Entropy and dispersion of Energy

Arya Biswas

This paper takes a different take on the entropy increase of the universe . Instead of purely statistical explanations, this paper tries to explore how entropy and the formation of macro bodies might emerge from velocity dynamics of particles.

It's not a finished or polished work; rather, it's something I've developed independently as a young learner trying to explore big questions like entropy, energy behavior in isolated systems, and much more.

I'm not claiming this to be a complete or flawless theory. It's more like an open book, a step in my learning process, filled with original ideas, some rough edges, and a lot of curiosity. I know there may be mistakes, and I fully welcome criticism that's part of the journey.

If you do find the time to read it, I would be sincerely grateful if you could go through the entire paper before forming a judgment. Even a short comment or suggestion would mean a lot to me, as your perspective as an expert could help shape how I grow in this field.

The main theory begins on ***page 24****, but I recommend reading the first 23 pages as well , they provide important context that will help connect the ideas later.*

What is Entropy ?

Entropy can be understood as a measure of disorder or randomness within a system. For example, if you take a handful of sand and throw it, the grains spread out randomly. Initially, the sand is more organised in your hand, but once thrown, it disperses and becomes more disordered. This spreading out of the sand signifies an increase in entropy, as the system moves from a state of lower disorder to one of greater randomness.

Everything us humans do leads to eventually an increase of entropy . From cooking a meal to bursting a firecracker to exploding the biggest atomic bomb. It can look like some forms of work are decreasing entropy like compression or crystallisation but in reality the amount of energy required and released during these processes leads to an overall increase of entropy.

If we consider the universe as an isolated system, every process within it contributes to an overall increase in entropy.

Stellar Processes: When stars undergo nuclear fusion, they convert hydrogen and other elements into heavier elements while releasing enormous amounts of energy as light and heat. This energy disperses throughout space, increasing the entropy of the universe by spreading out thermal energy and particles across vast regions.

Supernovae: When a massive star explodes in a supernova, it ejects its outer layers into space, creating a shockwave that scatters heavy elements and energy. This explosion significantly raises the disorder in the surrounding space as elements are dispersed across a broad area, contributing to the overall increase in entropy.

Cosmic Microwave Background (CMB): The CMB is the remnant radiation from the Big Bang, now stretched and cooled to just above absolute zero. As the universe has expanded, this radiation has become more uniform and spread out, reflecting an increase in entropy as the initial high-energy state of the universe has evolved into a more dispersed and disordered state.

Entropy in Cosmic Structures: Even on a smaller scale, the formation of structures like stars, planets, and black holes involves an increase in entropy. For example, the gravitational collapse that forms a star or a black hole results in a concentration of mass and energy, but it also leads to the release of energy in the form of radiation and accretion disks, which spreads energy and increases entropy in the surrounding space.

In all these examples, while local systems might experience moments of increased order (like the formation of a star or planet), the overall effect on the universe is an increase in entropy as energy and matter become more spread out and disordered.

Second Law of Thermodynamics: It states that in an isolated system, entropy either always increases or remains constant, but it never decreases.

The second law was initially explored by French physicist Sadi Carnot in 1824 through his studies on heat engines. It was further developed by German physicist Rudolf Clausius, who introduced the concept of entropy, and Scottish physicist William Thomson (Lord Kelvin), who highlighted the limitations of energy conversions. Their combined work in the mid-19th century formalised the principles of the second law of thermodynamics.

$P1$. Increasing Entropy and constant Entropy :

Let’s try to explore when entropy is increasing and when it stays constant in an Isolated system. Before understanding in which type of isolated system entropy stays still and in which type it always increases we have to understand the concept of Time Systems.
[if you have read the concept of time systems earlier in my “X.Time” paper you can directly move to page : 15]

Time Systems :

Time systems are basically different types of isolated systems. Time Systems can be classified based on the energy content and the motion of those energy content inside the system.

a. Zero Time System : This is an isolated system where inside the system no energy exists.

Entropy inside this system :

$S = k.ln(W)$ = $k.ln(1)$ = 0 [since only one microstate]

b. Pseudo Zero Time system with infinite and finite energy : Consider an isolated system comprising three bodies, each devoid of kinetic energy and therefore at a complete standstill, never engaging in any movement or interaction with one another. Remarkably, these bodies possess unique hypothetical properties, remaining immune to decay unlike conventional entities in our universe, which typically succumb to decay either through entropy increase or interaction with other entities. Given their perpetual state of non-interaction, they are shielded from decay caused by external forces. Furthermore, their distinctive hypothetical composition resists decay induced by entropy. As the sole constituents of the system, their presence halts the progression of entropy within this closed environment. Additionally, lacking kinetic energy, they are indefinitely anchored in their respective positions within space.

Finite Energy Case:

- The bodies are stationary, non-interacting, and immune to decay.
- Since they do not change position, interact, or decay, there is only one possible arrangement (microstate).

Infinite Energy Case:

- The bodies are stationary, non-interacting, and immune to decay.
- Similar to the finite energy case, they remain in fixed positions without changing states, leading to only one possible arrangement (microstate).

So , In both cases, the system has only one microstate

So for both cases : $S = k.ln(W)$ = $k.ln(1)$ = 0

C. Time systems with finite energy :

Suppose there are p numbers of body in an isolated system and each has a finite mass .

So net mass in the system : M = $\int_0^p m$ = $\int_0^p m$ = mp

Now think of a situation where in the system the temperature increases from T1 to T2 . at T1 temperature all the bodies concentrated into a small space suppose $1\ mm^3$ and T2 temperature the bodies expands and take a space of $1\ km^3$. In which case the entropy will be higher?
These bodies are not fixed in a certain position in space so they don't lack KE.

Let's illustrate the point using simple statistical argument :

In Scenario 1, when the particles are confined to a small volume, there are relatively few ways the particles can be arranged due to the limited space available. Let's denote this number of configurations as $C1$.

In Scenario 2, with the same number of particles occupying a much larger volume, the number of possible configurations increases significantly. Let's denote this number of configurations as
$C2$, and it's expected to be much larger than $C1$.

Since entropy is related to the natural logarithm of the number of configurations $S = k.\ln(W)$, and assuming the number of particles (p) remains constant in both scenarios, the entropy difference between the two scenarios can be expressed as:

$$\Delta S \;=\; k.\,ln(C2) - k.\,ln(C1) = k.\,ln(\frac{C2}{C1})$$

Since , $C2$ >> $C1$

So, ΔS $=$ (+)ve .

(we have to remember no constraints exists in this isolated system so theoretically it's infinitely large)

d. Time systems with infinite energy :

Suppose there are p numbers of body in an isolated system and each has an infinite mass .

So net mass in the system : M = $\int_0^p m$ = $\int_0^p \infty$ = ∞

So basically an infinite amount of energy exists in the system.

Now think of a situation where all the bodies in the system concentrated into a small space suppose $1\ mm^3$ and another situation the bodies expands and take a space of $1\ km^3$. In which case the entropy will be higher?

These bodies are not fixed in a certain position in space so they don't lack KE.

Let's illustrate the point using simple statistical argument :

In Scenario 1, when the particles are confined to a small volume, there are relatively few ways the particles can be arranged due to the limited space available. Let's denote this number of configurations as $C1$.

In Scenario 2, with the same number of particles occupying a much larger volume, the number of possible configurations increases significantly. Let's denote this number of configurations as
$C2$, and it's expected to be much larger than $C1$.

Since entropy is related to the natural logarithm of the number of configurations $S = k.\ln(W)$, and assuming the number of particles (p) remains constant in both scenarios, the entropy difference between the two scenarios can be expressed as:

$$\Delta S \ = \ k.\,ln(C2) - k.\,ln(C1) = \ k.\,ln(\frac{C2}{C1})$$

Since , $C2$ >> $C1$

So, ΔS $=$ (+)ve .

(we have to remember no constraints exists in this isolated system so theoretically it's infinitely large)

e. Repetitive time systems with translational motion :

Suppose we have a cube of $1\,m^3$ (the cube is an isolated system) Inside the cube there are "n" numbers of bodies; each body has a different velocity but all of them have the same motion where they move from one side of the cube to another side in a linear shortest path.

If we consider that the size of the cube can not increase or it will always stay as $1\,m^3$ volume ,also these bodies also don't decay with time and don't show any type of random motion.

Entropy Consideration

Entropy is a measure of the number of possible microstates consistent with the macroscopic state of the system and is also associated with the level of disorder or randomness in the system.

Given the characteristics of the system:

1.Isolated System: The cube does not exchange energy or matter with its surroundings.

2.Fixed Volume: The volume of the cube is constant at 1 m^3.

3.Non-decaying Bodies: The bodies do not decay over time.

4.Deterministic Motion: Each body moves in a predictable, linear path without any random behaviour.

Since the bodies follow deterministic, non-random paths, the system's behaviour remains highly ordered. There is no increase in disorder over time, as each body follows a predictable trajectory from one side of the cube to the other.

In such a highly ordered system with deterministic motion, the number of possible microstates (W) is fixed.

$$S = k.\ln(W)$$

Since W = constant ; S = constant

The entropy of this system remains constant over time. The deterministic, non-random motion of the bodies ensures that there is no increase in disorder or the number of accessible microstates. Therefore, the entropy stands still.

f. Repetitive time systems with rotational motion :

Suppose an isolated system with fixed volume where there are “n” number of bodies all the bodies are stagnant in one place but they rotate around their own axis . Each of the bodies has a unique and different angular speed

Note : Size of the cube doesn’t increase and also the bodies do not decay with time.

Same as the last one,

Since the bodies follow deterministic, non-random paths, the system's behaviour remains highly ordered. There is no increase in disorder over time.

So , Entropy(S) will be constant.

g. Repetitive time systems with rotational and translational motion:

This is basically an isolated system with a fixed volume suppose $a\,m^3$ Inside the system there are “n” number of bodies each has a unique and different angular speed and unique different linear velocity. These bodies rotate around it’s own axis and also show a linear motion where they travel from one side of the system to another side in a shortest straight line path.

Note : Size of the cube doesn’t increase and also the bodies do not decay with time.

Entropy Calculation

The combination of deterministic rotational and translational motion results in a more complex system compared to one with only rotational or translational motion. However, since both types of motion are deterministic and non-random:

- The positions and orientations of the bodies can be predicted precisely at any given time.
- The overall behaviour remains ordered due to the lack of random motion or interactions.

The number of possible microstates (W) for this system is still fixed because the motion, though complex, is predictable and non-random

$S = k.\ln(W)$

Since W = constant ; S = constant

h. time systems with random motion:

Suppose there is an isolated cubic system of $a\,m^3$, $(a \neq \infty)$ in the system there are "n" number of bodies. Those bodies instead of following a fixed linear or circular motion , have a complete random motion just like brownian motion.

We know there are a lot of collisions happen between bodies with other bodies in this type of system.
(Note : theses bodies don't decay nor the volume of the system increases)

Assumptions and Definitions

1. **System**: Isolated cubic system has a constant volume
2. **Bodies**: n bodies undergoing random motion with collisions.
3. **Non-decaying**: The bodies do not decay or lose energy.
4. **Equilibrium**: The system eventually reaches a state of thermodynamic equilibrium.

Initial State: At the initial state, if the bodies are not moving or are moving in a highly ordered manner, the number of microstates $W_{initial}$ is relatively low.

Random Motion and Collisions:

- When the bodies start to move randomly and collide, they explore a larger number of possible configurations.
- For a system in equilibrium, the number of microstates $W_{equilibrium}$ is maximised. The system explores all possible configurations given its constraints.

Maximisation of Entropy:

- In equilibrium, the entropy ($S_{equilibrium}$) is maximised because the system has had enough time to explore all accessible microstates.
- The number of microstates $W_{equilibrium}$ is large, and thus, the entropy reaches its maximum value ($S_{equilibrium}$).

Since $W_{equilibrium}$ is the maximum number of microstates the system can have due to its constraints , $W_{equilibrium}$ = constant .

$S_{equilibrium} = k.\ln(W_{equilibrium}) = \text{constant}$.

i. time systems with random motion and real Bodies :

Suppose there is an isolated cubic system of $a\,m^3$, $(a \neq \infty)$ in the system there are "n" number of bodies. Those bodies have a complete random motion just like brownian motion.

In this system though the volume of the system can't increase but the bodies are just like real life bodies we have they are breakable and can decay with time.

Assumptions and Definitions

1. **System**: Isolated cubic system with constant volume.
2. **Bodies**: n bodies undergoing random motion and capable of decay.
3. **Volume**: The volume of the cube remains constant.
4. **Decay**: The bodies can decay over time, potentially leading to breakdown into smaller particles or other forms.

Analysis of Entropy Behavior

1. **Initial State**:
    - If the bodies initially have low entropy due to ordered or specific configurations, as they start moving randomly and decaying, the system explores a larger number of microstates.
    - The initial entropy will be relatively low.
2. **Random Motion and Decay**:
    - Random Motion: The bodies' random motion increases the number of accessible microstates because the system's configuration becomes more varied.
    - Decay: As bodies decay, they may break into smaller fragments, increasing the number of microstates even further. Each decay event introduces additional possible states for the system.
3. **Entropy Increase**:
    - As the bodies continue to decay and move randomly, the entropy of the system increases. This is because more microstates become available as the system evolves and the bodies break down into more elementary components.
4. **Reaching a Stable State**:
    - Final Decay: Once the bodies have decayed to a point where they cannot decay further (e.g., they reach a stable form or state of maximum disorder), the system reaches a final equilibrium state.
    - Constant Entropy: After reaching this stable state, the entropy becomes constant. The system will have maximised the number of microstates possible given the constraints of volume and the final configurations of the bodies.

Mathematical Insight

- **Microstates Calculation**: The number of microstates W increases as the bodies decay and move randomly. At equilibrium, this number is maximised for the given constraints.
- **Entropy at Equilibrium**: Once the system reaches a state where decay is no longer occurring and the bodies have reached a final stable configuration, the entropy is given by:

$$S_{equilibrium} = k.\ln(W_{equilibrium})$$

Since , $W_{equilibrium}$ = constant ; $S_{equilibrium}$ = constant.

j. time systems with random motion and infinite decaying bodies :

Consider an isolated cubic system with a fixed volume of V = $a\,m^3$, $(a \neq \infty)$ Inside this cubic system, there are n hypothetical bodies exhibiting random motion similar to Brownian motion. These bodies have the unique hypothetical property of being able to decay indefinitely, meaning they continually break down into smaller and smaller components without reaching a final, stable form.

Note : Size of the cube doesn't increase.

Behaviour of Microstates: In this system, the bodies exhibit random motion and can decay indefinitely. As a result:

- **Random Motion**: The random motion of the bodies increases the number of possible configurations, thus increasing W.
- **Infinite Decay**: As the bodies continually decay into smaller fragments, the number of possible microstates (W) keeps increasing over time and never reaches a final form.

The decay process generates an ever-expanding range of configurations as the bodies break down into more and more numerous and varied smaller components.

Mathematical Description: Given that the decay process is infinite and continuous, the number of microstates W(t) as a function of time t grows without bound. The entropy at time t is:

$$S(\mathrm{t}) = k.\ln(W(\mathrm{t}))$$

where $W(\mathrm{t})$ represents the number of microstates at time t. As t increases, $W(\mathrm{t})$ increases indefinitely due to ongoing decay, leading to a continuous increase in entropy.

Entropy Growth:
Since there is no upper limit to the decay process, $W(\mathrm{t})$ increases without bound, resulting in :

$$\lim_{t \to \infty} S(\mathrm{t}) = \lim_{t \to \infty} k.\ln(W(\mathrm{t})) = \infty$$

This indicates that the entropy of the system will keep increasing indefinitely and the entropy in this system will always increase.

From the above illustrations we can see there are only three possible cases where the entropy is always increasing in the isolated system, those were:

i. Time systems with finite energy.

ii. Time systems with infinite energy.

Iii. Time systems with random motion and infinite decaying bodies.

From these three cases we can conclude that for entropy to always increase in an isolated system either,

• *We need an isolated system where no constraints exists and which is infinitely large, or*

•*The bodies need to decay indefinitely without reaching a final form for an infinite amount of time.*

In all the other cases entropy is either always constant in the system or becomes constant after reaching a certain time.

$P2.$ Interaction of Energies :

a. Energy content of the Universe :

In our universe, energy and matter exist in various forms, each contributing to the structure and behaviour of the cosmos. The energy content of the universe can be broadly divided into ordinary matter, dark matter, and dark energy.

Ordinary matter constitutes about 5% of the universe and includes the particles that form everything we observe, such as stars, planets, and galaxies. This matter is categorised into three main types: quarks, leptons, and bosons. Quarks are tiny particles that combine to form protons and neutrons, the core components of atoms. There are six types of quarks (up, down, charm, strange, top, and bottom), each with its unique properties. Each quark also has a corresponding antiquark with the same mass but opposite charge. Leptons include particles like electrons, which orbit the nucleus of an atom, and neutrinos, which are extremely light and interact very weakly with other matter. There are six leptons (electron, muon, tau, and their associated neutrinos), and each lepton has an antilepton counterpart, with the electron's antiparticle being the positron. Bosons are particles that mediate forces, such as the photon, which is responsible for light and electromagnetic forces, and the gluon, which holds quarks together inside protons and neutrons. The Higgs boson is another important particle, as it gives mass to other particles. Unlike quarks and leptons, bosons can be their own antiparticles, except for the W and Z bosons, which also have antiparticle counterparts.

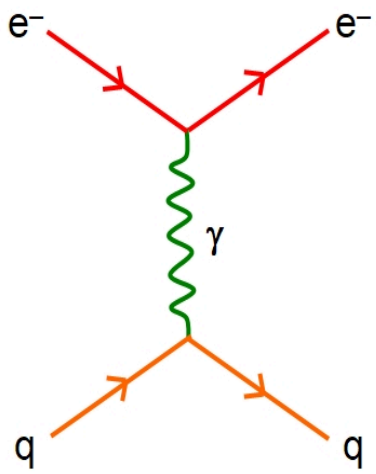
Beyond ordinary matter, most of the universe's energy exists in forms that are not directly visible. Dark matter accounts for about 27% of the universe and, while invisible, exerts a strong gravitational pull that helps shape galaxies. Scientists have proposed various particles, such as WIMPs (Weakly Interacting Massive Particles), as candidates for dark matter, but none have been confirmed yet. Dark matter does not have a known antiparticle, as it is not yet fully understood.The largest portion of the universe's energy, about 68%, is composed of dark energy. This mysterious force is believed to drive the accelerated expansion of the universe.

b.Interaction of energy particles :

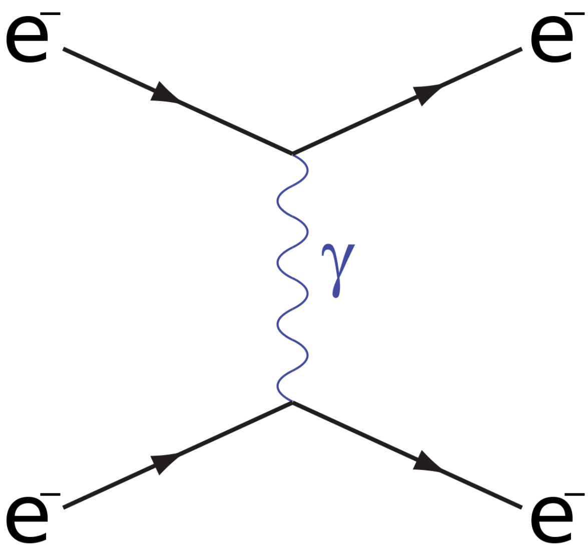
The best way to show the interaction between energy particles are with the help of Feynman diagrams. Feynman diagrams are widely regarded as one of the most effective ways to depict interactions between energy particles such as quarks, leptons, and bosons. Developed by physicist Richard Feynman in the 1940s, these diagrams provide a visual representation of particle interactions that simplifies complex quantum processes. In a Feynman diagram, particles are represented as lines, with their interactions shown as vertices where these lines meet. The diagrams capture the exchange of force-carrier particles, such as photons or gluons, which mediate the fundamental forces between particles.

Few Feynman diagrams are :

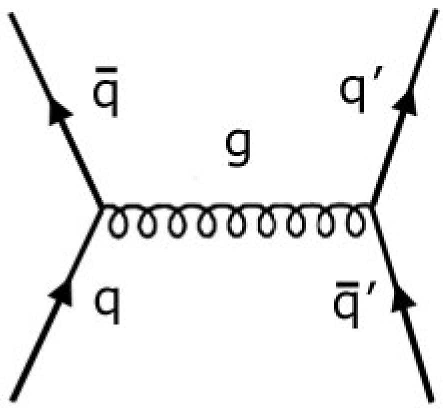
Electron-Quark Photon Exchange: This diagram represents the interaction between an electron and a quark through the exchange of a photon. In this process, the electron and quark interact electromagnetically, with the photon acting as the mediator of this force. This interaction is a key component of Quantum Electrodynamics (QED), which describes the electromagnetic force between charged particles. The diagram shows an electron and a quark exchanging a photon, illustrating the fundamental nature of electromagnetic interactions at the quantum level.



Electron-Electron Photon Exchange: This diagram illustrates the electromagnetic interaction between two electrons, mediated by a photon. This process is an example of electron-electron scattering, where the photons exchanged between the electrons represent the electromagnetic force. This type of interaction is described by QED and is crucial for understanding phenomena such as Coulomb repulsion between like-charged particles. The Feynman diagram for this process helps visualise how the photons are exchanged and how they influence the behaviour of the electrons.

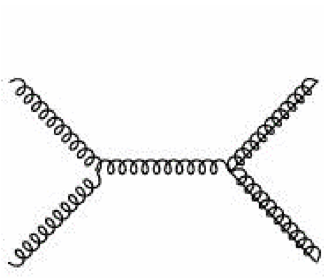


Quark-Quark Gluon Exchange: In this diagram, two quarks interact via the exchange of a gluon. Gluons are the mediators of the strong force, which holds quarks together within protons, neutrons, and other hadrons. This diagram illustrates how quarks exchange gluons, leading to the binding of quarks within a hadron. The



gluon exchange depicted in this diagram is fundamental to Quantum Chromodynamics (QCD), the theory that describes the strong force and the interactions between quarks and gluons.

Gluon-Gluon Gluon Exchange: This diagram represents the interaction between two gluons, mediated by a third gluon. Unlike photons, gluons themselves carry a strong force, resulting in self-interactions. This type of interaction is an essential aspect of QCD, demonstrating the complex nature of the strong force and the role of gluons in binding quarks together. The Feynman diagram shows how gluons can interact with each other, highlighting the intricacies of the strong force and the dynamics of gluon exchanges.



If you observe closely you can see in all of the Feynman Diagrams there is one thing common . Let’s try to see together what that thing is .

Suppose you have two energy particles with mass (quark , electron) , suppose they interact / collide elastically .

Suppose before interaction they had a mass of $m1$ and $m2$ and after interaction $m3$ and $m4$.
Before interaction their velocities are $u1$ and $u2$ after $v1$ and $v2$.

According to law of momentum conservation :

$$m1u1 + m2u2 = m3v1 + m4v2$$

According to law of energy conservation :

$$\frac{1}{2}m_1u_1^{\ 2} + \frac{1}{2}m_2u_2^{\ 2} = \frac{1}{2}m_3v_1^{\ 2} + \frac{1}{2}m_4v_2^{\ 2}$$

Since it was an elastic collision / interaction :

$$m1u1 \ + \ m2u2 \ = \ m1v1 \ + \ m2v2$$

$$m1v1 \ = \ m1u1 \ + \ m2u2 \ - \ m2v2$$

$$v1 \ = \ \frac{m1u1 + m2u2 \ - m2v2}{m1}$$

$$v_1 \ = \ u1 \ + \ \frac{m2}{m1}(u2 \ - \ v2)$$

Again :

$$\frac{1}{2}m_1u_1^{\ 2} + \ \frac{1}{2}m_2u_2^{\ 2} \ = \ \frac{1}{2}m_1v_1^{\ 2} \ + \ \frac{1}{2}m_2v_2^{\ 2}$$

$$m_1u_1^{\ 2} + \ m_2u_2^{\ 2} \ = \ m_1v_1^{\ 2} \ + \ m_2v_2^{\ 2}$$

$$m_1u_1^{\ 2} + \ m_2u_2^{\ 2} \ = \ m_1\,[u1 \ + \ \frac{m2}{m1}(u2 \ - \ v2) \ ]^2 \ + \ m_2v_2^{\ 2}$$

$$m_2v_2^{\ 2} \ = \ m_1u_1^{\ 2} + \ m_2u_2^{\ 2} \ - \ m_1\,[u1 \ + \ \frac{m2}{m1}(u2 \ - \ v2) \ ]^2$$

$$v_2^{\ 2} \ = \ \frac{m_1u_1^{\ 2} + m_2u_2^{\ 2} \ - \ m_1\,[u1 \ + \frac{m2}{m1}(u2 - v2) \ ]^2}{m_2}$$

$$v_2^{\ 2} \ = \ u_2^{\ 2} \ + \frac{m_1}{m_2}\,[u_1^{\ 2} \ - \ v_1^{\ 2}]$$

$$v_2 \ = \ \Big[\ u_2^{\ 2} \ + \frac{m_1}{m_2}\,[(u_1 \ + \ v_1)(\ u_1 \ - \ v_1) \ ] \ \Big]^{\frac{1}{2}}$$

From this small illustration, we can observe that after the interaction, the energy particles acquire different velocities. Therefore, rather than moving together along the same path as a single entity, they will travel separately along their own independent paths as two distinct entities.

Let’s take another scenario : Suppose we have two massless energy particles (photons) interact / collide , Suppose initially both the photons moving in opposite direction to each other along “X” axis , their initial momenta are

$$p_1 = (p_x, 0)$$

$$p_2 = (-p_x, 0)$$

Total initial momenta : $p_i = (-p_x, 0) + (p_x, 0) = (0, 0)$

Suppose their final momenta are ,

$$p_1' = (p_x', \theta_1)$$

$$p_2' = (p_x'', \theta_2)$$

Total final momenta :

$$p_f = (p_x' cos\theta_1, \ p_x' sin\theta_1) + (p_x'' cos\theta_2, \ p_x'' sin\theta_2)$$
$$= (p_x' cos\theta_1 + p_x'' cos\theta_2), (p_x' sin\theta_1 + p_x'' sin\theta_2)$$

According to law of momentum conservation :

$$(p_x' cos\theta_1 + p_x'' cos\theta_2), (p_x' sin\theta_1 + p_x'' sin\theta_2) = (0, 0)$$

So in the “x” direction : $p_x' cos\theta_1 + p_x'' cos\theta_2 = 0$

So in the “y” direction : $p_x' sin\theta_1 + p_x'' sin\theta_2 = 0$

Suppose , $p_x' = p_x'' = p_x$

So in the “x” direction : $p_x cos\theta_1 + p_x cos\theta_2 = 0$

$$cos\theta_1 = -cos\theta_2$$

$$\theta_1 = -\theta_2$$

So in the “x” direction : $p_x sin\theta_1 + p_x sin\theta_2 = 0$

$$sin\theta_1 = -sin\theta_2$$

$$\theta_1 = -\theta_2$$

So, This means the final photons are scattered in opposite directions relative to their initial directions.

So we can also say that from this illustration we can see that after the interaction between two massless particles they scatter at different directions as separate entities instead of staying and moving together as a one single entity.

Based on Feynman diagrams and the mathematical analysis, we can conclude that, typically, after the interaction of two or more energy particles, each one of them behave as distinct entities and follow separate trajectories in spacetime. Rather than merging and acting as a single unit, these particles scatter in different directions, adhering to the principles of momentum and energy conservation. This separation underscores the fundamental nature of such interactions, where particles continue on individual paths rather than combining into one.

While it is common for particles to scatter and follow separate paths after interaction, there are scenarios where particles can merge to form a larger unit. This occurs in processes such as nuclear fusion or the formation of bound states like hadrons. However, these merging events are significantly less frequent compared to scattering interactions. The likelihood of particles combining into a new entity is much lower than their tendency to separate and follow distinct trajectories.

$P3$. Existing reasons of Entropy Increase:

As we have talked earlier In our universe, entropy, a measure of disorder and randomness, always tends to increase over time. This inherent tendency drives the transformation of ordered systems into more chaotic states. For instance, when sand is thrown, it disperses from a concentrated heap into a more disordered spread. This analogy reflects the broader principle that natural processes, from the cosmic scale to the microscopic, are guided by the second law of thermodynamics, leading to a continual increase in entropy as systems evolve towards greater disorder.

Let's explore some of the existing reasons of increase of Entropy :

1. Probabilistic Behaviour of Particles

- **Statistical Mechanics:** Systems tend to evolve towards the most probable configurations, which are those with higher entropy. This is because there are more microstates corresponding to disordered configurations than to ordered ones.

2. Second Law of Thermodynamics

- **Fundamental Law:** The Second Law of Thermodynamics states that in an isolated system, entropy either increases or remains constant over time. This law is a cornerstone of thermodynamics and applies universally, meaning that the overall entropy of the universe must increase.

3. Expansion of the Universe

- **Cosmic Expansion:** As the universe expands, energy spreads out over an increasing volume, leading to a higher level of disorder. The expansion itself contributes to an increase in entropy because it dilutes energy and matter across a larger space.

4. Irreversible Processes

- **Thermodynamic Irreversibility:** Most natural processes, such as heat transfer, chemical reactions, and mixing of substances, are irreversible and lead to an increase in entropy. For example, heat flows from hot to cold objects, and this process increases the entropy of the system.

5. Energy Dissipation

- **Dissipative Systems:** Whenever energy is transformed from one form to another (e.g., mechanical work to heat), some of it is irreversibly lost as heat, which disperses into the surroundings, increasing the overall entropy.

6. Time's Arrow

- **Direction of Time:** Entropy gives time a direction, known as the "arrow of time." As time progresses, entropy increases, marking a clear distinction between the past (lower entropy) and the future (higher entropy).

7. Thermal Equilibrium

- **Equilibrium States:** Systems naturally evolve toward thermal equilibrium, where temperatures become uniform. In reaching this equilibrium, the entropy of the system increases as energy is more evenly distributed.

8. Gravitational Collapse

- **Star and Black Hole Formation:** The collapse of gas clouds to form stars and the formation of black holes are processes that lead to significant increases in entropy. While these processes might seem to create order, they result in the release of vast amounts of energy, increasing the entropy of the surrounding environment.

9. Quantum Effects

- **Quantum Entanglement:** Quantum mechanics suggests that entropy increases as quantum systems become more entangled over time. As particles interact, they become entangled, leading to a more complex system with higher entropy.

10. Cosmic Microwave Background Radiation (CMB)

- **CMB as Evidence:** The uniform distribution of the CMB across the universe is evidence of an increase in entropy since the Big Bang. The CMB represents the "cooling down" of the universe, a process that increases the entropy of the universe as energy becomes more evenly spread out.

11. Hawking Radiation

- **Black Hole Entropy:** According to Stephen Hawking's theory, black holes emit radiation (Hawking radiation) and gradually lose mass, increasing the entropy of the universe. The eventual evaporation of black holes would contribute significantly to the universe's entropy.

12. Cosmological Events

- **Supernovae and Galaxy Formation:** Events like supernova explosions and the formation of galaxies involve the redistribution of matter and energy, which contributes to an increase in entropy on a cosmic scale.

13. Entropy and Information Theory

- **Information Loss:** In the context of black holes and the universe's expansion, information loss can be linked to entropy. As information about the state of particles becomes more inaccessible (e.g., in a black hole), entropy increases.

14. Increase in Disorder over Time

- **Natural Tendency:** Over time, any system left to itself tends to move from ordered to disordered states. This is a fundamental principle underlying the increase in entropy in any system, including the universe.

15. Particle Decay and Reactions

- **Subatomic Processes:** The decay of particles and the subsequent release of energy in various forms (like radiation) contribute to the increase in entropy. Reactions at the atomic and subatomic levels are generally accompanied by an increase in entropy.

16. Entropy in Biological Systems

- **Life Processes:** While living organisms locally decrease entropy by creating order, the energy they use for these processes is taken from their environment, leading to an overall increase in entropy in the universe.

These points approximately summarise most of the key reasons for the continual increase in entropy in our universe as understood by humanity till date. The interplay of these factors defines the thermodynamic evolution of the universe.

1. Radial Dispersion Theory :

• *Basics illustrations :*

Illustration 1 *: suppose we have an isolated cubic system of V m^3 inside the cube there is one ball (It's a special hypothetical ball which doesn't decay due to interaction or any other means as we talked earlier in time systems) the ball has a constant velocity of $v\, ms^{-1}$ let's calculate how much times the ball will interact with the wall or bump into the walls of the cubic system in $t\ sec$.*
(the ball has a random motion inside the system so we can only calculate the average value)

Consider, The volume of the cube is : $V = L^3$

First we have to consider the **mean free path** (λ)

The **mean free path** (λ) is defined as the average distance the ball travels before colliding with a wall of the cube. In general, this can be a function of the cube's side length L , expressed as $f(L)$

So, $\lambda = f(L)$

Now, let's calculate the average time (τ) between two collisions between ball and wall,

$$\tau = \frac{\lambda}{v} = \frac{f(L)}{v}$$

So, average number (N) of collisions in $t\ sec$ between ball and wall ,

$$N = \frac{t}{\tau} = \frac{vt}{f(L)}$$

From this we can have a average value that how many times the ball will collide or interact with the wall of the cubic system in a fraction of $t\ seconds$.

***Illustration 2** : suppose we have an isolated cubic system of V m^3 inside the cube there are two balls (these are the same hypothetical balls as earlier which doesn't decay due to interaction or any other means) the balls has a constant velocity of $v1\ ms^{-1}$ and $v2\ ms^{-1}$.*
.Inside the isolated system both the balls show completely random motion , they are interacting and colliding with each other and with the walls of the cubic system.
let's calculate in $t\ sec$ how many times the balls are interacting or colliding with the walls of the system(including both the balls) .
(note : only measuring the collision between walls and balls)
(the ball has a random motion inside the system so we can only calculate the average value)

Consider, The volume of the cube is : $V = L^3$

Considering **mean free path** (λ) , In this system, the **mean free path** λ specifically denotes the average distance that a ball travels before it collides with one of the walls of the cube. It does **not** refer to:

- The distance between two ball-to-ball collisions.
- The distance between one ball to wall and one ball to ball collision.

Consider : $\lambda = f'(L)$

Let's calculate Average Time (τ) Between Collisions for Each Ball, For each ball, the time between collisions with the walls is determined by the mean free path and the ball's velocity:

$$\tau_1 = \frac{f'(L)}{v_1} \qquad \tau_2 = \frac{f'(L)}{v_2}$$

The average number (N) of collisions each ball makes with the walls in time t sec is :

$$N_1 = \frac{t}{\tau_1} = \frac{v_1 t}{f'(L)} \qquad N_2 = \frac{t}{\tau_2} = \frac{v_2 t}{f'(L)}$$

The total number of collisions (N_{net}) between the balls and the walls in a time t seconds is equal to the sum of the collisions made by each ball individually with the walls:

$$N_{net} = N_1 + N_2 = \frac{v_1 t}{f'(L)} + \frac{v_2 t}{f'(L)} = \frac{t\,(v_1+v_2)}{f'(L)}$$

Illustration 3 *: suppose we have an isolated cubic system of V m^3 inside the cube there are n number of balls (these are the same hypothetical balls as earlier which doesn't decay due to interaction or any other means) the balls has a constant velocity of $v1$, $v2$, $v3$, $v4$,.... $vn\ ms^{-1}$ .Inside the isolated system all the balls show completely random motion , they are interacting and colliding with each other and with the walls of the cubic system.*
let's calculate in $t\ sec$ how many times the balls are interacting or colliding with the walls of the system(including all the balls) .
(note : only measuring the collision between walls and balls)
(the ball has a random motion inside the system so we can only calculate the average value)

Consider, The volume of the cube is : $V = L^3$

In this case , There are n balls in the system.

- Each ball i (where i = 1,2,...,n) has a constant velocity v_i metres per second.

Consider : $\lambda = f''(L)$

Calculate the average time between two ball to wall collisions for i th ball :

$$\tau_i = \frac{f''(L)}{v_i}$$

So, the number of collisions ball i will make with the walls in time $t\ sec$ is:

$$N_i = \frac{t}{\tau_i} = \frac{v_i t}{f''(L)}$$

So, total number of collisions (N_{net}) made by all n balls with the walls in a time $t\ sec$ is the sum of the collisions made by each ball :

$$N_{net} = \sum_{i=1}^{n} N_i = \sum_{i=1}^{n} \frac{v_i t}{f''(L)} = \frac{t}{f''(L)} \sum_{i=1}^{n} v_i$$

This gives us the number of times the balls will hit the walls of the isolated system in a fraction of time.

Conclusion : In the illustrations we've worked through, we found that in every isolated cubic system with a finite volume, the balls inside will always collide with the walls a certain number of times during a finite time period. Whether we looked at one ball or several moving at different speeds, the outcome was the same.

It happens because the system has fixed boundaries and the balls are continuously moving in a linear manner. No matter how many balls there are or how fast they're going, they can't avoid the walls. So, in any isolated system with a fixed size, the objects inside will definitely collide with the walls a certain number of times as long as they keep moving in a linear way .

This principle holds true as long as the system remains isolated and the objects continue in their straight-line motion.

• *Motion of energy particles :*

1. Scattering process

$$A + B \to A' + B'$$

It describes how particles change direction and energy upon interaction. For instance, in an electron-quark scattering event, an electron interacts with a quark , altering their trajectories and energies.

In an isolated system composed solely of quarks, leptons, and bosons in their particulate forms, the motion of these particles can be effectively approximated as linear segments between interactions. Each particle travels in a straight line until it encounters another particle, at which point their velocities and trajectories are altered due to collisions. These interactions are discrete events governed by the principles of momentum and energy conservation.

Although particles move at high speeds and experience frequent collisions, resulting in complex and seemingly random overall trajectories, the motion between individual collisions remains linear. This linear approximation is valid because the system is isolated with no external fields influencing the particles, allowing us to focus purely on the particle-particle interactions.

Suppose, v_0 represents the velocity of an energy particle immediately after a collision or interaction with another energy particle in the isolated system.

Since it is an isolated system so no external force acts on the energy particle after the collision.

$$F = ma = 0 \implies a = 0$$

Since no external acceleration so the velocity of the energy particle will be constant till the next interaction.

$$v_0 = \text{constant}$$

For massless particles, suppose a photon, the velocity always remains constant even after interaction with another energy particle. May their direction of motion change but the velocity never changes .

$$v_{photon} = c = \text{constant}$$

Since between two interactions or collisions neither the magnitude nor the direction of the velocity changes so the energy particle will show a linear motion between interactions .

2. Particle Transformation :

$$A + B \rightarrow C + D$$

It involves one type of particle changing into different particles through interactions . For example, a down quark within a neutron interacts with the W boson. This interaction causes the down quark to transform into an up quark. As a result, the neutron changes into a proton, and the process emits an electron and an antineutrino.

$$d + W^- \rightarrow u + e^- + \bar{\nu}_e$$

For a particle i with mass m_i and velocity v_i

$F_i = m_i a_i = 0 \Rightarrow a_i = dv_i/dt = 0 \Rightarrow v_i = constant$ (since no external force)

Suppose each particle after interaction has a velocity of

v_{i_1} , v_{i_2} , v_{i_3}

So, $v_{i_1} = v_{i_2} = v_{i_3} = constant$

Since the magnitude and the direction of velocity is constant for all three of them, so all three of them will move in a straight line before each of them has a next interaction separately .

3. Particle Creation :

$$A \rightarrow B + C$$

Particle creation involves the generation of new particles from existing ones through interactions. A notable example is pair production, where a photon with sufficient energy interacts with the electromagnetic field to create an electron-positron pair.

$$\gamma + field \rightarrow e\text{-} + e\text{+}$$

For a particle i with mass m_i and velocity v_i

$F_i = m_i a_i = 0 \Rightarrow a_i = dv_i/dt = 0 \Rightarrow v_i = constant$ (since no external force)

Suppose each particle after interaction has a velocity of

v_{i_1} , v_{i_2}

So, $v_{i_1} = v_{i_2} = constant$

Since the magnitude and the direction of velocity is constant for both of them, so both of them will move in a straight line before each of them has a next interaction separately .

4. Particle Merging :

$$A \quad + \quad B \quad \rightarrow \quad C$$

Particle merging involves two or more particles combining to form a new particle or a set of particles through interactions. For example, in positron-electron annihilation, a positron and an electron collide and annihilate each other, resulting in the creation of photons.

$$e^- \; + \; e^+ \; \rightarrow \quad \gamma \; + \; \gamma$$

The velocity of photons is always constant : c

Since the magnitude and the direction of velocity is constant for both of them, so both of them will move in a straight line before each of them has a next interaction separately .

So, In exploring the interactions between energy particles, we encounter several distinct types, such as scattering, particle merging, and particle creation. Despite the variety in these interactions, a fundamental characteristic remains consistent: particles always travel in straight lines between interactions.

During these interactions, particles may experience changes in their direction, velocity, or even undergo transformation into different types of particles. For example, in scattering events, particles might change direction or speed due to collisions. In particle merging, particles combine to form new particles, while in particle creation, energy transforms into particle-antiparticle pairs.

However, regardless of the type of interaction, the key commonality is that in the absence of external forces, each particle maintains a straight-line trajectory with a constant velocity between interactions.

So, particles continue in their linear path until acted upon by an external force or until it interacts with another particle or field.

- ***Main Theory :***

Suppose we consider a cubic isolated system with a finite side length of "L" metres. Inside this system, several types of energy particles, including quarks, leptons, and bosons, exist in their particulate form. These particles are not only interacting with each other but also with the walls of the system. Due to the high-energy nature of these particles, they are moving at immense speeds, constantly colliding and exchanging momentum within the confined space. The interactions between the particles are governed by fundamental forces, such as the strong force acting between quarks or the weak force affecting leptons. Meanwhile, bosons, the force carriers, facilitate these interactions. The particles' motion is dynamic, and as they travel within the system, they continuously transfer energy during each interaction or collision, contributing to the overall behaviour of the system. The finite boundaries of the cubic system further constrain the particles, forcing them to reflect off the walls, adding another layer of complexity to their already chaotic motion. These walls, in turn, act as barriers that contain the energy particles, ensuring the system remains isolated, with no energy entering or escaping.

Since the particles only exist in particulate form so ,

So, total number of collisions (N_{net}) made by all n particles with the walls in a time $t\ sec$ is :

$$N_{net} = \sum_{i=1}^{n} N_i = \sum_{i=1}^{n} \frac{v_i t}{f''(L)} = \frac{t}{f''(L)} \sum_{i=1}^{n} v_i$$

Where $f''(L)$ represents the mean free path, and v_i is the velocity of $i\ th$ particle.

But , we know for most of the energy particles velocity is not constant; their velocity , momentum , energy can change after every interaction they had with other energy particles.

Only focusing of velocity,

Suppose a particle i of velocity v_{i_1} has a interaction with another particle and it's velocity becomes v_{i_2} after that it moves linearly with v_{i_2} velocity for few moment and had another interaction with another particle and it's velocity becomes v_{i_3}

so , average velocity of $i\,th$ particle is : $v_{i_{avg}} = \frac{v_{i_1} + v_{i_2} + v_{i_3}}{3}$

Now , suppose particle i undergoes φ_i interactions with other particles over a time t changing its velocity after each interaction. Let the velocities after each interaction be $v_{i_1}, v_{i_2}, v_{i_3}, \ldots\ldots v_{i_{\varphi_i}}$ . . The average velocity $v_{i_{avg}}$ of the particle during this period is:

$$v_{i_{avg}} = \frac{v_{i_1} + v_{i_2} + v_{i_3} + \ldots\ldots + v_{i_{\varphi_i}}}{\varphi_i} = \frac{1}{\varphi_i} \sum_{j=1}^{\varphi_i} v_{i_j}$$

So, total number of collisions (N_{net}) made by all n particles with the walls in a time $t\ sec$ is :

$$N_{net} = \frac{t}{f''(L)} \sum_{i=1}^{n} v_{i_{avg}} = \frac{t}{f''(L)} \sum_{i=1}^{n} \left(\frac{1}{\varphi_i} \sum_{j=1}^{\varphi_i} v_{i_j}\right)$$

In an isolated cubic system, particles such as quarks, leptons, and bosons move linearly between interactions with each other and the walls. Despite frequent changes in velocity due to collisions, the average velocity can be used to estimate the total number of collisions between the particles and the walls of the system N_{net} within a given time t.

Concept of : *Spherical Energy Flux*:

Suppose a three dimensional object emits three particle of velocity v_1, v_2, v_3 in different directions in three dimensional space so the average velocity of the three particles are (only consider the magnitude of the velocity not the direction)

$$v_{avg} = \frac{v_1 + v_2 + v_3}{3}$$

now suppose in t time n’ particles are emitting of velocity of $v_1, v_2, v_3, \dots v_{n'}$ in all direction in three dimensional space so the average velocity

$$v_{avg} = \frac{1}{n'} \sum_{i=1}^{n'} v_i$$

But , if we consider this formula for energy particles and in a real world scenario we know these energy particles can have interactions with many more energy particles and after each interaction its velocity can change .

$$v_{avg,total} = \frac{1}{n'} \sum_{i=1}^{n'} \frac{1}{\varphi_i} \sum_{j=1}^{\varphi_i} v_{i_j} \qquad \text{(according to the last part)}$$

In the case where energy particles are emitted from an object in all directions, the resulting distribution forms what is known as a flux. This flux describes the rate at which particles or energy disperse through space. Even if the emitter isn’t perfectly spherical, over time, the emission spreads uniformly due to the nature of three-dimensional space. Eventually, the particles flow outward in all directions, creating what can be referred to as a "spherical flux," where the distribution of particles becomes approximately radial and symmetric.

We can think the average velocity of the flux is $v_{avg,total}$

So net energy emitted by the body in t time is ,

Suppose net mass in form of energy particles emitted in time t is : m_{net}

$$E = (\gamma - 1)\ m_{net} c^2 + m_{net} c^2$$

$$= \gamma\ m_{net} c^2$$

$$= \frac{m_{net} c^2}{\sqrt{1 - \frac{v_{avg,total}^2}{C^2}}} = \frac{m_{net} c^2}{\sqrt{1 - \frac{\left(\frac{1}{n'} \sum_{i=1}^{n'} \frac{1}{\varphi_i} \sum_{j=1}^{\varphi_i} v_{i_j}\right)^2}{C^2}}}$$

$$= \frac{m_{net} c^2}{\sqrt{\frac{C^2 - \left(\frac{1}{n'} \sum_{i=1}^{n'} \frac{1}{\varphi_i} \sum_{j=1}^{\varphi_i} v_{i_j}\right)^2}{C^2}}}$$

Consider , $\left[C^2 - \left(\frac{1}{n'} \sum_{i=1}^{n'} \frac{1}{\varphi_i} \sum_{j=1}^{\varphi_i} v_{i_j}\right)^2\right] = \psi_c$

So, $E = \frac{m_{net} c^2}{\sqrt{\frac{\psi_c}{C^2}}} = \frac{m_{net} c^2}{\frac{\psi_c^{1/2}}{C}} = \frac{m_{net} c^3}{\psi_c^{1/2}}$

So, $E = = m_{net} c^3 \psi_c^{-1/2}$

Continuation of Main Theory :

Earlier we have considered, Suppose we consider a cubic isolated system with a finite side length of "L" metres. Inside this system, several types of energy particles, including quarks, leptons, and bosons, exist in their particulate form. These particles are not only interacting with each other but also with the walls of the system. Due to the high-energy nature of these particles, they are moving at immense speeds, constantly colliding and exchanging momentum within the confined space.The particles' motion is dynamic, and as they travel within the system, they continuously transfer energy during each interaction or collision, contributing to the overall behaviour of the system. The finite boundaries of the cubic system further constrain the particles, forcing them to reflect off the walls, adding another layer of complexity to their already chaotic motion. These walls, in turn, act as barriers that contain the energy particles, ensuring the system remains isolated, with no energy entering or escaping.

Earlier we have calculated ,

So, total number of collisions (N_{net}) made by all n particles with the walls of the isolated system in a time $t\ sec$ is :

$$N_{net} = \frac{t}{f''(L)} \sum_{i=1}^{n} \left(\frac{1}{\varphi_i} \sum_{j=1}^{\varphi_i} v_{i_j}\right)$$

But we know inside the system this scenario can rise , where one particle colliding with the wall multiple times in t time and another particle colliding null.

So, suppose we have to calculate in t time how many particles interact with the walls and not the total number of collisions of the particles with the wall. If a particle collides one or multiple times we have to take it as one particle.

We can also think a particle will only collide with the wall if its velocity has an outward component directed towards the wall while colliding. If its overall motion is inward or parallel to the wall, it won't collide. This outward-directed motion would typically occur after interactions or changes in velocity that redirect the particle towards the boundary of the system.

Let $P_{outward(i)}$ represent the probability that the $i\ th$ particle is moving in a direction that will cause it to collide with the wall. This probability depends on the direction of the particle's velocity relative to the walls at the time of colliding.

The total number of particles expected to collide with the walls (x_N) at a time t is given by , sum of $P_{outward(i)}$ over all the particles :

$$x_N = \int_0^t \sum_{i=1}^{n} P_{outward(i)} = \int_0^t \int_0^n P_{outward}$$

But if we give the system a lot of time suppose $t \rightarrow \infty$ then indeed at one point or another all the particles will have an outward velocity at the time of colliding .

We can think as the $P_{outward(i)}$ similar to binary system where if it has a overall outward direction while colliding with the wall and collides with the wall value of $P_{outward(i)}$ is 1 and if it doesn't have a outward direction and doesn't collide $P_{outward(i)}$ is 0.

So at, $t \rightarrow \infty$ value of $P_{outward(i)}$ for all n particles will be 1 .

$$\lim_{t \rightarrow \infty} x_N \approx n$$

So more the time flows value of $P_{outward(i)}$ will be 1 for more the particles.

$P_{outward}$ is a function of time , in this case more the time passes value of $P_{outward}$ gradually increases.

So in the isolated cubic system the energy particles are constantly interacting with each other which changes the velocity , direction , Energy and some other components of one particle many times in every fraction of second.

Also the particles are interacting / colliding with the wall of the isolated system.

Total number of particles expected to collide with the wall in t time is :

$$x_N = \int_0^t \sum_{i=1}^{n} P_{outward(i)} = \int_0^t \int_0^n P_{outward}$$

Now think of a scenario where, in an instant, the isolated cubic system with finite side length L, which had previously been containing quarks, leptons and bosons suddenly becomes an open system. All six constraining walls that once kept the energy particles confined disappear at the same time. This abrupt removal of boundaries transforms the system from a closed, isolated environment into an open space. The confinement that once defined the system no longer exists, leaving it unbounded and open to the surrounding space.

So earlier every time a particle a with an outward velocity colliding with the wall now will move outside due to the absence of any constraints and since in the isolated system earlier particles were colliding in approximately every part of all of the six constrain walls due to the three dimensional nature of the system and random motion of abundant number of particles . Now all of the colliding particles with the walls earlier will move outside due to their outward velocity . which will create a *Spherical Energy Flux or Radial Energy Flux.*

Average velocity of that flux in t time will be:

$$v_{avg,total} = \frac{1}{n'} \sum_{i=1}^{n'} \frac{1}{\varphi_i} \sum_{j=1}^{\varphi_i} v_{i_j}$$

So energy released from the system in t time is :

$$E = m_{net} c^3 \psi_c^{-1/2}$$

Distance covered by the flux in t time (D_t) :

$$D_t = v_{avg,total} . t = \frac{t}{n'} \sum_{i=1}^{n'} \frac{1}{\varphi_i} \sum_{j=1}^{\varphi_i} v_{i_j}$$

Since it is a spherical flux and if we think D_t as the radius of the sphere we can easily calculate the overall spherical volume (V_t) in which the energy flux will spread in t time :

This formula will only work when the time period is : $0 \rightarrow t$

$$V_t = \frac{4}{3} \pi D_t^{\ 3} = \frac{4\pi t^3}{3n'^3} \left(\sum_{i=1}^{n'} \frac{1}{\varphi_i} \sum_{j=1}^{\varphi_i} v_{i_j} \right)^3$$

Consider $D_t >> L$

So we can think that E amount of energy takes up a volume of V_t

Dependence of $P_{outward}$

In analysing the behaviour of energy particles within a system, understanding the factors that determine the probability of a particle having an outward-directed velocity is crucial. This probability, denoted as $P_{outward}$ dictates how likely a particle is to collide with the system's boundaries / leave the system for an open system. Several key factors influence $P_{outward}$ ranging from the particle's velocity and position within the system to its interactions with other particles and much more . These factors, discussed below, provide a brief insight into that.

Average Velocity:

- $P_{outward} \propto average\ velocity$
- Higher average velocity increases the chances that particles will have a component of velocity directed outward

Velocity Distribution:

- $P_{outward} \propto magnitude\ of\ outward\ velocity\ component$
- The larger the outward component of the velocity, the higher the probability.

Position in the System:

- $P_{outward} \propto \frac{1}{distance\ from\ wall}$
- Particles closer to the walls are more likely to have an outward velocity .

Particle Interactions:

- $P_{outward} \propto number\ of\ collisions/\ interactions$
- More interactions increase the chances of gaining an outward velocity.

Time:

- $P_{outward} \propto t$
- As time increases, the likelihood of a particle having an outward velocity increases.

Energy and Temperature:

- $P_{outward} \propto temperature$
- Higher temperature means higher velocity, leading to a higher chance of outward motion.

Number of Particles:

- $P_{outward} \propto Number\ of\ particles$
- With more particles in the system, the likelihood that some particles are moving outward increases

Conclusion :

In an infinitely large isolated system, consider a smaller, finite isolated system of length L containing numerous high-energy particles such as quarks, leptons, and bosons. Within this smaller system, these particles exhibit random and high-speed motion, interacting with each other and with the walls of the system. If, at some instant, the constraints of the smaller system are removed—i.e., all six walls disappear—these particles, now free from confinement, will move outward.

Given that the probability of particles having an outward velocity ($P_{outward}$) is significant, most particles will escape the confines of the smaller system and disperse into the larger, infinitely large system. This dispersal of particles will increase the entropy of the larger system. As the large system is infinitely large and unconstrained, its entropy will continually increase due to the continuous influx of particles.

Effects on our Universe:

In our universe, from the smallest coffee mug to the largest galaxy, no object is enclosed by an isolated system of finite length as previously discussed. Everything in the universe, composed of quarks, leptons, and bosons (excluding dark matter and dark energy), is in constant motion with intense velocity. These fundamental particles continuously interact with each other, altering their direction and energy moment by moment, akin to the behaviour observed in a finite isolated system.

However, unlike our finite isolated system, celestial bodies such as rocks and stars are not confined within such systems; they exist freely in space. Each of these objects acts as an open system within the vast expanse of the universe. Given that particles within these bodies also have a probability of possessing an outward-directed motion ($P_{outward}$) Similar to the earlier discussion, they continuously emit particles into free space.

Although there are other particles and fields in space that could act as constraints, their effect is minimal compared to the rigid walls of a finite isolated system. Therefore, the outward-moving particles from any object in the universe, whether a rock or a star, create a spherical energy flux in three-dimensional space. This flux is a result of particles dispersing from the object in all directions.

In essence,approximately everything in the universe continuously generates a spherical energy flux around it. The intensity of this flux (energy emitted per unit time) and the average velocity of the particles can vary significantly depending on the characteristics of the emitting body. Due to the constant release and dispersion of energy particles, there is a continuous increase in entropy across the universe .(more in this topic later)

For very high energy density bodies like the centre of a black hole probably spherical energy flux is not a thing.

Note: *While this theory primarily addresses particles as distinct entities within the system, it is important to acknowledge that, according to Quantum Field Theory (QFT), particles are actually excitations of their corresponding quantum fields. For simplicity and practical purposes, this analysis focuses on the particle nature, treating particles as discrete entities rather than delving into their field-based origins. This approach aids in clarity and ease of understanding while remaining consistent with the fundamental principles of QFT.*

2. Gravitational Clotting Theory :

In the *Radial Dispersion Theory*, the outward velocity of fundamental energy particles generates a spherical energy flux. This flux disperses energy in all directions, increasing the volume over which energy is spread and contributing to higher entropy. As particles move outward and their energy disperses spherically, it leads to a more uniform energy distribution and greater disorder. The theory posits that this continual dispersion of energy through spherical flux drives the increase in cosmic entropy, reflecting the universe's tendency toward greater disorder.

Just as anything in our universe radiates a spherical energy flux due to the abundance of free outer space, we can similarly think that at the time of the Big Bang, all matter and energy emitted from the singularity as a giant spherical energy flux. This initial emission represents the energy content of our universe. As space itself expands, the matter and energy content of the universe also expand, taking advantage of the abundant free space created by this expansion (We are not talking about effects of dark energy in the expansion of space here).

However, key questions arise: If energy spreads out from the singularity as a spherical flux, why didn't the energy disperse uniformly? Why isn't our universe a homogeneous sphere of energy? Instead, it's filled with complex structures—galaxies, stars, and other celestial bodies. Why didn't the energy particles remain dispersed individually, and what caused them to form such organised structures?

In this section, we will explore these fundamental questions and investigate the factors that led to the formation of organised matter and energy structures in the universe.

Particle Contributions to Macro Body Formation :

Macro Bodies : Large-scale structures formed from the fundamental energy particles. Galaxies, stars, planets, living organisms, human-made systems such as computers , other technological devices and non technological objects are all indeed Macro Bodies.

Though every macro body is indeed made by quarks , leptons and bosons but if we look at some observational data we can clearly see that there are some energy particles which mostly exist inside macro bodies in our universe and there are some other energy particles which mostly exist in the form of free particles or they have a lower tendency to form macro bodies.

Table 1: Galaxy Share and Rest Percentage :

Particle	**Galaxy Share (Percentage of Each Particle's Total Energy)**	**Rest Percentage**	**Exists in Form**
Photon	~1-5%	~95-99%	Electromagnetic radiation (e.g., light)
Gluon	~90-95% (in hadrons)	~5-10%	Binding energy within hadrons
Quark	~90-95% (in hadrons)	~5-10%	Constituent of protons, neutrons, mesons
Quark + Gluon $(q + g)$	~90-95% (**visible** mass in galaxies)	~5-10%	Combined in hadrons
Electron	~5-10%	~90-95%	Free particles, bound in atoms
Muon	Negligible	~100%	High-energy particles (short-lived)
Tau	Negligible	~100%	High-energy particles (short-lived)
W and Z Bosons	Negligible	~100%	Transient in weak interactions

By examining “Table 1” we can draw several key conclusions about the distribution and role of different fundamental energy particles within macro bodies:

1. **Dominance of Quarks and Gluons**: Quarks and gluons, as the primary constituents of hadrons, significantly dominate the mass and energy content of macro bodies, particularly in galaxies. Their combined presence highlights their crucial role in the formation and stability of these large-scale structures.
2. **Electron Presence**: Electrons, while contributing to a smaller fraction of the total energy in macro bodies compared to quarks and gluons, are essential in forming atoms and contributing to the visible matter in galaxies.
3. **Short-Lived Particles**: Particles such as muons, taus, and W/Z bosons, due to their short lifetimes, contribute minimally to the overall energy and structure of macro bodies. Their presence is transient and primarily limited to high-energy processes rather than stable structures.
4. **Photon Contribution**: Photons, although fundamental to electromagnetic radiation, represent a very small fraction of the total energy within macro bodies. They primarily contribute to the observable light and radiation but have a negligible impact on the structural composition of galaxies.

From Table 1, we observe that the tendency to form macro bodies is highest for quark-gluon combinations $(q + g)$, reflecting their integral role in the structure of hadrons and, consequently, in the formation of galaxies and other large-scale structures. Electrons, while having a lower tendency than quark-gluon combinations, still play a significant role in macro body formation, particularly in atomic and molecular structures. In contrast, photons exhibit the lowest tendency to form macro bodies, predominantly existing as free particles and contributing minimally to the formation of hadrons. This distinction highlights the varying roles and behaviours of fundamental particles in the creation and stability of cosmic structures.

KE/TE Ratio (ξ_k) :

It’s basically the ratio of Kinetic Energy and Total Energy for fundamental energy particles.

$$\xi_k = \frac{Kinetic\ Energy}{Total\ Energy} = \frac{KE}{TE} = \frac{(\gamma-1)\, m c^2}{\gamma\, m c^2} = \frac{(\gamma-1)}{\gamma} = 1 - \frac{1}{\gamma}$$

Let’s calculate the values of ξ_k for different energy particles according to their average velocity and average energy ,

Table 2 : Average Energy, ξ_k value , and Energy Share :

Particle	**Average Energy (eV)**	**Average Velocity**	**KE/TE Ratio (ξ_k)**	**Universe Energy Percentage**	**Galaxy Share**
Photon	~1 eV (visible light)	Speed of light (c)	1	~0.01%	~1-5%
Gluon	~1-3 GeV (in hadrons)	Speed of light (c)	~0.9 - 1.0	Included in ~4.9% baryonic matter	~90-95% (in hadrons)
Quark	~2-4 GeV (within hadrons)	Relativistic (varies)	~0.1 - 0.3	Included in ~4.9% baryonic matter	~90-95% (in hadrons)
Quark + Gluon $(q + g)$	~2-4 GeV (average hadron mass)	Relativistic (varies)	~0.1 - 0.3	Included in ~4.9% baryonic matter	~90-95% (visible mass)
Electron	~0.511 MeV (rest mass)	~0.1c - c (varies)	~0.1 - 0.9	Included in ~4.9% baryonic matter	~5-10%
Muon	~105 MeV (rest mass)	~0.2c - c (varies)	~0.2 - 0.8	Negligible	Negligible
Tau	~1.777 GeV (rest mass)	~0.3c - c (varies)	~0.3 - 0.7	Negligible	Negligible
W and Z Bosons	~80-100 GeV (rest mass)	~0.5c - c (varies)	~0.2 - 0.8	Negligible	Negligible

By analysing the data presented in Table 1 and Table 2, we can observe the following key points regarding the relationship between energy particles and their likelihood of forming macro bodies:

1. **Particles with Lower KE/TE Ratios:**
   - Particles that exhibit a lower ratio of kinetic energy to total energy (KE/TE) or lower value of ξ_k tend to have a higher tendency to form macro bodies. These particles are more commonly found within large-scale structures such as galaxies, stars, and planets. Their presence in such structures is indicative of their propensity to contribute to the formation and maintenance of these macro bodies. Such as $(q + g)$.

2. **Particles with Higher KE/TE Ratios:**
   - On the other hand, particles with a higher KE/TE ratio or high value of ξ_k are generally less likely to form macro bodies. These particles are more frequently found in a free state throughout the universe rather than being part of dense structures. Their high KE/TE ratio reflects their tendency to remain outside of large-scale aggregations. Such as photons.

In summary, the observed data highlights a clear relationship where particles with lower KE/TE ratios are more associated with macro bodies, while those with higher KE/TE ratios are more likely to exist in free form.

- ***Main Theory :***

Gravitational Well : A gravitational well is a curvature in the fabric of spacetime, created by large, concentrated energy sources such as galaxies, stars, or other macro bodies. This concept is grounded in the principles of general relativity, which describe how mass and energy warp spacetime, influencing the movement and behaviour of surrounding particles.

According to Radial Dispersion Theory, these macro bodies continuously emit energy particles outward into space. The ability of these particles to escape the gravitational well is determined by their kinetic energy to total energy (KE/TE) ratios or ξ_k value . Particles with low KE/TE ratios or low ξ_k value lack sufficient energy to overcome the gravitational pull, while those with high KE/TE ratios or high ξ_k value can escape the well more easily.

To illustrate this, consider two balls on an upward slope: a low-mass, high-velocity ball ascends the slope effortlessly, whereas a high-mass, low-velocity ball struggles to do so.Though this is a simplified analogy for a much more complex process .

When energy particles encounter a gravitational well in their path, which is earlier formed due to other energy sources (Dark Matter , Matter) , the energy particle's fates vary based on their energy characteristics. High KE/TE particles may fall into the well but often possess enough kinetic energy to escape its grip. In contrast, low KE/TE particles tend to be trapped within the well. This dynamic can be visualised through a practical analogy of three different coloured balls—red, blue, and white—rolled over a large hole. Over numerous trials, the white ball escapes most frequently, the blue ball escapes occasionally, and the red ball remains trapped inside the hole. This observation reflects the behaviour of particles in gravitational wells.

In the context of macro body formation, quarks, which are fundamental constituents of matter, predominantly remain within gravitational wells due to their significant mass. Leptons(electrons) exhibit a more variable presence, sometimes escaping the gravitational well while other times becoming trapped. Bosons(photons), which mediate fundamental forces, are the least likely to be found within these wells.

As a result, the gravitational well becomes populated with a concentration of quarks and fewer leptons, leading to the formation of macro bodies such as stars and galaxies. We can think of this as the reason why macro bodies consist mainly of Quarks $(q + g)$ and approximately no macro bodies have photons (bosons) as their main constituent.

So, The tendency of certain energy particles to form macro bodies is closely linked to the probability of these particles remaining within a gravitational well. This probability is inversely proportional to their kinetic energy to total energy (KE/TE) ratio, often referred to as the ξ_k value. In essence, as the KE/TE ratio increases, the likelihood of a particle escaping the gravitational well also increases, leading to a lower probability of contributing to the formation of macro structures. Conversely, particles with a lower KE/TE ratio are more likely to be trapped within the well, enhancing their potential to aggregate and form larger celestial bodies.

Let, P_{well} represent the probability of a particle remaining inside the gravitational well.

So, $$P_{well} \propto \frac{1}{\xi_k}$$ or, $$P_{well} = \frac{k_w}{\xi_k}$$

k_w is the proportionality constant here.

Suppose we are calculating the probability for $i\,th$ particle ($i = 1, 2, \ldots, n$)

$$P_{well,i} = \frac{k_w}{\xi_{k,i}}$$; $\xi_{k,i}$ is the ξ_k value of $i\,th$ particle

So , probability of n number of particles to remain inside the gravitational well

$$P_{well,total} = \sum_{i=1}^{n} P_{well,i} = k_w \sum_{i=1}^{n} \frac{1}{\xi_{k,i}}$$

Force in a Gravitational Well :

Suppose we have a macro body in a gravitational well it's net energy density is ρ_{macro} also consider ϕ_{macro} is the intensity of the spherical energy flux emitted by the body.

So we can say, $\rho_{macro} \propto \frac{1}{\phi_{macro}}$

Also we have seen that the probability of escaping the gravitational well will increase as the ξ_k will increase.

Suppose $\xi_{k,avg}$ is the average value of KE/TE ratio for all the different types of energy particles in the body.

Since more and more particle will escape the gravitational well as the $\xi_{k,avg}$ will increase.

So, $\phi_{macro} \propto \xi_{k,avg}$

Also, $\phi_{macro} = \chi \cdot \xi_{k,avg} \cdot \frac{1}{\rho_{macro}}$

the symbol χ represents the constant that accounts for factors like mass and radius of the body.

We know , flux is defined as the number of particles emitted per unit area per unit time.

So, $\phi_{macro} = \frac{N}{A\,\Delta t}$ or, $N = \phi_{macro}\, A\, \Delta t$

N is the number of particles emitted in time Δt.

A is the area of the macro body.

Let p_{avg} represent the average momentum for every emitted particle (including massless and massive particles).
So total momentum (P_{total}) emitted from the body in time Δt is,

$$P_{total} = N \cdot p_{avg} = (\phi_{macro} A\, \Delta t) p_{avg}$$

Force F_{flux} is defined as the rate of change of momentum with respect to time,

$$F_{flux} = \frac{dP}{dt} = \frac{(\phi_{macro} A\, \Delta t) p_{avg}}{\Delta t} = A \cdot \phi_{macro} \cdot p_{avg}$$

or , $$\phi_{macro} = \frac{F_{flux}}{A \cdot p_{avg}}$$

Also, $$\phi_{macro} = \chi \cdot \xi_{k,avg} \cdot \frac{1}{\rho_{macro}}$$

Or, $$\frac{F_{flux}}{A \cdot p_{avg}} = \chi \cdot \xi_{k,avg} \cdot \frac{1}{\rho_{macro}}$$

Or, $$F_{flux} = A \cdot \chi \cdot p_{avg} \cdot \xi_{k,avg} \cdot \frac{1}{\rho_m} \qquad (\rho_m = \rho_{macro})$$

Now let’s consider F_{single} is the average force due to a single particle in the flux.

Suppose number of emitted particle in a certain time period is n.

So, $$F_{single} = \frac{1}{n} F_{flux}$$

$$= A \cdot \chi \cdot p_{avg} \cdot \xi_{k,avg} \cdot \frac{1}{\rho_m} \cdot \frac{1}{n}$$

Considering the effect of Gravity :

When an energy particle is situated within a gravitational well, it experiences two distinct forces acting in opposite directions. The first force, directed outward from the centre of the well, arises from the spherical energy flux. This outward force tends to push the particle away from the gravitational well. Conversely, the second force acts inward, pulling the particle toward the centre of the well. This inward force results from the curvature of spacetime caused by the mass creating the gravitational well. The interplay between these opposing forces governs the particle's behaviour within the well.

$F_{single,outward}$ *is the outward force due to the spherical energy flux acting on the particle, pushing it away from the centre of the gravitational well.*

$F_{single,inward}$ *is the inward force due to the gravitational curvature, pulling the particle toward the centre of the well.*

$F_{single,net}$ *is the net force acting on the single energy particle.*

so,

$$F_{single,net} = F_{single,outward} - F_{single,inward}$$

If $F_{single,net}$ is positive then the particle experiences a net outward force, causing it to move away from the centre of the gravitational well.

If $F_{single,net}$ is negative then the particle experiences a net inward force, resulting in its acceleration towards the centre of the gravitational well.

If $F_{single,net}$ is zero then the particle is in a state of equilibrium, where the outward and inward forces balance, leading to no net movement.

The $F_{single,outward}$ can be easily derived from the formula of earlier F_{single} we just have to exclude the $1/\rho_m$ component because energy density is the reason of forming gravitational wells so $1/\rho_m$ is directly related to $F_{single,inward}$

So, $\phi_{macro} \propto \xi_{k,avg}$

Or, $\phi_{macro} = \chi' \cdot \xi_{k,avg}$ [χ' : Proportionality constant]

Also, $\phi_{macro} = \frac{N}{A\,\Delta t}$ or, $N = \phi_{macro} A\,\Delta t$ [considering uniform emission]

We know, $P_{total} = N \cdot p_{avg} = (\phi_{macro} A\,\Delta t) p_{avg}$

So, $F_{flux,outward} = \frac{dP}{dt} = \frac{(\phi_{macro} A\,\Delta t) p_{avg}}{\Delta t} = A \cdot \phi_{macro} \cdot p_{avg}$

Or, $\phi_{macro} = \frac{F_{flux,outward}}{A \cdot p_{avg}}$

Or, $\frac{F_{flux,outward}}{A \cdot p_{avg}} = \chi' \cdot \xi_{k,avg}$

Or, $F_{flux,outward} = A \cdot p_{avg} \cdot \chi' \cdot \xi_{k,avg}$

So, $F_{single,outward} = A \cdot p_{avg} \cdot \chi' \cdot \xi_{k,avg} \cdot n^{-1}$

Or, $F_{single,outward} = \frac{A \cdot \chi' \cdot p_{avg} \cdot \xi_{k,avg}}{n}$

For calculating the $F_{single,inward}$ we have to take the help of Einstein's field equation. Suppose there is Macro Body of energy density ρ_{macro} (ρ_m) which creates a curvature in space time fabric and inside the curvature suppose all the energy particle have an energy of $E_{particle,average}$ $(E_{p,avg})$

Since while calculating $F_{single,outward}$ we considered the average value of momentum and KE/TE ratio so now we also have to take the average value of Energy of the particles.

The foundation of general relativity is described by the Einstein field equations,

$$R_{\mu\nu} - \frac{1}{2}g_{\mu\nu}R + g_{\mu\nu}\Lambda = \frac{8\pi G}{c^4}T_{\mu\nu}$$

For a static, spherically symmetric mass distribution with energy density ρ_{macro}

$$T_{\mu\nu} = \begin{vmatrix} \rho_m c^2 & 0 & 0 & 0 \\ 0 & P & 0 & 0 \\ 0 & 0 & P & 0 \\ 0 & 0 & 0 & P \end{vmatrix}$$

For many cases, especially for non-relativistic scenarios, the pressure P can be neglected.

We know : $$g_{\mu\nu} = \eta_{\mu\nu} + h_{\mu\nu}$$

$$\eta_{\mu\nu} = \begin{vmatrix} -1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{vmatrix}$$

So , $$g_{00} = -1 + h_{00}$$

The gravitational potential Φ is related to the perturbation h_{00}

$$h_{00} = \frac{2\Phi}{c^2}$$

So , $$g_{00} = -1 + \frac{2\Phi}{c^2}$$

The motion of particles in a gravitational field is described by the geodesic equation,

$$\frac{d^2x^\mu}{d\tau^2} + \Gamma^\mu_{\alpha\beta} \frac{dx^\alpha}{d\tau}\frac{dx^\beta}{d\tau} = 0$$

The spatial components of the acceleration a^i can be expressed in terms of the Christoffel symbols

$$a^i = -\Gamma^i_{00}$$

The Christoffel symbols are given by:

$$\Gamma^\mu_{\alpha\beta} = \frac{1}{2}g^{\mu\nu} \left(\frac{\partial g_{\nu\beta}}{\partial x^\alpha} + \frac{\partial g_{\nu\alpha}}{\partial x^\beta} - \frac{\partial g_{\alpha\beta}}{\partial x^\nu}\right)$$

We will focus on Γ^{i}_{00}

$$\Gamma^{i}_{00} = \; - \; \tfrac{1}{2} g^{ij} \; \frac{\partial g_{00}}{\partial x^{j}}$$

We know , $g_{00} \; = \; -\; 1 + \frac{2\Phi}{c^2}$

So, $$\frac{\partial g_{00}}{\partial r} = - \; \frac{2}{c^2} \; \frac{\partial \Phi}{\partial r}$$

For a mass M contained within a radius r, the gravitational potential is given by :

$$\Phi(r) \; = \; - \frac{GM}{r}$$

Or, $$\frac{\partial \Phi}{\partial r} \; = \; \frac{GM}{r^2}$$

So, $$\frac{\partial g_{00}}{\partial r} = - \; \frac{2}{c^2} \; \frac{GM}{r^2}$$

So, $$\Gamma^{i}_{00} = \quad g^{ij} \; \frac{GM}{c^2 r^2}$$

In a weak field we approximate $g^{ij} \approx \delta^{ij}$

So, $$\Gamma^{i}_{00} = \quad \delta^{ij} \; \frac{GM}{c^2 r^2}$$

So, $$a^{i} \; = \; - \; \Gamma^{i}_{00} \; = \; - \; \frac{GM}{c^2 r^2}$$

We know , $F = ma$

So, $$F = \frac{E_{p,avg}}{c^2}\left(-\frac{GM}{c^2 r^2}\right)$$

Or, $$F = -\frac{GME_{p,avg}}{c^4 r^2}$$

$E_{p,avg}$ is the average energy of energy particles inside the well

$$M = \rho_m V = \frac{4\pi R^3 \rho_m}{3}$$

Considering that the Macro Body is spherical and has a radius of R

Or, $$F = -\frac{G 4\pi R^3 \rho_m E_{p,avg}}{3c^4 r^2}$$

Or, $$F = -\frac{4\pi G R^3 \rho_m E_{p,avg}}{3c^4 r^2}$$

Magnitude of the force :

$$|F| = \frac{4\pi G R^3 \rho_m E_{p,avg}}{3c^4 r^2}$$

So, $$F_{single,inward} = \frac{4\pi G R^3 \rho_m E_{p,avg}}{3c^4 r^2}$$

so, $$F_{single,net} = F_{single,outward} - F_{single,inward}$$

Or, $$F_{single,net} = \frac{A \cdot \chi' \cdot p_{avg} \cdot \xi_{k,avg}}{n} - \frac{4\pi G R^3 \rho_m E_{p,avg}}{3c^4 r^2}$$

In the context of gravitational dynamics, we explore the behaviour of energy particles within the gravitational well created by a macro body characterised by an energy density ρ_m. This body generates a curvature in the fabric of spacetime, influencing the motion of energy particles such as quarks, leptons, and bosons. To accurately account for the gravitational effects on these particles, it is essential to consider the total energy density $\rho_{total}(\rho_t)$ which includes not only the energy density of the macro body but also contributions from other forms of energy present in the same volume, such as dark matter.

So, $$F_{single,net} = \frac{A \cdot \chi' \cdot p_{avg} \cdot \xi_{k,avg}}{n} - \frac{4\pi G R^3 \rho_t E_{p,avg}}{3c^4 r^2}$$

If there is only the macro body present inside the well then $\rho_t \approx \rho_m$

When $F_{single,net}$ is negative, it indicates that the energy particles inside the gravitational well are unable to generate enough outward force to overcome the inward gravitational pull. This happens because the kinetic energy (KE) of the particles is insufficient to escape the gravitational well. As a result, these energy particles begin to accumulate, unable to disperse or break free from the well's gravitational influence. This accumulation marks the onset of gravitational clotting.

In this process, the particles continuously gather within the well, deepening its gravitational influence and attracting even more particles. Over time, the accumulation of energy particles leads to the formation of larger and more stable macroscopic structures, such as galaxies, stars, and planets. The gravitational clotting process essentially serves as the mechanism through which the universe organises dispersed energy particles into well-defined, large-scale structures.

According to Radial Dispersion Theory, every entity in the universe—whether it is a massive star or even something as simple as a candy—generates a spherical energy flux that propagates outward. This flux facilitates the dispersion of energy, which can be considered a fundamental factor in the ongoing increase of entropy in the universe.

On the other hand, Gravitational Clotting Theory provides a detailed mechanism for the formation of macroscopic bodies based on the dynamics of energy particles and the curvature of spacetime. Within a gravitational well, when an energy particle experiences a positive value of $F_{single,net}$ It is able to escape the well and disperse outward due to the spherical energy flux. Over time, as more particles within the macro body achieve a positive $F_{single,net}$ the likelihood of these particles escaping the well increases. This dynamic not only contributes to the formation of larger structures but also aids in the overall increase of entropy in the universe.

In summary, while Radial Dispersion Theory emphasises the role of energy flux in increasing entropy, Gravitational Clotting Theory elucidates the processes leading to the aggregation of matter, together providing a comprehensive view of cosmic evolution.

A crucial question remains: **Will the entropy of the universe always increase?**

The expansion of space creates room for the dispersion of energy particles. In our initial discussion on Time Systems, we identified three scenarios in which entropy consistently increases in an isolated system:

1. Time systems with finite energy.
2. Time systems with infinite energy.
3. Time systems with random motion and infinite decaying bodies.

From these cases, we can conclude that for entropy to continually rise in an isolated system, we require either:

a. An isolated system that is infinitely large with no constraints, or

b. Bodies that decay indefinitely without reaching a final form over an infinite duration.

Current theories suggest that the second condition (b) does not apply to our universe. This leads us to the first condition (a), where the universe must be infinitely large, which is theoretically feasible if space continues to expand. However, to fully grasp this concept, we must better understand Dark Energy and its role in the universe's expansion. Until we achieve a comprehensive understanding of Dark Energy, we cannot make definitive statements about the perpetual increase of entropy in the universe.

Supernovae and KE/TE-Driven Gravitational Escape :

In the framework of Radial Dispersion and Gravitational Clotting Theory, every macroscopic body generates a spherical energy flux due to the continuous outward motion of its constituent energy particles. The ability of these particles to escape the body's gravitational well is governed by a competition between two opposing forces: the outward flux force, driven by the particle's kinetic energy, and the inward gravitational force, driven by spacetime curvature.

This relationship is captured by the force balance equation:

$$F_{single,net} = F_{single,outward} - F_{single,inward}$$

where:

- $F_{single,outward} \propto \frac{KE}{TE}$, representing the tendency of a particle to escape due to its high velocity relative to its total energy.
- $F_{single,inward} \propto \rho$, representing the gravitational confinement due to energy density ρ,
- and $F_{single,net}$ determines whether a particle will remain bound within the gravitational well or escape into surrounding space.

This dynamic offers a novel and thermodynamically grounded interpretation of **supernovae**. When a massive star reaches the end of its fusion cycle, particularly after the collapse of the iron core, an enormous amount of energy is released in a very short span of time. This sudden energy release—driven by gravitational collapse, nuclear degeneracy breakdown, and intense neutrino outflow—leads to a **dramatic increase in the average kinetic energy** of the star's constituent particles.

In terms of the KE/TE ratio, this means:

$$\left(\frac{KE}{TE}\right)_{avg} \uparrow \quad \Rightarrow F_{single,outward} \gg F_{single,inward}$$

Once this threshold is crossed, the **net force on a significant portion of particles becomes positive**, leading to large-scale unbinding. The star no longer sustains its internal gravitational cohesion, and a **massive outward flux of energy particles** follows — an event observed macroscopically as a supernova explosion.

This process aligns naturally with the Radial Dispersion Theory: the sudden excess outward force generates an intense spherical energy flux that ejects material into the surrounding space. It also connects directly to entropy, as the violent dispersal of high-energy particles increases the number of accessible microstates and leads to a sharp, irreversible rise in the system's entropy.

In summary, within this framework, a **supernova can be understood as a transition point** where the average KE/TE ratio of fundamental particles rises beyond a critical level, causing the net outward force to dominate over gravitational confinement. The result is catastrophic energy release, rapid entropy production, and large-scale structural reconfiguration of matter—an elegant thermodynamic endpoint to stellar evolution.

Testable Predictions

1. Spherical Energy Flux Around All Macro Bodies

The theory predicts that every macro body—regardless of size or structure—continuously emits a spherical flux of energy particles, especially those with high KE/TE ratios (such as photons and neutrinos). This emission is not limited to thermal radiation but includes any form of kinetic energy-based dispersion of fundamental particles. The resulting flux has the following characteristics:

Radial, isotropic dispersion of mostly high KE/TE particles,

Gradual reduction of energy density over a spherical volume,

Ongoing increase in entropy around the emitting object.

This outward emission is a direct consequence of the force imbalance condition applied at the particle level. Even without explosive dynamics, the presence of high-velocity particles ensures a continuous energy outflow.

Testable implication:

Sensitive detection systems should observe low-level, isotropic fluxes of high-energy particles (such as neutrinos or background photons) surrounding all macroscopic energy sources—including stars, neutron stars, and possibly dense planetary bodies. Instruments like IceCube (for neutrinos) or future deep-field CMB detectors may be capable of identifying this diffuse, entropy-generating flux pattern.

2. KE/TE Ratio Bias in Structure Formation

A central consequence of the gravitational trapping mechanism is that particles with lower KE/TE ratios are significantly more likely to remain within gravitational wells and contribute to the formation of macrostructures. Conversely, particles with high KE/TE ratios tend to escape confinement and exist as free, unbound entities across the universe.

This framework predicts that:

Bound structures (galaxies, stars, planets) will predominantly contain particles with low KE/TE ratios—such as quarks (within baryons) and bound electrons.

Unbound regions (intergalactic medium, cosmic background) will be dominated by high KE/TE particles such as photons and neutrinos.

Testable implication:

Large-scale surveys of matter-energy composition across cosmic structures should reflect this distribution bias. In gravitationally bound systems, the energy content should be skewed toward massive, lower-KE/TE particles. In contrast, diffuse cosmic regions should show higher proportions of massless or near-massless particles with KE/TE ≈ 1. This can be tested through cosmological mapping of baryonic vs. non-baryonic matter, neutrino density models, and CMB spectral analysis

3. Supernovae and the Threshold of Outward Force

Within the Radial Dispersion and Gravitational Clotting framework, a supernova is interpreted not merely as a structural collapse, but as a critical thermodynamic transition driven by the internal energy dynamics of the star. Throughout its life, a star maintains an equilibrium between two opposing forces: the gravitational pull due to its immense energy concentration, and the outward force generated by the kinetic motion of its constituent energy particles. This outward force is directly influenced by the internal energy distribution, particularly the relative proportion of kinetic energy within the system.

As a star approaches the end of its life cycle, its internal structure becomes increasingly unstable. The collapse of the core and the cessation of fusion reactions lead to the release of enormous energy in a very short span of time. According to this theory, the critical condition that triggers a supernova arises when the average kinetic energy of the star's fundamental particles becomes sufficiently high that the outward-directed force generated by their motion overwhelms the inward gravitational confinement.

At this tipping point, the star can no longer contain its internal energy. A large portion of its mass-energy is suddenly and violently ejected into space, not because of gradual dispersal, but because the energy particles have acquired enough velocity and directional momentum to overcome the curvature of spacetime that previously bound them. This results in a massive outward flux of energy and matter—a supernova explosion.

Testable implication:
If this interpretation is correct, then the final stages of a star's life should exhibit a rapid increase in the kinetic activity of its internal particles. This could manifest in observable phenomena such as an early burst of high-energy neutrinos, a rapid expansion of outer layers, or changes in the timing and structure of the shock wave that initiates the explosion. Stellar simulations that model particle-level energy distributions may also be able to detect this transition, offering a new predictive condition for identifying stars on the verge of a supernova event.

References

Boltzmann, L. (1877). Über die Beziehung zwischen dem zweiten Hauptsatze der mechanischen Wärmetheorie und der Wahrscheinlichkeitsrechnung respektive den Sätzen über das Wärmegleichgewicht. *Wiener Berichte*, 76, 373–435.

Callen, H. B. (1985). *Thermodynamics and an Introduction to Thermostatistics* (2nd ed.). Wiley.

Feynman, R. P., Leighton, R. B., & Sands, M. (1963). *The Feynman Lectures on Physics, Vol. 1*. Addison-Wesley.

Hawking, S. W., & Penrose, R. (1996). *The Nature of Space and Time*. Princeton University Press.

Padmanabhan, T. (2010). *Gravitation: Foundations and Frontiers*. Cambridge University Press.

Pathria, R. K., & Beale, P. D. (2011). *Statistical Mechanics* (3rd ed.). Elsevier.

Penrose, R. (2010). *Cycles of Time: An Extraordinary New View of the Universe*. Bodley Head.

Reif, F. (1965). *Fundamentals of Statistical and Thermal Physics*. McGraw-Hill.

Zeh, H. D. (2007). *The Physical Basis of the Direction of Time* (5th ed.). Springer.

Simulations

1. Simulation: Emergence of Radial Dispersion from a Confined System

To visualize the radial dispersion from a constrained space, a 3D simulation was developed using VPython. The setup begins with 400 particles randomly distributed inside a transparent cube. Each particle moves independently with a constant velocity vector. Although wall collisions are not explicitly modeled, the initial confinement provides a spatial reference that all motion begins within a bounded volume. As the simulation progresses, particles move freely and eventually pass beyond the original cube boundary. Over time, the system exhibits a clear emergence of spherical like symmetry: particles disperse outward in all directions, forming a visually expanding radial structure. This outcome aligns with the core principle of the Radial Dispersion Theory (RDT).

Live Simulation Link:

Radial Dispersion Theory

2. Simulation: Gravitational Clotting Theory (GCT)

To illustrate the behavior of particles under the influence of a gravitational body, a 3D simulation was developed using VPython. A large, centrally fixed mass emits particles continuously over a 60-second duration. Each emitted particle is assigned an initial velocity corresponding to its kinetic-to-total energy (KE/TE) ratio, which is visually encoded by color:

- **Blue** particles have high KE/TE ratios and escape easily.
- **Orange** particles have moderate KE/TE ratios; some escape, while others are pulled back.
- **Red** particles have low KE/TE ratios and are largely trapped near the central mass.

Over time, the simulation clearly demonstrates the natural sorting of particles based on their KE/TE ratio. This behavior supports the central idea of the **Gravitational Clotting Theory (GCT)**: gravitational systems act as energy filters, allowing only high KE/TE matter to disperse, while continuously retaining **low-KE/TE particles** through curvature-induced attraction.

Live Simulation Link:

Gravitational Clotting Theory

To observe the simulation dynamics clearly, it is recommended to **zoom in near the white central mass** and follow the particles as they are emitted. This helps in visualizing the differences in escape behavior across particle types.

Message to the Reader

Acknowledged Limitations

- Many of the arguments presented are conceptual but lack formal mathematical proofs.
- The modeling and illustrations are early-stage and would benefit from deeper mathematical or computational refinement.
- Some sections may feel over-extended in explanation, while others could use more detail or formal structure.

These limitations along with others are acknowledged openly and with full recognition of the complexity of the subject.

To the Respected Reader

This paper is not intended as a definitive or finished theory. It is best viewed as an **exploration paper,** a young and independent attempt to think differently about entropy. While I have done my best to build ideas with care and curiosity, I know that the work remains incomplete in both depth and rigor.

Still, I believe the ideas here from entropy constancy to radial dispersion to gravitational clotting and also believe that they open up new ways of asking questions about energy flow in the universe. I share them in the hope that they may contribute to deeper conversations in physics, and perhaps spark new insights.

The guidance or collaboration of an expert would be deeply valued, as it could help refine and elevate this framework in meaningful ways.

Thank you for reading,
Arya Biswas

Email: fidon452.3@gmail.com