the general science journal

English CPH E-Book

Theory of CPH

Section 2

Experimental Foundation of CPH Theory

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Contains:

Introduction

In this section I will take a new looking on experimental phenomenon that relatives to relationship between gravity and electromagnetic.

Notice that many physicists, such as Faraday and Planck noted the great similarities between electric fields and gravity. If a unified field theory can be found, someone must resolve whether or not it is based on particles and gravity fields or electromagnetic fields. But CPH theory is some in between these two concepts.

CPH Theory started of relationship between force and energy. Photon appears to have no further internal substructure. But many phenomenons's as Compton's effect, pair production, red-shift and blue-shift… show photon has a structure.

We know there is a unit informer in universe that is photon, and all of our information's of universe transfer by photon.

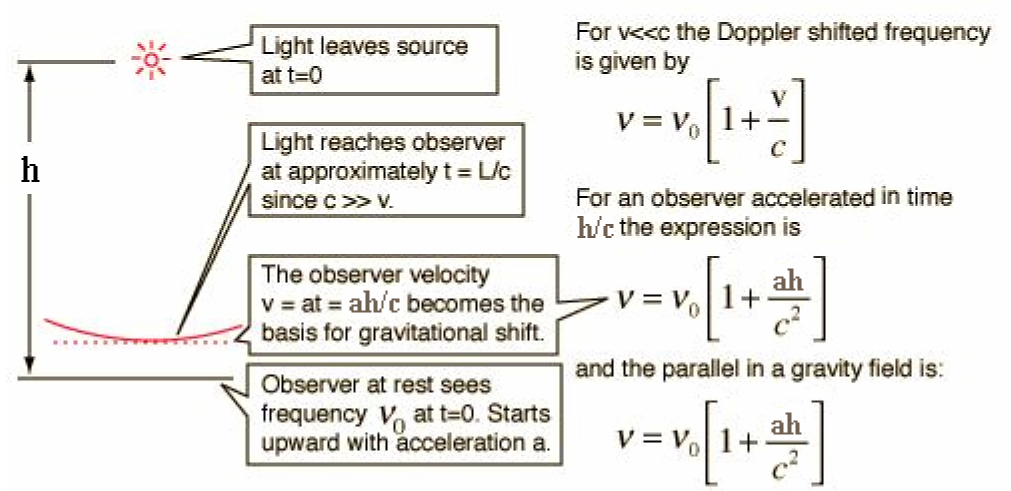
Until we do not know everything about photon and its structure, our information's about universe is questionable.

With best Regards

Hossein Javadi

Gravitational Red Shift

According to the principle of equivalence from general relativity, any frequency shift which can be shown to arise from acceleration of a radiating source could also be produced by the appropriate gravitational field. Thus the expected shift in radiation frequency in a gravitational field can be related to the relativistic Doppler shift experienced from an accelerating light source.



The above result about frequency of light for the first time proclaimed by Einstein in General Relativity. In fact Einstein had attended to light like other masses. Because in Relativity photon carries energy so, it has mass.

Gravity and the Photon

The relativistic energy expression attributes a mass to any energetic particle, and for the photon:

$$E = mc^2 = h\nu$$

The gravitational potential energy is then:

$$U = \frac{-GMm}{r} = \frac{-GMh}{rc^2}\nu_0$$

When the photon escapes the gravity field, it will have a different frequency:

$$h\nu = h\nu_0\left[1 - \frac{GM}{rc^2}\right] \qquad \nu = \nu_0\left[1 - \frac{GM}{rc^2}\right] \qquad \frac{\Delta\nu}{\nu_0} = -\frac{GM}{rc^2}$$

Since it is reduced in frequency, this is called the gravitational red shift or the Einstein red shift.
For when photon is falling in a gravitational field like the above formula is result able with the opposite sign:

$$h\nu = h\nu_0\left[1 + \frac{GM}{rc^2}\right] \qquad \nu = \nu_0\left[1 + \frac{GM}{rc^2}\right] \qquad \frac{\Delta\nu}{\nu_0} = +\frac{GM}{rc^2}$$

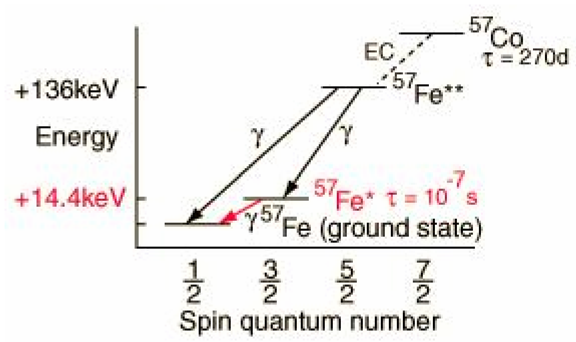
It calls blue-shift. In generally we have;

$$\nu = \nu_0\left(1 \pm \frac{GM}{r\,c^2}\right)$$

The checking of difference frequency was made possible by the discovery of Mossbauer Effect. In 1958, Mossbauer discovered that some gamma rays emitted from solids are come out without the nucleus recoiling individually, the recoil being taken up by whole of the crystal lattice, so there is a negligible Doppler shift. The Mossbauer Effect experimented by Pound and Rebka (in1960) from 22.6m Jefferson's tower in Harvard University.

Mossbauer Effect in Iron-57

The study of the Mossbauer Effect in Iron-57 has been very fruitful because of the narrow natural line width of the 14.4 keV transition. This transition is characterized by:



Lifetime	$\tau \approx 10^{-7} s$
Natural linewidth	$\Gamma = \frac{\hbar}{\tau} \approx 10^{-8} eV$
Fractional width	$\frac{\Gamma}{E} \approx 10^{-12}$

While one atom can emit a photon which is absorbed by the reverse transition in an identical atom a short distance away (resonance fluorescence), the same cannot happen for nuclear transitions from isolated nuclei. The reason is the large recoil energy compared to the natural line-width of the transition.

Using the iron as an example, the 14.4 keV gamma ray has momentum pc=14.4 keV. The recoil momentum of the emitting iron nucleus must match that if it acts as an isolated particle. The recoil energy can be calculated from the momentum, and it is usually convenient in such cases to put everything in electron volts.

$$E_{recoil} = \frac{1}{2}mv^2 = \frac{p^2}{2m} = \frac{p^2c^2}{2mc^2}$$

The energy of recoil of the iron-57 nucleus is

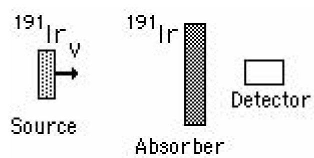
$$E_{recoil} = \frac{p^2c^2}{2mc^2} = \frac{(14.4keV)^2}{2(53.022GeV)} \cong 0.002eV$$

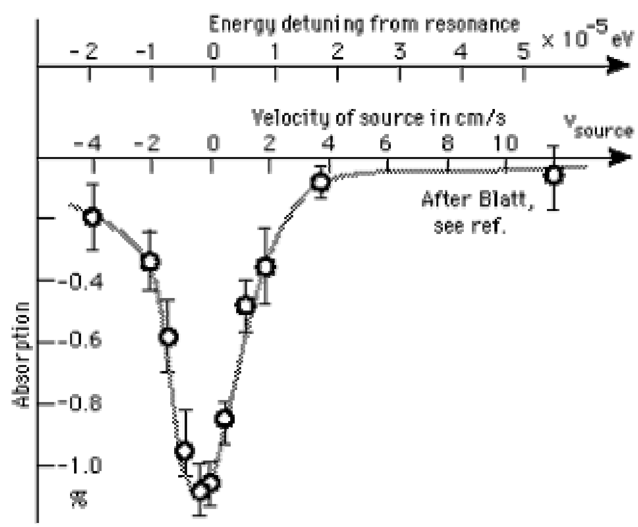
This is five orders of magnitude greater than the natural line-width of the iron transition which produced the photon. This recoil energy reduces the photon energy by this amount as seen by a potential absorbing nucleus at rest.

To get resonance absorption, you have two options: nail down the nucleus in a crystal lattice so that it has almost no recoil, or move the source and absorber relative to each other so that the Doppler shift of the photon moves it to the necessary energy for absorption.

Mossbauer Absorption, Ir-191

As an example of the Mossbauer Effect 129 keV gamma rays from iridium-191 were measured as a function of source velocity. A velocity of only about 1.5 cm/s was enough to drop the absorption to half its peak value. Sample and absorber were cooled to 88K





A half-width of only about 0.65 x 10^{-5} electron volts makes this absorption an extremely sensitive test of any influence which would shift the frequency. It is sensitive enough to measure the Zeeman splitting from the magnetic field of the nucleus. Such processes have been used as a test of the gravitational red shift from general relativity.

The Mossbauer Effect involves the emission and absorption of gamma rays from the excited states of a nucleus. When an excited nucleus emits a gamma ray, it must recoil in order to conserve momentum since the gamma ray photon has momentum. But this takes energy, and the gamma photon has less energy by about 1 eV for a 100 keV photon. The sharpness of an energy state in a potential target nucleus has a natural line width on the order of 10^{-5} eV, so that the shift in the photon energy prevents the target nucleus from absorbing the gamma photon.

Mossbauer discovered that by placing emitting and absorbing nuclei in a crystal, you could use the crystal lattice for recoil, lessening the recoil energy loss to the point that these extremely sharp emission and absorption lines would overlap so that absorption was observed. An important result was that you now had an extremely sensitive detector for energy shifts - a motion of either source or absorber with velocities on the order of millimeters per second was enough to detune the absorption.

Harvard Tower Experiment

A photon with energy $E=mc^2$ has mass that gives by;

$$m=h\nu/c^2$$

And its weight is;

$$mg=(h\nu/c^2)g$$

Suppose photon falls toward the earth in distance y, so we have;

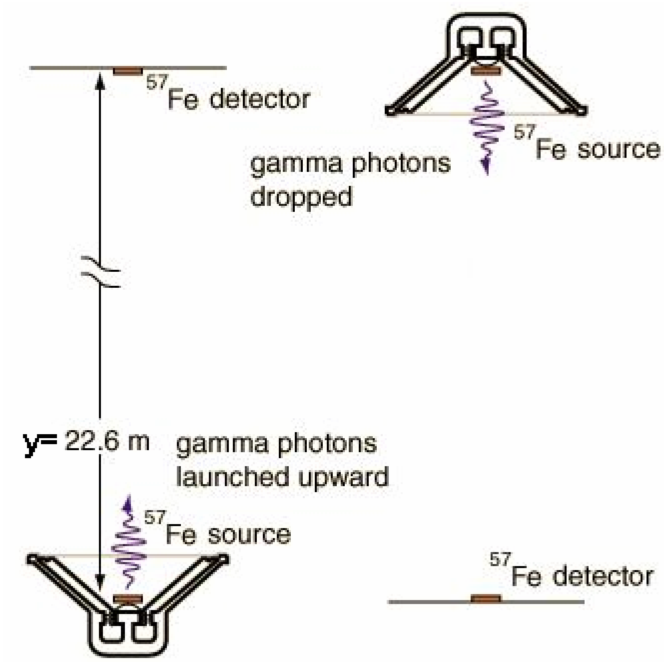
$$h\nu'=h\nu+mgy=h\nu+(h\nu/c^2)gy$$

$$\nu'= (1+gy/c^2)\nu$$

Relativistic changing in its frequency is;

$$\Delta\nu/\nu=(\nu'-\nu)/\nu=gy/c^2$$

In just 22.6 meters, the fractional gravitational red shift given by;



$$\nu = \nu_0 \left[1 + \frac{gy}{c^2} \right]$$

Is just 4.92 x 10^{-15}, but the Mossbauer Effect with the 14.4 keV gamma ray from iron-57 has a high enough resolution to detect that difference. In the early 60's physicists Pound, Rebka, and Snyder at the Jefferson Physical Laboratory at Harvard measured the shift to within 1% of the predicted shift.

By just using the expression for gravitational potential energy near the Earth, and using the m in the relativistic energy expression, the gain in energy for a photon which falls distance h is;

$$\Delta E = mgh = \frac{E}{c^2} gh = \frac{14.4keV}{c^2} g \cdot 22.6m$$
$$\Delta E = 3.5x10^{-11} eV$$

Comparing the energy shifts on the upward and downward paths gives a predicted difference.

$$\left(\frac{\Delta E}{E}\right)_{down} - \left(\frac{\Delta E}{E}\right)_{up} = \frac{2(3.5x10^{-11} eV)}{(14.4keV)} = 4.9x10^{-15}$$

The measured difference was

$$\left(\frac{\Delta E}{E}\right)_{down} - \left(\frac{\Delta E}{E}\right)_{up} = (5.1 \pm 0.5)x10^{-15}$$

The success of this experiment owed much to the care of Pound and Rebka in preparing the source. They electroplated cobalt-57 onto the surface of a thin sheet of iron and then heated the combination at 1220 K for an hour. The heat treatment caused the cobalt to diffuse into the iron to a depth of about 300 nm or 1000 atomic spacing. The source was then mounted on the cone of a loudspeaker driven at 10Hz to sweep the source velocity in a sinusoidal variation. The detector was a thin sheet of iron about 14 micrometers thick which was also annealed. The heat treatments were found to be crucial in obtaining high resolution.

Notice:

There is a very important deduction in Mossbauer Effect that is able shows a great relationship between Quantum Mechanic and General Relativity. We can get an important result of Mossbauer Effect and this experiment, if we take a new look on it. This phenomenon has been connecting the microscopic quantities to macroscopic effect. I endeavored to have a new different looking to the effect of Gravitation on the photon. But let's do continue red-shift in gravitation effect on photon in a black hole, and then do reconsider it again.

Black Hole

A black hole is an object so massive that even light cannot escape from it. This requires the idea of a gravitational mass for a photon, which then allows the calculation of an escape energy for an object of that mass. When the escape energy is equal to the photon energy, the implication is that the object is a "black hole".

According to relation

$$\nu = \nu_0 (1 - \frac{GM}{rc^2})$$

When a photon is not able escape of gravitational field of a black hole? Answer is that when the frequency of photon shifts to zero, because a photon moves by its kinetic energy, so when ν=0, then photon cannot escapes of a black hole. In the other word, photon loses all of its energy.

$$\nu = 0 \rightarrow 1 - \frac{GM}{rc^2} = 0$$

$$rc^2 = GM$$

$$r = \frac{GM}{c^2}$$

So if mass M collapses to radius r, a photon will be red-shifted to zero frequency.

Actually, Schwarzchilds's calculated gravitational radius differs from this result by a factor of 2 and is coincidently equal to the non-relativistic escape velocity expression.

$$v_{escape} = \sqrt{\frac{2GM}{r}}$$ which if v is set equal to c gives a radius $$r = \frac{2GM}{c^2}$$

Schwarzschild Radius

Note that this condition is independent of the frequency, and for a given mass M establishes a critical radius.

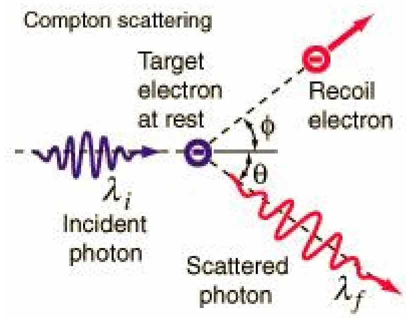
Important Notice;

When photon's frequency shifts to zero, all of its energy converts to Sub-photonic element that photon has made of them. In the other word photon energy changes to gravity energy that usually we call gravity intensity. Now suppose a photon with very small scale energy (as microwave background) falls in a black hole, what will happens for it? If we do accept that there is correct the Mossbuaer Effect in black hole, then frequency of photon will shifts to blue speedy. Shifting frequency goes to what? As we know there is not any limit for growing the electromagnetism wavelength. So, these photons are able to produce any articles and antiparticle as proton and antiproton. Seems in around of a black hole, is very different of a star.

However, presently we are attending to red-shift that photon loses all of its energy. And photon does decay to its sub-photonic elements.

Compton Scattering

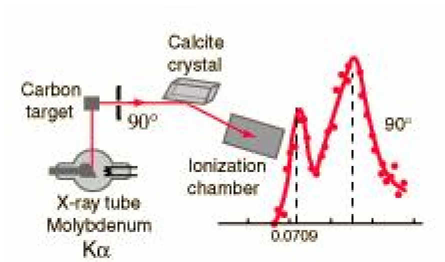
Arthur H. Compton observed the scattering of x-rays from electrons in a carbon target and found scattered x-rays with a longer wavelength than that incident upon the target.



The shift of the wavelength increased with scattering angle according to the Compton formula:

$$\lambda_f - \lambda_i = \Delta\lambda = \frac{h}{m_e c}(1-\cos\theta)$$

Compton explained and modeled the data by assuming a particle (photon) nature for light and applying conservation of energy and conservation of momentum to the collision between the photon and the electron.



The scattered photon has lower energy and therefore a longer wavelength according to the Planck relationship.

At a time (early 1920's) when the particle (photon) nature of light suggested by the photoelectric effect was still being debated, the Compton experiment gave clear and independent evidence of particle-like behavior.

Notation

The Compton Effect is approving that photon has sub-photonic elements. In during the collision, Photon loses a part of its elements. We must do consider Compton Effect, Mossbuaer Effect, shifting to zero frequency and pair production together.

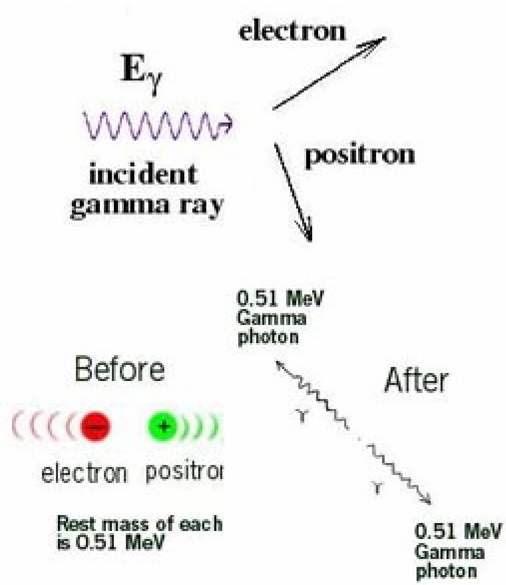
Pair production

This process is effective at high energies (>1.022 MeV). This is because the process is a result of a γ ray converting to an electron-positron pair i.e. E= $2m_0c^2$ where m_0c^2 is the rest mass of the electron). Although this energy is relatively low, the process is only significant for γ -ray energies of several MeV

The kinetic energy can be described as,

$$E_e = E_\gamma - 1022 \text{ keV}$$

In the process, the γ ray is converted to an electron positron pair as shown schematically in figure. As the positron slows down, further annihilation takes place resulting in the production of two photons of equal energy (511 keV).



These annihilation photons have significance for the final spectrum. If both are recorded then the full energy peak will be registered. However, if only one is recorded, then the peak would measure E_γ - 0.511 MeV. Similarly, if both escape, energy of E_γ - 1.022 MeV would be recorded.

Summary

As this section names Experimental Foundation of CPH Theory, I tried show some experimental that based on modern theoretical physics conceptions.

1- **As General Relativity proclaimed, frequency (and energy) of photon depends path. In gravitation field photon shifts to blue (or red).**
2- **Mossbuaer Effect is based on Quantum Mechanics conceptions and experiments show red-shift (also blue-shift) General Relativity's proclaim is correct.**
3- **In black hole the frequency of photon shifts to zero. So, important question is that; what will happens to photon energy when it is escaping of gravitational field of a black hole?**
4- **In red-shift (or blue-shift) photon can have following cases;**

A. photon goes of ν to ν' ($\nu < \nu'$), it takes energy equal Δmc^2; we do not know Δmc^2 goes to what amount, especially in black hole.

B. photon goes of ν to ν' ($\nu > \nu'$), it loses energy equal Δmc^2; we know Δmc^2 can be equal $h\nu$, photon shifts to zero frequency (in black hole).

Questionable Deduction1

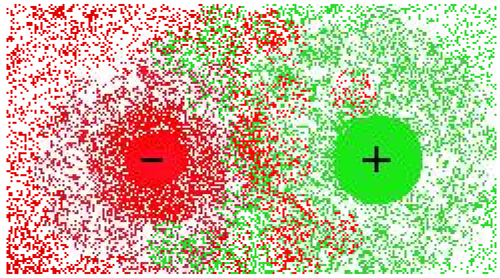
Electromagnetic energy and gravity are two seeming of one quantity. So, it shows Faraday, Plank and Einstein (and other physics that tried to unified electromagnetic and gravity) were not at wrong way. But what they had not attend to which, is that gravity is forms of sub-quantum elements that behavior like charge and magnetic field. In fact gravitons are color-charge and magnet-color.

5- **Compton Effect shows we can take a part of photon energy. So, its other reason that photon contains sub-photonic elements. According**

$$W=\Delta E=\Delta mc^2$$

This is a problem that least amount of Δmc^2 is what? And sub-photonic elements have which properties? Sub-photonics behave like charge or magnetic field?

6- Pair production shows, before of production we have electromagnetic energy, after of product we have two fermions (electron and positron), and two electric fields (negative electric field of electron and positive electric field of positron) and two magnetic field around electron and positron. According Quantum field Theory, there is photon bosons that carry electric forces.



Electron and positron have electric fields and magnetic fields, Seems that before of pair production there were not these bosons

So, it's acceptable that fermions produce bosons. Also, according red-shift and blue-shift, boson produces electromagnetic energy, and according pair production electromagnetic energy produces fermions.

Questionable Deduction2

According above items, is not important how can unify fields without attend to structure of photon? Consideration to structure of photon is not only macroscopic problem, yea its microscopic problem.

The next section belongs to this concept that how we can define structure of photon by CPH theory. This definition must be able does explain the essence of phenomenon's relative. Over than we can see how this definition of photon's structure can help us to combine the Classical Mechanics, Quantum Mechanics, Relativity and Higgs field.

With Best Regards

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