Origin of the Universe: a Theoretical Model

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Questions about the origin and nature of our universe have always stimulated and exercised every curious mind. While several theories exist, the Big Bang model is widely accepted as the correct model of the origin of our universe. However, some of the observations of the behavior of matter and light in our universe are not yet fully explained by the Standard Big Bang Model. In this paper, some corrections to the Big Bang model are presented, which result in a new model that provides a much better explanation of the observed behavior of matter and light in our universe.

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1. Introduction

In the last 20-30 years, some discrepancies between the predictions of the theory of general relativity and observed phenomena have come to light. While several alternative theories have been proposed, no new theory has emerged that can appropriately explain our observations. [1, 2] To explain observations of large scale behavior, contemporary theories resort to the arbitrary and, by their very definition unverifiable, elements of dark matter and dark energy. Dark matter supposedly adds to the total gravity of the universe and hence, prevents it from falling apart (expanding too fast). Similarly, dark energy is believed to be pulling the universe apart (increasing its rate of expansion). If contemporary theories resorted to only one of these two elements, they may have been somewhat acceptable, though still questionable and debatable until verified. But by resorting to both, these theories essentially say that we are still ignorant about the behavior of our universe at the large scale. We can neither explain the rates of expansion in the various observable parts of our universe nor can we fully explain the observed effect of gravity in the various parts of our universe. Dark energy is resorted to for the first question and dark matter for the second. Indeed, contemporary theories are so strongly dependent on these two arbitrary and unverifiable elements that they suggest that there may be far more dark matter in the universe than observable matter. Similarly, they insist that there should be sufficient amounts of dark energy to overcome even the gravitational attraction that such massive amounts of dark matter will necessarily add to our universe. In fact, contemporary theories claim that the known universe is only about 4% of our universe and that dark matter and dark energy make up 96% of our universe. What do we know about our universe if the largest and thus, most influential part of it is still obscure to us (both dark matter and dark energy, *i.e.* 96% of our universe)? While some scientists have proposed that dark matter may be solid hydrogen, there is no explanation as to why this hydrogen should remain undetectable? [3]

We have perhaps hit a point where we need to tabulate the errors, flaws and inconsistencies in our contemporary popular theories and seek actively to improve these theories to eliminate such problems or else to search for better theories that do not suffer from such problems. In this paper, we will primarily focus on the large-scale behavior in our universe. We shall look at some flaws and inconsistencies in existing theories of large scale behavior and evolution of our universe and shall then seek to eliminate those problems. We shall see the emergence of a new theory that proves the behavior of gravity is similar to that of the other three forces and which provides better explanations of observed large scale behavior in our universe, without depending on any arbitrary elements.

The Current Standard Model

It is widely believed that the universe originated from the Big Bang, which occurred some 13.7 billion years ago. Further, at the instant of the Big Bang, the universe had zero size (point size) and was infinitely hot. This zero-sized universe was homogeneously and isotropically filled. At the Big Bang, this point sized space started expanding, and therefore cooling, thus giving rise to the universe as we see it today. This space, which makes up our entire universe, is said to be still expanding today. However, this picture raises some very important questions:

1) Why is the universe apparently so uniform and yet rather disk-like? A completely uniform universe should have been spherical. The Theory of Relativity suggests that a universe as massive as ours would be flat due to space-time curvature. However, space-time curvature is not able to fully explain the behavior of gravity in our universe, leading to the search for dark matter. Further, the most important question with the idea of space-time curvature causing a flat universe is, how does matter choose which direction to curve space-time in, leading to the flat universe that we observe? All directions are the same for any matter – gravity acts equally in all directions - and hence space-time should be pulled equally towards matter from all directions. This should lead to a universe with equal radius in all directions but more dense space-time close to matter bodies and less dense space-time away from matter. The prevailing concept does not at all explain why space-time gets curved preferentially only along one dimension. Space-time curvature therefore is unable to fully explain the flat universe that we observe.

2) What is the mechanism of space-time curvature? How does matter manage to wrap or bend space-time around itself? At our present level of understanding, the universe would have to be much more massive in order that space-time curvature may sat-

isfactorily explain several observations, leading to the search for dark matter in our universe.

3) Contemporary theories suggest that at the instant of the Big Bang, for a fraction of a second, the universe expanded at speeds greater than the speed of light in free space. How and why did this phenomenon occur?

4) Why were there such large density variations in the earliest stages of the universe leading to the formation of the stars, galaxies etc.? Further, why are the galaxies moving away from us at speeds directly proportional to their distance from us (along with a small sideways velocity)? A homogeneously and isotropically filled universe should not lead to such large density variations unless some external forces (forces not a part of the universe) were at work. There is no explanation at all of how such large variations could develop from a homogeneous and isotropic universe.

5) Why is there such a large excess of particles of matter over their corresponding anti-particles in the universe? The explanations given for this are not at all satisfactory. If the universe was homogeneous and isotropic at the instant of the big bang, creation of matter-antimatter pairs should have resulted in equal numbers of matter and antimatter particles being formed. How then did we end up with an excess of matter particles? An alternative possibility is that not all matter-antimatter particles were annihilated but this implies that just as we have entire galaxies and clusters of galaxies made up of matter, there should also be regions in our universe composed entirely of anti-matter. This gives rise to the question that why did these particles and antiparticles of matter move away from each other instead of annihilating each other. Again there is no satisfactory explanation for this. Further, no spontaneous creation of matter-antimatter particles has ever been observed. In fact, if matter-antimatter particles annihilate with each other yielding energy, then spontaneous creation of such a pair is equivalent to creating energy which would violate the First Law of Thermodynamics which states that free energy cannot be created. Perhaps this is the reason spontaneous creation of real matter-antimatter particles is not observed in nature. Theoretically, it may be possible to convert some energy into matter-antimatter pairs that upon annihilation with each other yield no more than the amount of energy spent to create them. This is the maximum possible as per the First Law of Thermodynamics while the Second Law of Thermodynamics would suggest that perhaps 100% of the energy spent to create the pairs will not be recovered as some energy must be spent to do work (*i.e.* a 100% efficient engine for conversion of energy to such pairs and then recovery of energy by annihilation of these pairs may not be possible).

6) What was the trigger that caused space to start expanding? Did the universe start expanding because it was infinitely hot? If so, how did it get to be infinitely hot? Why did it not start expanding at much lower temperatures? Why is space still expanding today when the universe has become so cold? There is no explanation for this without relying on dark energy. Even if we rely on dark energy, it would imply that the rate of expansion of the universe should be declining. As the universe expands, the energy density of the universe (energy density considering both normal energy and dark energy) declines, in other words, the universe becomes cooler. Thus, if expansion was caused by high temperature (infinitely hot state) at the instant of the Big Bang, this rate of expansion should perpetually decline as the universe keeps on expanding and so becomes cooler. This rate of expansion should continue to decline until the energy density of the universe becomes zero, *i.e.* the average temperature of the universe becomes zero Kelvin. At this point, the rate of expansion of the universe should also become zero. By now, the temperature of the universe is already very close to zero Kelvin on average. But the rate of expansion of the universe is not declining at all. As per the standard model, this implies that though the universe is growing in size, its energy density must at least remain constant so that the rate of expansion of the universe does not decline. This implies that as our universe expands, it must be gaining energy so that its energy density does not reduce. This can be true only if we assume that dark energy is spontaneously being created in our universe in clear violation of the First Law of Thermodynamics. In fact, as per the standard model, the energy density of our universe must be continuously increasing in order to explain increasing rate of expansion of the universe. This is only possible if massive amounts of dark energy are spontaneously being created as our universe gains size. It might be very convenient to assume that dark energy is also capable of violating the laws of thermodynamics but it may be more scientific to search for alternative mechanisms for the expansion of the universe.

7) Why is space expanding only in those locations or regions where there is no matter but is not expanding at all in regions where even a tiny amount of matter exists? The standard model states that space itself is expanding but we observe that our galaxy is not expanding. Our very own solar system is not expanding. Even planets, stars and the smallest of asteroids are not expanding. Why does space expand in regions where no matter exists but is not at all expanding in regions where even the tiniest amount of matter exists? A uniform expansion of space would have caused galaxies, the solar system, etc to expand in size as well. Further, it should have also caused matter bodies themselves to gain in size as well, eventually even tearing apart some of them. In the book, The Grand Design, the authors describe the expansion of space as the blowing up of a balloon where the various matter bodies are like markings on the surface of a balloon. [4] But, as can be tested quite easily by writing something on a balloon and then blowing it up, in such a case, as the balloon expands the size of the lettering also increases.

8) What was the origin of the point that started expanding at the Big Bang to give rise to our universe? How was this point created; how did it come into existence?

9) It is said that we cannot talk about the Big Bang because at that point of time all the laws of science would break down. This logic implies that at the Big Bang the universe was in a state of infinite disorder. How did we end up with an ordered universe from a state of infinite disorder? The laws of thermodynamics state that order cannot increase in any system spontaneously. Spontaneous processes should actually lead to greater disorder in a system with increase in time. Work must be done with external forces, and some energy must be spent to achieve greater order.

2. Materials and Method

The standard model assumes that at the instant of the Big Bang, the universe had zero size and was infinitely hot. Matter only appeared much later in the form of matter-antimatter pairs with a small excess of matter forming. This implies a violation of the principle of conservation of baryon number which should have ensured creation of only equal numbers of matter-forming and antimatter-forming fundamental particles. What is the theoretical basis for the belief that such a violation of the principle of baryon number conservation ever occurred? The only reason for this belief is that we do not have any other explanation for the subsequent preponderance of matter over antimatter in our universe since we assume that at the instant of the Big Bang, the universe only contained energy and did not have any matter or antimatter particles. The assumption that a violation of the principle of baryon number conservation ever occurred is an arbitrary element that we resort to in order to prop up existing theories. **Thus, we will our start our work with the assumption that at the instant of the Big Bang, at least some matter particles were already present in the universe and that no violation of the principle of conservation of baryon number ever happened.** As will see, this assumption leads to a new picture of the Big Bang and subsequent evolution of our universe and is able to better explain some of the phenomena that we observe in our universe today.

Our contemporary theories suggest that we cannot study events at the instant of the Big Bang and before that instant due to the large relativistic and quantum effects that would have been present at the Big Bang. Again, this is purely an assumption with no basis either in proven law or in theory. In fact, as per standard theory and as per our observations, relativistic effects such as space-time curvature exist only in the vicinity of matter bodies; the bodies themselves are not affected by any such effect caused by their own mass. For example, the path of a moving matter body is affected by space-time curvature only when it comes under the influence of the gravity of another massive body. Thus, at the instant of the big bang, if the universe comprised of just one point, then all the relativistic effect present at that instant of time would be present only outside this point. Similarly, quantum effects become significant only in systems where the amount of matter present within the system is heavily dominated by the amount of energy present in the system. At the instant of the Big Bang, if there was sufficient preponderance of matter to account for all of the mass in the universe today without relying on any violation of the baryon number conservation principle, then it implies that at that instant, the universe should have had as much mass as present today or even more. In such a highly massive state, it is reasonable to assume that any quantum effects at that instant would have been negligible. **If quantum and relativistic effects were indeed negligible within the universe at the instant of the Big Bang, it implies that the laws of physics will also apply to the Big Bang event itself.**

We have started with the assumption that the universe had at least as much mass at the instant of the Big Bang as it does today. This straight away implies that the universe should have had non-zero size at the instant of the Big Bang; otherwise, the density of matter within the universe at that instant would have been infinite which does not agree with any known observation. This immediately leads us to question the size and shape of the universe at the instant of the Big Bang. In keeping with our goal of seeking a model that can explain the evolution of our universe and the laws of nature without resorting to arbitrary violations of the same laws, we must look at various possible shapes and states of the universe at the instant of the Big Bang and then consider only those that show some potential for fulfilling our requirements. In keeping with the principle of a homogeneous and isotropic universe, we will only look at symmetric shapes.

In 1922 Alexander Friedmann had made two assumptions about the universe:

1) the universe is, on a large scale, identical in all directions

2) the above assumption is also true at any other point in the universe.[5]

We have already discussed that quantum and relativistic effects at the instant of the Big Bang should not have been significant. Thus, it is reasonable to assume that the Friedmann hypothesis is likely to hold true even at the instant of the Big Bang. If all of the matter and energy present in the universe at the instant of the Big Bang was concentrated in one very dense, very hot region, then which are the shapes that can satisfy the Friedmann conditions? The most obvious candidate for this is a sphere as it clearly satisfies the Friedmann conditions. Such a sphere, just before the instant of the Big Bang, would have been similar to the stars or black holes or other massive bodies that we see in the universe today, except that it would have been far more massive than a star or black hole in our universe can possibly be. The mass of this sphere should have been large enough to lead to the creation, after the Big Bang, of all of the matter that we see in our universe today. The Big Bang event itself, in this case, should have been similar to the supernova phenomenon that we see in our universe today. The only difference is that the Big Bang would have occurred on a much larger scale than typical supernovae due to the much larger mass of this sphere compared to the amount of mass involved in the typical supernovae. The evolution of the universe after the Big Bang would have been similar to events after supernovae. Matter and immense amounts of energy would have been expelled from this sphere at the Big Bang. Later, as cooling happened, the neighboring fundamental particles of matter in some regions would be sufficiently close to each other to aggregate and form atoms eventually leading to the formation of new matter bodies. This is similar to observations and theories of the formation of second generation stars and planets after some supernovae.

There is one problem with this picture though. As mentioned earlier, space-time curvature should cause space-time to be very dense in regions close to some matter and less dense in regions away from any matter but there should always be equal density of space-time in all directions at equal distance from the same matter body. Nature does not distinguish between directions at all. It is only for our convenience that we define various directions or various axes (x, y, z axes for space). Thus, there is no explanation in this model for the emergence of a flat universe. The Big Bang, just like a super massive supernova, would have spewed out matter and energy in all directions in roughly equal quantities. The result would have been a 3-dimensional universe rather than the flat universe that we observe. Hence, we need to search for another structure for the universe at the instant of the Big Bang. **After considering various candidate shapes, it appears that the shape that can best explain the universe as it is today is a spinning disc, *i.e.* a disc rotating about an axis passing through its center.** In the next section, we will see how the universe evolved from a spinning disc into the form that we observe today. Hence, this is the **list of assumptions** that we start with in search of a coherent and consistent theory that can explain our universe as we see it today:

1) At the instant of the Big Bang, the universe already had enough matter to lead to all of the matter that we see today, *i.e.* there was never any violation of the principle of conservation of baryon number.
2) Quantum and relativistic effects within the universe should have been negligible – the implication of this is that the laws of physics will apply even to the Big Bang event.
3) All of the mass of the universe was a part of a single spinning disc at the instant of the Big Bang.

3. Theory

In the previous section, we have seen the assumptions made as we begin our search for a theory that can explain our observations of the universe without using any arbitrary elements:

1) At the instant of the Big Bang, the universe already had enough matter to lead to all of the matter that we see today, *i.e.* there was never any violation of the principle of baryon number conservation.
2) Quantum and relativistic effects within the universe should have been negligible – the implication of this is that the laws of physics will apply even to the Big Bang event.
3) All of the mass of the universe was a part of a single spinning disc at the instant of the Big Bang.

Let us now see how such a universe is likely to behave during the Big Bang.

3.1 The Big Bang

At the instant of the Big Bang, just like during a supernova, the disc of matter that made up the universe till then, would explode releasing a large amount of its matter and tremendous amounts of energy. Most of this matter will move outwards, *i.e.* radially away from the center of the disk. Thus, this expansion will mostly be in a plane passing through the center of the disk and parallel to the face of the disk. Most of the matter released at this point of time will be in the form of the fundamental particles of matter since aggregations of fundamental particles such as electrons, neutrons are not likely to be stable in the very hot conditions prevalent at that instant of time.

Why is it not possible that all of the matter in the disk should have been converted to energy at the instant of the Big bang? We have already said that the laws of physics should have been applicable even at the instant of the Big Bang as well. Specifically, the Law of Conservation of Momentum should be applicable to the universe before and after the Big Bang – if the Big Bang was indeed like a supernova, then it was merely an internal event in the universe and so the total momentum of the universe should be equal before and after the Big Bang. If all of the matter present in the universe just before the Big Bang was indeed in the form of a single spinning disk, it implies that the universe must have had some non-zero angular momentum before the Big Bang. If the entire mass of this disk had been converted to and released as energy at the instant of the Big Bang, then the angular momentum of the universe would not be the same before and after the Big Bang – after the Big Bang the angular momentum of the universe would have vanished. The Law of Conservation of Momentum does not allow that. Therefore, at the Big Bang only a part of the mass of the disk could have been converted to and released as energy. The rest of the mass of the disk should have been released as the fundamental particles of matter at the instant of the Big Bang. It is because of this that today we have so many matter particles in our universe. The energy released at the instant of the Big Bang may have produced some particle-antiparticle pairs of matter but these pairs would simply annihilate with each other and hence, do not bother us at all. What happened to the disk at the Big Bang is exactly like what happens when very massive stars explode. Even when the entire star explodes only a part of the mass of the star is converted to and released as energy. The rest of the mass of the star is released as matter particles which later lead to the formation of other heavenly bodies like planets, second generation stars, *etc*.

We have already discussed the rotating state and the shape of the disk just before the Big Bang. We have seen that this disk would release energy and the fundamental particles of matter at the instant of the Big Bang. What would be the velocity of each of the particles released at the Big Bang? The net velocity of each of the fundamental particles of matter released at the Big Bang would have two components of velocity:

1) A component directed away from the center of the disk along the radius for that particle in the disk just before the Big Bang. This velocity component will, henceforth in this paper, be called the radial velocity component of each particle. The radial velocity component will be equal for each particle and will be caused due to the energy released at the Big Bang. This velocity component will be there even if the disk was not rotating at the instant of the Big Bang. Further, the more energetic the explosion, *i.e.* the more the amount of matter of the disk converted to and released as energy at the Big Bang, the higher will be the numerical value of this component for each particle. The radial velocity component will have equal numerical value for each particle released at the Big Bang. Further, this velocity component will be directed away from the center of the disk along the radius for each particular particle in the disk just before the Big Bang.
2) A component in the direction of rotation of the disk tangential to the radius for each particle in the disk at the instant of the Big Bang. This velocity component will, henceforth in this paper, be referred to as the tangential velocity component of each particle. This velocity component will be the direct result of the rotation of the disk. The numerical value of this velocity component will be a multiple of the rate of rotation of the disk and the radial distance for that particle from the center of the disk. The tangential velocity component will have different values for different particles and will have the same numerical value for all particles that are equidistant from the center of the disk at the instant of the Big Bang.

As can be seen, both these velocity components will lie on the plane of the disk at the instant of the Big Bang. This is what leads to a flat, planar universe.

We have already seen the two components of the velocity of each of the particles released at the instant of the Big Bang. If the disk was not rotating then at the instant of the Big Bang each particle would only have acquired the radial component of their velocity - hence all the particles would have had equal speeds but only particles lying on the same radius on the disk before the Big Bang would have been moving in the same direction as well. Consequently, only particles lying on the same radius would have had the same velocity even though all particles would have had equal speeds. In the case of the rotating disk, all particles would also have a tangential component to their net velocity. As a consequence of this it can be seen that no two particles would be moving in the same direction at the instant of the Big Bang - though particles that were equidistant from the center of the disk before the Big Bang would have equal speeds (vector addition of the 2 components of velocity of a hypothetical particle released at the Big Bang will lead to velocity dependent on position of particle in the disk and as per the Pauli Exclusion principle, no two particles can have the same position and the same velocity). Therefore, the velocity of each of the particles released at the Big Bang would be unique. No two particles released at the Big Bang would be moving in the same direction and also with the same speed at the instant of the Big Bang – even though particles equidistant from the center of the disk before the Big Bang would be moving with equal speeds. This can be called the **unique-velocity principle**. As we shall see later, this has a very large impact on the evolution of our universe.

We have seen that the entire mass of the disk was not converted to energy at the instant of the Big Bang. We still do not know why the universe had to be as massive as it really is. Is there any factor which determines or at least limits the amount of mass that the disk could have converted to and released as energy at the Big Bang? Henceforth in this paper, the ratio of the amount of mass of the disk that was converted to energy at the Big Bang to the total mass of the disk just before the Big Bang will be known as the K-ratio. The K-ratio would depend on the following three factors:

1) The radius of the disk at the instant of the Big Bang.
2) The rate of rotation of the disk at the instant of the Big Bang.
3) The maximum possible net velocity for the heaviest particle released at the Big Bang from the disk.

How do we derive the K-ratio? We have already seen the two components of velocity of each of the particles released at the Big bang from the disk. Each of the fundamental particles of matter released at the Big Bang would have had some small mass and hence, as per relativity, their maximum possible velocity will have to be lesser than the speed of light. The net velocity of each particle released at the Big Bang will depend on the tangential and radial components of velocity for that particle as explained above. The tangential velocity component of each particle depends only on the rate of rotation of the disk and the distance of the particle from the center of the disk at the instant of the Big Bang (along the radius for that particle). The radial velocity component for each particle will depend on the amount of mass of the disk that is converted to energy at the Big Bang – the more energetic the explosion, *i.e.* the more the amount of mass that is converted to energy, the greater will be the value of the radial velocity component. The radial velocity component will have the same numerical value for each particle released at the Big Bang. It is this radial velocity component that is limited by the rule that the net velocity of any particle released at the Big Bang cannot exceed the relativistic maximum possible velocity for that particle. This limit on the radial velocity component will determine how energetic the Big Bang was – *i.e.* how much energy was released at the Big Bang. This, in turn, determines the amount of mass of the disk that was converted to energy at the Big Bang. The tangential velocity component will be maximum for those particles that are farthest from the center of the disk, *i.e.* particles which are at the outermost edge of the disk, at the instant of the Big Bang. The radial velocity component will have the same numerical value for each particle released at the Big Bang.

3.2 Evolution of the Universe

We have seen the two components of velocity of each of the particles released at the Big Bang. We have seen how our universe came to be as massive as it actually is. We will now look at the development of the universe after the Big Bang leading to the formation of galaxies.

Suppose that there are two massive bodies gravitationally attracting each other such that the distance between these two bodies is much smaller than the distance between either of these bodies and any of the other massive bodies present in the universe. In this case we can treat the two bodies as a part of an effectively closed system consisting of these two massive bodies only. The gravitational attraction acting on this closed system due to any other massive body present in the universe will only be an external force. This is what we observe in our universe, for *e.g.* in the case of our solar system. For the solar system, the gravity of our galaxy is only an external force. The gravity of our galaxy does not in any way affect the motion of the planets and satellites, which are a part the solar system, relative to each other – it only pulls the entire solar system towards the center of our galaxy. The solar system, of course, is not a two-body system but is a many-body system.

How does gravity act within such effectively closed systems? The implication of the observation described in the previous paragraph is that the net gravitational force acting on each body is simply the vector sum of all the gravitational forces acting on that particular body. Each of the massive bodies within such effectively closed systems would be attracted gravitationally by each of the other massive bodies present in the system and also by bodies outside the system. But the distance between the bodies in such closed systems is much smaller than the distance between the system and any of the massive bodies present outside the system. Hence, the gravitational force acting on the bodies that are part of such a closed system, due to bodies outside the system, will be nearly equal and therefore can be treated as an external force. Ignoring this external pull, we can see that in every possible case, the net gravitational attraction acting on any of the bodies that are a part of such a closed system will be directed towards the center of mass of the closed system.

What is the gravity of the universe? Our universe can be treated as a closed system. Each of the galaxies present in the universe can also be treated as closed systems. Every galaxy present in the universe gravitationally attracts every other galaxy present in the universe. Due to these gravitational forces, the net gravitational force acting on each of the galaxies present in the universe will be directed towards the center of the universe. This net gravitational attraction that acts on each galaxy is the gravity of the universe for that galaxy. As the universe has expanded to a very large size today the distance between the galaxies has become very large. Hence, the gravity of the universe has weakened considerably compared to the earlier stages in the development of the universe. Is the value of this gravity the same for each of the galaxies present in the universe? The gravity of the universe will have the same value only for those galaxies, which are equidistant from the center of the universe. If we draw concentric circles of varying sizes on the plane of the universe - the center of each circle being the center of the universe - all the galaxies lying on the same circle will have the same value of the gravity of the universe. Further, the value of the gravity of the universe will be maximum at the outer edge of the universe and will go on decreasing as we move inwards towards the center of the universe. This is exactly the same as what we observe about the gravity of the earth. The value of the gravity of the earth is maximum at the surface of the earth. As we move inwards towards the center of the earth, the value of the gravity of the earth goes on decreasing. For both phenomena – the variance in the value of the gravity of the earth within the planet and the variance in the value of the gravity of the universe – the principle involved is also exactly the same. For the outermost layers, nearly all of the mass in the inner layers exerts a gravitational pull directed towards the center of mass of the system as a whole whereas in case of layers closer to the center only the mass in layers further inward exert a pull towards the center while layers further outward will exert a pull outward. It is due to this that the outermost layers experience the maximum net gravitational pull.

What is the gravity of each galaxy? Each massive body present in a galaxy gravitationally attracts every other massive body present in that galaxy. The net force acting on any massive body present in a galaxy is the gravity of the galaxy for that particular body. This force will seek to pull each massive body towards the center of the galaxy in which that massive body exists. Further, the value of the gravity of each galaxy is maximum at the outermost edges of the galaxy and decreases as we move inwards towards the center of the galaxy – exactly the same kind of variation that is observed in the value of the gravity of the universe. We will see later in this paper how the gravity of each rotating galaxy will ultimately cause the formation of a black hole at the center of such galaxies.

Due to the very large intergalactic spaces, we can treat every galaxy as a closed system and the gravity of the universe can be treated as an external force on each galaxy. Within any galaxy too, there are often very large distances between massive bodies so that two or more massive bodies, which are close to each other, can be treated as parts of a closed system containing these nearby bodies only. In such cases, the gravity of the galaxy acting on these closed systems is simply an external force. Each of the massive bodies within such a closed system will be gravitationally attracted towards the center of mass of the closed system. As the gravity of the galaxy acting on the closed system is an external force, it can be said that the center of mass of the closed system will be acted on by the gravity of the galaxy. It must be noted here that there may or may not be any massive body at the center of mass of such closed systems. As a consequence of the gravity of the galaxy, the entire closed system is pulled towards the center of mass of the galaxy, *i.e.* towards the galactic center. Further, every galaxy can also be treated as a closed system and the gravity of the universe acting on their galactic centers is merely an external force directed towards the center of the universe.

At the instant of the Big Bang, the disk converted to and released as energy a substantial part of its mass. The rest of the mass was released as the fundamental particles of matter – at the instant of the Big Bang the universe was a planar cloud of particles and energy. Further, we know that different parts of this planar cloud of particles had different densities. How did this happen? We have seen that at the instant of the Big Bang the disk contained the fundamental particles of matter. How were these particles arranged in the disk? The Pauli Exclusion Principle states that two similar particles cannot have the same state – the same position and the same velocity – at the same instant of time. By the exclusion principle, therefore, neighboring particles in the disk just before the Big Bang could not have been similar. Further, the combination of neighboring fundamental particles in different regions of the disk would be such as to produce the closest packing possible. Among these combinations of neighboring particles, it is possible that some combinations had a much higher propensity for getting converted to energy than other regions. The K-ratio determines the amount of mass that the disk could have converted to energy at the Big Bang. Different regions of the disk may have had different propensities for getting converted to energy and due to this, different regions of the disk would be preferentially converted to energy – giving rise to local density variations in the planar cloud of particles that constituted our universe at the instant of the Big Bang. Due to the unique direction of the net velocity of each of the particles in the universe, these local density variations would never get smoothed out and will persist in the universe until it contracts to a single rigid body.

At the instant of the Big Bang, the universe was a planar cloud of particles having different densities in different regions. How will the gravity of the universe affect the motion of the particles released at the Big Bang? This gravity will be active from the instant of the Big Bang itself. Further, this gravity will seek to pull all particles towards the center of the universe and will act along the imaginary straight line joining each particle to the center of the universe. Hence, at all instants of time the gravity of the universe will only act along the radius of the particle at that instant of time. But each particle released at the instant of the Big Bang will have a radial as well as a tangential component of velocity. Therefore, at any instant of time after the Big Bang, each particle will have some non-zero velocity perpendicular to its radius at that instant of time. Due to this non-zero velocity component perpendicular to the radius of the particle, the gravity of the universe will not and cannot cause any particle to move in a straight line towards the center of the universe. A mathematical model for movement of matter bodies under the influence of gravity is presented further ahead in this paper.

As the universe expanded it also cooled – its temperature decreased. Soon, within very small regions, the nuclear forces started to dominate and these caused the neighboring particles to combine to form atoms or sub-atomic particles. What is the nature of these nuclear forces? For a set of particles that combined to form an atom or a sub-atomic particle, the nuclear forces acting on them before they combined are merely internal forces. Therefore, as per the law of conservation of momentum, the momentum of each atom or each sub-atomic particle will be equal to the net vector sum of the momentum of each of the constituent particles. Consequently, it can easily be seen that each atom formed in the universe, at the instant of its formation, would also have two components of velocity - one along the imaginary straight line joining that atom to the center of the universe, *i.e.* along its radius and the other perpendicular to this, *i.e.* tangential to the radius of that atom. Hence, each atom formed in the universe will also be moving with a unique velocity. This will happen since each of the atoms and sub-atomic particles formed will be agglomerations of neighboring particles only. Thus, each of these atoms and sub-atomic particles will have the same momentum as the net momentum due to the unique velocities of their constituent fundamental particles. The unique velocity principle, therefore, implies that each atom formed in the universe moves in a unique direction. At all instants of time, the gravity of the universe will seek to pull each atom towards the center of the universe, along the radius for that atom at that instant of time. Hence, at all instants of time, the gravity of the universe will only act along the radius of the atom at that instant of time. But each atom will have a radial as well as a tangential component of velocity. Therefore, at any instant of time, each atom will have some non-zero velocity perpendicular to its radius at that instant of time. Due to this non-zero velocity component perpendicular to the radius of the atom, the gravity of the universe will not be able to cause the atom to move in a straight line towards the center of the universe.

Later, as the universe went on expanding, it cooled further and the process of formation of atoms ceased. Neighboring atoms would again combine to form stars. For a group of atoms that coalesced to form a star, the gravitational force that caused them to combine is merely an internal force. Hence, the momentum of a star at the instant of its formation will be equal to the net vector sum of the momentums of each of its constituent atoms. Consequently, each star, at the instant of its formation, will have two velocity components, one along the imaginary straight line joining that star to the center of the universe, *i.e.* along its radius and the other perpendicular to this, *i.e.* tangential to the radius of that star – similar to the case of the formation of atoms. Further, each star formed will be moving in a direction different from that of any other star, atom or particle in the universe. The unique velocity principle can therefore be stated as "every matter body (irrespective of whether it is a star or planet or atom or a fundamental particle), formed or present in the universe after the Big Bang, is moving with a unique velocity at each instant of time unless acted on by some external force". No two matter bodies formed after the Big Bang can ever move in exactly the same direction and with the same speed simultaneously by themselves – such an incident can only be caused by the application of some external force.

Later, various stars, planets, *etc.* combined to form galaxies. For a group of matter bodies that aggregated to form a galaxy, the gravitational force that caused them to combine is merely an internal force. Hence, the momentum of a galaxy will be equal to the vector sum of the momentum of each of its constituent bodies. This will hold true for each and every body that is a part of a galaxy. Therefore, each galaxy in the universe will have two components of velocity at the instant of its formation - similar to the case of the formation of stars and atoms - one along the imaginary straight line joining that galaxy to the center of the universe, *i.e.* along its radius and the other perpendicular to this, *i.e.* tangential to the radius of that galaxy. Further, each galaxy in the universe will also be moving with a unique velocity as per the unique velocity principle.

We observe that the distant galaxies are moving away from us at speeds directly proportional to their distance from us. This speed is the difference in the numerical value of the tangential velocity component of that galaxy and our galaxy. At the instant of the Big Bang, the universe was a planar cloud of particles having regions of different densities. Each of these regions later – as the universe expanded – moved very far apart from each other and started behaving as a separate galaxy. Immediately after the Big Bang, each of these regions will have a net momentum equal to the vector sum of the momentum of each of the particles that are a part of that particular region. Hence, each of these regions will have a radial velocity component and a tangential velocity component at the instant of the Big Bang. The numerical value of the radial velocity component of each of these regions will be equal. The tangential velocity component of each of these regions will depend on the distance of their center of mass from the center of mass of the universe – *i.e.* from the center of the universe. Consequently, the difference in the tangential velocity component of any two of these regions will be directly proportional to the difference in the radial distances of the center of mass of the two regions from the center of the universe. At every instant of time, the gravity of the universe will pull each of these regions to the center of the universe along the imaginary straight line joining these regions to the center of the universe. Further, the difference in the distance that any two galaxies have covered since the Big Bang will be directly proportional to the difference in their tangential velocity components at the instant of the Big Bang. This is why today each galaxy appears to us to be moving away from us with speeds directly proportional to their distance from us.

Why do we see the slight sideways velocity in the motion of distant galaxies? This is a direct result of the fact that each galaxy is moving in a different direction from that of any other galaxy or body in the universe. As such, the slight sideways velocity in the motion of distant galaxies gives us a very strong indication of the correctness of the unique velocity principle. The space-time curvature model of the evolution of the universe does not have any explanation for the sideways velocity observed in the motion of galaxies.

As pointed out above, the gravitational effect on any body in a multi-body system is such that every matter body is pulled towards the center of mass of the system. Thus, within a galaxy every body is attracted to the center of the galaxy. Due to the gravity of each galaxy, eventually some matter body will reach the center of the galaxy and will rotate over there. As more and more matter accumulates at the center of the galaxy, this aggregation of matter will exert a gravitational force upon itself (essentially acting as a gravitationally closed system). Hence, the entire central region of the galaxy will collapse upon itself, ultimately leading to the formation of a black hole at the center of possibly every galaxy.

3.3 Mechanism of Apparent Space-Time Curvature

Why don't matter bodies move in a straight line under the influence of gravity? How does matter manage to wrap space-time around itself? In our universe, we see that bodies moving under the influence of some gravitational force never move in a straight line towards the source of the gravitational attraction - in three dimensions. We say that actually in four-dimensional space-time the bodies move in a straight line but that in three-dimensional space it appears to us that the bodies are moving on curved paths. But this statement is not consistent with the effects that we observe in normal co-ordinate geometry. When we shift from a co-ordinate system having lesser number of dimensions to a co-ordinate system having more number of dimensions our ability to move on curved paths increases and our ability to observe the curvature in the motion of other bodies also increases. For example, if move on the two-dimensional surface of the earth on a straight-line path we would eventually end up at the point where we started from. This is because in three-dimensional space we are actually moving on a curved path – in fact, our motion describes a complete circle when we reach the point we started from. Due to this effect the shortest distance between two points on the surface of the earth is a geo-disc, which is a straight line in three-dimensional space. Further, in case of one-dimensional motion a body can only move on the same straight line – whether forwards or backwards. In case of two-dimensional motion, the same body can move on several different straight lines. Further, it can also move on curved paths – for example, its path can describe a parabola or a hyperbola or a circle or some other curved shape. If we plot this two-dimensional motion on a one-dimensional graph, then at all instants the graph will show the body on the same straight line – whether moving forwards or backwards or absolutely stationary - while in two dimensions the body might actually be moving on different straight lines or even on curved paths. In two-dimensional motion a body will always be moving on the same plane but in three-dimensional motion a body can move on different planes. So the path of the moving body can now describe a sphere or other curved figures. A body moving on a circle in three dimensions might appear to be moving on a straight line on a two-dimensional graph. This is exactly what happens on the surface of the earth. It is impossible for a body to appear to move on a curved path if we are able to observe the body only in one dimension – irrespective of how the body is actually moving in two or three dimensions. Similarly, in two dimensions it is impossible for a body to appear to move on a curved path if in three dimensions the body is actually moving on a straight line. This can be easily verified. What, then, is the justification for the statement that curved motion in three dimensions is actually straight-line motion in four-dimensional space-time? Further, it is believed that there is no such thing as absolute space or absolute time in the universe. If that is the case, then how can space and time be combined to produce some absolute space-time?

If the concept of absolute space-time is indeed invalid then what is responsible for the curved motion of bodies under the influence of some gravitational force? It is the unique velocity that each of the matter particles released at the Big Bang acquired that is responsible for this curved motion of bodies under the influence of some gravity. First, we will see how this happens in the case of two bodies attracting each other gravitationally and then we will see how this works in the case of many bodies gravitationally attracting each other. Then, we will see the mathematical model for this motion under the influence of gravity.

First, for the sake of simplicity, let us consider the case of two massive bodies gravitationally attracting each other. We will assume that the two bodies are named A and B respectively. Further, we will assume that these two bodies are at infinite distance from all other massive bodies, *i.e.* these two bodies are being acted upon only by each other's gravity. We can treat these two bodies as a part of a closed system containing these two bodies only. The net gravitational effect on both these bodies is that they will be pulled towards the center of mass of this closed system. In this case the center of mass of the closed system may only be an imaginary point in space unless one of the two bodies is very much heavier than the other body. Let us name the center of mass of this closed system as point-M. The unique velocity principle implies that both bodies A and B will be moving with unique velocities such that their velocities do not lie along exactly the same direction. Hence, point-M will also be moving with some velocity – the weighted average of the velocities of bodies A and B (weighted in the ratio of their masses). As both bodies A and B have a unique velocity, the weighted average of their velocities, *i.e.* the velocity of point-M, will also be unique – all three A, B and point-M will be moving with different velocities. The net gravitational effect on body A is to pull it towards point-M. This gravitational force is acting along the imaginary straight line joining the center of mass of body A to the center of mass of the closed system, *i.e.* point-M. Henceforth in this paper, the imaginary straight line joining the center of mass of a body to the center of mass of the closed system containing the body will be called the C-line of that body. In the two-body case that we are discussing here, the gravitational force acting on body A will always be directed along the C-line of body A. Suppose that at this instant of time body A starts to move towards point-M and that at this instant of time the velocity of body A lies entirely along the C-line of A. In the next instant of time though, due to the fact that both body A and point-M are moving with different velocities, the velocity of body A will no longer lie along the C-line of A. If we now take the components of velocity of body A along the C-line of A, then we will see that there are two components:

1) A component along the C-line
2) A velocity component perpendicular to the C-line of the matter body A and lying on the plane of the closed system consisting of bodies A and B.

As body A moves towards point-M, the component of body A's velocity that is perpendicular to the C-line of body A will cause body A to also cover some distance along a path perpendicular to the C-line. Further, at different instants of time, as body A and point-M are moving in different directions, the C-line of body A will keep on changing. Accordingly, at different instants of time, the velocity components of body A along the C-line (at that instant of time) of A and perpendicular to this C-line will have different numerical values. Due to this constantly changing nature of the values of the two velocity components, as matter body-A moves towards point-M, it will cover different amounts of distance in the two directions, (one along the C-line and the other perpendicular to it) in different intervals of time. For very small intervals of time, the total distance covered by body A will be roughly the same (affected only by the acceleration due to gravity), even though the distance covered along the two directions will keep on changing. This is what leads to the curved path motion of bodies moving under the influence of gravity. Similarly, when body B starts moving towards point-M, its C-line will not remain constant but will be different at different time intervals since body B and point M will be moving with unique velocities. Hence, body B will necessarily develop a component of velocity perpendicular to the C-line of body B and lying on the plane of the closed system. This velocity component will cause body B also to start moving on a curved path. All three - bodies A and B and point-M – are moving in different directions and this is what caused bodies A and B to move on curved paths towards point-M. Eventually, bodies A and B will collide at point-M and then they will start moving with the velocity that point-M had at that instant of time. Further, the momentum of this closed system will be conserved before and after the collision of bodies A and B at M. This implies that after colliding at M, bodies A and B will be rotating. This is how the unique velocity principle causes curved path motion when two bodies gravitationally interact with each other.

We will now see how, in the case of many bodies gravitationally attracting each other, the unique velocity principle causes them to move on curved paths. The mechanism involved is exactly the same as in the case of the two-body system that we discussed above. Suppose that there are ten massive bodies attracting each other gravitationally. Further, let us assume that the distance between any two of these bodies is much smaller than the distance between any one of these bodies and any eleventh matter body. In such a case, the ten bodies together can be treated as a closed system containing these ten bodies only. As we have already seen, the net gravitational effect on each of the bodies will be such that the body will be attracted towards the center of mass of this closed system. Let the center of mass of this system be known as point M. Let one of the bodies that are a part of this system, be known as body H. The net gravitational effect on H is that it faces an attractive force towards M directed along the C-line of body H. Due to this gravitational attraction eventually body H will start to move towards M. As we have seen above in the case of the two-body closed system containing bodies A and B only, the universe will move on curved paths towards the center of mass of the universe, *i.e.* towards the center of the universe. Before looking at the mathematical model of the gravitational behavior described here, let us look at some other potential proofs of this behavior.

3.4 Proof of This Gravitational Behavior

First of all, if there had been some particles and bodies close to each other and moving with their velocities pointing in exactly the same direction, then we would have had a direct proof of this explanation. As per the implications of the explanation presented above, such particles would move in a straight line towards each other in three-dimensional space under the influence of each other's gravity. The space-time curvature model insists that all bodies and even light must always move on curved paths in the presence of some gravitational attraction. But the explanation presented here implies that bodies moving in the same direction, relatively close to each other and far away from any other body (so that they are only affected by each other's gravity and not by gravitational attraction from any other body) will move in a straight line towards each other. The state of the universe at the instant of the Big Bag leads to the unique velocity principle which implies that such naturally occurring bodies (*i.e.* bodies moving in the same direction and close to each other) are not likely.

Secondly, in the case of very strong gravitational fields in 2 body systems where one body is very massive and the other much lighter, so that the more massive body is effectively not accelerated by the gravity of the lighter body, the lighter body does sometimes move towards the heavier body in a straight line, in direct violation of space- time curvature theory. One example of this would be a space-shuttle or rocket. If the space-time curvature concept were true, then it would not be possible for a space-shuttle to travel in a straight line near a massive body, irrespective of the amount of acceleration provided to it, since space-time itself would have been curved. If space-time was indeed curved near a matter body, then providing greater acceleration to such a space shuttle would only cause it to move faster along curved paths.

Another indirect proof comes from the behavior of charged particles under the influence of electrostatic forces. In a cathode ray tube, the electrons released at the cathode can be accelerated towards the sides of the tube by placing a positively charged body on the side of the tube, *i.e.* perpendicular to the path of the electron in the absence of the positively charged body on the side of the tube. By this acceleration, electrons can be made to hit different positions on a screen placed at the anode end of the tube. But under the effect of this acceleration, particles do not move on a straight-line path. Instead they move on a curved path. The reason for this is that the velocity of the electron released at the cathode points towards the anode in a straight line. But an additional electrostatic attractive force acts along the imaginary straight line joining the positively charged body placed on the side of the tube to the electron at all instants. Let us call the imaginary straight line joining the positively charged body placed on the side of the tube to the moving electron, the D-line for that electron. The velocity of the moving electron does not lie entirely along the D-line for that moving electron. If we take the components of the velocity of the moving electron about the D-line for that electron, we will find two components:

1) A velocity component lying along the D-line for that electron

2) A component perpendicular to the D-line for that electron.

Further, as the electron is moving, while the charged body on the side of the tube is stationary, the distance between the electron and the positively charged body on the side is constantly changing. Hence, the numerical value of the two components of velocity will be changing at all instants of time. This constant change in the values of the two components of the velocity of the moving electron causes it to move on a curved path. In this case, due to the very small mass of the moving electron and the small mass of the positively charged body on the side of the tube, space-time curvature cannot be said to be responsible for the curved motion of the electron under the influence of the electrostatic force.

Generally, a cathode ray tube has a very small length and breadth so that eventually the moving electron reaches the anode end of the tube. If we make a cathode ray tube of very large dimensions and place a sufficiently strongly positively charged body, not on the wall of the tube, but close to the center of the tube, then we should be able to observe that the moving electron will eventually spiral into the positively charged body. This will occur when the positively charged body exerts sufficiently greater electrostatic force to appropriately accelerate the moving electron away from the anode.

A possible experiment would be to take a few metallic balls and rotate them very fast. These metallic balls should be placed side-by-side in a circle rather like a ball bearing. At the center of this ball bearing we can place an explosive. As the setup starts to rotate very fast we will detonate the explosive and thus accelerate the balls away from the center of the set-up. This will give rise to a Big Bang like model. After some small instant of time, we will turn on some opposite charge on two of the balls that were next to each other in the original ball-bearing setup. Consequently, the two balls would be under the influence of each other's electrostatic attraction. In such a case, we should be able to observe the two balls move on curved paths towards each other, exactly like massive bodies in space move towards each other on curved paths under the influence of each other's gravitational attraction. This experiment can also be conducted with two neighboring balls carrying opposite charge before the explosion itself. The results should be similar in this case as well.

A mathematical model analyzing a two-body system is presented along with this paper. This model shows that the concepts presented above do result only in curved motion under the influence of gravity.

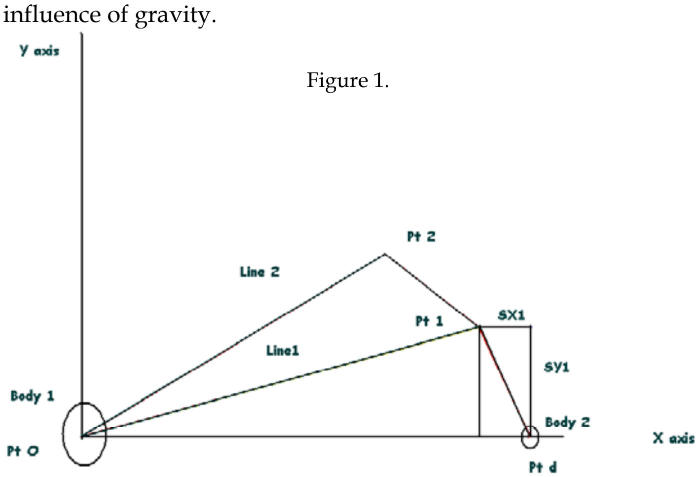

Figure 1.

Two matter bodies, bodies 1 and 2, attract each other gravitationally. For ease of mathematical representation, it is assumed that they only start attracting each other from the position shown in the diagram. At $t=0$, *i.e.* when they first start attracting each other, the center of mass of body 1 is the origin of the graph while the center of mass of body 2 lies on the x-axis of the imaginary graph at point d. The distance between the center of masses of the two bodies is therefore d units. It is further assumed that body 1 is so much more massive than body 2 that it does not start moving under the influence of body 2's gravity. It is also assumed that at $t=0$, all of body 2's velocity is parallel to the y-axis whereas body 1 is stationary.

Thus, for body 2

At $t=0$ (let us call this T_1 since this is the first instance of observation)

$V_{x1}=$ velocity at T_1 along the x axis

$A_{x1}=$ acceleration due to gravitational attraction from body 1 along the x axis at T_1

$V_{y1}=$ velocity at T_1 along the y axis

$A_{y1}=$ acceleration due to gravitational attraction from body 1 along the y axis at T_1

At $t=T$ (let us call this T_2 since this is the second instance of observation)

$S_{x1}=$ distance covered by body 2 parallel to the x-axis during T_1

Hence total distance already covered by body 2 at T_2 (*i.e* during T) is S_1, where:

$$S_1^2=S_{x1}^2+S_{y1}^2 \tag{1}$$

Thus

$$S_1^2=\left(V_{x1}\cdot T+\tfrac{1}{2}A_{x1}T^2\right)^2+\left(V_{y1}\cdot T+\tfrac{1}{2}A_{y1}T^2\right)^2 \quad . \tag{2}$$

(This is simply the full equation for the distance covered by any body during small time interval T under the influence of the gravitational pull of another body). In Fig. 1, at time $t=T$ (*i.e.* at T_2), the center of mass of body 2 lies at Pt_1. Thus at T_2:

$V_{x2}=$ velocity at T_2 along the x – axis

$A_{x2}=$ acceleration due to gravitational attraction from body 1 along the x axis at T_2

$V_{y2}=$ velocity at T_2 along the y – axis

$A_{y2}=$ acceleration due to gravitational attraction from body 1 along the y axis at T_2

At $t=2T$ (let us call this T_3 since this is the third instance of observation),

S_2 = total distance covered by body 2 during the time difference between T_2 and T_3.

In the given Figure, at $t=2\Delta T$ (*i.e.* at T_3) the center of mass of body 2 lies at Pt^2. In the scenario described here, at T_1:

$$V_{x1}=0$$

$A_{x1} = A =$ acceleration due to gravitational attraction from body 1 at T_1

$V_{y1} = V =$ total velocity of body 2 at T_1, and $A_{y1} = 0$

Hence at T_2:

$$S_{x1} = \frac{1}{2}aT^2 \text{ Sx1=Half aT^2} \quad , \tag{3}$$

$$S_{y1} = Vt \quad . \tag{4}$$

Thus

$$S_1^2 = S_{x1}^2 + S_{y1}^2 = \frac{1}{2}AT^2 + VT \tag{5}$$

Further, at T_2:

A_1 = acceleration due to gravitational attraction from body 1 at T_2

D_1 = distance of the center of mass of body 2 from the center of mass of body 1.

Thus

$$D_1 = \sqrt{(d + S_{x1})^2 + (S_{y1})^2} \quad , \tag{6}$$

Hence

$$A_1 = A \cdot (d / D_1)^2 \quad , \tag{7}$$

Thus, at T_2:

$$V_{x2} = A \cdot T \quad , \tag{8}$$

$$A_{x2} = A_1 \cos\theta_1 \quad , \tag{9}$$

Where $\theta_1 =$ angle that the imaginary line joining the center of mass of the two bodies at T_2 (*i.e.* line 1 in the Figure) makes with the x-axis

$$V_{y2} = V \tag{10}$$

$$A_{x2} = A_1 \sin\theta_1 \tag{11}$$

Hence at T_3:

$$S_{x2} = V_{x2}T + \frac{1}{2}A_{x2}T^2 \tag{12}$$

$$= AT^2 + \frac{1}{2}A_1\cos\theta_1 T^2 \tag{13}$$

$$S_{y2} = V_{y2}T + \frac{1}{2}A_2T^2 \tag{14}$$

$$= VT + \frac{1}{2}A_1\sin(\theta)T^2 \tag{15}$$

As can be seen from the above, body 2 will be moving in a straight line only if:

$$S_{y1} / S_{x1} = S_{y2} / S_{x2} \quad , \tag{16}$$

(*i.e.* if and only if the slope of its path is constant)

This condition will have to hold true over all small time intervals during the time that body 2 remains under the influence of body 1's gravitational attraction. But as can be seen by comparing Ax1, Ax2, Ay1 and Ay2, the components of acceleration along the x and y axes will keep changing as the angle between the x-axis and the imaginary straight line joining the centers of mass of the two bodies will keep changing. Hence, body 2 will not move on a straight line path but will move on a curved path. There is only one case where the condition for straight line motion will hold true. At the instant it first comes under the influence of the gravitational attraction from body 1, if all of the velocity of body 2 lies along the imaginary straight line joining their centers of mass, then body 1 will move on a straight line. In the given scenario, this implies Vy1 = 0. In that case, Sy (distance covered by body 2 along the y axis for a short interval of time) will always remain zero (since Vy1 = 0 and Ay1 = 0, it implies θ = 0 at all times). Hence, the slope of the path of body 2 will always remain zero (*i.e.* will be constant), yielding a straight line path. But the unique velocity principle implies that such a situation cannot occur in nature.

In the real world, the unique velocity principle implies that this condition (where all of the velocity of body 2, at the instant it first comes under the influence of the gravitational attraction from body 1, lies along the imaginary line joining their centers of mass) will never hold true since all bodies would be moving away from each other (diverging) initially, at angles not equal to either 180 degrees or 0 degrees (due to the presence of both a radial and a tangential component of velocity at the instant of the Big Bang). Thus, bodies will move on curved paths under the influence of gravity.

In the scenario presented here, it was assumed that body 1 is stationary. For analysis in the real world, if both bodies are moving, we need to calculate the values of V_x, V_y, A_x, A_y, S_x, S_y for both bodies for all small intervals of time T, while keeping the frame of reference constant all through. The other option is to assume that one of the bodies is stationary at $t = 0$ and assign the relative velocity of the two bodies to the second body at $t = 0$. Then, we need to calculate the total movement of the second body for small time interval T (*i.e.* motion due to the relative velocity at $t = 0$ and due to the gravitational acceleration from the first body) and also calculate the motion of the first body for the same time interval T due to the gravitational acceleration from the second body. After this, the distance between the two bodies at $t = T$ will be obtained and the new value of acceleration due to gravity can be calculated, keeping in mind the new distance between the centers of mass of the two bodies. This process can then be repeated for subsequent intervals of time. To verify this model, the motion of various known planets around their sun can be analyzed as per the above method, and their observed orbit can be compared to the orbit predicted by this model. Similar analysis can also be done for many body systems where the various bodies are of comparable masses.

This theoretical model (of motion under the influence of gravity and the state of the universe at the instant of the Big Bang and the subsequent evolution of our universe, including the unique velocity principle) implies that there is no need to depend on the space-time curvature concept to understand the curved motion under the influence of gravity that we observe in our universe today. A further implication is that most, if not nearly all, of the stars and other massive bodies formed after the Big Bang should have been spinning, *i.e.* they should have been rotating. This is so because the fundamental particles (and subsequently matter bodies) will only move on curved paths towards each other, irrespective of whether they move under the influence of gravity or any of the other forces. The law of conservation of momentum implies that the net momentum of local regions will remain the same both before and after the formation of massive bodies. Thus, massive bodies should have been rotating since their net momentum cannot be zero at any instant of time. Similarly, the subsequent second-generation stars, planets, black holes *etc*. should also be spinning, *i.e*. rotating.

4. Results and Discussion

We started with the **following assumptions** in search of a coherent and consistent theory that can explain our universe as we see it today, without resorting to any arbitrary elements:

1) At the instant of the Big Bang, the universe already had enough matter to lead to all of the matter that we see today, *i.e*. there was never any violation of the principle of conservation of baryon number.

2) At the instant of the Big Bang, quantum and relativistic effects within the universe should have been negligible – the implication of this is that the laws of physics will apply even to the Big Bang event.

3) All of the mass of the universe was part of a single spinning disc at the instant of the Big Bang.

This leads to a new picture of the Big Bang where all matter released at the instant of the Big Bang would have two components of velocity. Due to these components of velocity, no two particles will have exactly the same velocity (*i.e*. the same speed and the same direction simultaneously) – the unique velocity principle. A consequence of this principle is that neighboring particles could not have been moving in exactly the same direction immediately after the Big Bang. It is shown that under such circumstances matter bodies will move on curved paths under the influence of gravity without any space-time curvature at all. The theory described here is able to explain our observations of the universe without needing arbitrary and unverified elements like dark matter and dark energy.

The current standard model claims that at the instant of the Big Bang, the universe was point sized. This assumption largely derives from Lemaitre's work in which he had shown that extrapolating our expanding universe backwards in time ultimately leads to a point-sized state for the universe. [6, 7] But there is no physical proof at all that our universe ever actually had a point-sized state. In fact, the standard model itself accepts that our universe could not have acquired its present state from a point-sized initial state without several violations of the laws of physics. First of all, the concept of point-sized initial state of the universe implies that our universe could not have acquired its present mass at all without a violation of the principle of baryon number conservation. Secondly, even though the laws of physics insist that nothing can travel at velocities greater than the speed of light, a universe that started from a point-sized state must have expanded at a rate greater than the speed of light for at least a small period of time. Otherwise, a universe as massive as ours would collapse upon itself much before reaching its present size. Similarly, the concept of a point-sized initial state of the universe can not explain the motion of matter bodies in our universe without taking recourse to the arbitrary elements of space-time curvature and dark matter. The theory derived and presented in this paper does not require any such violations of the laws of physics and is able to describe the evolution of our universe and the observations therein more accurately than contemporary theories. Further, the Lemaitre workings do not deny the possibility that our universe never actually had a point-sized state at all. It can easily be seen that if our expanding universe is extrapolated backwards in time, with zero space-time curvature effects, it will lead to a spinning disk-like state much before the point-sized state is reached. Thus, the implication of this theory is that our universe is not as old as previously estimated. The universe is younger by at least the Planck era, *i.e*. the Planck era never happened at all. The universe did not start from a point-sized initial state but actually started from a spinning disk-like state.

In our universe today, the space-time curvature model is unable to explain the action of gravity in multi-body systems. At best, it is only able to explain the action of gravity in two-body systems where one of the bodies is so much larger than the other that only the smaller body is significantly accelerated due to the gravitational pull from the larger body. But in many body systems, where several massive bodies of comparable masses act on each other, space-time curvature implies that each of the bodies will seek to pull space-time around itself. In such a scenario, space-time curvature is unable to explain why bodies move on curved paths towards the center of mass of the system rather than on curved paths towards each other. The theory presented in this paper, on the other hand, is able to explain this phenomenon. Thus, for example, this theory explains how matter accumulates at the center of galaxies while the space-curvature model is unable to explain this at all.

Similarly, space-time curvature is unable to account for the velocities of matter bodies in many body systems such as galaxies. The space-time curvature model requires far more matter to be present within galaxies than estimated, in order to account for the velocities observed, leading to the dependence on the arbitrary element called dark matter. But the major problem with dark matter concept is that it will add to the overall gravity of the universe. This would imply that the universe could never have reached its present size but would have collapsed much earlier. The theory presented in this paper is able to explain the velocities of matter bodies in such systems. As per the unique velocity principle, all matter bodies must have acquired some velocity at the instant of the Big Bang (the two components of velocity). Thus, gravity alone is not the cause for observed velocities of matter bodies; rather, the impact of gravity and the unique velocity acquired by the matter forming particles released at the Big Bang is reflected in the velocities of matter bodies as observed today.

The observed rate of expansion of our universe is also not explained by the current standard model, leading to the need for the arbitrary element called dark energy. Dark energy is supposedly pulling apart our universe and thus has caused an increase in the rate of expansion of our universe. The problem with this idea is that if dark matter were indeed accelerating galaxies away from the center of the universe then it would also have accelerated our own galaxy. But no such acceleration has been observed at all. In an inertial frame of reference, it is not possible to conclude whether the frame of reference is stationary or has a constant non-zero velocity. But an accelerating frame of reference is non-inertial. Acceleration should be easily noticeable to an observer who is part of such a non-inertial frame. As pointed out though, no such acceleration of our galaxy has been observed. Secondly, if dark energy were indeed causing an increase in the rate of expansion of the universe, galaxies too ought to be expanding. It is not justifiable to say that dark energy will only cause an increase in the rate of expansion of the universe in those areas where there is little or no matter but will have no impact at all in those regions where matter density is higher. Hence, if dark energy is truly accelerating the rate of expansion of the universe, it should also have an inflationary impact on the radii of various galaxies. This again has not been observed at all.

The above are the two major problems with the idea that dark energy is causing an increase in the rate of expansion of the universe. In fact, the first of these problems implies that there is actually no acceleration whatsoever in the rate of expansion of our universe. The theory presented in this paper is able to explain why it appears to us that the rate of expansion of the universe is increasing. In the 1920s-30s, we had assumed that the rate of expansion of the universe is equal everywhere, *i.e.* the various galaxies are moving away from each other at rates proportional to their distance from each other. [8] But the unique velocity principle implies that all matter released at the instant of the Big Bang would have had two components of velocity. Of these, only the tangential component of velocity would have been proportional to the radial distance of that particle from the center of the disk at the instant of the Big Bang. If the particles released at the big bang only had this component of velocity then the rate of expansion of the universe would indeed have been equal everywhere, *i.e.* the various resultant galaxies formed from these particles would have been moving away from each other at velocities proportional to their distance from each other. But the radial component of velocity is an additional velocity component that each of the particles released at the Big Bang would have and it is this additional component of velocity that leads to a rate of expansion of the universe that is greater than what we had assumed in the 1920s-30s. This is what leads us to believe that the rate of expansion of the universe has increased.

4.1 Why Did Einstein Get It Wrong?

Albert Einstein's seminal works on relativity are at the core of physics, particularly cosmic physics, today. [9, 10] The standard model of the evolution of our universe draws heavily upon and indeed, is founded upon his idea of space-time curvature. But the space-time curvature model is incorrect, as shown in this paper. While this paper has shown the correct model of motion under gravity and the true state of our universe at the instant of the Big Bang and the consequent evolution of our universe, the question that now interests us is how did Einstein go wrong with the idea of space-time curvature?

The answer perhaps lies in the simple fact that Einstein's work on general relativity was done much before the Big Bang model came into existence. Einstein, in fact, had assumed that the universe is stationary, *i.e.* it is not expanding and several scientists had supported this idea vigorously for a very long time.[11] We definitively know this to be wrong today and in fact this was learned during Einstein's life-time itself but much after his work on general relativity. A stationary universe cannot survive forever – it will ultimately collapse upon itself due to gravity. Hence, Einstein had added a cosmological constant to keep the universe from collapsing. When it was discovered that the universe was not in fact stationary but was expanding, Einstein dubbed the cosmological constant his greatest blunder. He was wrong – space-time curvature was his greatest blunder. Just as Einstein had introduced the cosmological constant to solve one conundrum posed by gravity – namely, how can the universe remain stationary and yet not collapse due to gravity – he probably introduced the concept of space-time curvature to solve another problem presented by gravity – how and why don't the locally dense regions of the universe (dense in terms of the amount of matter they hold) collapse upon themselves due to their gravity. Our solar system should collapse upon itself, with all the planets colliding with the sun in just a few years time. Similarly, our Milky Way galaxy ought to collapse upon itself, with all of the matter in the galaxy aggregating at the center of the galaxy rapidly. And a similar fate ought to befall all galaxies and other similar locally dense regions of the universe. The gravitational constant was known, the distances between various planets and the sun was known to a large degree of accuracy and rough estimates of their mass were also available in Einstein's time. Hence, he needed to explain why gravitational collapse in such locally dense regions is not far more rapid than observed.

Just as Einstein solved the problem of the stationary universe not collapsing by resorting to the cosmological constant, he solved the problem of non-collapse of locally dense regions by using the space-time curvature model. In the real world, matter bodies do not just move on a straight line under the influence of gravity - they take curved paths towards the source of that gravitational attraction. As explained in this paper, this motion is a consequence of the unique velocity principle which is itself a result of the state of the universe at the instant of the Big Bang. But Einstein did not know that the universe is expanding – he was not aware of the Big Bang at all. Hence, he was unable to deduce the unique velocity principle. In the absence of this concept, the space-time curvature model was the only possible explanation for matter bodies moving on curved paths under the influence of gravity. The space-time curvature model implied that locally dense regions of the universe will take far longer to collapse than predicted by classical physics as matter bodies will move on curved paths and not on straight line paths towards the source of gravitational attraction. At a time when our knowledge of the universe was still very nascent, the space-time curvature model helped explain the motion of matter bodies to the extent that we were aware of such motion. But with the progress of time, our knowledge of the universe increased and we were able to observe many more matter bodies than previously. In such a situation, it was found that the space-time curvature model was unable to explain all of the motion of matter bodies under the influence of gravity. For example, it completely fails to explain the observation that rotating galaxies are able to maintain their shape even as they rotate, *i.e.* the rate of rotation throughout the galaxy remains roughly constant. Contemporary theories have responded to these observed problems by simply claiming that there must be dark, unverifiable, unobservable matter. This dark matter adds to the predicted gravity due to observable matter within galaxies and the consequent additional gravity accounts for the observed motion of matter bodies. But this approach is untenable. Gravity does not stop acting with increasing distance. Its effect only gradually and proportionately decreases with increasing distance. Thus, even if there was dark matter, the additional gravity due to this dark matter will also act over larger distances, just as it does over shorter distances. Hence, outer bodies in galaxies should still be rotating around the center of galaxies at rates much higher than the rate of rotation of inner bodies. Similarly, observations regarding the expansion of the universe that contradicted the space-time curvature model have been blamed on a mysterious unverifiable and unobservable dark energy – dark energy so widespread that it supposedly makes up over 70% of our universe. This approach is again unjustifiable. If dark energy is indeed accelerating the rate of expansion of the universe, it should also accelerate our own galaxy. Further, it should also cause galaxies themselves to expand. The theory presented in this paper accurately describes the state of our universe at the instant of the Big Bang, the consequent unique velocity principle and the resultant evolution of our universe. Motion of matter bodies on curved paths under the influence of gravity is a consequence of the unique velocity principle. Similarly, when we observe the rate of expansion of our universe, distant matter bodies do not appear to be moving away from us at rates in proportion to their distance from us – they appear to be moving away at rates greater than predicted - due to the two components of velocity that every matter forming particle would have acquired after the Big Bang, as described in detail earlier in this paper. Of these two velocity components, only the tangential velocity is proportional to the radial distance of that matter from the center of the universe. The radial velocity is an additional velocity component which will be equal numerically for all matter released at the time of the Big Bang. These two velocity components together, lead to the observation that the rate of expansion of our universe is higher than that predicted by contemporary theories.

4.2 Behavior of Light in a Gravitational Field

If the space-time curvature concept is indeed incorrect then what is the explanation for the bending of light in the presence of a gravitational field? The theory derived and presented in this paper implies that matter bodies move on curved paths under the influence of gravity due to the unique velocity principle and not due to space time curvature. In such a case, the implication of this theory is that photons must have non-zero rest mass. No matter how small the rest mass of a photon is, so long as it is greater than zero it will behave just like any other matter body in a gravitational field and will be similarly affected. Thus, the theory of motion of bodies under the influence of gravity and the mathematical model presented above in this paper will be equally applicable to motion of matter bodies as well as to motion of light.

There are interesting implications of this. While the unique velocity principle implies that no two matter bodies in the universe are likely to be moving in a straight line towards each other, there is no such restriction on light. Thus, in the absence of space-time curvature, if a light beam is cast on a matter body such that the light beam is travelling on a straight line path in three-dimensional space towards the body in the absence of any gravitational field, then the beam should continue on the same straight line path in three dimensions even when it comes under the influence of the gravity of that body. On the other hand, if the beam is cast away from the straight line path to the body in three-dimensional space, it should start bending towards the matter body as it enters the gravitational field of that body. This motion on a curved path will be exactly as shown in the mathematical model above for matter bodies. (One consideration that possibly needs to be kept in mind here that is that as per relativity, the speed of light cannot be increased. This may imply that light should not speed up as it enters a gravitational field, only the direction of its motion should change.) The space-time curvature model, on the other hand, implies that even if a light beam is cast on a matter body such that the light beam is travelling on a straight line path in three-dimensional space towards the body, it should still start moving on curved paths as soon as it comes under the influence of the gravity of that body. No such bending of light, travelling on a straight line path in three-dimensional space towards a matter body, due to the gravity of that same body, has ever been observed. Bending of light only occurs when a beam of light cast away from the straight line path to a matter body comes under the influence of that body's gravity. This is another case where the implications of the space-time curvature model and the theory presented in this paper differ.

5. Conclusions

We started out with the objective of seeking a model that can explain our observations of large scale behavior in the universe, without resorting to any arbitrary and unverifiable elements such as space-time curvature, dark matter and dark energy. To this end, we started with the following assumptions:

1) At the instant of the Big Bang, the universe already had enough matter to lead to all of the matter that we see today, *i.e.* there was never any violation of the principle of conservation of baryon number.

2) At the instant of the Big Bang, quantum and relativistic effects within the universe should have been negligible – the implication of this is that the laws of physics will apply even to the Big Bang event.

3) All of the mass of the universe was part of a single spinning disc at the instant of the Big Bang.

It is shown that these assumptions lead to a model of the origin and evolution of our universe that better explains our observations of observed phenomena than the standard model.

When discrepancies between predictions of existing theories and observations emerge, it is imperative that science should question whether the existing ideas are indeed worthy or new ideas are needed. Resorting to arbitrary elements to prop up flawed theories is not at all scientific. When predictions of contemporary theories fail to concur with observations, newer and better ideas must emerge. The way of science is to test all new ideas rigorously and verify if they explain observations or fail to do so and then to accept only those theories that pass this test. To hide behind unverifiable and arbitrary elements and then to say that it is impossible to delve any further in the quest for knowledge is not the way of science. To say that it is impossible to delve further is to assert that science has achieved its pinnacle and must now either not progress at all or possibly even degenerate.

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