Acceleration Theory (ET)

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ABSTRACT

Experimental results well demonstrated couple of things such as speed of the light finite, mass of the generated particles unchanged over the time and different kind of matter particles exist in the universe, i.e. dark matter, anti-matter and regular matter. In this paper, I am trying to suggest some improvements to the concepts and unify them by analysing different theories which were well proved over the time, such as Hubble parameters, universe age, relativity theory and Plank constant.

1. Acceleration Theory of Light Speed.

The new framework mainly depends on the concept of “Universe expanding” which was practically well proven. Let us assume, two objects located 3x10^8 meters apart (it is approximately equal to the velocity of the light per sec), say the objects as A and B. Take a light signal C, having a frequency f=3x10^8 Hz, velocity of the signal V= 3x10^8 meters/sec. The light signal takes one sec to travel from A to B, the 3x10^8 meters distance. Using our basic principle c = nλ, where C= velocity of light, n= frequency of the signal, λ= wavelength of the signal, the wavelength of the signal is 1 meter.

\[ \text{Distance} = \text{Velocity} \times \text{Time} \]

Here Distance = 3 x 10^8 meters, V= 3 x 10^8 meters/sec

\[ \text{Time} = \frac{\text{Distance}}{\text{Velocity}} \]

\[ \text{Time} = \frac{3 \times 10^8 \text{ meters}}{3 \times 10^8 \text{ meters/sec}} \]

\[ \text{Time} = 1 \text{ sec} \]

The light signal C takes exactly 1sec to travel from A to B.

Figure#1

Velocity of the light is 3x10^8 meters/sec; Time to reach B from A is 1sec

We know, our universe was expanding at certain rate, i.e accelerating, the distance between the two points, A and B will be increase by D meters after time period T, let’s say T=X million years, and D is distance increased due to Universe expansion between the objects. Total distance between two objects, A and B will become 3x10^8 +D meters.

Figure: 2

Let’s use the same light signal which we discussed before, having frequency f=3x10^8Hz and wavelength \( \lambda = 1 \) meter. Let’s find out the time taken it to travel from point A to B using our basic principle i.e. Distance = Velocity x Time, the light signal C should take more than 1sec to travel from A to B since the distance was increased by D meters, assume that the velocity of the light was constant with the help of Special theory of relativity. But in our theory, the light signal does not take more than 1sec even though the distance between the two objects was increased by D meters; light signal takes the same amount of time to reach the
object B. i.e. 1 sec. From this we it’s not easy to conclude that the light velocity was not constant, it might be changing with respect to time to satisfy the universe expansion principle.

Figure: 3
Velocity of the light = 3x10^8 meters/sec; T1-T0 is 1sec
Note: The time taken to travel the signal from A to B should not be equal to 1 sec because the distance between the two objects increased by D meters, but velocity limit of light does not change. It might be changing over the time, either increase or decrease.

1.1 Light Velocity Increasing or Decreasing?

From the previous explanation, it could be that velocity of the light may not be constant in the real universe. It would be either increasing or decreasing with time.

There are two possible cases:
Case#1: Light velocity is decreasing with respect to time
Case#2: Light velocity is increasing with respect to time
case#1: The Light velocity is decreasing with respect to time, velocity is inversely proportional to time.

\[
 c \alpha \frac{1}{t} \quad (1)
\]

Where \(C\) = Speed of light, \(t\) = time in sec

\[
 c = \frac{S}{t} \quad (2)
\]

Where \(S\) is proportionality constant

Here the parameter \(t\) has different definition; it’s the total amount of time from the day of light velocity started decreasing, from the big bang time. In our previous example the light signal \(C\) took (fig#3) 1sec to travel from object A to B though the distance between the objects were increased by D meters, it means the light signal velocity should be increased to satisfy the condition. The velocity of light should increase to travel the 3x10^8 + D meters in 1sec. From this it’s clear that the velocity is not decreasing, it’s might be increasing with time. Hence the Case#1 is invalid.

case#2: The Light velocity is increasing with respect to time, velocity is proportional to time

\[
 c \alpha t \quad (3)
\]

\[
 c = St \quad (4)
\]

Where \(C\) = Velocity of light, \(t\) = time in sec and \(S\) = Proportionality constant.

Let’s say the velocity of light is increasing with time to satisfy the basic principle of Universe expansion concept and represent the proportionality constant ‘S’ as a universal constant.

1.2 Calculate Universal Constant, S

We know the velocity of light \(C = 299792458\) m/s, age of Universe \(t = 13.7\) billion years. Convert the universe age into seconds, \(t = 13.7\) billion years = \(13.7 \times 10^9\) sec

\[
 c = \frac{St}{(5)}
\]

Substitute \(C\) and \(t\) values in equation\#5,

\[
 299792458 = S \times 432043200 \times 10^9 \text{ sec}
\]

\[
 S = 0.693894 \times 10^9 \text{ m/s}^2
\]

The Universal space constant \(S = 0.693894 \times 10^9 \text{ m/s}^2\)

Here \(S\) is a constant and it has unit's m/s^2, it shows that the velocity of the light is not just increasing it’s also accelerating with respect to time to satisfy the universe expansion, which is accelerating. In the previous example, the distance between the two objects is increased by D meters after \(X\) million years and the light velocity is increased by \(L\) m/s and in the same way, the distance between two objects will increase by 2D meters after 2X million years since universe expansion is accelerating. To satisfy this light velocity is accelerated by 2L m/s then the light signal can reach the second object in the same amount of time. Theoretically it shows, \(S\) is an accelerating constant.
1.3 Is the light velocity changing over the time?

From the above calculation, i.e. equation\(\#6\), Universal Space Constant \(S\) is \(0.693894 \times 10^{-9} \text{ m/s}^2\), for every 1 sec there will be a change of \(0.69x10^{-9}\) meters in light velocity. Let’s calculate how much time it take to increase the light velocity by 1m/s.

\[
0.693894 \times 10^{-9} \frac{\text{m}}{\text{s}^2} \quad \text{---- 1 sec}
\]

\[
1 \frac{\text{m}}{\text{s}^2} \quad \text{---- X (it’s the required value)}
\]

\[
X = (1 \text{ sec} \times 1 \frac{\text{m}}{\text{s}^2}) / 0.693894 \times 10^{-9} \frac{\text{m}}{\text{s}^2}
\]

\[
X = 1.411423 \times 10^9 \text{ sec}
\]

Converting the \(1.411423 \times 10^9\) sec into years...

\[
X = 0.45 \times 10^{-2} \text{ years}
\]

\[
X = 45 \text{ years}
\]

For every 45 years the speed of the light is increasing by 1 m/s.

The increase in the light velocity was very minimal hence we were not able to detect the changes in lab experimental environment. The velocity of light is a constant as per the Special theory of Relativity, the concept still valid at any given instant of time but not over the time, new theory is not violating the Special theory of Relativity.

1.4 How the \(C = N\lambda\) affected by the universal constant ‘\(S\)’?

From our previous calculations, the speed of the light is accelerating; Let’s try to figure out the wavelength and frequency of the signal with increase in velocity.

As per basic principle, \(C = N\lambda\) where \(N\) = frequency of the light signal and \(\lambda\) = Wavelength of the signal. Here we have 3 possible scenarios, let’s understand each one of them clearly.

**Case1:** \(N\) increased with increase in light velocity, \(\lambda\) as constant

**Case2:** \(\lambda\) increased with increase in light velocity, \(N\) as constant

**Case3:** Both \(N\) and \(\lambda\) are changing proportional to increase in \(C\).

**Case1:** frequency (\(N\)) increased with increase in light velocity, \(\lambda\) as constant

**Case2:** \(\lambda\) increased with increase in light velocity, \(N\) as constant

**Case3:** Both \(N\) and \(\lambda\) are changing proportional to increase in \(C\).

Let’s reuse the explanation provided in section\#1.1, light source having frequency \(N = 3 \times 10^8\) Hz, the light signal traveling between two points having distance of \(\text{D}=1\) meters. The light signal is having wavelength of 1 meter.

![Figure 4](https://via.placeholder.com/150)

Frequency of the signal \(N = 3 \times 10^8\) Hz, Wavelength of the signal \(\lambda = 1\) meter

Now perform the same experiment after 3 million years, assuming no difference in signal frequency so the equipment generates light signal with the same frequency \(N=3 \times 10^8\) Hz. Now the distance between two points changed to \(\text{D} = 2\) meters due to universe expansion, so there will be change in wavelength. Now perform the same experiment after \(X\) million years, the equipment we used in this experiment was designed in such a way that there will be no change in generated light signal frequency, i.e. \(N=3 \times 10^8\) Hz. Assume the distance between two points shown in above fig:4 increased from 1 meter to 2 meters due to universe expansion, here increased distance by 2 meters was an assumption, may not be accurate, it’s just taken for explanation of the theory.
Frequency of the signal $N = 3 \times 10^8$ Hz Wavelength of the signal $\lambda = 2$ meter With this explanation, it is clearly shown that the equipment was capable to generate same frequency which was generated $X$ million years before so we can say that frequency is constant all the time hence frequency is not changed but some other parameter might be changing. Let’s focus on that.

Case#2: Assume wavelength ($\lambda$) increased with increase in light velocity and frequency (N) constant. From the previous scenario, case#1, the frequency was not changed but the distance between two objects was increased from 1 meter to 2 meter after $X$ million years due to universe expansion. So the light signal wavelength has to stretch by 1-meter to maintaining frequency as constant.

Frequency of the signal $N = 3 \times 10^8$ Hz Wavelength of the signal $\lambda = 1$ meter

From this it’s shows that the wavelength of the light signal $C$ is changing with respect to the change in time and the change in light velocity. Here the wavelength $\lambda$ is increased because it’s completely depends on the space structure, I mean the wavelength increased but not the frequency to hence the same wave tries to stretch and fit between the points.

Case#3: Both frequency (N) and wavelength (\lambda) are changing proportional to increase in light velocity C. Logically it’s incorrect since proved that the signal frequency is constant in Case#1.

### 1.5 Why the velocity be a function of light? What happens if not?

It’s because of the Hubble Constant, we know the basic principle in the universe expansion, Hubble law

$$V = HD \quad (8)$$

$$H = \frac{1}{t} \quad (9)$$

from equation #4

$$C = St$$

Substitute equation 9 and 4 in equation 8

$$H = \frac{S}{C} \quad (10)$$

From the above equation #10, the Hubble constant decreases in case the light velocity increases, in other words, the universe acceleration rate is constantly decreasing. The reason behind was to maintain the universe expansion and we don’t have an infinite length universe, the universe dimensions are finite, but the dimensions are very big / wider. If the universe acceleration rate is constant, then there is a chance at a point the acceleration rate reaches where there is no universe at all. One more important point is the acceleration constant never equal to zero because the light velocity is not an infinite. In this way, all the time our universe expansion happens, and it never exceeds a limit. As per Special theory of Relativity the velocity of light is a constant, $c$, in the universe, the principle is valid at any instant of time but not for ever. The new theory is not violating the Special theory of Relativity. The main reason for the velocity limit constant was due to the space structure. The universe space structure allows everything to travel at a velocity, i.e. called the velocity limit which is equal to C.

In my opinion the mass of the light particles such as photons never be equal to zero. As the time passes, the space structure changes hence the velocity limit changes. So, anything can achieve the velocity of light in case the object mass is equal to light quanta. The gravitational waves also travel at same velocity of the light, C.
1.6 Summary of chapter 1

The light velocity is not constant in general, it’s accelerating, the acceleration constant was very low, it is \( S = 0.69384 \times 10^{-9} \text{ meter/second}^2 \) hence the current experiments were not able to detect the minor values. The light velocity will increase by 1 meter in every 45 years. The current velocity of the light is 299,792,458 m/s, will increase to 299,792,459 m/s after 45 years. The famous \( C = N \lambda \) equation is affected with the change and it’s clear that frequency is not changing but the wavelength was affected with the light velocity change.

Let’s move on to next topic, universe expansion. As we found that the velocity of light is changing over the time, so what could be the impact on universe with the behaviors. Let’s analyze the possibilities of universe changes.

2. Acceleration Theory of Universe

The Acceleration Theory of Universe explains how the matter was created in the universe. Let’s try to understand why the dark energy exists in our universe and its importance. What happens if a beam of light, i.e. photon falls on the dark energy and what kind of reactions it can make? Does the Photon convert the dark energy into matter? It looks to be true, when a Photon interacts with dark energy, the dark energy will be converted into atoms like electron, proton, neutron, etc... and these tiny matter particles will be grouped together and form the actual atoms then form molecules and finally form matter objects what we see today in the universe.

![Image of universe expansion](image)

I believe universe expansion is nothing but the rate at which the dark energy is converted into matter. The Dark energy might be having capability to bend into any shape. The reason for the expansion was in the initial days of universe, there was a single light source which was formed due to high density and pressure of the universe, as the time passes the amount of light source increased hence more amount of the dark energy was converted into matter. Dark Energy particles are tightly coupled with each other. The dark energy has a chemical bond in it. Because of the tightly coupling between the dark energy particles, the universe takes any shape, but it does not lose the bond between the particles.

2.1 Effect on Hubble Constant

Let’s take the Hubble’s equation for our further derivations.

\[
V = HD
\]

\( V = \text{Recession velocity}, \ H = \text{Hubble Constant} \) and \( D = \text{Distance} \)

Re-write the Hubble constant as

\[
H = \frac{1}{t}
\]

Universal constant, from equation #4,

\[
C = St
\]

From equation #4, #11 and #12

\[
H = \frac{S}{C}
\]
From the equation \( \text{#13} \), it's clear that the Hubble acceleration constant is decreasing with increase in the light velocity. It does not mean that the universe is negatively decreasing. It is the rate at which the Hubble constant is decreasing, it’s deaccelerating. Though the Hubble constant is decreasing, the amount of new space created was constant.

\[
\text{HC} = S
\]  

(14)

It's clear that, the new space created was constant all the time. It is also one of the main reasons for acceleration constant decreasing. The Hubble constant never becomes zero since the light velocity never touches infinite. The Hubble constant H and Light Velocity C are interdependent.

Conclusion from the above explanation is, the universe accelerating rate is nothing but more amount of the Photons falling on dark energy hence more amount mass particles generated, time to time. Using the Acceleration Theory of Light, C = ST, mass of an object decreases with respect to time keeping the relative velocity of a frame constant hence the energy generated from a particle remains constant.

### 2.2 How mass of the generated particles affected

As per the new theory, i.e. Acceleration Theory of light, C = ST, the mass of an object/particles decreases with respect to time keeping the relative velocity of the frame constant so the energy generated from a particle will be same forever even though the velocity of the light increases.

Derivation for the above statement

From Relativity theory

\[
m = \frac{m_0}{\sqrt{1 - \left(\frac{v}{c}\right)^2}}
\]  

(15)

Where

- \( m \) = mass of an object in a frame
- \( m_0 \) = initial mass in a reference frame
- \( v \) = velocity of given frame
- \( c \) = speed of light

Now assume at certain time in future i.e. \( t = t1 \) the velocity becomes \( v' = \frac{c}{2} \)

Substitute, \( v' = \frac{c}{2} \) in Equation 15

\[
m_{t1} = \frac{m_0}{\sqrt{1 - \left(\frac{\frac{c}{2}}{c}\right)^2}}
\]  

(16)

\[
m_{t1} = \frac{m_0}{\sqrt{\frac{3}{4}}}
\]  

(17)

\[
m_{t1} = \frac{2m_0}{\sqrt{3}}
\]  

(18)

Where \( m_{t1} \) = object mass at time \( t1 \)

Let's assume at some time the speed of the light increased from \( c \) to \( 2c \) but the velocity of the frame is same.

Now assume at certain time in future i.e. \( t = t2 \) the velocity becomes \( v' = \frac{c}{2} \) and \( c = 2c \)

Substitute \( v' = \frac{c}{2} \) and \( c = 2c \) in Equation 15

Object mass at time \( t2 \),

\[
m_{t2} = \frac{m_0}{\sqrt{1 - \left(\frac{\frac{c}{2}}{2c}\right)^2}}
\]  

(19)

\[
m_{t2} = \frac{4m_0}{3\sqrt{3}}
\]  

(20)

If we compare equation 18 and 20, it's clear that \( m_{t2} \) is less than \( m_{t1} \), \( m_{t2} < m_{t1} \)

(21)

### 2.3 How Plank Constant affected
From the Acceleration Theory of Light, the velocity of light \( C \) increases with respect to time and wavelength of the light signal increases.

\[ C - \text{Increasing with respect to time} \]
\[ \lambda - \text{Increasing with respect to time} \]

And from this section, we say that the mass of the generated particles decreases over the time, \( m \) decreasing with respect to time. So the Plank Constant \( h \) remains constant forever, irrespective of change in \( m, c, \lambda \).

### 2.4 Total space in the universe

As per Big Bang theory, the experiments proved that our universe is having age of around 13.7 billion years. By taking the universe age as one of the parameters let’s try to calculate total available free space in the universe. The following calculation uses the Acceleration Theory of Light, \( C = St \), here \( t \) = universe age in second.

Universe length \( L \) = \[ \sum_{i=1}^{13.7 \text{ billion years}} 0.6938 \times 10^{-9} \]

\[ = 1(0.6938 \times 10^{-9}) + 2(0.6938 \times 10^{-9}) + \ldots + 13.7 \text{ billion years}(0.6938 \times 10^{-9}) \]

\[ = 0.6938 \times 10^{-9}(1 + 2 + \cdots + 13.37 \text{ billion years}) \]

Convert 13.7 billion years into seconds…

\[ = 0.6938 \times 10^{-9}(1 + 2 + \cdots + 432043200 \times 10^9) \]

\[ = 0.64 \times 10^{25} \text{ meters} \]

Length of our universe \( L = 6.4 \times 10^{25} \text{ meters} \)

This not exactly the total dimension of universe but its total free space available in the universe.

### 2.5 Summary of chapter 2

It is clear from the above theoretical explanation, our universe is filled with dark energy, the mass particles generated when the dark energy interact with the photons, newly generated matter act as light source near future, it helps to converts dark energy into matter, which is continuous process, therefore, the universe expansion was accelerating. The newly generated matter particles do not have a constant mass forever, the mass of the particles decreases with time, but interesting thing is, the Plank constant was finite / constant forever, it’s the one of universal constant. And even the Hubble constant was affected, it might be decreasing over the time.
3. Acceleration Theory of Matter

Previous sections described how the matter was generated, with the help of Acceleration Theory of Universe. In this section, will discuss about different kind of matter and its properties. Let’s take the Photo Electric Effect for deriving the mathematical equation.

\[ hf = KE + W0 \]  \hspace{1cm} (30)

\[ h = \text{Plank's constant} \]

\[ f = \text{frequency of light signal} \]
\[ KE = \text{Kinetic Energy of photon} = \frac{mc^2}{2} \text{velocity at generated photon moves} \]
\[ W0 = \text{Work function is the minimum energy required to emit a photon} \]
\[ hf = \text{Energy of photon} \]

As per Acceleration Theory of Universe, when a light photon interacts with dark energy, the dark energy will be converted to matter particles. Let’s replace the work function W0 with mass energy equivalence theory, \( E = mc^2 \) which is equal to energy of the generated matter particle. It’s also nothing but energy stored in that matter particles.

\[ W0 = mc^2 \]
\[ hf = KE + mc^2 \]  \hspace{1cm} (31)
\[ hf = \frac{mv^2}{2} + mc^2 \]  \hspace{1cm} (32)

Here the dark energy has specific frequency at which the matter particles could be generated, and frequency required to convert the dark energy into matter particles is called Threshold frequency.

\[ \text{Threshold frequency} = f0 \]  \hspace{1cm} (33)

At exact the threshold frequency the generated particles will not have any kinetic energy,

\[ KE = 0 \text{ at } f0 = 0 \]  \hspace{1cm} (34)
\[ hf = 0 + mc^2 \]
\[ hf = mc^2 \]  \hspace{1cm} (35)

\( M0 = \text{mass of the generated particles. The M0 remains constant for different frequencies.} \)

3.1 Light frequency is unequal to Threshold frequency

Let’s find out if the photon frequency is not equal to threshold frequency, either the light frequency is less than or more than a given threshold frequency. We have three different conditions to discuss.

Case#1: light frequency = Threshold frequency (\( F = f0 \))

Case#2: light frequency > Threshold frequency (\( F > f0 \))

Case#3: light frequency < Threshold frequency (\( F < f0 \))

Case#1: Here the light photon frequency is equal to Threshold frequency (\( F=f0 \)). At threshold frequency the Kinetic energy of generated particle is equal to zero

\[ KE = 0 \]

Substitute \( KE=0 \) in equation 31

\[ hf = 0 + mc^2 \]
\[ hf = mc^2 \]  \hspace{1cm} (36)

The generated particles at the threshold frequency will not have any kinetic energy hence the particles will not move by its own, it requires external energy to move the particles. This kind of particles is called Regular matter particles which we see in our real world. For example, Earth made up of these regular particles. Any particles we see in real universe are made up of these regular matter particles.

Case#2: The light photon frequency is greater than Threshold frequency (\( F > f0 \))

From equation 36, we know \( hf0 = mc^2 \), \( hf0 \) is the minimum energy required to generate a particle from the dark energy. In this scenario, the frequency is above the threshold frequency hence the energy of
photon is more than the required so additional energy will act as kinetic energy of the generated particles.  
\[ h_f = KE + m0c^2 \]
\[ KE = hf - m0c^2 \]  \hspace{1cm} (37)  
\[ KE = +ve \text{ energy Because } hf > m0c^2 \]  \hspace{1cm} (38)  
The particles move with positive kinetic energy, for different frequency there will be corresponding kinetic energy levels, different particles move at different velocities. This kind of particles are called Dark matter particles. To be clear that the chapter#2 describes about the dark energy and chapter#3 describe about the dark matter, the dark energy will be converted to dark matter in specific conditions  
Case#3: Here the light photon frequency is less than Threshold frequency (\( F < f_0 \))  
\[ hf = KE + m0c^2 \]  \hspace{1cm} (37)  
\[ KE = -ve \text{ energy Because } hf < m0c^2 \]  \hspace{1cm} (38)  
Particles having negative kinetic energy are called Antimatter particles.  
- The Antimatter particles collide with dark matter particle which are having same amount of positive kinetic energy and generates energy, this process is called Annihilation process.  
- The main reason for dark matter particles having more gravitational force compare to regular matter was due to the velocity of the particles and kinetic energy in it.  
- From our previous scenario, say that the frequency available below the threshold frequency is less than the frequency above the threshold frequency hence there is more chance of having dark matter particles compare to Antimatter particles. Also, the antimatter particles collide with equal positive energy dark matter particles so there should not be any antimatter particles available in our universe. But I believe there could be minimal amount of antimatter particles available in our universe, those may not be having the equal amount of positive energy dark matter particles, it could be the reason why we are not able to detect antimatter particles in our universe easily.

### 3.2 Summary of chapter 3

1. Matter Particles having zero kinetic energy, act as Regular matter; Kinetic Energy =0  
2. Matter Particles having positive kinetic energy act as Dark matter; Kinetic Energy = positive energy (+ve energy)  
3. Matter Particles having negative kinetic energy act as Antimatter; Kinetic Energy = negative energy (−ve energy)  
4. Antimatter particles collide with dark matter particles if the energy levels of the particles are equal but having opposite polarity. The collision releases maximum amount of energy due to Annihilation Process.

### Conclusion:

1. The speed of the light is not just constant, it’s accelerating, the acceleration constant was very less, the acceleration constant is \( S= 0.693894x10^{-9} \) meter/sec^2 hence the practical experiments were not able to detect the minor values. The velocity of the light will increase by 1meter for every 45years. For example, the current speed of the light is 299,792,458 m / s, it will increase to 299,792,459 m / s after 45years. From the famous equation \( C = N \lambda \) equation, it is clear that the frequency of a given signal is not changing but the wavelength was affected due to change in the light speed, \( C \).  
2. It is clear from the above theoretical explanation, our universe is filled with dark energy, and the mass particles generated when the dark energy interact with the photons. And the newly generated
matter act as light source at one point, it helps to converts dark energy into matter, which is continuous process, therefore, the universe expansion was accelerating.

3. The newly generated matter particles do not have a constant mass forever, the mass of the particles decreases with time, but interesting thing is, the Plank constant is remained constant forever, it’s the one of universal constant. And even the Hubble constant was affected, it’s decreasing over the time.

4. Different Matter particles and it’s properties:
   a. Matter Particles having zero kinetic energy act as Regular matter; Kinetic Energy = 0
   b. Matter Particles having positive kinetic energy act as Dark matter; Kinetic Energy = positive energy, (+ve) energy.
   c. Matter Particles having negative kinetic energy act as Antimatter; Kinetic Energy = negative energy, (−ve) energy
   d. Antimatter particles collide with the dark matter particles if the energy levels of the particles are equal but having opposite polarity. The collision releases maximum amount of energy due to the Annihilation Process.

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