out by Halton Arp about the physical proximity of galaxies with different redshifts, then many of these contradictions are eliminated.

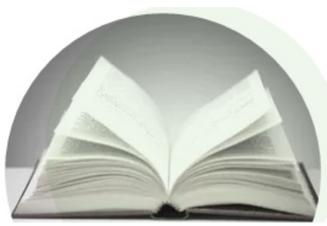
General relativity, which is accessible to an understanding of only a limited number of specialists, is based on the fruitful idea of the geometry of space, found itself in difficulty trying to explain the allegedly observed expansion of space including its added acceleration by hypothetical Energy-Field. The reader could get the impression that, in our speculative attempts relating to cosmology, the question of space and time is still or further mystified by the introduction of fictitious "hidden vacuum" and "Background Energy-Field." Indeed, in cosmological reasoning, we tried to return the discussion of the problem to the level of modern physics puzzles. However, this was not our ultimate goal. The goal was, as already mentioned, to illustrate the possibilities of combinatorial mathematics by using the apparatus of differential geometry in the form of the concept of monotone systems. After all, it was much more interesting to introduce the reader into the course of the issues on an example. To some extent, this tactic rather resembles our pedagogical approach.

In conclusion, it is appropriate to make some remarks on the application of the theory of Monotone Systems (better to call it the Monotone Phenomena) in geometry as described in the third narration. In principle, there is no need for this purpose to deal with the problems of modern physics, especially since nothing is much more confusing in modern physics as the asserted meanings of time and space. Indeed, the examples with which we illustrated the material in the physical sense, such as the "Potential energy of the avalanche", "Super-cooled water", "The tale of the creation of the Matter", etc., are quite random. It may therefore seem that our model of stereographic projection has nothing to do with the material presented in the book. However, it was here where the invisible side at first sight of Monotone Phenomena was hiding.

Monotonic phenomena makes it possible to performs some mappings of sub-manifolds of the Euclidian space, which makes, in turn, it possible to introduce the concept of a fixed point of the indicated mappings. In a certain respect here, we act within the framework of the

Brouer's theorem, similar to the fixed point or steady state in topology. In the general case we do not have specific procedures for calculating Brouer's fixed points. However, the positive issue lies precisely in the possibility of calculating the fixed points of these mappings of Monotone Phenomena where the advantage of our approach is coming out. The methods of differential geometry proved to be useful because the prospect of calculating the credential functions is opened, and on their basis the equations of equilibrium are compiled. Regardless of whether the equilibrium solution has a physical meaning, it is already sufficient that we are dealing here with some a novel approach revealing the phenomena of things as a consequence of the monotonicity property.

We hope that the Monotone Phenomena scheme will be subject to more extensive research, as this will contribute to the theoretical understanding, as well as assist in developing more affective algorithms aimed at finding the best solutions. The most promising avenue to pursue going forward, in our view, is the approach of steady states, or stable sets, which have been demonstrated in the third narrative presented here. In order to discover some important phenomena hiding in plain sight, we have offered various perspectives on different subjects, in atomic or continuous form. Our motive was to collate some evidence that demonstrates the opportunities for those enthusiasts that wish to open their minds and devote their time to the promotion and advancement of science.



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Evidently we have to acquire knowledge of the original causes (for we say we know each thing only when we think we recognize its first cause), and causes are spoken of in four senses. In one of these we mean the substance, i.e. the essence (for the 'why' is reducible finally to the definition, and the ultimate 'why' is a cause and principle); in another the matter or substratum, in a third the source of the change, and in a fourth the cause opposed to this, the purpose and the good (for this is the end of all generation and change). We have studied these causes sufficiently in our work on nature, but yet let us call to our aid those who have attacked the investigation of being and philosophized about reality before us. For obviously they too speak of certain principles and causes; to go over their views, then, will be of profit to the present inquiry, for we shall either find another kind of cause, or be more convinced of the correctness of those which we now maintain.

By Aristotle, 350BC

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