MATTER AND MASS

According to 'MATTER (Re-examined)'

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Abstract: Matter is the only substance that can provide objective existence in space and physical reality to an entity. All real entities are made of matter. Due to lack of a reference, we have no measuring scale to determine matter-contents of real objects. Instead one attribute of matter, mass, represents matter-contents of material objects. Mass, used for this purpose, is itself is often bifurcated into inertial mass, gravitational mass, etc. Inertial mass is measure of inertia, a property attributed to 3D matter-bodies. Gravitational mass is derived from magnitude of gravitational attraction, experienced by a macro body. However, importance accorded to mass (in place of matter-content of an object) caused matter to be regarded as an unnecessary entity even for existence of material bodies and encouraged developments of exotic theories and mysterious particles. Devising a logical measurement scale can help restore glory to matter, rightly due to it, as the only substance that can provide existence to all real objects.

Keywords: matter, mass, force, inertial mass, gravitational mass, universal medium, mass defect, photon, biton.

All conclusions expressed in this article are taken from alternative concept, presented in book 'MATTER (Re-examined)' [1]. For details, kindly refer to the same.

Matter:

An entity is a thing with distinct existence. It has existence in itself. To exist is to have a place in objective reality. Although it is very vague, a place of existence is always presupposed by rational beings, whenever an object is envisaged. Perceived entity has a distinct but separate existence from the perceiver. Perceiver (rational beings) may name an entity. A name is a word (or group of words) referring to an individual entity. Name singles out an entity by directly pointing to it. An entity may be real or imaginary. An entity that can be perceived by senses or tangible and is relatively stable in its form is a real object or real entity. An imaginary entity is functional in its character.

All real entities are materialistic. They are material objects made out of matter. Matter is the substance/stuff that gives real entities their materialistic existence. Matter is a physical substance that occupies space and can be perceived by one or more senses. Matter is distinct from qualities, properties, thoughts, mind and spirit. Only matter is real. All others are functional and are results of organized performance of matter-particles. Having matter-content, makes an entity a real object that can be

perceived by sensory organs. In (Aristotelian and Scholastic) philosophy; matter is in itself undifferentiated and formless and which, when subjected to change and development, receives form and becomes substance. Hence, matter is the substance any physical object consists or is composed of or simply matter is something that exists in space.

At different stages of history, the concept of matter had many variations, in the light of scientific knowledge prevailing at the time of what are considered as basic building blocks and their interactions. At one stage, atoms were considered as basic building blocks and all matter were considered to be constituted by atoms. Later, matter was viewed as solid, massive and movable particles. Still later, smaller fundamental constituents of matter were discovered to change constitution of matter. Currently, in physics and chemistry, matter is assumed to exhibit both wave-like and particle-like properties, the so-called wave-particle duality. Often, matter is disregarded and one of its attributes, the mass, is accorded status of reality. This attitude caused numerous unnecessary assumptions in modern physics.

Matter is the '*material substance that constitutes the observable universe and, together with energy, forms the basis of all objective phenomena*' (Wikipedea). All matter share certain fundamental properties, as understood from observation of nature. Every physical entity is assumed to have properties of mass, gravitation, inertia, etc. All primary properties of matter are amenable to mathematical description. Nevertheless, its secondary properties (or qualities) are not considered mathematically. Although, mass of an object is a measure of its inertia, it is commonly taken as a measure of the amount of material contained in it. Matter in bulk may have several states of existence in nature. A common definition of 'matter is anything that has mass and occupies volume'.

Matter has many definitions in physics, but the most common one, currently used, is that it is any substance, which has mass and occupies space and exists in one of the physical states. All physical objects are composed of matter, in the form of atoms, which are in turn composed of protons, deuterons, neutrons, electrons, etc. Currently, photons (corpuscles of radiation) are assumed to have no mass, so they are an example of something real, in present-day physics, which is not comprised of matter. They are also not considered as objects, in the traditional sense, as they cannot remain static. In cosmology, the term matter includes dark matter and dark energy, concepts used to explain some anomalous phenomena observed in the universe. These exotic forms of 'matter' do not refer to matter as substance that occupies space but rather to unknown entities of mass and energy. Definition of matter is revised in light of quantum mechanics, where concept of 'having mass', and 'occupying space' do not have same meaning as in everyday life. Some similar theories hold the view that physical bodies are made of several substances and properties of matter (including, mass and volume) are determined not only by constituent substances themselves, but by how they interact. In other words, matter is made of interacting 'building blocks'. According to special theory of relativity, matter (considered as mass) and energy are equivalent. Accordingly, mass (matter) can be converted into energy and energy into mass (matter). Usually, matter is ignored altogether in this theory.

The term 'matter', traditionally refers to substance that all physical objects are made of. One common way to identify this substance is through its physical properties. The concept of substance is essentially a philosophical term of art. In its generic sense, therefore, substances in any philosophical system are those things, which, according to that system, are foundational or fundamental entities of reality. For an atomist, atoms are substances, because they are the basic things from which everything else is constructed. In certain philosophy (David Hume's system), impressions and ideas are substances, for the same reason. Etc. Although in different senses, all philosophical systems acknowledge existence of substances. Substances are a particular kind of basic entity. Some philosophical theories acknowledge them as such and others do not. Conception of substance as basic entity derives from our notion of individuality of 'thing' or 'object', in contrast with 'properties' of entities and 'events'.

In its physical sense, substance is that which exists in itself and does not depend upon anything else for its existence. Attributes or characteristic properties are inherent in (and about) substances and depend on substance for their existence. Existence is recognised by rational mind. This may be the result of correct sensory perceptions; it may be the result of incorrect perception or it may be by mere thought

process. If existence is recognised by sensory perception, in order to exist, the substance needs a place. Hence, it is essential for a rational mind to presuppose a space for existence of a real entity. This is how we created functional entity of space in universe. Space is purely a functional entity. Its sole function is to provide a place of existence for real objects. It has neither a form, nor a structure nor physical properties. Such an entity cannot move, distort or act. In case of functional entities, space for existence is not required. They exist in the minds of perceivers.

Rational beings perceive entities by their sensory organs. Perceived information is then processed and compared with previous experience by rational being's mind to know and experience the entity and its existence. Existence is always particular and individual. This does not mean that all that is perceived by senses are real. Different sensory organs may perceive same object in different ways. Only one of them can correspond to reality.

A stick, partially dipped in water, may appear by sight as a bend object – an imaginary stick. By touch, it would appear in its real shape, a straight object – the real stick. Both, imaginary and real sticks, appear to exist in same location. If they exist in same location, surely they cannot be different but same entity. In this case, bend stick has no existence but straight one exists in space. Both real (straight) stick and imaginary (bend) stick are perceptions of mind, but by different sensory organs. Real (straight) stick exists in space and imaginary (bend) stick does not exist in space. Only real (straight) stick occupies space. It is a real entity. It has positive existence in space. Bend stick, perceived by rational being is an imaginary entity. It has no existence in space. It exists only in the mind of perceiver. This is an example of aberration of sensory perceptions. All entities, which have no real existence in space but have their existence only in mind of perceiver, are imaginary entities. They are functional and fulfil functions assigned to them.

One school of philosophy (led by David Hume) denied existence of substance, using epistemological principles. They argued that; since all human knowledge must be traced back to sensation, idea of substance must also be traced to same. Since sensory perceptions themselves cannot provide knowledge of substance, no one can know substance, as a distinct stuff from that of a collection of particular qualities or attributes. Thus, substances are nothing but a collection of simple ideas that are united by imagination, and have a particular name assigned to them. In its essence, knowledge of aesthetic object becomes knowledge of aesthetic experience itself. This school of thought adopts the approach that puts aesthetic experience first and then examines aesthetic object as an intentional object of that experience.

This consideration is suitable to functional entities like imaginary particles, art forms, etc. Imaginary entities are created by rational beings in their minds and all their attributes are also subscribed by them. A painting is nothing but a collection of canvas and colours. It is the rational mind that attributes its functionality and qualities. However, many scientists, in dealing with modern physics engaged this philosophy to produce exotic theories, based on imaginary particles and mysterious properties, which are acquiescent with complicated mathematical treatments. Simple logical reasoning is not allowed to question their genuineness or logic.

Mass:

Scientists and philosophers searched for long to define nature of matter. Other than, to observe certain qualities of matter, they were not successful in their attempt to know true nature of matter. Frustrated, more influential among them sought an easy way out of this predicament. Instead of considering matter itself as fundamental substance or stuff, a quality of matter was enthroned in its place as real entity. Thus, mass, measure of inertia of an object came to be regarded as real entity that represents its matter-content. All further development in physics was based on this illogical assumption.

Mass is distinct from matter. Since we have no measuring scales, to directly measure matter-content of an object, we depend on indirect measurements. One of the measuring systems, used in physics, to represent matter-content of an object, is its mass. Because matter is a poorly-defined concept and different definitions of matter agree on its property of mass, mass is used to represent matter, often in physics. Hence, we say that all real entities (made of matter) have attribute of mass. All matter has property of mass, but not all mass is associated with identifiable matter. Mass is defined as cause of

inertial property (resistance to being accelerated when acted on by external effort) of an object. Since functional entities contain no matter, they do not have attribute of mass. They can provide only intentional objects. An intentional object is part of a state of mind, whereas material object always has independent (and objective) existence. However, reverse is not always held true. For, there are real objects, which are assumed to have no mass.

'Mass', commonly refers to any of three properties of matter: inertial mass, active gravitational mass, and passive gravitational mass, which have been shown experimentally to be equivalent. Mass is also considered to have many attributes in various theories; It measures matter-content of an object (Material mass). It measures an object's resistance to change of its state of motion, when an external effort is applied (Inertial mass). It produces a gravitational field in space, surrounding the object (Active gravitational mass). It causes an object's interaction with an external gravitational field (Passive gravitational mass). In certain theories, mass is assumed to curve space-time or as difference between object's quantum frequency and its wave number (Quantum mass). Differences between inertial mass, gravitational mass and various other mass-related phenomena are distinct and can suit only the concept that is using a particular attribute. No practical experiments, so far, has shown any non-proportional difference in values of mass. Therefore, mass is generally accepted as an abstract concept.

In physics, 'mass' is defined as 'quantitative measure of inertia', a fundamental property presently attributed to matter. It is the resistance that a body of matter offers to change in its state of motion upon application of external effort. Mass of a body is the mathematical relation between external effort on it and rate of change of its state of motion - acceleration. Mathematically this relation is expressed as: $M = F \div a$, where, 'M' is magnitude of mass, 'F' is magnitude of external 'force' and 'a' is magnitude of acceleration. Since 'F' and 'a' can have only positive values, mass of a body can only be a positive number, larger than zero. However, depending on relative magnitudes of external 'force' and acceleration produced by action of effort, mass of a body can vary from very small value to infinity. Hence, no real body (constituted by matter) can be mass-less.

Magnitude of matter content of a body, measured by determining its mass, can have reasonable relation to its matter content only if the magnitudes of external force and body's acceleration are within reasonable limits. If for any reason, the external force by its action on the body, cannot change the state of motion of a body, by the above given relation, mass of the body will reach infinite proportion, even under steady magnitude of its matter content. This is a fallacy created by the equation rather than an increase in the matter content of the body.

All actions are understood by motion or changes in state of motion of objects. If there is no change in state of motion, it is understood that external effort is unable to act on object. Action of an effort always presupposes ability of 'force-applying body' to move faster than 'force-receiving body'. For action of external effort, 'force-applying body' has to move towards 'force-receiving body', at greater speed. Although 'force-applying body', when in contact with 'force-receiving body', does not apparently move faster, there has to be a minute difference in their speeds. It is this speed difference which enables the 'force-applying body' to press into 'force-receiving body'. By interacting, 'force-applying body' compels 'force-receiving body' to change its state of motion. This is possible only as long as speed of 'force-receiving body' is less than the speed of 'force-applying body'.

As difference in their speeds reduces, quantum of action of 'force-applying body' on 'force-receiving body' diminishes. As and when their speeds become equal, 'force-applying body' will no longer be able to act on 'force-receiving body'. This is simple logical reasoning. If mass of 'force-receiving body' were now determined by relation, ($M = F \div a$), it would have reached infinite in magnitude. Taking this as magnitude of its matter-content is absurd. Direction of motions being same, a slow moving macro body cannot act on a faster moving macro body. Similarly, however large the magnitude of (mathematical) 'force' may be, if linear speed of 'force-receiving body' is restricted by a limit, its mass may appear to approach infinite proportions. Both, these situations indicate inability of external effort to produce desired results rather than a change in constitution of 'force-receiving body'.

This situation, mass of an object approaching infinite proportions in calculations, is rescued by an

equally illogical suggestion that all energy (an undefined entity) supplied by 'force-applying body' is being converted into mass in 'force-receiving body' and thus taking magnitude of its mass to infinity. Unfortunately, no one has ever devised a logical mechanism for this conversion. The fact that object's matter-content has not varied at all is left to reader's imagination. Changes to matter-content of 'force-receiving body' or ability of 'force-applying body' to act on 'force-receiving body' are not considered. This mysterious energy/mass conversion is the phenomenon of 'relativistic mass'. Unchanged part of mass of 'force-receiving body', as may be determined, with its (absolute) speed being zero, is its 'rest mass'. Rest mass is assumed as equivalent to matter-content of the object.

While considering the magnitude of external effort, speed or ability of 'force-applying body' to act on 'force-receiving body' also needs to be considered. While forming above given equation of motion, no thought was spared about ability of 'force-applying body' to move. It was simply considered that any 'force-applying body' could move with infinite linear speed, if required. This thoughtlessness led to ignoring efficiency of external effort's action. Efficiency of external effort's action on an object is determined by relation between magnitude of possible highest linear speed of 'force-applying body' (V_{max}) and current linear speed of 'force-receiving body' (V).

Efficiency of effort, η, depends on highest possible speed, V_{max}, of matter-bodies and present speed, V, of 'force-applying body'.

$$\text{Efficiency of external effort, } \eta = \frac{(V_{max} - V) \times 100}{V_{max}} \ \%$$

Efficiency of external effort is highest (100%), when (absolute) speed of 'force-receiving body' is zero. Efficiency of external effort is zero or it is unable to act on 'force-receiving body', when its (absolute) speed becomes equal to highest possible speed (in the direction of motion) of 'force-applying body'. Since mass is only a functional entity, it can neither act or be acted upon. External effort on an object acts on its matter-content. Magnitude of action depends on magnitude of matter-content and efficiency of effort. Matter content of object does not vary due to action of effort. Nevertheless, depending on (absolute) linear speed of object, its mass varies. This is the result of variations in efficiency of external effort to act on object.

This phenomenon limits linear speed of (photon) light to its highest possible linear speed in space. Hence, speed of light is a critical constant [1]. Incidentally, attempt to increase linear speed of photon tends to increase its matter-content rather than its linear speed. Similarly, attempt to reduce photon's linear speed tends to reduce its matter-content rather than reduce its linear speed. This mechanism keeps linear speed of photon constant, with respect to absolute reference.

Speed of light (photon) is the highest limit at which any matter-particle can move. Efficiency of an external effort trying to act on a photon, in the direction of its motion, is zero. That is, no external effort is able to act on a photon in its direction of motion. Thus, by above definition of mass, magnitude of mass of a photon is infinity. Absurdness of this result is removed by declaring photons as mass-less entities. This also contends that as photons are mass-less, they have no matter-content. Without matter-content, they are no more real objects. Hence, although they can be perceived by our sensory organs, they are treated as functional entities. This is one of many examples, developed as a result of assuming mass as equivalent of matter-content. Nevertheless, ability of photon, a mass-less entity, to have momentum is maintained for the sake of some theories. This is contrary to definition of momentum (another attribute of matter), which is given by result of mass multiplied by linear velocity.

It is a fact of observation that light (photons) moves. In the current state of physics, light has no logical mechanism of motion; neither its cause nor its mechanism is understood. Hence, it is simply assumed that light (photon) moves at its observed speed without external influence or an accelerating stage. This is against basic physical laws. Because of this ignorance, it is simply assumed that a light corpuscle achieved its steady linear speed without action of external effort on it. Considering action in this way, by above equation, mass of a corpuscle of light becomes zero. Thus, light or photon appears a mass-less body. Reason for this confusion is our unawareness of structure of photons and mechanism of their motion.

It is due to critical linear speed of light that no external effort, in direction of its motion, can act on it. If direction of external effort is different from direction of its linear motion, external effort is found to act on light (photon) and cause its displacement in the direction of external effort. Light is noticed to bend its path while passing near very large macro bodies. Being shy to accept the fact of matter-content of photon, this phenomenon is illogically attributed to assumed physical curvature of space (an entity, without physical structure) due to gravitational field instead of gravitational attraction between photons and large macro body.

By definition, matter causes sensory perception. Sight is a sensory perception. Irrespective of the fact that light is instrumental to sense of sight, it is considered as a functional (mass-less) entity. Light is considered as mere wave motions of certain energy-particles (defined only in mathematical equations) through empty space. This is not right. Since photons cause sensory perceptions, they are made of matter that has positive existence in space. Their high speed of motion should not deprive them of their true nature. Corpuscles of light have matter-cores with definite structure and shape. Nature provides a simple and logical mechanism for their creation, motion and other actions. Photons (corpuscles of light) are basic 3D matter-particles and they form all other superior 3D matter-bodies.

Weight:

Although mass is defined in terms of inertia, it is also conventionally expressed as weight, on or near the surface of earth. Weight is essentially the 'force' of attraction due to gravity on a 3D matter-body. Therefore, it varies from place to place on earth's surface. In contrast, under ordinary circumstances, mass of a macro body remains constant, regardless of its location.

'Weight' is created when an object is acted upon by a gravitational attraction and the object is not allowed to free-fall, but is supported or retarded by a mechanical effort. In gravitational weight, weight is the magnitude of 'force', which must support a real object (at rest) in gravitational field. Such a 'force' confers weight to a 3D matter-body. Additional mechanical efforts, enhancing its retardation may increase its weight.

Though they are in fact different concepts and quantities, in everyday use, mass and weight are used interchangeably. This is made possible by assigning value of unity to magnitude of gravitational attraction, between earth and 3D matter-bodies on its surface, in equation relating weight, mass and gravitational attraction. Units of weight and mass are same for general purposes. However for proper scientific use, mass is measured in kilograms (or similar units in different systems) and weight is measured in terms of units of 'force'. The two terms refer to different, yet related, properties of matter. An object's weight depends on its environment, while its mass does not.

Measurement of matter:

Rightly, rest mass of a 3D matter-body (with respect to absolute reference) represents magnitude of its matter-content. They are not equal or same. Matter-content of a 3D matter-body is the quantity of substance it has and its mass is the quantitative measurement of inertia, associated with it. It is our inability to find a 'reference-matter-body' that compelled us to use rest mass to represent a 3D matter-body's matter-content and paved way for many subsequent misunderstandings. Since we had no reference, no measuring system could be devised to measure magnitude of matter-content of an object. Instead, we had been using measurements of properties attributed to matter to indirectly assess its matter-content. As explained above, this often gave improper results and encouraged development of exotic theories with virtual particles and mysterious assumptions.

The concept, explained in book 'MATTER (Re-examined)' concludes that matter-content of one type of 'primary-particles' (Bitons), when in free space, is of constant magnitude. (Free space is the region, where there are no other 3D matter-particles other than the 3D matter-particle considered and where universal medium is in perfect homogeneous state, except for accommodation of considered 3D matter-particle.) This property of constancy in magnitude of matter-content could be used to devise a measuring scale for matter-content. Matter-contents of bitons change during changes in their external environment. This could happen during accumulation of many bitons for formation of superior 3D matter-particles, like

fundamental particles, atoms, molecules, etc. Changes could also take place if nature of universal medium, surrounding the bitons, is varied.

'Matter-content level' of a 3D matter-body is the measure of matter-content in each of its primary particles. Changes in matter-content level of a 3D matter-body are indicated by changes in its heat level. A macro body in free space (in its coolest state) has highest matter-content. Since matter content and energy about a 3D matter-body are proportional to each other, energy associated with it is also at the highest level, when it is in free space. In this state, 3D matter-body is in its coolest condition. (This is contrary to present belief that a body's energy level increases as its temperature increases. [1])

Primary particles (bitons) lose parts of their matter and energy contents as distortions in surrounding universal medium are increased, either by accumulation of more primary particles or by presence of other 3D matter-bodies in the vicinity or by transfer of distortions from other regions of universal medium. Because of this phenomenon, whenever two or more primary (or fundamental) matter-particles or even macro bodies combine to make a single macro body, certain parts of their matter and energy contents are lost from composite macro body. Similarly, whenever a composite fundamental particle or even a macro body split into different fragments, each of the fragments absorbs matter and energy contents from surrounding universal medium to increase total matter and energy contents. This gives rise to phenomenon of 'packing fraction' or 'mass defect'. This is associated with changes in matter-content of 3D matter-bodies rather than association with assumed mass/energy conversion.

Combination of smaller 3D matter-bodies, to form larger macro body, changes composite macro body's heat level. As composite macro body becomes larger, its 3D matter-particles tend to lose their matter and energy contents. Hence, matter-content level of macro body can be related to its state of heat (temperature measurement). Using magnitude of constant matter-content of a primary matter particle in free space as a reference and relating it to matter-content of a primary particle in macro body, in its present state, total matter-content of macro body can be estimated.

Primary particles at the centre of a macro body experience greatest amount of distortions in surrounding universal medium. Hence, they are at lowest matter-content level of all other 3D matter-particles in macro body. If macro body is huge, matter-content levels of primary particles nearer to its centre may correspond to different physical state of matter. This phenomenon causes interior of large macro bodies to be in liquid/fluid/plasma state, even while its exterior may be in solid state. Although matter-content levels at the centre are lower, matter-density in that region is held higher than that at solid exterior by 3D matter-particles staying nearer to each other. If weight of atmosphere of such macro bodies is higher, they may have no solid exterior at all. Very huge macro bodies may have gaseous exterior with matter towards their centre in plasma state.

Conclusion:

Matter provides substance of the existence to real objects in nature. Matter content of a body is presently represented and measured in terms of its mass. Method of estimation of matter content in terms of mass and undue importance given to mass have caused many misinterpretations and gave rise to illogical theories. Mass is one of the attributes of a matter body. It is a mathematical relation between magnitude of external force acting on a matter body and the body's linear acceleration. By accepting an absolute reference, provided by the constant magnitude of matter content of a primary-particle in free space, it is possible to device a measuring scale to directly estimate matter content of a real object.

Reference:

[1] Nainan K. Varghese, *MATTER* (Re-examined), http://www.matterdoc.info .

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