# The Explanation for Dark Matter and Dark Energy

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***Abstract*—**The following assumptions of the Big Bang theory are challenged and found to be false: the cosmological principle, the assumption that all matter formed at the same time and the assumption regarding the cause of the cosmic microwave background radiation. The evolution of the universe is described based on the conclusion that the universe is finite with a space boundary. This conclusion is reached by ruling out the possibility of an infinite universe or a universe which is finite with no boundary. In a finite universe, the centre of the universe can be located with reference to our home galaxy (The Milky Way) using the speed relative to the Cosmic Microwave Background (CMB) rest frame and Hubble's law. This places our home galaxy at a distance of approximately 26 million light years from the centre of the universe. Because we are making observations from a point relatively close to the centre of the universe, the universe appears to be isotropic and homogeneous but this is not the case. The CMB is coming from a source located within the event horizon of the universe. There is sufficient mass in the universe to create an event horizon at the Schwarzschild radius. Galaxies form over time due to the energy released by the expansion of space. Conservation of energy must consider total energy which is mass (+ve) plus energy (+ve) plus spacetime curvature (-ve) so that the total energy of the universe is always zero. The predominant position of galaxy formation moves over time from the centre of the universe towards the boundary so that today the majority of new galaxy formation is taking place beyond our horizon of observation at 14 billion light years.

***Keywords*—**Cosmic microwave background, dark energy, dark matter, evolution of the universe.

## I. The Space Boundary Theory

THE approach taken is to set aside the Big Bang theory and try to deduce the evolution of the universe from different starting assumptions. The Big Bang theory deduces the evolution of the universe by assuming the cosmological principle [1]-[8] and a uniform progress back in time with a corresponding increase in temperature and density. However, evolution moves forward in time and it is entirely possible that a different evolution path leads to the universe that we observe today. The starting configuration of the universe for the Space Boundary theory is a spherical region of space with a space boundary which then expands at a fixed rate which is the same rate as is observed today. This puts the age of the universe at more than 330 billion years so we have to find a different explanation for the cosmic microwave background radiation (CMBR) [9]-[13].

The Big Bang theory describes the CMBR as radiation arising from the Big Bang at a time 13.8 billion years ago [14]-[17]. The Space Boundary theory describes the CMBR as radiation coming from a source located within the event horizon of the universe. This removes the time constraint on the age of the universe and allows the assumption of uniform expansion to be possible. This requires a discussion about the event horizon of the universe. The idea of an event horizon arises directly from the equations of the General Theory of Relativity [18]-[21]. Where there is a region of space with sufficient mass lying entirely within that region, spacetime is curved to such an extent that nothing can escape. Any high energy particles or radiation generated within this region of space will not be able to escape through the event horizon.

The condition that we observe radiation coming from the vicinity of the event horizon with a travel time of 13.8 billion years is that the radiation must have originated from a distance of 8.77 billion light years. Using this Schwarzschild radius it is possible to calculate the amount of mass in the form of galaxies that would be required to cause this event horizon. Then taking that mass density forward in time to the present, it gives a matter density consistent with current observational data. So the universe that we observe is consistent with the existence of an event horizon causing the CMBR.

## II. A Finite Universe

The conclusion is reached by ruling out the possibility of an infinite universe or a universe which is finite with no boundary. An infinite universe would require infinite energy for matter formation and would violate the law of conservation of energy.

A finite universe with no boundary is ruled out by the observation that the radiation from the CMBR follows a straight line path meaning that on the large scale of the universe the curvature is flat in the radial direction to the CMBR [22].

Given that the universe is finite with a boundary and making the symmetrical assumption that the boundary is spherical this means that the universe has a centre.

The space within the boundary of the universe is a spherical region of space which is expanding away from the centre of the universe and the recession velocity of each point of space is proportional to the distance from the centre of the universe.

## III. Our Position in the Universe

The CMBR provides a useful frame of reference for the universe called the CMB rest frame. This means that there will be a point located at the centre of the universe which is at rest with reference to the CMB rest frame.

When the CMBR is measured in great detail it reveals that the Home galaxy (the Milky Way) is moving at a speed of 552 km/sec with reference to the CMB rest frame [23], [24].

The universe is expanding uniformly in all directions at a steady rate of 1 part in 14 billion light years per year per light

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year [25]-[29]. Each galaxy in the universe can be thought of as being embedded in this expanding frame of reference where the recession velocity of each galaxy depends on the distance from the centre of the universe.

Using the velocity of the Home galaxy and the rate of expansion of space and using Hubble's law [30]-[32] we can locate the centre of the universe at a distance of approximately 26 million light years from the Home galaxy. Put another way, this means that the Home galaxy is located 26 million light years from the centre of the universe and is moving away from the centre of the universe at 552 km/sec.

## IV. Galaxy Formation

Going back 200 billion years, there were no galaxies, just an expanding spherical region of space and then galaxy formation started an estimated 126 billion years ago with the source of energy for the formation of galaxies is the energy released from the expansion of space and the galaxy formation events start closest to the centre of the universe.

The predominant position of formation of new galaxies moved away from the centre of the universe towards the boundary so that by now the majority of galaxy formation takes place beyond the observation horizon at 14 billion light years.

A galaxy formation event creates a spherical region in which the release of energy from space leads to the formation of neutrons some of which immediately bond to form neutron groups of two or more neutrons bonded together. These neutron groups are what we observe as dark matter [33]-[38].

Single neutrons will decay over a short time period to create a proton an electron and a neutrino. The protons and electrons can together form hydrogen atoms and then hydrogen molecules.

Some of the material (hydrogen and dark matter) will fall under gravity towards the central region of the galaxy and result in the formation of a large neutron star which will be viewed externally as a super massive black hole.

## V. Dark Energy

The existence of dark energy [39], [40] has been proposed to explain the variation in the recession velocity of more distant galaxies. The recession velocity of galaxies was expected to follow Hubble's law where the recession velocity of a distant object is proportional to its distance. The recession velocity of a distant galaxy is calculated by measuring the red shift of the light coming from the galaxy.

For observations of the more distant galaxies, it was found that the recession velocity for a given distance was less than expected under Hubble's law [41], [42]. This measurement was made possible by using distant supernovae to give an accurate estimate of distance using the luminosity of the supernova event. The conclusion taken from this unexpected recession velocity was that the expansion of the universe must have been slower in the past and that the expansion of the universe must be accelerating. The cause of this accelerated expansion was named dark energy. The alternative proposal is that the universe expansion is not accelerating but is uniform over time and distance. Instead, the difference in recession velocity for more distant galaxies is found by taking into consideration the gravitational acceleration directed towards the centre of the universe.

## VI. The Variation of the Radius of the Universe with Time

The proposal analysed here is that the recession velocity of the boundary from the centre of the universe is proportional to the radius. This means that to a first level of approximation, the rate of expansion of space is constant over time and distance.

T is time measure in years. R is distance measured in light years. Then $\Delta R/\Delta T = K_E R$ where $K_E$ is a positive constant. This means that $\Delta T = (1/K_E)\ \Delta R/R$. Integrating this expression we get:

$$T = (1/K_E) \log(R) + C. \tag{1}$$

Since the time value can be set to an arbitrary reference point we take the value of T = 0 to be when the radius of the universe was 1 light year. This makes the constant of integration (C) zero. From (1) for T we get: $R = \exp(K_E T)$. Also differentiating to get the recession velocity we get: $dR/dT = K_E \exp(K_E T)$.

To obtain the value of $K_E$ we use the observed local expansion of space as a first approximation. We also assume as a first approximation that the expansion of space is uniform out to the boundary. Currently the observation of galaxy recession velocities shows that (dR/dT)/R is equal to 1/(14 billion) which is therefore the value of $K_E$. (Note that the value of 1/(14 billion) light years per year per light year is taken from observations of the value of the Hubble constant. This value of $K_E$ corresponds to a Hubble constant value of 69.84 km/s per Mpc. If subsequent observations suggest a different value for $K_E$ this will affect the numerical results of this paper by a few percentage points.) So we have two equations relating T and R.

$$T = (1/K_E) \log(R)$$

$$R = \exp(K_E T)$$

To get an initial estimate of the current value of T and R, the observational evidence of the CMBR is used. The CMBR is coming from the event horizon of the universe and we observe the CMBR having travelled for 13.8 billion years at the speed of light.

The position of the event horizon 13.8 billion years ago can be calculated by considering the expansion of space at one part in 14 billion light years per year per light year during the travel time.

The calculation divides the total travel time of the CMB radiation into equal intervals dt in such a way that the contribution to the distance measurement at time t is given by dt/exp ($K_E$ t) for each time segment dt. Then by integrating dt/

exp ($K_E$ t) from t = 0 to t = 13.8 billion we obtain the result 14*(1 - exp(-13.8/14)) billion light years for the position of the event horizon at a time 13.8 billion years ago.

The event horizon must have been at approximately 8.775584 billion light years from the centre of the universe at the time 13.8 billion years ago. The CMB radiation has covered the original separating distance of 8.775584 billion light years during a travel time of 13.8 billion years because over that time interval the expansion of space has increased the distance to be covered.

For the CMB to be visible, the radius to the boundary must have been greater than the radius to the event horizon at a time 13.8 billion years ago. The minimum value for R at a time 13.8 billion years ago is therefore 8.77 billion light years. Using (1), T is currently greater than 320.53 + 13.8 = 334.33 billion years. Using R = exp($K_E$ T), the radius of the universe (R) is currently greater than 23.52 billion light years.

## VII. The Formation of Mass in the Universe

As the universe expands, the total energy (mass plus energy plus spacetime curvature) must remain the same. The expansion of space results in an increase in the radius of curvature of space at every point in space. There will be a relationship between the total mass formed within the universe and the volume of the universe. The proposed relationship is that the total mass of galaxies in the universe is proportional to the volume of the universe.

The formula M proportional to $R^3$ together with R = exp ($K_E$ T) implies that every 14 billion years the mass of all the galaxies in the universe increases by a factor of $e^3$ = 20.0855. This new galaxy formation is currently taking place mostly beyond 14 billion light years so beyond our observation horizon. Occasionally a galaxy formation event occurs within our range of observation and then we observe a large gamma ray burst coming from 6 to 10 billion light years.

Given that the number of galaxies in the universe increases by a factor of 20 every 14 billion years we can use this to make a rough estimate of the time since the formation of the first galaxy. When the first galaxy formed there was just one galaxy in the universe. After 14 billion years there were 20 galaxies. After 28 billion years there were 400 galaxies. After 14x9 billion years there were $20^9$ galaxies. This is the same as saying that after 126 billion years there were around 500 billion galaxies. Given that we can estimate the number of galaxies as greater than 500 billion, we can say that the time since the first galaxy formed is greater than 126 billion years.

## VIII. The Age of the Universe

The formulas for the expansion of space developed in Appendix 1 are:

$$T = (1/K_E) \log(R)$$

$$R = \exp(K_E T)$$

where $K_E$ = 1/14billion Light Years/Year per Light Year (LY/Y per LY)

In an elapsed time of 14 billion years the expansion of any region of space more than doubles: Suppose T2 = T1 + 14 billion years. Then log (R2) = log(R1) + 1. R2 = R1 x e where e is the exponential constant and has a value of approximately 2.71828. So if we were to assume that the equations of expansion operated down to the smallest scales then if we put R1 = 1 cm then R2 = 2.71828 cm. This implies that it takes 14 billion years for the universe to expand from 1 cm to just under 3 cm. It is not safe to assume that the expansion of space at such small scales follows the uniform expansion equations.

The approach taken is to apply the expansion equation for positive values of T only, meaning that the equation R = exp($K_E$ T) is only used for values of R greater than 1 light year. The characteristics of the expansion of the universe for values of R of less than 1 light year require further analysis outside the scope of this paper.

The analysis of the evolution of the universe in the Space Boundary Theory then starts when T = 0 and R = 1 light year. The universe is at least 334 billion years old as calculated in Appendix 1.

The question of whether the age of the universe is finite or infinite is outside of the scope of the Space Boundary Theory.

The universe may or may not have had a beginning.

## IX. Dark Matter Analysis

During galaxy formation the initial galaxy formation event results in the formation of neutrons in numbers corresponding to the total mass of the galaxy. We know that a single neutron will decay into a proton and an electron after an average period of around 15 minutes. If two neutrons collide before they decay into a proton and an electron then the neutrons will bond into a dineutron as this is a lower energy state. We also know that neutrons in a bonded state do not decay so easily into protons and electrons. This is a similar situation to neutrons in an atomic nucleus where the decay of a neutron is a low probability. So the formation of neutron pairs or possibly higher numbers of neutrons (neutron groups) during galaxy formation would have two effects. Firstly we would expect these neutron groups to fall under gravity and form the central black hole. Secondly, neutron groups would not be detectable by photons and would pervade the galaxy halo thus being an ideal candidate for dark matter.

Any material that falls under gravity towards the centre of the galaxy will increase the mass of the super massive neutron star which we observe as a super massive black hole at the centre of each galaxy.

The idea of neutron groups as dark matter depends on the binding energy of two neutrons being positive. The binding energy corresponds to the mass defect associated with the neutron to neutron bond.

## X. Black Holes

The description of the formation of galaxies includes the formation of the super massive black hole at the centre of every galaxy. The formation of the galaxy starts with the formation of a number of neutrons equivalent to the total mass of the galaxy. A proportion of the neutrons form neutron groups and move under the effect of gravity to form the central black hole.

In this section we investigate the hypothesis that all black holes contain neutron stars and that the event horizon of the black hole is caused by the mass and high density of the neutron star within the event horizon. One prediction from this hypothesis is that we should be able to see a range of sizes of neutron stars and black holes but any black hole will always be greater in mass than the largest observed neutron star. At present the largest observed neutron star is 1.97 solar masses and the smallest observed black hole is 3.8 solar masses.

We can estimate the size of neutron star where the event horizon is exactly at the surface of the star. The following symbols are used in the calculation: N is the number of neutrons in the neutron star; m is the mass of a neutron 1.675 x $10^{-27}$ kg; r is the radius of a neutron; R is the Schwarzschild radius [43] of the star; M is the mass of the star.

Schwarzschild radius formula gives: $R = 2GM/c^2$. We can start with M = Nm for the mass of the star. $R = 2GNm/c^2$ gives the radius of the star. The volume of the star is $4/3\ \pi\ R^3$. The volume of the star is also N x volume of the neutron = $4/3\ \pi\ r^3$. So $4/3\ \pi\ R^3 = N \times 4/3\ \pi\ r^3$. Therefore $R^3 = N\ r^3$

$$(2GNm)^3 = c^6\ N\ r^3$$

$$N^2 = c^6\ r^3\ /(2Gm)^3$$

Now we have to decide on the value of r to use. The effective radius value calculated in Appendix 4 of the Unification of Physics [44] is 0.630058 x $10^{-15}$ m. This gives a value of N as approximately 4.03 x $10^{57}$. This number of neutrons has a mass of 6.751 x $10^{30}$ kg which is 3.4 solar masses. The value of R is given by $N^{1/3}$ r which is 10.027 kilometres. The minimum radius for a black hole is approximately 10 km. This lends support to the theory that all black holes contain neutron stars which cause the event horizon of the black hole.

The calculated value for the largest observable neutron star (3.4 solar masses) and the smallest possible black hole (3.4 solar masses) is consistent with observation.

For black holes larger than 3.4 solar masses, the position of the event horizon at the Schwarzschild radius increases in proportion to the mass whereas the radius of the neutron star within the event horizon increases in proportion to the cube root of the mass. So for a supermassive black hole of 3.4 million solar masses the radius of the neutron star would be approximately one thousand kilometres whereas the Schwarzschild radius would be 10 million kilometres.

In summary, the space boundary theory and the spacetime wave theory point to the conclusion that the internal structure of a black hole is not a singularity but a neutron star of a mass corresponding to the observed mass of the black hole.

As of 2017, there has been considerable success with gravitational wave detectors which detect merging black holes and merging neutron stars [44], [45]. The neutron stars observed are always less than 3.4 solar masses and the merging black holes are all greater than 3.4 solar masses. The production of gravitational waves is the same in the two cases because, in both cases, we are observing merging neutron stars.

When two black holes merge the angular momentum of the system causes a rotating black hole to form. This is in fact a merger of two neutron stars which results in a rotating neutron star inside the event horizon. Where the mass inside the event horizon is rotating the calculation of the event horizon at the Schwarzschild radius has to be modified to take into account the rotation of the mass.

The event horizon may not be closed at the axis of rotation and the jets which are characteristic of rotating neutron stars can also be visible coming from the axis of the merged black hole. This opening of the event horizon at the axis also applies to the merging of galaxies where the central black holes combine and under the right conditions of mass and rotation the jets can emerge from the central black hole of the merged galaxy along the axis of rotation.

The neutron star may also contain a proportion of protons. The proton is approximately the same mass and volume as the neutron so the above calculation for the event horizon still applies. The electrostatic repulsion of the positively charged protons is overcome by the gravitational forces of the star. In the case of a rotating neutron star with a proportion of protons, the effect of the protons is to create an electric charge moving in a circular path, which then creates a strong magnetic field.

Neutron stars vary in their total mass, their speed of rotation and the proportion of protons and this variation then affects the ability of the neutron star to generate high energy jets emerging at the two poles along the axis of rotation.

## VI. CMBR

CMBR has been mapped in detail and is the key piece of evidence in support of the Big Bang theory. In the Big Bang theory the CMBR is believed to be the radiation coming from the Big Bang itself following a process called recombination.

In the Space Boundary theory of the evolution of the universe it is proposed that the CMBR is radiation coming from the vicinity of the event horizon of the universe. The General Theory of Relativity (GR) provides equations which allow us to calculate the curvature of spacetime due to a given distribution of mass. These equations have a solution first proposed by Schwarzschild: $R = 2Gm/c^2$. This equation can be used to calculate the event horizon for a given distribution of matter. The event horizon is at the radius R for a mass m. Nothing, not even light can escape beyond the event horizon. This formula is used to calculate the event horizon for a black hole and in this case we are looking from the outside towards a black hole which we can detect because of its gravitational effect on other objects. The equation can also be applied to the distribution of mass within the universe where we are observing from within the event horizon and in this case it shows that there will be a radius from which matter and radiation cannot escape.

Based on the observation that the radiation was emitted 13.8

billion years ago we can calculate that at the time of the emission of this radiation the distance to the source was 8.77 billion light years. This implies an event horizon at a radius of 8.77 billion light years at a time 13.8 billion years ago. We can then calculate the matter density required to create an event horizon at this distance. From this we can project that matter density forward in time assuming an expansion of 1/(14 billion) light years per year per light year and we find that the matter density observed today should be around 0.724 hydrogen atoms per cubic metre. So, the analysis is consistent with the CMB radiation coming from a source in the vicinity of the event horizon. The nature of this source of radiation is still a subject of investigation but the following hypothesis is presented.

The formation of galaxies takes place at points in space which are located progressively further from the centre of the universe. The model suggests that the number of galaxies increases by a factor of 20 every 14 billion years and the average position of formation of these galaxies moves from the centre of the universe outwards towards the boundary. The actual positions of formation will be spread out around some preferred or average position. Where the formation of galaxies is such that the new galaxies are forming within the existing distribution of galaxies there will be an increase in matter density to the point where an event horizon forms.

The proposal is that the CBMR is coming from a distribution of galaxies located within the event horizon. The general appearance of the CMBR is consistent with a distribution of galaxies which explains the local variations which seem to have a scale of around one degree of arc. Features such as the "cold spot" are explained as due to the general absence of galaxies in that area. It is not unusual to find voids in galaxy distributions.

For galaxies close to the event horizon any radiation in the direction of the event horizon cannot cross the event horizon and would be reflected with the possibility of polarisation of the radiation.

We need to explain the precise cause of the frequency spectrum of the CMB which closely matches black body radiation. The galaxies exist in a particular region of space close to the event horizon and the effect of this on the radiation observed might be a factor to consider.

There are some unexplained anomalies in the CMBR data when considered against the Big Bang model explanation for the cause of the CMBR and these would also need to be explained in the context of the new hypothesis.

This is a work in progress which needs more general critique and analysis. However, the analysis that shows the existence of the event horizon in the position calculated is correct based on the Schwarzschild radius calculation and the matter density data.

The precise cause of the CMB itself is still uncertain but the location of the source close to the event horizon is confirmed.

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