# The universe or nothing: The heat death of the universe and it's ultimate fate

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**Abstract**

This paper overviews my hypothesis of the ultimate fate of the universe, showing how it will reach the heat death, and how the dark energy has the main role in the universe movement and even it's end, this paper opens a new path in the searching about the nature of dark energy, by knowing that it's the reason why the universe is expanding, cooling and losing energy. And to note that in this paper we based on that the universe is closed.

## 1 Introduction

The universe is contained of ordinary matter called baryonic matter, the total energy of those matter is 5% of all the energy that exist in our universe, the rest of energy is divided into dark matter which composed about 27% of all the energy that exists in the universe, the rest 68% is made of dark energy.

Dark matter is weakly interacting with light and it never reflect light, we can't see it because it never shine, but dark matter act like gravity, dark matter attract things around it, we can detect dark matter by only one way, it's gravitational interaction as it curves space around it, **dark matter particles are yet to be discovered**.

Dark energy which makes up about 68% of the density energy of the universe act like anti gravity particle as it doesn't behave like gravity, as the universe is expanding and accelerating with time, so dark energy as the major energy in the universe is the reason why the universe is expanding and accelerating, the cosmological constant of dark energy, because it expands as the universe expanding unlike the baryonic matter and the dark matter, so the dark energy increases with the rate of accelerating of the universe to keep it's density constant, so as the universe expands, there will be more dark energy unlike dark matter and baryonic matter, they become more diluted as the universe is expanding, so the future universe will become more dominated with dark energy, and other types of energy will disappear so the stars will run out of fuel and all the stars will turn into black holes, as there will be no gas to form new stars, black holes will dominate the universe, with time these black holes will evaporate, giving out what is called hawking radiation, the universe will become empty, this is what we called the heat death of the universe.

## 2 Overview

The heat death of the universe is supposed to be our ultimate fate and it will be going so fast as the beginning of the universe, it will be accelerating to reach it's fate, the accelerating end state is called de sitter universe or de sitter phase. De sitter space explains the expansion and acceleration of energy into space, there is another phase to de sitter model of space time, it's the inflation, the inflation is what happened at the beginning of the universe, after the Big Bang.Zoline [1967]Frautschi [1982]

Table 1: The difference between matter dominated universe and radiation dominated universe

| Matter dominated universe | Radiation dominated universe |
|---|---|
| Energy | Photons |
| Atoms is complete | No atoms just free P and e- |
| Transparent universe | Dark universe. |

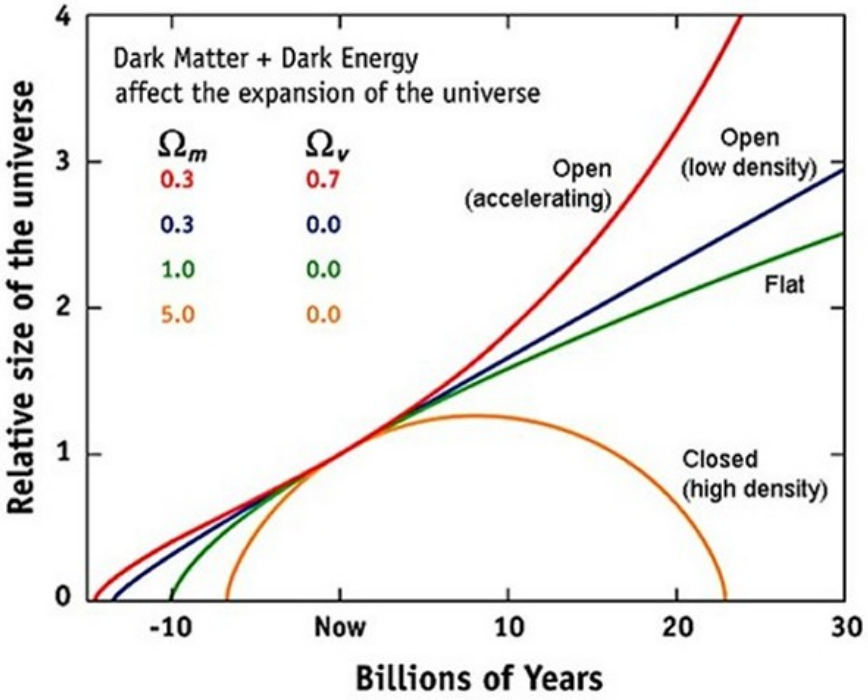


Figure 1: Critical density affect the expansion of the universe

the head death of the universe or the fate of the universe depends on the the energy which percent in space, we have three types of energy which are baryonic matter, dark matter and dark energy.Krauss and Starkman [2000]

Unlike nowadays, at the beginning of the universe, after the big bang by thousands of years, the universe was not dominated by any type of matter or energy, but it was composed of matter and dark matter which interacting with each others emitting some radiations in the form of photos and left some energy for us of matter and no anti-matter, so the universe at the beginning was dominated with radiations.

The universe expanded at the beginning under radiation dominance, then the universe expanded under the the matter dominance as it accelerating.

The radiation dominated the universe at the beginning and that radiation would have an energy equals

$$E = KT \tag{1}$$

This is according to Boltezmann equation as K is Boltzmann constant and T is the Temperature, so the higher the energy the higher the temperature, and atoms ionized at 3000 degrees Kelvin, by this we can say that the electrons at the beginning of the universe were having so much energy as they escaped the atom leaving it with just a protons and a nucleus, so at the beginning of the universe there were no atoms, but just protons and free electrons, so the huge number of photos that has been produced by matter and antimatter interaction in the form of radiation, those photos couldn't escape so far through the universe as

they couldn't escape the interaction with the electrons, that's why this Era in the universe is called the dark age as there is no light, photons couldn't escape the interaction with the free electrons, so you would see nothing. Trimble [1987]

The temperature of the universe has been decreased to 3 degrees kelvin so the universe is somehow cooled down, as it expanding, and the universe is cooled to let the electrons caught up by protons to form the hydrogen atoms, and on the other hand, the photons escaped the interaction with the electron as it's now busy with the protons, so you can see light now, so now the universe is transparent.Huang and Weinberg [1970]Cercignani [1988]

So the universe has two phase of expanding, the first phase was when the universe was dominated by radiations and the other phase is when the universe is dominated by matter, when the universe is dominated by radiation, the temperature was higher than now as the universe is dominated by matter, and according to equation number one, the higher the temperature, the higher the energy, note that at the time when the universe was dominated by radiation there were no dark energy.

I suggest that the dark energy is what driven the universe not the verse, the universe not drive the dark energy, as the dark energy expanding, the universe is expanding not the verse, and the dark energy is the reason why the universe is increasing in size, it's like it's the material of the the space it self, dark energy is the material of the baloon on hubble scale of expanding universe as this material is increasing, the universe itself will increase, so the dark energy is not the same as other types of energy, the baryonic matter or dark matter, as it not controlled or act like gravitational particle, it's nature is anti gravity, it can't be controlled, so the universe will not contract, but it will expand, till this energy reaches it's infinity, so it will contact to it's origin the same way it began it's expanding in a big crunch, but before the big crunch, the universe will face the heat death, as it will run of fuel and gas and lose energy, the stars will bomb away turning into black holes and the black holes will evaporate in a from of radiation called hawking radiation, then the universe will turn it's face to big crunch and will end.

## 2.1 Hawking radiation

Black holes could lose energy and evaporate by radiating out energy, but how could tat be while anything that get into a black hole couldn't be escape, as the velocity is greater than the speed of light.Visser [1998]

It's all about quantum fluctuation, as in space where you have nothing from nothing, so energy is zero, quantum fluctuation allows pairs of particles to be created, matter and anti-matter, as they interact and take you back to where energy is zero, as in quantum mechanics something can rise from nothing and goes back to nothing again.Parentani [2001]

If we suppose that quantum fluctuation will happen near a black hole in the future so, quantum fluctuation will create two particles matter which is positive energy and anti matter which is negative energy, the negative energy will get into the black hole reducing it's energy, and the positive energy will run into space as it's away from Schwarzschild radius of the black hole, so the black hole will evaporate because it will get negative energy which will make reduction to it's total energy. Hawking [1974]

## 2.2 Mathematics

According to our closed universe we supposed,we will imagine it in Fredman-roebertson-walker formula.

$$\frac{\dot{a(t)}^2}{a(t)^2} = \frac{8\pi g}{3}\rho(t) - \frac{K}{a(T)^2} \tag{2}$$

From this formula which has 3 segments the left segment is the kinetic segment which means the kinetic energy term, the centered segment is the potential energy term and the right segment is the constant term, the centered segment will always be positive because all the terms on it will always be positive and also the density of the universe will always be positive, so in the right segment if the constant K is positive this will lead to the all result of the equation will be positive, which will result into an open universe, which means that the universe will expand forever.

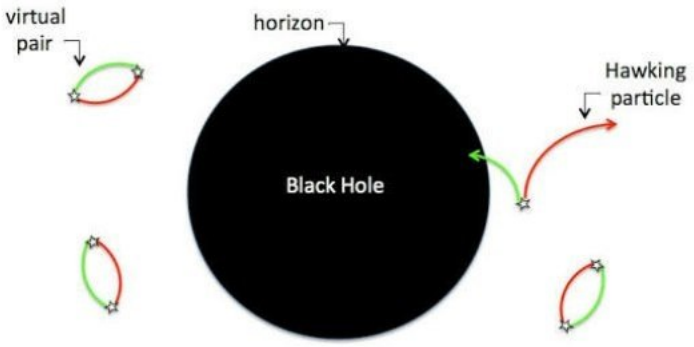


Figure 2: Quantum fluctuation and hawking radiation

On the other hand if K constant is negative, so the negative value of the right term will be bigger than the positive value of the centered term lead to that the whole equation is negative, leading to a closed universe which support my hypothesis that the universe will end into a big crunch after facing the ultimate heat death and losing energy after reaching the infinity.

Another equation that supports my hypothesis is that the universe is losing it's baryonic matter and other matter other than dark energy as the universe expands.

$$Mass = VolX\rho \tag{3}$$

According to this equation as the universe expanding the Vol will increase and the density will decrease while the Mass is constant.

## 3 Conclusions

In this paper we included topics that cover the scenarios of the fate of the universe and how the universe will end, overviewing the heat death of the universe, my hypothesis of dark energy and how it drive the universe and the role of quantum fluctuation in determining the fate of the universe.

## List of Figures



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## References

C. Cercignani. The boltzmann equation. In *The Boltzmann Equation and Its Applications*, pages 40–103. Springer, 1988.

S. Frautschi. Entropy in an expanding universe. *Science*, 217(4560):593–599, 1982.

S. W. Hawking. Black hole explosions. *Nature*, 248(5443):30–31, 1974.

K. Huang and S. Weinberg. Ultimate temperature and the early universe. *Physical Review Letters*, 25(13): 895, 1970.

L. M. Krauss and G. D. Starkman. Life, the universe, and nothing: Life and death in an ever-expanding universe. *The Astrophysical Journal*, 531(1):22, 2000.

R. Parentani. Quantum metric fluctuations and hawking radiation. *Physical Review D*, 63(4):041503, 2001.

V. Trimble. Existence and nature of dark matter in the universe. *Annual review of astronomy and astrophysics*, 25(1):425–472, 1987.

M. Visser. Acoustic black holes: horizons, ergospheres and hawking radiation. *Classical and Quantum Gravity*, 15(6):1767, 1998.

P. Zoline. The heat death of the universe. *Busy About the Tree of Life*, 1967.