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On the Mechanism of Inter-Conversion of Matter and Energy - A Probable Pathway along with a Proposition of Existence of 'Moulikana' as the Most Fundamental Building Unit of Everything in the Universe

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Abstract: ***From the Special Theory of Relativity (STR) by Einstein (Einstein 1923) it has been established that the two main constituents of the universe, matter and energy, are inter-convertible. But the mechanism of such inter-conversion is not clearly known. On the basis of a critical analysis of various man-made scientific experiments along with the innumerable natural incidents occurring each and every moment in the universe as well as in our earth and also on the basis of consequent relevant logical and mathematical arguments, it becomes necessary to propose the existence of rest mass of photons and also the existence of "Moulikana" as the most fundamental building unit of everything in the universe. With the help of these proposals, the mechanism of the above-mentioned inter-conversions, formation of all material and energy particles from "Moulikana", existence of dark energy and dark matter (unseen), rareness of the existence of positrons can be nicely explained. This is a purely theoretical research work of the author.***

Keywords: Matter and Energy, Moulikana, Mechanism, Inter-conversion, Materialisation and Dematerialisation

1. Introduction

It has been known for a long time that the universe has two main constituents-matter and energy. Matter and energy are completely different from each other, i.e. there is no relation between them. However, different types of energies are inter-convertible to one another and in a rough sense similar is the case for different types of matters. But our famous scientist Albert Einstein has changed this idea. It has been established by him that mass and energy are related to each other and they are also inter-convertible(Born 1963), which is governed by the famous equation of mass-energy equivalence,

$$E=mc^2 \quad \text{..... (1a)}$$

where E= energy, m=mass and c= velocity of light in vacuum.

Again, he also suggested that the velocity of light (c) in vacuum is a constant quantity and it is the limiting speed in the universe and a material particle can never attain the speed of light. According to him, the mass of a material particle is also not a constant quantity (Born 1964); it increases with its speed obeying the following relation-

$$m = m_0 \left(1 - \frac{v^2}{c^2}\right)^{-\frac{1}{2}} \quad \text{.....(1b)}$$

where, m=mass of the particle at velocity 'v', m_0=rest mass, and c=velocity of light. From the equation (1b) it is clear that the mass of a particle becomes infinity when it attains the speed of light.

As a consequence of these two ideas introduced by him, some interesting questions may arise in the mind of all common people, which are-

a) Does the mass of a particle become infinity at the speed of light?
b) Is there a limiting value of kinetic energy (K.E.) which a particle can carry with?
c) What is the mechanism behind the complete conversion of mass into energy and vice-versa?
d) Do photons possess rest mass?
e) Is there a limiting value of atomic number (Z) of an element?
f) Is the speed of light the limiting speed in the universe? Is the speed of light a constant quantity? And if so, why?

2. Some common changes in the world

Before going to find out the answers of the above questions, let us discuss our common experience which is easily conceivable by everybody. Of the two main constituents of the universe, matter can exist in five different states and these are solid, liquid, gas, plasma and BEC (Bose-Einstein condensate). The first three states are well known to us for a long time and we can realize them by simple experiments. The last two states (plasma and BEC) are recently known and can be noticed by performing tough experiments only. Now, let us suppose that we have an enormous source of energy and it can be continuously supplied to a certain piece of matter of definite mass. What will be seen then? If the present state of the matter be solid, it will melt on absorbing energy from the source and after that it will vaporize to attain the gaseous state, i.e. phase changes like solid to

liquid and then to gas will take place. If the present state of the matter be liquid it will vaporize on absorbing energy, i.e. phase change from liquid to gas will be noticed. Such phase changes will be seen by everyone and everywhere in the universe by performing simple experiments. These can be shown as follows, where energy is represented by 'Q' -

$$\text{Solid} \xrightarrow[+Q]{} \text{Liquid} \xrightarrow[+Q]{} \text{Gas}$$

Temperature of each and every system will be increased gradually on absorption of energy, but during phase transition (solid → liquid and liquid → gas) temperature remains unaltered although energy is consumed continuously. It is also known that low energy states are more stable than high energy states, i.e. solids are more stable than their corresponding liquids and liquids are more stable than their respective gases. Therefore, during reverse changes (gas → liquid → solid) energy will be released. Thus, it can be said that more the temperature of a system, the more is its energy content. After attaining the gaseous state what will be the changes if energy is further added to it? Probable changes will be as follows-

Molecular Gas + Q → Atomic Gas ……..(2a)
e.g.N_2(g) + Q→2 N (g)
H_2O(g) + Q→2H (g) + O (g)

Atom(g) + Q→Cations (g)+ electrons (g) ……..(2b) (Plasma State)
e.g. N(g)+Q→N^+, N^{2+}, N^{3+}……+ e^s

Cations (g)+Q→$^A_ZX^{Z+}$ (atomic nucleus) + e^s ……(2c)
e.g.N^+, N^{2+}, N^{3+} ……+ Q→N^{7+}(Only nucleus) + e^s

Atomic Nucleus +Q→ Protons (p) + Neutrons (n) …(2d)
e.g. N^{7+} + Q→7p + 7n

(n+p)+Q→ Pions, Kaons, mesons, quarks etc. (soup) ...(2e)

Soup+Q→ Only energy (no matter) ……..(2f)

Now, let us critically look into the reverse changes. It is known that the stability of a system is the maximum where its energy content is the minimum. If a certain amount of energy (Q) is needed for a particular change, the same amount of energy (Q)will be released during the backward or reverse change. All the above mentioned changes are energy consuming and hence each transformation has occurred with the formation of unstable products. So, all the above changes will occur spontaneously in the reverse direction with the evolution of energy, thereby lowering the energy content. Thus, these changes can be represented reversibly in the following way-

$$\text{BEC} \underset{-Q_1}{\overset{+Q_1}{\rightleftharpoons}} \text{Solid} \underset{-Q_2}{\overset{+Q_2}{\rightleftharpoons}} \text{Liquid} \underset{-Q_3}{\overset{+Q_3}{\rightleftharpoons}} \text{Gas} \underset{-Q_4}{\overset{+Q_4}{\rightleftharpoons}} \text{Atoms}$$

$$\text{Atoms} \underset{-Q_5}{\overset{+Q_5}{\rightleftharpoons}} \text{Plasma} \underset{-Q_6}{\overset{+Q_6}{\rightleftharpoons}} \text{n+p} \underset{-Q_7}{\overset{+Q_7}{\rightleftharpoons}} \text{Soup} \underset{-Q_8}{\overset{+Q_8}{\rightleftharpoons}} \text{Energy Only}$$

3. Probable Mechanism of Mass-Energy Inter-conversion

3.1. The equation E=mc^2 means that when a particle of mass 'm' is completely converted into energy, the amount of which is obtained by multiplying the mass (m) with the square of the velocity of light (c). The equation (1a) may imply that mass can be converted into only one form of energy, i.e. only into photons (or into electromagnetic radiation) and not into any other form of energy. But how does the complete conversion of matter into energy take place? What is the mechanism behind this? The mechanism of such conversion and also of reverse conversion (energy into mass) is not clearly known. What is known to us? It is known that whenever a change takes place with a loss of mass, say 'm' (m=m_1-m_2, where $m_1$and $m_2$are the masses of the system before and after the change respectively), an equivalent amount of energy (E=mc^2) is released. In such changes, the total number of particles remains unaltered -- only the high energy particles (possibly electrons, protons etc. present in the system) come back to their low energy states giving up excess energy, which is thought to be as the conversion of mass into energy. The excess energy stored within the system in the form of excess mass (m=E/c^2) is released again in the form of energy. Actual mechanism of complete destruction of matter into energy is not known. Again it is also known that during annihilation of an electron (e^-) with a positron (e^+) (Bragin and Di Piazza 2020), a pair of γ-ray photons are produced, where it is thought that complete destruction of mass always takes place. Thus, it should be assumed that complete destruction of mass always takes place through production of photons only. Electron-positron annihilation can be shown as---

e^- (0.51 *Mev*) + e^+ (0.51 *Mev*) → 2γ -Photons ……(3a)

Each γ -photon has an energy of 0.51 Mev. The reverse change of '3a' may also be made possible by any means; then the question- "How charged particles are produced from two charge less photons?" will arise. What is the answer of it? This point will be discussed later. It has been also established that a γ -photon of energy 1.02 *Mev* can split into an electron and a positron (Hubbell 2006) each having an energy of 0.51 *Mev*.

γ -photon (1.02 *Mev*) → e^- (0.51 *Mev*) +e^+ (0.51 *Mev*)……(3b)

The conversion '3a' may be regarded as the process of dematerialization (mass → energy), whereas '3b' as the process of materialization (energy →mass). The conversion '3b' indicates that the high energy photons having E ≥1.02 *Mev* are highly unstable and they have a strong tendency for materialization and actually they do so. It may now be assumed that there should be an upper limit of photon energy. In '3b' how are two charged particles produced from a charge less photon?

3.2. According to classical mechanics, kinetic energy (K.E.) of a particle of mass 'm' moving with a velocity 'v' is given by K.E.=$\frac{1}{2}mv^2$. According to special theory of relativity (STR), a material particle can never attain the speed of light

(c), i.e. 'v' should be always less than 'c' and also the mass (m) of a particle is not constant, it obeys the relation '1b'. As the speed increases, mass (m) also increases and it becomes infinity at the speed of light (c), which is meaningless and also impossible. That is why; a material particle cannot attain the velocity of light. Let the relation '1b' remains valid, then the question arises-is it possible for a tiny particle like an electron to attain a mass comparable to that of the whole universe? The answer is certainly-No. Therefore, there should be a limiting value of K.E. which a moving particle can carry with at least by retaining its particle character. Now, let us show by simple calculation using equation '1b' how mass of a particle increases with increase in velocity. Here m_0 is taken as unity (say 1g):

Table I: Variation of mass of a particle with velocity

v→ (in terms of c)	0	0.1	0.2	0.3	0.4	0.6	0.7	0.71	0.9	0.99	0.999	1.0
m→ (in g)	1.00	1.01	1.04	1.10	1.20	1.56	1.96	2.01	5.26	50.25	500.00	Infinity

From Table-I, it is clear that mass of a particle is almost doubled when it attains about 71% speed of light and mass increases very rapidly after attaining 99% speed of light. The mass becomes infinity at the speed of light. To attain an infinite mass, a particle, whatever be its initial mass, will have to absorb infinite amount of energy which will be stored within it as converted mass. On absorbing energy a particle generally increases its K.E. and it can be done in two ways – either by increasing 'v' or by increasing 'm', since K.E.=$\frac{1}{2}mv^2$. According to STR 'v' has a limiting value of 'c', $\frac{1}{2}mc^2$ will have a finite value. But it will be possible by the second option. If an electron attains infinite mass, then what will be its size or volume? Will it be like our earth or sun or a super massive star or anything else? Is it possible at all or not? Thus, attainment of infinite mass by a particle at the speed of light is not conceivable and is not also practically feasible and hence it may not be real. So, the validity of the relation '1b' is questionable. Thus, it is feasible that either a material particle can never attain the speed of light or it must lose its particle character just before attaining the speed 'c' or at speed 'c'. Then it must be converted into energy. A phase transition from matter form to energy form should take place before attaining speed 'c'.

It has been established that the temperature of a gaseous system (molecular or atomic) is related to its kinetic energy (K.E.), rather K.E. is directly proportional to its absolute temperature (T) and it can be shown that for one mole of a gas-

K.E. = $\frac{3}{2}$ RT

From this we get, KE=$\frac{1}{2}$MV_{av}^2 = $\frac{3}{2}$RT or, V_{av} = $\sqrt{\frac{3RT}{M}}$

where, M=molecular weight of the gas.

Let us consider the case of gaseous atomic hydrogen (where M=1). Now, for this

we get-

V_{av} = $\sqrt{3 \times 8.314 \times 10^7 \times T}$ cm/s

Or V_{av} = $1.58 \times 10^4\sqrt{T}$ cm/s …….. (3c)

Now, V_{av} can be calculated at different temperatures for gaseous atomic hydrogen system using above equation '3c' and results are shown is Table-II.

Table II: Variation of V_{av} with temperature of atomic hydrogen (H) gas

T (in K)	100	500	10^3	10^4	10^8	10^{10}	10^{12}	3.6×10^{12}	10^{14}	10^{16}
V_{av} (in cm/s)	1.58×10^5	3.5×10^5	5×10^5	1.58×10^6	1.58×10^8	1.58×10^9	1.58×10^{10}	3×10^{10} $(=c)$	1.58×10^{11}	1.58×10^{12}

It is clear from Table-II that at temperature of 3.6 X 10^{12}K average velocity of atomic hydrogen gas becomes 2.998×10^{10}cm/s, i.e. it has attained the velocity of light. So, it can be expected that it will be completely converted into energy, i.e. its matter form will be completely destroyed. It can also be shown by calculation that all gaseous atomic systems from ^1_1H to $^{238}_{92}U$ will be completely destroyed at or above the temperature of 3.6×10^{14} K. It can be firmly said that no material particle can withstand a temperature of 10^{15}K at least to retain its particle character. So, it can be concluded that the temperature of any system containing material particle cannot be increased to any degree and the upper limit is probably 10^{15} K, rather it is better to say that all material forms will be completely converted into energy at and above the said temperature.

3.3. What is about the limiting value of K.E.? Let a particle of mass 'm' to attain the speed of light (c) and let still its particle character or matter form be retained, then maximum K.E. of the particle will be $\frac{1}{2}mc^2$. However, it is not possible for a particle to attain this K.E. of $\frac{1}{2}mc^2$. Conversely, it can be said that if a particle attains the speed of light it must lose its particle character and will be completely turned into energy. Thus, the process of complete destruction of matter into energy may involve two steps-at first to attain the speed of light by it and then to switch over into energy. From the relation '1a' it is clear that more the mass of a particle, the more is the amount of energy which will be obtained through its complete destruction. A definite amount and not an infinite amount of energy will always be obtained from a particle of definite mass through such conversion. But according to relation '1b' the mass of a particle will be infinity on attaining the speed of light. Does this mean that an infinite amount of energy will be obtained during such conversion of a particle of finite mass? Obviously not. Therefore, the validity of relation '1b' is questionable. Now, let a particle of mass 'm' be energized to attain the speed of light, the energy being taken from an external source and then allow it to suffer phase transition to lose its so-called particle character to be transformed into energy; then the

total amount of energy released will be $\frac{3}{2}mc^2$ of which mc^2 comes from its mass obeying the relation '1a' and $\frac{1}{2}mc^2$ from its K.E. Let us now return the borrowed energy ($\frac{1}{2}mc^2$ as K.E.) to the external source. Since the total energy (mc^2) obtained from conversion of mass is always released as photons, so they should travel at the speed of light. Again, since a very large number of photons is produced from the conversion of a very small amount of mass, the process of phase transition is nothing but the process of fragmentation- such probable paths of fragmentation are shown in the relations '2a' to '2f'.

3.4. Now, it may be easily arrived at the conclusion that the limiting value of K.E. of a particle of mass 'm' will be $\frac{1}{2}mc^2$, i.e.K.E.$<\frac{1}{2}mc^2$ and K.E. can never be greater than or even equal to $\frac{1}{2}mc^2$, at least to retain its particle character. Now, as a consequence of this proposition, let us apply this idea on the electron and let us try to find out the largest possible chemical element in the universe.

So, for an electron the maximum K.E. will be –
K.E. (Electron) = $\frac{1}{2}mc^2$ = 0·5 × 9·11 × 10^{-28} x (3×10102erg = 4.1× $10-7$erg

According to Bohr's Theory, K.E. of a moving electron in H-like ion of atomic number 'Z' is given by –
K.E. = $\frac{Ze^2}{2r} = \frac{Ze^2}{2} \times \frac{4\pi^2 mze^2}{n^2h^2} = \frac{2\pi^2 z^2 e^4 m}{n^2h^2}$…….. (3d)
where, m=mass of the electron, n=principal quantum number, h=Planck's constant .

Again for a maximum K.E. 'n' should be unity, i.e. ,
K.E. = $\frac{2\pi^2 z^2 e^4 m}{h^2}$ Or, K.E. = $13.58z^2$ ev = $z^2 \times 2.176 \times 10^{-11}$ erg.
This value of K.E. must not exceed 4.1 x 10^{-7}erg.

Therefore, there should be an upper limit of the value of 'Z' (atomic number), then-
$Z_{max}^2 \times 2.176 \times 10^{-11} = 4.1 \times 10^{-7}$
Or, $Z_{max} = \sqrt{\frac{4.1\times10^{-7}}{2.176\times10^{-11}}} = \left(\frac{4.1\times10^{-7}}{2.176\times10^{-11}}\right)^{1/2} = 137.3 = 137$

Using Bohr's Theory, this limiting value of 'Z' (=137) can also be obtained from the assumption that an orbital electron cannot have a speed greater than that of light at least to retain its particle nature. From Bohr's Theory we get –
v (Election) = $\frac{2\pi e^2 z}{nh} = \frac{2.185\times10^8\times z}{n}$ cm/s
when n=1, 'v' becomes maximum and as v=c, z=Z_{max} , So that
$Z_{max} = \frac{3\times10^{10}}{2.185\times10^8} = 137.3 = 137$

For an element of atomic number of 138, the velocity of an electron in the first orbit (n = 1) will be 3.0153 ×10^{10}cm/s , which is greater than that of light and hence is not possible. Thus it can be concluded that limiting value of atomic number will be 137 (Z ≤ 137) and no element with Z>137 can be prepared or found or discovered anywhere in this earth . In that case, the nature of the electron in the first orbit will be imaginary. Now, let us wait for the discovery of an element with Z >137 for violation of this prediction.

4. Do photons have rest masses?

4.1. In Quantum Theory, light is considered as a stream of particles called photons. Photons are such a class of particles which do not take rest, rather they are always in motion and they always move at a fixed velocity (c) in vacuum. Actually, none can see a motionless photon anywhere in the universe. Since there is no single photon at rest, it is assumed that photons should have no rest mass. In every gaseous system none can see a gas molecule taking rest so long as the gaseous state is retained. All the gas molecules are always in motion whatever be their temperature and pressure. Does this mean that gas molecules should have no rest mass? Each gas molecule has a definite rest mass. However, all the gaseous systems can be transformed into their respective liquid and solid states and in the solid state all the gas molecules are at complete rest and hence they have rest masses. Like gases, photons cannot be transformed into either liquid or solid states. Photons interact with matter everywhere in the universe and they are frequently absorbed by matter. Photons are thus bound within a matter and they remain there at rest for a long time until they are released as photons again. At least to justify the validity of the relation $E=mc^2$, photons should be converted into masses during their stay within a solid matter; consequently a slight increase in mass of the solid absorbing matter must be noticed and actually the converted mass of the photons are added to the absorbing solid. So, it should have to be assumed that photons do have rest masses.

4.2. From de Broglie's relation we get, $\lambda=\frac{h}{mv}$ for a moving particle of mass 'm' and velocity 'v'. This relation is also valid in case of photons, where, $\lambda=\frac{h}{mc}$ or $m=\frac{h}{\lambda c}$; then, 'm' should be the rest mass of a photon. This also indicates the existence of rest mass of the photons.

4.3. Mass and energy are inter-convertible and during dematerialization process mass is converted only into photons and not into any other forms of energy. Therefore, both matter and energy (photons) should have the same building unit and they should have particle nature with definite rest masses.

4.4. Velocity of light (photons) is constant and nothing can add or subtract to the velocity of light. What does this imply then? The energy of a photon is nothing but its K. E. only and it is $\frac{1}{2}mc^2$. In this relation 'c' is constant and unchangeable and hence, if one wants to increase (or decrease) the energy of a photon, only its 'm' will increase (or decrease); i.e. applied energy will be stored within a photon as 'm' (mass). Again, we know that E (energy) = hv (photon), so as E increases only the frequency (v) increases. Therefore, an increase in frequency (v) of a photon actually means an increase in 'm' (mass) of it.

4.5. All other forms of energy except photons require a material medium for their propagation; i.e. they are always associated with matter. Photons can move in free space

independently and they do not require a material medium to do this. A material particle can also move in free space independently without any help of material medium. Thus, one should have to assume that photons are particles having definite rest masses.

4.6. A material body having a definite mass always suffers gravitational interaction. Photons do suffer gravitational interaction, i.e. they show bending during propagation nearby a massive star. This is possible only when a photon has a rest mass.

4.7. Like material particles, any number of photons can be united into a single photon and any single photon can be split into any number of smaller photons (this will be shown later). However, in the second process there should exist a lowest limiting value of photon mass below which no photon will be found, i.e. the tiniest photon cannot be split further. This indicates the quantum nature of photon structure and also a similarity with matter.

All the above mentioned seven points (4.1. to 4.7.) indicate that the photons have rest masses and they are actually a special class of particles of definite masses and they should again possess quantum nature in their structure.

5. Proposal for the Photon Rest Mass

How can matter be converted into energy? For prediction of a probable mechanism it is necessary to assume that the photons have rest masses. Now, it is proposed that each photon has a rest mass. Although, all photons in the universe are always in restless motion, but if they are trapped within a matter they will stay there at complete rest and hence the proposal. During motionless condition photons do not have any K.E. It is also proposed that during motion some of the rest mass of a photon is converted into energy obeying the relation E = mc² (provided the relation remains valid here), which is associated with it as K.E. and each photon can carry a K.E. of $\frac{1}{2}mc^2$, where 'm' is the mass of the moving photon.

Thus if a photon has a rest mass of 'm_0' during the trapped condition within a material body, then it can be said that its rest mass 'm_0' is the sum of its mass (m) in motion and its K.E. (converted into mass). So, total energy available from a photon is m_0c^2. According to this new proposal even moving at the speed of light a photon should retain its particle character of special class with a definite mass 'm' carrying a K.E. of $\frac{1}{2}mc^2$ with it. However, this is not possible for bigger material particles other than photons. It can be shown mathematically that only one-third of the rest mass (m_0) is needed to be totally converted into energy to be associated with it as K.E. and the rest two-third of 'm_0' is retained as the mass of the moving photon. This is shown below.

Let a photon has a rest mass 'm_0' and let 'x' be the fraction of its mass which is completely converted into energy obeying the relation E=mc² and it is associated with the photon as its K.E. in motion. Thus,

The photon mass retained = (1- ***x***)m_0

Mass converted into energy as K.E. = ***x***. m_0

Therefore, K.E. = ***x***.m_0 c²

Associated K.E. with the moving photon according to the proposed concept = $\frac{1}{2}$(1- ***x***)m_0c^2

So, we get, ***x***.m_0c^2 = $\frac{1}{2}$(1- ***x***)m_0c^2.

or, 2 ***x*** = 1-***x*** or, ***x*** = $\frac{1}{3}$

Thus, it is seen that 'm' becomes two-third of 'm_0'.

Now, total mass and energy of a photon = m+$\frac{1}{2}mc^2$

=$\frac{2}{3}m_0 + \frac{1}{3}m_0c^2 = \frac{2}{3}(m_0 + \frac{1}{2}mc^2)$

where, m_0= rest mass of the photon and m=mass of the photon in motion.

Thus, all photons have the same property, i.e. each of them always retain 66.67 % of the rest mass 'm_0'as its mass in motion and rest 33.33 % of $m_0$as it's K.E. It may be noted here that in case of each photon 'm' and K.E. are inseparable. The photons obey additive rules, i.e. during union of two photons of massesm_1, and $m_2$and energies E_1 and E_2 respectively to produce a third photon of mass m_3 and EnergyE_3, the following relation holds good –

$E_1 + E_2 = (m_1 + \frac{1}{2}m_1c^2) + (m_2 + \frac{1}{2}m_2c^2) = (m_1 + m_2) + \frac{1}{2}(m_1 + m_2)c^2 = m_3 + \frac{1}{2}m_3c^2 = E_3$

i.e. $E_1 + E_2 = E_3$

So, it is hereby also proposed that during dematerialization process complete conversion of matter (or mass) into energy never take place; only one-third of the mass is converted into energy (associated as K.E. only) and remaining two-third contribute towards the total mass of the produced photons in motion.

The primary requirement for dematerialization is at first to attain the speed very close to that of light by the material body and then fragmentation takes place, because very large numbers of photons are produced from a very small amount of matter. At this stage the material particle splits into smaller particles having masses below a critical value, because very high energy photons with large masses are highly unstable and suffer materialization (conversion of energy into matter). To achieve the nature of photons, the fragmented material particles may then undergo contraction i.e. contraction in size or volume takes place to such an extent to have radii as small as possible, at least to lose their material character completely. The constancy of the speed of light is nothing but a simple consequence of this new idea. When a photon is added to another photon the resulting one becomes simply a bigger photon (as shown above) with larger mass , i.e. only it's mass increases keeping the velocity same. During splitting the resulting photons become of smaller masses without any change in their speeds. However, a question may be raised regarding the constancy of the speed of light and this was indicated in my previous paper (Mondal 2022). It has been shown there that the velocity of light had different values at different stages of the evolution of the universe.

6. Union and splitting of photons

Now, let us discuss on how union and splitting of photons can take place. Both union and splitting of photons generally require a material site. It is known that photons are frequently absorbed by matter. How and where can it take place? Charged particles like electron, proton etc, present in the matter can absorb and release photons. The mechanism is very simple and is shown below:

Let us promote an electron in a Bohr atom from E_1 to E_2in the first step and then from E_2 to E_3in the second step for which two photons of energies $hv_1(=E_2- E_1)$ and $hv_2(=E_3-E_2)$ respectively will be absorbed by the electron separately, i.e. two photons are grasped by the matter and they would remain at rest there. Now, let the electron be compelled to jump from $E_3$to E_1in one step by releasing the photon of energy $hv_3(=E_3-E_1)$. Obviously, $hv_3 = hv_1 + hv_2$. Time lag between these two processes may be very small (few nano second) or very large (few billion year); but whatever be the time lag, union of photons can thus take place (This is shown in Fig. 1A and 1B). Splitting of a photon can also take place by the reverse process-the electron is at first promoted from $E_1$to $E_3$and then allowed to jump from E_3 to $E_2$and then to E_1. In this case, it can be shown that the photon hv_3splits into two photons $hv_2$and hv_1(This is shown in Fig. IIA and IIB). Thus, it is clear that electrons, protons etc present in the matter are the suitable places where union, storing and splitting of photons can take place.

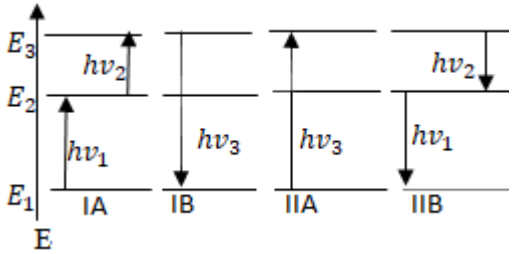

Figure: Mechanism of union and splitting of photons

In such cases of union and splitting of photons no extra energy term is needed because each term is the energy term. Unification of lower energy photons will produce continuously higher and higher energy photons. But this process cannot go on up to any degree, because very high energy photons are highly unstable and they will be destroyed either by fragmentation into smaller photons or by materialization through production of positron electron pair (it is shown earlier). Again, it is reasonable to raise the question whether the splitting of photons can continue up to any degree or not. Obviously there must be an end of the process, i.e. the smallest or the tiniest photon obtained by this process cannot be split further and this is the smallest fundamental building unit of everything (matter and energy) in the universe. Let it be named 'MOULIKANA'-'Moulik' means fundamental and 'Kana' means particle and these two are fused together as 'Moulikana'.

7. Classification of the world of matter and energy

Now, it is quite reasonable to classify the world of matter and energy into the following groups. There are mainly four groups of particles and these are

1)Group-A particles: World of 'Moulikanas' or M-particles.
2)Group-B particles: World of photons
3)Group-C particles: World of quarks, gluons, mesons, kaons, electrons, positrons etc.
4)Group-D particles: World of protons, neutrons, atoms, molecules, stars, galaxies, etc.

However, there are mass barriers between any two of the above-mentioned groups and these are 'w_0' between A & B, M$b_1$between B and C, and Mb_2 between C & D. All the group-A particles (i.e. Moulikanas) are identical in all respect having the mass 'w_0'. All photon (Gr-B) masses lie in the range 'w_0' to 'Mb_1' Particles having masses larger than 'Mb_1' can never attain the speed of light; such high energy photons (m>'Mb_1') are readily converted into electrons and positrons. Particles having masses in between 'Mb_1' and 'Mb_2' constitute the world of quarks, gluons, mesons etc. (Group-C), while those having masses larger than 'Mb_2' makes the world of atoms, molecules, planets, stars, galaxies etc. This classification can be shown in the following table (Table-III)

Table III: Classification of particles on the basis of mass and speed

Particle Group	Probable Mass Range (in g)	Upper Critical Value of Mass (in g)	Speed (in terms of c)	Type of Particles
A	10^{-65} (Probable) = w_0 No Range	10^{-65} (=w_0)	>> c	World of Moulikanas or M-particles only.
B	10^{-65} to 1.82×10^{-27}	1.82×10^{-27} (=Mb_1)	c	World of all detectable and undetectable photons
C	1.82×10^{-27} to 1.66×10^{-24}	1.66×10^{-24} (=Mb_2)	<c	World of Quarks, Gluons, Mesons, Kaons, Electrons, Positrons etc.
D	$>1.66\times10^{-24}$	No upper limit	<<c	World of protons, neutrons, atoms, molecules upto stars and galaxies

8. New Proposition

From the laws of gravitation (by Newton) it is known that the gravitational force of attraction (F) between two material objects is directly proportional to the product of their masses only and not on their nature. What does this actually mean? Total amount of mass present is solely responsible for this attractive force, whereas their nature has no role at all. Whatever be the nature of the body, may it be gold or platinum, or iron or aluminium or ice (or water) or a piece of stone or anything else the attractive force (F) remains the same. Photons also suffer gravitational interaction. From a

critical analysis of these observations one must have to take the decision that matter (all type) and energy (photons) should have the same building unit. Again, to explain the mechanism of conversion of matter into energy and energy into matter and also the quantum nature of photon structure it is necessary to take the same decision that there should be only one fundamental building unit of everything in the universe and nothing can be more fundamental than it and this is the 'Moulikana' as proposed earlier. They can also be termed as M-particles. The following are the proposed nature of 'Moulikanas' or M-particles:

1) Each 'Moulikana' (or M-particle) has the smallest unit of rest mass (w_0) in the universe, i.e. no particle having smaller mass than it can be found anywhere in the universe.
2) All M-particles are identical in all respect and hence they should have only one mass value which is yet to be determined. The predicted value will be in the range 10^{-65} to 10^{-45} g. The most probable lowest value of its rest mass (w_0) will be 10^{-65} g.
3) They are all chargeless, i.e. neutral.
4) They are always in motion and their speed is much greater than that of light.
5) All M-particles are extremely stable and cannot undergo further fragmentation.
6) Since a M-particle is the smallest unit of energy (or mass), it is not possible for any system to give up or take up energy quantum having smaller value than this.
7) M-particles are not photons, rather they constitute a special class of particles.
8) Any number of M-particles can be united to produce photons -- at least two M-particles are required to be united to produce a photon. The formation of photons can be shown as-

$$w_0 + w_0 \longrightarrow 2w_0 \xrightarrow{+w_0} 3w_0 \text{ and so on}$$

All photons should have masses in multiples of w_0, such as $2w_0$, $3w_0$, $4w_0$,….$nw_0$where 'n' is an integer. However, there is an upper limit of photon mass (or energy) when it will be highly unstable and hence cannot be formed. A γ-photon of energy 1.02 *Mev*is known to split frequently into an electron (e^-) and a positron (e^+); therefore it should be concluded that upper critical mass limit of aphoton will be the combined mass of $e^-$and e^+, i.e. 1.822x10^{-27}g (=1.02 *Mev*).

9) As soon as two or more M-particles are united to form photons, the special character of 'Moulikana' is lost and the resulting particles show the behaviour of simple photons.

9. Probable mechanism of formation of material particles from M-particles

How are two charged particles ($e^-$and e^+) produced from a chargeless γ-photon (1.02 *Mev*) during its spontaneous splitting into an electron (e^-) and a positron (e^+)? Again, during annihilation of $e^-$and $e^+$to produce a pair of chargeless γ -photon, the question 'how the electric charges vanish' will arise. Whatever be the cause behind these two changes, it can be firmly said that the electric charges exist in a hidden state within the photons. But how they are residing there inside the photons? To explain the mechanism of the above two opposite changes, it is necessary to propose that 'Moulikanas' or M-particles can be converted into two types of charged particles -- one is M^+ carrying one unit of positive charge, and other one is M^- carrying one unit of negative charge. Thus, there will be three M-particles- M^0 (neutral) $M^+$and M^-. Probably through collision between two neutral M^0 particles, $M^+$and M^- are produced

$$M° + M° \rightarrow M^+ + M^- \text{……. (9a)}$$

Possibility of such collision may be very small in case of two isolated free M^0particles; but this may be quite large during splitting of big photons where a very large number M^0-particles are present in very compact form. The formation of $e^-$and e^+can be explained in the following way. Let a γ-photon of energy 1.02 Mev contains 2y number of M^0- particles; 'y' being any whole member, the value of which is yet to be determined and then let two of its M^0 particles are transformed into one $M^+$and one M^-particles and then split into $e^+$and e^-as shown below-

$2yM^0$ (γ-photon) $\rightarrow$ 2(y-1) $M^0 + M^+ + M^- \rightarrow$ [(y-1) M^0+ M^-] + [(y-1)M^0+M^+]$\rightarrow e^-$ (electron)+ e^+(positron)…….(9b)

Annihilation of e^- and e^+ to produce two γ-photons of energy 0.51 Mev each can also be shown as- $e^- + e^+ \rightarrow$ [(y-1) M^0+ M^-] + [(y-1) M^0+ M^+] $\rightarrow$ [(y-1) M^0 + (y-1) M^0 + M^- + M^+] $\rightarrow$ [2(y-1) M^0 +M^0 + M^0] $\rightarrow$ [2yM^0]$\rightarrow$yM^0+yM^0 $\rightarrow$ 2γ-photons ……..(9c)

Here reverse transformation of (9a) takes place as -M^- + $M^+ \rightarrow M^0 + M^0$

The cause of formation of two charged M-particles from two neutral M-particles cannot be predicted now, but it becomes necessary to assume this for the explanation of changes '9b' and '9c'. Both $e^-$and e^+contain same number (y) of M-particles where only one M-particle is charged (viz. $M^-$for $e^-$and $M^+$for e^+).

M-particles thus become the only fundamental building unit of everything in the universe. At present, most of the M-particles are present in isolated free state, while a few of them are united (as shown above) to produce photons and all other material particles up to stars and galaxies. A proton contains a large number (y') of M-particles of which one is $M^+$and y'=1836y; similarly a neutron contains 1838y number of M°- particles only. Most of the positrons (e^+) formed in '9b' are used up to produce protons and this is the cause of rareness of positrons in the universe. Mechanism of formation of other bigger particles viz. atoms, molecules upto stars and galaxies from protons, neutrons and electrons is to some extent well-known to us. Now, it is clear that the free M-particles are the major constituent of the universe and they may contribute nearly 70% of total mass of it. Thus, the so-called dark matter and dark energy are nothing but these free unchanged M-particles. Since their (M-particles) interaction with matter does not produce any

observable effect, their detection as well as their mass determination will be very difficult; perhaps we have to wait for a long time for this. Unless and until we have an ultra-modern technology to detect them, the free M-particles will remain undetectable to us. Moreover, the photons having masses in between 10^{-45}g to 10^{-65} g will also remain undetectable, because their detection is equally difficult like M-particles. These types of photons are present in large numbers and hence they also contribute a part to the dark matter and dark energy in the universe.

Table IV: Probable pathway of formation of all photons and all material particles from 'Moulikana'.

Particle World	Probable composition with mass (inMev or in 'g')
World of Moulikana	M Particles only ($\approx 10^{-65}$ g) ↓
World of Stable Photons	2M ↓ 3M ↓ yM (γ-photon, 0.51 Mev) ↓
World of unstable photons having tendency towards materialization	2yM ↓ 3yM ↓ nyM and so on ↓ Materialization
World of Leptons	Electron(e^-, 0.51 *Mev*) Positron (e^+, 0.51 *Mev*) Neutrino (Mass ?) Muon (106 Mev) ↓
World of Mesons	Pions (π^0, π^+, π^-, 140 *Mev*) Kaons (K^+, K^- ~500 *Mev*) Eta (~550 *Mev*) ↓
World of Baryons along with other particles	Proton (p, 938.3 *Mev*) Neutron (n, 939.6 *Mev*) Lambda (1116 *Mev*) Sigma (~1200 *Mev*) Xi (~1320 *Mev*) Omega (1672 Mev) ↓
World of Macro-bodies	Atoms Molecules Giant Molecules Aggregates of above Planets Stars Galaxies and so on.

Now, a probable pathway of unification of M- particles to produce undetectable photons, normal photons, particles of so-called material world such as electrons, positrons, atoms, molecules up to planets, stars and galaxies are shown in Table- IV.

It is clear from Table -IV that splitting of a γ-photon (1.02 *Mev*) into $e^-$and $e^+$and also the annihilation of $e^-$and $e^+$to produce a pair of γ-photons (0.51 *Mev*each) indicate that there are some special numbers of M-particles for which extra stability is gained like magic numbers in the shell model of atomic nucleus. Both $e^-$and e^+contain 'y' number of M-particles and hence this (y) is the first magic number. Thus material particles containing y, 2y, 3y,.... number of M-particles will gain extra-stability. But when photons containing y, 2y, 3y,..numbers of M-particles, they have a strong tendency towards materialisation and they do so. However, photons containing intermediate number of M-particles in between y, 2y, 3y..... and less than 'y' are also stable and can exist. The probable value of 'y' will be in between 10^{18}(when, $w_0 = 10^{-45}$g) and 10^{38}(when, $w_0 = 10^{-65}$g). Whatever be the cause of materialisation and dematerialisation, it may be inferred that photons have very compact size and material particles have large expanded or swollen up size. During conversion of energy (photon) to matter expansion (or swelling) of size of the photon takes place and at the same time its speed decreases from 'c' and during reverse change contraction in size of the material particle takes place and its speed increases up to 'c'. To obtain real material objects containing atoms, molecules from electrons, the process will have to take a long journey where intermediate unstable particles like muons, pions, kaons, quarks etc. are produced.

10. Conclusion

From a critical analysis of the natural incidents spontaneously occurring each and every moment in the universe as well as in our earth and also to suggest a probable mechanism of inter-conversion of matter and energy, it becomes necessary to propose the existence of 'Moulikana' as the most fundamental building unit of everything in the universe. This model is quite able to explain the presence of huge amount of dark energy and dark matter (unseen) and also the rareness of positrons (e^+) in the universe. Moreover, why do photons suffer gravitational interaction? This is not clearly known. But in this model, it becomes clear. As the photons possess rest masses, they must undergo gravitational interaction -- the more the rest mass (and hence frequency) of a photon, the more will be the degree of bending during their journey nearby a massive star. Although, it is not now possible to obtain experimental proof of the existence of 'Moulikana' with the help of our present day technology, but one day in

future it will be possible when our technology will be sufficiently developed up to that level.

References

[1] Born M. 1963, Special Theory of Relativity, Nature, 197, 1287
[2] Born M. 1964, Einstein's Theory of Relativity, Dover Publication, ISBN 0-486-60769-0
[3] Bragin S. and Di Piazza A. 2020, Phys. Rev. D, 102, 116012
[4] Einstein A. 1923, The Special and General Theory, Princeton University Press.
[5] Hubbell J.H. 2006, Electron Positron pair Production by Photons: A Historical Overview, Radiation Physics and Chemistry, 75(6), 614-623
[6] Mondal N.G. 2022, The Idea of Big-Bang and Expanding Universe – Is it a Reality or an Illusion?, IJSR, Vol. 11, Issue 3, p. 509-515, ISSN: 2319-7064