MATTER AND MASS

(According to "*Hypothesis on* MATTER")

Nainan K. Varghese, matterdoc@gmail.com
http://www.matterdoc.info

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 content of a real object. We had been using one of the attributes of matter, mass, to represent matter content of real objects. Mass, used for this purpose, is itself is often bifurcated into inertial mass, gravitational mass, etc. Inertial mass is the measure of inertia, a property attributed to real matter bodies. Gravitational mass is derived from magnitude of gravitational attraction, experienced by a matter body. However, importance accorded to mass (in place of matter content of a body) caused matter to be regarded as an unnecessary entity even for existence of real bodies. This 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 the "*Hypothesis on* MATTER" [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 the matter is real. All others are functional and are results of organized performance of matter bodies. 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 the 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. Currently, matter is (generally) regarded to have certain 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 a body is a measure of its inertia, it is commonly taken as a measure of the amount of material contained in the body. Matter in bulk may have several states of existence in nature. A common definition of 'matter is anything that has mass and occupies a 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 the concept of 'having mass', and 'occupying space' do not have the same meaning as in everyday life. Some similar theories hold the view that physical bodies are made of several substances and the properties of matter (including, mass and volume) are determined not only by the constituent substances themselves, but by how they interact. In other words, matter is made up 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 the substance that all 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, the substances in any philosophical system are those things, which, according to that system, are the foundational or fundamental entities of reality. For an atomist, atoms are the substances, because they are the basic things from which everything else is constructed. In certain philosophy (David Hume's system), impressions and ideas are the 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 the 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 the existence of a real entity. This is how we created the functional entity of space in the universe. Space is purely a functional entity. It provides its sole function to provide a place of existence for real objects. It has neither a form, nor a structure nor physical properties. Such a body 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 body – an imaginary stick. By touch, the stick would appear in its real shape, a straight body – the real stick. Both, the imaginary stick and the real stick, appear to exist in the same location. If they exist in the same location, surely they cannot be different but the same entity. In this case, the bend stick has no existence but the straight one exists in space. Both the real (straight) stick and the imaginary (bend) stick are perceptions of mind, but by different sensory organs. Real (straight) stick exists in space and the imaginary (bend) stick does not exist in space. Only the real (straight) stick occupies space. It is a real entity. It has positive existence in space. Bend stick, perceived by the rational being is an imaginary entity. It has no existence in space. It exists only in the mind of the 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 the mind of perceiver, are imaginary entities. They are functional and fulfil functions assigned to them by rational beings.

One school of philosophy (led by David Hume) denied the existence of substance, using the epistemological principles. They argued that; since all human knowledge must be traced back to sensation, the idea of substance must also be traced to the same. Since the 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 the aesthetic object becomes the knowledge of aesthetic experience itself. This school of thought adopts the approach that puts the aesthetic experience first and then examines the 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 the nature of matter. Other than, to observe certain qualities of matter, they were not successful in their attempt to know the true nature of matter. Frustrated, more influential among them sought an easy way out of this predicament. Instead of considering the matter itself as the fundamental substance or stuff, certain quality of matter was enthroned in its place as a real entity. Thus, the mass, a measure of inertia of a body came to be regarded as a real entity that represents matter content of a body. 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 relay on indirect measurements. One of the measuring systems, used in physics, to represent matter content of a body, is its mass. Because matter is a poorly-defined concept and different definitions

of matter agree on matter's property of mass, mass is used to represent matter, often in physics. Hence, we say that all real entities (made of matter) have the attribute of mass. All matter has the property of mass, but not all mass is associated with identifiable matter. Mass is defined as cause of inertial property (resistance of an object to being accelerated when acted on by an external force) of an object. Since functional entities contain no matter, they do not have the attribute of mass. They can provide only intentional objects. An intentional object is part of a state of mind, whereas the material object always has independent (and objective) existence. However, the 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 a body (Material mass). It measures an object's resistance to change of its state of motion, when an external force is applied (Inertial mass). [The term 'force' is used in this article, in its general meaning to represent an effort or cause of an action.] 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 (Curvature) or as the difference between an object's quantum frequency and its wave number (Quantum mass). Differences between inertial mass, gravitational mass and the 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 a change in its state of motion upon application of an external force. Mass of a body is the mathematical relation between an external force, acting on the body and the rate of change of body's state of motion, its acceleration. Mathematically this relation is expressed as:

$$M = F \div a$$

where, 'M' is the magnitude of mass, 'F' is the magnitude of external force and 'a' is the 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 the relative magnitudes of external force and the acceleration of the body, produced by the action of the force, 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 the state of motion of bodies. If there is no change in a body's state of motion, it is understood that the external force is unable to act on the body. Action of a force always presupposes a force-applying body's ability to move faster than force-receiving body. For the action of an external force, the force-applying body has to move towards the force-receiving body, at a greater speed. Although the 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 the force-receiving body. By interacting, the force-applying body compels the force-receiving body to change its state of motion. This is possible only as long as the speed of the force-receiving body is less than the speed of the force-applying body.

As the difference in their speeds reduces, quantum of action of the force-applying body on the force-receiving body diminishes. As and when their speeds become equal, the force-applying body will no longer be able to act on the force-receiving body. This is simple logical reasoning. If the mass of the force-receiving body were now determined by above given relation ($M = F \div a$) it would have reached infinite in magnitude. Taking this as the magnitude of its matter content is absurd. Direction of motions being the same, a slow moving body cannot act on a faster moving body. Similarly, however large the magnitude of a (mathematical) force may be, if the linear speed of the force-receiving body is restricted by a limit, its

mass may appear to approach infinite proportions. Both, these situations indicate inability of external force to produce the desired results rather than a change in the constitution of force-receiving body.

This situation, mass of a body approaching infinite proportions in calculations, is rescued by an equally illogical suggestion that all energy (an undefined entity) supplied by a force-applying body is being converted into mass in the 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 the body's matter content has not varied at all is left to reader's imagination. Any 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 force-receiving body's mass, as may be determined, with its (absolute) speed being zero, is the 'rest mass' of the body. Rest mass is assumed to be equivalent to the matter content of the body.

While considering the magitude of external force, speed or ability of the 'force-applying body' to act on the 'force-receiving body' also needs to be considered. While forming the above given equation of motion, no thought was spared about the ability of the '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 disregard the efficiency of external force's action. Efficiency of external force's action on a body is determined by the relation between the magnitude of possible highest linear speed of force-applying body (V_{max}) and the current linear speed of the force-receiving body (V).

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

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

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

This phenomenon limits the speed of (photon) light to its highest possible linear speed in space. Hence, speed of light is a critical constant. [Mechanism of motion and limitation on linear speed of matter bodies are explained in 'Hypothesis on MATTER']. Incidentally, any attempt to increase the linear speed of a photon tends to increase its matter content rather than its linear speed. Similarly, any attempt to reduce a photon's linear speed tends to reduce its matter content rather than reduce its linear speed. This mechanism keeps the linear speed of a photon constant, with respect to absolute reference.

Speed of light (photon) is the highest limit at which any matter body can be moved. Efficiency of any external force trying to act on a photon, in the direction of its motion, will be zero. That is, no external force will be able to act on a photon in its direction of motion. Thus, by the above definition of mass, magnitude of mass of a photon will become infinity. Absurdness of this result is removed by declaring photons to be as mass-less bodies. 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 body, 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 the 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 the light (a photon) moves at its observed speed without any 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 an external force on it. Considering the action in this way, by the above equation, mass of a light corpuscle becomes equal to zero. Thus, the light or a photon

appears to be a mass-less body. Reason for this confusion is our unawareness of structure of photons and mechanism of their motion.

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

By definition, matter causes sensory perception. Sight is a sensory perception. Irrespective of the fact that light is instrumental to the 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 the photons cause sensory perceptions, they are made up 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 the 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 (apparent) attraction due to gravity on a matter body. Therefore, it varies from place to place on earth's surface. In contrast, under ordinary circumstances, mass of a 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 force. In (gravitational) weight, weight is the magnitude of force, which must be applied to support a real object (at rest) in a gravitational field. Such a force confers weight to a body. Additional mechanical forces, enhancing retardation of the body may increase a body's weight.

In everyday use, mass and weight are used interchangeably, though they are in fact different concepts and quantities. This is made possible by assigning value unity to magnitude of force of gravitational attraction, between bodies on surface of earth and the earth, in equation relating weight, mass and gravitational attraction. Units of weight and mass are the 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 body (with respect to absolute reference) represents magnitude of its matter content. They are not equal or the same. Matter content of a body is the amount of substance the body has and body's mass is the quantitative measurement of its inertia, associated with the body. It is our inability to find a 'reference-matter body' that compelled us to use rest mass to represent a body's matter content and paved way for many subsequent misunderstandings. Since we had no reference, no measuring system could be devised to measure the magnitude of matter content of a body. Instead, we had been using measurements of properties attributed to matter to indirectly assess matter content of a body. As explained above, this often gave improper results and encouraged development of exotic theories with virtual particles and mysterious assumptions.

The concept, explained in 'Hypothesis on MATTER' concludes that the 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 matter particles other than the matter particle considered and where the universal medium is in perfect homogeneous state.) This property of constancy in the 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 matter particles, like fundamental particles, atoms, molecules or macro bodies. Changes could also take place if nature of universal medium, surrounding the bitons, is varied.

'Matter content level' of a body is the measure of matter content in each of its primary particles. Changes in the matter content level of a body are indicated by changes in its heat level. A body in free space (in its coolest state) has highest matter content. Since matter content and energy about a body are proportional to each other, energy associated with a body is also at the highest level, when the body is in free space. In this state, the body will be in its coolest condition. (This is contrary to present belief that a body's energy level increases as its temperature increases. For this conclusion, 'Hypothesis on MATTER' shows a logical mechanism.)

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

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

Primary particles at the centre of a macro body experience greatest amount of distortions in the surrounding universal medium. Hence, they will be at the lowest matter content level of all other particles in the body. If the 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 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 the solid exterior by body-particles staying nearer to each other. If the weight of atmosphere of such 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.

References:

[1] Nainan K. Varghese, *Hypothesis on MATTER* (second edition), (2003), http://www.booksurge.com/Hypothesis-on-MATTER-Second-Edition/A/1419689789.htm

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