The fundamental role played by the speed of light

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While analysing collapses concerning the nuclei forming *Multiple Nucleus Quasars* (MNQs), as well as trying to find an *easy* and *satisfactory* solution to the "puzzle" for the cadmium sulphide detector, we were induced to revise the present setting of Gravity and Electromagnetism.

The following points form the base of this new setting:

1. there exists a "physical" space whose characteristics (electric, magnetic and gravitational) vary according to its density;
2. in a gravitational field the speed of light varies;
3. the physical dimensions of bodies vary when these are plunged into a gravitational field.

Space becomes a "mediator" (that is to say the medium to communicate) among the main forces of Nature (electric, magnetic and gravitational) which do not need supposing any "action-at-a-distance" [1].

The fact of the existence of a "physical" space, furthermore, allows us to fix the link between Gravity and Electromagnetism. We will see how this link can be obtained, in a suitable way, in varying the speed of light.

We will start resuming the problem of Gravity, that is to say the study a *static Gravitational field*. The question concerning Gravitational Waves, that is to say the study of a *dynamic Gravitational field*, will be discussed later on.

1 Some Experiments

The experiments proposed hereunder, aim to better clarify the fundamental role speed of light plays for a Gravitational Field.

Experiment 1. Let us take a cube shaped container having each side of 1 m length, leaning on a trolley that can move on tracks (see **Figure 1**).

[1] While for Electromagnetism the existence of a physical space (aether) had already been considered by Faraday and Maxwell, as far as we know, for Gravity nothing has been done yet.

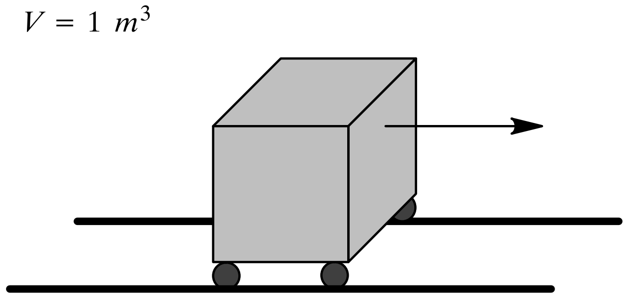

Figure 1: The volume V of 1 cubic meter

Let us consider a celestial body having an M mass and two equipotential surfaces: surface A, the same surface of the body, and surface B above of the surface A. An inclined plane where the trolley can move, connects the two surfaces (see **Figure 2**).

Let us fill the container with water so that we can obtain a body having a mass m corresponding to 1,000 kg and let us put the trolley far from surface A (i.e. in pulling it from B with a rope) and bring it onto surface B. Let W be the work done during this operation that we suppose will go on slowly and without any friction.

According to our experience, we know that in B body m has increased its (potential) gravitational energy content. That is to say, during displacement to the initial gravitational energy U_A, the body had on surface A, the work W done on it has been added:

$$\Delta U = U_B - U_A = W \quad (1)$$

If, by the moment, we consider as effective the following relation between energy, mass and speed of light [2]:

$$Energy \approx mass \times c^2 \quad (2)$$

through this experiment, we can (only) state that, during displacement, energy has varied (increased) as there may have been a variation of the speed of light, in the body's mass m, or in both.

Experiment 2. Let us suppose to perform the same work W as before on body m and keep it, in this case, on surface A. We know by experience, that the body will accelerate, getting a given constant speed v_A (see **Figure 3**).

[2]Expression (2) must not be confused with Einstein most famous relationship $\Delta E = \Delta m\ c^2$, where the hypothesis that speed of light is constant is inborn. With (2) the possibility that c, too, may vary is accepted.

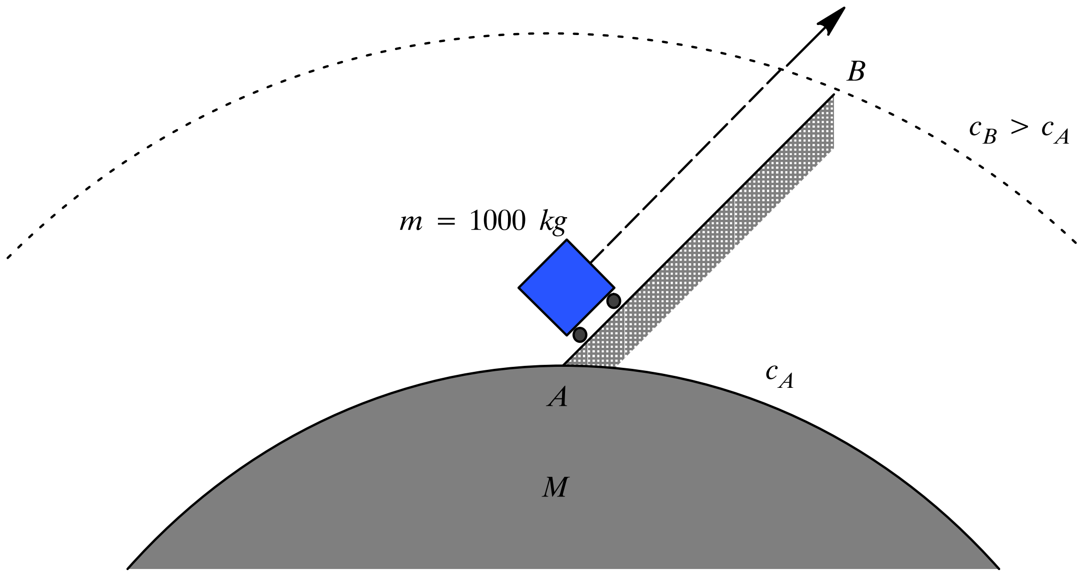

Figure 2: The moving away from M of 1,000 kg mass

In this case, body m, has gained kinetic energy T corresponding to the work, W, done. That is to say:

$$T = \frac{1}{2}\ m\ {v_A}^2 = W \tag{3}$$

According to the experience acquired with particle accelerators, we know that, in gaining speed, a body increases its mass and that such an increase of mass, Δm, results as equal to:

$$\Delta m = \frac{T}{c^2} \equiv \frac{T}{{c_A}^2} \tag{4}$$

Once speed v_A is reached, we move the trolley far from surface A letting it go up (by inertia) to the same inclined plane of **Experiment 1**. We know by experience that while the trolley gradually gets far from surface A it slows down correspondingly and, progressively, spends the kinetic energy it had previously gained.

We can also say that mass, Δm, gained during acceleration is progressively "burnt out" by the body in order to go far from surface A. Once it has reached surface B, body m has spent all its kinetic energy and it is in the same conditions as at the end of **Experiment 1**.

It seems, therefore, more logical to uphold that in **Experiment 1**, very likely, the "proper" mass, m, of the body did not undergo any variations in going from A to B. That is to say, in going from A to B only the speed of light c has varied (increased), due to the decreasing of gravitational field produced by M.

This experiment strengthens, therefore, the idea that in a gravitational field the following may result [3]:

$$\Delta U \equiv U_A B - U_A \approx m\left({c_B}^2 - {c_A}^2\right) \tag{5}$$

In other words, *the (gravitational) energy owned by body m, very likely, results as being directly proportional to the square of the speed of light* of the place where this one is plunged. More exactly, *when there is a gravitational field, the higher is the speed of light the lower is its intensity.*

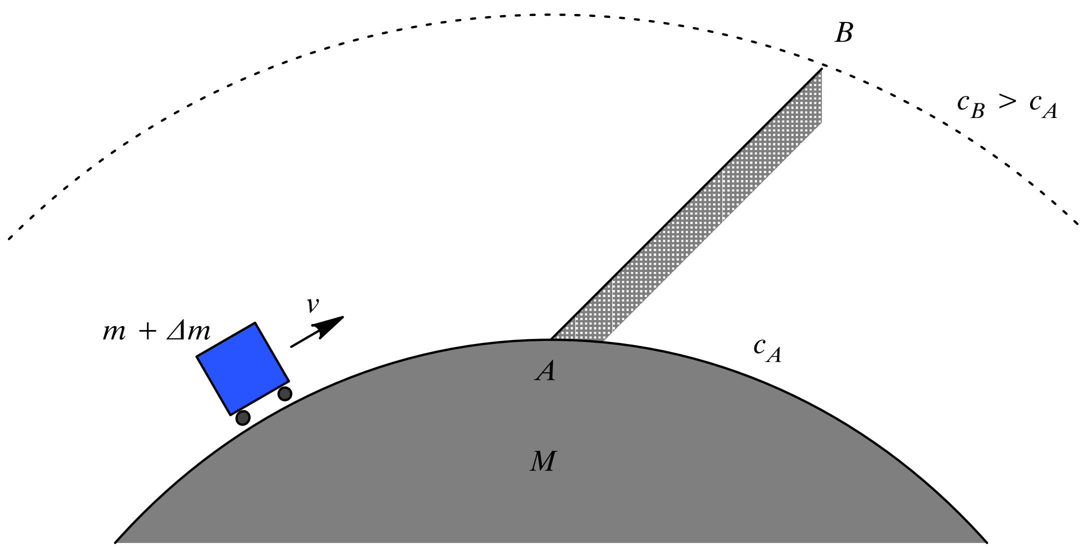

Figure 3: The acceleration and moving away fom M of 1,000 kg mass

[3]We will see that in (5) there is a coefficient of 3/2. That is to say:

$$\Delta U \equiv U_A B - U_A = \frac{3}{2}\left({c_B}^2 - {c_A}^2\right)$$

Experiment 3. Let us put an interferometer on the trolley. Namely, in this case, a rod (e.g. a standard-metre) having length l and a steady-state electromagnetic wave whose wave length λ is always equal to or a multiple of l (see **Figure 4**).

In this case too, the interferometer is moved far from surface A and slowly carried to B. According to our experience, we know that during displacement no (meaningful) variations of the interfering fringes are detected.

There is to note that, if interference fringes are not modified, it means that, during displacement from A to B, the number of waves contained in the rod has remained the same. That is to say,

$$\frac{l}{\lambda} = constant \tag{6}$$

But in moving from A to B speed of light c has varied (increased), owing to the fundamental relationship of waves:

$$\lambda\,\nu = c \tag{7}$$

where ν is the frequency of laser light, it has to be upheld that in the displacement from A to B length l of the rod has to vary in a directly proportional way to the speed of light c:

$$\frac{l_B}{c_B} = \frac{l_A}{c_A} = constant \tag{8}$$

while the frequency of light keeps constant:

$$\nu_B = \nu_A = constant \tag{9}$$

that is, very likely, also in accordance with the experimental fact that in the displacement from A to B no variations in the frequency of light emitted by the interferometer laser source are remarked.

The results of this important experiment can be summarized as follows:

- the physical (linear) dimensions of the bodies modify in a way which is directly proportional to the speed of light;
- light frequency does not vary in a gravitational field.

Previously, we called all this as "compliance with the speed of light". We will go on using this way of naming it.

Experiment 4. Considering the previous **Experiment 1** mass body m is replaced with a capacitor having capacity C. Using an electric generator, the capacitor is charged on surface A and in this way, an electric charge corresponding to Q_A is, thus, deposited on the plates (we suppose to be perfectly conducting) (see **Figure 5**).

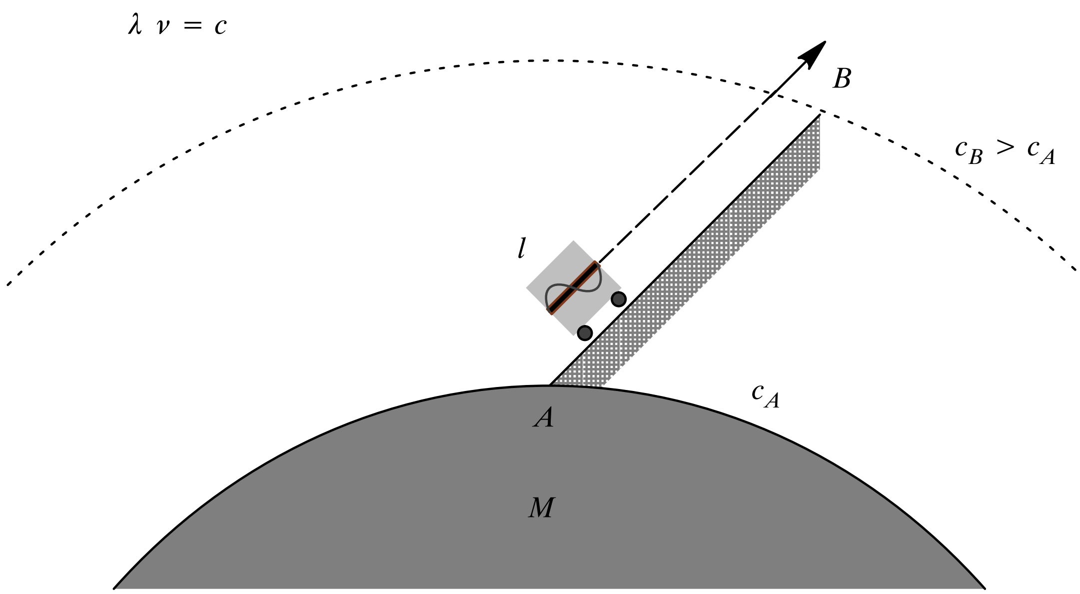

Figure 4: The moving away from M of the interferometer

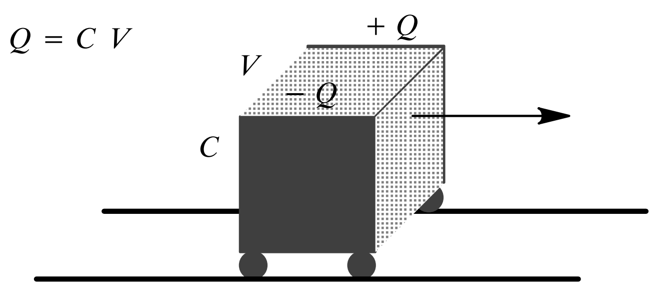

Figure 5: The capacitor C

By experience, we know that at the end of the charge the difference of potential between the plates corresponds to:

$$V_A = \frac{Q_A}{C} \tag{10}$$

while, the energy supplied is now confined inside the dielectric as electrostatic energy, which value results to be:

$$U_A = \frac{1}{2}\,\frac{{Q_A}^2}{C} \equiv \frac{1}{2}\,C\,{V_A}^2 \tag{11}$$

And now, let us pull the capacitor off surface A bringing it slowly onto B (see **Figure 6**).

But, in passing from A to B the speed of light has varied (increased), so that dielectric constant has varied (decreased) too! Therefore, also in this case we must uphold that there is an increase of the (electrostatic) energy of the capacitor and that such increase corresponds to work W done during displacement from A to B [4]:

$$\Delta U = U_B - U_A = W \tag{12}$$

In B the capacitor should have an energy corresponding to:

$$U_B = \frac{1}{2}\,\frac{{Q_B}^2}{C} \equiv \frac{1}{2}\,C\,{V_B}^2 \tag{13}$$

and a difference of potential between the plates by:

$$V_B = \frac{Q_B}{C} \tag{14}$$

Work spent for displacement should, therefore, result as:

$$W \equiv U_B - U_A = \frac{1}{2\,C}\left({Q_B}^2 - {Q_A}^2\right) \equiv \frac{1}{2}\,C\,\left({V_B}^2 - {V_A}^2\right) \tag{15}$$

How is it possible that in the displacement from A to B the capacitor electrostatic energy has increased? What happened to the electric charge Q and to the difference of potential V?

In this case, the most reasonable reply could be that, during displacement from A to B, both the electric charge and the difference of potential have varied (increased) on the plates!

The above statement is partly supported by the well known fact that, in Electrostatics, each time an isolated capacitor shows a dielectric constant variation, there is a variation of the difference of potential between the plates [5].

If we compare (5) with (15) we have a very strong indication that charge Q and difference of potential V may vary in a directly proportional way to the speed of light c. That is to say:

$$\frac{Q_B}{c_B} = \frac{Q_A}{c_A} \tag{16}$$

[4] Also the weight of the capacitor might have varied, however this fact is not enough to explain the whole, as we can choose a capacitor with a light mass and charge it with any amount of energy.

[5] The most worrying thing is that, contrary to what indicated by Electrostatics, we have to uphold that in decreasing the dielectric constant, both the difference of potential and the charge increase and viceversa. We will see that this contradiction is only apparent and can be easily overcome in considering that the "physical" dimensions of the capacitor vary (increase).

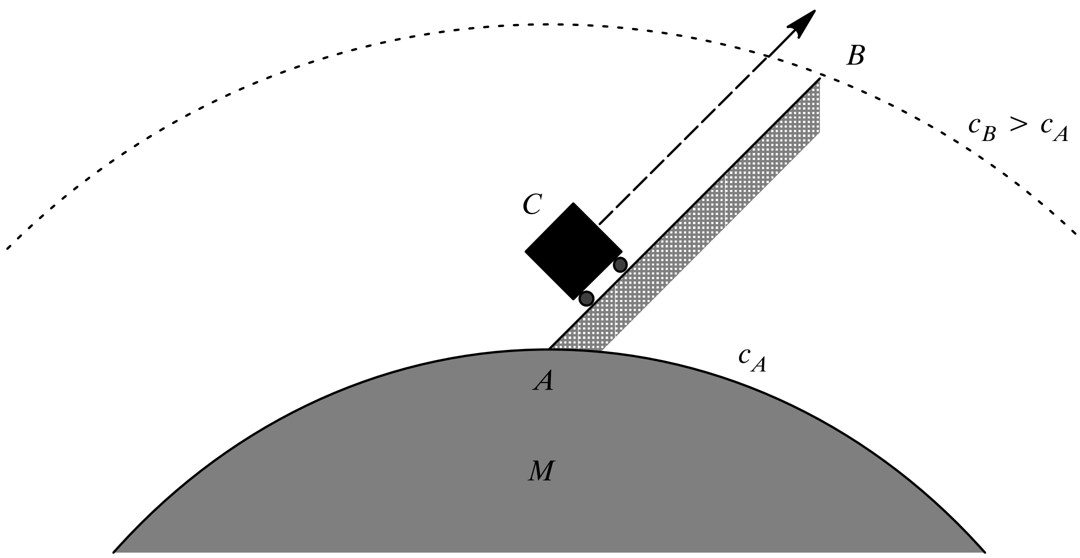

Figure 6: The moving away from M of the capacitor C

$$\frac{V_B}{c_B} = \frac{V_A}{c_A} \tag{17}$$

However, we cannot state this is certain as we do not know if during displacement from A to B also capacity C of the capacitor has varied [6].

However, if (16) and (17) are reliable, the following would result:

$$\Delta U \equiv W = \frac{U_A}{c_A}\left({c_B}^2 - {c_A}^2\right) = \frac{U_B}{c_B}\left({c_B}^2 - {c_A}^2\right) \tag{18}$$

We can, therefore, define the "electric" mass of the capacitor (that is to say, the mass related with the electrostatic energy) in the following way:

$$m_\epsilon = \frac{U}{c^2} = \frac{U_A}{{c_A}^2} = \frac{U_B}{{c_B}^2} = constant \tag{19}$$

which, in a completely similar way to **Experiment 1**, during displacement from A to B, very likely, undergoes no variations.

To conclude, as the number of electric charges on the capacitor plates have undergone no variations (the capacitor was isolated during displacement), it comes out that in passing from A to B there must have been an increase of the electron (and proton) electric charge!

[6] We will see that capacity during displacement keeps constant.

Experiment 5. Conclusions of **Experiment 3** allow us to easily apply to the inductor, too, the results obtained for the capacitor.

Let us replace the capacitor of **Experiment 4** with an inductor having inductance L formed by N (perfectly) conducting wire turns.

Let us now charge the inductor onto surface A in letting a current I_A circulate in it. As there are no losses, we know that current I_A, continues circulating inside the inductor (see **Figure 7**).

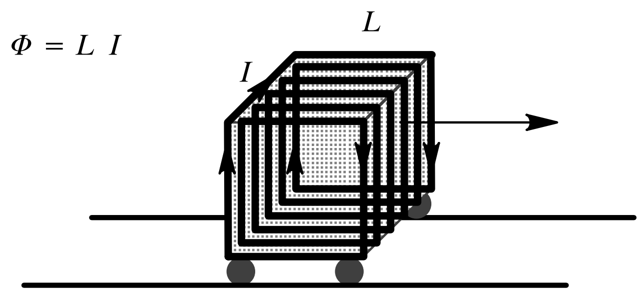

Figure 7: The inductor L

The energy supplied to the inductor is, now, in the form of magnetic energy which value results as follows:

$$U_A = \frac{1}{2}\,\frac{{\Phi_A}^2}{L} \equiv \frac{1}{2}\;L\;{I_A}^2 \tag{20}$$

while the magnetic flux is given by:

$$\Phi_A = L\;I_A \tag{21}$$

Let us now pull the inductor off surface A bringing it slowly onto surface B (see **Figure 8**).

As in passing from A to B the speed of light has varied (increased), the magnetic permeability must have varied (decreased) too! Therefore, in this case too we must uphold that there has been an increase of (magnetic) energy of the inductor and that said increase is equal to work, W, done during displacement from A to B. The inductor in B has, very likely, the following energy:

$$U_B = \frac{1}{2}\;L\;{I_A}^2 \tag{22}$$

and a magnetic flux of:

$$\Phi_B = L\;I_B \tag{23}$$

In case inductance L keeps constant, the energy variation would be, therefore:

$$W = U_B - U_A = \frac{1}{2}\ L\ \left({I_B}^2 - {I_A}^2\right) \equiv \frac{1}{2\ L}\ \left({\Phi_B}^2 - {\Phi_A}^2\right) \tag{24}$$

But, according to **Experiment 4** we know the electric charge increases proportionally to the speed of light c, while we have seen that, according to **Experiment 3** clock does not vary in a gravitational field. Therefore, also current I passing through the inductor must vary in a directly proportional way to c! In this case, we have [7]:

$$\frac{I_B}{c_B} = \frac{I_A}{c_A} \tag{25}$$

$$\frac{\Phi_B}{c_B} = \frac{\Phi_A}{c_A} \tag{26}$$

To conclude, thanks to (2), for the inductor too we can define a "magnetic" mass in the following way:

$$m_\mu = \frac{U}{c^2} = \frac{U_A}{{c_A}^2} = \frac{U_B}{{c_B}^2} = constant \tag{27}$$

which, during displacement from A to B would not have any variations.

Experiment 6. Considering **Experiment 3** previously presented, we replace the interferometer with a box (having perfectly conducting walls) that contains some electromagnetic radiation.

We know that inside the box the radiation field is formed by steady-state waves (oscillation modes), that take place inside it and can be represented by the following expression [8]:

$$\Delta n_\nu = \frac{8\ \pi\ \nu^2}{c^3}\ \Delta\nu \tag{28}$$

where $\Delta\nu$ represents the number of steady-state waves per unit of volume having frequencies between ν and $\nu + \Delta\nu$.

What does it happen if we move the box from A to B (see **Figure 9**)?

According to what previously stated, as also the dimensions of the box show variations that are directly proportional to the speed of light, *volume V of the box increases according to the cube of the speed of light, therefore the number of (steady-state) waves inside the box remains constant*!

[7] Here too, contrary to what indicated by Electromagnetism, we must uphold that when magnetic permeability decreases, there is an increase of both the magneto-motive force and of the flux and viceversa!

[8] (28) is a well known expression of Physics, mainly obtained through geometrical considerations. It is used, for example, to calculate radiation of a black body in the theory of solid specific heats and in the acoustics of closed housings.

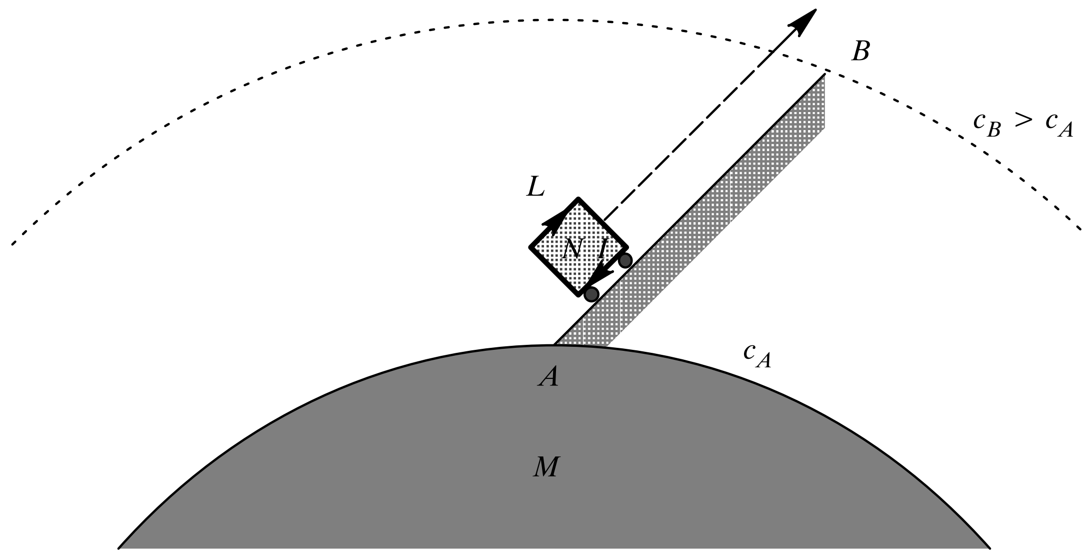

Figure 8: The moving away form M of the inductor L

This is a comforting result for us, as in **Experiment 4** the number of electric charges on the capacitor plates will remain constant.

In Experiment 3 with the interferometer, we have seen that the "dimensions" of an electromagnetic wave (that is to say, there is an increase of the wave length), in the course of displacement from A to B, increase in a directly proportional way to c. But what about its amplitude?

In a similar way to the previous experiments, here too, we have to admit that *the energy of the electromagnetic waves increases in a directly proportional way to the square of the speed of light*!

But we know that the energy of a wave is directly proportional to the product of amplitude times wave length therefore, in displacement from A to B, we should uphold that its amplitude has varied (increased) in a directly proportional way to its speed c!

In a gravitational field, therefore, an electromagnetic wave keeps its shape [9].

[9]This is the main reason why, when a gravitational wave arrives, we cannot notice anything!

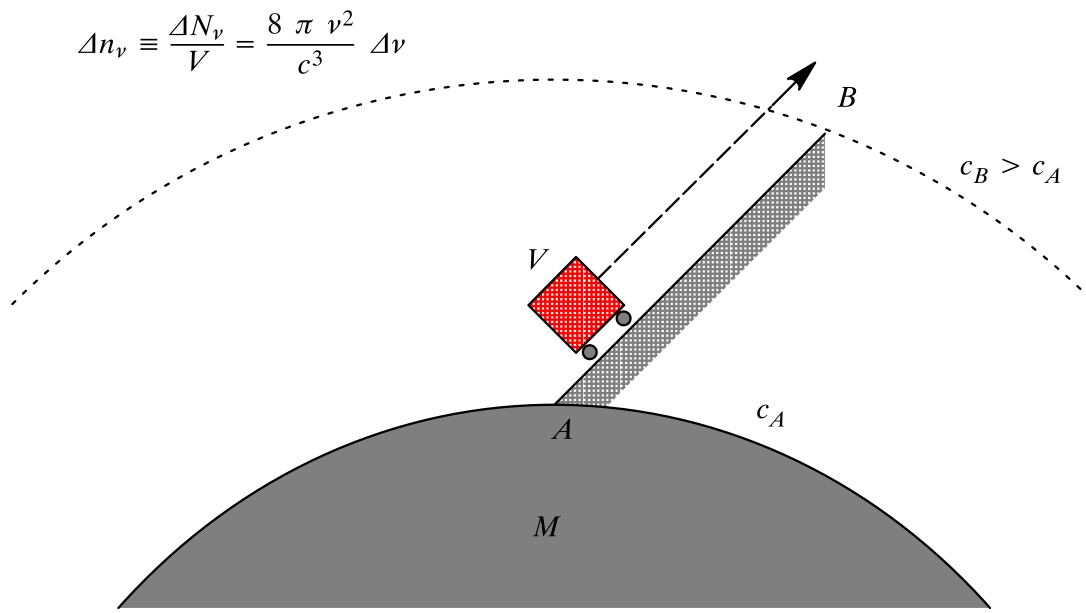

Figure 9: The moving away from M of the volume V of e.m. radiation

2 A fundamental property of space

As the linear dimensions of bodies vary in direct proportion to the speed of light, also volume V of the container of **Experiment 1** increases in a directly proportional way to the cube of said speed. That is to say:

$$V_B = V_A \left(\frac{c_B}{c_A}\right)^3 \tag{29}$$

Furthermore, as the body proper mass has no variations in a gravitational field, the result is that the body density varies in an inverse proportional way to the cube of the speed of light.

Consequently, *the "physical" space mass contained in volume V keeps constant too*! Therefore, also the density of space δ varies in an inverse proportional way to the cube of c. Namely:

$$\delta_B = \delta_A \left(\frac{c_A}{c_B}\right)^3 \tag{30}$$

(30) represents a fundamental property of the "physical" space. And we can also write it as follows:

$$\delta_B\ c_B^3 = \delta_A\ c_A^3 \equiv constant \tag{31}$$

where the constant may be determined starting from the conditions of space "at rest". We have [10]:

$$constant = \delta_\infty \; c_\infty^3 = 3 \; 10^{17} \; \left(3 \; 10^8\right)^3 = 8.1 \; 10^{42} \; kg/s^3 \qquad (32)$$

3 Discussion

What reported in the previous paragraphs, stimulates a wide discussion.

1. Can an observer plunged into a gravitational field (for example the one into A, into B or on board the trolley) notice that dimensions have varied (e.g. of the trolley, the container, the interferometer, etc...)?

   The answer is no, he cannot! The observer cannot notice anything because his "standard metre" has modified according to the speed of light.

   The observer on board the trolley, while gradually getting off surface A, does not even notice that the distance between the tracks is varying!

2. Can that same observer notice that the difference of potential on the capacitor plates or the current passing through the inductor have changed?

   In this case, too, the answer is no, he cannot! The observer cannot notice anything as also instruments such as voltmeters, ammeters, and so on... modify according to the speed of light!

3. What can the other instruments, optical and electromagnetic instruments (e.g. photometers, interferometers, etc...), "see"?

   These instruments, too, are not in a position to notice that the wave length of radiations has varied as they, too, modify according to the speed of light! And they cannot notice, as well, that the luminous radiation energy has varied.

   A standard photometer actually measures, for example, an energy density, that is to say the energy of light hitting it per unit of photosensitive surface. And because of, like energy, a surface too varies as the square of the speed of light does, this instrument cannot notice anything [11]!

4. Can we notice from our Earth that the speed of light on the Sun has varied (decreased)?

[10] The density of space (at "rest") can be calculated from the mass of proton and volume of electron, and said value is: $\delta_\infty = 3 \; 10^{17} \; kg/m^3$

[11] Up to how only our detector has noticed it, as the cadmium sulphide photoresistor varies its electric resistance in function of the real energy of the photons hitting it, while the number of photons emitted per unit of time by the vacuum diode keeps constant (as the anode current is kept absolutely constant)!

The answer is no, we cannot! We cannot notice this, because radiations emitted by the Sun gradually approaching the Earth, increase its wave length proportionally to c.

In **Appendix A.1** one can find the calculation about this variation concerning the Sun.

5. What kind of instrument is, then, an interferometer?

   We can think of an interferometer as a *clock-metre*, that is to say a double instrument, where time and length are close related [12].

   It is a standard metre as, in counting the number of waves of a specific electromagnetic radiation contained in the rod, we are in a position to determinate its length. It is, at the same time, a standard clock, too, as if we count the number of waves (having a known length) in the rod, we are in a position to state the corresponding frequency.

   Substantially, we can say that it is a standard metre as the number of waves in it does not change (even if the speed of light varies) and it is a standard clock as its frequency does not vary (even if the speed of light varies!).

6. What can observer B see while the trolley is gradually approaching him?

   The volume of 1 m^3 of the container is smaller in B than when it is in A, but the observer who is in B cannot notice it as the light representing it, when it reaches B, has a large wave length.

   This means that the container which is in A is always seen as corresponding to 1 m3 in B, where the standard metre, however, is "physically" larger than the one owed by the observer in A!

   Therefore, the sizes of bodies plunged in a gravitational field measured from outside (the gravitational field) are not effective sizes, but larger ones.

   In other terms, a gravitational field acts for us (that is to say for our eyes) as a "lens" that causes us to see objects plunged into the field, larger than they actually are!

   In **Appendix A.2** what reported is the calculation concerning this variation in the case of the Sun.

7. What does it happen to light when it passes through a gravitational field?

   In passing through a gravitational field, light undergoes a slowing down and a change in its direction, because of the variation of space refraction index, which on the analogy of what happens to the other parameters, such as dielectric constant and magnetic permeability, increases correspondingly to the increase of its density.

[12] This (simple) link among length, propagation speed and time is typical of transmission lines.

What we can see very well, then, is the distortion produced by a very intensive gravitational field on celestial objects (e.g. galaxies) that are beyond it. In this respect, it is absolutely convincing when we observe the small arclets that can be noticed around galaxy clusters (see **Abell 2218**) [13].

8. And what about the "gravitational" redshift?

   The gravitational redshift, that is to say the decrease of light frequency when it passes through a gravitational field, does not exist, as clocks plunged in it do not vary at all!

   The redshift, sometimes observed on some celestial bodies, is due to local motions of these latter respect to us.

9. And what about Einstein formula?

$$\Delta E = \Delta m\ c^2 \tag{33}$$

   This relation is of no help to us in a gravitational field, as the speed of light varies. In a gravitational field, the following expression seems to be more useful:

$$\Delta E \approx m\ \Delta c^2 \tag{34}$$

   provided mass m is given a more suitable meaning.

10. It is well known that to be able to explain the behaviour of radiation inside a box, it is necessary to give to every oscillation mode (steady-state wave) an energy that is directly proportional to its frequency according to:

$$E_\nu = h\ \nu \tag{35}$$

   where h is the Planck constant.

   Therefore, also *such a relation is of no help to us in a gravitational field, as the radiation frequency does not vary, while we know that energy varies.*

   It comes out that, in passing from A to B, Planck constant h must necessarily vary! That is to say, in a gravitational field we would have, instead:

$$\Delta E \approx \nu\ \Delta h \tag{36}$$

   Why don't we notice that Planck h constant does not vary? Plank constant, is an energy times time and, as time does not change, h is namely an energy, therefore what previously said at previous Point 3 is effective as well.

[13]In this case, it is not too appropriate to speak of gravitational lens as a real "lens effect" where there is a concentration of luminous rays due to the gravitational field. What happens here is only a distortion of objects.

11. What dit it happen to the gravitational mass of M?

    An observer on board the trolley, while gradually getting off surface A, can see the gravitational mass of M increasing as the *"thickening" of space* produced by M itself is added to the proper mass of M.

    That is to say, for gravitational mass, the following important relationship works:

    $$gravitational\ mass = proper\ mass +'' thickened''\ space$$

    In other words, if we move from A to B, on one side the gravitational field is reduced quadratically to the distance from M (geometrical effect) and on the other side, it increases owing to the effect due to the space "thickening".

    Practically, all this leads to a deviation of Newton gravitation law.

    This increase of the gravitational mass is meaningful only for very massive systems (e.g. objects motion around Galaxies or around MNQs).

    In celestial objects of the same dimensions as the Sun this effect results very small and can only be perceived at a very far distance footnoteSee in this respect the (anomalous) deceleration of Pioneer 10..

12. What about "dark matter"?

    "Dark matter", being matter, does not exist. What does exist, is the "thickening" of space that matter produces around itself and that, on a gravitational point of view, behaves as real matter!

4 A new frame of reference

Before summarizing what said up to now, it is necessary to state two very important points:

- It is not the gravitational field that modifies space density, but it is matter that in producing the thickening of space around bodies modify the density.

  Namely, in passing from A to B the gravitational field modifies because it is space density (and, therefore, the speed of light) that modifies and not viceversa.

- It is not the electric field (or the magnetic field) that modifies the dielectric constant (or the magnetic permeability), but it is the dielectric constant (or the magnetic permeability) that, because of space density variations, modifies the electric field (or the magnetic field).

Namely, passing from A to B it is not the electric (or magnetic) field that varies, but it is the charge (or current) that produces that specific electric (magnetic) field to be varied.

The above specifications represent two very important points in this new frame for the Gravity, as they allow us to state a link among *Gravitational*, *Electric* and *Magnetic* fields.

The new logical frame of reference should, namely, be the following.

Going away from a celestial body, that is to say moving from one point with higher gravity to a point with lower gravity, it results that:

→ space density decreases

therefore,

→ dielectric constant decreases

→ magnetic permeability decreases

→ speed of light increases

→ physical dimensions of the bodies increase

while,

→ clock frequency (oscillator) does not vary

→ proper mass (or particle mass) of bodies does not vary

therefore,

→ both electric charge and electric current increase

→ wave length of electromagnetic radiation increases

→ gravitational mass increases

→ energy increases (in a directly proportional way to c^2)

We will see on the contrary that the following do not vary:

→ capacity of a capacitor

→ inductance of an inductor

→ resistance of a resistor

We intend to conclude in pointing out how the interpretation of the interferometer behaviour in terms of variable speed of light gives us one of the most important contributions.

The experiment performed by Michelson and Morley at the end of 1800 with the interferometer, being interpreted in terms of speed of constant light, had stated the death of Faraday and Maxwell space (aether) being, on the contrary, interpreted in terms of speed of variable light, it becomes one of the most important proofs of its existence!

A APPENDIX

A.1 Variations of the speed of light on the Sun

According to what stated in the text, the following relation is effective on the surface of the Sun:

$$\frac{3}{2}\left(c_{\odot}^2 - c_{\infty}^2\right) = -\frac{G\ M_{\odot}}{R_{\odot}} \tag{37}$$

where $M_{\odot}$ and $R_{\odot}$ are, respectively, the mass and radius of the Sun while c_{∞} is the speed of light with the gravitational field absent. As:

$$\left(c_{\odot}^2 - c_{\infty}^2\right) \approx 2\ c_{\infty}\ \left(c_{\odot} - c_{\infty}\right)$$

it is possible to approximate (37) and obtain for the variation of the speed of light:

$$\Delta c_{\odot} \approx -\frac{G\ M_{\odot}}{3\ c_{\infty}\ R_{\odot}} \tag{38}$$

If we replace the values, we obtain:

$$\Delta c_{\odot} \approx \frac{6.67\ 10^{-11}\ 2\ 10^{30}}{3\ 3\ 10^{8}\ 695\ 10^{6}} = 213\ m/s$$

Namely, we get that *on the Sun, the speed of light is 213 m/s slower than it should be in the same place without the Sun.*

On the Earth, the variation of the speed of light due to the presence of the Sun, on the contrary, is:

$$\left(\Delta c_{\odot}\right)_{Earth} = -\frac{G\ M_{\odot}}{3\ c_{\infty}\ d_{SE}} \tag{39}$$

where d_{SE} indicates the distance Sun-Earth. If we replace the values we obtain:

$$\Delta\left(c_{\odot}\right)_{Earth} \approx \frac{6.67\ 10^{-11}\ 2\ 10^{30}}{3\ 3\ 10^{8}\ 150\ 10^{9}} = 1\ m/s$$

A.2 The effective dimensions of the Sun

As stated in the text the sizes of bodies plunged into a gravitational field are directly proportional to the local speed of light. Therefore, the Sun radius measured from outside its gravitational field is larger than the effective one by an amount of:

$$\left(\Delta R_{\odot}\right)_{\infty} = R_{\odot}\ \frac{\left(\Delta c_{\odot}\right)}{c_{\infty}} \approx 695\ 10^{6}\ \frac{213}{3\ 10^{8}} \approx 491\ m$$

This means that, *the real Sun radius is of only 491 m lower than the one should measure outside its gravitational field.*