# Half photon effect discovered for mass particles: kinetic capacity effect of photons and rest mass particles

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*Abstract: In an Einstein like Gedanken Experiment, the relativistic changes of energies of a photon and a rest mass particle caused by the same relative movement were compared and it was discovered , that the same relative movement was causing very different energetic changes on the photons and rest mass particles: photons have significantly more "capacity" for kinetic energy then mass paricles. A mass particle behaves near to the speed of light as an half photon. The discovery was made back in 1999.*

***Kinetic energy relation of photon and particle***

We will compare how different the (kinetic) energies of a photon and a rest mass particle are effected by the relativistic movement with relative velocities between classical low and velocity of light $c_0$ in vacuum.

The experiment is as a *gedanken experiment* in relativistic tradition fully sufficient, does not need any prove as far as we accept optical Doppler effect and special relativity. So the prove is build in and we will conclude a new fact about ability's of photons and mass particles.

We think therefore off a monochrome photon sender in an earth's inertial frame (IF), where also free, *resting* electrons will be set out into the space around. One another, flying laboratory, let say on a space shuttle, is "running" through this earth's laboratory many times with different growing velocities and measuring the frequency of the photons changed by Doppler effect and the mass of the electrons, changed relativistically by Lorentz factor.

In Fig.1 we see, anticipatory, the graphs of the calculated relativistic kinetic energies of a particle and of a photon, which were so conditioned, that they had the same energy in the sender inertial frame (IF) in earth's laboratory as a normalisation – it's making easier for us to compare the relativistic effects on both so very different objects. We see the graph of the

photon raising much earlier with a sharper slope, then the graph of the particle – roughly we see that at each point of $\beta$ ($\beta = V_r/c_0$) the photon has gotten significantly much more kinetic energy as the particle. But the "space shuttle" is just changing it's own speed, nothing special is happening with the photons and electrons.

We see that under the same conditions a photon is able to get in itself about double as much *kinetic* energy (because of relative movement) as a particle can get! This can only have something to do with the *inner structure* of the photons and particles themselves – and so it was obvious to set up the hypothetical idea of a particle as a *looped,* or better to say, *folded photon* – especially as the factor 2 is visible in the roughly graphic relations.

The total energy of a rest mass particle is set together by its rest mass energy and its kinetic energy by the known relativistic formula easy to find in each standard edition like Bergmann [2], with $\gamma = (1-\beta^2)^{-\frac{1}{2}}$ being the Lorenz factor:

$$E_\Sigma = E_0 + E_{kin.} = m_0 \cdot \gamma \cdot c_0^2. \qquad (1)$$

With rest mass energy $E_0 = m_0 \cdot c_0^2$ the relativistic kinetic energy of a particle will be:

$$E_{kin.} = E_\Sigma - E_0 = m_0 \cdot c_0^2 \cdot (\gamma - 1), \qquad (2)$$

where $m_0$ is the rest mass of the particle, and $c_0$ the velocity of light in vacuum.

As we are first only interested in comparing the *changes* of the energies caused to the particle and photon by the same relative movement, that means only in their *kinetic* energies – and also we don't want to be dependent on a concrete particles rest mass or "*start energy"* of the photon – so we use the very common way to normalize the kinetic energy by the rest mass energy and we get the well known rest mass independent relativistic formula for the *relative* kinetic energy of a particle:

$$\Delta E_{rel.} = \frac{E_{kin.}}{E_0} = \gamma - 1. \qquad (3)$$

According to Equation (3), we draw the graph in Fig.1 of the relative kinetic energy of a particle in relation to $\beta(V_r)$.

Next we are interested to find an adequate function for changes of "kinetic energy" of a photon to be able to compare with the particle above. We assume a photon having a *starting energy* $E_{0ph} = h \cdot v_0$ in the Inertial Frame (IF) of the earths laboratory, where $h$ is Planck's constant and $v_0$ is it's original frequency in senders IF (we could also take this photons starting energy so, that it equals to the rest mass energy of the particle above, to be able to compare directly in absolute values – but we will need it later only for comparing linear

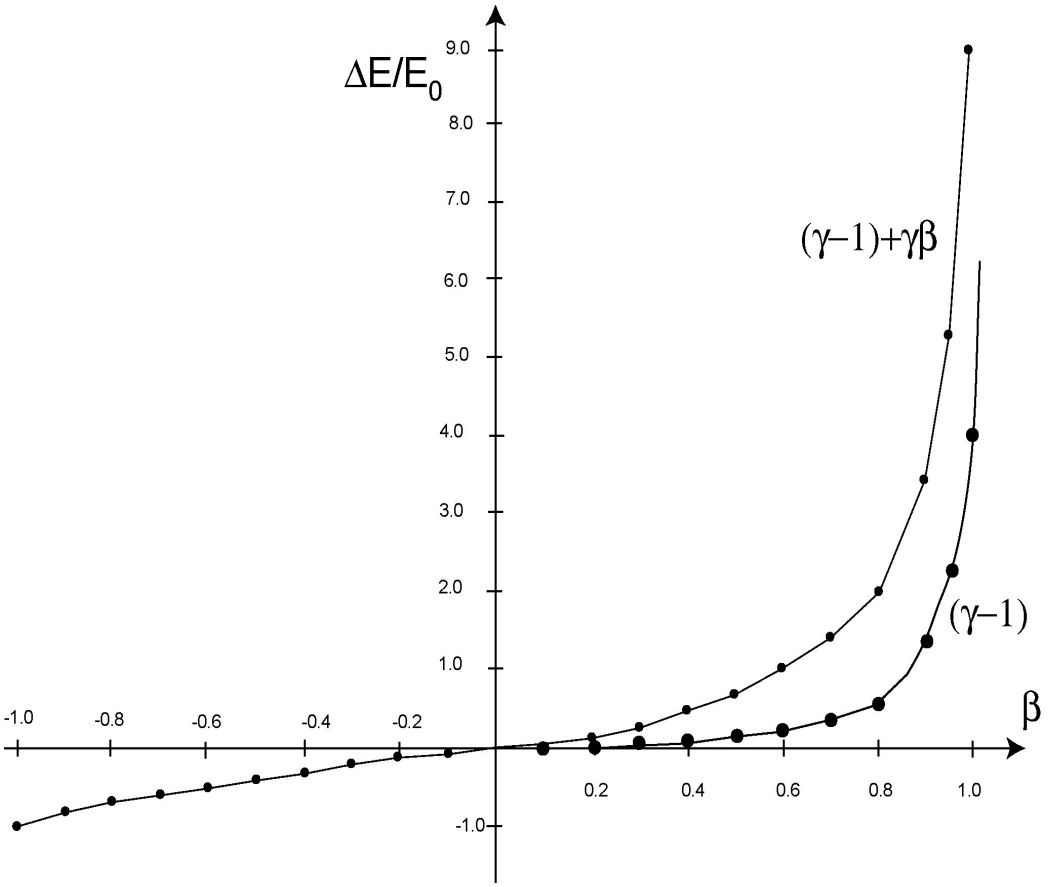


**Fig.1.** Relativistic kinetic energies of a particle *(γ-1)* with dick points, and of a photon *[(γ-1) ±γ·β]* , with small points

momentums). Then the energy of the blue or red shifted photon will be with shifted frequency $v'$ in the moving IF:

$$E'_{Ph.} = h \cdot v' \qquad (4)$$

Now we will build in the same manner as we did before for the particle the relativistic energy difference to the "original" energy of the photon in senders IF – this is equivalent to a "kinetic" energy of the photon, and we will call it so here, even if we know, that all energy of a photon is kinetic as there is no rest mass – but for comparison we will keep the unique terminology to be clear we are comparing adequate values caused by the same relative

moving action. Actually the kinetic energy of a rest mass particle is also equivalent to it's change caused by movement – but compared always with it's resting "movement energy" being zero. In case of photon we begin instead of a missing rest mass by the "starting energy" in the original IF of the sender. So we get for photon its *kinetic energy*:

$$E_{Ph.kin.} = h \cdot (\nu' - \nu_0). \qquad (5)$$

And so we put the same normalization method on Equation(5) dividing it by the photons original (starting) energy:

$$\Delta E_{Ph.rel.} = \frac{E_{Ph.kin.}}{E_{0\,ph}} = \frac{\nu'}{\nu_0} - 1. \qquad (6)$$

In a standard edition of physics Bergmann [2] we find the relativistic relation for a relativistic Doppler shifted frequency and adopt it for our case:

$$\nu' = \nu_0 \cdot \gamma \cdot (1 \pm \beta). \qquad (7)$$

This we set into Equation(6) and we get for the photons relative "kinetic" energy for positive relative velocity:

$$\Delta E_{Ph.rel.} = \gamma \cdot (1 + \beta) - 1 = (\gamma - 1) + \gamma \cdot \beta. \qquad (8)$$

As we see the relative kinetic energy of the photon has got an additional term $\gamma \cdot \beta$ if compared to articles in Equation(3). We also draw this relation in Fig.1 over the graph for the particle, and as a photon can also be red shifted, we also draw the graph for negative velocities, $(\gamma\text{-}1)\text{-}\gamma \cdot \beta$.

For the negative velocity we see it in Fig.1 unsymmetrical ending by –1 which means all energy of the photon is emptied to zero when it's frequency will be 0 and it's wavelength endless.

**Table 1.** Relative kinetic Photon-Particle Energy capacity $\kappa_{rel.}$

| B | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 | 0.6 | 0.7 | 0.8 | 0.9 | 0.95 | 0.98 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $\kappa_{rel.}$ | 20.9 | 10.9 | 7.5 | 5.8 | 4.7 | 4.0 | 3.4 | 3.0 | 2.6 | 2.4 | 2.22 |

The graphs in Fig.1 are showing very clear, that a photon evidently is able to transform the *same* relative movement of sender and receiver into *more* kinetic energy then a rest mass particle can do. It seems the photon has a *better capacity* for the kinetic energy – or let say it expressively – photons are *more relativistic* then electrons! In relativistic literature we are

used to see similar looking compares, but between kinetic energies of a rest mass particle in classic and in its relativistic description – the present "kinetic capacity" compare of photons and rest mass particles seems to be unknown, or we will still find a source describing it.

## *Half photon factor*

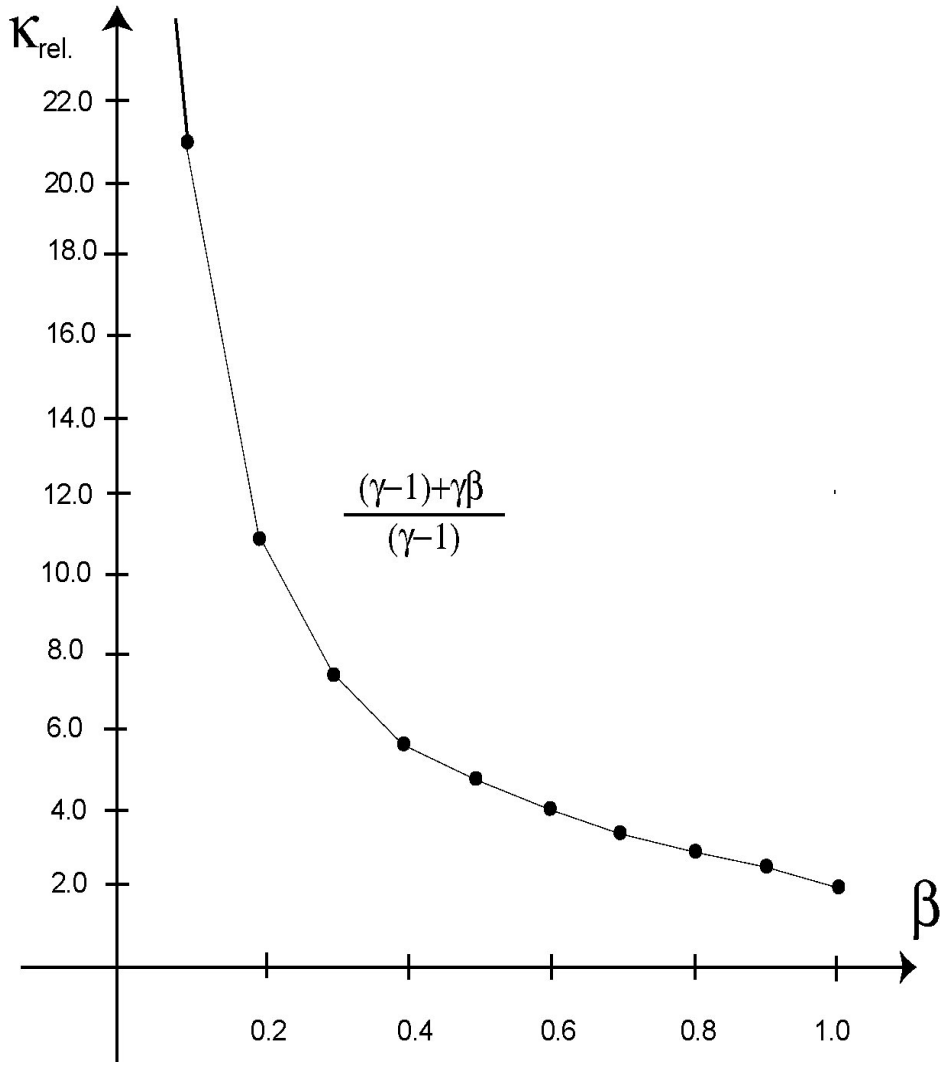


**Fig. 2**. Relative kinetic Photon-Particle Energy capacity $\kappa_{rel.}$

To see more exactly how much better the photon is "consuming" the kinetic energy of relative movement we will build a quotient of both relative values for photon and particle and will draw again a graph in Fig.2 according to Table 1. The sad quotient we name a *relative kinetic photon-particle energy-capacity* $\kappa_{rel.}$ Or shorter, a ***half photon factor***:

$$\kappa_{rel.} = \frac{(\gamma - 1) + \gamma \cdot \beta}{(\gamma - 1)} = 1 + \frac{\gamma \cdot \beta}{(\gamma - 1)}. \qquad (9)$$

The conclusion is simply to make, as any one can see, that relativistically a mass particle will end at near speed of light as just a half photon. It does have also a spin ½ which is also half of the photons spin. There must be something very similar in photons and mass particles and we know about particle waves according to de Broglie.

Another conclusion is, that photons are much better capacitors of the energy then mass particles, as the *half photon factor* is very big by classical low speeds used in technical applications. It can be like 200-500 times. So accumulation of energy can be targeted to use photons, instead of chemical elements or mechanical rotation.

This is just a wonder like fact, which can be count on as real phenomenon. As we still do not have any idea, what are photons and particle really, this new discovered attributes of matter should be known by each physician scientist.

Using this facts we offered a new particle model, based on a hypotheses of a looped photon in another publication [7]. It was easy to show how Doppler effect leads to energy mass and momentum of a particle according to relativistic Lorentz transformations.

References:

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