Mathematical representation of Einstein's theory related to quantum physics with just one graph

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Abstract: - This paper presents the Theory of relativity and its coupling with quantum physics using the equations set by Einstein, Planck, and de Broglie. Using the Lorentz factor, known as the cosine function, we construct a graph that fully correspond to Einstein's Theory of relativity and relates it to quantum physics. This connection is made using a sine rule via Planck equation and results in de Brogli wavelength. In this way, the known fact of the cosine rule for Einstein's theory is simply and elegantly extended by applying the sine function. What we get is fascinating - the merging of sines and cosines on the same basis unites quantum and relativistic physics. Thus, when changing the velocity variable in the range from zero to the speed of light, the required energy to accelerate the particle follows the theoretical range from zero to infinity, while the radiation energy is limited by the mass of the particle that is accelerated. This paper in a logical, systematic and mathematical way enables us to unite quantum and relativistic physics within one graph on which they are all together: Einstein, Lorentz, Planck and de Broglie.

Key-Words: - theory of relativity; quantum physics; Einstein; Lorentz; Planck; de Broglie; graphical representation

1 Introduction

Using mathematical and theoretical methods, we will combine the works of the great scientists H. A. Lorentz, A. Einstein and L. de Brogli into one. Our primary intention is to unite relativistic and quantum physics.

Starting from the foundations laid down by A. Einstein in the Theory of relativity with the Lorentz factor, which will be shown graphically, we will see that there is a link with quantum physics defined over the same angle obtained from the Lorentz factor but now with its sine function.

Every new idea takes time to be recognized, but it will be shown here that there is neither a mathematical nor a theoretical contradiction that would prevent its immediate practical use.

In order to make a complete diagram, it is necessary first to construct, step by step, the first diagram that includes the known facts from relativistic physics. This will also be the proof that we are heading in the right direction and justify our procedure. After that, in the next step we will merge our diagram with quantum physics.

2 Triangle construction with Lorentz factor

In Fig.1 a triangle is constructed based on the fact that the Lorentz factor is the cosine of the angle. This is also evident from the formula of the Lorentz factor when we write the numerator and denominator each under its root and then take the root out of the denominator. Then in the denominator we get a hypotenuse equal to the speed of light *c*, and in the numerator we get adjacent cathetus written in Pythagoras' rule. The ratio of the adjacent cathetus to the hypotenuse is the trigonometric rule of the cosine (1).

$$\sqrt{\frac{c^2-v^2}{c^2}}=\frac{\sqrt{c^2-v^2}}{\sqrt{c^2}}=\frac{\sqrt{c^2-v^2}}{c} \qquad (1)$$

In the construction of the triangle, the hypotenuse will be identified as the speed of light, the constant c, the opposite cathetus corresponds to the velocity of the body *v*. The adjacent cathetus in the diagram is marked with the letter x, because it is absent in the Lorentz factor, and we just use it in the construction of a triangle. Its value, as mentioned before, is defined by Pythagoras' rule (2):

$$x = \sqrt{c^2 - v^2} \quad (2)$$

The angle between this cathetus and the hypotenuse will be named φ. The speed of light is the absolute value and we will show this fact by the arc of a circle with radius corresponding to the speed of light *c*.

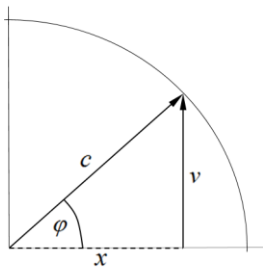

Fig. 1. The velocity graph constructed with Lorentz factor

For the sake of verification, from the constructed triangle, the cosine of angle φ is equal to :

$$\cos\varphi = \frac{x}{c} = \frac{\sqrt{c^2-v^2}}{c} = \frac{\sqrt{c^2-v^2}}{\sqrt{c^2}} = \sqrt{\frac{c^2-v^2}{c^2}} \quad (3)$$

The sine of angle φ, determined by the graph, is equal to:

$$\sin\varphi = \frac{v}{c} \quad (4)$$

The theoretically maximum for the angle is 90°, and at that angle the velocity of particle would be equal to the speed of light.

3 Construction of the energy graph obtained by Theory of relativity

Einstein uses the Lorentz factor in his Theory of relativity, thus it is possible to construct an energy graph. From the fact that he uses Lorentz factor, the angle between velocities is identical to the angle between energies. The Einstein energy graph is shown in the Fig.2. The construction is defined by the Theory of relativity [1] [2] [5]. so that the rest energy of the particle is the adjacent cathetus.

$$E_0 = m \cdot c^2 \quad (5)$$

Hypotenuse is the energy defined by the relativistic theory that a particle has as it moves at velocity *v*.

$$E = \frac{m\cdot c^2}{\sqrt{\frac{c^2-v^2}{c^2}}} \quad (6)$$

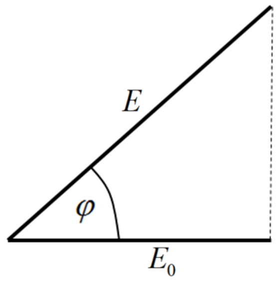

Fig. 2. Energy graph by Theory of relativity

$$\cos\varphi = \frac{E_0}{E} = \frac{m\cdot c^2}{\frac{m\cdot c^2}{\sqrt{\frac{c^2-v^2}{c^2}}}} = \sqrt{\frac{c^2-v^2}{c^2}} \quad (7)$$

As velocities and energies construct the graph with an equal angle, with Lorentz defining the velocity of the particle as opposite cathetus, and Einstein defining the adjacent cathetus as the rest energy, they are connected with this same angle φ to form similar "quasi triangles" in Fig.3.

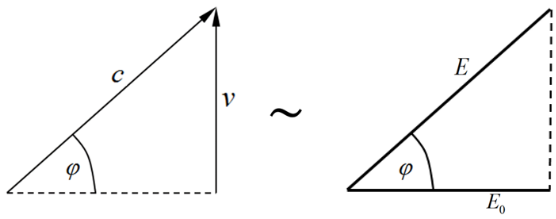

Fig. 3. Similar "quasi triangles" of velocity and energy

To construct a more complex graph that will also include the radiation energy of a particle moving toward the reference system, and for better overall presentation and Einstein's Theory of relativity - we will rotate the energy triangle by placing the relativistic energy obtained by the Lorentz factor on the abscissa and the rest energy E_0 at an angle φ as shown in Fig.4.

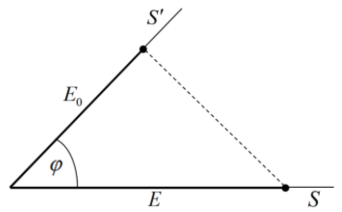

Fig. 4. Graphic representation of the movement of the body from our system to a new system

This allows us to show on an abscissa the energy that needs to be given from our system to accelerate the particle to a velocity *v* to transfer it to a new system, non-inertial. This is also shown in Fig.4 as a system S' at an angle φ, into which we will move the particle when we give it energy. Our system is in the Fig.4 denoted by the letter S, and system S' is the system into which we moved the particle when we gave it energy.

This representation correctly shows us that the energy of a particle in its system is still equal to the rest energy E_0 when we calibrate the observation that S' is the reference system, and the projection of rest energy E_0 at right angle (90°) is the energy E we have given to transfer it to system S' defined by the angle φ, and its velocity by the Lorentz factor, by which we determine the angle φ.

In Fig.5 it is shown how the angle of the system in which we move the particle relative to our system changes with respect to the transmitted energies displayed on the abscissa. The higher the transmitted energy, the greater the angle, because the particle has a higher velocity. We also see this in the graph shown in Fig.1 and this is identical to Einsten's theory.

We can see that this graphical representation behaves completely in accordance with Einstein's relativistic theory, as it is expected in accordance with previous graphs where we have found that the cosine rules.

From graph in Fig.5 it is visible that if we want to accelerate the body to greater velocity we need more energy. The dashed tangential projection of the point E_0 (5) from the circle to the abscissa shows us the amount of energy E required to move the particle to a given non-inertial system (6).

It can also be seen from graph in Fig.5 that if we want to achieve a higher velocity of a particle via the Lorentz factor, this position represents a larger angle, and we need higher values of energy. The amounts of energy are not proportional to the angle, but increase rapidly with larger angles.

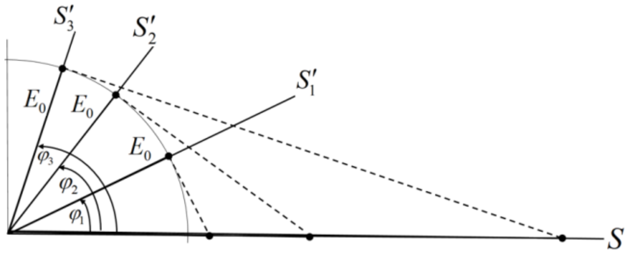

Fig. 5. Displacement of a particle into another system and its associated angle

Larger angles require more and more energy to change to higher angles. It can also be seen from the graph in Fig.5 that a particle approaches an angle of 90° when its velocity theoretically approaches that of light and the energy required for such velocity tends to infinity.

To whichever system we move a particle, with the given energy and accelerating it to velocity v, that particle within its system, will always rest in its system and have the same rest energy E_0. This is why we have made this graph in Fig.5 in the form of a circular arc with radius E_0, on which we place the tangents on the position to abscissa which shows us the energies we need for it. When we calibrate the energy at rest it always equals to E_0.

4 Construction of the energy graph of moving particle

Before combining the radiation diagram with the relativistic diagram, let us determine what the position and angle of energy E_0 would be if the particle reached the speed of light. So far, we have found that the angle in the diagram increases with velocity *v*, with the energy position E_0 moving away from the abscissa, raising and approaching the ordinate. If the particle theoretically reached the speed of light it would have a position at an angle of 90° and theoretically its mass would be converted to photon energy equal to exactly E_0. This is shown in the diagram we see in Fig.6.

This is important: the energy position E_0 when the particle reaches the speed of light on the diagram has an angle of 90°, and the energy has a position on the ordinate at the moment when all the mass of the particle is converted to photon energy. This leads us to the conclusion that the radiation energy may need to be displayed on the ordinate. When the velocity of the particle is less than the velocity of light, it has an angle of inclination φ and an orthogonal projection of the radiation energy less than E_0.

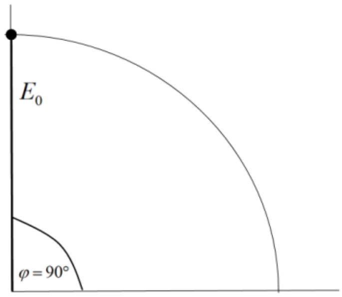

Fig. 6. Position and energy of particles at a velocity equal to the speed of light

At boundary conditions, it behaves the same as the sine rule on a unit circle: when the velocity is equal to zero, the energy position E_0 is at an angle equal to φ = 0° and the radiation energy at orthogonal projection to the ordinate is equal to zero, while at an angle of φ = 90° it has its maximum. It has the same properties as the sine rule. It has graphical and mathematical sine circumferences.

The assumption we need to check, is whether the sine rule really describes and defines the radiation energy. The two boundary conditions correspond to the theory and to our assumption, which leads us to the conclusion that our assumption may indeed be true. If our assumption is correct, it will allow us not only to present graphically together relativistic and quantum physics, but also to merge these two theories. To test the assumption, we set the mathematical model to the general case shown in the graph in Fig.7. We will then check it with mathematics to see if the solutions fit the existing formulas.

The radiation energy of a particle will be named E*. First, we will show in the diagram the position of the particle at an angle defined by an arbitrary velocity *v*, and with the help of mathematics using the trigonometric sinus rule, determine the particle radiation energy E* using the relations (4) and (5).

$$E^* = \sin\varphi \cdot E_0 \qquad (8)$$

From Fig. 1 we determined by relation (4) sine defined by the ratio of the particle velocity and the speed of light and by relation (5) the rest energy of the particle E_0. When we substitute these relations into relation (8), we obtain the amount of radiation energy that is projected on the ordinate.

$$E^* = \sin\varphi \cdot E_0 = \frac{v}{c} \cdot m \cdot c^2 = m \cdot v \cdot c \qquad (9)$$

$$E^* = m \cdot v \cdot c \qquad (10)$$

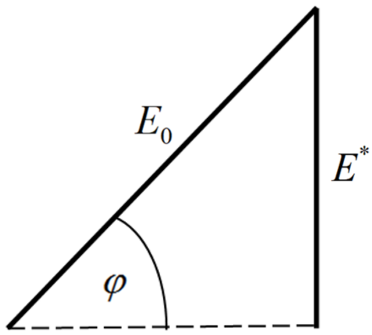

Fig. 7. Determination of the radiation energy of a particle from a graph by the sine of an angle.

Then in the next diagram in Fig.8 we orthogonally project that energy on the ordinate.

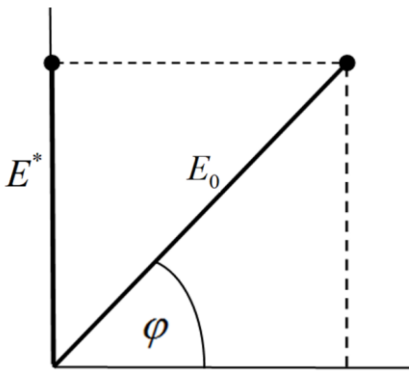

Fig. 8. Projecting radiation energy at the ordinate

To determine the wavelength of the radiation energy of a particle, we must equate it, with the energy of a photon according to Planck's quantum theory [3] :

$$E = h \cdot \frac{c}{\lambda} \tag{11}$$

When we equate them, we get:

$$h \cdot \frac{c}{\lambda} = m \cdot v \cdot c \tag{12}$$

$$\frac{h}{\lambda} = m \cdot v \tag{13}$$

After editing we will obtain the amount of the wavelength of radiation energy (14):

$$\lambda = \frac{h}{m \cdot v} \tag{14}$$

We have just obtained that the radiation energy of a particle moving at velocity *v*, projected orthogonally on the ordinate, has a wavelength of radiation corresponding to de Broglie wavelength [4]. These wavelengths are equal. We can conclude that it is correct to represent it on ordinate, with orthogonally projection by the sine rule, the radiation energy of a particle which moves at velocity *v*.

With graph in Fig.3 we show "quasi triangles" of velocity and energy obtained by Theory of relativity. Just the same "quasi triangle" is connected with radiation energy within graph in Fig.9. It is the sine function that connects radiation energy and the rest energy E_0 .

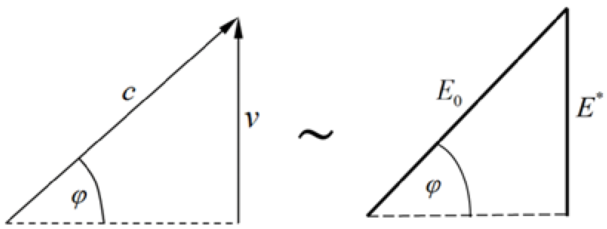

Fig. 9. Similar "quasi triangles" of velocity and radiation energy

$$\frac{v}{c} = \frac{E^*}{E_0} \tag{15}$$

$$E^* = \frac{v}{c} \cdot E_0 \tag{16}$$

In this paper we want to show that a quantum of energy radiated by a particle while moving at high velocity and which corresponds to de Broglie wavelength is compatible with the rest energy. New factor defined by the sine rule is also compatible with Einstein energy in the Theory of relativity, just in the the same way Einstein introduced the Lorentz factor.

5 Graphic and theoretical fusion of Einstein’s relativistic theory with quantum theory

By mathematical rules of trigonometry we can graphically connect relativistic and quantum physics using well known and recognized formulas. We conclude that the energy graph of Einstein's relativistic theory coupled by the Lorentz factor, which is the cosine of an angle φ, also connects the same angle with quantum physics, the radiation energy of a particle, and de Brogli wavelength using the sine of that same angle φ.

Graph in Fig.10 combines relativistic and quantum facts. The abscissa shows the energy we give to accelerate the particle to velocity *v*, which will define the angle φ of the system S'. On the ordinate is projected the energy that particle radiates.

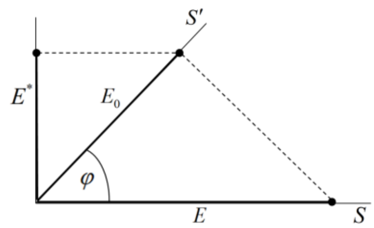

Fig. 10. The coupling of relativistic theory energy and radiation energy in the same diagram

Just as the relativistic energies are connected between systems by the Lorentz cosine factor, there is the factor *k* (17) that couples them with the radiation energy. This factor *k* is defined by the sine rule of the same angle formed by the velocity and light velocity vectors as for the Lorentz factor, and it is:

$$k = \sin\varphi = \frac{v}{c} \tag{17}$$

At the last graph in Fig.11 we combine everything that represents this theory by which we relate relativistic and quantum physics. We also add to the energies on the graph the velocities shown by vectors that form the angle that defines the factors that bind the energies. With a circular arc we want to show that the speed of light is the absolute magnitude by which we represent the unit circle of our graph. In any system S', wherever we move the particle, at any angle, the rest energy in each system is equal to E_0.

The particle is defined by its mass, the rest energy E_0 is invariant regardless of which particle system it is located when the observation is calibrated to it. The energy we give to a particle is a variable that defines the angle of the system we will move it to. With this fact, the graph shown in Fig.5 is constructed.

Likewise, the mass of a particle, its rest energy and its velocity define the energy with which it radiates towards our system, by relation (10).

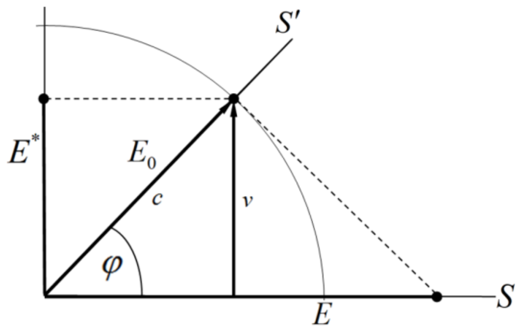

Fig. 11. The uniqueness of the graph of energy and velocity

6 Conclusion

Based on the fact that in the Theory of relativity we need the Lorentz factor to connect energies, it was logical to assume and conclude that perhaps we could also link them by a similar factor with the radiation energy of that particle. It is remarkable that the energy of a particle can be linked by a complex graph to other energies by the trigonometric rule of the sine which is defined by the velocity of the particle and the speed of light, just as in Theory of relativity cosine function connects them.

We can conclude that it is appropriate for them to be connected by trigonometric rules. In this paper we are not only discussing about the graphical unification of relativistic and quantum theory, but also proving the theoretical and mathematical unification of relativistic and quantum physics. This is actually the true purpose of this paper and purpose of all diagrams in this work - the unification of relativistic and quantum theory. A significant contribution of this paper is the introduction of another factor in addition to the Lorentz factor. Therefore we can connect the quant of energy of moving particle with the rest energy and thus with the Theory of relativity. The relationship between these energies, defined by these factors, can be represented by a single graph. It is not our intention here, nor are we trying to connect these energies with Schrödinger's wave function.

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