Kinetic capacity effect of photons and rest mass particles, and a relativistic rest mass model

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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 found, 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. To explain this phenomena, which could be named kinetic capacity effect, a physical model of a "folded and looped photon" was created and checked quantitatively through relativistic Doppler effect for kinetic and total energies, and for linear momentum. De Broglie's material wave was identified as modulation wave of two interfering waves of the correlated half photons inside of the particle, resulting in known group and phase velocities. Photons themselves were not changed in physical description, so Quantum Mechanics will stay in use with them, and Special Relativity has now extended abilities for entering into particles, opening a way through discussed model to unify both theoretical worlds. For the moment, the two classical theories, waves and relativity, have confirmed exact the hypothesis of present model.

Keywords: special relativity, half photons, blue and red side of particle, looped photon, folded photon, de Broglie, material wave, rest mass model, kinetic capacity effect

Louis de Broglie [1] had offered in 1924 to describe particles as waves similar to photons, which he thought to have a small rest mass. The imagination of particle waves helped to explain quantified stability criteria in Bohr's atom model and motivated Schrödinger to the formulation of wave Quantum Mechanics. We are going so far back to the basics in physics and start new at this point (probably) to find an "overlooked" way. In the following description we will use simplified terms to name *particles* all objects with rest mass and spin ½ – and with *photons* all quanta with spin 1, no rest mass and moving at velocity of light. Sometimes we will call particles for even more clarity *rest mass particles*.

One “folded” photon viewed through relativistic Doppler effect

The offered particle model is based on the idea to interpret a particle as a *looped* or *folded* photon running circular in itself – as a complete (squeezed) “photonic ring” existing also in a *free moving* particle. Such a particle will then, after being set into movement, have on the one “side”, running in the same direction as particle itself, a “blue” shifted *half photon*, and on the other side, running aback the particles moving direction, a “red” shifted half photon – so both half photons are running with the speed of light “against” each other. They are not separated but are staying a correlated *unit*, which is running circularly changing both sides. According to the Special Relativity on this, the relativistic effects of both half photons will happen in *opposite direction*, because they are moving opposite. As consequence the kinetic and total energy of the particle must be the sum of the relativistic energies of the two *contra verse* running half photons – and the same must be valid for the linear momentum and rest mass. Because the *blue shifted side* of the particle has more mass and energy resulting in a bigger linear momentum it is able to “take” the *red shifted side* into own direction – but the red side with it’s momentum succeeds to “slow down” the summary speed of the whole particle, and so these both opposite movements are defining a *moving direction* and *relative speed* for a given inertial frame (IF) in the space for such a particle – a summary linear momentum for it. To prove these hypotheses we will use the linear relativistic Doppler effect of Special Relativity (SRT). The other prove will be analysis of inner interference between half photons as waves.

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 0 and velocity of light c_0 in vacuum. In the case of half photons we will shift the one of them “blue” and the other “red”. The experiment is as *gedanken experiment* in Einstein’s tradition fully sufficient, and 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 and the mass of the electrons. As they are no *half photons* existing free, which we could measure directly, we will take instead whole photons coming in front blue shifted, and whole photons coming red shifted behind the space shuttle after passing earth's laboratory – and we will just put a factor ½ into the resulting formulas for energy and momentum of half photons.

In Fig.1 we see, anticipatory, the graphs of the 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 – 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 β ($\beta = V_r/c_0$) the photon has gotten about double as much 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* $E_{0\text{ph}} = h \cdot v_0$ 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

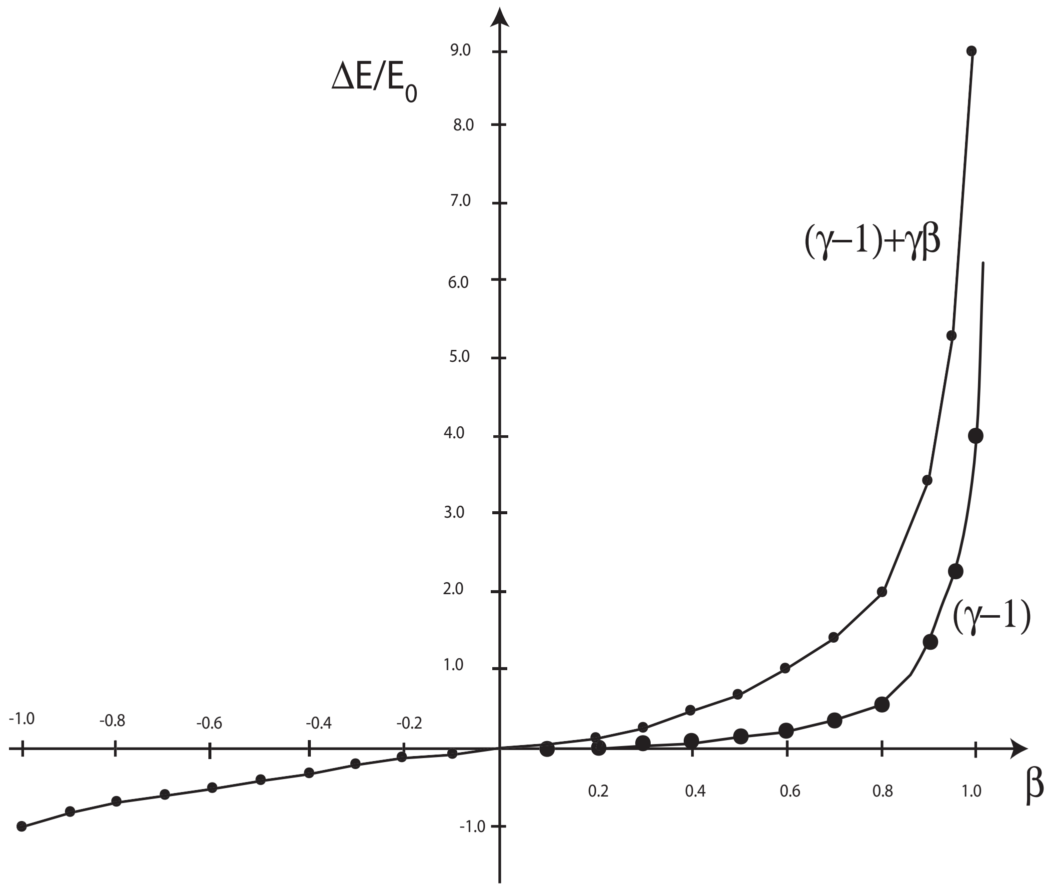

Fig.1. Relativistic kinetic energies of a particle *(γ-1)* with dick points, and of a photon *[(γ-1) ±γ·β]* , with small points

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

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

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:

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

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, $(\gamma-1)-\gamma \cdot \beta$.

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

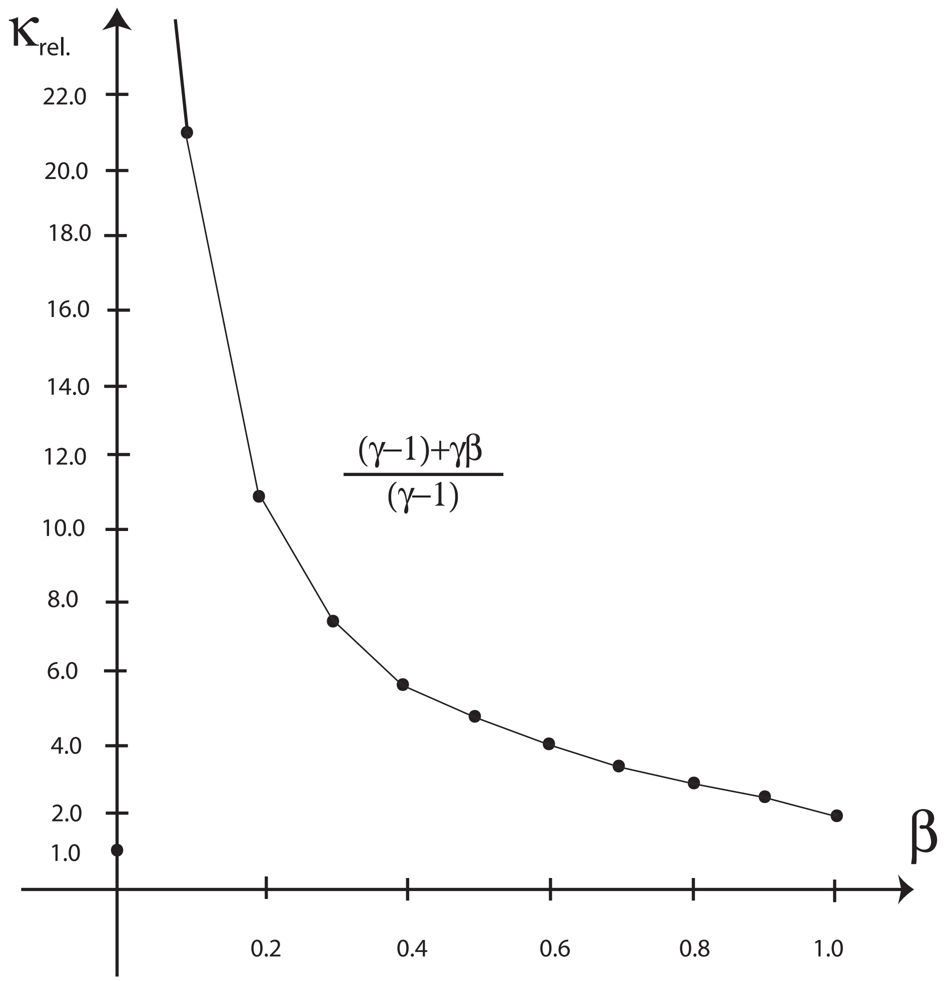

Fig. 2. Relative kinetic Photon-Particle Energy capacity $\kappa_{rel.}$

and rest mass particles seems to be unknown, or we will still find a source describing it.

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* $\kappa_{rel.}$:

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

Two half photons running opositely and the summary of them to a particle

According to the model there is on the one "side of the particle" a half photon running in direction of the movement of particle, and on the other side of particle a half photon running aback. As a consequence the forwards running side will be *blue shifted* by relativistic Doppler effect, and the aback running side will be *red shifted*.

One very *symbolical* sketch of such a particle is to see in Fig.3 where the photon is divided symmetrically (b), what means the number of "wave picks" is equal on both sides, and so the length of them seems different to us. This difference in length is just a relativistic length effect, which makes the wavelength of the blue half photon shorter then of the red half photon. These symbolical waves are to be understood as *wave packets* according to Quantum Mechanical theories as we are *changing nothing on photons* themselves in the presented model – we just draw them here very simplified to show symmetry and the *relativistic effect* of the wavelength. They are not to understand running on two parallel tracks, as in Fig.3 (b) – rather they are running *through each other* - by reason of symmetry.

According to the relativistic Doppler Effect, both opposite running sides of the particle will be effected in an opposite way: while the blue side is getting more energy with growing β, the red side will *loose* energy. That means only one side of the particle is involved in *growing* the kinetic energy while the other side is working *against* it, *loosing* energy. The red side can not loose as much kinetic energy as the blue side can catch: in Fig.1 is good to see that the blue side can improve it's energy into endlessness while the red side only can be pumped empty to zero energy – because there is no negative endlessness in energy, the graph is not symmetrical. The sum of the energies of both half photonic sides of the particle builds its complete energy and so it can only stay back behind the relative energy of a photon, which is

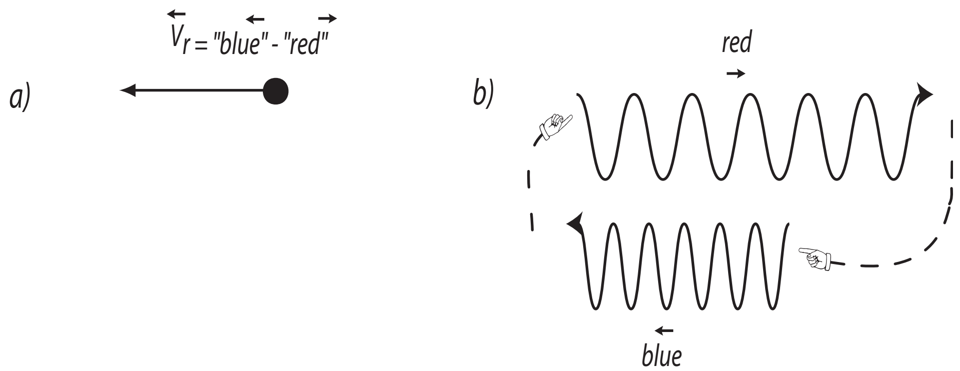

Fig.3. Photonic particle model **a)** particle classically, with symbolical velocity formula **b)** particle with two opposite running half photons as wave envelopes – *„blue"* und *„red"*

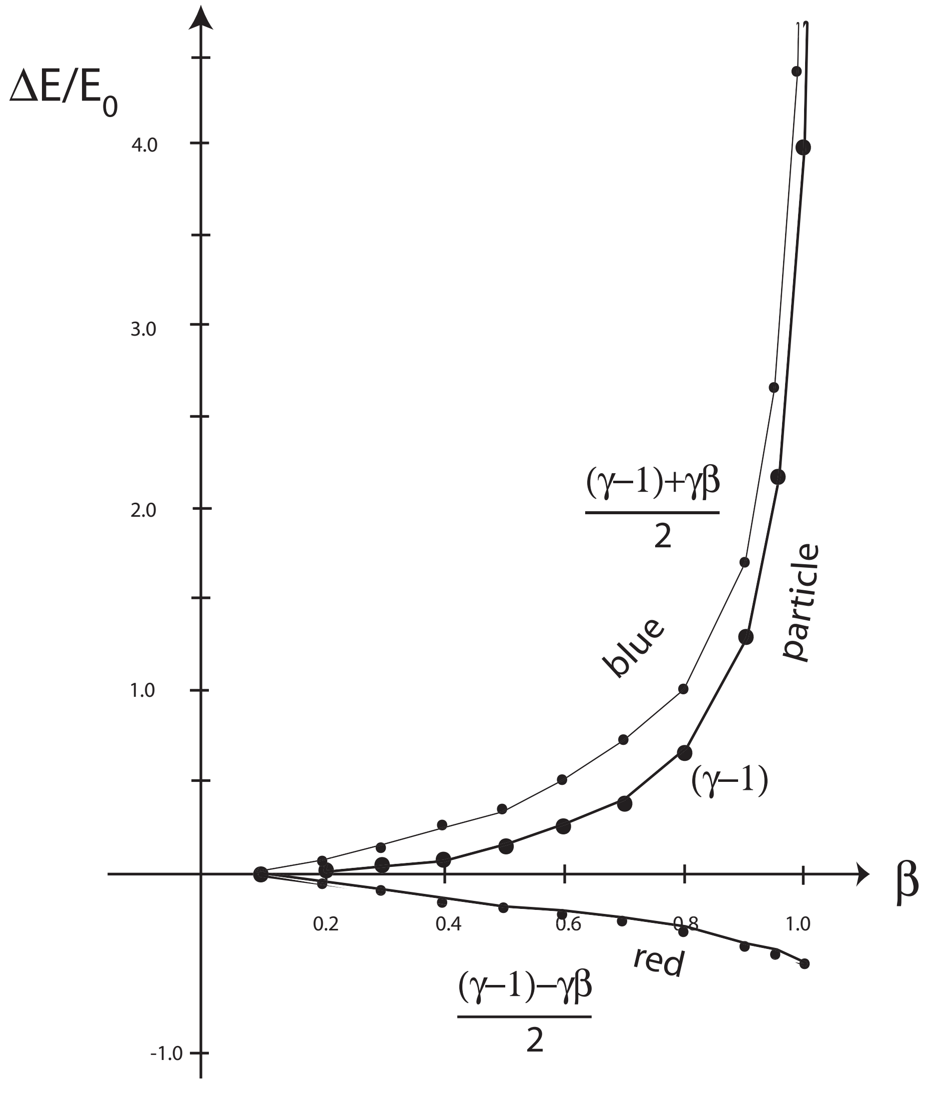

Fig. 4. Relativistic kinetic energies of the two half photons shifted by relativistic Doppler effect: of one ***blue*** and one ***red***, and their sum *(γ-1)* to a ***particle***

always in its whole length "blue" (or "red") shifted. That's why a rest mass particle will be as maximum in capacity for kinetic energy as good as a half photon only – as we will see it now.

When the one side is a *blue shifted*, and the other side a *red shifted* half photon, then we can set for the whole relative kinetic energy of the particle:

$$\Delta E_{rel.} = \frac{E_{kin.}}{E_0} = \frac{\Delta E_{Ph.blue.}}{2} + \frac{\Delta E_{Ph.red.}}{2}, \qquad (10)$$

and setting into it Equation(8) where the red shifting means just negative β, we get:

$$\Delta E_{rel.} = \frac{1}{2}\cdot((\gamma-1)+\gamma\cdot\beta)+\frac{1}{2}\cdot((\gamma-1)-\gamma\cdot\beta)=\gamma-1, \qquad (11)$$

where after recombination we've got the known relation of equation (3) for the relative normalized kinetic energy of a *rest mass particle* – so the hypotheses succeeds to get (kinetically) by means of energy, starting with two opposite running half photons one rest mass particle!

The result of the equation (11) we draw again as a graph in the Fig.4, where we have separate the red and blue half photons and also their sum.

We should not forget, that we just have compared and added the *kinetic energies* only. To be able to compare with the wavelength of de Broglie we must put the *rest mass* of particle and the whole mass-energy of photon into account. It is of interest to find out which of the new particle frequencies are "identical" with de Broglie's or are "visible" in some experiments.

Linear momentum of particle set together by two half photons

Being encouraged by success of previous calculations and qualitative interpretations to explain *kinetic energy* of a particle just by attributes of two oppositely running half photons we of course want to prove if it is possible to get the *linear momentum* of the rest mass particle also out of the momentums of the two opposite running half photons. We will view a particle of a rest mass m_0 and a photon having the same energy in the sender IF – to be able to compare them directly in absolute values if necessary. Therefore we start by a particle like in

Fig.3(b) and we summarize the linear momentums of the red and blue side together, with their directions:

$$p = p_{blue} - p_{red}. \qquad (12)$$

The momentum of a (whole) photon is known as $p=h\cdot \nu/c_0$ and with Equation(7) for the Doppler shifted frequency we get for the summarized linear momentum of the two half photons:

$$p = \frac{h\cdot\nu\cdot\gamma\cdot(1+\beta)}{2\cdot c_0} - \frac{h\cdot\nu\cdot\gamma\cdot(1-\beta)}{2\cdot c_0} = \frac{h\cdot\nu\cdot\gamma\cdot\beta}{c_0}. \qquad (13)$$

With the known relation for the mass of a photon $m_{ph}=h\cdot \nu/c_0^2$ we get for $m_{ph}\cdot c_0=h\cdot \nu/c_0$ and we put it in Equation(13) – remembering, that we have chosen the (original) mass of the photon to be equal to the rest mass of particle, we get for the linear momentum:

$$p = m_{ph}\cdot c_0\cdot\gamma\cdot\beta = m_{ph}\cdot\gamma\cdot V_r = m_0\cdot\gamma\cdot V_r. \qquad (14)$$

This is the *known* relativistic formula for the linear momentum of a *rest mass particle*! We have identified for it the masses $m_{ph}= m_0$ being equal by initial conditions. So we have seen linear momentums of two opposite running half photons building exactly the linear momentum of a rest mass particle.

If the particle will be stopped to rest (which is not possible in a quantum mechanical measurement equipment, but we just think it classically ideal at the moment), then the momentum in equation (14) will be zero, and also it is zero in equation (13) for relative speed zero. Here the momentums of the two opposite running photons are "deleting" each other, because they will have the same magnitude. And we see, that "deleting" is not really physically – instead they are staying *inside* of particle two "anti-equal" linear momentums in opposite direction building one equilibrium. They are not measurable outside and around the particle, as it is ideal resting, but they are significantly taking part in creating the *rest mass* and *inertia* of the particle, which we would "feel" immediately if we impact this particle by another one – but this we will discuss later on.

Total energy of particle

To be able to compare with de Broglie's wave we must take in account also the *rest mass* of particle into the energy balance of the half photonic particle – to have our half photons *complete*. According to the present model each particle has two *internal* frequencies – one of them we can call "red", and the other "blue", or in other words, one "forward frequency" and one "backward". This arises the question which of the both frequencies makes itself recognizable in known interactions? Which of the new frequencies are at all measurable?

One resting particle equals in the present model of course also to the two half photons running in opposite directions, and would the particle be really resting, then both sides of particle would have the same energy, means the same frequency and wavelength. We treat this question idealistically in classical terms and forget for the moment about zero point energy of the quantum mechanics.

Observing a particle as a looped (better folded) photon in present model, we start with choosing a particle of rest mass m_0 and a photon which energy equals to m_0, and we divide it for the two sides of particle:

$$m_0 = \frac{h \cdot \nu_0}{c_0^2} = \frac{m_0}{2} + \frac{m_0}{2}. \qquad (15)$$

This photon is going to be "fold up" into a particle and it's "resting frequency" will be correlated to it's rest mass:

$$\nu_0 = \frac{m_0 \cdot c_0^2}{h}. \qquad (16)$$

For the idealized resting particle this frequency equals exact both – the blue and red frequencies of the particle. We just are putting in equation (15) the photonic equivalents for the energy, and so is the resting energy of our particle created to the known:

$$E_0 = \frac{1}{2} h \cdot \nu_{blue} + \frac{1}{2} h \cdot \nu_{red} = \frac{h}{2} \cdot (\nu_{blue} + \nu_{red}) = h \cdot \nu_0. \qquad (17)$$

Being set into movement relativistic Doppler effects will take in opposite directions on the two sides of particle – so we put in equation (17) the Doppler relations for red and blue frequencies:

$$E_0^{'} = \frac{h}{2}[\nu_0 \cdot \gamma(1+\beta) + \nu_0 \cdot \gamma(1-\beta)] = h \cdot \nu_0 \cdot \gamma = E_\Sigma. \qquad (18)$$

Then we've got a formula which we identify as the relativistic formula for the *total* energy of a rest mass particle, if $h \cdot \nu_0 = E_0$ with equation (17). Through it under our eye's, starting with *resting energy* E_0 alone, by just relative movement with β the ***total energy*** of particle was created from two half photons shifted by relativistic Doppler effect! Also this basic attribute of particles is now derived relativistic in the present model – and it is no wonder any more after previous successful results with kinetic energy and linear momentum, as all this formulas are related basically – but it confirms that we have used them correctly.

To compare better with de Broglie's wave, we must transform it into the wave length, because all data and formulas in the literature are in such form. From equation (18) we substitute for the "blue frequency":

$$\nu_{blue} = 2 \cdot \nu_0 \cdot \gamma - \nu_0 \cdot \gamma \cdot (1-\beta) = \nu_0 \cdot \gamma(1+\beta) = \frac{m_0 \cdot c_0^2}{h} \cdot \gamma(1+\beta), \qquad (19)$$

and the "red frequency" in analogy to it:

$$\nu_{red} = \nu_0 \cdot \gamma(1-\beta) = \frac{m_0 \cdot c_0^2}{h} \cdot \gamma(1-\beta). \qquad (20)$$

The wavelength is then easy to get with the definition $c_0 = \lambda \cdot \nu$:

$$\lambda_{blue} = \frac{h}{m_0 \cdot c_0 \cdot \gamma \cdot (1+\beta)}, \qquad (21)$$

and the same for "red" wavelength:

$$\lambda_{red} = \frac{h}{m_0 \cdot c_0 \cdot \gamma \cdot (1-\beta)}. \qquad (22)$$

De Broglie's relation for the matter wavelength is known, we look it in Bergmann [2] as:

$$\lambda_{Broglie} = \frac{h}{p} = \frac{h}{m_0 \cdot \gamma \cdot V_r} = \frac{h}{m_0 \cdot \gamma \cdot \beta \cdot c_0}, \qquad (23)$$

where relative velocity V_r was expressed through β for comparison. It is evident that both, red and blue inner wavelengths of the particle are not to identify with de Broglie's wavelength – but as next we will look if it can be an *interference* effect. Now the initial hypotheses is standing on such basic conceptions of physics like mass, kinetic and total energy and linear momentum.

Inner Interference between half photons

Classical wave theory is able to describe photons as electromagnetic waves very good as far as we do not ask about energy and momentum – we know it is working perfect in optics. We will describe *interference* between the two correlated and oppositely running half photons. Two classic waves running parallel are causing *dispersion* with each other, resulting in a group velocity and a phase velocity of the summarized wave. We check this giving the two (half) photons waves classical descriptions, which might not differ from the "whole photons" as waves have mathematically endless length (so it is meaningless to say "half photons" in the view of waves theory):

$$\begin{aligned} f_1 &= A \cdot \sin(\varpi_1 t - k_1 x), \\ f_2 &= A \cdot \sin(\varpi_2 t + k_2 x + \varphi), \end{aligned} \qquad (24)$$

where k are wave numbers, ω angular frequencies, and φ is phase angle being in this case zero, because it is one and the same *looped photon*, so its "half's" are correlated – the same is true for magnitude A. In this form they are moving waves, not standing ones. Their frequencies and wave numbers are (relativistic) different, but they are correlated too, and can be expressed through each other. Both photon's waves themselves have group velocity equal to phase velocity being speed of light (in vacuum). By superposition and trigonometric identities, looked up in Bartsch [4], the sum is:

$$f_\Sigma = 2A \cdot \sin \frac{(\varpi_1 + \varpi_2)t + (-k_1 + k_2)x}{2} \cdot \cos \frac{(\varpi_1 - \varpi_2)t - (k_1 + k_2)x}{2}. \qquad (25)$$

In case of resting particle $\omega_1 = \omega_2$, and $k_1 = k_2$ we would get a standing wave with resting frequency ω_0:

$$f_{\Sigma 0} = 2A \cdot \sin \omega_0 t \cdot \cos(-kx) = 2A \cdot \sin \omega_0 t \cdot \cos(kx). \qquad (26)$$

Here we set frequency and wavelength into equation (25):

$$f_\Sigma = 2A \cdot \sin \frac{2\pi[(\nu_1 + \nu_2)t + (-\frac{1}{\lambda_1} + \frac{1}{\lambda_2})x]}{2} \cdot \cos \frac{2\pi[(\nu_1 - \nu_2)t - (\frac{1}{\lambda_1} + \frac{1}{\lambda_2})x]}{2}, \qquad (27)$$

and replace wavelength using definition $\nu \cdot \lambda = c_0$:

$$f_\Sigma = 2A \cdot \sin\pi[(\nu_1+\nu_2)t + (-\frac{\nu_1}{c_0}+\frac{\nu_2}{c_0})x] \cdot \cos\pi[(\nu_1-\nu_2)t - (\frac{\nu_1}{c_0}+\frac{\nu_2}{c_0})x],$$
$$f_\Sigma = 2A \cdot \sin\pi[(\nu_1+\nu_2)t - \frac{\nu_1-\nu_2}{c_0}x] \cdot \cos\pi[(\nu_1-\nu_2)t - \frac{\nu_1+\nu_2}{c_0}x]. \tag{28}$$

Because $\nu_1 > \nu_2$ in our case is always greater, being "blue" frequency against the "red", both *sin* and *cos* terms have negative wave numbers *k*, which means both are representing waves moving into positive x-direction, which is moving direction of the particle.

Phase velocity is known, for example by Feynman [5] as $V_{ph} = \frac{\varpi}{k}$, so we get in *sin* term:

$$V_{ph\sin} = \frac{(\nu_1+\nu_2)}{\nu_1-\nu_2}c_0, \tag{29}$$

which is always larger then speed of light in present case. And for *cos* term:

$$V_{ph\cos} = \frac{(\nu_1-\nu_2)}{\nu_1+\nu_2}c_0, \tag{30}$$

which is always smaller then speed of light. According to Equation (7) $\nu_{blue} = \nu_0 \cdot \gamma \cdot (1+\beta)$, and $\nu_{red} = \nu_0 \cdot \gamma \cdot (1-\beta)$, and we set $\nu_1 = \nu_{blue}$, and $\nu_2 = \nu_{red}$, into Equation(29) and get:

$$V_{ph\sin} = \frac{2\cdot\nu_0\cdot\gamma}{\nu_0\cdot\gamma\cdot 2\cdot\beta}c_0 = \frac{c_0^2}{V_r}, \tag{31}$$

which we can identify as known *phase velocity of matter waves* being always higher then velocity of light. The same we calculate for *cos* term:

$$V_{ph\cos} = \frac{\nu_0\cdot\gamma\cdot 2\cdot\beta}{2\cdot\nu_0\cdot\gamma}c_0 = V_r, \tag{32}$$

and we see (surprisingly) this is the particles velocity.

Group velocity, which is propagation velocity of a super positioned wave, is known, for example by Feynman [5], as $V_{gr} = \frac{d(\varpi)}{dk} = \frac{d(\nu)}{dk}$ and we calculate it also for *sin* and *cos* terms:

$$f_\Sigma = 2A \cdot \sin\pi[(2\cdot\nu_0\cdot\gamma)t - \frac{\nu_0\cdot\gamma\cdot 2\cdot\beta}{c_0}x] \cdot \cos\pi[(\nu_0\cdot\gamma\cdot 2\cdot\beta)t - \frac{2\cdot\nu_0\cdot\gamma}{c_0}x] \tag{33}$$

where we take out all common constant factors of *k* and *ω*:

$$f_{\Sigma} = 2A \cdot \sin\{2 \cdot \nu_0 \cdot \gamma \cdot \pi[t - \frac{\beta}{c_0} x]\} \cdot \cos\{2 \cdot \nu_0 \cdot \gamma \cdot \pi[\beta \cdot t - \frac{1}{c_0} x]\}, \quad (34)$$

and we see in *sin* term "*ω"* =1 (*ω* and *k* are normalized by constant factors) and is no function of *k*. Therefore the group velocity will be zero by this term. The same we do for *cos* term: $"\varpi" = \beta = \frac{V_r}{c_0}$, and $"k" = \frac{1}{c_0}$, so $\omega = f(k) = V_r \cdot k$, and we get for group velocity:

$$V_{gr} = \frac{d(\varpi)}{dk} = V_r \cdot \frac{d(k)}{dk} = V_r, \quad (35)$$

the known (and expected) value equal to particles velocity. So the classic wave theory is confirming present model, which through it is giving to phase velocity of de Broglie's waves one *physical* meaning. The process of changing the moving directory at the reverse points of the looped photon according to Fig.3(b) can be understood as reflections – in the view of wave model.

So present model, which describes kinetic phenomena, the *kinetic capacity effect,* between photons and rest mass particles, was confirmed by two classical theories – special relativity and wave mechanics. A result which makes inquisitive to search for a quantum mechanical description of it. Nothing was changed on the photon waves, and as the present model is simply using photons to build particles, Quantum Mechanics can be expected to describe also the here presented photonicaly constructed particles. It is not necessary at the moment to think present model to be a *reality*, as so many our mathematical model's doesn't tell it, but indeed it was able to describe classically the presented phenomena. It is a *rest mass model*, as it is constructed in it by photons.

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