Using the model StW for optical approach to gravity.

Spassky Stanislav. (stanislav@spassky.net)

Summory.

Earlier, the author has proposed a simplified model representing a particle with nonzero rest mass by stable wave object of standing quasi-classical wave type (denoted as StW), which is able to move. This model is a pair to a simplified model representing a photon by stable fragment of quasi-classical traveling wave (denoted here as RunW). If we assume that the gravitational field bends the trajectory of the RunW object optically (due to changes in the wave parameter c), then the StW object must also be drawn in by the gravitational field optically. The derivation of the gravitational radius is produced.

In the previous article was proposed a simplified model of particles with nonzero rest mass, represented by a stable wave formation of a standing wave type (denoted as StW object). The wave medium was assumed to be quasi-classical and nonabsorbing. This model was offered as a pair to a simplified model of a photon represented by a stable fragment of traveling wave (denoted here as RunW object). StW object is seen as some form of RunW object, closed on itself. The basis for this assumption was the same ratio between internal energy and internal frequency for particles of both types (Planck's law). Possible mechanisms of wave objects stability were specified.

From the assumption that our world is made of wave objects of both types, the invariance of the speed of light in SR was explained. It was shown that the description of the laws of such a world must be simplest in inertial systems (inertial frames of reference) tied by Lorentz transformation. In all these systems, the wave operator has the same form as in systems resting with respect to the wave medium. Hence, all wave objects in all these systems look as in systems resting with respect to the medium. This also applies to the traveling wave propagation velocity (c). There is no more need for formal requirement for all inertial systems to be equally symmetrical with respect to ether. With full mutual symmetry of inertial systems only part of them actually rests with respect to the medium. It was supposed that this model might be very useful in studying SR.

The StW object can be represented as a set of multidirectional plane waves. At rest, the harmonic frequencies coincide, and all wave energy flows (coinciding with momentum with an accuracy of a factor) are balanced. The overall momentum of the object is zero. When StW object is set in motion in an isotropic medium, the wave vector k of each plane component acquires an increment in the direction of motion. Vectors of the transverse components turn forward by arcsin(v/c), so that in the moving system they are seen as transversal to motion. The front vectors will lengthen and move closer together; the back vectors will shorten and thin out. The total wave energy will increase, and the net momentum will appear. The object acquires a configuration typical for a certain value of ratio v/c. But in some inertial (Lorentz) systems, it will look as it did at rest.

It is known that the trajectory of a photon is bent by the gravitational field. This can be interpreted as the bending of a traveling wave in non-uniform optical space (with parameter c variable due to the presence of masses (energy)). Meanwhile, it looks like the motion under the action of some central force of gravity. Since our StW object is represented as a set of plane harmonics, all of them will change direction according to optical laws of refraction. But for each of them it will look as if they were exposed to the attraction of the central field. In contrast to the acceleration in the isotropic or potential field, when the energy of StW objects changes, in our optical interpretation of gravitational field and nonabsorbing medium, the energy of StW object must remain. But due to the refraction of the harmonics, the object acquires the configuration of plane wave vectors characteristic for StW object with changed value of v/c.

This can be interpreted as in the region with a value $c<c0$ StW, an object at rest has a stable form of internal energy less than it had at rest in the region more distant from the center of gravity. Passing to the region with a lower value of c, the object compensates the difference between an object's rest energies by increasing the value v/c. For this reason, it is expected that a quantum emitted by the object from this region should also have reduced energy.

For definiteness, we choose for consideration the StW object, which at rest has the uniform distribution of plane components in all directions. Central gravitational field is presented by layers with decreasing values of c to the center. Object will move from left to right along the radius from remote point with the accepted value of $c=c0$ to the center.

Consider StW object, with its center located on the border separating the 2 layers with different values of c, $c1$ and $c2$ ($c1>c2$). The very principle of refraction (for each plane component) is based on the necessity to make images of both waves (and their wavelengths and speeds) at the very border identical for different speeds of wave propagation on both sides of the border. The overall picture of StW object section at the border shows that the transverse dimensions of StW object when crossing the border are preserved. It means that in both regions the StW object at rest will have the same dimensions, that is, the spatial dimensions are preserved. And this means that all the oscillation frequencies in StW objects at rest will be proportional to the ratio $c2/c1$, i.e. in region 2 "time" must flow more slowly. This applies to the entire field. The photons that come from the "outside" and preserve their frequency in motion would be "perceived" here by StW objects, as having increased their frequency, i.e. having increased their internal energy due to the potential gravitational field.

Why do we not consider the reflected waves at the borders? In fact, there is a gradual turn of the front of each plane component in accordance with Huygens principle without reflected wave. Using of the law of refraction is simply more convenient for calculations in our case. In StW objects we built flat components similarly to the photons, which in passing through the gravitational field retain their shape and energy.

Now our task is to associate changing c with a value of a potential of the gravitational field (in the conventional sense). To do this, we divide the central gravitational field into spherical zones (i) of thickness (dRi) with some value of c(i), and with a value of $c0$ at R =∞. We are not interested in the complete motion of StW object. We will put it at rest at each border between the layers for identification of changes when crossing the border. Due to the harmonic refraction, the left parts of the harmonics will correspond to StW at rest, while the right part will correspond to motion with some value v/c.

$$c_i = c_0 * (c_1 / c_0) * (c_2/c_1) * ... * (c_i / c_{i-1})$$

where (ci/c(i-1)) is ratio, inverse to refractive index in the transition from layer (i-1) to layer i.

We will use the identification of two pictures: StW acceleration from rest in an isotropic medium, and a picture of harmonics turn in StW at rest at the border of two layers due to refraction. More precisely, we will compare the changes in the direction of transverse harmonics only. The transverse harmonic StW, when accelerating from rest in an isotropic medium, as already noted, turns forward through an angle arcSin (v/c). The total internal StW energy increases by factor of $\beta=1/\sqrt{(1-v^2/c^2)}$.

In the case of transition from layer c(i-1) to layer ci, the transverse harmonic turns forward up to the angle of total internal reflection in layer ci. The angle of total internal reflection A is measured from the boundary plane.

For the angle of total internal reflection $c_i/c_{(i-1)} = \sin(\pi/2-A)=\cos(A)$; $\cos(A)=\sqrt{1-\sin^2(A)}$. Equate this expression to $\sqrt{1-v_i^2/c_i^2}=1/\beta$ for an isotropic medium. Obtain

$$c_i = c_0 * \prod_{j=1}^{i} c_j / c_{j-1} = c_0 * \prod_{j=1}^{i} \sqrt{1 - v_j^2 / c_j^2} =$$

$$= c_0 * \prod_{j=1}^{i} c_j^2 / \left(c_j^2 + |dU_j|\right) = c_0 * \prod_{j=1}^{i} 1 / \left(1 + |dU_j| / c_j^2\right) =$$

$$= c_0 * \prod_{j=1}^{i} e^{-|dU_j|/c_j^2} = c_0 * e^{\int_{R(i)}^{\infty} -|dU|/c(r)^2 dr}$$

We have intermediate result $c(R) = c_0 * e^{\int_R^{\infty} -|dU|/c(r)^2 dr}$

Let us analyze the expression qualitatively. Note that c(R) stands both on the left and on the right under the integral sign. While c(R) varies slightly, in the right side we may approximately consider $c(R)=c_0$. Then $c(R)=c_0 * e\text{^}(-(GM/R)/c_0^2)$. When (GM/R) becomes somewhat comparable with c_0^2, a sharp "falling" of c(R) down to 0 begins due to the fact that decreasing c(R) stands on the right side in the denominator, and the fraction is in exponent. Then we take the logarithm and differentiate:

$$\ln(c(R)/c_0) = -\int_R^{\infty} \left(GM/r^2\right) / c(r)^2 dr$$

$$c(R)' / c(R) = \left(GM/R^2\right) / c(R)^2$$

$$2 * c(R) * c(R)' = 2 * GM / R^2 \quad . \quad \textbf{Taking into account } c(\infty) = c_0 :$$

$$c(R)^2 = c_0^2 - 2 * GM / R$$

When $R = 2*GM/c_0^2$, c(R) becomes 0. That is, we obtain the so-called "gravitational radius". It is clear that within the sphere with gravitational radius the wave motion is absent due to changes in the wave properties of the medium. Outside this radius but close to it, the wave objects do exist, but in an extremely slow form.

The derivation can be made more compact, in differential form and for any configuration of the gravitational field:

$$= c_j / c_{j-1} = \sqrt{1 - v_j^2 / c_j^2} =$$

$$1 - |dc| / c(R) = \qquad = 1 / \left(1 + |dU_j| / c_j^2\right) = 1 - |dU(R)| / c(R)^2$$

$$dc / c(R) = dU(R) / c(R)^2$$

$$c(R)^2 = c_0^2 - 2 * |U(R)|$$

References.

1. ^ K. Schwarzschild, "Uber das Gravitationsfeld eines Massenpunktes nach der Einsteinschen Theorie", *Sitzungsberichte der Deutschen Akademie der Wissenschaften zu Berlin, Klasse fur Mathematik, Physik, und Technik* (1916) pp 189.