THE TWIN UNIVERSE THEORY

by Brian Cook

Abstract

The standard model of cosmology provides a picture of the evolution of the universe that introduces several problem areas that are difficult to explain. Perhaps the most significant of these is the assertion that 95% of our universe in missing and totally unknown to us. This article suggests an alternative theory stating that suggests there is no missing matter and energy to account for in the universe that we observe in astronomy today. The theory goes on to describe how the big bang might be one of a continually repeating cycle.

Content

1. Introduction

Ninety five percent of our universe is physically unknown to us. This astonishing statement needs to be reiterated in a different way. All of the things that we see around us on this planet, the sun and all of its solar system, the stars that make up our galaxy and all of the billions of galaxies that we observe in our universe, represent just five percent of the matter particles and energy who's existence we can physically explain. The remaining 95% is made up of matter and energy that is totally unknown to us. We have never been able to detect or measure it and we continue to search for it today.

One might reasonably wonder why the cosmologists, that study the universe, are so certain that this state of affairs is accurate and correct. Is it possible that their *Standard Model of Cosmology* is lacking some vital clues that will lead us to understand the content of everything in the universe? We need to understand why cosmology has developed this picture of the universe and question whether a different interpretation can be made. For this, we need to look first at the history of the subject and investigate every stage of the model's development.

2. The history of cosmology

Mankind has looked upwards into the sky for many millennia. The sun, the moon and the stars were the obvious focus of curiosity and together, they became known as the universe. They all appeared to traverse the sky with regular periodicity, so it was not surprising that planet earth was assumed to be the centre of the universe and all of the objects in the sky orbited around Earth. This notion was held sacrosanct by all in authority for many years.

The development of the clock in the fifteenth and sixteenth centuries caused some to question this notion. It was now possible to fix the timing of the sun's regular motion across the sky and it was noticed that the stars and moon did not match the periodicity of the sun. The two brightest objects in the night sky other than the moon are now known to us as the planets Venus and Jupiter. Venus in particular was seen to progress erratically across the night sky. It would progress from west to east along with the stars and then stop and regress from east to west. Clearly its orbit was not being controlled by the Earth.

It was Copernicus, in the sixteenth century, who stated that Earth held no special place in the centre of the universe. This is known as the *Copernican Principle*. He advocated the heliocentric principle that the sun was the centre of the universe that Earth orbited it and was later supported by the work of Kepler and Galileo. When Newton published his laws of gravitational motion, late in the seventeenth century, the Copernican principle was firmly ratified.

Right through the eighteenth and nineteenth centuries, the Milky Way galaxy was believed to be the extent of the universe. Furthermore the universe was believed to be in a steady state that was not expanding. Telescopic observations were improving and some of the objects seen were indistinct and fuzzy. In the nineteenth century, Mendeleev classified these objects with M numbers and dismissed them as of no significant astronomical interest! Later we were to learn that some of these objects were galaxies beyond the Milky Way.

It was Einstein at the start of the last century that was uncomfortable with a steady state universe. Having developed his theories on gravity, he could not understand why the universe would not contract under its own mass. That is when he decided to introduce his gravitational constant as a fiddle factor to correct for a steady state and to later reject this factor as his biggest blunder.

The first measurement of a *Doppler red shift* in a spiral galaxy was made in the early part of the last century by Silpher. At that time, the significance of the observation was missed and astronomers did not realise that it was a spiral galaxy, receding beyond our own milky way. It was referred to as a spiral nebula and was thought to be contained within our milky way. The reality became evident when Edwin Hubble discovered through observations that the universe contains many such objects and is expanding. This was an incredible concept to take on board as it confounded any idea of a steady state and caused observers to extrapolate the expansion backwards in time to come to the conclusion that everything started with a *big bang*. It took a while for the steady state advocates to accept this, but almost everyone agrees on it now.

2.1. The hot big bang

It was Lemaître who first postulated the big bang and his idea was later developed by Gamow, but it was Hubble that provided the details that ultimately led to the general acceptance of the big bang in science. Not everyone agrees on the nature of the hot big bang or the way that it immediately developed. There are some very woolly ideas about the composition of the immediate universe before the *inflation period* for example. Most agree that it all started from a big bang, but what materially was created by the big bang as a precursor to inflation is unclear. Some accounts suggest it was no more than a few grams of 'something' that became inflated later to the *quarks and leptons* that formed the universe. This is further complicated by the prediction of Dirak that equal amounts of *matter and antimatter* were created by the big bang and further still by the calculation that showed that the majority of matter created was of an *exotic, unknown nature*. Whether those few grams contained antimatter and/or an exotic form of matter is hypothetical. However, both of these entities provide difficulties that we will discuss later.

The term Big Bang was first coined somewhat ironically by Hoyle in 1949. Hoyle was actually a strong advocate of the steady state universe. The term implies an explosion and is really a misnomer, given that the present model of cosmology describes a massive inflation of space rather than a detonation. The model assumes that the universe was filled homogeneously and isotropically with energy and was inflating rapidly. Scientists believe that they can model the universe right back in time to first fractional part of one second. Nevertheless, they have to concede that there was a minute period after the genesis known as the *pre-Planck* period, when conditions of temperature and pressure were beyond all of our known laws of physics. The model therefore contains several assumptions and in spite of tremendous advances in recent years, it is quite probable that it will need to be modified in the future as more information comes to hand. At present there is no good evidence of any evolving events in the universe prior to an age of about 10^{-15} seconds.

According to the theoretical model, a tremendous number of changes happened in the universe before it was 10^{-15} seconds old and we need to examine these to try to understand what happened stage by stage.

3. The Standard Model of Cosmology

3.1 The singularity

It is a consequence of Hubble's observation that the universe is expanding, that if this is extrapolated backwards in time, it leads to the idea of a *singularity* as the start of the universe. The big bang is said to be the sudden expansion of space from a point singularity. This object contains the entire universe compressed to virtually infinite pressure, temperature and density, but what exactly is it and what is its size? Does it have zero diameter in which case it does not exist surely. It must have a diameter of a *Planck length* at least in order to exist. The Planck length is the smallest possible length for anything to exist. Of course, there are real examples of singularities in the world today in the form of black holes. These are the remnants from the explosions of massive stars. When these stars come to the end of their lives, they have a strong enough gravity to compress the core of the star's matter down to a singularity. We are told that no object or energy can escape from a black hole once it is inside a certain radius, known as the *Schwartzchild radius*. That is why black holes are black. They are strange and not well understood. We observe them in our macro world, but if they contain a singularity, they too provide a real mystery in the universe today. Perhaps there is a better explanation.

Between the big bang and inflation there was an ultra brief period of slower expansion described as the pre-Planck period. It lasted for a mere 10^{-36} seconds. The standard model states that the universe had a volume less than a trillionth of the size of a proton at this time. It claims that the universe built its enormous mass out of what they describe as negative gravitational energy. One might ask where all of this massive amount of negative gravitational energy came from given that the singularity must have started from a rest position of zero motion and needed force to get it moving. The standard model states that the universe did not build its huge mass of particles until the inflation period. Presumably during inflation, the kinetic expansion energy was decelerating at such an enormous rate that it created this huge negative gravitational energy that was converted into mass.

3.2 The antimatter complication

The big bang created equal amounts of matter and antimatter as calculated by Paul Dirak. Antimatter is now known to definitely exist and we can create particles of it in the laboratory. What is needed is to know why this antimatter is not around in our universe today and why it disappeared. It is thought that there was an imbalance of one part in a billion in favour of matter in the early universe. When a matter particle comes into contact with its antimatter equivalent, annihilation happens and the two particles are converted into energy according to Einstein's famous equation. It has been suggested that the early universe was a violent plasma containing many unstable particles such as *b-mesons* that decay in an unbalanced way leading to what is known as a *charge-parity (cp) violation*. This is said to possibly give rise to the excess of matter. When cosmologists try to justify this with mathematical calculations, they are many orders of magnitude out. They calculate so much energy that the universe should have exploded. There is a long way to go before the standard model can explain the disappearance of antimatter by the annihilation method, leaving a remaining excess of matter to form the present universe. It has difficulty in justifying a mechanism for such an imbalance.

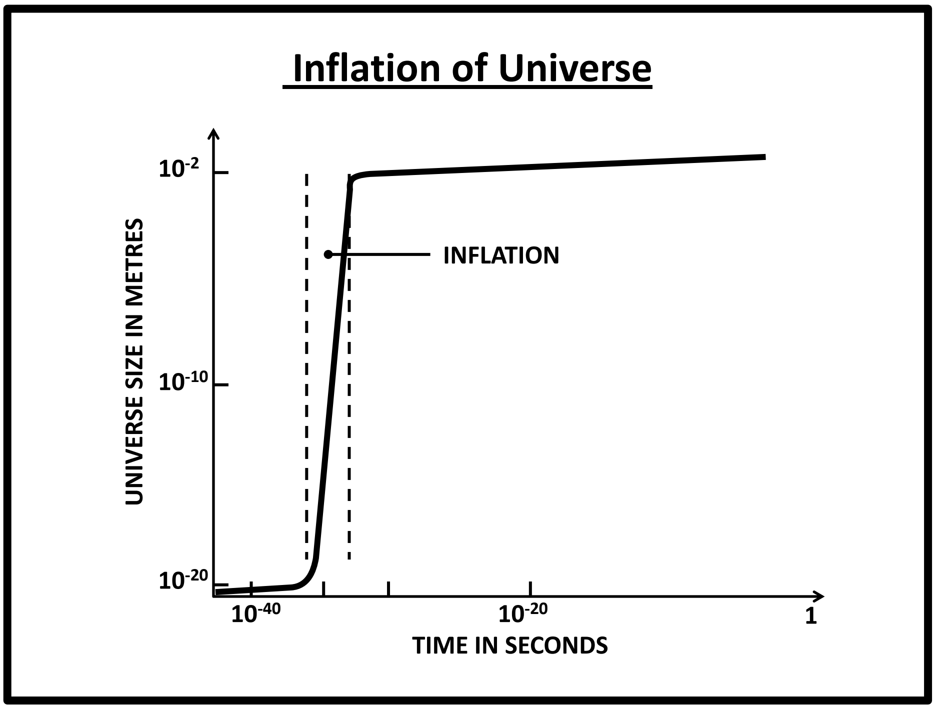
3.3 The theory of inflation

Inflation is a theory that the universe made a sudden colossal expansion immediately after the big bang. It is thought that the big bang started from a singularity with a few grams of material. There was an enormous 'false vacuum' energy involved that started the initial expansion and later a huge amount of matter was created out of negative gravity. This happened during the inflation period after 10^{-36} seconds of existence and there was a massive acceleration of the expansion that launched the universe with amazing Newtonian precision. It was such a precise launch that the universe has been able to continue to expand for 14 billion years to this day without interruption. It also has a *critical density* that ensures what is known as a *flat Euclidean geometry universe*. A critical density also means that it is so precise that the universe will continue to expand until it eventually stops still in perfect balance that neither starts to contract nor continues to expand.

The inflation period suddenly stopped again at 10^{-32} seconds. According to Alan Guth, who introduced inflation theory, the size of the universe at the start of inflation was a billionth of the size of a proton. There was at least a 10^{30} times expansion during the ultra brief inflation period, after which the universe was at least the size of a grapefruit. After the inflation, annihilation started to remove the antimatter. This did not begin until after quarks had converted into *baryons*. The removal was completed in two stages, first with protons and neutrons annihilating with their antimatter counterparts and finalised one second later with electron-positron (anti-electrons) annihilations.

The measurements related by Alan Guth seem to confirm the view that the universe must have been a lot smaller still than one billionth of a proton at the big bang itself. The annihilations produced a billion times as much energy as the entire energy equivalent of our present universe, into a volume that was then less than the size of our solar system. However, these annihilations were simply a conversion of matter into an equivalent amount of energy. There is no massive increase in the total energy of the universe, but a lot of the energy could have been in the form of a large temperature increase. However, the critical density of the universe remains the same.

3.4.. The abruptness of inflation



It is difficult to understand why inflation should stop so abruptly again at 10^{-32} seconds and resume normal expansion speeds.

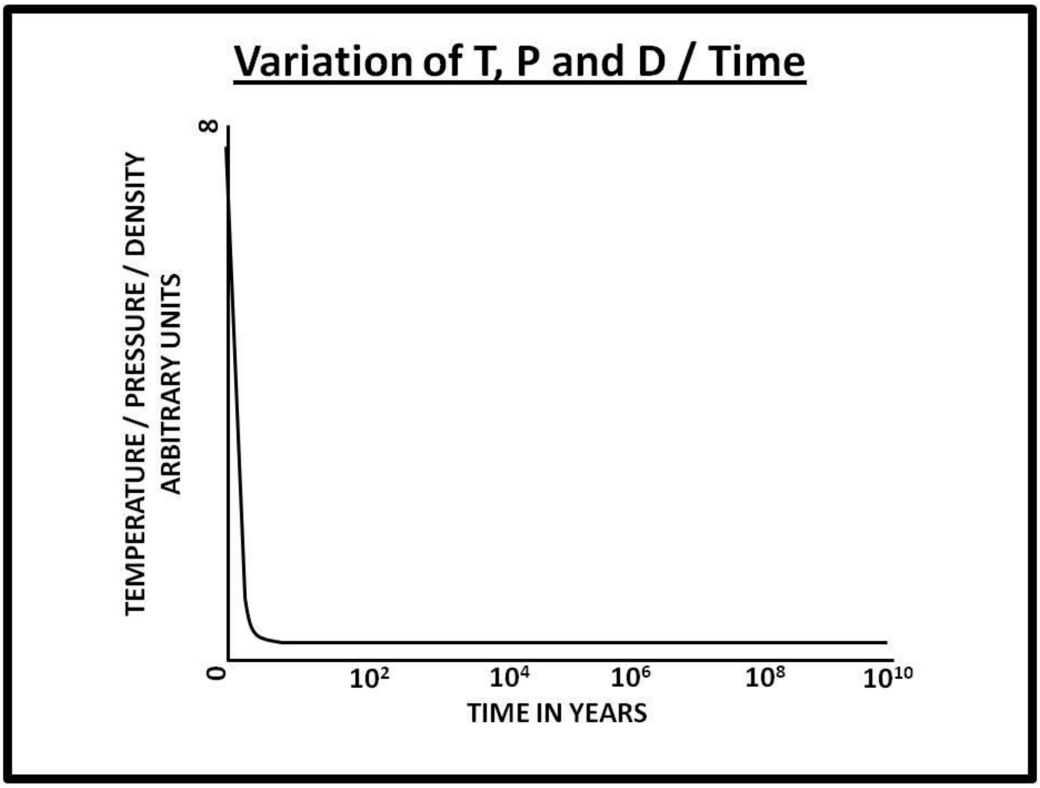
3.5 The speed of the inflation

It is interesting to consider the data given by Guth and calculate the *expansion speed* involved during inflation. Speed is the distance over time. The distance can be taken as the amount that the diameter of the universe expanded during inflation. According to Guth this can be taken as the diameter of a grapefruit, because the starting diameter is negligible. If the grapefruit's diameter is about 10 centimetres which is 10^{-2} metres and assuming that the time taken during inflation was the total time from the big bang to the end of inflation, that is 10^{-32} seconds then:

$$\begin{aligned} \text{Speed} &= \text{Distance / Time} \\ &= 10^{-2} / 10^{-32} \\ &= 10^{30} \text{ metres / second} \end{aligned}$$

This is massively faster than the present speed of light and even if the universe was an order of magnitude larger after inflation, the speed would still be enormously faster. The claim is that it is possible for space to expand at any speed. Only matter and energy are confined to the speed of light as indicated by Einstein.

Of course, this is talking about the first second of existence. How do we know what the speed of light was then? We know what it is now and assume that it is a constant, but we have only been able to measure it accurately for a century or two. What is that compared with 14 billion years? We have no evidence to show that the speed has always been constant. In fact, it seems more probable that the speed has not always been a constant - why might that be?
The diagram below plots the way that temperature, pressure and density are believed to have varied from the big bang to the present day. There seems every reason to suspect that the speed of light might have varied in the same way, following a similar curve to that shown in the diagram below. If we were to be measuring all of these parameters today with accuracy and with no knowledge of cosmology, we would probably be assigning them all with constant values too.



It is necessary to think about all of the mathematics of cosmology that uses a constant speed of light in calculations. If this is wrong it doesn't bear thinking about, but it is a possibility that should be considered.

3.6 The vacuum energy of space

There is yet another weird idea to examine. It is said that space contains a *vacuum energy*. At the same time it was said that space can expand at any speed, whilst matter and energy must obey Einstein. In this way, matter and energy are carried along with the expansion of space, but how then can space itself have a vacuum energy if it can expand at any speed? It would almost seem that space and vacuum energy must be different entities.

3.7 The post inflation composition

The products of inflation, according to the standard model, would have been a *quark-gluon* *plasma* with its antimatter equivalents, together with the two other unknown items that make up the 95% of the missing universe that will be discussed later, namely exotic dark matter and dark energy.

It could be instructive at this point to look at what are believed to be the fundamental particles belonging to the 5% of the universe that we understand. These are given in the table below.

The Fundamental Particles	
Quarks:	
Up, Charm and Top	- with +ve charge
Down, Strange and Bottom	- with -ve charge
Leptons	
Electron, Muon, Tauon	- with -ve charge
Electron neutrino	- all with zero
Muon neutrino	electric
Tauon neutrino	charge

The quarks and leptons are the fundamental particles and there are six of each. As far as we know, there are no sub divisions of any of these particles. The quarks do combine to form baryons and the name baryon covers the more familiar particles that we know such as protons and neutrons, but also the less familiar mesons. These are all composites of quarks. Protons are stable and neutrons are semi stable. They both contain three quarks. Mesons are unstable in comparison and may be composed of two or more quarks.

There is a problem. A proton contains three quarks, but their combined masses are only a fraction of the mass of a proton. There has to be a force that binds the quarks together. This force is the *gluon* that was mentioned above and it is also known as the *strong force*. It creates the balance of the mass of the proton.

The leptons are tiny particles compared to a proton. The best known is the *electron*, which is a composite part of an atom. *Muons and tauons* are unstable compared with electrons and decompose rapidly.

The three *neutrinos* are vastly smaller still than an electron. So small in fact that they have only recently been found to have any mass. The three types of neutrino morph continually with each other when travelling through the universe. They have no electrical charge and pass through matter with ease. There are probably millions of them passing straight through us right now. They can pass right through our planet without being hindered or deflected. That is why they are so difficult to detect.

It is believed that all of these particles each have a *super symmetric partner* that is somewhat heavier. There is a hypothetical theory of *super symmetry* that requires these particles, but as yet, no evidence has been found for any of them to suggest that they really exist.

The gluon or strong force is one of a number of forces that are classed as *bosons* and forces have the equivalent of mass. There are a few other bosons and one of them is the *Higgs* that has been well publicised.

3.8 The disappearance of antimatter

It was during inflation that the standard model claims that the extreme physical conditions present, brought about an imbalance of one part in a billion in the matter content of the plasma over antimatter due to a possible charge parity violation. Whether or not the presence of exotic dark matter had any influence on creating the imbalance could be a possibility. We have to assume that there was no difference in the amounts of matter and antimatter at the big bang itself. The disparity happened during inflation whilst the enormous mass of the universe was being created but it was also the tremendous fall in temperature that made a significant difference to the plasma content.

The standard model says that no annihilations occurred before the *transition* of quarks into baryons at 10^{-5} seconds. This transition caused the first big change in the plasma, forming various types of baryon from the quarks but many of these were unstable and rapidly decayed. The main baryon products that remained stable after quark transition were the protons and neutrons. According to the standard model the baryons underwent annihilation with their antimatter counterparts producing an enormous amount of energy as we have already said, but this did not disturb the critical balance of the launch. There does not seem to be any obvious reason why there were no quark- antiquark annihilations at an earlier stage before quark transition. However, the billionth part of matter left over from these annihilations formed the universe that we see today.

3.9 Neutrino decoupling

All of the above events happened inside the first fraction of a microsecond of existence. By the time that the universe was 0.7 seconds old, the temperature had dropped to about 10^{11} K and this was the point at which *neutrino decoupling* occurred. At the previous higher temperatures, neutrinos had the energy to take part in nuclear reactions with other matter, but with falling temperature these reactions stopped and neutrinos became liberated to travel unimpeded through the universe.

3.10 Electron / anti-electron annihilation

It was after neutrino decoupling at about 1 second, that electrons and positrons (anti-electrons) annihilated, again producing more energy into the universe in place of matter. This completed the removal of antimatter from the universe that we know today. At this stage the plasma still contained exotic dark matter and dark energy. Presumably the exotic dark matter did not have an antimatter equivalent to annihilate.

3.11 Neucleosynthesis

The next main development was *nucleosynthesis*. It involved nuclear reactions between protons and neutrons to form the nuclei of light elements. The temperatures were high enough for *nuclear fusion* to occur. Neutrons have a relatively short *half life* of just over ten minutes, but this is a long time compared with the speed of the fusion reactions. However, all the time that fusion is occurring, neutrons numbers are decreasing because they are decomposing as well as reacting and this affects the reaction products.

When we talk of a half life of ten minutes, we must remember that this means that only half of the neutrons decompose in that time, but half still remain. The number of neutrons continue to be halved every subsequent ten minutes.

Neutrons did, however, become stabilised when they formed *elements* with protons that created the light nuclei of *deuterium (hydrogen 2), helium 3, helium 4 and lithium 7*. Interestingly, the fact that *tritium (hydrogen 3*) is not mentioned as a possible product during nucleosynthesis is because it immediately fuses with deuterium to form helium 4 and another neutron. The amounts formed of these elements became fixed by the physical conditions of the plasma and the amounts that we measure today exactly match those that have been theoretically calculated. This more than any other factor, gives credence to the view that the universe began with a big bang.

These nuclear reactions lasted whilst free neutrons were available for about 15 minutes. That was when the temperature fell below 10^8 K and there was no longer enough energy for fusion to continue. Thus these nuclei remained stable throughout the remaining plasma period. There is, however, one aspect of nucleosynthesis that is puzzling. During this 15 minute period, the temperature of the plasma was between 10^8 K and 10^9 K. This temperature should have been high enough to form heavier elements like carbon by what is known as the *triple alpha reaction*. This reaction happens in stars at similar temperatures, so there seems no reason why this should not have happened during nucleosynthesis.

It would seem that the products of nucleosysnthesis were affected by the mass number of baryons present. It may be difficult to understand why this should have any affect the ratio of the products of nucleosynthesis. Certainly the ratio of protons to neutrons would be important as would the half life of a neutron. The total number of baryons would remain the same throughout, but as new products were synthesised, the proton to neutron ratio changed and this would explain why the final products were affected.

3.12 The plasma cooling period

There was no change in the plasma content in the period right through to *recombination*. The only change was physical as the universe expanded and density and pressure dropped together with a temperature drop from 10^8 K down to about 5000 K.

Throughout this 380,000 year period the universe remained as an opaque plasma. This was because temperatures were still high enough for *photons* and electrons to be constantly colliding with each other. Electrons were still free and unbound at these temperatures and numerous enough to keep the photons contained within the plasma. This was greatly reducing the energy of individual photons whilst multiplying their numbers. By the time of recombination, photons had increased in numbers and their energies had decreased whilst their *wavelengths* had increased to the *red end of the visible spectrum*.

3.13 Recombination to form atoms

Recombination occurred when temperatures had reduced to levels varying between 5000 and 3000 K. This allowed the light baryon nuclei, formed during nucleosynthesis, to capture electrons into orbits around them and form *atoms*. As the electrons became fixed in atoms, they could not collide freely with photons any more. For the first time photons could travel unimpeded by free electrons through the universe and as a result the universe lost its opaqueness and became transparent.

3.14 Photon decoupling and the CMB

The photons liberated at recombination are seen today as the *cosmic microwave background* (CMB). These photons were emitted at red to near infrared wavelengths. Today we see this radiation with a red shift of 1100 and increased wavelength, which is why we observe it in the *microwave* region of the *electro-magnetic spectrum*. This happens because of the long time that the radiation takes to reach us. The journey stretches the wavelength of the radiation into the microwave region of the spectrum. This lengthening of the wavelength is what we refer to as the red shift.

There is something a bit odd about the data regarding a red shift of 1100 for the CMB at about 380,000 years. Recent observations show that an object with a red shift of about 11 has been discovered that appeared when the universe was only 500,000 years old. Putting these two sets of figures together, it amounts to a massive decrease in red shift in a very short space of time. It is difficult to reconcile that these data are correct. It would also seem that the following era referred to as the dark era, was in fact very short and not the several hundred thousand years long previously thought.

After recombination, the universe consisted of neutral atoms of hydrogen, deuterium, helium 3 and helium 4 with just a trace of lithium 7. The main constituents would have been hydrogen and helium 4. The standard method says that exotic dark matter and dark energy were still present.

3.15 The Dark Era

As already stated, the *dark era* must have been a short era in cosmology terms. It was the period in the universe when atoms had been formed to produce hot gas clouds at high pressure. Too hot in fact to condense into stars, so the universe remained devoid of any newly created light, hence the name. However, the universe was transparent to the light from the CMB which was allowed to pass through it. The gas clouds cooled in temperature and the differentials in densities magnified. Little else happened until these gas clouds became dense and cool enough for the first stars to form.

The main products of recombination were hydrogen and helium 4. The photons liberated were in the red to near infrared end of the spectrum, these photons had insufficient energy to excite the electrons around the newly formed atoms to higher energy levels., so no new photons were created in the dark era and because the CMB radiation passed through it unimpeded, the era remained essentially dark.

The standard model of cosmology has little more to say about the dark era other than to describe how the tiny density fluctuations in the CMB called *anisotropies*, became magnified during this period as the cosmos expanded and density differences in the gas clouds became more pronounced. These differences were amplified by the presence of exotic dark matter. This played a key role in the star and galaxy formation that followed the dark era.

3.16 Exotic dark matter

Several calculations have been made that show that the maximum amount of baryonic matter in the universe is no more than 5%, whereas the total amount of matter is 27%. That means that there is a lot more non baryonic matter about whose nature has yet to be discovered. This statement needs to be explained and verified. One method of explanation uses the *mass to light ratio* and was indicated as an early approximation, but it has been the observations from the CMB that have provided the most trustworthy data for the density contributions of the different forms of matter to give a flat universe. These data have been calculated from *angular power spectra* and tend to confirm the matter distribution figures above. There are also observational reasons to verify the presence of dark matter. When we study the *rotational speeds of galaxies* it becomes clear that there is not enough gravity evident in the visible matter in galaxies to hold them together whilst they are spinning so rapidly. They ought to fly apart because of the *centrifugal force* of their spinning motion. Clearly there is a lot more matter somewhere providing the gravity to hold galaxies together. It is also claimed that this exotic dark matter plays an important role in galaxy formation, although it is admitted that the formation mechanism is not well understood.

3.17 Star and galaxy formation and the Jeans Mass

By the end of the dark era, several clouds of dense hydrogen gas had built up enough density to allow gravitational collapse to occur. The parameters that give rise to this collapse were first calculated by James Jeans. He realised that the tendency for collapse due to gravity is opposed by the mutual repulsion of atoms. This happens because atoms have external shells of electrons with negative charges that repel one another. There is also the *vibration* of atoms due to their temperature that mitigates against the tendency to be compressed. For collapse to occur, the *Jeans mass* must be exceeded. This means that the gravity of the gas cloud must overpower the forces of repulsion. The gravity of a gas cloud is related to the number density and the total mass of the atoms or molecules in it and must be high enough for gravity to dominate over the mutual repulsion of atoms. At the same time, the temperature must be low enough for gravity to overpower the vibrational energy of the gas. As the gas clouds cooled during the dark era, the temperature eventually became low enough in some clouds for the Jeans mass to be exceeded.

3.18 The earliest stars to form

The way in which a gas cloud can collapse to form a star is fairly well explained. When the gravitational mass of the cloud overcomes the energy of the molecules in it, the cloud contracts and heats up due to compression. Eventually, the gas gets so compressed and hot that nuclear fusion starts and the gas cloud's collapse is halted by the fusion energy balancing gravity. The star is born and becomes stabilised on its *main sequence*. Although this process is well understood and accepted, the formation of galaxies is not, but it does seem increasingly certain that galaxies formed at the same time as stars immediately after the dark era ended. The first stars were thought to be massive of the order of 100 times the mass of the sun or more. These would be bright blue stars with surface temperatures in excess of 20,000 K. These stars would have very short lives, burning all of their nuclear fuel rapidly in just a few million years before exploding in *supernovae* that fused their light elements together in ways that liberated the first heavy elements into the cosmos.

These extremely bright stars shone with enough energy to *ionise* the surrounding gas, producing the so called *re ionisation period*. Ionisation is the opposite of atom formation when a strong energy source forces the electrons around an atom to be stripped away from its nucleus, leaving positively charged nuclei and free electrons These first stars were said to begin to appear when the universe was less than half a billion years old.

There is, however, some uncertainty about the first objects to light up the universe. There is doubt that single stars could appear alone and still be visible to us at those distances. It is more likely that such objects were galaxies.

3.19 Galaxy formation

There are several theories about the way that galaxies formed and as yet none seem to fit the bill adequately. It is thought that some collapsing gas clouds were massive enough for multiple star formation. The standard cosmology model states that non baryonic matter played a key role in this by its distribution throughout the gas cloud. The nature of this exotic dark matter is as yet pure conjecture. One possibly says it consists of particles known as WIMPS. This stands for *weakly interacting massive particles*. So weak in fact that no such particle has ever been seen to interact with normal matter at all except through its gravitational influence. Another suggestion identifies wimps as the *super symmetric partners* of neutrinos, referred to as *neutrilinos*, but they remain undetected and are a total mystery to us at present. They do give rise to some very odd properties. We are told that they aid the collapse mechanism by surrounding normal gas and concentrating it at the centre. This process is known as *monolithic collapse*. This is a major reason why non baryonic matter is thought to be important in galaxy and star formation. It is counter intuitive. The wimp particles must be far more massive than any hydrogen molecules, so logically one would expect the heavier particle to occupy the central role in the monolithic mechanism, unless the system is spinning fast enough for centrifugal forces to counter gravity. This would tend to reduce the pressure of hydrogen at the centre rather than concentrate it. Secondly, if wimps do not interact with normal matter, it is hard to see how containment can work. The only way that normal matter can be amassed is through a concentration of wimps attracting normal matter with its gravity from a central position of wimps within, not the other way around.

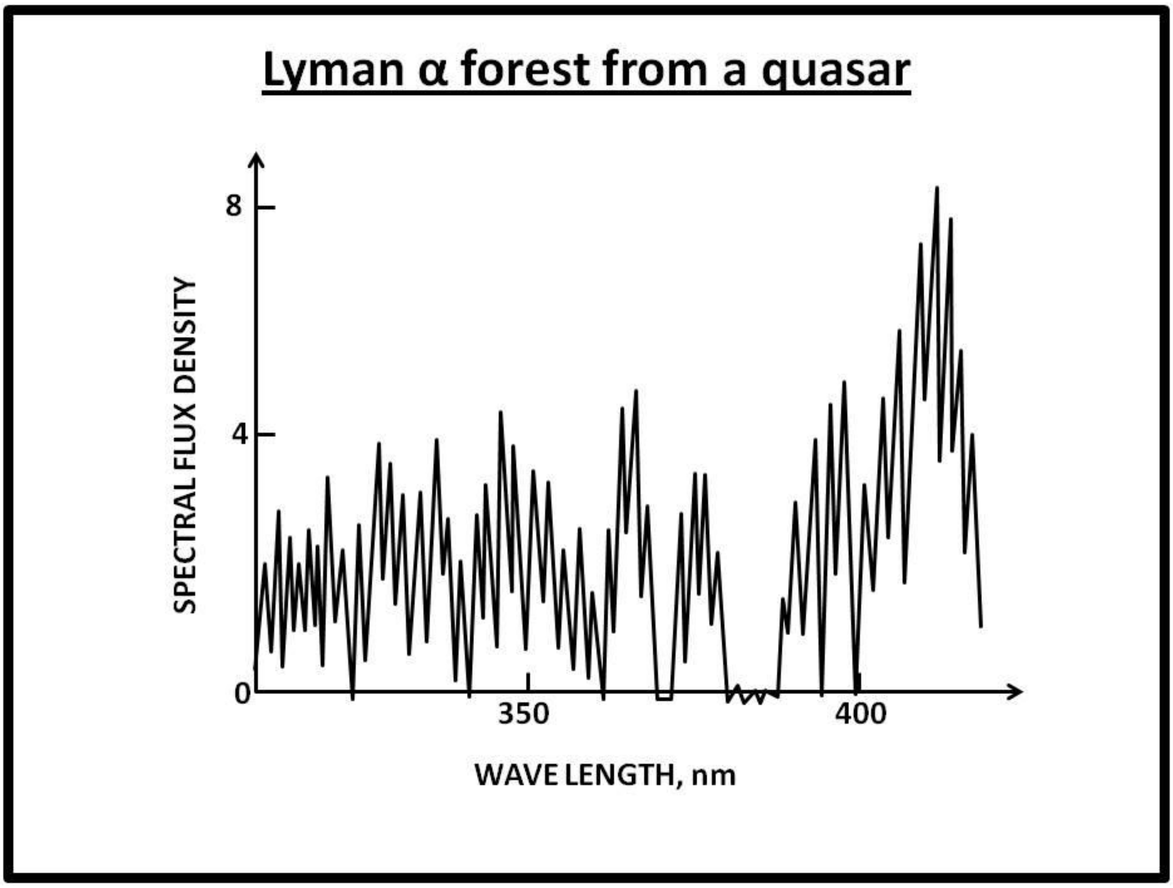
This is not a satisfactory way to explain galaxy formation. It does not account for the observation that most galaxies have *super massive black holes* at their centres. It is a bit of a mystery how these black holes arose. Any mechanism that involves steady accretion runs into problems of the time taken for a super massive black hole to accrete. There is evidence to suggest that these distant objects with high red shifts could not be stars or even supernovae to be visible at that distance. It is almost certain that the very earliest objects that we observe at 500,000 years are galaxies rather than stars for us to be able to observe them. What is more, those galaxies would not be visible to us if they shone with the power of an Andromeda or a Milky Way. They must be producing phenomenal energy from an *active galactic nucleus* (AGN) such as a *quasar*. These objects are believed to derive their power from the presence of a central super massive black hole that is in the process of devouring a star or a large gas cloud and producing a phenomenal amount of energy. This suggests that mature galaxies with active super massive black holes must have formed almost immediately after the dark era. It is most likely that these objects were either quasars or *Seyfert* galaxies both of which have active galactic nuclei.

3.20 The re-ionisation of the universe

These bright objects caused the big light up period in the evolution of the universe and led to what is known as re-ionisation. The brilliance of the galaxies and stars in the early universe were so energetic that the gas in their vicinity was ionised by their strong radiation. As we have seen, ionisation of atoms occurs when a powerful energy source like a bright star strips the electrons away from orbiting an atom's nucleus. This leaves positively charged ions and free electrons. It is believed that there were enough of these powerful young stars and galaxies to ionise the entire universe.

3.21 The Lyman α radiation evidence

The number of free ionisable atoms in the universe are not thought to be enormous at this time. According to the standard model, observations of the distant quasars indicate that normal baryonic gas is relatively sparse.



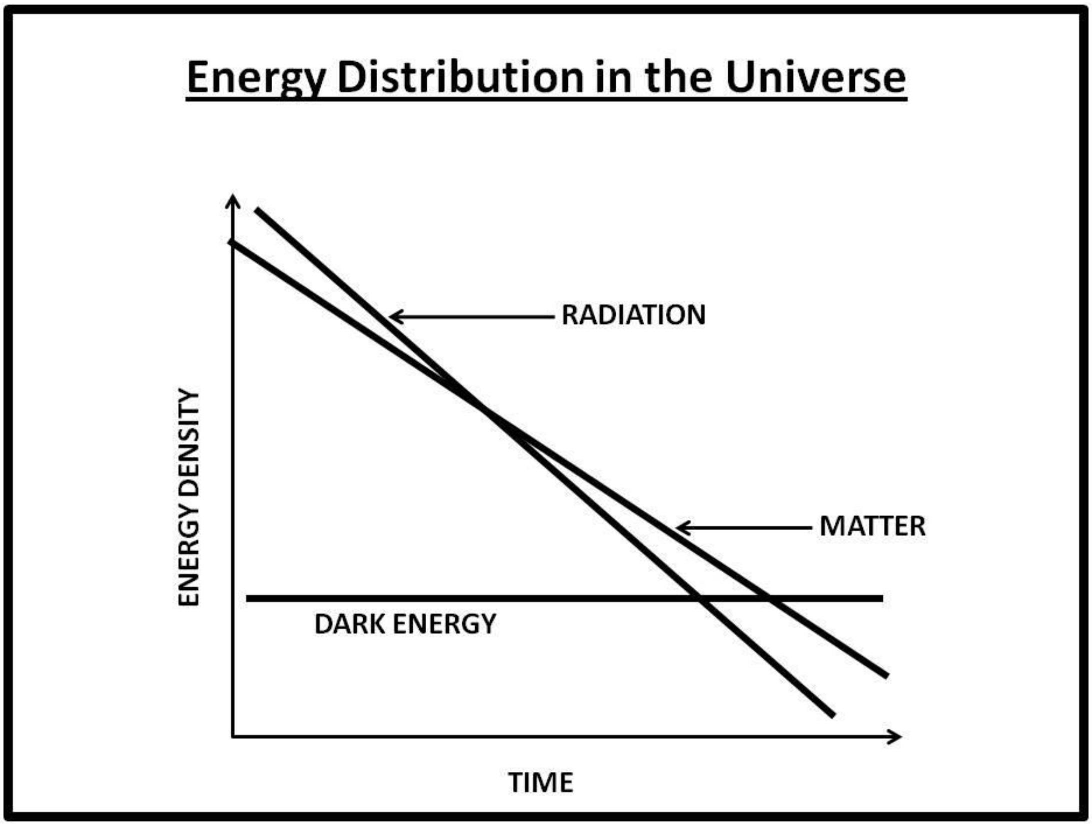
The above diagram shows the spectrum of a quasar as seen from Earth and in particular its *Lyman α (Lyα) hydrogen absorption lines* as its radiation passes through the cosmos. The quasar would have originally emitted these Lyα lines at a wavelength of 121 nanometres (nm) in the *ultraviolet* region of the electromagnetic spectrum, but we see it today with greatly increased wavelength (or high red shift) towards the visible region. In the diagram, the Lyα line of the quasar has been red shifted to a wavelength of 417 nanometres. The quasar is an enormous distance away from us and as its light travels towards us, its frequency decreases and its wavelength increases. As a result, the wavelength of the original ultraviolet radiation is stretched and reaches us just into the red wavelengths if the visible electro-magnetic spectrum at 417 nm. At wavelengths between these two values (121 and 417 nm), there is a *forest of adsorption peaks* and each peak is caused by a gas cloud nearer to us than the quasar and in a line to intercept its radiation.. Each gas cloud absorbs radiation from the quasar and re-emits it at 121 nm from a lesser distance than the quasar. As a result the radiation of each reaches us at a shorter wavelength than the red shifted radiation of the quasar, because it has had less distance to travel in reaching us. It is clear from the forest of peaks that there are a lot of gas clouds out there. It is admitted that there are many more peaks associated with voids in the cosmos as opposed to those identified with visible galaxies, but this is not necessarily unexpected. Most peaks are small indicating that the gases that created them are very small and low in density. There are occasional clouds where the density is much higher giving rise to deep broad adsorption lines and these are known as *damped Lyman α systems*. They are denser gas areas that might be near to creating new star birth. One of these damped systems can be seen at wavelengths around 380 nm. The adsorption of radiation by these gas clouds is known as the *Gunn Peterson effect* and the forest of small peak absorption lines indicate low amounts of atomic hydrogen present. If there are significantly larger amounts there, then they must be in an ionised form that does not radiate.

Non baryonic matter sculpted the present universe. The model says that this dark matter helped to confine large clouds of ordinary gas during the expansion phase of the dark era. Eventually the gas collected in the core of the dark matter at high enough pressure to exceed the Jeans mass and initiate star birth. The claim is that all galaxies today have a halo of exotic dark matter around them to account for the motion of the stars within.

The standard model states that exotic dark matter was created in the big bang along with quarks and leptons. Whether this was the result of the big bang itself or produced during inflation is unclear. The matter is thought to be made of heavy wimp particles that do not interact in any known way with ordinary matter other than through gravity. There has been no indication that the big bang produced any anti-wimps although it has been suggested that wimps can collide with each other to produce antimatter particles. The number of wimps created in the big bang is said to coincide with the density of dark matter inferred from astronomical observations. There has even been talk of hot or cold versions of wimps, the difference being the speed at which the particles move. That seems to suggest that wimps ought to be capable of transporting temperature. It is also said that hot wimps can contain more baryons in the monolithic mechanism than cold wimps.

3.22 Dark energy

The evolution of the universe over the eons has been a steady process. The universe expanded and decreased in temperature.



The diagram above shows that the rate of expansion decreasing with age, but eventually *dark energy* came to dominate and started to accelerate the expansion. It is necessary to look at why the idea of dark energy came to be main stream and why the cosmologists are so sure of its existence.

The standard model describes dark energy as the *cosmological constant* that is probably a *vacuum energy*. This energy is said to remain constant and as space expands, the amount of vacuum energy expands with it. The larger the space, the greater the total amount of vacuum energy it contains. The diagram above shows the distribution of energy in the universe from the time of the big bang. In the initial stages, radiation energy dominated, but this was soon overtaken by the energy due to matter. This persisted for a few billion years until dark energy came to dominate. The universe's rate of expansion declined during the periods of radiation and matter energy domination, but after dark energy dominated, the expansion of the universe started to accelerate. That is the situation that we have today.

It was late in the last century that the *speed of the recession of galaxies* was being studied by Perlmutter et al. They were developing improved methods of measuring distances to galaxies and relating them to their speed of recession. In particular the two methods using *Cepheid variable stars and type 1a supernovae* were being used to measure distances. They found that these data were indicating something strange. It appeared that distant galaxies were further away from us than would be expected from the universe's *Hubble expansion rate*. The explanation seemed to be that some unknown force was pushing them away and overcoming gravity. That force has become known as dark energy. It seems strange that within our local group of galaxies, we observe galaxies rushing towards us. Clearly gravity is dominating dark energy within our local group. A force that can accelerate the expansion of the universe seems to be unable to overcome gravity's contraction force on a smaller scale. Forces normally weaken the greater the distance that they act over and this might seem to be a reversal of the *inverse square law*. However, dark energy is said to be uniform throughout space and as space expands, the dark energy within it grows at the same rate to keep the ratio of dark energy to space constant. So within all galaxy clusters like our own, the force of gravity is strong enough to dominate over dark energy and causes the galaxies within the cluster to move towards each other. In inter cluster space, where gravity is considerably weaker, dark energy dominates and pushes clusters apart, so the standard model is in fact consistent with observations.

It is calculated that our universe that has been expanding for nearly 14 billion years has now reached a sphere that is 46 light years in diameter. When we look at the cosmic microwave background (the earliest light emissions from the time of recombination), we observe it in every direction of the compass. Furthermore, the temperature is the same in all directions at 2.732 degrees K. Yet opposite directions are now too far apart for the CMB to be in contact in these opposing directions, for it to be able to equilibrate this temperature. This is known as the *horizon problem* and is solved by inflation theory.

This is the picture of our universe that we see today, an expanding universe whose expansion is accelerating. The universe is said to be finite and boundary less. This sounds impossible on first sight, but we are told to picture the galaxies of the universe as dots on the surface of an expanding balloon. As the balloon inflates we see all of the dots moving away from each other. The balloon is said to be a two dimensional representation of our three dimensional universe. The standard model expands this picture into the future and claims that the universe will expand with increasing speed, until all matter disperses completely into a cold wilderness of darkness. Every last galaxy and star will have emitted its last energy and radiation and cooled down completely into a dark abyss. Even the most stable particle, the proton, might eventually decay away. The balloon has burst.

4. Problems with the standard model

There is a whole catalogue of question marks in the above story of the standard model. These can be listed as follows:

- The nature of the singularity and the hot big bang. The idea of a singularity without a finite size for its diameter is not understandable.
- The products of the hot big bang. If it is true that the universe created most of its mass during inflation, one wonders what the actual hot big bang created.
- The disappearance of antimatter. There is still no good explanation for its disappearance from our universe. Nor do we see why annihilations had to wait for quarks to be transformed into baryons, together with their antimatter equivalents.

- The abruptness of inflation. There may be a reasonable explanation for the force needed to start inflation with abruptness, but it is difficult to see why it should slow down so violently at the end of inflation.
- The constant speed of light. There is this acceptance that the speed of light has been constant throughout the 14 billion years of existence. There is no good reason for making this assumption.
- The billion to one imbalance of matter over antimatter. It has been suggested that the imbalance arose from a charge-parity (cp) violation to give rise to the excess of matter. Attempts to try to justify this with mathematical calculations, indicates so much energy that the universe should have exploded.
- The vacuum energy of space. Space is said to be able to expand at any speed whilst containing vacuum energy. This is not consistent with Einstein's relativity.
- The triple alpha mechanism in nucleosynthesis. It would seem that temperatures were high enough at this time for this nuclear reaction to occur.
- The red shift incompatibility of the cosmic microwave background. The red shift of the CMB and the red shifts of the earliest objects to appear after the dark era are not compatible with the times of their occurrence.
- The monolithic mechanism. The ability of exotic dark matter to encircle and compress ordinary matter through its gravity is strange to contemplate.
- Dark matter due to hot and cold WIMPS. The nature of these particles seems highly improbable.
- Galaxy formation. The first objects to appear after the dark era must have been mature galaxies with super massive black holes. We need an explanation for their early appearance.
- Dark energy. Said to be this vacuum energy of space again. Yet it is also said to be three quarters of the universe.
- A finite boundary less universe. This sounds to be impossible.

Half of these items occur in that initial period before 10^{-15} seconds of existence. This is the period of greatest doubt and nobody can have definite information of the events that happened at that time. The standard model of cosmology is believed to be the best theory, but could there be other ideas to eliminate some of the above problems?

5. An alternative theory of cosmology

5.1 The creation

Begin again with the hot big bang. It is accepted that all observations point to a big bang as the start of the universe around us. According to the standard model, the universe began from a point singularity at near infinite density, temperature and pressure and there was a sudden expansion of space. It is not said to be a bang in the sense of an explosion, but a sudden expansion of space that carried matter and energy with it as it increased in volume. There were apparently just a few grams of something undefined at the big bang and the majority of the universe was created at a later stage.

There has been a lot of theoretical debate about how the universe might have come into existence and even if there were events in time before the big bang. All of this is pure conjecture. It has been suggested that our universe is just one of a *multiverse*, a multiplicity of universes in addition to or in parallel with our own, with membrane boundaries called *branes* of individual universes that were perhaps colliding together to cause big bangs. It has also been suggested that space itself is unstable even though it is nothing and because it is unstable, it was bound to give rise to something. These ethereal ideas were suggesting the possibility that time existed before the big bang and that atoms and energy may not have been created at that stage. It really does not matter if this is true or not, the fact is that matter had to be created out of nothing at some time and it is not really relevant when. If it happened before the big bang then that merely defers the mystery of how it happened back in time. It in no way removes the mystery. No attempt can be made to explain the creation. One should merely accept that it had happened and leave it at that.

The standard model says that the universe started from the sudden expansion of a singularity, but one might ask what is meant by a singularity. Is its diameter zero in which case it surely doesn't exist. The concept of a singularity must be misleading. The object that was the big bang must have existed even if it was created out of space and to have produced the world that we see around us, suggests that it had finite proportions.

5.2 The size of a singularity

There are objects in the universe today that are said to be singularities. We know them as black holes. There is a massive black hole at the centre of our galaxy and black holes are believed to be in all galaxies. All of these objects need finite proportions to exist and some discussion to suggest the nature of what is called a singularity seems appropriate.

We know that when a star eventually runs out of its hydrogen as nuclear fuel, there are temporarily no more fusion reactions producing the energy to stabilise it on its main sequence and it firstly expands into a *red giant* and then starts to contract under its own gravity. Up to this point, its gravity has been resisted by the energy of its nuclear fusion. For a star the mass of our sun, it eventually contracts down to a finite size known as a *white dwarf* and stops at that. This is because a force known as *electron degeneration energy* exerts the pressure to resist gravity at this stage and prevent further collapse. The star becomes a stable white dwarf.

Sometimes the white dwarf is part of a double star system that enables it to start to attract mass away from the neighbouring star. If the white dwarf acquires enough mass to exceed 1.4 times the mass of our sun (the so called *Chandrasehkar limit*), gravity will overpower electron degeneration energy and will again dominate to cause further collapse. This will continue until it once more becomes stabilised as a much smaller object known as a *neutron star or pulsar*. At this stage, gravity is again resisted, this time by another force known as *neutron degeneration energy*.

Then if the neutron star's mass exceeds five solar masses, gravity wins again and the star collapses to this singularity that we call a black hole, or does it? Perhaps there are other level(s) of degeneration energy with particles like quarks for example, that stop a collapse to a singularity point. Maybe a black hole is a finite sized object stabilised by quark degeneration energy. It might easily be a finite sized object fitting within its *event horizon*, which is the *Schwartzchild radius* boundary. Inside this radius, gravity is so strong, that it prevents all energy and matter from escaping which means that we are unable to look inside it to see if a finite object exists there. Could it be that the big bang was an ultra, super massive black hole? Maybe it was also a finite sized object. It would seem that the whole of our universe was compressed into a very small volume at enormous pressure, temperature and density but it could have been in a volume of significant size. There is no understanding of how these conditions ever arose out of nothing and it is doubtful that we will ever know.

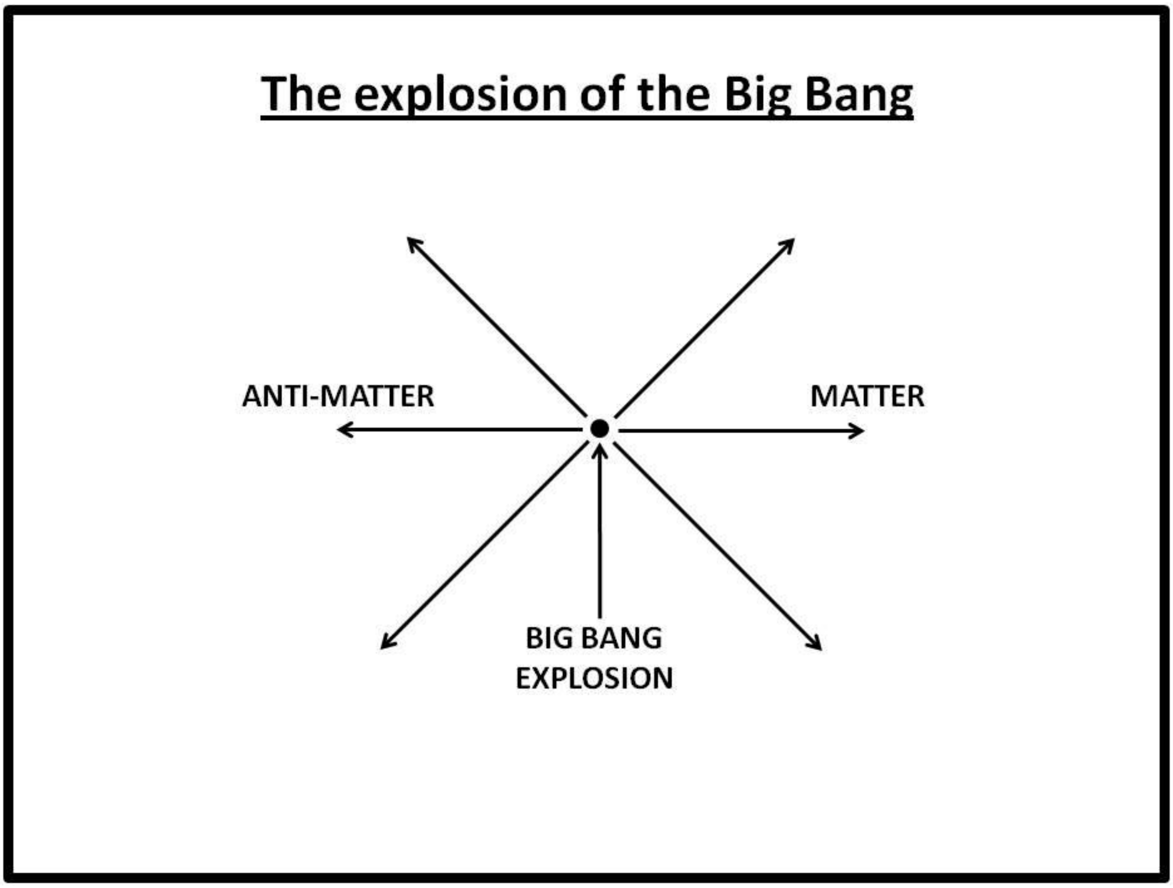
The idea that the singularity is a finite sized object does overcome another problem of the creation. The size of the universe, known as its *scale factor*, is inversely proportional to temperature and density. But if the scale factor goes back to zero as in the case of a true singularity, then the temperature and density are at infinity and no scientist likes to see infinite parameters in his or her calculations. Infinity is an acceptable idea in mathematics, but it has no place in the real world.

5.3 The big bang explosion

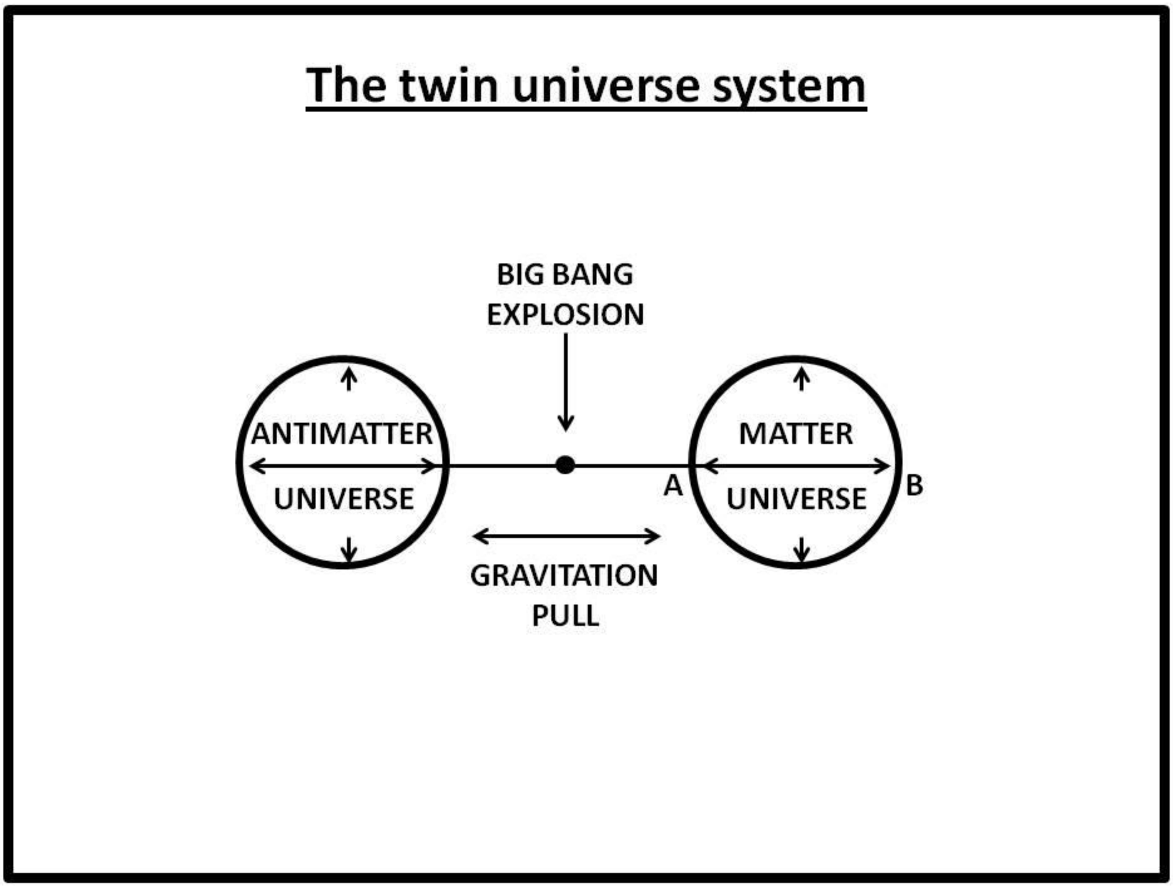
Our new theory starts with a finite sized object that contained the entire universe. The size of this object is unknown but would be enormously larger than the size of super massive black holes seen at galactic centres. It is not too outrageous to suggest that it could have already been the size of a grapefruit, similar in size to the object said to be the product of inflation in the standard model. How such an object ever came to exist is a permanent mystery, but it existed at unimaginable conditions of pressure, temperature and density beyond any known physics. So extreme were these conditions, that the compressed object was homogeneous throughout before it truly exploded.

5.4 Matter and antimatter

We know that the big bang created equal amounts of matter and antimatter as calculated by Paul Dirak. We need to know why this antimatter is not around in our universe today and why it disappeared. This theory suggests that the big bang was a *genuine explosion of a polar nature* that separated matter from antimatter.



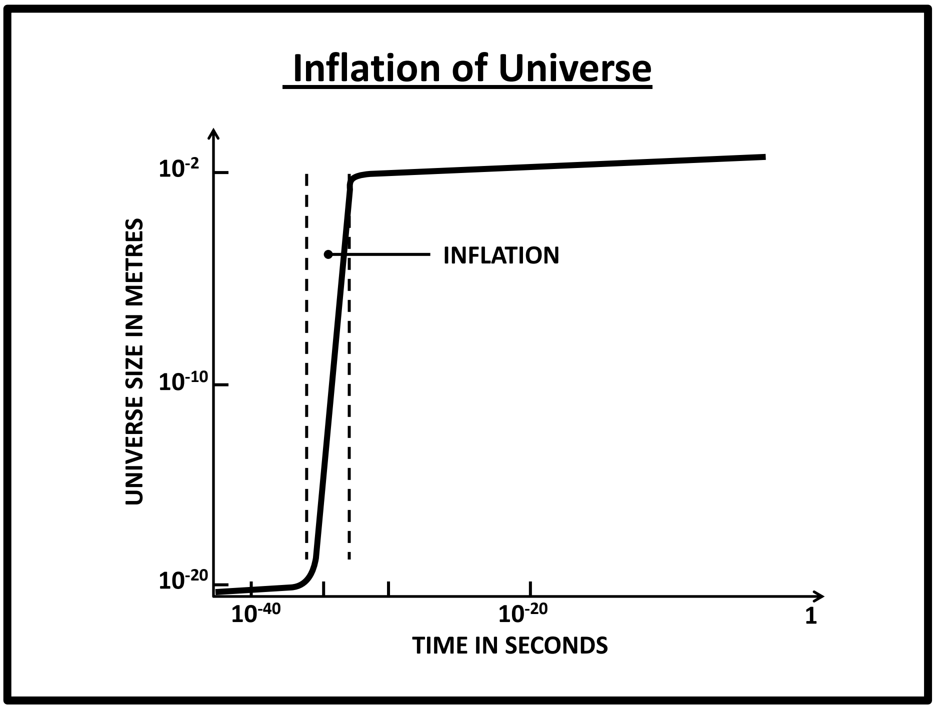
Equal amounts of these were thought to have been ejected in opposite directions from the point of the explosion. These ejections would have been in the form of quark-gluon plasmas. One is composed of matter, the other antimatter and both plasmas are at exceptional temperatures and densities. Exceptional enough to be homogeneous throughout. This has created two universes, separated from each other and each expanding in all directions as they move apart. The antimatter universe is permanently beyond our visible horizon and is only connected to our matter universe by its gravity, making one massive system. The diagram below shows how the separation occurred.



This idea is said to overcome the problem of the disappearance of antimatter. It simply vanishes away from us and there is no question of upsetting the delicate balance of critical density on which our universe was launched. This eliminates the need for antimatter annihilation.

5.5 The inflation theory

In the discussion of the standard model of inflation, it was accepted that an inflation period could have been kick started by the four unified forces of physics becoming separated and releasing energy, but why inflation should suddenly stop again a fraction of a picosecond later and resume normal expansion speed is rather dubious. It is this tremendous abruptness of the inflation period that causes the doubt and why it should end so suddenly at 10^{-32} seconds. It would seem more reasonable to suggest that the rapid expansion and drop in temperature caused the resumption of normal expansion rates.



There may be another explanation that eliminates the special need for inflation. According to Guth, the universe could have been as small as a grapefruit after inflation and this was sufficient to overcome the problems of the flatness and horizon. We have previously postulated that the universe may have been a finite size at the big bang. It could already be the size of a grapefruit and be homogeneous so maybe inflation is not needed to launch the universe.

In this theory, we have two quark-gluon plasmas diverging in opposite directions from a point of explosion. One is composed of matter, the other antimatter. Both plasmas are at exceptional temperatures and densities. The antimatter universe is permanently beyond our visible horizon and is only connected to us by its gravity. This idea overcomes the problem of the disappearance of antimatter. It simply vanishes away from us and there is no question of its annihilation upsetting the delicate balance of critical density on which our universe was launched. Having eliminated the possible need for inflation and antimatter annihilation, it is necessary to see if the theory is consistent with the way that the universe has evolved to this day.

5.6 The Plasma Years

The products of the big bang are quarks, leptons and gluons present as a plasma at conditions that are beyond any known physics. The antimatter universe contains the antimatter equivalents of these products. At this point, we will ignore the presence of exotic dark matter and dark energy as described in the standard model. These will be discussed at a later stage but at this time, we will discount their existence. An antimatter universe, if it exists, would be expected to develop as a mirror image of our own universe. We therefore only need to look at how our own universe has developed when dealing with the evolution theory and would expect an antimatter universe to behave in the same way.

5.7 Inflation and annihilations

As we have discussed above, this theory suggests that inflation may not be necessary to overcome the problems of flatness and horizon. From the initial explosion, the expansion rate was enormous and steadily decelerated as the temperature, pressure and density decreased. There were no massive annihilations to explain the disappearance of antimatter. However, the extreme conditions in the plasma would have created matter / antimatter pairs that would have immediately annihilated again.

5.8 Neutrino decoupling

The next major event to occur happened when the universe was 0.7 seconds old and the temperature had dropped to about 10^{11} K. This was the point at which neutrino decoupling occurred. At the previous higher temperatures, neutrinos had the energy to take part in nuclear reactions with other matter, but with falling temperature these reactions stopped and neutrinos became liberated to travel unimpeded through the universe. This event is no different to the description given in the standard model.

5.9 Neucleosynthesis

Much of what occurred next is also the same as that described in the standard model and is described again here. Nucleosynthesis involved reactions between protons and neutrons to form the nuclei of light elements. The temperatures were high enough for nuclear fusion to occur. Neutrons have a relatively short half life of just over ten minutes, but this is a long time compared with the speed of the fusion reactions. However, all the time that fusion is occurring, neutrons numbers are decreasing because they are decomposing as well as reacting and this affects the reaction products.

Neutrons were stabilised when they formed elements with protons that created the light nuclei of deuterium (hydrogen 2), helium 3, helium 4 and lithium 7. The amounts formed of these elements became fixed by the physical conditions of the plasma and the amounts that we measure today exactly match those that have been theoretically calculated. This more than any other factor, gives credence to the view that the universe began with a big bang.

These nuclear reactions lasted whilst free neutrons were available for about 15 minutes. That was when the temperature fell below 10^8 K and there was no longer enough energy for fusion to continue. Thus these nuclei remained stable throughout the remaining plasma period. This is the same as the standard model.

5.10 The plasma cooling period

The same series of events were also happening in the plasma of the antimatter universe. There was no change in the plasma content in the period right through to recombination. The only change was physical as the universe expanded and density and pressure dropped together with a temperature drop from 10^8 K down to about 5000 K.

Throughout this 380,000 year period the universe remained as an opaque plasma. This was because temperatures were still high enough for photons and electrons to be constantly colliding with each other. Electrons were still free and unbound at these temperatures and numerous enough to keep the photons contained within the plasma. This was greatly reducing the energy of individual photons whilst multiplying their numbers. By the time of recombination, photons had increased in numbers and their energies had decreased whilst their wavelengths had increased to the red end of the visible spectrum. This is the same as the standard model.

5.11 Recombination to form atoms

Recombination occurred when temperatures had reduced to levels varying between 5000 and 3000 K. This allowed the light baryon nuclei, formed during nucleosynthesis, to capture electrons into orbits around them and form atoms. As the electrons became fixed in atoms, they were unlikely to collide with photons any more. For the first time photons could travel freely through the universe and as a result the universe lost its opaqueness and became transparent. This is the same as the standard model.

5.12 Photon decoupling and the CMB

The photons liberated at recombination are seen today as the cosmic microwave background (CMB). These photons were emitted at red to near infrared wavelengths. Today we see this radiation with a red shift of 1100 and increased wavelength, which is why we observe it in the microwave region of the electro-magnetic spectrum. This happens because of the long time that the radiation takes to reach us. The journey stretches the wavelength of the radiation into the microwave region of the spectrum. This lengthening of the wavelength is what we refer to as the red shift. This is the same as the standard model.

5.13 The Dark Era

This is an era where we deviate considerably from the standard model regarding the presence of exotic dark matter. This must have been a short era in cosmology terms. It was the period in the universe when atoms had been formed to produce hot gas clouds at high pressure. Too hot in fact to condense into stars, so the universe remained devoid of any newly created light, hence the name. However, the universe was transparent to light from the CMB which was allowed to pass through it.

The standard model states that it was an uninteresting time when the universe expanded, cooled in temperature and the differentials in densities magnified. Little else happened until these gas clouds became dense and cool enough for the first stars to form.

5.14 The case for dark matter

Atom formation involved the *association* of electrons with the atomic nuclei that had formed much earlier. This process occurred when the temperature of the universe fell to between 5000 and 3000 K. As electrons became fixed into atoms, they could no longer collide with photons. For the first time, photons could travel freely through the universe and as a result the latter became transparent.

The main products of recombination were hydrogen and helium 4. The photons liberated were in the visible spectrum towards the red to near infrared end of the spectrum, these photons had insufficient energy to excite electrons to higher energy levels, so the CMB radiation passed through the dark era unimpeded. No light was emitted by the atoms formed during the dark era.

The hydrogen was not in atomic form for very long. When hydrogen atoms formed at the time of recombination, the temperature was soon down below 3000 K and this was low enough for *molecules* to begin to form. Atomic hydrogen atoms pair up to form molecules preferentially to achieve a *lower energy state* and this is thought to be what happened. The vast majority of the hydrogen would be molecular almost immediately after recombination and being a very weak emitter of radiation, we would be unable to detect it today at such vast distances.

We know that there is difficulty in detecting molecular hydrogen in the near vicinity of our own galaxy, let alone the far reaches of the universe. We are told that we are now discovering more and more molecular hydrogen clouds surrounding our own galaxy that cannot be directly detected from molecular hydrogen radiation even at these short cosmic distances. We are only able to infer its presence from its association with carbon monoxide molecules that tend to surround these gas clouds. Of course, carbon monoxide would not have been present in the early universe making detection then less likely still, especially at astronomically greater distances from us. We are now starting to detect enough molecular hydrogen gas to begin to account for the motion of stars within our galaxy. We do not need any supplementary exotic dark matter to provide the gravitational forces needed to account for the rotation of the stars in our galaxy.

We are also getting better at detecting molecular hydrogen further afield in the cosmos. We recently observed that a huge gas cloud connecting the two galaxies Andromeda M31 and Triangulum M33. These galaxies are a huge distance apart so this is a mighty big gas cloud. Even so, the two galaxies are still in our own local group of galaxies, which is a small distance compared with the cosmos as a whole.

It is highly likely that there must be incredible amounts of undetected molecular hydrogen gas out there in the cosmos that are unknown to us, filling the voids between galaxies and clusters of galaxies. In most cases this gas will not be ionised, just as it is not significantly ionised between our own local group of galaxies. It is likely to remain undetected for some time. It is also true that all of this hydrogen will contain 25% helium 4 that will also be difficult to detect from its weak radiation at great distances, but will add substantially to the mass of normal matter in the cosmos.

It is not too difficult to accept that there could easily be massive amounts of baryonic material out there to account for all of the dark matter in the universe. The contention here is that exotic dark matter does not exist. If we are right about this, it does make this period in our evolution more interesting. The standard model of cosmology has little to say about this era other than to describe how the tiny fluctuations in the CMB called anisotropies, became magnified during this period as the cosmos expanded and density differences became more pronounced. These differences were amplified by the presence of exotic dark matter. This played a key role in the star and galaxy formation that followed the dark era. It is agreed that these density differences did build up in the dark era as a prelude to star formation, but the dark matter was molecular hydrogen and helium rather than something exotic.

The main reason why the standard model insists that dark matter is present in an exotic form is because there is insufficient gravity evident in the visible matter in galaxies to hold them together whilst they are spinning so rapidly. They ought to fly apart because of the centrifugal force of their spinning motion. Secondly, we are told that exotic dark matter plays an important role in galaxy formation, although they do admit that the formation mechanism is not well understood. This theory takes the view that all the matter in the universe, light and dark is normal baryonic material and exotic forms do not exist. The dark matter mostly consists of molecular hydrogen and helium 4, neither of which emit enough radiation to be visible to us at astronomical distances.

5.15 Star formation

Many of the paragraphs that follow are repeats of the standard model where there is no dispute. By the end of the dark era, several clouds of dense hydrogen gas had built up enough density to allow gravitational collapse to occur as the Jeans mass was exceeded. The gravity of the gas clouds had the mass, density and temperature to overpower the forces of repulsion. This allowed the gas clouds to collapse. The way in which a gas cloud can collapse to form a star is fairly well explained. When the gravitational mass of the cloud overcomes the energy of the molecules in it, the cloud contracts and heats up due to compression. Eventually, the gas gets so compressed and hot that nuclear fusion starts and the gas cloud's collapse is halted by the fusion energy balancing gravity. The star is born and becomes stabilised on its main sequence.

The first stars were thought to be massive of the order of 100 times the mass of the sun or more. These would be bright blue stars with surface temperatures in excess of 20,000 K. These stars would have very short lives, burning all of their nuclear fuel rapidly in just a few million years before exploding in supernovae that fused their light elements together in ways that liberated the first heavy elements into the cosmos. These first stars were said to begin to appear when the universe was less than half a billion years old. There is, however, some uncertainty that these first objects to light up the universe were stars. There is doubt that single stars could appear alone and still be visible to us at those distances. It is more likely that these earliest objects were galaxies.

5.16 Galaxy formation

There are several theories about the way that galaxies formed and as yet none seem to fit the bill adequately. It is thought that some collapsing gas clouds were massive enough for multiple star formation. The monolithic mechanism involving exotic dark matter is unnecessary and it is assumed that many of these clouds had enough mass to create whole galaxies. It remains difficult to account for the observation that most galaxies have super massive black holes at their centres. It is a bit of a mystery how these black holes arose. Any mechanism that involves steady accretion runs into problems of the time taken for a super massive black hole to accrete. There is evidence to suggest that these distant objects with high red shifts could not be stars or even supernovae to be visible at that distance. It is almost certain that the very earliest objects that we observe at 500,000 years are galaxies rather than stars for us to be able to observe them. What is more, those galaxies would not be visible to us if they shone with the power of an Andromeda or a Milky Way. They must be producing phenomenal energy from an active galactic nucleus (AGN) such as a quasar. These objects are believed to derive their power from the presence of a central super massive black hole that is in the process of devouring a star or a large gas cloud and producing a phenomenal amount of energy. This suggests that mature galaxies with active super massive black holes must have formed almost immediately after the dark era. It is most likely that these objects were either quasars or Seyfert galaxies both of which have active galactic nuclei.

How could active galaxies of this type come into being so soon after atom formation? We know that the earliest objects appeared around half a billion years after the big bang. The CMB formed at atom formation and photon decoupling after 380,000 years of existence. This means that the dark era lasted for little over 100,000 years. Yet almost immediately, mature active galaxies with super massive black holes came into existence.

A possibility might be that these initiating gas clouds were so vast and dense that a massive core collapsed fast enough to be able to crush and bypass all nuclear burning phases and form a super massive black hole directly. The shock wave rebound then fragmented the surrounding gas and helped to compress each fragment into stars. In this way, mature galaxies formed immediately at square one together with super massive black holes.

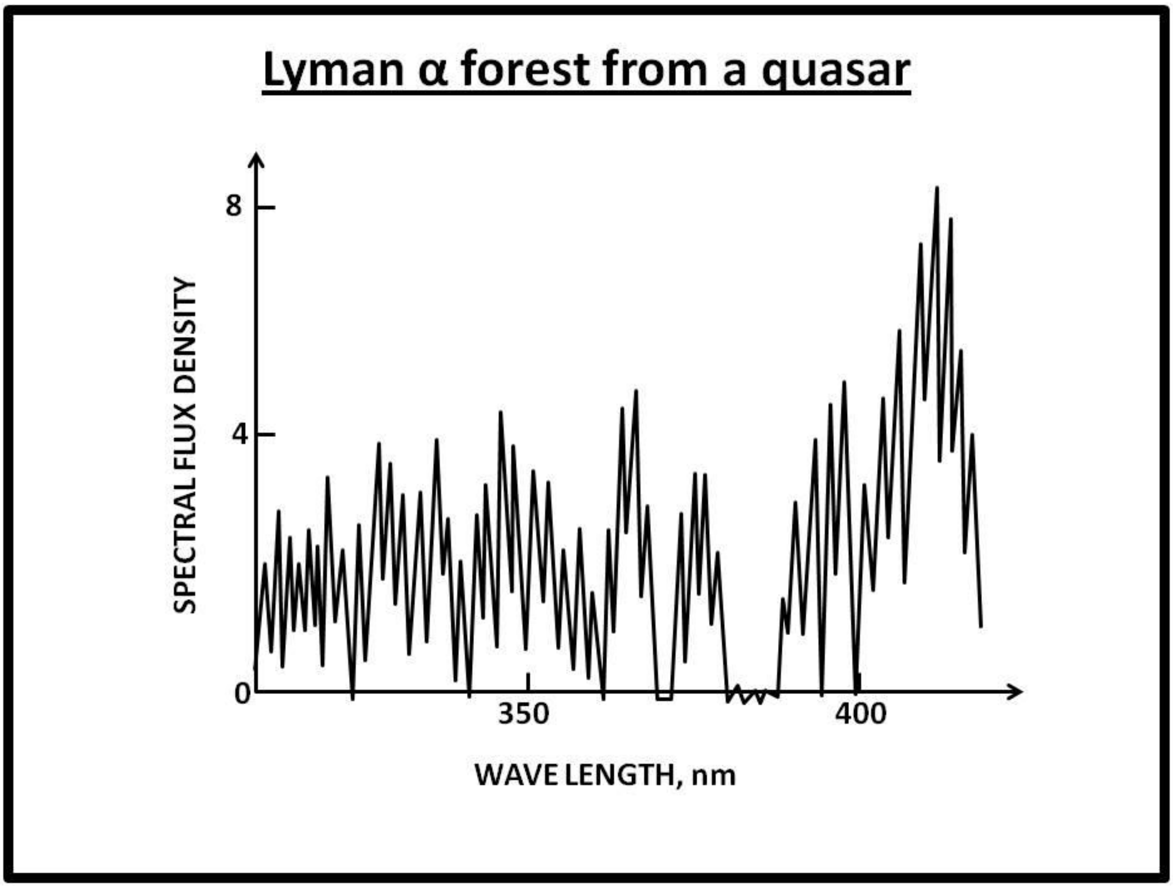
5.17 The re-ionisation of the universe

We are sure that these early bright objects caused the big light up period in the evolution of the universe and led to what is known as *re-ionisation*. The brilliance of the galaxies and stars in the early universe were so energetic that the gas in their vicinity was ionised. This leads us to question the extent of this ionisation. Most cosmologists think that nearly all of the baryon material became ionised. This might not be so if we are right about the amount of baryonic material in the universe. The ionisation energy needed for molecular hydrogen is not insignificant and is even higher for helium. It is likely that molecular hydrogen and helium, many parsecs away from these bright energy sources, would not be ionised and would remain dark and undetected. The ionising power will diminish with distance according to the inverse square law.

5.18 Another look at the Lyman α radiation evidence

The spectrum of the quasar shown previously and repeated below, had Lyman α (Lyα) hydrogen absorption lines that were originally emitted at a wavelength of 121 nanometres (nm) in the ultraviolet region of the electromagnetic spectrum and we see it today with greatly increased wavelength (or high red shift) towards the visible region. In the diagram, the Lyα line of the quasar has been red shifted to a wavelength of 417 nanometres.

The quasar is an enormous distance away from us and as its light travels towards us, its frequency decreases and wavelength increases. As a result, the wavelength of the original ultraviolet radiation is stretched and reaches us just in the red wavelengths if the visible electro-magnetic spectrum at 417 nm. At wavelengths between these two values (121 and 417 nm), there is a forest of adsorption peaks and each peak is caused by a gas cloud nearer to us than the quasar and in a line to intercept its radiation. Each gas cloud absorbs radiation from the quasar and re-emits it at 121 nm from a lesser distance than the quasar. As a result the radiation of each reaches us at a shorter wavelength than the red shifted radiation of the quasar, because it has had less distance to travel in reaching us. It is clear from the forest of peaks that there are a lot of gas clouds out there.



There are many more peaks associated with voids in the cosmos as opposed to those identified with visible galaxies. The adsorption of radiation by these gas clouds is known as the Gunn Peterson effect. There is not very much atomic hydrogen present to emit the photons that create the forest of peaks, but that is because most of the hydrogen present is molecular. The number of peaks in the forest clearly show a continuous distribution of hydrogen throughout the cosmos. The Gunn Peterson effect ignores the probability that the majority of hydrogen present will be in molecular form that does not radiate significantly. It is perfectly possible that there are large amounts of baryonic gas present in every peak. It is presently unconventional to suggest that exotic dark matter does not exist and that all of the matter in the universe is composed of baryons. Maybe some proof of the existence of exotic dark matter will arise in the future, but as yet it has failed to show itself.

5.19 The exotic matter particle

The best suggestion for an exotic form of matter has been for particles known as wimps. These have so far failed to register on any detector including those sensitive enough to detect neutrinos so they are less reactive than a neutrino. This is surprising since if they supposed to be the much heavier super symmetric partner of the neutrino known as the neutrolino. It is difficult enough for us to detect neutrinos but one might expect that a heavier particle would be more likely to collide with atoms in a detector and register. It is therefore surprising that we are able to detect neutrinos but there is no trace of a neutrolino.

There has been no suggestion that the big bang produced any anti-wimps although it has been suggested that wimps can collide with each other to produce antimatter particles. The number of wimps created in the big bang is said to coincide with the density of dark matter inferred from astronomical observations. There has been mention of hot or cold versions of wimps, the difference being the speed at which the particles move. This suggests that wimps ought to be capable of transporting temperature.

Wimps have a number of peculiar properties. It is said that they only exert a gravitational influence on the universe. In the monolithic mechanism, wimps appear to be able to surround and contain ordinary matter within it without reacting with it in any way. For some strange reason, baryons collect at the centre. Presumably exotic dark matter has the ability to warp space-time as does any other concentration of mass. If that is true, then it does have an indirect influence on light as well as matter, whose paths can be deflected by the warping of space. It is also said that hot wimps can contain more baryons than cold wimps. By any reckoning, a wimp has to be one very peculiar particle. These peculiarities lead one to doubt in the existence any exotic dark particle.

5.20 Cosmic evolution

From galaxy and star formation through to the present day, evolution was a steady process. The universe continued to expand and the temperature dropped as a result. The rate of expansion decelerated as the universe got bigger, at least in the early eons. In the standard model, it is said that the deceleration stopped and the expansion began to accelerate as dark energy dominated. That does not happen with this theory.

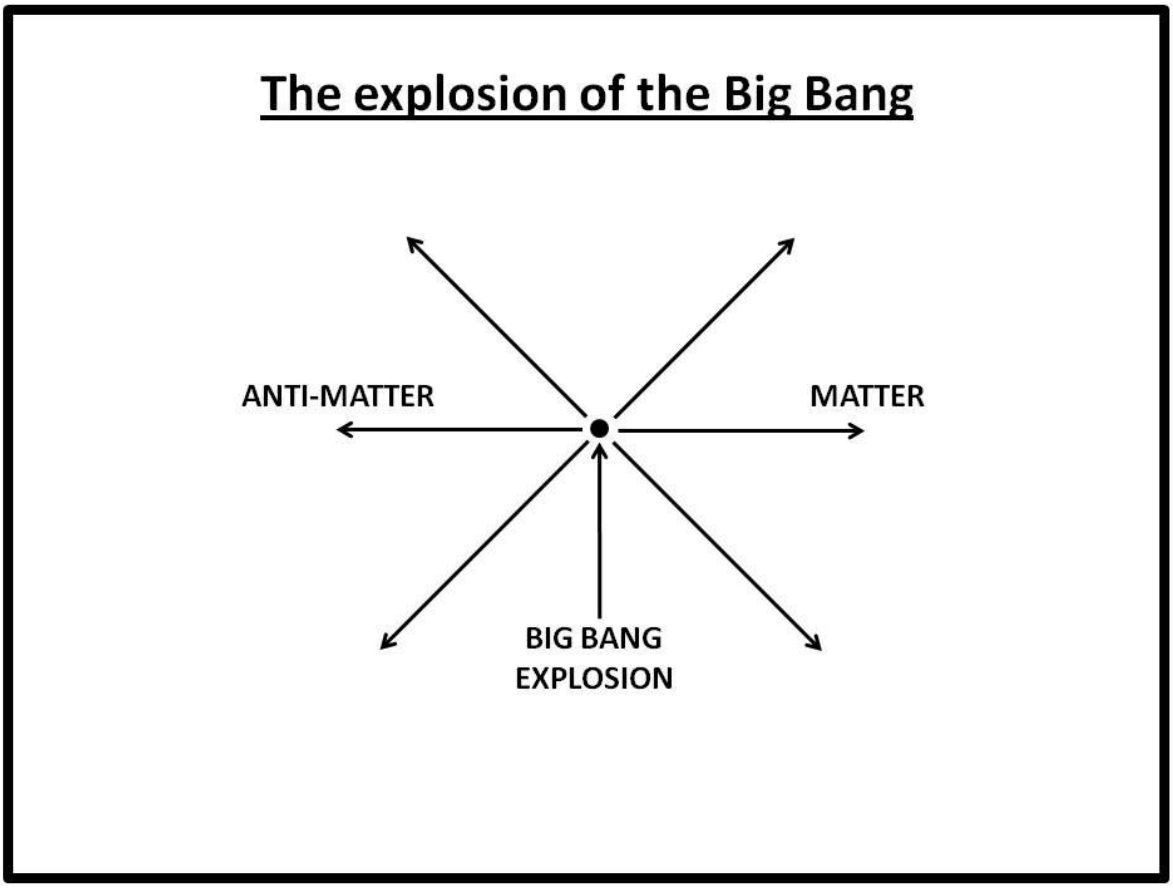
The temperature of the universe is inversely proportional to its volume or size. When the first atoms were formed at recombination, we know that the temperature of the universe was about 3000 K. It is only in the last half century that we have been able to measure the present temperature of the universe. This was due to the accidental discovery of the CMB by *Penzias and Wilson* during the 1960s. We are now able to measure the temperature of the CMB as 2.73 K. 13 billion years have passed from recombination to today and during that time the universe has decreased 1000 fold in temperature. This enables us to say that the universe has correspondingly increased 1000 times in volume.

The deceleration in the expansion of the universe was believed to be uniform and continuous throughout evolution up until the end of the last century. It was the work of *Perlmutter, Reiss and Schmidt* that challenged this view. From their studies of type 1 supernovae they were able to the measure distances of galaxies from earth and comparing them with their red shifts. They found that these data were indicating something strange. It appeared that distant galaxies were further away from us than would be expected from the universe's expansion rate according to Hubble's law. The explanation seemed to be that some unknown force was pushing them away and overcoming gravity. That force became known as dark energy.

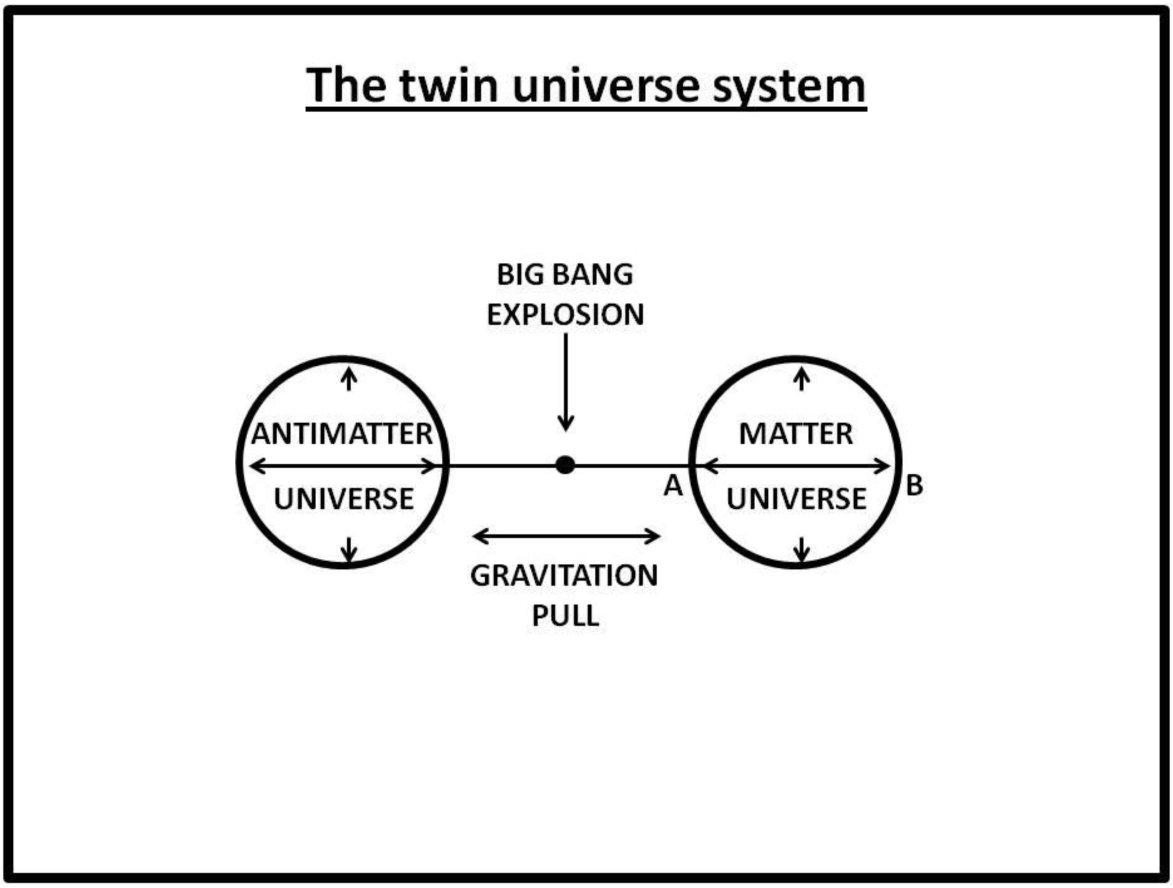
5.21 The dark energy question

There is no dispute with the Perlmutter data, but our alternative theory needs to be examined in the light of these observations. It may be that the standard model is misinterpreting the data. This possibility was suggested by the observations of the Russian born cosmologist, *Kashlinsky.* Looking at some early maps of the CMB, he observed a group of galaxies, between the *constellations of Vela and Centaurus,* that appeared to be rushing away from us in one direction with excessive speed. The phenomenon was referred to as *dark flow*. Some recent studies of the CMB throw some doubt on this observation. However, there is an unexplained void in the CMB that appears to be influencing the movement of galactic clusters in its vicinity. This might be another indication of dark flow and indeed the void might be the signature of an antimatter universe. Checks on its validity are still ongoing, but if dark flow exists, it cannot be explained by dark energy producing extra repulsion in one direction only of the cosmos. The only explanation offered so far is the gravitational attraction of another universe beyond our observational horizon. This is consistent with our alternative theory.

The contention is that the universe is not being pushed apart by a mysterious force, but is being pulled apart by the gravitational influence of the antimatter universe. The explanation goes right back to the big bang itself. The claim here was that the hot big bang was a genuine explosion that ejected equal amounts of matter and antimatter in opposite directions.

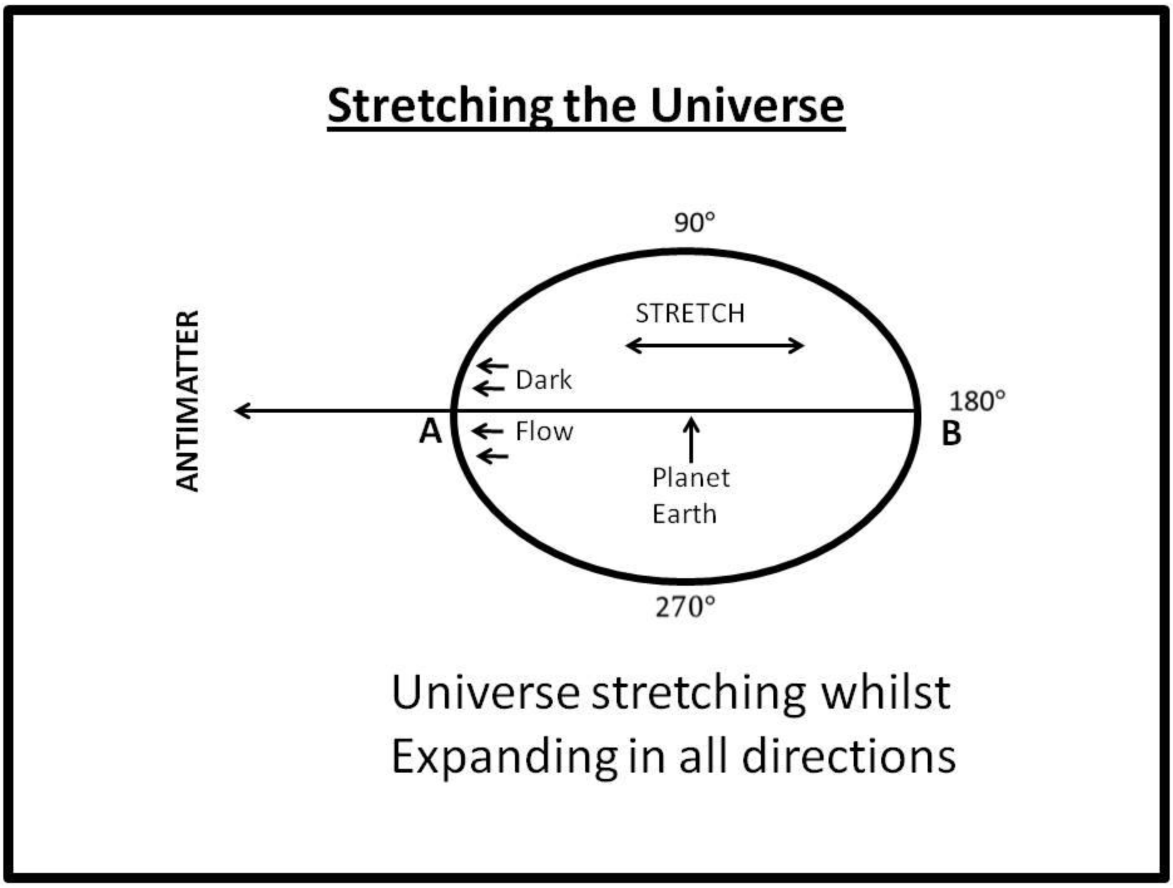


Equal amounts of these were thought to have been ejected in opposite directions from the point of the explosion. These ejections would have been in the form of quark-gluon plasmas. One is composed of matter, the other antimatter and both plasmas are at exceptional temperatures and densities. Exceptional enough to be homogeneous throughout. This has created two universes, separated from each other and expanding in all directions as they move apart. The antimatter universe is permanently beyond our visible horizon and is only connected to our matter universe by its gravity, making one massive system.



If we accept this picture of the big bang, we should look at how we would expect a system of this type to evolve over the eons to the present day. There is no dispute that the Perlmutter data is correct and that the universe is increasingly expanding, but the question is why? The contention is that an antimatter universe is stretching our universe apart with its gravitational pull.

The pull due to gravity at point A on the side of our universe nearest to the antimatter universe is going to be much stronger than on the most distant side at B, due to the inverse square law. So not only are each of these two universes expanding in all directions individually, but they are exerting gravitational pulling on each other and this is stretching them and causing them to expand even further. The theory also emphasises the view that our universe has boundaries and the fact that we see receding galaxies in all directions from earth, means that we are located in the middle of our universe and not toward one of the boundaries.



The conclusion of this theory is that dark energy does not exist as well as exotic dark matter. There is also an inference that the universe has boundaries. This is inconsistent with the standard model which states that the universe is boundary less as well as finite. No matter where we are in the universe, it will always look the same in every direction. We should think of the universe as the two dimensional representation of the points on the surface of an expanding balloon. As the balloon is enlarged, the points on its surface separate steadily from each other in the same way that galaxies are separating, but no matter where we are on the balloon's surface, we will always see this picture of galaxies receding from us.

The problem with this scenario is that the balloon is not a two dimensional representation. It is using a third dimension of curvature to eliminate the two dimensional boundaries. Try the same trick with an actual three dimensional object then no matter how you twist and turn it, you will never get rid of an external boundary. The best you can do is to end up with a sphere that still has an outside boundary and the only way to get rid of it is to introduce a fourth dimension and extend that boundary to infinity. That will mean that the universe must be infinite.

An infinite universe also arises from the idea that it will always appear the same in all directions no matter where you are located within the universe. If it appears the same when we go to the full extent of our visible horizon and then go on from there to the next visible horizon, we have a process that goes on and on to infinity. So either way we are talking about an infinite universe.

An infinite universe does not make any sense. It is impossible for it to arise from a finite big bang in finite time. We have to insist that we must be living in a finite universe with boundaries. If the universe has finite boundaries, one might ask what is beyond those boundaries? The answer is there is no beyond. Space exists only to the boundaries of matter and energy. Beyond is only an abstract idea.

The theory provides an interesting diversion. It has been calculated that in the 14 billion years of existence, our universe has expanded to a diameter of 46 billion light years in size. That is not said to be large enough to explain the *Euclidean flatness* of the universe. This is the so called flatness problem. Whenever we look at the geometry of the universe, the angles indicate perfect Euclidean flatness, whereas some curvature ought to be detectable within the 46 billion light years. However, that figure could be doubled by the presence of an antimatter entity and stretched further still by the recession of the two components from each other. This could imply a total system with a diameter in excess of 150 billion light years, when curvature would be too small to see and everything would appear flat.

6. The final reckoning

In this alternative model of the universe there is no missing 95% in the form of dark energy or exotic dark matter, so we now need to look at the new composition and how its critical density is made up. We have got to be able to find that 95% of the universe to account for such a theory. Not that the standard model has a satisfactory way of explaining that missing amount.

It must clearly consist of matter and energy. Cosmologists calculate the total matter content of our universe at 27 %. This is only half of the total system according to the new theory and all should be normal baryons and anti baryons. It may be that this figure is somewhat larger when the antimatter universe is taken into account. A recalculation might provide a different and somewhat larger figure. So much for the matter, what about the energy? If part of the energy of the universe is no longer dark energy, what is it?

The standard theory provides an energy picture over the eons, that indicates an eventual domination of dark energy over matter and radiation. It shows the universe decelerating for several billion years, then it stops and begins to accelerate again as dark energy becomes dominant. The alternative theory indicates a steady deceleration throughout the eons and continuing from now into the future. Clearly there must be kinetic energy associated with the expansion and this is steadily diminishing as expansion slows down. As kinetic energy falls, a negative gravitational energy builds up.

The question is what happens when the universe eventually runs out of kinetic energy? The implication of a flat universe is that it will expand until this happens and then stops still. All of the kinetic energy has transformed into negative gravitational energy. That negative gravitational energy has to be resisted to prevent collapse. It would seem that there is now nothing to prevent gravity from initiating another collapse. It has to be that the universe is balanced on a knife edge in a state of unstable equilibrium. The distribution density of matter is so sparse that gravitational forces are very weak and the mutual repulsion of atoms is equal to the force of contraction. This is enough to counter gravity.

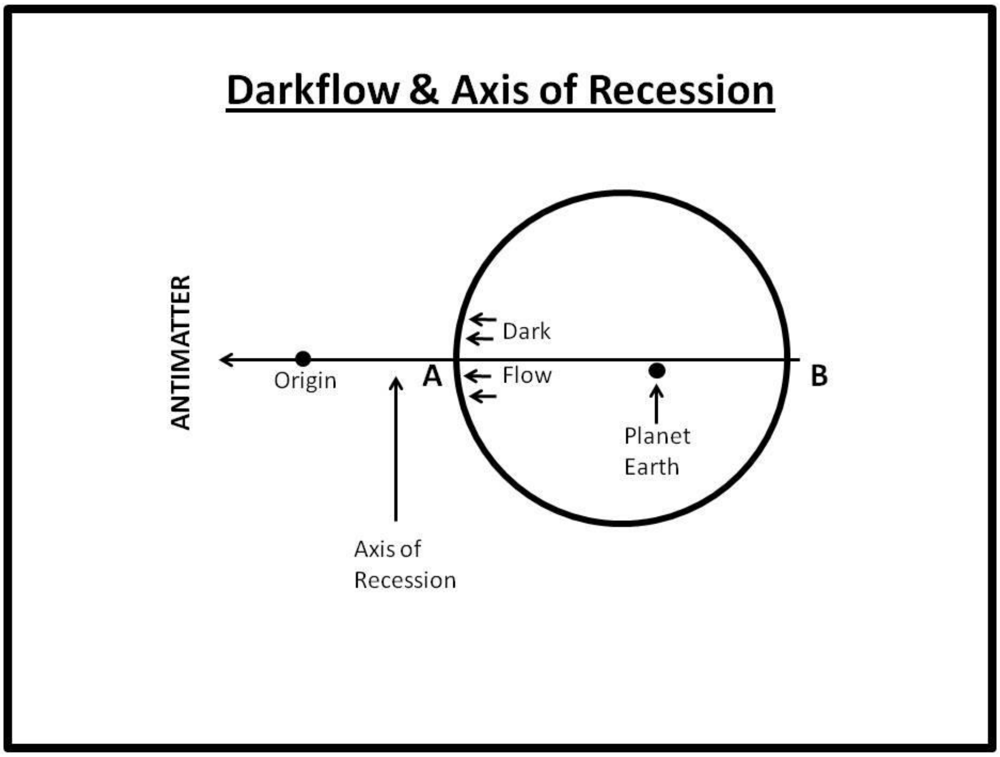
It must be the same sort of reasoning as why our planet’s atmosphere does not coalesce under its own gravity. It is the question of Jeans mass over again. At critical density, when the universe stops expanding, it has a Jeans mass that is not high enough at any location for contraction to occur and all forces must be finely balanced. A change in this density distribution could tip the balance either way.

If the density is marginally less than critical, the universe will continue to expand for ever or until all matter eventually decays away. It will be an ‘open’ universe producing the same dreary kind of future that the standard model currently indicates, albeit that the standard model shows an accelerating expansion that eventually is said to exceed the speed of light. If the number density is fractionally more than critical, or there is a seeding volume in which the Jeans mass is exceeded, then gravity will initiate a collapse and we have a ‘closed’ universe. The third alternative is that the universe stands still at exactly critical number density. Then we do have a *steady state universe* at last.

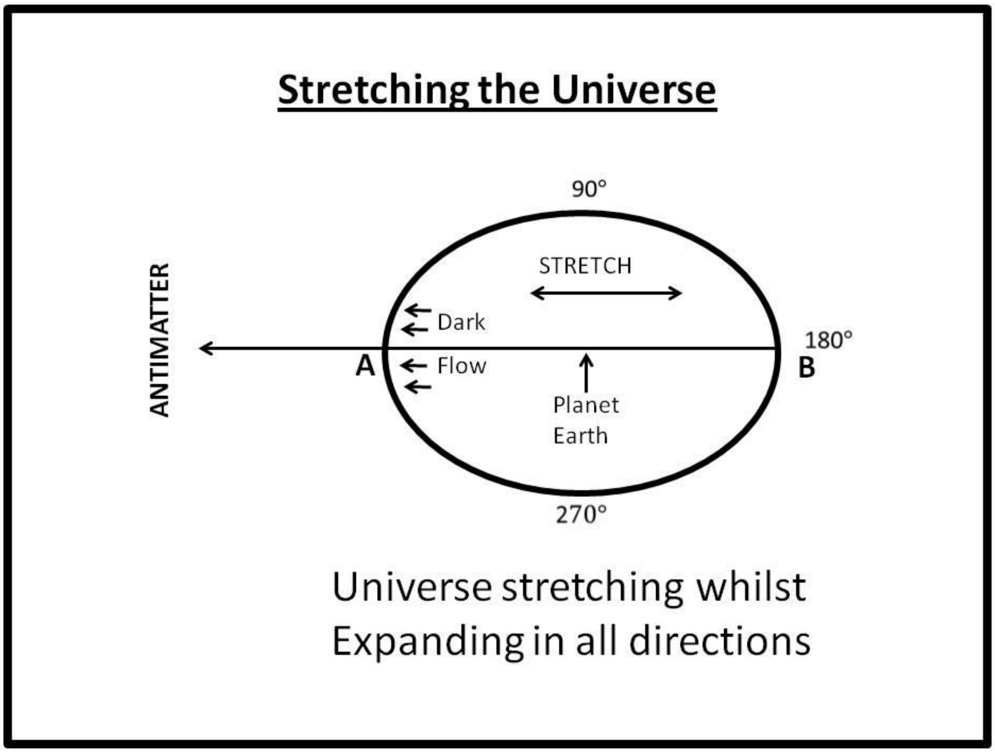
The possibility of a closed universe is an interesting thought. The universe will contract with accelerating speed and will steadily increase in temperature due to compression. It will eventually contract to a big crunch, be it another singularity or the finite sized object as previously postulated. Maybe that will be the trigger of another universe to start all over again. Moreover, that may be the way that this universe started.

7. Disproving the alternative theory

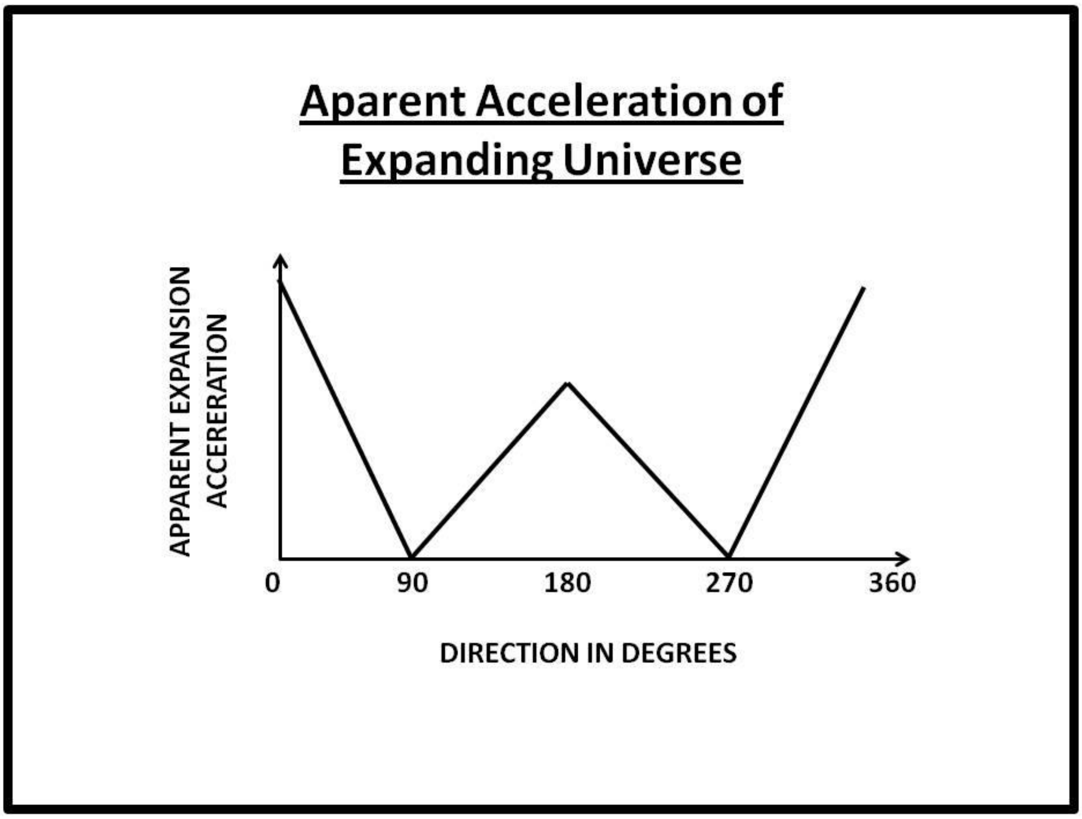
Given that dark flow proves to be a reality, it would be a natural and expected consequence of the theory. The gravity of an antimatter universe should cause dark flow to exist. If there is an antimatter universe out there beyond our observable horizon then the dark flow could be pointing us in its direction. It should also be pointing back to the point of the big bang explosion as well as towards the antimatter universe. This can be seen in the diagram below. In this diagram the direction has been arbitrarily named as the ‘axis of deceleration’.
Consider how the stretching due to the gravitational pull of antimatter should look to us from our position in our universe. Along the axis of deceleration, we should see what appears to us as an accelerating expansion of the universe. However along an axis normal to the axis of deceleration, we should see no evidence of an accelerating expansion.



Now starting from zero at point A, the direction of dark flow in this diagram, scribe a 360 degree plane as in the diagram below.



The universe is stretching whilst expanding in all directions. As the plane is traversed, there should be varying degrees of apparent acceleration, starting from a maximum at the dark flow position through to zero at 90 degrees; another lesser peak at 180 degrees and zero again at 270 degrees. This is illustrated in the diagram below.



Looking in different directions, it should be possible to see variations in the apparent acceleration of the expansion from our position in the universe. The data may already be available to see if these variations are present. The accelerations have already been measured by Perlmutter et al, but what might still be missing is the direction from earth for each of the type 1a supernovae examined. If it is possible to go back to that data and add directions for each of the supernovae, then it will be possible to draw an actual 360 degree plot for real and see if it matches the above diagram. If it does not match, then the theory is not likely to be correct. It is recommended that this test should be evaluated carefully and should be easy to apply. Although this test can disprove the theory, should the real data match the above diagram, it will give the theory added value.

In summary there seem to be more problems with the standard model of cosmology compared with the alternative theory. The latter seems to overcome a number of those problems. The new theory seems more intuitively consistent with classical physics and can be potentially disproved.

There are shortcomings in all theories, but this is not surprising as cosmology is still in its infancy. Cosmologists admit that there are still several mysteries to explain.

BAC / Feb 2014