Adv. Studies Theor. Phys., Vol. 2, 2008, no. 10, 491 - 505

Mass Attraction Caused by Ultralong-Wave Photons?

Christoph Schultheiss

Forschungszentrum Karlsruhe GmbH, Institut für Hochleistungsimpuls- und
Mikrowellentechnik, Postfach 3640, D-76021 Karlsruhe, Germany
christoph.schultheiss@ihm.fzk.de

Abstract

In the frame of Special Relativity it can be demonstrated that the wavelength of a photon, which is confined between two perfectly reflecting moving mirrors, develops in congruence with the distance between the mirrors. Thus, the expansion of space after the big bang opens the possibility to deal with a flux of congruently expanded photons with ultra long wavelength (ULW). Each particle in space could undergo continuing collisions with ULW photons. This can lead to electric screening effects between particles proportional to their charge and consequently to virtual attraction forces, a force similar to gravitation. This idea is not new: In 1784 Le Sage already developed a theory of inward-directed pressure caused by a flux of hypothetic particles in space. For the case of extremely long wavelength photons – as Le Sage's particle - it can be demonstrated that relativity is conserved. Movements in the frame of tiny fractions of wavelength ($<< \lambda \sim 10^{25}$ m) during short times ($<< \lambda/c$) will not cause Doppler shifts i.e., do not change the colour of the ULW spectrum. Such movements will also not cause an increased collision rate, since the collision probability underlies quantum mechanical uncertainty; the rate-deviation in this case is proportional to $\Delta\lambda/\lambda$ which is nearly zero. To simulate gravitation, fluxes of ULW photons in space are discussed corresponding to an energy density of up to 10^{65}

Joule/m^3, which is a small thermal fraction in comparison with the zero point radiation of about 10^{114} Joule/m^3.

PACS numbers: 98.80.- k, 95.30.Sf, 03.30.+ p
Keywords: Cosmology, gravitation, Special Relativity

1. Introduction

Currently, hypothetic dark energy is under discussion that could account for the phenomenon of accelerated expansion of space [1]. Furthermore, the existence of gravitating dark matter is necessary to preserve the validity of the gravitation law [2]. This paper should be understood as an approach to explain the expansion of the universe and the deviation of gravitational attraction in large mass collections like galaxies based on well-understood physical laws.

The accelerated expansion of universe reminds to a historic theory of gravitation developed by Le Sage and others in the late 17th –century shortly after Newton's detection of gravitation [3]. They understood gravitation as an inward-directed pressure on masses generated by friction of an isotropic flux of hypothetic particles. However, implications of the theory are deceleration of necessarily over light fast particles, corresponding heat development in masses by friction etc. so that discussions about this theory ended in 1920 with the rise of General Relativity (GR). In this paper it will be demonstrated that relativity and the quantum mechanics (QM) of ultra long wavelength (ULW) photons as "hypothetic particles" will effect gravitational pressure without the negative implications mentioned above.

It is necessary to recall Einstein's argument [4] that electromagnetic fields are in reality swarms of photons that interact with charged particles by means of collisions [5]. Therefore, the exact description of collision processes is the Compton formalism. It is also necessary to recall the conclusion of Schrödinger that Compton shifts are in reality Doppler shifts, i.e., changes of photon energy rely exclusively on Doppler transformation [6]. Within this framework, moving mirror processes are modeled in which a photon reflects back and forth between two mirrors, thus accelerating them. This represents a compelling model of the photo effect. In this exact relativistic calculation, the light wave expands by multiple Doppler shifts proportional to the increasing distance between the mirrors (path-wave-congruence).

The idea presented here is that from the very first stage of the big bang, both the wavelength of light and (optically thick) matter [7] could have expanded in a congruent manner. Hence, space may be densely filled with photons of cosmic wavelength distribution, which interact with charges [8]. When such ULW photons penetrate large masses like planets, then a small fraction of flux can get lost by Compton scattering, comparable with radio long waves passing a dust particle. Thus, a mass located over the planet's surface is more strongly impacted by ULW photons coming from the open sky than by ULW photons coming through the planet. Therefore, due to the photon momentum transfer, the mass is accelerated towards the planet's surface, an effect similar to that of gravitation. However, the overall behavior of interaction between masses and ULW photons is an expansion or explosion driven by the pressure of ULW photon collisions.

2. Model of generation of ULW photons by means of moving mirrors and effect of congruence between path and wave.

Let a moving mirror system consists of two perfectly reflecting mirrors. One can be fixed (m_∞), the other one is movable as shown in Fig.1. A photon moves back and forward in 180° reflections leading to an outward directed pressure. Under the action of a high number of reflections the photon energy shrinks, the kinetic energy of the mirror approaches hν, and the mirror separation grows. The relationship between mirror separation and photon energy is the question and is the subject of the following investigation:

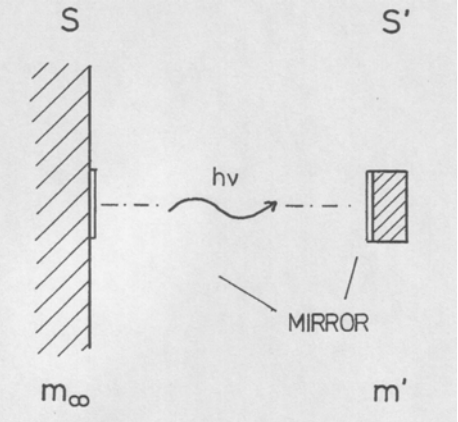

FIG.1 Fixed (S) and movable mirror (S′) with photon

The exact description of a 180° collision of a photon with a particle is the Compton formalism. Here the movable mirror mass as well as the photon changes energy and momentum during collision [9]. These changes cause the well known wavelength shifts for photons (Compton shift). Several authors [6, 9-13] concluded that these shifts are identical to Doppler shifts, that is, after the interaction the charge moves with the velocity $\beta' = v'/c$ and the interacting photon, coming back from the moving mirror mass, becomes Doppler red-shifted corresponding to β'. This will be demonstrated more detailed next.

With the abbreviations: $\alpha = \frac{h\nu}{mc^2}$, $\gamma = \left(1-\beta^2\right)^{-1/2}$ and for an initial velocity $\beta = 0$, by mutual addition and subtraction of both energy and momentum equations:

$$\alpha + 1 = \alpha' + \gamma' \qquad (1)$$

$$\alpha + 0 = -\alpha' + \beta'\gamma' \qquad (2)$$

and the use of the defining equation: $\gamma' + \beta'\gamma' = (\gamma' - \beta'\gamma')^{-1}$ the well known solutions: $\alpha' = \alpha(1+2\alpha)^{-1}$ and $\gamma' = 1 + 2\alpha^2(1+2\alpha)^{-1}$ result. Furthermore Eq.1 rewritten gives: $\gamma' = \alpha - \alpha' + 1$ and Eq.2 gives $\beta'\gamma' = \alpha + \alpha'$. By subtraction and addition we have $\gamma' - \beta'\gamma' = 1 - 2\alpha'$ and $\gamma' + \beta'\gamma' = 1 + 2\alpha$. Because of the upper defining equation it follows that $\gamma' - \beta'\gamma' = 1 - 2\alpha' = (1+2\alpha)^{-1}$. A comparison with the solution for α' (see above) gives:

$$\gamma' - \beta'\gamma' = D' = \frac{\alpha'}{\alpha}, \qquad (3)$$

which is the Doppler equation. For the case of an initial velocity analogous to Eq.1 and 2, the energy and momentum laws have the form $\alpha + \gamma = \alpha' + \gamma'$ and $\alpha + \beta\gamma = -\alpha' + \beta'\gamma'$. With the abbreviated Doppler factor $D = \gamma(1-\beta)$ the solution is [14]:

$$DD' = \frac{\alpha'}{\alpha} \qquad (4)$$

Of course, each transformation during following reflections leads to additional Doppler terms in the product DD´D´´D´´´... of Eq.4 and so on.

It will be shown next that multiple Doppler shifts lead to an expansion of the wavetrain congruently with the distance given by the equation of motion of the movable mirror. The Minkowski presentation of Fig. 2, left, shows the wavetrain path (shown as an arrow) in the fixed mirror system S and Fig.2, right, shows the wavetrain path in the movable mirror system S´. If the wavetrain arrow in one system is horizontally aligned (wavetrain head and tail arrive simultaneously), then in the other system the wavetrain arrow is slanted (the arrival times of wavetrain head and tail are not simultaneous). The coordinates of the laboratory system S in Fig.2 are transformed into the system S´ of the movable mass m by means of the Lorentz transformation $ct' = \gamma(ct - \beta x)$ and $x' = \gamma(x - \beta ct)$. The transformation relates to the common origin, where the *ct*-axis meets the *ct´*-axis. This point is in the past at the virtual time $ct_0 = -L/\beta$. Therefore, before the transformation all coordinates in Fig.2 should be rewritten.

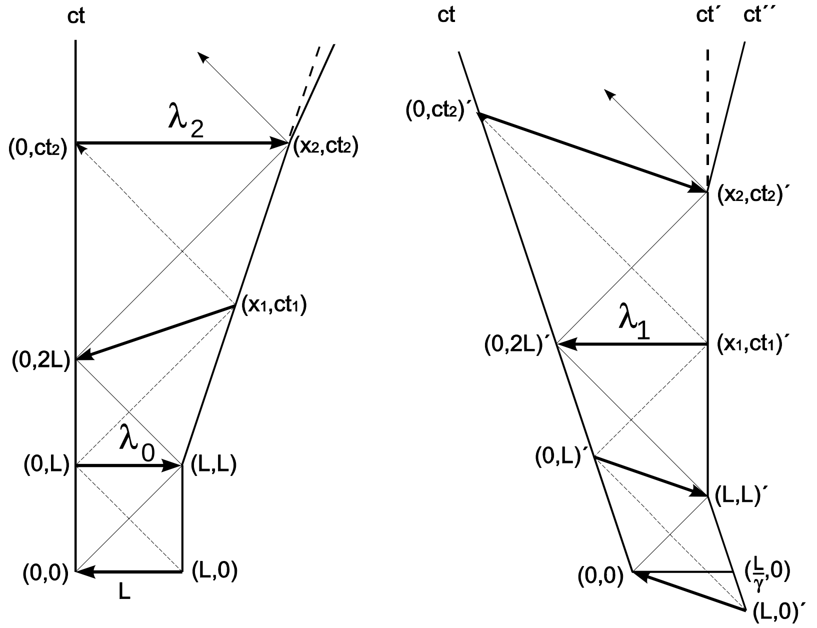

FIG. 2. Minkowski space-time presentations S, S′ of 180°-Compton collisions of a photon between fixed- (ct-axis) and movable mirror (ct′-axis). The wavetrain arrows are alternately horizontal- (λ_0, λ_1 and λ_2) or slanted. The photon is assumed to be at the wave head.

The transformed coordinates are:

$$(0,L)' \to \left(0,\frac{L}{\beta}\right)' = \left[-\gamma L,\gamma\frac{L}{\beta}\right] \tag{5}$$

$$(L,L)' \to \left(L,\frac{L}{\beta}\right)' = \left[0,\gamma\frac{L}{\beta}\left(1-\beta^2\right)\right] \tag{6}$$

$$(0,2L)' \to \left(0,\frac{L}{\beta}(1+\beta)\right)' = \left[-\gamma L(1+\beta),\ \gamma\frac{L}{\beta}(1+\beta)\right] \tag{7}$$

$$(x_1,ct_1)' = \left(L\frac{1}{1-\beta},\frac{L}{\beta}\frac{1}{1-\beta}\right)' = \left[0,\ \gamma\frac{L}{\beta}(1+\beta)\right] \tag{8}$$

$$(x_2,ct_2)' = \left(L\gamma^2(1+\beta)^2,\frac{L}{\beta}\gamma^2(1+\beta)^2\right)' = \left[0,\ \gamma\frac{L}{\beta}(1+\beta)^2\right] \tag{9}$$

$$(0,ct_2)' = \left(0,\frac{L}{\beta}\gamma^2(1+\beta)^2\right)' = \left[-L\gamma^3(1+\beta)^2,\frac{L}{\beta}\gamma^3(1+\beta)^2\right] \tag{10}$$

This results in the following expressions for the wavetrain lengths:

$$\begin{aligned} \lambda_0 &= \quad (L,L)-(0,L) &&= L \\ \lambda_1 &= -(0,2L)' + (x_1,ct_1)' &&= L\,D^{-1} \\ \lambda_2 &= \quad (x_2,ct_2)-(0,ct_2) &&= L\,D^{-2} \quad \text{etc.} \end{aligned} \tag{11}$$

The scheme in Eq.11 demonstrates that just when the wave-head touches the opposite mirror, the mirror separation and the horizontally aligned wavetrain path are exactly equal in length. In the subsequent collisions (λ_3 etc.) we have to distinguish between Doppler factors with different values appearing in Eq.11 since the photon energy decreases.

Equation set 11 can be called *"congruence equations".* With increasing mirror distance, the photon momentum decreases but will not vanish in this framework, even for cosmic separations. In this sense, the number of photons is conserved [15].

Note, that in this context a thermalization of ULW photon energy via an instantaneous photo effect process is irrelevant, since a further transfer of energy from ULW photons onto particles demands a continuous expansion of the wave in the moving mirror system, respectively in space (see Fig,2), and calls for cosmic time scales.

Note, in light of congruent expansion (Eq.11), a Photo Effect will have the following character: For instance, visible light is "absorbed" by a black fabric which means the photon undergoes a number of (mainly) elastic Compton collisions with fabric electrons, loses energy due to Doppler shifts, and is converted into long wavelength infrared photons (conservation of the number of photons).

Note, inelastic collisions have the potential to absorb a photon within the short time interval λ/c. However, such considerations play no role in the ULW scenario where absorbing atoms or molecules with corresponding ULW-energy bands are not present.

Note, in the calculation of Fig.2, the photon is located at the wavetrain head. In reality, because of QM-uncertainty the photon collision can appear during the whole oscillation period [16]. This leads to QM-uncertainty in the mirror- and wave expansion, but in a statistical average the congruence between path and wave is true.

3. Tiny movements, with respect to ULW wavelength and ULW oscillation time, against the ULW photon spectrum and effect on relativity. Limitation of Doppler law in sub-wavelength processes.

Figure 2 suggests that the change of wavelength in the Doppler process requires an expansion of the wavetrain between moving mirrors during a full oscillation period. If the mirror movement is disturbed during the oscillation period by means of "high frequency" displacements caused by outer means, deviations from the

Doppler process should be expected. Assume that at a time point ct = -T, just before the photon arrives at the point (L,L) in Fig.2 left, an external force starts to move the mirror outward (T is tiny in comparison to L). In a linear approximation the increase of separation as well as the increase of the wavetrain length is (for the case $\beta \ll 1$):

$$\lambda \approx L\left(1-\beta\frac{T}{L}\right) \tag{12}$$

A derivation using the Lorentz transformations (not shown here) gives $\lambda = L\sqrt{1-2\frac{\beta}{1-\beta}\frac{T}{L}}$. Equation 12 deviates from the Doppler shift expression because of the dominant term T/L, where L is on the order of 10^{25} m. Even for particles moving with light speed, Eq.12 describes immeasurably small effects on λ. If, for instance, particles generated by a 10 km long linear accelerator have β -values on the order of 0,9999, then the factor in Eq.12 is in the order of 10^{-21}, which means if Eq.12 is considered as a Doppler equation a wavelength shift corresponding to a velocity of 3.10^{-10} m/s can be expected. Therefore, Special Relativity is hardly affected by a ULW photon scenario. However, an increased collision rate because of the anisotropy during motion against the ULW-spectrum would violate relativity. Since, on the other hand, it is uncertain whether the ULW photon is emitted at the head or at the tail of the wave, it is irrelevant (by the order L/T) whether the charge moved over the distance T during the ULW oscillation time L/c or is at rest. For instance, for Mercury with an orbital radius of $T \approx 10^{11}$ m and $L = 10^{25}$ m the increase of the collision rate, proportional to $T/L \approx 10^{-14}$, is tiny.

4.1 The appearance of an ULW photon flux in space

The critical point of the theory is the existence of an intense spectrum of ULW photons. This question couples back to the theory of big bang and its boundary conditions. The ULW scenario demands a very high initial number of photons. In the next chapter (Chap.4.2) indications are found that we have to deal with up to 10^{119} photons/m^3 respectively up to 10^{195} photons in space. If this is true, then in the early stage of big bang where space diameter and wavelengths were submicron, the total photon energy exceeded all values by many magnitudes which have been discussed up to now in big bang theories. But the big bang theory is lacking the zero-point radiation contribution (which exceeds the energy of hadrons - protons, electrons, neutrons etc. - roughly by a factor of 10^{90}) and a decision pro or contra a ULW spectrum is therefore not possible.

4.2 Attraction on masses caused by screening effects within the ULW photon flux.

Let j be the isotropic flux of ULW photons which penetrate the interaction sphere F_p of a charged particle (see Fig.3). Let us look for an estimation of F_p: Depending on the Thomson cross section

$\sigma_p = \pi r_p^2 = \frac{8}{3} \pi r_0^2 \cdot \frac{\omega^4}{\left(\omega^2 - \omega_p^2\right)^2}$ for elastic scattering of electromagnetic waves [17],

Compton collisions between particle and photons take place. The radius $r_0 = 10^{-15}$ m is the classical electron radius and ω_p is the "natural frequency" for the case that the frequencies of particle oscillations are higher than the frequency ω of the wave [18]. For ULW photons, one can assume that $\omega_p >> \omega$. Therefore, the ω-term in the cross section is ω^4 / ω_p^4 and very small in value [19]. Thus, the particle interaction radius derived from the above cross section is

$$r_p = 2\sqrt{\tfrac{2}{3}}\, r_0 \frac{\omega^2}{\omega_p^2} \tag{13}$$

and the interaction sphere area is $F_p = 4\pi r_p^2 = \frac{32}{3} \pi r_0^2 \frac{\omega^4}{\omega_p^4}$. The dimension of the flux j through F_p is the number of photons per unit time. A second particle located at the larger sphere area with radius *R* around the first particle (see Fig.3) reflects or scatters with the same probability σ_p a ULW photon approaching from the outside and prohibits a flight to and a reflection from the center particle. A virtual mutual central force between both particles appears under the assumption that after the reflection the photon is blocked from undergoing new Compton collisions as for example with charges at the outer sphere. It is true that QM-uncertainty allows the spontaneous appearance of the photon at every path interval of the wavelength with the same probability [16]. However, for the ratio of the size of a planet relative to the ULW-wavelength, which is in the order of 10^{-19}, the probability is practically zero.

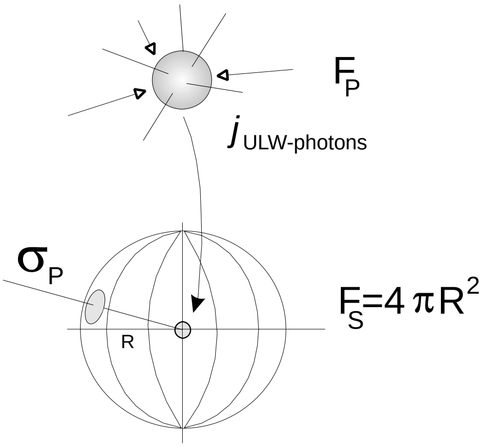

FIG. 3. An isotropic flux j of penetrating ULW photons enters the interaction sphere F_p of a charged particle located at the center of a larger sphere with radius R. A second charged particle located at the larger sphere with cross section σ_p screens photons from the center particle and virtual attraction forces will appear.

Analytically, this means that before the isotropic photon flux j enters the particle interaction sphere F_p, it passes through the outer shell area F_S in a nearly normal direction because the quotient r_p/R is generally small (see Fig.2). The particle at the outer sphere scatters with the above mentioned Thomson cross section σ_p. Hence the flux j at the center particle is reduced by the quantity of scattered flux Δj, a factor which is governed by the area factor σ_p/F_S:

$$\Delta j = j\frac{\sigma_p}{F_S} = \tfrac{2}{3} j \frac{r_0^2}{R^2}\frac{\omega^4}{\omega_p^4} \tag{14}$$

The reduced flux j-Δj appears at the screening particle site. In the opposite direction the flux j is unchanged. Thus, the center particle experiences an overshooting force caused by Δj via the screening particle.

To quantify the resulting virtual attraction force one has to consider all types of scatterings from 180° reflections to small-angle scatterings. In the latter case nearly no momentum transfer from the photon to the particle occurs while in a 180° reflection, the (non-relativistic) momentum transfer is $2\cdot h/\lambda$. This will be taken into account by a correction factor ε. The force f on the center particle (charge) is:

$$f = \Delta j \; 2\varepsilon \frac{h}{\lambda}$$
$$f = \varepsilon \tfrac{4}{3} j \frac{r_0^2}{R^2} \frac{\omega^4}{\omega_p^4} \frac{h}{\lambda} \tag{15}$$

If the nature of this force is gravitation, then j can be calculated by setting:

$$f = f_{\text{Gravitation}}$$
$$2\varepsilon \tfrac{4}{3} j \frac{r_0^2}{R^2} \frac{\omega^4}{\omega_p^4} \frac{h}{\lambda} = g \frac{m_p^2}{R^2} \tag{16}$$

where g is the gravitational constant and the factor of 2 results from the fact that matter appears electrically neutral, i.e. in the form of positive-negative charge pairs. Effects coming from deviations from neutrality can be neglected because electrostatic forces are a factor of 10^{40} stronger than gravitational forces. Hence, the force of ULW photons on neutral mass units counts double. The coupling strength in terms of q/m is 2 e/(m_p + m_e). A similar situation can be assumed with neutrons, where the magnetic moment [20] indicates negative and positive charges, which both participate in the interaction with ULW photons.

However, photon interactions with ULW photons look different. Following the QM uncertainty $\Delta E \cdot \Delta t \geq h$, for the time interval Δt photons decay into virtual electron-positron pairs with $\Delta E = (m_e^- + m_e^+) \cdot c^2 = 2\, m_e c^2$ and recombine afterwards in a process which takes place with a duty cycle of $\nu\Delta t$ [16]. Collisions with ULW photons (photon-photon interaction) occur only during the uncertainty time interval Δt. The twin charges suddenly gain the deflection velocity $v = g\, (\nu\Delta t)^{-1}\, \Delta t$. Thus the deflection d is two times greater than the Newtonian one [21]:

$$d = g\, (\nu\Delta t)^{-1}\, \Delta t \cdot t \rightarrow g\, t^2 \tag{17}$$

In the case of an anisotropic ULW photon flux the path of a photon is polygonal. An increased gravitational deflection of photons (by the factor of two) is also predicted by GR.

Finally from Eq.16 j takes the form:

$$j = \tfrac{3}{4} \frac{1}{\varepsilon}\; g \frac{\lambda\, m_p^2}{h\, r_0^2} \frac{\omega_p^4}{\omega^4} \tag{18}$$

To determine j numerically one has to give an estimate for ω_p; all the other parameters in Eq.18 are known and ε is about 0,3. With $2\pi/\omega \approx 10$ billion years for ULW photons (age of the universe, diameter of universe in light years) and $2\pi/\omega$ between 1 and 10 billion years for typical periodic motion of a charge collection like galaxies, Tab. 1 shows the flux j, the energy density E and the radius of the interaction sphere r_p for these cases. The latter one is small and could have values down to the Planck length. Although huge, the energy density E of the ULW flux in Tab.1 can be considered as a small thermal fraction upon the spectrum of the zero point radiation [22], which is assumed to have a total energy density of about 10^{114} Joule/m^3 [23].

TABLE 1. Dependency of the ULW photon flux j, energy density $\varepsilon = \frac{jp}{4\pi r_p^2}$, where p is the momentum of the ULW photon ($p_{ULW} \sim 10^{-60}$ kg m/s) and interaction sphere radius r_p as a function of disturbance frequency ω_p. A frequency of 10 years is discussed below.

$2\pi/\omega_p$ in years	j in photons/s	r_p in m	Energy density ε in Joule/m^3	ULW-photons/m^3
10,000,000,000	10^{24}	10^{-15}	10^{-7}	10^{44}
100,000,000	10^{32}	10^{-19}	10^{9}	10^{60}
1,000,000	10^{40}	10^{-23}	10^{25}	10^{76}
10,000	10^{48}	10^{-27}	10^{41}	10^{92}
100	10^{56}	10^{-31}	10^{57}	10^{108}
10	10^{60}	10^{-33}	10^{65}	10^{116}
1	10^{64}	10^{-35}	10^{73}	10^{124}

Comments on this:

1. Table 1 offers a variety of disturbance frequencies, where 10 billion years corresponds approximately to the frequency of ULW photons and has maximum cross section (see Eq. 13, $\omega_p \sim \omega$), while the cross section in the one-year case shrinks down to nearly zero and extreme ULW photon flux densities are necessary to simulate gravitation.
2. An estimate for the real disturbance frequency could be be gained by looking at the single sided acceleration at the border of a black hole. If for instance a frequency corresponding to 10,000 years is chosen, then an acceleration in the order of $b \sim 2\, j\, p_{ULW}/m_p \sim 10^{15}$ m/s^2 results.

3. An interesting estimate will be a cross section for electromagnetic scattering in the dimension of a Planck length. The flux in this case is about 10^{60} photons per second through a proton and the disturbance frequency is 10 years (see Tab.1). In comparison with the zero-point-radiation energy density [23], which is estimated to be 10^{114} Joule/m^3 (cut-up frequency is the Planck length), the thermal ULW-spectrum contributes with 10^{-49} to the total zero point energy, which is extremely small.

4. Charged objects with a lower periodic motion in comparison with ω_p will have an increased gravitation constant g and vice versa.

5 ULW-photons and the perihelion precession of planets

If a charge is in motion due to the relativistic length contraction, the interaction sphere F_p in Fig.2 is compressed in the flight direction (x-coordinate). The same elliptical compression happens for the larger sphere in Fig.2 as well as for the second charge with cross section σ_p which is located at the radius R around the centre charge.

The outer charge may move with the angular frequency ω around the larger sphere. Due to the length contraction the polar coordinates $r(t) = r \sin \omega t$ and $x(t) = r \cos \omega t$ changes into

$$y(t) = r\left(1-\beta^2 \cos \quad \omega' t\right)^{\frac{1}{2}} \sin \omega t \quad \text{and} \quad x(t) = r\left(1-\beta^2 \cos \quad \omega' t\right)^{\frac{1}{2}} \cos \omega t\,, \qquad (19)$$

where $\omega'\gamma = \omega$. The x-axis is length contracted: ($x' = x\,\gamma^{-1}$) and the movement along this axis is slowed down ($v' = v\,\gamma^{-1}$).

Now, let a charge (or a planet) have a circular motion around a center charge (or a star). Then a mixed situation appears since the charge in orbital motion is length contracted in flight direction (with respect to the center frozen at $\omega t = \pi/2$) while the center charge at rest is not. Because of Eq.19 the acceleration $\ddot{y}$ in the direction of the center charge is:

$$\ddot{y} = -\; R\,\omega^2 \left(1+\beta^2\right) \quad \text{or} \qquad \Phi = M R^2\, \omega^2 \left(1+\beta^2\right) \qquad (20)$$

The attraction force is increased by a term of the order of β^2 and is therefore identical to the second order approximation in β of the gravitational potential given in General Relativity [24]:

$$\Phi \cong -f\,\frac{M}{R}\left(1+\beta^2\right) \qquad (21)$$

Equations 20 and 21 describe the potential which are behind the motion of perihelion of an elliptical planet orbit.

6 Conclusion and outlook

The model of mass attraction presented here is based on ULW photon-charge collisions as the main interaction process in space. Many questions arise and many aspects of the model still have to be investigated. The following substantial observations may support the ULW photon collision model:

1. The way the space expands could be a consequence of a universally present ULW photon pressure on charges in matter.

2. The increase of the Hubble constant at the outer space areas may indicate a single-sided photon pressure at the boundary.

3. The screening of penetrating ULW photons by outer regions of large mass accumulations such as disk-like galaxies may be the reason why the outer spirals rotate with abnormally high angular velocity while the inner one do not, a phenomenon that has been interpreted as an effect of gravitating dark matter.

4. The Pioneer anomaly (deceleration) may have the same background [25].

5. Electrons experience the same force like protons but have an 1836 times smaller mass.

Acknowledgement. I would like to express my gratitude to A. Citron for helpful discussions about the interpretation of the path-wavelength congruence as well as to E. Borie for critical reading of the draft.

References

[1] K.C. Freeman, The Galactic spheroid and old disk, Astrophys. J. **160**, 811 (1970)

[2] See, for example, D. Burstein, W.K. Ford, V. Rubin, Jr.N. Tonnard, Rotation Velocities of 16 Sa Galaxies and a Comparison of Sa, Sb, and Sc Rotation Properties, Astrophy. J. **289**, 81 (1985), and

C. Armendariz-Picon, V. Mukhanov, and Paul J. Steinhardt, Dynamical Solution to the Problem of a Small Cosmological Constant and Late-Time Cosmic Acceleration, Phys. Rev. Lett. **85**, 4438 (2000)

[3] S. Aronson, The gravitational theory of Georges-Louis Le Sage, 1964, The Natural Philosopher **3**, 51

[4] A. Einstein, Über die Entwicklung unserer Anschauung über das Wesen und die Konstitution der Strahlung, Phys. Z. **22**, 817 (1909) (in German)

[5] In 1909 Einstein demonstrated (see ref. [4]), that during the interaction of gas atoms with electromagnetic waves (both thermal distributed) the gas cools down and the radiation heats up because of overshooting violet shifts (in comparison with red shifts). He suspected a principal failure of the field conception and concluded that the process is carried by gas atom-photon collisions.

[6] E. Schrödinger, Dopplerprinzip und Bohrsche Frequenzbedingung, Phys.. Z. **23**, 301, (1922) (in German)

[7] To be distinguished from the Cosmic Background Microwave Radiation, which escapes about $4\cdot 10^5$ years after the big-bang. (see: R. Alpher et R. Herman, New Measurements of the Cosmic Microwave Background at $\lambda=3.2$ cm and $\lambda=1.58$ cm-Evidence in Support of a Blackbody Spectrum, Nature **162**, 774 (1948)). In the time span between, which is subject of this paper, the space was hot and opaque, photons collided permanently with particles.

[8] The derivation is restricted to one dimension since conclusions with respect to momentum and energy do not demand higher dimensionality

[9] W. Cantor, Equivalence of Compton Effect and Doppler Effect, Stroboscopic Letters **4** (3 & 4), 59 (1971)

[10] A. Anton, J. Ardini, R. Kidd, Compton effect as a double Doppler shift, Am. J. Phys. **53** (7), 641 (1985)

[11] D. S. Lemons, Doppler shift and stellar aberration from conservation laws applied to Compton shift, Am. J. Phys. **59** (11), (1991)

[12] D. Wilkins, A new angle on Compton scattering, Am. J. Phys. **60** (3), 221 (1992)

[13] D. G. Ashwood, R. C. Jennison, The scattering of an electromagnetic wave by a free electron, J. Phys. A: Math. Nucl. Gen.**7**, No. 7, 803 (1994)

[14] This result recommends the following interpretation: The Compton effect can be considered as a two-step event. First step is the reflection of the photon, where both mass and photon change from the laboratory system S into the moved collided system S'. Then in a second step, the re-transformation of the photon into the laboratory system takes place. In this step the Doppler red shift as formulated in Eq.3 occurs. This shift corresponds exactly to the velocity difference β' as energy and momentum laws demand.

[15] The conservation of number of photons gives the certainty that ULW-photons can be generated (by any expanding systems) and will exist.

[16] W. Heisenberg, Physikalische Prinzipien der Quantentheorie, Hochschultaschenbücher, Band **1**, p 20 (1958) (in German)

[17] See for instance: R. P. Feynman, Lectures on Physics, (California Institute of Technology 1965), Vol.**1**, p. 32-8

[18] See ref. [17]. The ω/ω_p -factor is a measure for deviation from resonance and determines the decrease of energy transfer from photon to the scattering charge.

[19] See ref.[17]. Coherent interferences of neighbored mirrors with separations small in comparison with the wavelength may increase the reflection probability in square to their number.

[20] Particle Data Group, Rev. mod. Phys. **41**, 109 (1969)

[21] M.J. Klein, A.J. Kox, R. Schulmann in The Collected Papers of Albert Einstein, Princeton University Press, Vol.**3**, DOC 23, 497, footnote [11] (1996)

[22] H.B.G. Casimir, On the attraction between two perfectly conducting plates, Koinkl. Ned. Akyd. Wetenschap. Proc. **51**,793 (1948)

[23] See G.J. Maclay in http//www.quantumfields.com/ZPV.html

[24] R. Adler, M. Bazin and M. Schiffer, Introduction to General Relativity, McGraw-Hill, New York, p. 206 (1965)

[25] J.D. Anderson, P.A. Laign, E.L. Lau, A.S. Liu, M.M. Nieto, S.G. Turyshev, Indication, from Pioneer 10/11, Galileo, and Ulysses Data, of an Apparent Anomalous, Weak, Long-Range Acceleration, Phys. Rev. Lett. **81**, Nr. 14, 2858 (1998) and http://www.physicalcongress.spb.ru/english/cherep/doppler.asp

Received: November 23, 2007