The Ritz Ballistic Theory & Adjusting the Speed of Light to *c* near the Earth and Other Celestial Bodies

Nina Sotina
PhD in Physics, Moscow State University
448 Neptune Avenue, Apt. 12E, Brooklyn, NY 11224
e-mail: nsotina@gmail.com

Nadia Lvov
Assistant Professor, Division of Mathematics and Physics
Essex County College, 303 University Ave., Newark, NJ 07102
e-mail: lvov@essex.edu

In 1908 Walter von Ritz suggested that the speed of light is equal to the constant ***c*** only when measured relative to the source. Ritz systematically redeveloped Maxwellian electrodynamics bringing it into agreement with this hypothesis. Assuming that ***c*** is the speed of light at the output of the light source and that the law of velocity addition from classical mechanics is valid for the case of a moving source, the results of the famous Michelson-Morley experiment, the aberration of starlight, and a number of other related experimental results come into agreement. The single objection to the hypothesis at that time was provided by astronomical observations of the motion of binary stars. The Ritz theory came to an end with the work of W. de Sitter (1913) who claimed to have a convincing argument for showing that the hypothesis of Ritz was inconsistent with the results of spectroscopic observations of binary stars. A hidden postulate in de Sitter's argument, however, is that the speed of light propagating from the stars is not affected by anything. To refute de Sitter's argument, it would be sufficient to assume that the speed of light adjusts to the value of ***c*** at the vicinity of Earth and other celestial bodies. The authors show that this assumption added to the Ritz hypothesis explains well spectroscopic observations of the binary stars. This combined hypothesis: the Ritz ballistic hypothesis and the adjustment of the speed of light to ***c*** near celestial bodies (in particular near the Earth), also explains experiments performed at CERN in 1964. An additional argument in favor of the suggested hypothesis is the derivation of the formula for the transverse Doppler Effect presented in this work.

1. The Pre-relativistic Period in Physics

It is interesting to look into the pre-relativistic period of the history of physics and recall the cause of the so-called "crisis in physics" that was settled with the development of the Special Theory of Relativity (**SR**). It was known at the time that the propagation of light in a vacuum was described by Maxwell's equations, which were not invariant under the Galilean transformations, but were invariant under the Lorentz transformations. The mere fact that the linear wave equation $\partial^2 u / \partial t^2 = a^2 \Delta u$ is invariant under the Lorentz transformations is of little importance. For example, an equation of this type describes the longitudinal vibrations in a rod, but no one concludes from this fact that the Galilean principle is not valid and that it is necessary to change the geometry of space. In the case of a rod, physicists know that the equation describing the vibrations is approximate. It is essential only that the classical law of velocity addition is valid for the velocity of the rod's translational motion and of the elastic vibrations' propagation. So at the end of the 19th century it was expected that the same situation is also true for the velocity of light, provided that light propagates through some elastic medium, that is, the ether. Two different points of view existed, however, as to whether the Earth orbits the Sun without imparting any motion to the ether or whether the ether is dragged along with the earth (as is the case with air). From the observations of the aberration of light (if interpreted from the viewpoint of the wave theory of light) it followed that the ether surrounding the earth does not share the earth's motion. It also followed from the Michelson-Morley experiment that, on the contrary, the ether must be carried with the earth. Having discarded the hypothesis of the "luminiferous" ether defining a preferred reference frame and having introduced a model of four-dimensional pseudo-Euclidian space with metric $ds^2 = dx^2 + dy^2 + dz^2 - c^2 dt^2$, **SR** provided an explanation for the aberration of stellar measurements, the results of the Michelson-Morley experiment and other experiments for the detection of the "ether wind".

Was there a compelling necessity to link space and time together and go beyond the framework of the three-dimensional model of Euclidean space? Did another logical way out exist for overcoming the difficulties encountered by physics at the beginning of the 20th century? Yes, in fact, such a way was proposed by Walter von Ritz in 1908 [1]. The beginning of twentieth century was a "point of divergence" on the evolutionary path of Physics. The logical path on which the science could be further developed depended on external factors occurring at that time rather than on the internal logic of the science itself.

Ritz suggested that the speed of light was equal to c only when measured relative to the source. The so-called Ritz emission theory is in accord with the observation for the aberration of star positions, the Fizeau experiments, the original Michelson-Morley experiment, and also most other experiments carried out for determining the "ether wind". W. de Sitter (1913) claimed, however, to have a convincing argument that the hypothesis of Ritz was inconsistent with the results of spectroscopic observations of binary stars [2]. The argument of de Sitter in his own words is as follows. *"If the source of light has speed **u** in the positive x direction, according to the Ritz theory the speed of light radiated in the same direction is **c + u**, where **c** is the speed of light with respect to the source* (Fig.1). *Let us imagine there is a binary star and an observer placed at a large distance **d** at the orbit plane. According to Ritz, the* *light radiated by the star at point A reach the observer in time* $d/(c+u)$, *and the light radiated at point B in time* $d/(c-u)$. *(Here A and B are points on the opposite ends of the orbital diameter perpendicular to the direction from the star to the observer). Let us designate T half of the orbital period (the orbit is considered to be circular). As a result, the time interval of the star motion from point A to point B will be* $T + 2ud/c^2$, *and the time interval during which the star was at the second half of its period will be* $T - 2ud/c^2$. *Assuming further that* $2ud/c^2$ *is of the same order of magnitude as T, it will be impossible, if the Ritz theory were valid, to agree the observations with the Kepler's laws. For all spectroscopic binary stars* $2ud/c^2$ *is not only of the same order of magnitude as T, but, in most cases, may be even greater. If we assume, for example, that* u *equals 100 km/sec,* $T = 8$ *days,* $d/c = 33$ *years (that is, the parallax is 0.1''), then* $T - 2ud/c^2 = 0$. *All these quantities are of the same order of magnitude, which is often so for well known spectroscopic binaries. (Most parallaxes will be less than 0''.) The existence of spectroscopic binary stars and the fact that in most cases the observed linear velocity is in complete agreement with the Kepler's laws represent strong evidence in favor of invariance of the speed of light."*

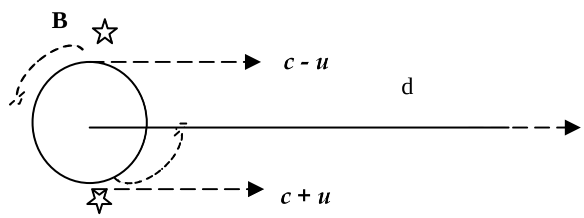

Fig. 1. A binary star: a system of two stars A and B.

A hidden postulate in de Sitter's argument, however, is that the speed of light propagating from the stars is not affected by anything. There were attempts to prove the consistency of Ritz's theory using the extinction theorem, the most important contribution being made by J.G. Fox [3]. The theorem states that if an incident electromagnetic wave traveling with speed c associated with a vacuum enters a dispersive medium, its fields are canceled by part of the fields of the induced dipoles (macroscopically by the polarization) and replaced by another wave propagating with a phase velocity characteristic of the medium. The incident wave is extinguished by interference and replaced by another. The motion of the source and the speed of light relative to it are irrelevant according to this theorem.

There are, however, some experiments whose results are not explained by the extinction theorem. The experiment performed at CERN, Geneva, in 1964 [4] was considered to be the most convincing evidence against the Ritz theory. In this experiment the speed of 6 GeV photons produced in the decay of very energetic neutral pions was measured by time-of-flight over paths up to 80 meters in length. The pions were produced by the bombardment of a beryllium target with 19.2 GeV protons having speeds (inferred from the measured speeds of charged pions produced in the same bombardment) of 0.99975c.

2. Adjusting the Speed of Light to *c* near Celestial Bodies

What conclusion can be derived from the CERN experiment? The only conclusion that follows from that experiment is that the speed of photons equal c as measured with respect to the Earth (without taking into account the rotational motion of the Earth about its axis). At least two other hypotheses can be suggested for the explanation of this fact besides SR, that are in agreement with the Ritz theory. (Note that SR also agrees with the Ritz theory since the speed of a photon according to SR equals c in the frame of reference of the source.)

The first hypothesis: assume (as Ritz did) that there is no ether, and the photon leaves a source with velocity $\vec{c}$ relative to the source. From the Ritz viewpoint the velocity of the photon must remain $\vec{c}$ with respect to the source and $\vec{c}+\vec{u}$ with respect to Earth, where $\vec{u}$ is the velocity of the source. The CERN experiment, however, showed that the speed of photon with respect to Earth is c independent of the source motion. This result may have the following explanation: the speed of the photon adjusts to the value of c at the vicinity of Earth or other celestial bodies due to the interaction of the photon with the fields (possibly unknown yet) associated with these bodies. This idea in a way is "extension" of the extinction theorem.

The second hypothesis: the ether is dragged along with the earth (or the celestial body), and c is the speed of the photon with respect to the ether. Besides we assume that light is not a regular linear wave propagating in the ether, and a photon has inertial properties like a soliton in ordinary liquid. Moreover, the photon has quantum properties like structures existing in superfluids. (The following interesting process is observed, for example, in superfluid He-3: a structure, called a "hedgehog", having a spin propagates with a high speed in a superfluid like a particle). The emitted photon in this case is a process that propagates through the ether with the speed c.

Any of the above hypotheses makes the Sitter's argument unconvincing and is in accord with observations for the aberration of star positions, the original Michelson-Morley experiment, and other experiments carried out for determining the "ether wind". In this context it is interesting to give the conclusion of L. Brilluoine's analysis of the principal experiments of **SR**: "… the isotropic Euclidian space with the variable speed of light might represent a model that would be most consistent with the experimental physical observations." [5]

We show below, that it is possible on the basis of any of the above two hypotheses to obtain the relativistic formula for Doppler Effect [6, 7].

3. The Doppler Effect for a Photon

The equations for the transverse and longitudinal Doppler Effect are derived below. Note that any of the above two hypotheses can be used in the derivations, because they have two ideas in common: the first is that the speed of a photon with respect to the source is equal to the fundamental constant c and that the law of velocity addition from classical mechanics is valid, and secondly, that the speed of the photon adjusts to the value c near the Earth. The equations are derived from the 'photon's point of view', however, some clarifications to this view have to be made, because there are various definitions of 'photon' that are used in different branches of physics. Such a difference in the use of the term reflects, in particular, the fact that there is no unified point of view on the nature of the material carrier of the associated quantum of energy, that is, the photon. Below we presume a photon to be a hypothetical particle which accounts for the signal at the output of a photodetector. Although there is no strict definition of the photon in the framework of any consistent theory, the photon as a particle (with the wave properties characteristic of the particle) is used in a number of optical studies where an attempt is made to go beyond the framework of the conventional (Copenhagen) interpretation.

It is worth noting that the first corpuscular models of the light field consisting of elementary particles, each possessing the energy $h\nu$ of a quantum of light, where ν is the radiation frequency, were developed after A. Compton's experiments on X-ray scattering (1922). The observed change in the frequency of the scattered radiation was explained by the elastic collision of an electron with a particle possessing energy $h\nu$ and impulse $p = E / c$. In 1929, G.H. Lewis called this particle a photon. Below, the equation for Doppler's effect is derived for the case of a circularly polarized photon in the pure state. In this context particular properties of the photon can be discussed: its polarization, energy, mass.

First we derive the equation for the energy of the photon emitted by a moving source. Consider an inertial frame of reference linked to the observer where the source of light with mass M moving in a vacuum with velocity $\vec{\mathbf{u}}$. The energy of the source is composed of kinetic energy $Mu^2/2$ and internal energy E of the excited atoms. When a photon is emitted, the internal energy of the source is changed and becomes E^*. In addition the source undergoes a recoil due to the emission pressure: its speed gains an increment of $\vec{\mathbf{u}}' - \vec{\mathbf{u}}$ (where $\vec{\mathbf{u}}'$ is the speed of the source after emission of the photon). From the laws of conservation of energy and momentum for the photon and the source respectively, it follows that

$$\frac{Mu^2}{2} + E = \frac{(M - m_0)u'^2}{2} + E^* + E_{ph} \tag{1}$$

$$M\vec{\mathbf{u}} = (M - m_o)\vec{\mathbf{u}}' + m_o\vec{\mathbf{w}} \tag{2}$$

where m_0 is the mass carried away by the photon emitted with speed c with respect to the source, E_{ph} is the photon energy in the observer's frame of reference, and $\vec{\mathbf{w}} = \vec{\mathbf{c}} + \vec{\mathbf{u}}$ is the photon velocity in the same frame. Note that the vector $\vec{\mathbf{w}}$ is directed towards the observer.

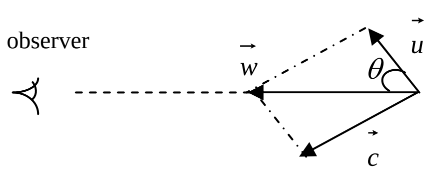

Fig. 2. Velocity addition for the photon emitted by a moving source.

From Eq. (2), we obtain for $\vec{\mathbf{u}}'$:

$$\vec{\mathbf{u}}' = \frac{M\vec{\mathbf{u}} - m_0(\vec{\mathbf{c}} + \vec{\mathbf{u}})}{M - m_0} \tag{3}$$

After emission of the photon, the internal energy of the atom is decreased by the amount $h\nu_0$, where ν_0 is the natural frequency of the atom, that is, $E - E^* = h\nu$. Taking this and Eq. (3) into account, Eq. (1) can be expressed as follows:

$$\begin{aligned} E_{ph} - h\nu_0 &= \frac{Mu^2}{2} - \frac{\left(Mu - m_0(\vec{\mathbf{c}} + \vec{\mathbf{u}})\right)^2}{2} \\ &= \frac{m_0u^2 + 2m_0(\vec{\mathbf{u}} \bullet \vec{\mathbf{c}}) - m_0{}^2(\vec{\mathbf{c}} + \vec{\mathbf{u}})^2 / M}{2(1 - m_0 / M)} \end{aligned} \tag{4}$$

If the mass M of the source is much greater than that of a photon, the terms containing m_0 / M may be ignored. In this approximation, Eq. (4) takes the form:

$$E_{ph} = h\nu_0 + m_0(\vec{\mathbf{u}} \bullet \vec{\mathbf{c}}) + \frac{m_0u^2}{2} \tag{5}$$

Using the relation $m_0c^2 = h\nu_0$ (note that this is not a consequence of special relativity), Eq. (5) can be represented in two equivalent forms:

$$E_{ph} = h\nu_0\left(1 + \frac{\vec{\mathbf{u}} \bullet \vec{\mathbf{w}}}{c^2} - \frac{u^2}{2c^2}\right) = \frac{m_0w^2}{2} + \frac{h\nu_0}{2} \tag{6}$$

where $$w^2 = c^2 - u^2 + 2uw\cos\theta \tag{7}$$

Here we denote θ as the angle between the velocity of the source and the direction from the source to the observer, i.e. the angle between vectors $\vec{\mathbf{u}}$ and $\vec{\mathbf{w}}$.

Consider a special case $u = 0$. In this case Eq. (6) implies:

$$h\nu_0 = \frac{h\nu_0}{2} + \frac{m_0c^2}{2}. \tag{8}$$

A very important result follows from Eq. (6) and Eq. (8): the energy of a photon, as an entity with mass m_0, can be represented with two components, the first being the kinetic energy of the center of mass, where we assume all of the photon's mass is concentrated; the second is the energy associated with the motion about the centre of mass, which is characteristic of the photon's intrinsic degrees of freedom. (This important result was first obtained by L. Boldyreva and N. Sotina [6, 7]). **Now let us take into consideration the Earth influence on the speed of the photon.**

Case 1: Suppose that a source of light is at rest with respect to the Earth, and an observer is moving with a constant speed $\vec{\mathbf{u}}$ relative to the Earth. In the frame of reference of the Earth, the mass of the photon emitted by the source is equal to m_0 and there is no reason why it should change in the observer's frame of reference prior to interaction of the photon and the receiver.

It is experimentally established that the absorption of light occurs in quanta of energy $h\nu$, where ν is the detected frequency. Assume that all the energy E of the photon is equal to the energy detected by the measuring system (which is no different than that of conventional physics). Under this assumption, from Eq. (6) we obtain, to within $\beta^2 = (u / c)^2$ inclusively,

$$\nu = \nu_0\left(1 + \frac{\vec{\mathbf{u}} \bullet \vec{\mathbf{w}}}{c^2} - \frac{u^2}{2c^2}\right) \tag{9}$$

If $\vec{\mathbf{u}} \perp \vec{\mathbf{w}}$, that is, $\vec{\mathbf{u}} \bullet \vec{\mathbf{w}} = 0$, then the expression for the transverse Doppler effect follows from Eq. (7):

$$\nu = \nu_0\left(1 - \frac{\beta^2}{2}\right). \tag{10}$$

Using Eq. (9) and Eq. (7) we obtain the detected frequency of the photon for any value of θ:

$$\begin{aligned} \nu &= \nu_0\left(1+\beta\frac{w}{c}\cos\theta-\frac{\beta^2}{2}\right) \\ &= \nu_0\left(1+\beta\cos\theta-\frac{\beta^2}{2}+\beta^2\cos^2\theta+O\left(\beta^2\right)\right) \end{aligned} \quad (11)$$

Eq. (11) agrees, to within an accuracy of $\beta^2=(u/c)^2$ inclusively, with that of the equation describing the Doppler Effect in **SR.**

Note also that the Eq. (11), has two solutions when the frequency does not change ($\nu=\nu_0$) 1) when the relative speed of the photon is zero ($u=0$), and 2) when $u=2c\cos\theta$. In these cases $w=c$ and, consequently, the total energy of the photon is the same in both frames of reference. The relativistic equation for the Doppler Effect also has two solutions when the frequency of light is unchanging, however, in **SR** the second solution agrees with the derived solution above only approximately (with an accuracy of β^2 inclusively) and does not have an obvious physical interpretation. The fact that in our consideration the second solution (corresponding to the case when the frequency is unchanging) is the **exact** solution of Eq. (11), and has a simple physical interpretation is an additional argument in favor of the theory developed in this work.

Case 2: Now suppose that an observer is at rest with respect to the earth, and a source is moving with constant speed $\bar{u}$ relative to the observer. In this case, there is one more entity, namely the Earth, which can have an influence on the speed, mass, and frequency of the photon. Making the following two assumptions, namely that:

1. the emitted photon has the speed c and energy $h\nu_0$ in the frame of reference of the source, and
2. in the frame of reference of the observer, the speed of the photon also equals c, but its energy has value $h\nu$ (which is no different than that of conventional physics)
3. we again can obtain Eq. (11) for the Doppler effect, (ν in this case is the photon's frequency with respect to an observer at rest).

Indeed the emitted photon has energy given by Eq. (6) in the frame of reference of the observer. After the photon's speed adjusts to the value of c with respect to the earth its energy assumes the value $h\nu$. Substituting $h\nu$ in Eq. (6) for E_{ph} we obtain Eq. (11) for the Doppler Effect.

Note, that in the process of adjustment of the speed to $\boldsymbol{c}$, the photon's total energy in the frame of reference of the observer remains constant but its momentum, frequency and mass change. The change in the photon's mass supports hypothesis 2 (see above), which states that the photon is not a particle, but rather is some sort of process, like a soliton in a superfluid.

The surprising coincidence of the correspondence of Eq. (11) with the equation that describes the Doppler Effect in **SR** (for $\theta=\pi/2$ they coincide up to β^3 inclusive) can be readily explained. The same two ideas can be found in **SR**: 1) the Ritz idea, that the speed of the photon equals $\boldsymbol{c}$ with respect to the source, and 2) the fact that the speed of the photon also equals to c in the reference frame of the observer.

A fundamental question arises: why does Eq. (11), derived here on the basis of the law of conservation of energy agrees to such high accuracy with the equation from **SR** derived from kinematic considerations? From the fact that relativistic kinematics correctly explains the results of certain optical experiments, it can be concluded that in the four-dimensional kinematic formalism of **SR** there are dynamics 'hidden' in the geometry of space. In other words, the interaction of light with devices (or fields associated with Earth) appears to behave in a way such that optical experiments can be described through the kinematic of **SR** [7].

4. Light Curve for Eclipsing Binary Stars

Let us go back to the discussion of the Ritz theory. As it was explained above, this theory is in accord with most experiments carried out for determining the "ether wind". The Ritz emission hypothesis, however, is inconsistent with the results of spectroscopic observations of binary stars and also the experiment performed at CERN, Geneva. However, if we add the assumption that the speed of the photon adjusts to c near Earth and other celestial bodies to the Ritz hypothesis, the latter comes in agreement with the observation of the motion of binary stars. Furthermore, this combined hypothesis provides alternative explanations for all fundamental experiments of **SR**. It also has been demonstrated earlier, that the equation for not only the longitudinal but also the transverse Doppler Effect can be derived on the basis of this hypothesis. It is important to note that explanation of the transverse Doppler Effect up to now has been considered the sole prerogative of **SR**.

The question arises as to whether there are any phenomena which give different results when explained with **SR** versus with our theory. The answer is yes; one such phenomenon is seen with the behavior of light in the vicinity of binary stars. Specifically, a light curve plotted on the basis of **SR** is different than the curve plotted on the basis of our theory.

According to the first postulate of **SR,** in any inertial frame of reference, light propagates isotropically, independent of the motion of its source, and the speed of light is equal to the well-known constant $\boldsymbol{c}$. It follows from this postulate, that the light curve for eclipsing binary stars studied in the work of W. de Sitter, should be a horizontal straight line with drops of intensity corresponding to eclipses.

Consider the case of eclipsing binary stars, a system of two stars A and B, whose plane of orbit lies in the line of sight of the observer. According to our hypothesis the speeds of photons emitted by star A are equal to $\boldsymbol{c}$ with respect to that star, and similarly the speeds of photons emitted by star B are equal to c with respect to star B. Because the stars are orbiting the common center of mass with a linear velocity $\vec{\mathbf{u}}$ (for simplicity consider $\vec{\mathbf{u}}$ to be the same for both stars), the speeds of photons moving in the direction of the line-of-sight of the observer should be different. After some time, however, the speeds of the two sets of photons can 'equalize' and have the same value c, for example, due to their motion near another celestial body. Of course, the problem is that we don't know the mechanism for this 'equalization'. If we assume that the photons' speeds adjust their values to c in the ether, then the question remains concerning how the ether moves through space. We can say with certainty, however, from the above argument that the light curve of a binary star is not a straight line. Below we show this mathematically.

Let d be the distance at which speeds of photons equalize. Obviously, the light curve plotted by the observer located at some distance d from the binary system (call this point M) is the same as the curve plotted by the observer on Earth (because the photons travel further with the same speed).

The relationship between the current time t and the time of the photon's arrival at the point M (for both stars A and B) is given by the following equation:

$$\frac{d}{c(1+\beta\cos\omega t)}+t=\tau_1 \tag{12}$$

for the photon emitted by star A, and

$$\frac{d}{c(1-\beta\cos\omega t)}+t=\tau_1 \tag{13}$$

for the photon emitted by star B.

Let ω indicate the angular speed of the stars orbital motion about the common center of mass, $\omega=2\pi/T$, where T is the orbital period, and $\beta=u/c$. The position of the stars at the initial moment of time $t=0$ is shown on Figure 1.

Assume that the number of photons emitted per unit time n is the same for both stars. Let m_1 be the number of photons per unit time arriving at the point M from the star A, and m_2 be the number of photons per unit time arriving at the point M from the star B. In the time interval Δt each star emits $n\,\Delta t$ photons. The number of photons arriving at point M are therefore $m_1(\tau_1)\Delta\tau_1$ and $m_2(\tau_2)\Delta\tau_2$ respectively. Then for star A we have

$$n\,\Delta t=m_1(\tau_1)\Delta\tau_1\approx m_1(\tau_1)\frac{d\tau_1}{dt}\Delta t\,, \tag{14}$$

and for star B:

$$n\,\Delta t=m_2(\tau_2)\Delta\tau_2\approx m_2(\tau_2)\frac{d\tau_2}{dt}\Delta t \tag{15}$$

where $d\tau_1/dt$ can be found from Eq. (12) as

$$\frac{d\tau_1}{dt}=1+\frac{d\beta\omega\sin\omega t}{c(1+\beta\cos\omega t)^2}\,, \tag{16}$$

and $d\tau_2/dt$ can be found from Eq. (13) as

$$\frac{d\tau_2}{dt}=1-\frac{d\beta\omega\sin\omega t}{c(1-\beta\cos\omega t)^2} \tag{17}$$

We are studying the change in light intensity in the frame of point M. Thus, we have to substitute τ_1 and τ_2 for t in Eq. (16) and Eq. (17) respectively. According to Eq. (14) and Eq. (15) the relative density of photons arriving at point M from star A is

$$\frac{m_1(\tau_1)}{n}=1/\frac{d\tau_1}{dt}(t\to\tau_1) \tag{18}$$

The relative density of photons arriving at point M from star B is:

$$\frac{m_2(\tau_2)}{n}=1/\frac{d\tau_2}{dt}(t\to\tau_2) \tag{19}$$

So, the total relative density s of photons arriving at point M is as follows:

$$s=\frac{m_1(\tau_1)+m_2(\tau_2)}{n}=\frac{1}{d\tau_1/dt}+\frac{1}{d\tau_2/dt} \tag{20}$$

From the viewpoint of SR, $s=2$, and the graph of s versus time should be constant. In our case the graph of the function s given by Eq. (20) shows that the curve, which represents the relative photon density $s=s(t/T)$ as measured at the point M, is a periodic function with the period $T/2$ (where T is the orbital period of the star system) (Fig.3).

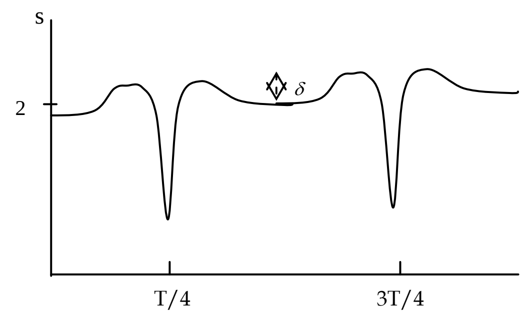

Fig. 3. Light curve for an eclipsing binary star.

The variations δ from $s=2$ depends on the distance d from the star to the point M, (the point where the photons' speeds equalize). Using data for the binary system WW Aurigae, we obtain that at a distance $d=10$ AU , $\delta=8.463\times10^{-8}$, and for $d=1000$ AU, $\delta=6.113\times10^{-5}$. In the case of WW Aurigae, δ is small and probably not detectable in observations.

Light curves showing uneven brightness, however, are often observed. Besides the drops in intensity due to eclipses, there are observed deviations from constant values in the regions of light curve between these drops. Astronomers have different explanations for these variations, some of which are quite obviously contrived. This topic clearly requires further study to arrive at a credible resolution. And yet the new results of the observation of binary stars might provide new arguments in favor of the Ritz hypothesis, to which we have added the hypothesis of the adjustment of the speed of light to c near celestial bodies.

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