

# Topical: Dark Energy, Dark Matter and Fate of the Universe

## Dark side of Special Relativity and Space-Time

### Abstract

Space-Time and special relativity theory of matter generation and matter destroying explain the universe how to origin and evaluation as well as why it is happening. It explains the universe's constitution of matter, anti-matter, energy, and dark energy as well as their properties. It explains the dynamics of the universe especially expansion and compression and how the power created for it by matter transforming. It also explains the inflation and collapse of the universe.

Therefor ultimate fate describes by matter generation and matter destroying is nothing, expanding, flat, compression, nothing, and yet another universe to begin again. As well as it explains how the universe structures of galaxies and stellar and how those are evolved.

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White paper submitted to the Decadal Survey on  
Biological and Physical Sciences (BPS) Research in Space 2023-2032

## 1. Introduction

Our universe explained as homogeneous and isotropic. This is explained by Robertson Walker metric (Mambrini, 2013).

$$s^2 = c^2 dt^2 - R^2(t) \left[ 1 - kr^2 + r^2(d\theta^2 + \sin^2 \theta d\phi^2) \right]$$

where  $k$  is the curvature, and  $t$  is the time measured by a fundamental observer (at rest with local surroundings), and  $R$  is a time-dependent scale factor.

The General Relativity solution for the scale factor  $R$  is given by the Friedmann equation as follows (Mambrini, 2013).

$$\ddot{R} = -\frac{4\pi G}{3}R \left( \rho + \frac{3P}{c^2} \right) + \frac{\Lambda}{3}R \quad (\text{Force Equation})$$

$$\dot{R}^2 = \frac{8\pi G}{3}\rho R^2 - kc^2 + \frac{\Lambda}{3}R^2 \quad (\text{Energy Equation})$$

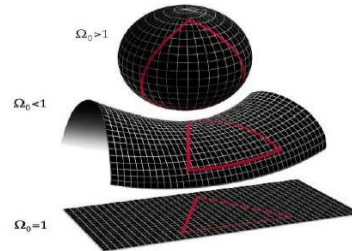
where  $P$  is the pressure and  $\Lambda$  is the cosmological constant,  $k$  is the curvature. Energy density changes in the universe (Fluid equation) as follows.

$$\dot{\rho} + 3\frac{\dot{R}}{R} \left( \rho + \frac{P}{c^2} \right) = 0 \quad (\text{Fluid Equation})$$

Albert Einstein's theory of special relativity that expresses the fact that mass and energy can be interchanged into each other.  $E = mc^2$ , in the equation, the kinetic energy ( $E$ ) of that body is equal to the increased relativistic mass ( $m$ ) of body times the speed of light squared ( $c^2$ ) (Bodanis, 2005).

The above equations explain how the universe origin, evaluation, and how it looks likes. The universe can have three possible curvatures depending on the value of  $k$  and  $\Omega$ .

- $k = 1$ , Universe is closed
- $k = 0$ , Universe is flat
- $k = -1$ , Universe is open



## 2. Dark Energy, Dark Matter problem and power mechanism of the Universe

The universe describes by  $\Lambda$  CDM (Lambda – Cold Dark Matter) model, which is the currently accepted model for explaining the universe (Silk, 2000). The present Constitution of the Universe according to the  $\Lambda$  CDM model is Baryonic matter: 24%, Dark matter: 4.6% , Dark energy: 71.4% . Also Friedmann equations use  $\Lambda$  as dark energy. But there is no clear description of the dark energy and dark matter, also the origin and evaluation of dark energy and dark matter.

The  $\Lambda$  CDM model explains the origin of the universe from Big Bang, then inflation, Big Bang Nucleosynthesis, and expanding universe (Boesgaard, 1985). But no method to explain how the power generated to the Big Bang and inflation.

### 3. Solution of Special Relativity, Friedmann equations and Fluid equation explain dynamics of the universe with Dark Energy, Dark Matter

Solution to the Friedmann equations, fluid equation and special relativity explains how matter and energy created. According to that matter can generated with negative energy. Matter can destroy with negative energy. The negative energy can identified as dark energy. The negative matter can identified as Dark matter.

Process of transforming energy - matter create the power to universe to expand and compress. According to the special relativity, matter generated by compressing energy by speed of light and opposite power apply to the universe to expand. Also when energy generated by expanding matter in speed of light, opposite compression power applied to universe to compress. This solve the power requirement to the Big Bang. This provide mechanism to how the power originate for universe to Inflation, Expansion, Steady State, Compression and Collapse. This will provide the possible answer to how the universe work does.

### 4. Detailed Space Architecture of Energy, Matter, Dark Energy, Dark Matter and Universe power generation

Consider an initial stage with no matter in the universe and nothing all over. Then according to the fluid equation  $(\rho) + (P = -\rho c^2)$  can be generated without effect to the equation. Then  $P = -\rho c^2$ , Which is explained as the pressure of vacuum energy, where cosmological constant dominates the universe. In the fluid equation, it was written as  $(\rho) + ([-\rho * c^2]/c^2)$ .

According to the special relativity, it explains as

$$\begin{aligned} & \text{density } \rho + \text{negative density}(-\rho) * \text{expand speed } c * \text{compressed by speed } c \\ \Rightarrow & \text{density } \rho + \text{dark energy}(\Lambda = -E = -\rho c^2) * \text{compressed by speed } c \\ \Rightarrow & \text{density } \rho + \text{anti-matter}(-\rho) \end{aligned}$$

The anti-matter(- $\rho$ ) can identified as dark matter.it is comparable with special relativity energy -> mass transformation.

$$\begin{aligned} & 0 = E - E \quad \{\text{initially Energy and Dark Energy}\} \\ \Rightarrow & 0 = (E/c^2) * c^2 + (-E/ c^2) * c^2 \quad \{\text{divide by } c^2 \text{ and multiply } c^2\} \\ \Rightarrow & 0 = \rho * c^2 + (-\rho) * c^2 \quad \{ E = mc^2 \Rightarrow m=E/c^2\} \\ \Rightarrow & 0 = \rho + ([-\rho * c^2]/c^2) \quad \{\text{equivalent to fluid equation, } P = -\rho c^2\} \end{aligned}$$

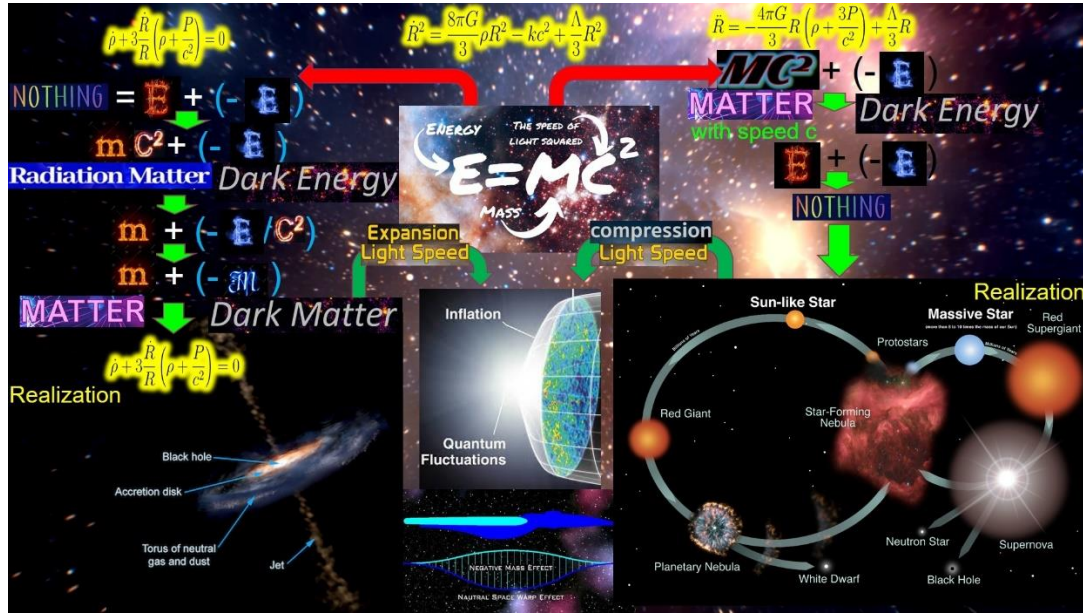
It can explain as positive density can generated with negative density expand by speed of light and apply compression of speed light again. This expansion of speed of light apply, since the opposite force to compression of energy by speed of light.

It explains how the initial mass generated as positive density and dark energy compressed by the speed of light. Not the positive density expands by speed of light nor the positive mass and anti-matter. It also explains dark energy as negative pressure and universe origin as:

density  $\rho$  + dark energy( $\Lambda = -E$ ) \* compressed by speed of light

Apply the initial  $\rho$  and  $P = -\rho c^2$  to Friedmann force equation, give initial  $\Lambda = -8\pi G$ . Also applying  $\Lambda = -8\pi G$  for Friedmann energy equation, give initial scale factor  $R=ct$  (initial curvature  $k=-1$  for open universe in big bang inflation). Which also comparable for the expansion of speed  $c$  given by fluid equation. Therefore inflation is start with scale factor  $R$  equals to speed of light( $c$ ). Initially generated matter gets nearly equivalent speed of light, hence generated as radiation matter. This process is the power generation process to universe to expand.

How does the Universe work: Engagement of Dark Energy and Dark Matter



This will refuse the concept of initial high density soup, alternatively can consider origin from nothing or origin from Energy and Dark Energy soup and then it had transform to Matter and Dark Matter.

## 5. General Theory of Curvature

Friedmann energy equation explains the conservation of energy and can rearrange as:

$$\frac{1}{2}m\dot{R}^2 = \frac{4\pi G}{3}\frac{mR^3\rho}{R} - \frac{1}{2}mc^2k + \frac{4\pi G}{3}\frac{mR^3\rho_v}{R}$$

K.E.                      P.E.                      constant particle E.                      cosmological constant

Where  $k$  is the curvature. Therefore the curvature explains the constant particle energy and depends on the matter change of the university. Energy also expresses as matter from generated from special relativity,  $m = E / c^2$ .

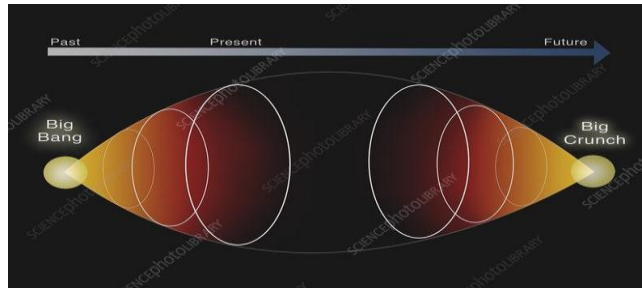
If the matter space increasing, the universe is open and  $k < 0$ , if matter increasing only and  $k = -1$ . If the matter space decreasing, the universe is closed and  $k > 0$ , if matter decreasing only and  $k = +1$ . Mass can be destroyed transforming equivalent energy in star, equivalent  $m = E / c^2$ . General curvature can be as follows.

$$k = (m_d - m_c) / (m_d + m_c)$$

where  $m_c$  = matter created,  $m_d$  = matter destroyed,  
 when  $m_d = 0$ , then  $k = -1$ , open universe. when  $m_d = m_c$ , then  $k = 0$ , flat universe.  
 when  $m_c = 0$ , then  $k = +1$ , closed universe.

## 6. The Fate of the Universe

Detailed analysis the concept with Dark Energy, Dark matter and the space time concepts of Cosmology, which is Curvature, Friedmann Equations, Fluid equations,  $\Lambda$ , State parameter  $w$ , Density parameter ( $\Omega_m, \Omega_r, \Omega_\Lambda$ ), Hubble Constant  $H_0$ , will give Einstein De Sitter like model, which will explain the universe by all the possibilities (Fate of the universe) with Dark Energy and Dark Matter.



The fate of the universe describes by matter generation and matter destroying model as follows.

- Inflation( $\rho = 0, k = 0$ , Dark Energy and Energy only)

$$R \propto \exp\left(\sqrt{\frac{\Lambda}{3}} t\right)$$

Since the  $\Lambda$  is negative inflation in dark energy, opposite compression in positive energy makes positive matter.

- Expansion( $\rho > 0, k < 0$ )

When  $k = -1$ , positive matter and dark energy are equal, then  $R=ct$

When  $-1 < k < 0$ , since the matter destroying process, it makes

Dark Energy > positive matter

Then  $R$  gets complex value. Therefore expansion applies to complex parts of dark energy or anti-matter. Then positive matter gets a relative expansion, that's why positive matter remains the same size without expansion.

- Flat( $\rho > 0, k = 0$ )

$$R = \exp\left\{\left[\frac{8JIG + \Lambda}{3}\right]^{1/2} * t\right\}$$

Since the matter destroying process and all related dark energy of matter destroying process not destroyed,  $\Lambda > 8JIG$ , therefore expansion in the complex part of dark energy. Since the universe is flat

$$R = e^{-xt}, \text{ where } x = \left[\frac{8JIG + \Lambda}{3}\right]^{1/2}$$

- Compression( $\rho > 0, k > 0$ )

When  $0 < k < +1$ , since the matter destroying process, Dark Energy > positive matter, Then  $R$  gets complex value. Therefore expansion applies to complex part of dark energy or anti-matter. Then positive matter gets relative compression,

that's why positive matter remains the same size without compression. When  $k = +1$ , and if positive matter and dark energy are equal, then  $R = -ct$  for complex part of dark energy.

- Collapse ( $\rho = 0, k = 0$ , Dark Energy and Energy only) in the last step of the universe

$$R \propto \exp\left(\sqrt{\frac{\Lambda}{3}} t\right)$$

Since the  $\Lambda$  is negative, collapse in dark energy, opposite compression in positive energy makes positive matter. Positive matter traverse speed of light, since the compression speed of light, makes positive energy. The last expansion makes all anti-matter portions to dark energy and will negate with positive energy.

Also detailed analysis of this concept with observed phenomenon of space will give picture of universe as a whole as well as Galaxy formation and Star formation mechanisms.

## 7. Benefits to the space community

The space time, fluid flow and special relativity process of Energy, Dark Energy, Matter and Dark Matter explain the universe how to origin and evaluation as well as how does the universe work. This explain the concept of dark energy and dark matter and their contribution to universe dynamics, especially galaxy and stellar evolution.

It explains the dynamics of the universe especially expansion, compression as well as inflation and collapse. And how the power created for the universe for those events by matter generation and matter destroying. Detailed study the concept also explains how galaxies and stellar formation and evolution as well as other structures evolution. This will useful for future Dark Energy and Dark mater searches as well as determine physics of Stellar and Black Holes. Also provide mechanism to how the universe Inflation, Expansion, Steady State, Compression and Collapse. This will provide the possible answer to how the universe work does.

## 8. Conclusion

The special relativity process of Energy, Dark Energy, Matter and Dark Matter explain the universe how to origin and evaluation as well as how does the universe work. This will refuse the concept of initial high density soup, alternatively can consider nothing or Energy and Dark Energy soup initially and in then it had transform to Matter and Dark Matter. According to that matter can be generated with negative energy and matter can destroy with negative energy. The negative energy can be identified as dark energy. The negative matter can identified as dark matter.

It explains the fate of the universe for all possibilities as expansion, flat, compression as well as inflation and collapse. And how the power created for the universe for those events by matter transformation. This explain the contribution of dark energy and dark matter for the universe power mechanism. It also explains how galaxies and stellar formation and evolution as well as other structures evolution.

## Reference

- Bodanis, D., A Biography of the World's Most Famous Equation, 2005.  
DOI: 10.1119/1.3099672
- Boesgaard, A.M., Big Bang Nucleosynthesis: Theories and Observations, Ann. Rev. Astron. Astrophys. 1985.23: 319-78, 1985.  
DOI:10.1146/23.090185.001535
- Mambrini, Y., Histories of Particles in the Dark Universe, 2013.  
[http://www.ymambrini.com/My\\_World/Physics\\_files/Universe.pdf](http://www.ymambrini.com/My_World/Physics_files/Universe.pdf)
- Silk, J., The Big Bang: Third Edition, Henry Holt and Company: New York, 2000