Interactions and Group Symmetries in the Physical Universe

Daniele Sasso*

Abstract

The question of fundamental interactions in nature, of their interpretation and of their interrelations isn't defined well yet and it regards whether interactions in the microscopic elementary universe or interactions in the macroscopic universe. It is very important then to can relate interactions to symmetries because these allow a simplification of the mathematical description of the physical reality and consequently a simplification of models. In this paper let us consider two group symmetries that regard respectively interactions that happen into the elementary universe and into the macroscopic universe, that aren't considered adequately in mainstream physics. The question in particular refers to the group symmetry relating to interactions between light and mass in the macroscopic and cosmological universe and to the group symmetry of interactions between charge and energy quantum in the microscopic and nanoscopic universe. The theoretical study of these interactions, connected with the existence of first experimental confirmations, allows then to define new physical effects.

1. Introduction

The observation of the nature proves the only physical reality that is truly observable happens and is represented by interactions. These establish a process of cause and effect that allows to describe the observed reality in the order of models and paradigms that have to be in concordance with that. Any type of physical event is the outcome of an interaction, the simple vision through eyes too is an interaction between photons and retina. Observation is always deterministic, i.e. there is a precise relation between the observed event and the outcome of the observation even if that relation can be affected by casual or systemic errors of measurement. In some physical situations an aleatory and indeterministic observation is possible but it is caused by the same stochastic nature of the physical process like for instance the toss of dice. The concept of symmetry then is used very often in physics because it involves normally a simplification of the description of the physical reality. Symmetries have various and different typologies: space symmetry, geometric symmetry, time symmetry, matter symmetry, physical symmetry, etc... .

*** e_mail: dgsasso@alice.it**

Space symmetry involves all points of three-dimensional space are equivalent and this symmetry is defined also "homogeneity" of the empty space.
Geometric symmetry of space regards the uniformity of geometrical properties with respect to one point or to another geometrical entity of space. The most interesting geometric symmetry is no doubt the spherical symmetry.
Time instead is one-dimensional and it involves a different level of symmetry for which all time instants are equivalent with regard the same only direction (" iso-homogeneity of time"). The time iso-symmetry regards the codified succession of days, the cyclic succession of weeks, the cyclic succession of months or simply the time succession of cycles of a time periodic function. The time iso-symmetry, in contrast to space symmetry, doesn't have the property of reversibility.
Matter symmetry is defined by symmetric properties of parts that compose matter like the repetitive symmetry of atoms and molecules, or the repetitive symmetry of parts that compose a system (fractal).
Physical symmetry regards the behavior of different physical systems when it is characterized by manifest uniformity: fields with central symmetry, analogy of mathematical models, etc... . The Principle of Relativity, based on a principle of invariance of physical laws, defines a physical symmetry too. Similarly Conservation Laws, that describe the situation in which a physical quantity (not a physical law) is constant before and after a physical process, are physical symmetries.
Symmetries regard whether the macroscopic reality or the microscopic reality, but in this last case it needs to consider the existence of an important Principle of Asymmetry[1] that characterizes matter and antimatter in the microscopic Elementary Universe.
In this paper let us define a few new physical symmetries that don't have been considered in postmodern mainstream physics: the symmetry Mass-Light-Mass (symmetry MLM or M^2L^2) and the symmetry Charge-Quantum-Charge (symmetry CQC or C^2Q^2): both symmetries are related to four fundamental interactions and they are group symmetries, i.e. not the single interaction generates the symmetry, but the system of the four interactions generates overall a group symmetry.

2. The physical symmetry of gravitational field and of the electrostatic field

Gravitational field and electrostatic field are characterized by the same central symmetry and by a evident analogy regarding dynamics of the motion of a mass or of a charge.
The analogy is a physical symmetry that is determined by the affinity of mathematical models and for the two fields under consideration the respective dynamic scalar mathematical models [2][3] are

$$m_o \frac{dv}{dt} + kv = \frac{G\, M_o\, m_o}{r^2} \qquad (1)$$

for the gravitational field generated by a pole mass M_o that produces an attractive force on the mass m_o and

$$m_o \frac{dv}{dt} + kv = \frac{Qq}{4\pi\varepsilon_o r^2} \qquad (2)$$

for the electrostatic field generated by a positive pole charge +Q that similarly produces an attractive force on a trial negative charge -q with mass m_o.
Supposing that k=0 (absence of external resistances), solutions[2][3] of the two dynamics are

$$v(r) = \sqrt{\frac{2 G M_o}{r_o} \frac{r_o - r}{r}} \qquad (3)$$

for the gravitational field and

$$v(r) = \sqrt{\frac{Q q}{2 \pi \varepsilon_o m_o r_o} \frac{r_o - r}{r}} \qquad (4)$$

for the electrostatic field, where for both cases r_o is the initial position of the trial mass or of the trial charge into the force field in which for the sake of argument $v(r_o)=0$. The fundamental difference between the two dynamics is that anyway, also in the absence of external resistances (k=0), dynamics of the electrostatic field depends on the mass m_o of the trial charge (for instance an electron). The graphic representation of speeds of the two dynamics is qualitatively similar as per the analogy [2][3][4].
If now we consider for the electrostatic field the case in which both charges have the same sign, the electrostatic force is repulsive. In that event considering that time acceleration dv/dt is related to the space acceleration dv/dr by

$$a = \frac{dv}{dt} = \frac{dv}{dr}\frac{dr}{dt} = v\frac{dv}{dr} \qquad (5)$$

the solution of dynamics of motion is

$$v(r) = \sqrt{\frac{Q q}{2 \pi \varepsilon_o m_o r_o} \frac{r - r_o}{r}} \qquad (6)$$

in which, like in the event of attractive force, the trial charge is placed initially at the distance r_o where $v(r_o)=0$.
The speed of the charge +q, that suffers the repulsice force of the field that is generated by the pole charge +Q, tends at great distance from the pole (r=infinite) to the constant value

$$v(\infty) = \sqrt{\frac{Qq}{2\pi\varepsilon_o r_o m_o}} \qquad (7)$$

The graphic representation of the speed of the charge into the repulsive field is reported in fig.1

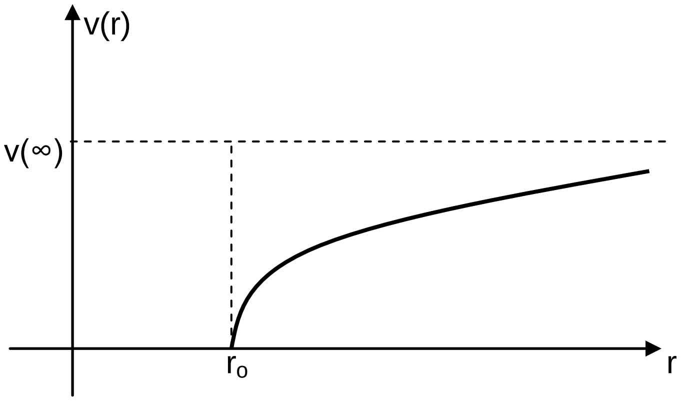

Fig.1 Graphic representation of the speed of an electric charge into a repulsive field

This repulsive behavior has been verified never in the gravitational field and therefore the comparison between the two mathematical models proves only the exixtence of a strong analogy between the two fields in the event of attractive force. It is possible to conclude indeed all fields with central symmetry are characterized by the same analogy regarding dynamics of motion into the field.
The reason why it isn't possible to suppose a stronger relationship than the simple physical symmetry between gravitational field and electrostatic field, in addition to the fact that in the gravitational field there isn't the repulsive force, is that the two fields are generated by different physical sources. The gravitational field is generated by mass of physical systems while the electrostatic field is generated by electric charge. It determines the exclusively attractive property of gravitational field. These considerations don't exclude the fact that there is a relationship between charge and mass like there is a relationship between charge and spin ("Theorem of Spin and Charge" in the NSM), but this relationship can exist only for charged physical systems like massive elementary particles and not for neutral systems.

3. The group symmetry MLM (Mass-Light-Mass)

Let us want to consider now the symmetry Mass-Light-Mass that is characterized by four interactions that generate four different effects and an evident physical symmetry of group:

a. Interaction Mass-Mass
b. Interaction Mass-Light
c. Interaction Light-Mass
d. Interaction Light-Light

The symmetry MLM is a symmetry Matter-Energy at level macroscopic and it regards reciprocal interactions between mass and energy.

3.a Interaction Mass-Mass

Interaction Mass-Mass is defined by Newton's Law of Gravitation for which two bodies with mass M and m respectively attract each other with a force F whose scalar intensity is given by

$$F = \frac{GMm}{r^2} \qquad (8)$$

In Newton's theory the (8) defines the reciprocal interaction at distance between the two bodies, where $G=6.67x10^{-11}\ Nm^2/kg^2$ is the gravitational constant. The force F is in actuality a vector for which the (8) gives the intensity of the force, that has the direction of the line joining barycentres of two bodies and it is applied in the barycentre of mass m if the mass M is supposed at rest.

General Relativity is based on a different model of gravity and it supposes instead no direct interaction is present between the two masses, but each mass changes the spacetime for which the interaction and dynamics of motion is a consequence of the deformation and of the curvature of the spacetime.

Physics of Gravitational Fields (PGF)[4][5] accepts the concept that there isn't a Newtonian action at distance between the two masses but it proves a direct physical interaction between the two masses exists, without the necessity of an intermediary action of the spacetime, and it is due to the interaction between the primary gravitational field of the mass M, that exists in every point of the space domain since the initial instant of physical existence of the mass M, and the secondary gravitational field generated by the mass m since the initial instant in which it is into the primary field. If the body with mass M is a pole mass (with M>>m) that generates the primary gravitational field, then through the gravitational field and the gravitational potential that are present in every point of the useful physical space and of the field domain , mass M produces an attractive force towards mass m, that in its turn generates a secondary field and a gravitational potential in every point of the common domain. Therefore in PGF the interaction mass-mass is in actuality the effect of the interaction between gravitational fields and it is neither a Newtonian action at distance nor an Einsteinian deformation of spacetime. In PGF dynamics of motion of the mobile body has been considered and studied in the preceding paragraph in various physical situations [2].

With regard to the existence of gravitational waves, the scientific collaboration LIGO-VIRGO has announced their measurement, and it has supposed those gravitational waves come from the collision of two black holes that would be happened billions of years ago at greatest distances from the Earth. About this PGF proves perturbations (or waves) of gravitational field that propagate in the shape of waves are possible and this event would have to be studied and analyzed according to real experimental procedures, because if those waves exist really, then it would have to be possible to measure them also by experiments regarding the Earth gravitational field. In fact we have supposed and proved those gravitational waves are due to the perturbation of the pre-existent primary gravitational field and they are caused by the fall of a body into the gravitational field itself. Physical characteristics of gravitational waves in PGF[4] are:

$$\text{wavelength } \lambda_p = r_o - r$$
$$\text{perturbation duration } T_p = 1/a_r = 1/f_p \qquad (9)$$
$$\text{perturbation speed } c_p = \lambda_p / T_p = \lambda_p f_p$$

in which

$$T_p = \frac{1}{a_r} = 2r\sqrt{\frac{r(r_o - r)}{2GM_o r_o}} \qquad (10)$$

and a_r is the space acceleration, or oscillation frequency, of the gravitational perturbation (wave) that is given by

$$a_r(r) = -\frac{dv}{dr} = \frac{1}{2}\sqrt{\frac{2GM_o r_o}{r^3(r_o - r)}} \qquad (11)$$

The speed of the front of gravitational wave is for every value of r

$$c_p(r) = \sqrt{\frac{GM_o r_o(r_o - r)}{2r^3}} \qquad (12)$$

A graphic representation of wave perturbation for every value of r is given in fig.2, where it is possible to observe gravitational wave propagates perpendicularly to the fall direction of the mass m_o.

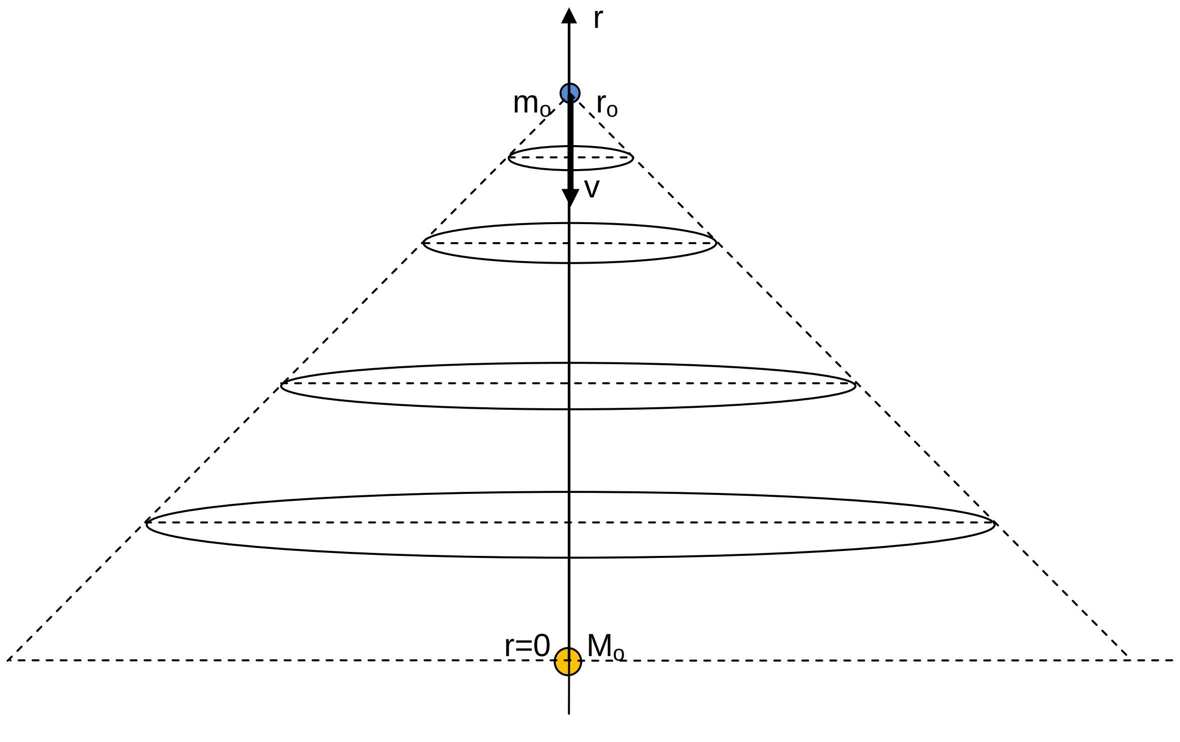

Fig.2 Representation of gravitational wave that propagates perpendicularly to the body fall.

3.b Interaction Mass-Light

Interaction Mass-Light is defined in General Relativity by the Einstein effect concerning the deflection of light into a gravitational field generated by a mass M and described by the scalar tensor model of curvature spacetime. The effect of curvature in GR is given by

$$C = \frac{4GM}{c_o^2 r} \qquad (13)$$

where the deflection of light C has a hyperbolic trend with the distance r of ray of light from the barycentre of mass M.
In TR and in PGF this interaction is explained considering light is a beam of energy particles (photons) and every particle is in actuality an electromagnetic nanowave that can be related to an equivalent mass[2][4][5][6] ($m_{eq}=hf/c^2$). As per this equivalence we calculated the following expression of the deflection of light[6]

$$\Delta_n = \frac{2GM}{c_o^2 R} \frac{\sin(n\alpha_o)}{n} \qquad (14)$$

in which c_o is the physical speed of light in vacuum and $\alpha_o \approx R/D_{TS}$. R is the radius of the pole mass, D_{TS} is the distance between the barycentre of the pole mass and the position of the observer, n at last is an integer number (n=1, 2, 3...). The trend of the deflection in TR isn't hyperbolic but trigonometric decreasing. Let we have called "Einstein second effect" the deflection of light into a gravitational field given by (14) in honour of the scientist who first studied systematically and defined the effect, and let we distinguish this effect from "Einstein first effect" that regards instead the cosmological redshift[5].

3.c Interaction Light-Mass

Interaction Light-Mass is defined by the Rancourt Effect, from the scientist who first has verified sistematically the existence of the interaction that he communicated in the Question raised by Parviz Parvin in ResearchGate: "Is gravity a Newtonian force or Einstein space-time curvature?". Louis Rancourt, at first alone and after in collaboration with Phil Tattersall, has performed a series of experiments in which he has maked use of a horizontal panel where light propagated. This panel was placed at first under the test mass m and after over the test mass[7][8] .
When the test mass is placed under the panel a small decrease of weight is observed (fig.3). When the test mass is placed over the panel a small increase of weight is observed (fig.4). The two experiments prove light produces a gravitational effect on a test mass, besides this interaction light-mass (Rancourt Effect) is symmetrical with the interaction mass-light (Einstein second effect) in which light suffers the action of gravitational field.
Let we want to give now a theoretical explanation of the Rancourt Effect in the order of the Theory of Reference Frames (TR) and of Physics of Gravitational Fields (PGF), starting

from the consideration that if great masses produce a measurable interaction on light, then also light would have to produce a measurable interaction on small masses.
We know in the absence of panel and of shaft of light the interaction between the mass M of the Earth pole and test mass m is given by gravitation law of the interaction mass-mass.
In that case the gravitation force represents the weight p of mass m in the gravitational field generated by mass M of the Earth

$$p = F = \frac{GMm}{r^2} \qquad (15)$$

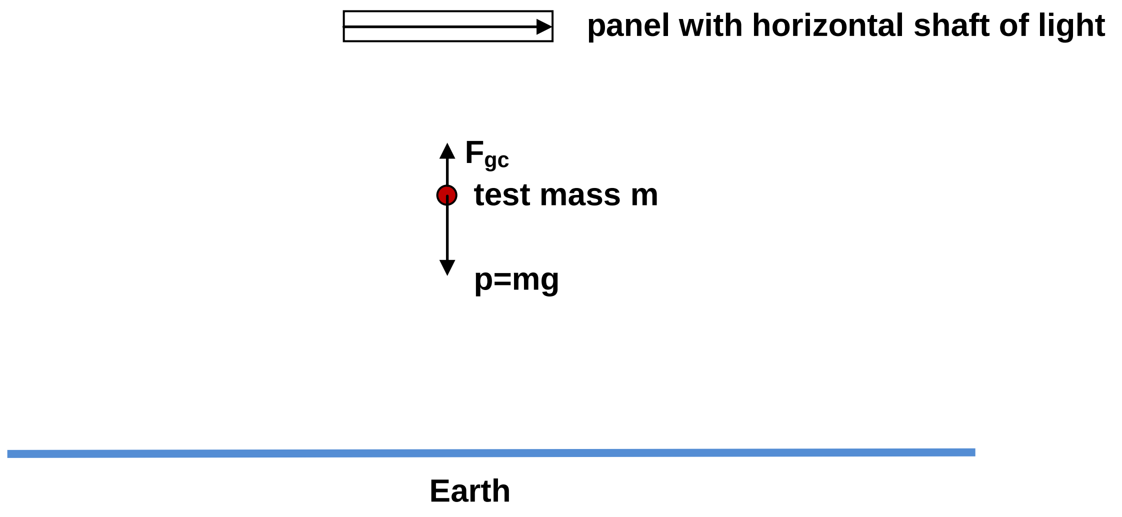

Fig.3 The test mass is placed under the panel

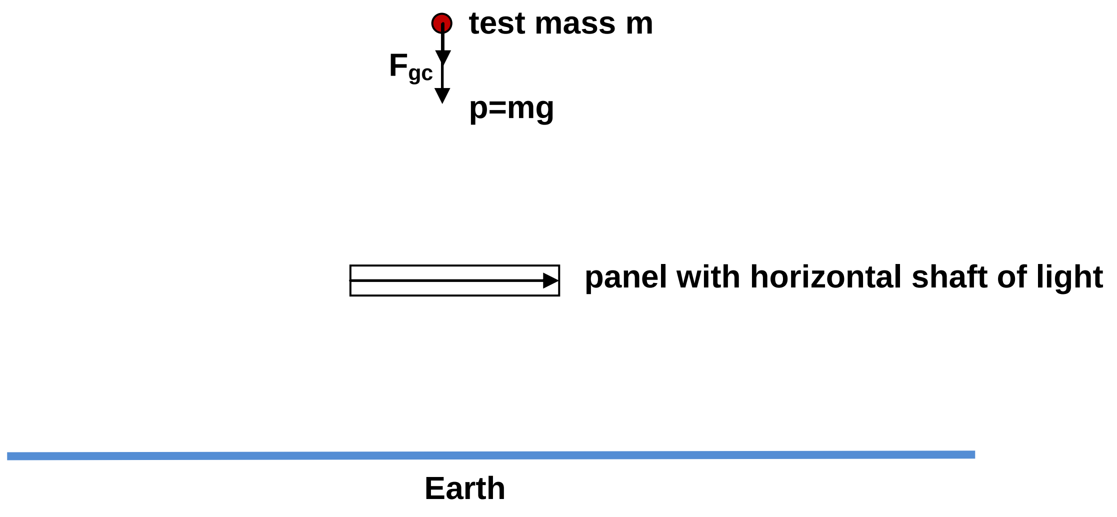

Fig.4 The test mass is over the panel

Let's suppose now that a fixed panel is present and inside a shaft of light moves in horizontal direction. We know the light is a beam of N photons (with N greatest) that travel the panel in a shortest time: every single photon of light represents an electromagnetic nanowave with frequency in the visible band. As per Planck and Einstein's relationships a photon has an equivalent mass [9]

$$m_f = \frac{hf}{c_o^2} \qquad (16)$$

Consequently N photons have an overall equivalent mass $M_f = Nm_f$.
A photon with typical frequency $f = 0.5 \times 10^{15}$Hz, has an equivalent mass $m_f = 0.369 \times 10^{-35}$kg.
As per the equivalence every photon with mass m_f generates a gravitational nanofield

$$E_{gf} = \frac{Gm_f}{r^2} \qquad (17)$$

and the shaft of light composed of N photons, that is inside the panel, generates an overall equivalent gravitational field

$$E_{gc} = \frac{NGm_f}{r^2} \qquad (18)$$

This field produces an attractive force on the test mass m given by

$$F_{gc} = \frac{NGm_f m}{r^2} \qquad (19)$$

In the event of test mass under the panel (fig.3), the attractive force F_{gc} of light is opposite the weight p of the test mass and therefore the overall force that acts on the mass m causes a decrease of the weight of mass m, like the experimental measure proves, i.e. the test mass experiences a smaller gravitational force and its weight decreases

$$p_t = \frac{G(M - Nm_f)m}{r^2} \qquad (20)$$

In the opposite event with the test mass that is placed over the panel (fig.4), we have on the contrary a small strengthening of the gravitational force and consequently a small increase of the weight of the test mass

$$p_t = \frac{G(M + Nm_f)m}{r^2} \qquad (21)$$

In the considered equivalence light, that is in actuality a beam of electromagnetic nanowaves, generates a small gravitational field as per its equivalent mass that is derived by Planck and Einstein's relationships producing a decrease or a increase of the weight.

Earth's gravitational force on a test mass m near the Earth surface ($r \approx R_T$=6372.8km) is F_T=9.8m [N] while the gravitational force produced by one typical photon at the distance of about 1m on the same test mass is $F_f = 2.5 \times 10^{-46}$m [N]. It follows that if the shaft of light is composed of N photons the overall gravitational force of the shaft of light on the test mass is about

$$F_{fN} = 2.5 \times 10^{-46} \, Nm \, [N] \tag{22}$$

and

$$F_{fN} = 0.25 \times 10^{-46} \, NF_T \, [N] \tag{23}$$

From the (23) we deduce the attractive force (Rancourt effect) of the shaft of light on the mass m is much smaller than the attractive force of the Earth from which the difficulty to observe and to measure. Besides that force depends on the number N of photons that constitute the shaft and on their frequency for which increasing the number of photons and the frequency of energy quanta the attractive force of the shaft increases. A simply reckoning shows that for getting a percentual variation of 0.15% with regard to the weight of a mass m a shaft of light composed of about $N = 3994 \times 10^{43}$ typical photons is required.

3.d Interaction Light-Light

Interaction LIght-Light is the result of Parviz Parvin's idea in the order of the same question in ResearchGate in which L. Rancourt communicated his experimental results on the interaction Light-Mass. Experimental verifications about this interaction aren't known and therefore in this paper we will search for giving only a theoretical explanation of this interaction (Parvin effect) that represents the fourth aspect of the symmetry MLM. Previously we have proved every photon has an equivalent mass given by the (16) and consequently two photons with frequencies f_1 and f_2, as per gravitation law , must attract each other with a smallest force

$$F = \frac{Gh^2 f_1 f_2}{c_o^4 r^2} \tag{24}$$

where r is the distance between paths of the two photons. Consequently two shafts of light that travel along parallel directions at a distance r, must attract each other with a force

$$F = \frac{Gh^2 f_1 f_2 \, N_1 N_2}{c_o^4 r^2} \tag{25}$$

in which N_1 and N_2 are numbers of photons of the two shafts.
Only experimental proofs and confirmations will be able to furnish further knowledges about this interaction that being smallest is very difficult to measure.

4. The group symmetry CQC (Charge-Quantum-Charge)

The symmetry CQC is a symmetry of microphysical systems and it regards charge and energy quantum. This symmetry is defined by four interactions that generate the group symmetry:

a. Interaction Charge-Charge
b. Interaction Charge-Quantum
c. Interaction Quantum-Charge
d. Interaction Quantum-Quantum

For energy quanta let us consider the physico-mathematical model[10] derived by the "rational trigonometry" that associates to every energy quantum a function of nanowave that is defined only inside a single cycle of the trigonometric function while it isn't defined outside that cycle. It allows to periodize the nanowave with regard to the whole axis of the independent variable and to have in Fourier's frequency domain only one spectrum line. This choice of the mathematical model allows to remove the indetermination of Heisenberg's model that is due to the presence of numerous spectrum lines.
For electric charges let us consider the physico-mathematical model[11][12] deduced from the "Theorem of Spin and Charge" that establishes an important relationship between the spin of elementary particles that has mechanical nature and the electric charge. This relationship involves electric charge has a mechanical origin and it is able to explain well the quantized nature of electric charge because spin itself has quantized nature.

4.a Interaction Charge-Charge

Interaction charge-charge is defined by Coulomb's law that characterizes the electrostatic field, for which two charges Q and q attract each other if the two charges have opposite sign and they repulse if the two charges have the same sign, with a vector force whose intensity is given by

$$F = \frac{Qq}{4\pi\varepsilon_o r^2} \qquad (26)$$

where ε_o is the dielectric constant in vacuum if charges are in vacuum and r is the distance between the barycentres of the two charges. Also for this interaction, like for the interaction mass-mass, the force isn't an action at distance between the two charges but it is an interaction between the two electrostatic fields that exist inside the space domain that is common to the two fields. In the event of charges with the same sign the force is repulsive, and in the event of charges with opposite sign the force is attractive. If charges regard massive elementary particles with charge e (interaction electron-electron, interaction proton-proton and interaction proton-electron), the intensity of the force is, whether in the attractive or repulsive case,

$$F = \frac{e^2}{4\pi\varepsilon_o r^2} \qquad (27)$$

In these cases the interaction charge-charge is far prevailing on the interaction mass-mass of same particles.
In the event of one electron and of one positron (antimatter) the outcome is a collision positron-electron with the disappearance of two massive particles and the production of two, three or four energy quanta[11]. The same thing would have to happen for a collision proton-antiproton. In the event of one electron and one proton the outcome can be the formation of a hydrogen atom or a collision proton-electron.
Like the fall of an ordinary body or of a massive particle into a gravitational field generates a gravitational perturbation , so also the motion of an electrical charge into an electrostatic field generates an electrostatic perturbation[13] that propagates with space acceleration $a_r(r)$

$$a_r(r) = -\frac{dv}{dr} = \frac{1}{2r(r_o-r)}\sqrt{\frac{Qqr_o(r_o-r)}{2\pi\varepsilon_o m_o r}} \qquad (28)$$

Physical characteristics of electrostatic perturbation are fully similar to characteristics of gravitational perturbation and further the speed of the front of electrostatic perturbation, for every r, is given by

$$c_e(r) = \sqrt{\frac{Qq(r_o-r)}{2\pi\varepsilon_o m_o r_o r}} \qquad (29)$$

Electrostatic perturbation has the same graphic representation as gravitational perturbation (fig.5).
Let us observe acceleration and speed depend on whether the two electric charges or the mass of moving charged particle. For gravitational perturbation instead acceleration and speed depend only on pole mass.
We know a charged massive particle, accelerated from an electrostatic field, emits also radiant electromagnetic energy but the two effects into the electrostatic field (electrostatic perturbation and electromagnetic emission) are different even if both are due to the accelerated motion of the charged massive elementary particle into the electrostatic field: in particular the perturbation is due just to the accelerated motion into the electrostatic field, while the electromagnetic emission is due to the variation of electrodynamic mass with speed when particle is accelerated.
Besides the two effects present a fundamental difference: in fact the electrostatic perturbation has continuous nature and it is generated for every value of the distance r, the electromagnetic radiation instead has quantum nature and it is emitted by particle only for a few characteristic discrete values of electrodynamic mass, speed and distance.

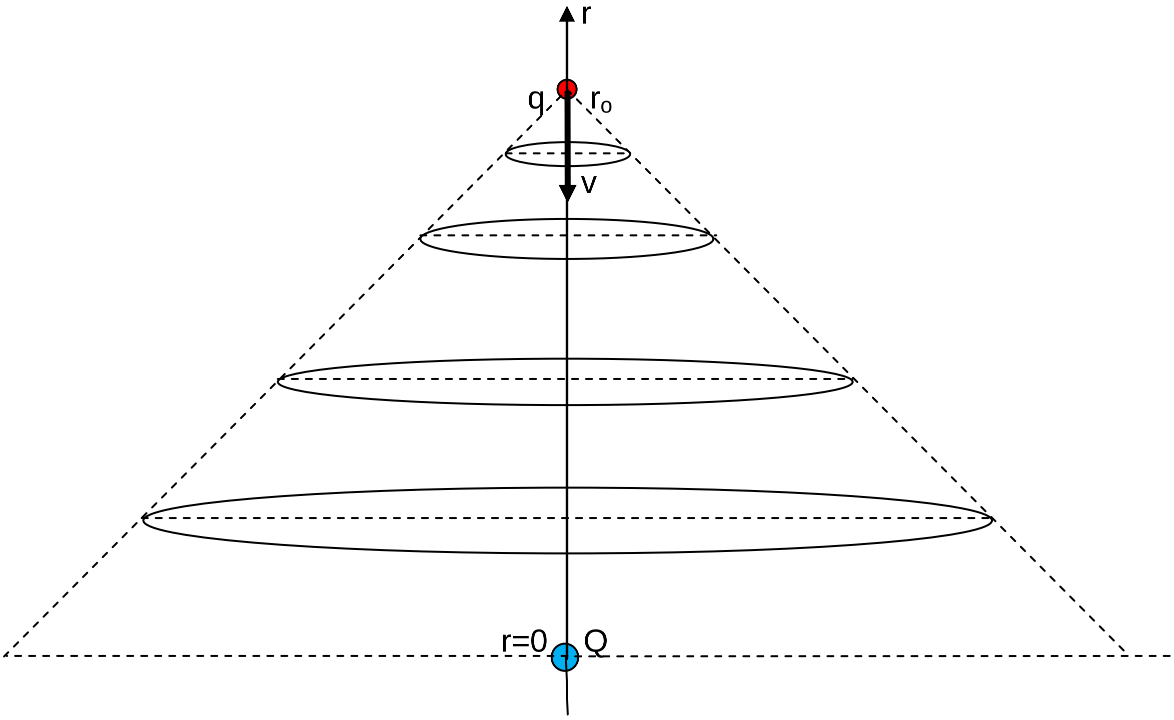

Fig.5 Graph of electrostatic perturbation for different values of r and different values of λ_e.

4.b Interaction Charge-Quantum

Interaction charge-quantum consists in the collision and therefore in a contact interaction between a moving free elementary charge and an energy quantum that moves with the physical speed of light. In the physical process of collision fundamental principles of conservation are respected: energy, mass, momentum, charge, spin. The examination of collision (fig.6), in the event of a charge with momentum $p=mv$ and of an energy quantum with energy $E=hf$ before the collision, shows the process of collision produces a charge and an energy quantum with different physical characteristics (oscillation). In fact after the collision the charge has greater momentum and greater kinetic energy while the quantum has greater wavelength, smaller frequency and smaller energy. After the collision we have

$$v' > v \qquad \lambda' > \lambda \qquad f' < f \tag{30}$$

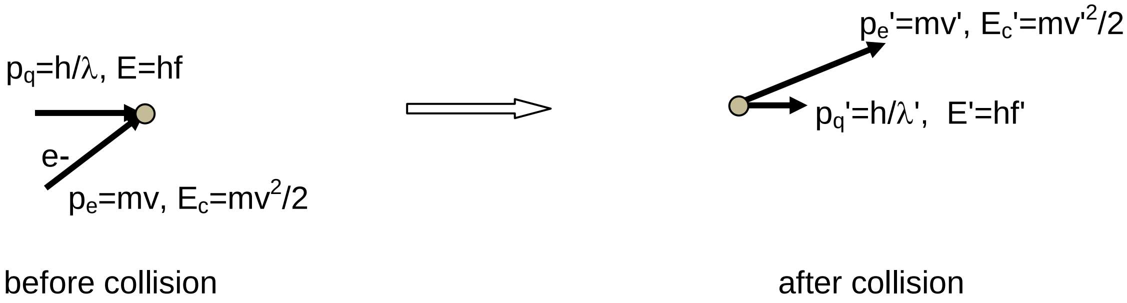

Fig.6 Graphic representation of the contact interaction charge-quantum in the event of electron

In the event that the charge is a peripheral electron and consequently it is supposed practically free because it is little tied into atom, the interaction charge-quantum is described by the Compton effect[14] that consists in the change of the wavelength and of the frequency of energy quanta that collide with free electrons. In the Theory of Reference Frames the Compton effect (fig.7) is described by the following relationship for the frequency

$$f - f' = \frac{hff'}{mc^2}(1 - \cos\theta) + \frac{h(f - f')^2}{2mc^2} \qquad (31)$$

and for the wavelength

$$\lambda' - \lambda = \frac{h}{mc}(1 - \cos\theta) + \frac{h(\lambda' - \lambda)^2}{2mc\lambda\lambda'} \qquad (32)$$

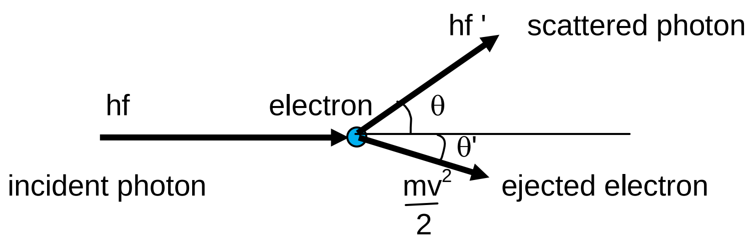

Fig.7 Graphic reprentation of the Compton effect

Relationships of the Compton effect in TR are different from analogous relationships in the relativistic classical formulation because of the presence in the (31) and in the (32) of an effect of the second order that is instead absent in the relativistic classical formulation. That effect of the second order proves the Compton effect, even if smallest, exists also when θ=0. This effect (for θ=0) is altogether absent in the relativistic classical formulation.

4.c Interaction Quantum-Charge

Interaction quantum-charge is described in physics by a very known effect: the photoelectric effect that describes the collision between one energy quantum and one electron that is tied inside matter.
The photoelectric effect consists in the emission of electrons by atoms supposed fixed when they are hit by photons or in general by energy quanta. The photoelectric effect is defined by the known law of emission of electrons

$$E_c = h(f - f_s) \qquad (33)$$

where f is the frequency of incident quantum, f_s is the frequency of photoelectric cut-off of metal matter and E_c is the maximum kinetic energy of emitted electrons.

4.d Interaction Quantum-Quantum

In the event that quanta belong to the visible band, the interaction quantum-quantum is part of the interaction light-light concerning photons (interaction photon-photon). In the general case this interaction regards energy quanta that are into any band of frequency. Anyway the expression of the interaction quantum-quantum, like for photons, is deducible from the virtual equivalent mass of every energy quantum and it is given by the relation (24) that we here rewrite

$$F = \frac{Gh^2 f_1 f_2}{c^4 r^2} \qquad (34)$$

where r is the distance between directions of path of the two quanta, f_1 and f_2 are frequencies of nanowave functions that represent quanta.

Group interactions here considered don't use up the whole typology of natural interactions, in fact for instance interactions inside nucleus[12] are outside this picture, but certainly they give an important systematic picture of a few fundamental interactions that are present in nature.
This paper and previous others by author prove the real physical universe is different whether from the thought universe or from the indeterministic universe that are privileged models of universe in postmodern physics.

References

[1] D. Sasso, The Principle of Asymmetry in the Elementary Universe, viXra.org, 2014, id: 1411.0413
[2] D. Sasso, Dynamics of Motion in Gravitational Fields of First Type,viXra.org, 2015, id: 1506.0014
[3] D. Sasso, Dynamics and Electrodynamics of Moving Real Systems in the Theory of Reference Frames, arXiv.org, 2010, id: 1001.2382
[4] D. Sasso, Physics of Gravitational Fields, viXra.org, 2014, id: 1405.0028
[5] D. Sasso; Not linear Element, Cosmological Redshift and Deflection of Light in the Gravitational Field; viXra.org; 2011; id: 1111.0036
[6] D. Sasso, Predictions on Observations and Measurements of the Deflection of Light on the Occasion of 2015 Solar Eclipse According to the Theory of Reference Frames, viXra.org, 2014, id: 1401.0188
[7] L. Rancourt, Why I believe that light can decrease gravity and why gravity is a pushing force, 2012, ResearchGate.net
[8] L. Rancourt, P. Tattersall, Further Experiments Demonstrating the Effectvof Light on Gravitation, Applied Physics Research, Vol.7, No 4, 2015
[9] D. Sasso, On Different Meanings of Mass in Physical Systems, viXra.org, 2014, id: 1401.0047
[10]D. Sasso, Physico-Mathematical Models of Elementary Particles and Physical Processes of Oscillation, viXra.org., 2016, id: 1601.0231
[11]D. Sasso, On primary Physical Transformations of Elementary Particles: the Origin of Electric Charge, viXra.org,, 2012, id: 1202.0053
[12]D. Sasso, Bosons in the Zoo of Elementary Particles, viXra.org, 2013, id: 1305.0035
[13]D. Sasso, On physical Behavior of Elementary Particles in Force Fields, viXra.org, 2014, id: 1409.0013
[14]D. Sasso, Relativity and Quantum Electrodynamics in the Theory of Reference Frames:the Origin of Physical Time, viXra.org, 2011, id: 1109.0018