Mass - Energy equivalence

- The dynamic directional mass -

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This article tries to clarify several theoretical concepts related to some physical quantities, such as mass and energy, starting from their definitions stated by my theory PT [1]. All explanations will be situated within the framework generated by the granular mechanics - a given of our current universe, that actually determines all the laws of physics, at any scale.

1. The Mass

What is mass in fact? Is it well defined by the modern physics?

If we look back to the manner in which the mass was firstly defined in my theory ([1], chapter 6.2), and if then take into consideration the postulate stating that a granule is continuously moving (seen from the AFR), it seems quite natural that the mass of all granular structures is somehow connected to movement and its value could vary under certain conditions. However, the parameters of the granules (either free or belonging to a structure), including the elementary impulse and energy, are all constant over time!

The symbolic, the rest and dynamic mass

As the granules are elementary quantities of essence, having a certain volume and a shape stable in time, we may associate them a symbolic mass denoted by $\boldsymbol{\mu}$, of constant value (it does not depend on granular motion), which has a classical meaning of amount of substance.

In order to ensure a unitary perspective on the mass of granular structures, regardless of their shape, a new and complete definition is needed to be used in granular mechanics:

Any granular structure, defined as a finite group of granules whose granular density exceeds the local one and that acts as distinct entity, simple or composite, with certain stability in time, possesses the following characteristics:

- A symbolic mass, given only by the number of granules, scalar, constant quantity, invariant in all frames of reference.

- A rest mass, given by the symbolic one and by the value of the granular impulse.

- A dynamic mass, given by the spatial distribution of the internal granular impulses, which now may be considered a direction-dependent quantity (tensor), whose values will vary with the absolute velocity of the structure.

Note 1: The granules in a structure can be bonded to each other or separated, and this aspect was not considered here (yet it has certain significance to the quantum interactions).

Note 2: Mass, the dynamic one especially, no longer seems to be a fundamental physical quantity, as the mass in its classical sense does. What gives a clear meaning to the new mass and preserves the role of fundamental quantity is the elementary granular impulse (energy). The dynamic mass is a feature of the granular structures that only appears during their interactions through different fields.

Note 3: The total mass of the bigger structures (atoms, molecules, where some elementary particles are bound together by various fields) may be obtained by the temporal averaging of the component masses, the result being different from a normal mathematical summation; the movements of the component particles are "confined", they all have a lower number of degrees of freedom and thus their dynamic masses are changing. The distribution of mass of the local fields (different forms of energy) also contributes to this, but only in a very small extent.

Note 4: The total mass of macroscopic bodies (made up of atoms) is also an average value.

Note 5: The rest mass is a particular case of dynamic mass at zero absolute speed.

An elementary particle that is made up of **N** granules may therefore have a symbolic total mass **N μ**, a total energy (kinetic, the granular energy being denoted by **ε**) **N ε** and a total impulse **N p**. Observation: the last two quantities depend on the frame of reference; also, these formulas are valid in a particular case, only when we observe the particle from the AFR and only if, virtually, all the granules would have the same direction.

The first type of mass above, the absolute *symbolic mass*, was introduced in order to maintain the classical perspective on particle's mass, in which case it only depends on the amount of substance (on the number of constituent granules), and this will not be speed-dependent.

If we would consider a particle being at rest in AFR and its constituent granules rotating on different layers (all velocity vectors are parallel with the side surfaces), we could introduce an absolute *rest mass*, correlated with the mass seen as amount of substance and with the external impulse necessary to determine a global movement with the speed **v**. This rest mass would be a constant which only depends, in principle, on the number of particle's constituent granules and on their elementary granular impulse.

The *dynamic mass* could be introduced same way, as a quantity that depends on the number of granules and on the *distribution* of the impulse vectors inside the considered structure (therefore on its global speed, which may be relativistic). As all structures in question are not spherical, there will automatically be a certain dependence of dynamic mass on the spatial orientation (on the global direction), as shown in Figure 3 for electrons and protons. This mass will therefore be expressed as a function of direction (the direction of an ideal flux, uniform and very thin, that acts upon the particle), but in practice we will use **mean** values, averaged for the duration of the intrinsic motion of precession. *Note*: The directional dynamic mass tends to get uniform values with the precession at small global speeds, its average value becoming constant.

If we are to analyze the dynamic mass on a single direction, there will be found a minimum value for the particle being at absolute rest (equal to the rest mass), when we may assume *in a simplified manner* that all its internal vectors have the same orientation, perpendicular on the future direction of travel. In this case, the variation of an external impulse that would determine the same acceleration to the particle within a certain period of time would have a *minimum value* (this is the natural way in which the mass must be regarded, or as the value of an external impulse that would produce a certain speed - see Annex 1). The dynamic mass manifests similarly in case a particle speeds up or slows down (during the same intervals and under infinitesimal impulses), generating this way certain spatial symmetry. If the particle has the speed **c**, it may only be slowed down, and on this direction its mass is *finite*. Note: No inertial / gravitational mass differentiation will be further detailed, as this distinction is only valid in case of very large and dense cosmic bodies.

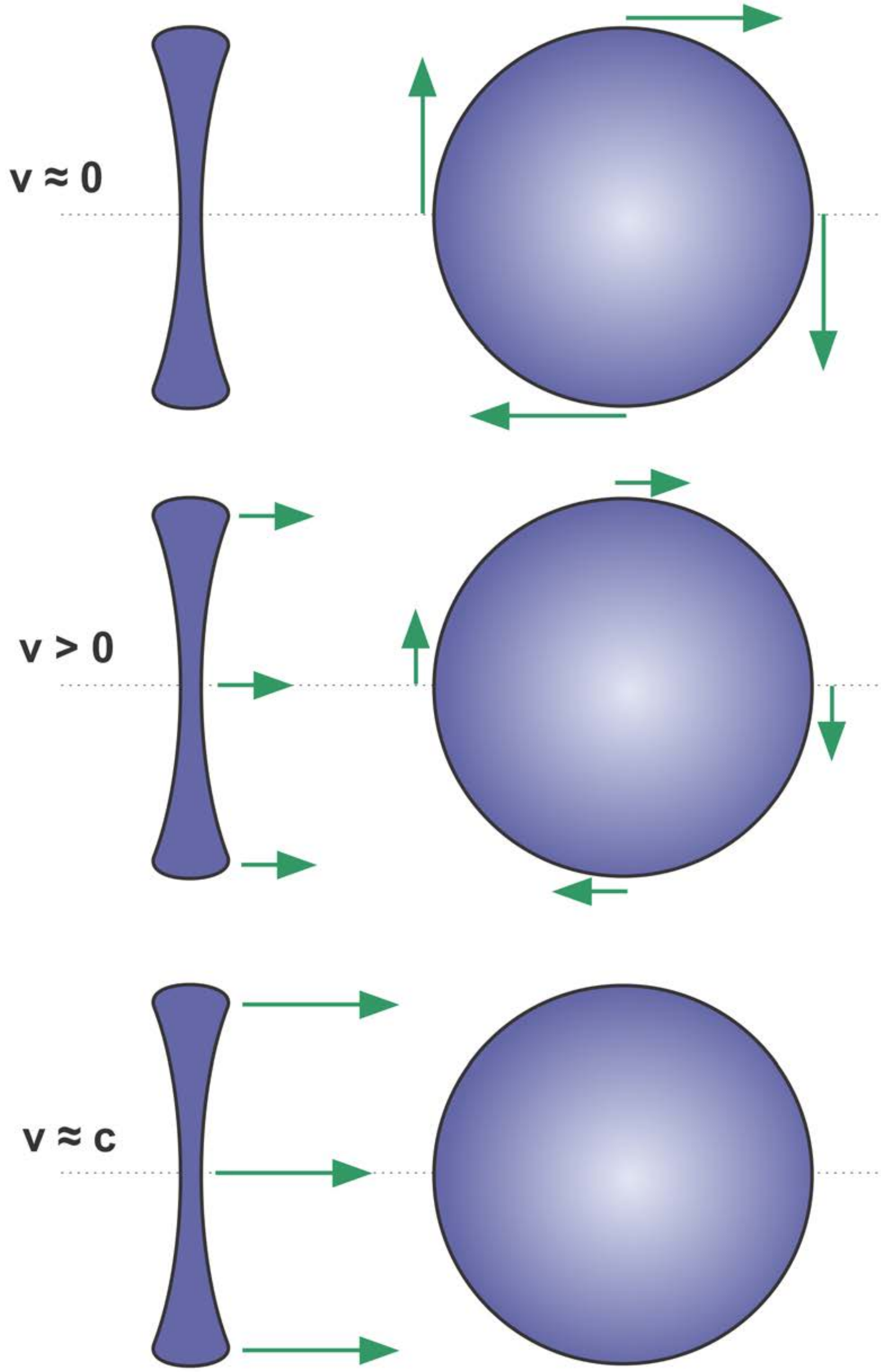

Figure 1 - *Distribution of the rotational and translational speeds of an electron*

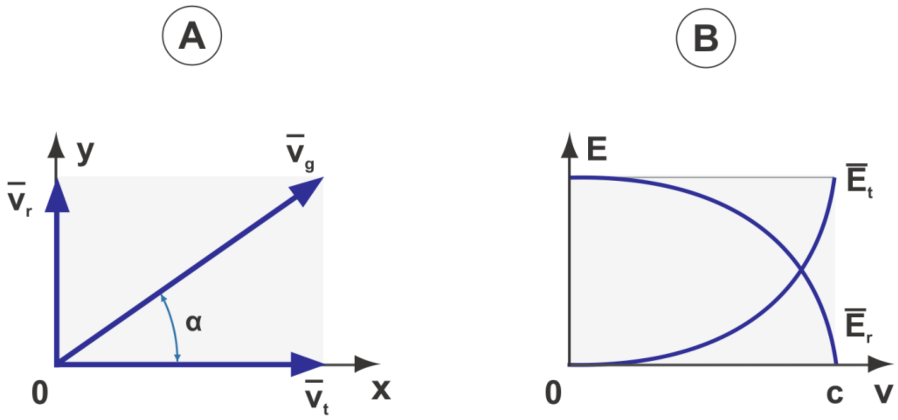

Figure 2 - *Distributions of speed and of kinetic energy*

2. The Energy

The kinetic energy, a kind of energy that is discussed now, is always associated to an entity, i.e. to a granular structure in motion. If we look at the particle above from the AFR and then analyse the directivity of its granular movement versus the global simplified one, we may discern three possible cases (as shown in Figure 1) of distribution of the elementary kinetic energies:

- Only rotational motion at the absolute velocity value **c**.
- Rotational and translational motions.
- Only translational motion at the absolute velocity value **c**.

These cases (similar to the previous ones, from the chapter about mass) involve an ideal, simplified particle, which does not perform the precession movement (anyway, Prime Theory [1] assumed that the global velocity vector can be neither parallel nor perpendicular to the surface of a particle). An external force (charged particles and their electric/magnetic fields, or a gravitational field) acting a certain time upon the ideal particle will transfer it certain impulse, which will result in a direction change of all internal granular impulses. The energy "transferred" through the fluxes of the respective field is received by the particle and the real effect it produced is a change in particle's energy distribution, a change of the ratio between its rotational and translational energy, while its total energy remains in fact unchanged. Therefore, the particle "exhibits" by its translational motion more or less from the internal, total energy, as much as it was transferred through the action of the external granular impulses. Once it has reached the speed of light, the particle can no longer receive more impulses from the outside on that direction (because either its speed became equal to that of the external impulses or because the frontal granular collisions prevent any speed increase).

Figure 2 shows (on the left) the (normal) decomposition of the particle's global velocity $\mathbf{v_g}$ into rotational and translational components $\mathbf{v_t}$ and $\mathbf{v_r}$, their values obeying this formula:

$$\mathbf{v_g^2 = v_r^2 + v_t^2} \quad \text{where} \quad \mathbf{v_g = c = constant}$$

The total kinetic energy in the flux/particle system is *conserved*; the flow will change its direction and the particle will change both global and rotational absolute speeds.

It seems natural in this context to redefine the kinetic energy, ignoring for now the mechanical work, the forces and the mass in classical sense. The kinetic energy $\mathbf{E_k}$ will therefore be seen as a derived parameter of the proper state of the particle that has reached a certain absolute global speed - energy of the absolute movement, as in my book [2], chapter 3.4 - a scalar quantity proportional to the square of the absolute speed, to the number of granules and the elementary energy.

That particle has rotational kinetic energy $\mathbf{E_r}$ and translational one $\mathbf{E_t}$, which can be summed:

$$\mathbf{E_k = E_r + E_t} \quad \text{where} \quad \mathbf{E_k = N\,\varepsilon = constant}$$

The formula of $\mathbf{E_t}$ may be easily obtained from the previous equations:

$$\mathbf{E_t = k\,v_t^2 = N\,\varepsilon\,v_t^2 / c^2} \quad \text{where} \quad \mathbf{k = constant}$$

This function is graphically represented in Figure 2, on the right side.

3. The Time

Things are very simple at granular level, time is a reflection of the fact that this medium is made up only of granules and they all move with the constant speed **C**; therefore, time has a constant rate in any AFR, which may be set arbitrarily. There is no reason to consider other frames of reference in this environment, and its granular density will be considered a constant value.

At quantum level and above we have to deal instead with structures. The granular structures, regarded as distinct entities, may have different absolute speeds in AFR, less or equal to **c**, and thus different relative speeds. They all vibrate, oscillate and interact with each other through fields; these things happen at a certain rate if particles move slowly and at a lower rate if their speed gets close to the speed of light **c**. As it was specified above, all structures "move" a part of their internal speed, energy, impulse into their *external* translational movement when they interact through various fields (or vice-versa, "absorb"). However, their total energy is a constant value, which means that this amount of energy is actually split into different parts based on the absolute motion of particles.

Time may be associated, at this level, with the proper, internal movement of particles, the one which reflects itself in their precession and which imposes a rate of all possible interactions. The component of the granular speed that determines the internal rotation could be therefore a perfect reference for the local time of particles (see Annex 2). We may simply say that, at lower global speeds (absolute and translational ones), the local time is flowing uniformly at a maximum rate; however, this rate drops significantly at relativistic speeds, close to **c**. The simultaneous "movements" through time and space are therefore limited to the global maximum speed, as it was described by the principles of relativity, and this happens because an entity (particle in our case) may move through space and also fix its local time's rate *by the same internal granular motion*.

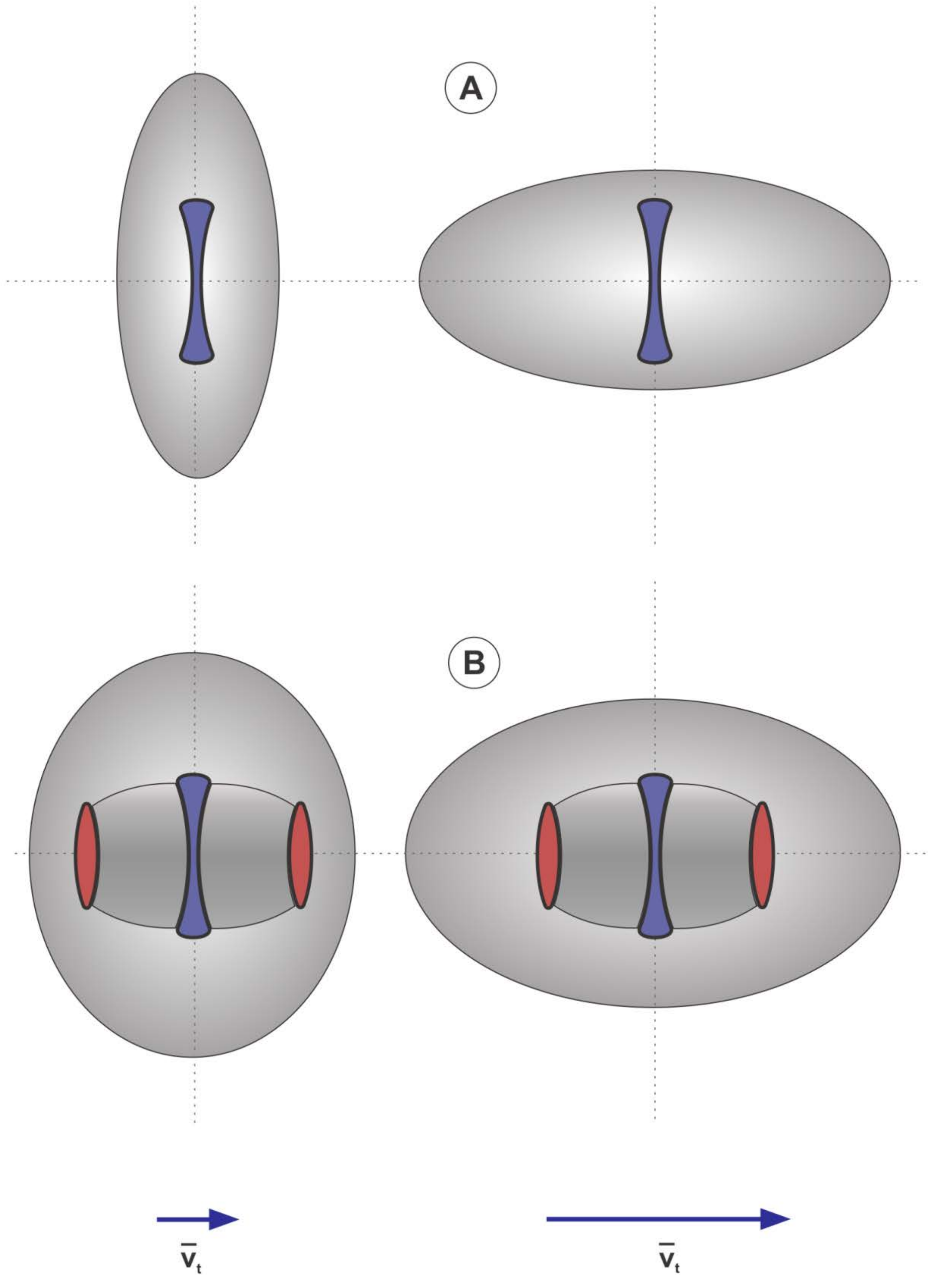

Figure 3 - *The distribution of dynamic mass of electrons and protons*

4. Photons

The photon structure is created when an electrical charged particle has relativistic absolute speed and, at the same time, it slows down or speeds up in a certain field.

Photons are spiral structures with variable pitch, made up of compact granular layers that are simultaneously moving at speed **c** in a unique direction. The symbolic mass of a photon is given by the number of granules all those granular layers contain, **N μ** (N is different to various particles and to photons). The impulse of each component granule is perfectly aligned with the direction of travel, therefore the total impulse is pointing in the same direction and its value will be **N p**. The kinetic energy is only of translational kind, a constant value, **N ε**. The dynamic mass, instead, is variable:

- It is infinite on photon's direction of travel, because it no longer may receive extra impulse to accelerate and increase its speed.

- Photons cannot be slowed down when they travel through the uniform, free space; only their direction may be changed under the action of some lateral fluxes. These fluxes will "see" a mass of minimum value if they flow perpendicularly on the photon's traveling direction, mass that will increase toward a maximum value as the angle of incidence decreases (curvature of the photon's trajectory in a strong gravitational field).

Note: The mass of electrophotons could have a similar description, regardless their variable and unstable structures (see [3], section 4.2).

The frequency of the granular layers' envelope variation gives a measure of the photon energy in quantum physics, not the total kinetic energy described above, **N ε**. This difference appears because photons transfer only a part of the energy during their special interaction with the orbiting electrons - that synchronisation of their movement through the impulse transferred by the photon's granular layers. Nevertheless, the values of these energies are proportional under normal conditions, and the photon's total energy, **N ε**, always conserves.

Let us analyze now a simple example to support this last thing, for example the redshift of a photon passing through a gravitational field. At granular level, this phenomenon is produced by the decreasing gradient of gravity, which increases the distance between photon's layers on the field exit - by changing their speed at different moments. As a result of this process, photons will have the same number of component granules and therefore the same total energy, which will be conserved. Only the eventual transfer of energy toward an orbiting electron will no longer be identical, it will have a slower "rate" that corresponds to a jump of less energy. In other words, out of the total energy a photon contains, only a fraction is transferred to the orbiting electrons, the remainder being practically lost in the granular space.

5. Composite particles

The composite particles are made up of two or more elementary particles (quarks) that are held together by the gluonic field (strong interaction). The constituent particles perform their precession movement in a special way, synchronous or not, being elastically bounded together by gluons of a very high granular density (they are reducing the number of degrees of freedom). The mass distribution of the composite particles is mainly determined by the gluonic field, which adds the most mass (as number of granules) to the total mass. We may approximate the path of the granular fluxes with the line connecting the center of the particles, one half of the gluonic field's granules moving in each direction at any moment. Therefore, the dynamic mass of this field has a maximum value on that direction and it has a minimum on the perpendicular ones. Anyway, these values will be averaged over one precession period and we may practically work with a single value of mass, which will still be dependent on the absolute speed value.

6. Conclusion

The mass-energy equivalence is implicit, and this could have been observed since the moment when the granular properties were stated. This article only adds some details to the concept of dynamic mass of the granular structures and tries a new definition for their kinetic energy. Moreover, this new perspective explains why relativistic phenomena occur at the quantum level, shedding more light upon the concepts of mass, time, impulse and other physical quantities.

Mass, seen as substance, cannot be converted into energy or vice versa. Mass has energy since the granular matter was created, and it may take several structured forms in the amorphous spatial fluid, forms that contain significant amounts of localized energy (kinetic energy). Consequently, it results that the mass and energy cannot be created or destroyed; they only may be grouped in certain compact forms, stable or not in time.

The dynamic mass of a particle is a measure of the amount of kinetic energy (elementary impulse) that must be grouped and oriented to interact with that particle, to adjust its internal impulses in order to allow a global movement with a certain absolute speed. These things are identical for all macroscopic objects, which are in fact smaller or bigger collections of elementary particles - bounded and organized as atoms and molecules - whose masses will be averaged.

This duality related to the motion of all particles helps us to also explain their *inertia*. All the free particles keep the ratio between their rotational and translational speeds during the global motion, and this means they are holding their previous state - which is equivalent to maintaining that kinetic energy they reached after the last interaction with a field. A certain particle, being either at rest or in motion, requires an impulse transfer from a directional granular flux in order to change its current state, to overcome the structure's inertia. This is similar with the (kind of classical now) concept pointing to the action of a force on particle's mass that changes its current state of motion.

The concentration and dispersion of granular kinetic energy are representing in fact the working mechanism of any field, allowing the energy exchange between all quantum and macroscopic entities. The gravitational field, which is generated by the consistency of space, provides through its granular fluxes the primary support for all these field interactions. By their relative position in these fields, both micro and macro objects can get various types of energy (for example potential energy) in the systems they are composing. However, regardless of the form or name it would have, the energy always means an aggregation of those granular, elementary energies of kinetic nature.

The quantum interaction always conserves the elementary energies involved, no matter the mode and form they are concentrated at a moment. This seems perfectly natural as these interactions conserve the *symbolic mass*, i.e. the number of granules. The granular fluxes, any field they would constitute at a given moment, are intermediating by their granular mass in motion all transfers of energy/ impulse between particles.

The dynamic mass, as well the energy, cannot have infinite values - as they all are in fact configurations of the internal energies and impulses (finite in number and magnitude) of particles. If a particle reached the absolute speed **c**, its impulse along the direction of travel can no longer be changed and this aspect causes an apparent dynamic mass of infinite value in that direction.

7. Annex 1

Let be an *ideal* elementary particle whose internal granular impulses (or velocity vectors) form the angle α with the global direction of travel. As their speed can be assumed to be **c**, the particle's global speed will be $v = c \cos(\alpha)$. The internal impulse (unfolded) is denoted by p_1, and the value of an external impulse that will act at a given time is p_2, $p_2 <= p_1$. As a result of this event, the angle α will become α', which is equivalent to a new value of the global speed $v' = c \cos(\alpha')$. The final angle has been already calculated ([7], Chapter 3) and it has this formula:

$$\alpha' = 2 * \arctan(p_1 \sin(\alpha) / (p_2 + p_1 \cos(\alpha))) - \alpha$$

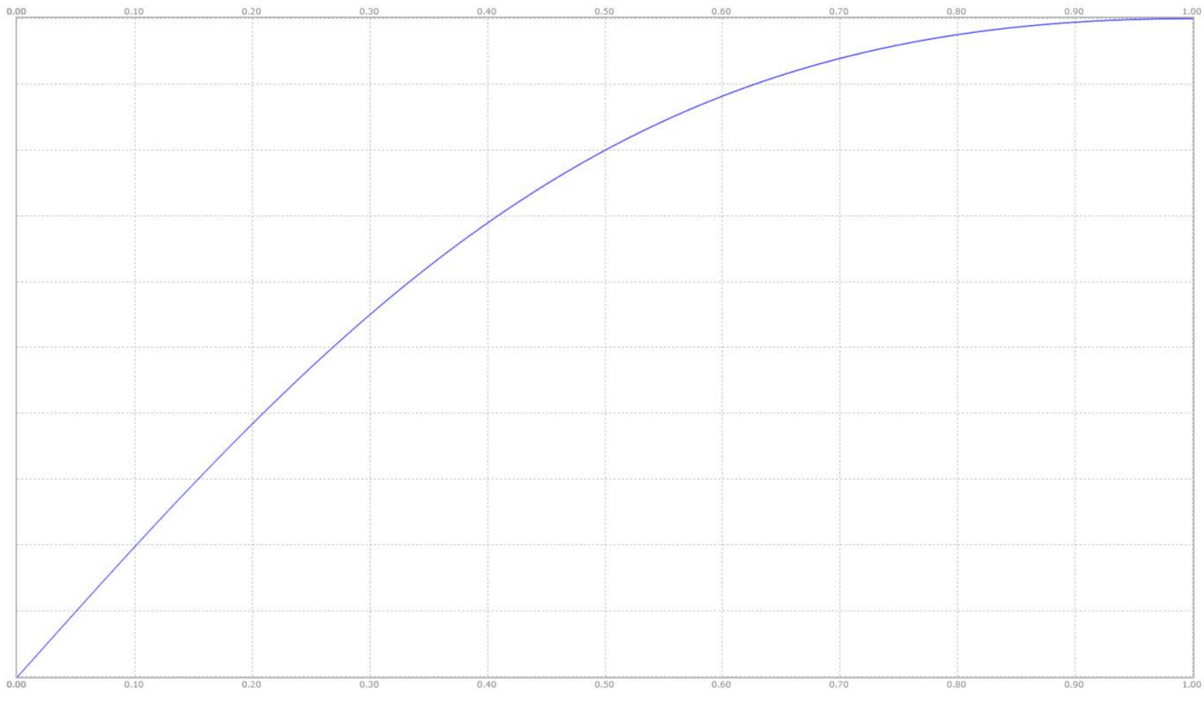

Figure 4 - *Dependence of the translational speed on impulse*

If we represent **v'** as function of the external impulse, it may be easily noticed a nonlinear dependence, meaning that an increasingly higher impulse is required for the same increase in speed of the particle (and vice versa when it is slowed down). The speed limit **c** could be reached by particles (starting from rest) if they receive a single impulse of $\mathbf{p_2}$ value. Seen from the dynamic mass perspective, you may easily notice that, if a particle is accelerated by a certain flux, it will "exhibit" a variable dynamic mass, having minimum value at the absolute velocity **zero** and maximum value (but finite) just before reaching the absolute speed **c**.

Figure 4 features on the horizontal axis the normalized external impulse (to the internal one) and on the vertical axis the absolute velocity (values between 0...c), both being linearly represented.

8. Annex 2

Let us now consider the distribution of speed as in Figure 2, on the left, where the speed of rotation $\mathbf{v_r}$ is assumed to fix the rate of particle's interactions through its precession motion and through the value induced to the dynamic mass. The time is therefore inversely proportional to $\mathbf{v_r}$:

$$\mathbf{\Delta t = k / v_r} \quad \text{where} \quad \mathbf{k = constant}$$

For a particle at rest, time is that of the AFR, and its rotation speed is exactly **c**:

$$\mathbf{\Delta t = k / c}$$

While it is in motion, its local time is **Δt'**:

$$\mathbf{\Delta t' = k / v_r = k / (c \sin(\alpha)) = k / c / (1 - \cos^2(\alpha))^{1/2} = k / c / (1 - v^2/c^2)^{1/2}}$$

And it simply results that the time is given by

$$\mathbf{\Delta t' = \Delta t / (1 - v^2/c^2)^{1/2}}$$

which is the well-known formula of the relativistic time dilation.

9. References

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Acronyms and Conventions

AFR - Absolute Frame of Reference

SR - System of Reference

TR - Theory of Relativity

TA - Theory of the Absolute

PT - Prime Theory [1]

"Abc" - Figurative language