Part 4.

Derivation of relativistic forces to accelerate elementary mass based on its "wave" motion in a parallel space.

1. Derivation of the relativistic force under longitudinal acceleration of elementary mass.

In the first part of this work, it was stated that the elementary mass is a wave micro-object, which keeps constant movement with speed of light. Movement exists as an inverse movement and it takes place relative to parallel space, because of this, the movement is hidden for our world. In order to confirm the validity of this assumption, this part offers the conclusion of relativistic force to accelerate the elementary mass on basis of its "wave" motion in a parallel space.

Before the mathematical analysis, let us recall the physical processes occurring in this model at movement of elementary mass relative to a parallel space. See figure 1. It depicts the reference system ξ,**x**,**y**. The plane of **x**,**y** belongs to our world. Axis of ξ is axis of the parallel space. An elementary mass, it is point (**m**) that is depicted by a black ball. The mass moves at a constant velocity (**V**) along the positive direction of the axis **x**. Aether of parallel space passes through the elemental mass with tilt relative to the **x**-axis downward.

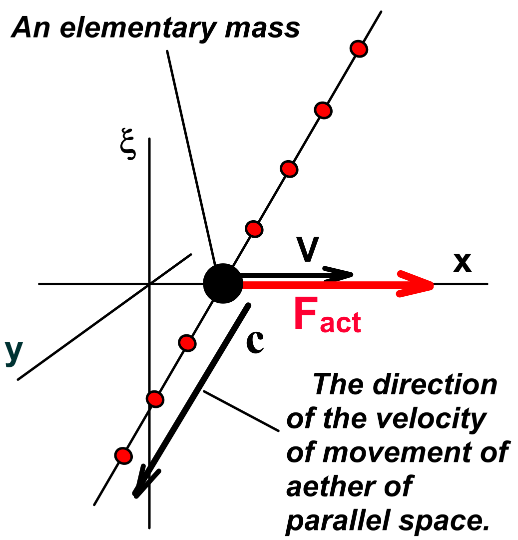

Figure 1.

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Such a motion of aether maintains its overall speed of passage through the elementary mass. This speed is equal to the speed of light **c**. In this section, the **y**-axis is not used in mathematical analysis; therefore, in the subsequent figures we remove this axis.

Suppose a force acts on the elementary mass. It is designated as ($\mathbf{F_{act}}$). Its direction coincides with the direction of movement of the elementary mass along **x**. The force is valid for an infinitesimal period $\mathbf{\Delta t}$. At first, we determine how this force can accelerate the elementary mass. After, we find the amount of force ($\mathbf{F_{act}}$).

We can understand the physics of this force by several ways. But to confirm really the assumption about that parallel space passes through elementary mass, we are using a virtual movement of this elementary mass in parallel space. And we will see the reason because of which the ordinary force of Newton ($\mathbf{F_{act}}$) becomes a relativistic force. This approach indirectly proves that there is a parallel space and it is material by its nature.

Consider the reference frame with axes ξ,**x** and let inside it elementary mass moves with velocity **V** along **x**. Because of this movement, the aether of parallel space encounters with the elementary mass along **x**-axis, and passes through the elementary mass. Consequently, along the ξ-axis, the parallel space will move at a slower speed and it is equal to $\mathbf{(c^2-V^2)^{1/2}}$. Obviously, in the case of changing speed of elementary mass along axis (**x**) in the common space ξ,**x** inertia force will manifest. The physics of this process has been described in the first part of this work. Recollect, aether is the bearer of the space in which the elementary mass exists as the object of a wave. Therefore, we can say that the elementary mass has a movement in parallel space. But when a curvature of straight path takes place, in this space there must be manifested the inertia force, and reaction force to warping path. This version of the movement of elementary mass is displayed in Figure 2. For this model we believe that the elementary mass has virtual movement in the opposite direction relative to the direction of movement of aether of parallel space.

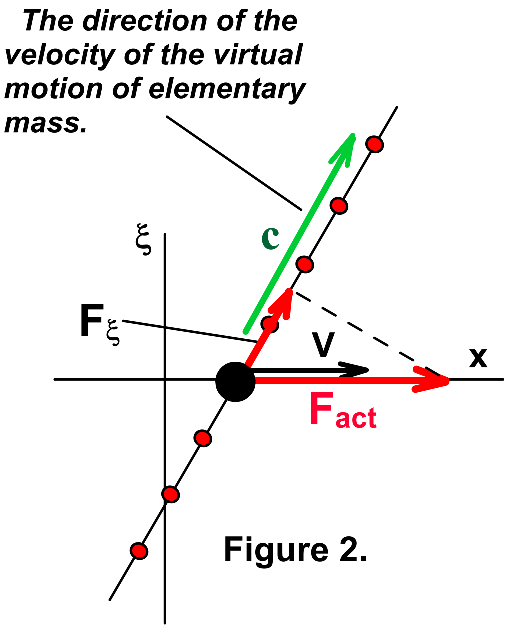

Figure 2.

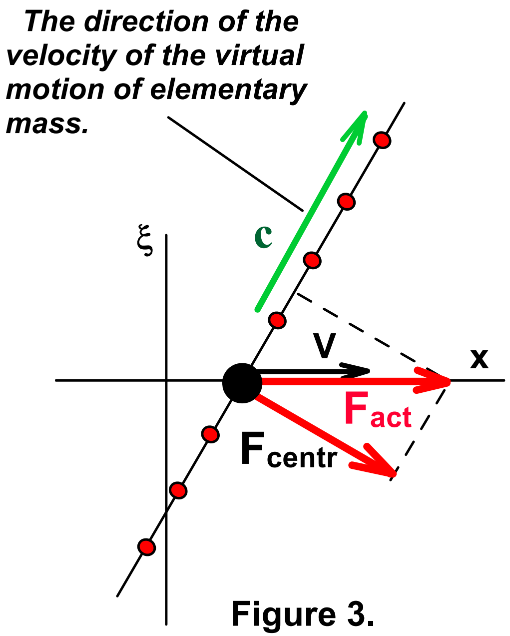

Figure 3.

See the green vector that is equal to the speed of light (**c**). There it has the opposite direction and coincides with direction of the virtual movement of the elementary mass. At moving of elementary mass in parallel space the **x**-axis is always aligned with of the elemental mass.

Let analyze the effect of the force ($\mathbf{F_{act}}$), in detail. To do this, consider the action of its two components. The first component of force we obtain by means of force projection ($\mathbf{F_{act}}$) onto the speed vector of the virtual motion of elemental mass. The projection of this force is denoted by ($\mathbf{F}_\xi$) and we consider its action. Obviously, this force is to give extra speed of the virtual movement of the elementary mass and the speed will be more of the speed of light. But this is impossible, because the wave velocity of the elementary mass is always equal to the speed of light. We conclude that the force ($\mathbf{F}_\xi$) does not accelerate the elemental mass.

Consider the action of the second component of the force ($\mathbf{F_{act}}$). For this we shall project this force so that it is as perpendicular to the velocity vector (**c**) and passes through the elementary mass, simultaneously. See Figure 3. On the figure, this force vector is shown by ($\mathbf{F_{centr}}$). It will not affect the wave speed of the virtual motion of the elemental mass.

However, it changes direction of movement of elementary mass, and compels the elementary mass to go according to a virtual arc. See Figure 4. We believe that under action of the force ($\mathbf{F_{centr}}$) for infinitesimal period $\mathbf{\Delta t}$ elementary mass gets extra speed along the **x**-axis. Let the speed is equal to ($\mathbf{V_{add}}$), and it is much less than the speed **V**. That is $\mathbf{V_{add} << V}$. Then the speed of the elementary mass along the **x**-axis becomes equal to $\mathbf{V_x = V + V_{add}}$. In parallel space the virtual speed becomes equal to $\mathbf{U_\xi = [c^2 - (V + V_{add})^2]^{1/2}}$.

The total speed of the elementary mass does not change and remains equal to the speed of light. Since the acceleration period $\mathbf{\Delta t}$ is taken extremely small, during this period, elementary mass moves inside of parallel space according to an arc with a constant curvature. Vector "wave" speed of elementary mass there is as the tangent vector to the arc of the virtual motion of elemental mass. The radius of curvature of the arc is a constant for infinitesimal time $\mathbf{\Delta t}$. If this radius we combine with elementary mass, it will be perpendicular to the vector of the "wave" speed of elementary mass and will be coincide with the force vector ($\mathbf{F_{centr}}$). Let remark the radius of curvature as $\mathbf{R_m}$. See the Figure 4. From all of this follows the following conclusion. Because each moment of time during period $\mathbf{\Delta t}$, the force ($\mathbf{F_{centr}}$) is perpendicular to the "wave" of the movement of the elementary mass and force vector is directed along the radius of curvature at the center of the arc, this force acts as a centripetal force. Its value is equal to:

$\mathbf{F_{centr} = m \bullet a_{centr}}$, here $\mathbf{a_{centr}}$ – is as centripetal acceleration.

From physics we know that the centripetal acceleration is:

$$\mathbf{a_{centr} = \frac{V_{lin}^2}{R_m}}$$

here $\mathbf{V_{lin}}$ – is a linear velocity of movement of the elementary mass on a circle of radius $\mathbf{R_m}$. In our case, the linear velocity $\mathbf{V_{lin}}$ is "wave" speed (**c**) of the elementary mass.

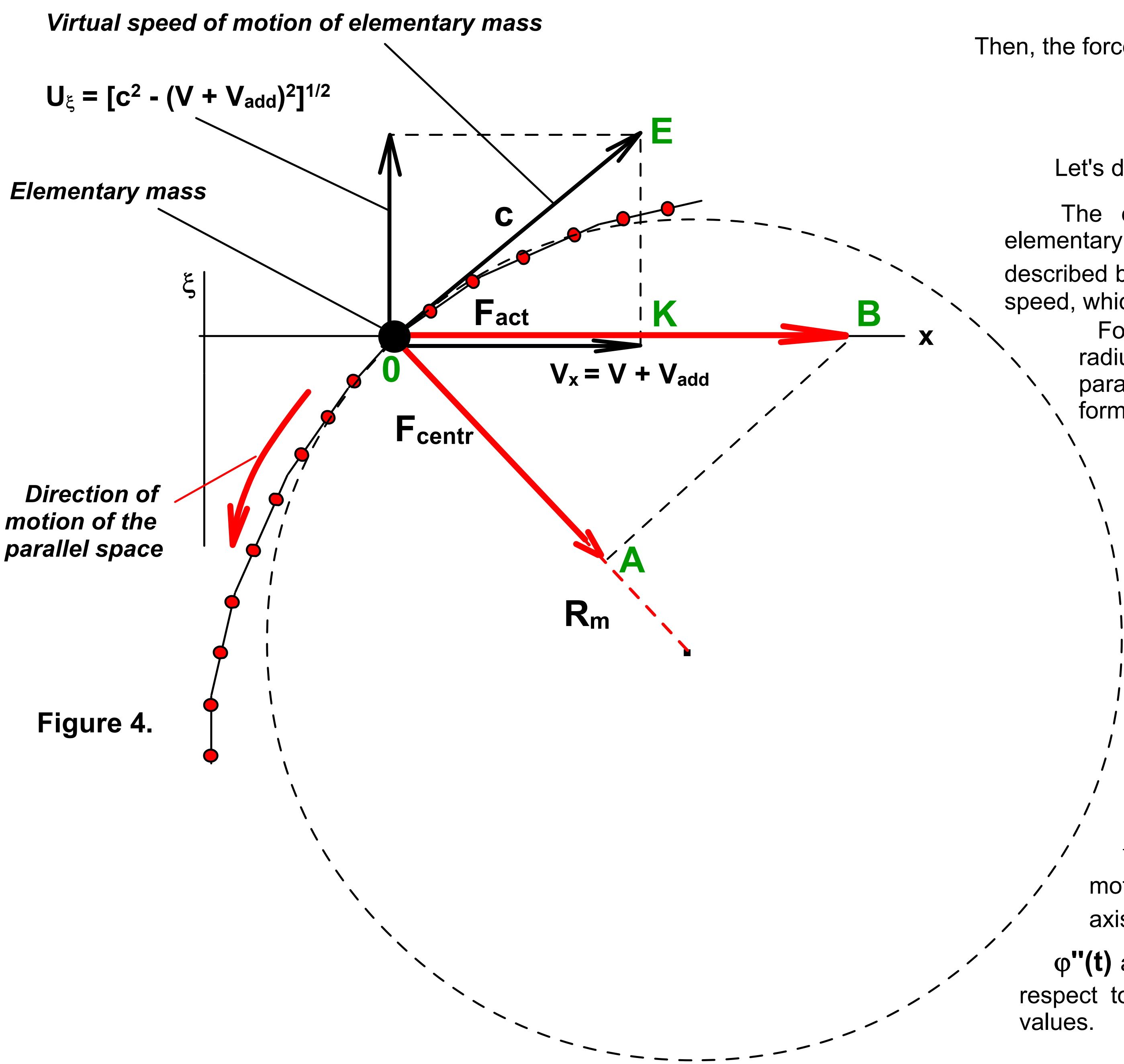

Figure 4.

Therefore, the centripetal acceleration is equal to

$$a_{centr} = \frac{c^2}{R_m}$$

Then, the force (Fcentr) is:

$$F_{centr} = \frac{m \cdot c^2}{R_m} \qquad (1)$$

Let's define the radius $\mathbf{R_m}$.

The curve of the virtual movement of the elementary mass during acceleration, itself is not described by coordinates ξ,**x**. It is described by using speed, which is a function of the time parameter.

For this case, according to mathematics the radius of curvature of the curve given by parametric form can be found from the formula:

$$R_m = \frac{[\{\varphi'(t)\}^2 + \{\psi'(t)\}^2]^{3/2}}{\left|\varphi'(t)\cdot\psi''(t) - \varphi''(t)\cdot\psi'(t)\right|} \qquad (2)$$

The value of the denominator is taken by modulo.

$\varphi'(t)$ and $\psi'(t)$ are the first derivatives with respect to **t**, and they are equal to the following values.

$\varphi'(t)$ is equal to the speed of the elementary mass along **x**-axis, i.e. $\varphi'(t) = V + V_{add}$.

$\psi'(t)$ is equal to the speed of the virtual motion of the elementary mass along the axis ξ, i.e. $\psi'(t) = [c^2 - (V + V_{add})^2]^{1/2}$.

$\varphi''(t)$ and $\psi''(t)$ are the second derivatives with respect to **t**, and they are equal to the following values.

$\varphi''(t)$ is equal to the acceleration of the elementary mass along **x**-axis, i.e.

$$\varphi''(t) = \frac{dt\,(V + V_{add})}{dt}$$

Speed **V** is the initial speed of the elementary mass along **x**-axis. It is constant and does not change over time. Therefore, the derivative of this speed is equal to zero:

$$\frac{dt\,(V)}{dt} = 0$$

Hence $\varphi''(t) = \dfrac{dt\,(V_{add})}{dt} = a_x$

$\psi''(t)$ is equal to the acceleration of the elementary mass along the axis ξ, i.e.

$$\psi''(t) = \frac{dU_{\xi}}{dt} = \frac{d\{[c^2 - (V + V_{add})^2]^{1/2}\}}{dt} = \frac{-\,a_x\,(V + V_{add})}{[c^2 - (V + V_{add})^2]^{1/2}} \quad .$$

Making the substitution of values of $\varphi'(t)$, $\psi'(t)$, $\varphi''(t)$, $\psi''(t)$ in formula (2) we find the radius of curvature R_m :

$$R_m = \frac{[(V + V_{add})^2 + c^2 - (V + V_{add})^2]^{3/2}}{\left| \dfrac{-\,a_x\,(V + V_{add})}{[c^2 - (V + V_{add})^2]^{1/2}} - a_x\,[c^2 - (V + V_{add})^2]^{1/2} \right|} = \frac{c^3\,[c^2 - (V + V_{add})^2]^{1/2}}{a_x \left| [(V + V_{add})^2 + c^2 - (V + V_{add})^2]^{3/2} \right|} =$$

$$= \frac{c\,[c^2 - (V + V_{add})^2]^{1/2}}{a_x} \quad .$$

Given that the speed $V + V_{add} \approx V$, since $V_{add} << V$, the last expression takes the form:

$$R_m = \frac{c}{a_x} \cdot (c^2 - V^2)^{1/2} = \frac{c}{a_x} \cdot \left(1 - \frac{V^2}{c^2}\right)^{1/2} \quad .$$

Substituting the value R_m in (1) we define force F_{centr}.

$$F_{centr} = m \cdot \frac{c^2 \cdot a_x}{c^2 \left(1 - \dfrac{V^2}{c^2}\right)^{1/2}} = m \cdot \frac{a_x}{\left(1 - \dfrac{V^2}{c^2}\right)^{1/2}} \qquad (3)$$

As it is mentioned earlier, the centripetal force F_{centr} is created by force F_{act}, which in our world acts onto the elemental mass. In this analysis, the force acts along the **x**-axis. See Figure 4.

Let define the value of the force $\mathbf{F_{act}}$ required for the operation of centripetal force $\mathbf{F_{centr}}$. It is determined from the triangle $\mathbf{\Delta A0B}$ and numerically is equal to:

$$\mathbf{F_{act}} = \frac{\mathbf{F_{centr}}}{\cos(\angle \mathbf{A0B})} \qquad (4)$$

Cosine of corner $\angle\mathbf{A0B}$ we can find from the similar triangles: $\mathbf{\Delta A0B}$ and $\mathbf{\Delta KE0}$. They are rectangular and sharp corners $\angle\mathbf{A0B}$ and $\angle\mathbf{KE0}$ are equal to each other because of mutually respective rays of angles are as perpendicular. On this basis their cosines are equal to each other:

$$\cos(\angle \mathbf{A0B}) = \cos(\angle \mathbf{KE0})$$

Cosine $\angle\mathbf{KE0}$ can be found from the speeds that forming a triangle $\mathbf{\Delta KE0}$:

$$\cos(\angle \mathbf{KE0}) = \frac{\mathbf{U_{\xi}}}{\mathbf{c}} = \frac{[\mathbf{c}^2 - (\mathbf{V} + \mathbf{V_{add}})^2]^{1/2}}{\mathbf{c}}$$

Given that the speed $\mathbf{V + V_{add} \approx V}$, since $\mathbf{V_{add} \ll V}$, the last expression takes the form:

$$\cos(\angle \mathbf{KE0}) = \left(1 - \frac{\mathbf{V}^2}{\mathbf{c}^2}\right)^{1/2}$$

Substituting the value of the cosine to the expression (4), we find:

$$\mathbf{F_{act}} = \frac{\mathbf{F_{centr}}}{\cos(\angle \mathbf{A0B})} = \frac{\mathbf{F_{centr}}}{\left(1 - \frac{\mathbf{V}^2}{\mathbf{c}^2}\right)^{1/2}}$$

Substituting the last expression of the value of the force $\mathbf{F_{centr}}$ from (3), we get:

$$\mathbf{F_{act}} = \mathbf{m} \cdot \frac{\mathbf{a_x}}{1 - \frac{\mathbf{V}^2}{\mathbf{c}^2}} \qquad (5)$$

In this formula it remains to take into account that the mass has a value of:

$$\mathbf{m} = \frac{\mathbf{m_0}}{\left(1 - \frac{\mathbf{V}^2}{\mathbf{c}^2}\right)^{1/2}}.$$

Substituting the value of $\mathbf{m}$ in the expression (5) we finally obtain the value of forces $\mathbf{F_{act}}$. It is equal to

$$F_{act} = m_0 \cdot \frac{a_x}{\left(1 - \frac{V^2}{c^2}\right)^{3/2}} .$$

It coincides with the expression of the force for longitudinal acceleration of mass obtained by Einstein in the special theory of relativity.

Let's analyze the obtained result for the force for the relativistic longitudinal acceleration of elementary mass on the basis of its movement as "wave" in parallel space.

Firstly, in our world reaction force that prevents acceleration of the elementary mass arises from the arising of centrifugal force. This force comes from the curvature of the path of movement of the elementary mass in parallel space.

Secondly, the transition of Newton's force into relativistic form is caused by a change in the radius of curvature of the virtual movement of the elementary mass in a parallel space and by drift of the centripetal force from our world into inwards of the parallel space.

From the model considered for relativistic force, the main theoretical conclusion of this section follows, the essence of which is as following. Theoretically it is possible to accelerate elementary mass up to the speed of light without using the relativistic forces. To do this in a parallel space, we need to create a deceleration force. In order to understand this, see Figure 5. In this figure, the centripetal force is divided into two forces $\mathbf{F_{actn}}$ and $\mathbf{F}_{\xi}$. Obviously, the force $\mathbf{F_{actn}}$ much less relativistic forces $\mathbf{F_{act}}$. To compare these forces with each other, see Figure 4. To accelerate the elementary mass by force $\mathbf{F_{actn}}$ we must create $\mathbf{F}_{\xi}$ force acting on the elementary mass in a parallel space. By its essence, it is the deceleration force. It will reduce the speed of movement of elementary mass along the axis ξ. The vector sum of the forces $\mathbf{F}_{\xi}$ and acceleration force $\mathbf{F_{actn}}$ acting in our world should give precisely the vector $\mathbf{F_{centr}}$ of centripetal force needed to accelerate a point mass. By this method, the overclocked elementary mass will give an additional gain in energy during deceleration in our world, and it gives the using of the energy of the parallel space. For braking motion of the elementary mass along the axis ξ enough reduce the flow speed of aether of parallel space passing along this axis. Such deceleration of aether of parallel space is equivalent to action of the force $\mathbf{F}_{\xi}$.

Now, we will run a small analysis of radius of curvature of the virtual path of the elementary mass at different speeds its initial speed of $\mathbf{V}$.

1. If in our world, the elementary mass is being moved at a speed close to the speed of light and is accelerated, the radius of curvature of the virtual path goes to zero:

$$\lim_{V \to c} (R_m) = \lim_{V \to c} \left[\frac{c^2}{a_x} \cdot \left(1 - \frac{V^2}{c^2}\right)^{1/2} \right] = \mathbf{0}, \text{ because } \quad \lim_{V \to c} \left[\frac{V^2}{c^2} \right] = 1 \quad .$$

2. If at the beginning, the elementary mass is at rest and after, it has a small acceleration, and in this case, the radius of curvature of the virtual path of the elementary mass becomes a huge. Its value becomes equal to:

$$\lim_{V \to 0} (R_m) = \frac{c^2}{a_x} \quad \text{due to the fact that} \quad \lim_{V \to 0} \left[\frac{V^2}{c^2} \right] = \mathbf{0}, \text{ therefore} \quad R_m = \frac{c^2}{a_x} \qquad (6)$$

Let analyze the radius of curvature that is obtained when the elementary mass has acceleration that is equal to $\mathbf{a_x}$ = 10 meters/seconds^2 = 0,01 km/seconds^2.

For such acceleration the force of Newton is necessary. With help of this small analysis we can see the small curvature of the virtual path that the elementary mass has in the parallel space and how big the radius of this curvature. Let substitute all the values in the last expression:

$$\mathbf{R_m} = \frac{\mathbf{c^2}}{\mathbf{a_x}} = \frac{\left(\mathbf{300\ 000}\ \frac{\mathbf{kilometres}}{\mathbf{seconds}}\right)^2}{\mathbf{0{,}01}\left(\frac{\mathbf{kilometres}}{\mathbf{seconds^2}}\right)} =$$

$$= \mathbf{9\ 000\ 000\ 000\ 000\ kilometres}$$

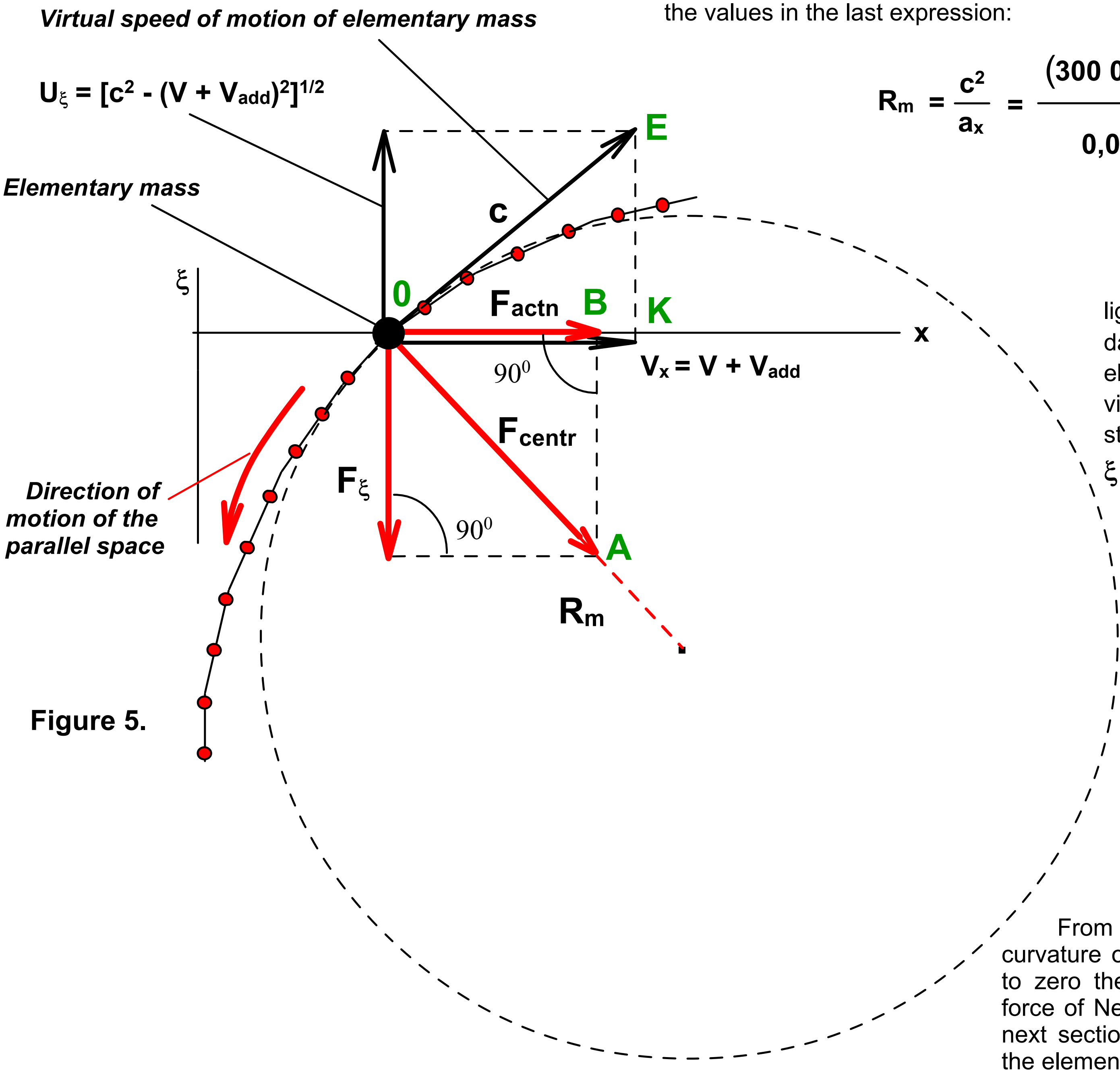

Figure 5.

The resulting value is large enough. The light beam can pass this radius for ≈ 347 days. The curvature of the virtual path elementary mass tends to zero. Arc of virtual path straightens and becomes a straight line, which coincides with the axis of ξ in parallel direction.

Center of the virtual circle will be located in our world. Because of this, the vector of centripetal force $\mathbf{F_{centr}}$ coincides with the axis $\mathbf{x}$. Therefore, the force $\mathbf{F_{act}} = \mathbf{F_{centr}}$.

The value of the elementary mass at low speeds is equal to the elementary mass at rest. Therefore, substituting the value of the radius of curvature $\mathbf{R_m}$ (6) in the expression (1) we obtain the value of the force:

$$\mathbf{F_{act}} = \mathbf{F_{centr}} = \frac{\mathbf{m \cdot c^2}}{\mathbf{R_m}} = \mathbf{m \cdot a_x} \qquad (7)$$

From analysis follows if the curvature of the curvature of the virtual path elementary mass tends to zero then the acceleration force becomes by a force of Newton. This conclusion will be used in the next section when transverse acceleration force for the elementary mass will be found.

In this section, the description of the material is finished. Let's find the value of the force for the transverse acceleration of the elementary mass.

2. Derivation of relativistic transverse force for acceleration of elementary mass.

For the next description, let's introduce the initial conditions for the transverse force. Suppose that before the start of action of the force, the elementary mass moves uniformly in a straight line in space of "our world" with an arbitrary speed $\mathbf{V} \ll \mathbf{c}$. The value of a speed is not greater than the speed of light. We choose a system of reference ξ, **x** as it was done in the first section of this part, that is let the **x**-axis coincide with the elementary mass and with the direction of its movement, and so on. We supplement the frame of reference by additional axes **y** and **y '**. Let there the axis **y '** always is combined with the elementary mass. Suppose that along this axis acts transverse force $\mathbf{F_y}$. We introduce a new axis ξ'. Suppose that it coincides with the vector wave velocity (**c**). See Figure 6.

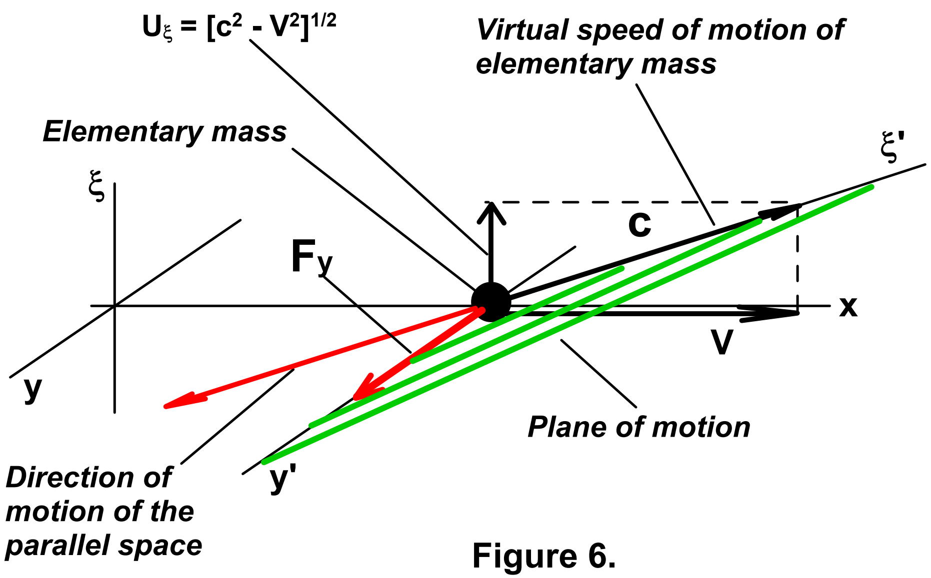

Figure 6.

It is obvious that the acceleration of elementary mass in the plane **y'**,ξ**'** represents a condition where before action of the force $\mathbf{F_y}$ elementary mass was at rest relative to the axis **y'**. This case for accelerating elementary mass has been considered in the previous section, when there was made a conclusion (7). There is only one difference between these accelerations. The derivation of (7) corresponds to the acceleration of the elementary mass at rest. Therefore, the value of the elementary mass was consistent with the mass at rest. At transverse acceleration of the elementary mass is assumed that the elementary mass has an initial speed **V**. Because of this, the value of elementary mass is equal to:

$$\mathbf{m} = \frac{\mathbf{m_0}}{\left(1 - \frac{V^2}{c^2}\right)^{1/2}}.$$

Therefore, if the elementary mass is accelerated by the force $\mathbf{F_y}$ at a constant acceleration, we must take into account the relativistic changing of mass in the formula (7). Then, if we take into account that after the transverse acceleration elementary mass acquires a speed $\mathbf{V_y} \ll \mathbf{V}$, we get the final result for the transverse force:

$$\mathbf{F_{acty}} = \mathbf{m_0} \cdot \frac{a_y}{\left(1 - \frac{V^2}{c^2}\right)^{1/2}}.$$

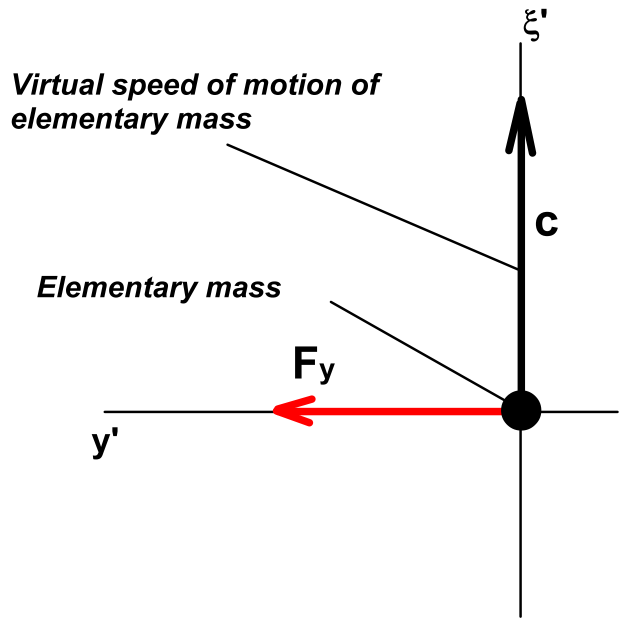

Figure 7.

Last expression coincides with the expression of the transverse force in the special theory of relativity. This was required in order to prove.