

# *Interaction between force, energy and mass*

*Giustino Travaglini*

## **Abstract**

Until now in modern physics energy, force and mass have been considered separate and distinct entities, the various forces of nature have not been linked into a single, coherent theory, and general relativity shows inconsistencies with some mechanical phenomena quantum. The purpose of this article is to show that energy, force and mass are a single entity which I will refer to as “energy force” furthermore general relativity can harmonize with quantum mechanics in a single theory but needs to be expanded. To arrive at this result, I used recent studies carried out on some phenomena of quantum mechanics, in particular on the existence, nature and characteristics of "quantum entanglement". The results obtained from the observation and study of "quantum entanglement" show that energy, force and mass are one and that light is to be considered not as an entity that moves with a constant speed but as a accelerating variable entity.

## **Introduction**

Entanglement or quantum correlation is a quantum phenomenon, not reducible to classical mechanics, for which, in the condition, foreseen by the superposition principle of quantum mechanics, in which two or more physical systems (typically two particles) form a system whose quantum state is represented by a combination of their individual states, the measurement of an observable of a system (subsystem) also simultaneously determines the value of the same observable of the others. Since the state of quantum superposition is independent of a spatial separation of such systems (subsystems), entanglement implies in a counterintuitive way the presence of distant correlations between them and, consequently, the non-local character of the physical reality. According to quantum mechanics it is possible to create a system consisting of two particles characterized by certain global values of some observables. This implies that the value of one of these measured on a single particle (a typical example is spin) instantly influences the corresponding value of the other, which will be such as to maintain the initial global value, according to the conservation law. This remains true even in the experimentally possible case that the two particles are spaced apart, without any spatial limit. It should be noted that the measurement process relating to the single particle is subject to the quantum rules of probability. In practice, two particles can be obtained which, according to theory, should possess this characteristic, by making them interact appropriately or by acquiring them from a natural process that originates in the same instant (for example a single radioactive decay), so that they are described by a state defined global quantum, while individually maintaining an indefinite character until a measurement is performed. I will not dwell on the mathematical formalism as many studies carried out with photons are already known, neutrinos and electrons have demonstrated the existence of quantum entanglement. [1-3]

## **The Energy Force**

The existence of quantum entanglement is indisputable however the phenomenon does not agree with the theory of relativity which, among its pillars, has the constant of the speed of light at about 300,000 km/s. We know that the formula for Energy is:

$$E = mc^2$$

Where E=energy, m=mass, c=constant (speed of light in vacuum). The constancy of the speed of light in a vacuum does not agree with the property of simultaneity present in quantum entanglement. Postulating that light is an accelerating entity and not an entity moving at a constant speed resolves this inconsistency.

Called "c t" the way of the light speed in one second, set " $ct = 3 \times 10^8$  [m]" that become a constant with the unit [m] and rewrite the energy formula:

$$E = m a c t$$

Where E=energy, m=mass, a=acceleration (acceleration of light),  $ct = 3 \times 10^8$  [m]

Now the simultaneity present in the phenomenon of quantum entanglement is explained.

If it is true that:

$$E = m a c t$$

You get:

$$m = E / a c t$$

Looking at the new Energy formula:

$$E = m a c t$$

We realize that the Energy formula is identical to that of the Force where:

$$F = ma$$

Where F=force, m=mass, a=acceleration

Consequently we have:

$$m = F / a$$

Since  $m=m$  then:

$$F / a = E / a c t$$

Therefore we get:

$$F = E / (3 \times 10^8 m) = ma$$

This means that by expanding the theory of general relativity and considering light as an accelerating entity it is possible to conclude that force is equal to energy and mass, therefore force, energy and mass are a single entity which I will here call "energy force".

To rewrite the equations of relativity considering light as a variable acceleration, we need to modify the basic equations of general relativity to include this new characteristic of light. Since recent discoveries suggest that light is no longer a constant but subject to variable acceleration, we must adapt the equations to reflect this dynamic.

This modification implies that the total energy of an object depends not only on its rest mass and momentum but also on the acceleration of light interacting with it.

### 1. Field Equation with Light-Matter Coupling

$$R_{\mu\nu} - \frac{1}{2} R g_{\mu\nu} + \Lambda g_{\mu\nu} = \frac{8\pi G}{c^4} T_{\mu\nu}$$

Where:

$R_{\mu\nu}$  is the Ricci tensor,  $R$  is the Ricci scalar,  $g_{\mu\nu}$  is the metric tensor,  $\Lambda$  is the cosmological constant,  $G$  is the universal gravitational constant,  $C$  is the speed of light in vacuum,  $T_{\mu\nu}$  is the energy-momentum tensor.

To include the effect of the variable acceleration of light in the energy-momentum tensor, we can introduce additional terms that reflect this new understanding. These terms is represented by functions dependent on time and space that describe the evolution of the energy and momentum of light along its path in spacetime. We add nonlinear terms involving temporal and spatial derivatives of the fields and potentials associated with light.

Modified energy-momentum tensor is:

$$T_{\mu\nu} = T_{\mu\nu}^{(m)} + T_{\mu\nu}^{(r)} + T_{\mu\nu}^{(l)}$$

where:

- $T_{\mu\nu}^{(m)}$  represents the contribution from non-luminous matter and energy.
- $T_{\mu\nu}^{(r)}$  represents the contribution from classical electromagnetic radiation, without accounting for the variable acceleration of light.
- $T_{\mu\nu}^{(l)}$  represents the new contributions that incorporate the effect of the variable acceleration of light.

The term  $T_{\mu\nu}^{(l)}$  is represented by a more complex expression:

$$T_{\mu\nu}^{(l)} = \rho_\gamma c^2 u_\mu u_\nu + p_\gamma g_{\mu\nu} + \Pi_{\mu\nu}$$

where  $\rho_\gamma$  is the energy density of light,  $p_\gamma$  is the pressure of light,  $u_\mu$  is the four-velocity of light, and  $\Pi_{\mu\nu}$  is a tensor representing any additional effects due to the variable acceleration of light.

## 2. Equation of Motion for Light

$$\nabla^\mu F_{\mu\nu} = \frac{1}{c} J_\nu$$

where  $F_{\mu\nu}$  is the electromagnetic tensor,  $J_\nu$  is the current associated with light, and  $\nabla^\mu$  represents the covariant derivative;

## 3. Conservation Equation for Energy-Momentum

Incorporating the variable acceleration of light into the conservation equation for energy-momentum requires considering how this acceleration affects the stress-energy tensor. Since light carries energy and momentum, its variable acceleration influences the distribution of energy and momentum in spacetime.

The modified conservation equation for energy-momentum with light experiencing variable acceleration can be expressed as:

$$\nabla_\mu T^{\mu\nu} = a^\nu$$

where  $\nabla_\mu$  denotes the covariant derivative with respect to the spacetime index  $\mu$ ,  $T^{\mu\nu}$  is the stress-energy tensor, describing the distribution of energy, momentum, and stress in spacetime,  $a^\nu$  represents the four-acceleration of light, which varies with position and time due to its variable acceleration.

## 4. The equation of geodesic motion

The geodesic equation, which describes the motion of a free particle in curved spacetime, is given by:

$$\frac{d^2 x^\mu}{d\tau^2} + (\Gamma_{\alpha\beta})^\mu \frac{(dx)^\alpha}{d\tau} \frac{(dx)^\beta}{d\tau} = \frac{q}{m} (F_\nu)^\mu \frac{(dx)^\nu}{d\tau}$$

where  $x^\mu$  are the spacetime coordinates,  $\tau$  is the proper time,  $(\Gamma_{\alpha\beta})^\mu$  are the Christoffel symbols describing the affine connection,  $\frac{d}{d\tau}$  represents the derivative with respect to proper time,  $q$  is the charge of the particle,  $m$  is its mass, and  $(F_\nu)^\mu$  is the electromagnetic field tensor.

To include a variable acceleration of light, we can modify the geodesic equation by adding a term that accounts for this acceleration. Let's assume that  $a^\mu$  represents the variable acceleration of light. The modified geodesic equation can be expressed as:

$$\frac{d^2 x^\mu}{d\tau^2} + (\Gamma_{\alpha\beta})^\mu \frac{(dx)^\alpha}{d\tau} \frac{(dx)^\beta}{d\tau} = \frac{q}{m} (F_\nu)^\mu \frac{(dx)^\nu}{d\tau} + a^\mu$$

where  $x^\mu$  are the spacetime coordinates,  $\tau$  is the proper time,  $(\Gamma_{\alpha\beta})^\mu$  are the Christoffel symbols describing the affine connection,

$\frac{d}{d\tau}$  represents the derivative with respect to proper time,  $q$  is the charge of the particle,  $m$  is its mass, and  $(F_\nu)^\mu$  is the electromagnetic field tensor.

The term  $a^\mu$  represents the variable acceleration of light, which may depend on the properties of the medium through which light

propagates or other physical interactions. This modification accounts for the fact that light can be subject to non-inertial forces due to this variable acceleration.

### **Results**

- There is an equivalence between energy, mass and force which from now on will be considered as a single entity called "energy force";
- The phenomenology of energy- force confirms the correctness of the general and restricted theory of relativity which, however, are limited because they describe a particular case of the motion of light, i.e. the one in which it moves at a constant speed, not taking into account the more general case in which light is an accelerating variable entity;
- Quantum entanglement represents an empirical demonstration of light as an accelerating variable entity and not as an entity capable of moving only with constant speed;

### **Verification Experiment**

An experiment that could demonstrate that light undergoes variable acceleration could be based on the phenomenon of light aberration.

Light aberration is a phenomenon observed when the Earth moves through space while light travels through the vacuum.

This movement of the Earth can influence the angle under which we observe light from a distant star, creating an apparent deviation in the star's apparent position.

The experiment could be structured as follows:

1. Place a telescope on a rotating mount that allows for changing the observation angle.
2. Locate a distant star and record its apparent position in the sky using the telescope.
3. Repeat the observations at different times of the year when the Earth is in different positions along its orbit.
4. Measure the variations in the angle under which the star appears in the telescope.
5. Compare these variations with predictions based on the theory of light aberration, which takes into account the Earth's orbital motion and the speed of light.

If the acceleration of light were uniform, there would be no deviation in the observation angle of the star.

However, if the acceleration of light were variable, discrepancies between theoretical predictions and actual measurements of the angle of light aberration might be observed.

To increase the accuracy of the experiment, it would be necessary to control and correct for any factors that could affect the measurements, such as the effect of atmospheric distortion or other environmental factors.

Additionally, the use of precision instruments and sophisticated measurement techniques would be essential for obtaining reliable results. 5

### **Acknowledgement**

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### **References**

1. Kocher CA, Commins ED. Polarization correlation of photons emitted in an atomic cascade. Phys. Rev. Lett.,1967.10;18(15):575.
2. Formaggio JA, Kaiser DI, Murskyj MM et al.Weiss TE. Violation of the Leggett-Garg inequality in neutrino oscillations. Phys. Rev. Lett. 2016.26;117(5):050402.
3. Hensen B, Bernien H, Dréau AE, et al, Experimental loophole-free violation of a Bell inequality using entangled electron spins separated by 1.3 km.:1508.05949. 2015.24.