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Einstein's theory of special relativity with respect to sound waves

Leandro Meléndez Lugo

Abstract
An original theory of special relativity acoustics is developed. For this new theory with a focus on sound waves instead of electromagnetic waves, new coordinate transformations that are different from the Lorentz transformations, which transform a spherical wave front for the observer at rest into another spherical wave front for the observer in uniform relative motion, are deduced. Previously, it has been quantitatively demonstrated that Lorentz transformations do not do what Albert Einstein says they do. In the demonstration that is described in the present study, we conclude that the constancy of the speed of light, using the Lorentz transformations, for one of the two observers, is not satisfied. Also, within this new acoustic theory new expressions for the Doppler Effect are obtained, with differences in regard to the traditional expressions. Finally, new relativistic consequences are found that present differences with respect to those from the theory of Albert Einstein.

Keywords: Special relativity, Lorentz symmetry, Lorentz transformations, relativistic consequences, time dilation

1. Introduction
A special relativity acoustics theory. Why generate another theory of special relativity, in this case an acoustic theory? That is, with sound instead of electromagnetic waves. This new argument began in 2005, a year that was declared as the International Year of Physics, commemorating the fiftieth anniversary of the death of Albert Einstein (1879-1955) and the 100 years of the Special Theory of Relativity [1, 2]. On that occasion, a series of conferences at the National Autonomous University of Mexico were organised. One specialist spoke of Einstein's theory of special relativity. During question time he was asked about the possibility of applying Albert Einstein's theory where observers would communicate with sound waves instead of electromagnetic waves. The lecturer responded hesitantly: "You know... that light is something special... therefore... you could not have what you are proposing". During the coffee hour after the conference, discussions were held with the lecturer but no clear conclusion was reached in this regard.
Using Einstein's theory of special relativity it is feasible to affirm that light plays a secondary role [3]. That is, light is only the medium that allows communication between two observers in uniform relative motion. Nevertheless, in the original work of Einstein in the postulates, in particular the one of the light, it is understood another thing. Albert Einstein gives preponderance and more protagonism to the constancy of the speed of light [1-3]. In fact, much of the relativistic results, according to Einstein's theory, have to do with very special aspects of light and especially the effect that speed can have on material bodies [1-3]. In this theory of special relativity acoustics, among other issues, there are important differences in the relativistic consequences with respect to Einstein's original theory. This is not only because it is using sound, but because much of the conceptualisation (time and space) and part of the development (the genesis) of the theory turns out to be very different, particularly considering the Doppler Effect that Einstein only contemplated collaterally [1]. With respect to the Doppler Effect, caused by the relative velocity, it can be affirmed that there does not seem to be another effect of greater importance on the perception of the events by the two observers in uniform relative motion. Moreover, as will be seen, the mathematical transformations for this acoustic theory turn out to be different from the Lorentz transformations.

It should be noted in this part that the Lorentz transformations do not do what Albert Einstein claims they do [1, 2]. "Transform a spherical wave front for an observer at rest into another spherical front for another observer with uniform relative motion". Before entering into the details related to this fact, it is advisable to fix positions. To begin to develop a topic, it is of great importance to be equipped in advance with operational definitions on the concepts to be used, that allow a precise and adequate reference when it is required. Certainly, a definition must also be established on what is to be understood by a theory of relativity [5]. What is a special relativity theory? A definition can be: A theory of special relativity is a set of knowledge, usually of speculative origin, that explains and predicts the different perceptions of each event that two observers with uniform relative motion have [5]. Under this definition, it can be ensured that the genesis of a theory of special relativity can be constituted by a set of mathematical transformations that comply with the philosophical foundations of the theory and are linear expressions that preserve the physical reality of the events (maintaining geometry and uniqueness), in addition to experimental confirmation. Also, from this definition it can be affirmed that light is only a means of communication between both observers.

The aim of this study, among other elements, is to show that: The anti-intuitive character of Albert Einstein's theory of special relativity (the constancy of the velocity of light and $c - v$ in the analysis), which from time to time appears in the body of literature on the subject [5], has its main reasoning exposed in some sections of the present paper. This will be undertaken with a basis in the development of the theory of special relativity acoustics, in which fundamental differences are established with respect to the traditional relativistic conclusions made by Einstein.

2. Space and time definition

There are several factors that generate the anti-intuitive character of Einstein's theories [6]. In a theory of relativity it is imperative to define space and time, not so much philosophically but in a somewhat operative way. In fact, some people say that Einstein's theory of special relativity is basically a description of space and time [7, 8]. Normally, in order to define an object we use some of its characteristics. This is why objects such as space and time, being so complex and incorporeal, have several definitions. For example, time can be described as: Time, opportunity, occasion, circumstance, season, environment, climate, temperature, free space, life of a person, accident of the verb that expresses the moment in which the action is performed, etc.

What is space? What is time? [7].

Many of the traditional definitions that are given for these entities can leave one with a sense of discomfort. For example:

For Aristotle (384-322 BC), time is the number of the movement according to the before or after.

René Descartes (1596-1650) related space with the extension of bodies. He argued: Space is identical to extension, but extension is linked to bodies, therefore space does not exist without bodies, hence there is no empty space.

Isaac Newton (1642-1727), in a scholium added to the Principia, has this description of time: "Absolute Truth and mathematical time, by itself, and by its own nature, flows uniformly, without relation to any external thing".

Ernst Mach (1838-1916) justifiably maintained that time in this way: "It is an abstraction which is reached through the change of things" [9].

Albert Einstein, replacing the legendary ether with the space-time, somehow denies, as does Descartes, the existence of empty space, since in an extreme case the metric tensor representing Einstein's gravitational field could have values that do not depend on the coordinates, anywhere there will be field [1, 2]. In this sense, there is no space without field (empty) for everything fills space-time. The substance of which space-time is made seems to be infinite. For Einstein, the idea of field represents the real, it represents reality. There is no free-field space.

With respect to the nature of space, there was a great controversy between Gottfried Leibniz (1646-1716) and Isaac Newton. Newton defended the absolutist conception of space: It is a three-dimensional container, in which God placed the material universe. Leibniz defended the relational concept of space: It is the totality of spatial relationships between material objects. Before there were material objects, space did not exist.

Ultimately, here we aim to simplify and to implement traditional philosophy, with respect to the objects of space and time, to a more domestic environment, which might be more in line with our understanding. Therefore, using the Cartesian approach, space and time are defined as:

Space: It is that which mediates between two different objects and in different positions.

Time: It is that which mediates between two distinct and non-simultaneous events.

Space and time are not something that can be perceived directly through our senses. One cannot hear, smell or touch space-time. It is noteworthy that the two concepts, which as entities do not belong to the three-dimensional world of what we call reality, are the basis of the differential equations that govern the time evolution of, among other things, the material bodies themselves.

3. Space and time are different entities

After these definitions of space and time, one can see a great difference between space and time. On the one hand, the existence of a universe without time can be conceived. It would be a universe with inert matter, without activity, without changes of any kind that could give rise to events. Without the existence of events, nothing changes, there are only bodies with which space can be defined, but not time. Therefore, it is possible to conceive the existence of a universe where there is space but there is no time. In this case, there would be no beings to ask questions of what is space or what is time.

Conversely, it seems impossible to conceive of a universe where there is no space but where there is time. It could be an empty universe, hence there is no space, but because there is no matter, events could not be generated that would allow the existence of time. This produces a specific differentiation between these concepts; between what is time and what is space. There can be a universe with space but without time but not the opposite, a universe with time without space cannot exist.

With regard to this argument, it is important to remember that Albert Einstein in his theory of relativity introduces space-time where the concept of what is time and what is space are precisely equal, and everything is the same thing. For Einstein, time turns out to be another spatial dimension (i.e. it has dimensions of space) [1, 2].

In more modern times, Stephen Hawking states that what is called real time always passes from the past to the future (there is an arrow of real time). He goes on to say, this establishes the only differentiation between space (which does not have this constraint) and real time [5, 10]. Hawking also introduces an imaginary concept of time [5]. Imaginary time would be conceptualised, according to Hawking, in an imaginary space-time on a sphere, where the parallels represent space and the meridians would mark the directions of imaginary time. In this representation on the sphere, the imaginary time behaves as another spatial dimension, in the sense that, we speak of circles, both for the parallel lines and for the meridians on the sphere. For example, in this case the universe is born in $\tau = 0$ imaginary time, in the North Pole as the only point. As this time passes away, there would be a displacement towards the south on the sphere. In this process, the circles of latitude, equidistant from the pole, become larger (expansion of the universe) reaching a maximum size, then they return to zero at the South Pole. In particular, this description seeks to eliminate the problem of the singularity of the universe [5].

With respect to the arrow of time, this concept is generated when we talk about the concept of time in relation to entropy (order and disorder), and we have the feeling that there is an arrow that represents time, travelling in one direction without stopping at a certain speed. Apparently, time is something that always travels from the past to the future, with some speed [5, 10]. In that case, what is the speed of time? Is there a universal speed with which time passes? Is there a speed at which the arrow of time travels? [10]. In affirming that something travels, it should be constituted by something material; it could be matter or at least energy, as with wave movements.

Recreating the reality of our environment where everyday life develops, observing with attention, there seems to be nothing that travels, but what can travel, change, transform, are the objects whose movements or states are continually being related to a pre-set "time pattern". It seems that what "transits" (changes) are the objects within a scenario where some event elapsed that is being used like a pattern, like a means of comparison. Normally, the pattern that is used turns out to be the event called the rotation of the earth on its own axis. Using a very small part, of this "something" that exists between two dawns, we define the unit of time that turns out to be the second [9].

Therefore, with respect to the sense of time, in our daily life what actually travels and moves is precisely the planet earth, although apparently, as noted by Aristotle, the sun moves around the earth. How fast is this happening? In attempting to respond to this questioning, it can be understood that the very concept of speed is very relative, since the speed of any mobile is, in fact, being compared, in a strict sense, with the rotation of the earth, which contains in some way the second concept that is established. That is, the velocity is defined as the displacement divided by the unit of time, the second.

From all of the foregoing explanation we can say that, strictly speaking, there is no intrinsic, absolute universal velocity by which time could pass. The philosophical contradiction appears in the fact that, in ourselves, as human beings, we do seem to feel as though we exist in this "passing" of time and as a counterpart space does not provide this feeling, because space usually seems to simply be there, without elapsing.

Returning to the arrow of time, a case where this idea of the arrow of time was also used, was in that argument of Stephen Hawking, where he suggested the possibility of reversing the direction of the arrow of time, when the expansion of the universe stops, once the gravity, due to the average density of the universe, would manage to stop the supposed universal expansion that was produced by the Big Bang. He proposed that, in the stopping of the expansion, the arrow of time would also stop its "movement", and at that moment it would reverse its sense and from there, events would be set back. That is to say, everything would be lived in reverse in the sense of a the frames of movie that are played backwards [5]. However, this is no longer considered as such. Hawking, at some point, without much pretence, had to admit that he was wrong to argue in this way. However, it seems that Hawking's assertion does persist, in that the conditions, in the phase of contraction of the universe, if this occurs, would not be adequate for the existence of intelligent beings. Here in this part, it means that by then the stellar fuel (hydrogen) at a universal level would have been consumed and the whole universe would be in a state of maximum entropy. In this state, it seems that life cannot be produced. For the vital processes, it is required that there is an increase of entropy, that there is an arrow of time [5]. The arrow of time would point in the direction in which the entropy must increase. If it is no longer possible to increase entropy, neither time nor life seems to have possibilities. Not only does the time arrow not reverse its sense at the end of the expansion of the universe, but according to Hawking, the arrow of time disappears [5].

In conclusion, time and space are different. There is no time arrow or anything representative to travel at any given speed. There is no speed at which time passes. The very rotation of the earth on its own axis is used as a pattern of comparison, as a clock.

4. A time that extends and another dimensioned

Just as the movement of translation of the earth around the sun and the rotation of the earth on its axis are used as patterns of comparison for any event in the everyday world, this new theory of special relativity acoustics also requires patterns of comparison. In this theory will be two concepts of time that will enter the game of comparison in order that two observers in uniform relative motion have different perceptions of events. One of these times has to do directly with the frequency of the source, in this case the sonorous (T period). The other is involved with the velocity of sound propagation (t). It will be defined according to the distance travelled by the wave front. For a spherical wave front produced at the origin, the radius of the spherical wave front will be proportional to time$^{(v_s t)}$. The constant of proportionality will be precisely the sound velocity v_s. This concept of time adheres to Einstein's conception of time multiplied by velocity as a spatial dimension [1, 2]. However, in this new theory, it will clearly differentiate between time and space.

The concepts of time (T) are more attached to the idea of Descartes, "that which mediates between two events", which has a direct relation to the notion of period or frequency, rather than to the idea of space. This concept of time is more related to the concept of rhythm, than with what could be the time that is handled in the equations that describe the state of a system. The rhythm of a clock (f frequency), as will be seen, is transformed differently, compared to the time associated with the distance while travelling the disturbance, the radius of the wave front. In fact, the two concepts of time are different, not only according to their definition, but also within this new theory will have different factors of transformation. One will have a law of quadratic transformation in the relative velocity between observers, while the other will have a law of linear transformation in the relative velocity. In Einstein's theory of relativity, two concepts of time are also handled: that associated with speed and that which has to do with the rhythm of clocks. For reasons that are not specified, at some point in the development of Einstein's theory of relativity, these two concepts of time merge into one. Of course, a single transformation law for this concept is also handled [1, 2].

5. Galileo and Lorentz transformations

What is the Doppler Effect?

The Austrian mathematician and physicist, Christian Johan Doppler (1803-1853), in 1842 published a note where he called attention to the change in the colour of objects and the change in the perception of the frequency of sound due to the relative movement between the source and the observer [12].

In 1845, the Dutch scientist Christoph Hendrik Diederik Buys Ballot (1817-1890) performed a relatively simple experiment. Using a locomotive pulling an open carriage with several trumpeters, he showed that the tone of a sound (frequency), emitted by an approaching source, seems to the observer more acute than when the source is moving away or is at rest [12].

How important is the Doppler Effect? As will be shown, this manifestation is of great importance. Precisely, the "relativity" of the perceptions that have different observers in relative movement, comes from this effect. The relativistic effects described here in this new theory of relativity have nothing to do with some mysterious or magical entity such as the dilation of time. They occur, basically due to the Doppler Effect. That is, due to the effect of the speed on perception, when the source and/or the observer move. Therefore, in a theory of special relativity, the perception of sound will be different for two observers with uniform relative motion.

The most simple and well-known example of a special relativity theory is the theory of special relativity as expounded by Galileo Galilei (1564-1642). Galileo transformations are shown in Fig. 1, where v_0 is the uniform velocity with which the observer moves relative to the observer at rest o .

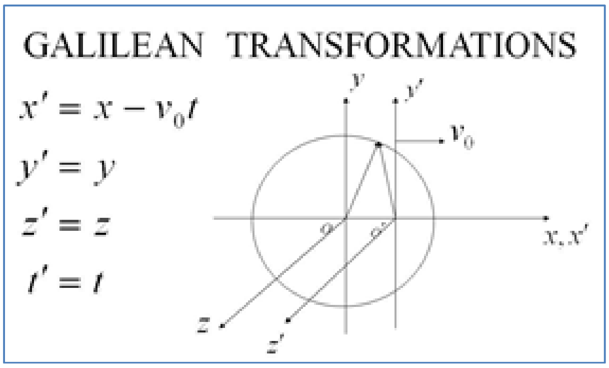

Fig 1: An observer in a reference frame with origin o is at rest. The reference frame with origin o' moves with velocity v_0 in the positive direction of the axis x with respect to the medium.

In order to simplify the exhibition, in the figures usually there will be projections on the plane xy although it is really a representation in three dimensions. In this first case studied in this work, the frame of reference that is in motion, is assigned variables with premiums, for example o', t' .

The consequences of Galileo's theory of special relativity, traditionally in textbooks, are mentioned inaccurately and incorrectly [13]. Since it is an idealised and very simple case, it is referred to as the non-relativistic case, which usually means that v_0 is much smaller than the signal propagation velocity, and therefore it is called the classical case [13]. In studying the relativity of Galileo, it should be emphasised, firstly, that it is a theory where time is absolute, equal for both observers. This has very important consequences. This fact is equivalent to affirming that the speed of propagation of the signal, with which both o y o' observers communicate, is infinite. In turn, this implies that there can be no delay in the signal that could cause some effect or variation of temporality [8], such as is produced by the Doppler Effect. This latter important conclusion about the impossibility of the Doppler Effect in this theory is not normally considered in textbooks. Not only is the argument avoided but the existence is affirmed, that is to say, a non-relativistic Doppler Effect is used, in the case of the transformations of Galileo [13].

Before going into the details of this argument, let us look at another case of special relativity theory. A more complicated example of a special relativity theory is constituted by Albert Einstein's theory of relativity [1-3, 14, 15]. In his original publication of 1905, after establishing a peculiar synchrony and also a sui generis simultaneity, Einstein first "deduced" the Lorentz transformations [1, 2, 14, 15]. This work of Einstein had no references and of course gave no credit to the Irish physicist George FitzGerald (1851-1901) or the Dutch physicist Hendrik A. Lorentz (1853-1928) who, before Einstein, tried to explain the contradictory results of the Michelson-Morley experiment [4, 10]. In their works on contraction of a body that travels by the ether, they also considered the variation in the rhythm of clocks. In addition, it can be said that Einstein would not have give credit to Lorentz and FitzGerald, since supposedly in his work, he himself deduces these coordinate transformations (Lorentz transformations) [1, 2]. The Lorentz transformations are shown in Fig. 2 [15] and, as before, v_0 is the uniform velocity with which the observer moves relative to the observer at rest o.

The Einstein hypothesis in his work of 1905 basically consists of: An electromagnetic source at rest and an observer in uniform relative motion. In $t = 0$ both, source and observer, coincide in the origin o. At that moment the source emits a pulse, whose wave front is considered spherical with radius equal to ct. The observer o' moving towards the positive direction of the x axis also perceives a spherical wave front with radius equal to ct' [1, 2].

Fig. 2 shows both perceptions. The wave front for the observer o' has been intentionally shifted in the vertical direction, as shown in the figure, in order to obtain more clarity in the description of the situation.

The Lorentz transformations shown in Fig. 2 are such that they transform the wave front

$$x^2 + y^2 + z^2 = c^2t^2 \qquad (1)$$

into the wave front given by

$$x'^2 + y'^2 + z'^2 = c^2t'^2 \qquad (2)$$

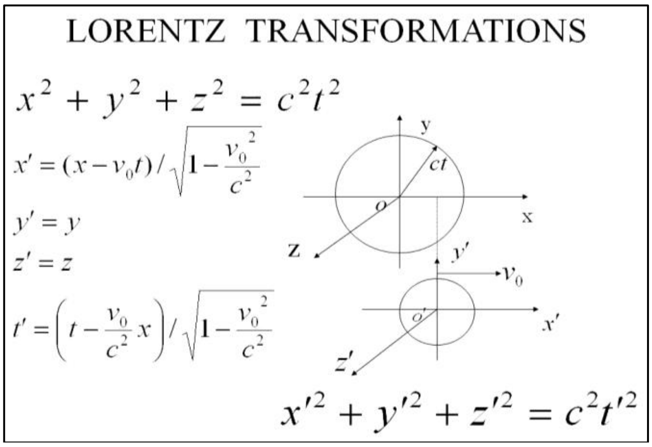

Fig 2: Lorentz transformations are said to transfigure the spherical wave front $x^2 + y^2 + z^2 = c^2t^2$ perceived by the observer at rest o, into the "spherical" wave front $x'^2 + y'^2 + z'^2 = c^2t'^2$, perceived by the observer in uniform relative motion o' (the latter is moved vertically for clarity).

Notwithstanding, the theories must comply with at least two restrictions:

a) Consistency with the experiment.

b) Consistency with its philosophical foundations.

In the philosophical and restrictive aspects that must have a theory, it is of importance to reconsider the possible postulates that are introduced in that theory.

Albert Einstein proposed two postulates in his special relativity theory [1, 2]:

- (The principle of relativity) The laws of electrodynamics and optics will be valid for all coordinate systems in which the mechanics equations govern.
- (Light velocity constancy) Light is always propagated in the empty space with a defined velocity which is independent of the state of motion of the emitter body [16].

It must be remembered that a postulate is a proposition whose truth is admitted without proof.

In an ideal situation, a theory would have no postulates. It would suffice having the underlying philosophical foundations and premises. That is, there should be no need to include postulates. The premises are propositions whose truth has already been previously proved. In any theory, introducing a new truth without evidence is the creation of a risk. The truth thus introduced might not be the truth, as such. As a point of comparison, it is sometimes said that Quantum Mechanics has a set of six postulates. It should be clarified that there is no uniqueness in this statement. However, such a large set of postulates is striking for a theory as highly praised as Quantum Mechanics [17].

One truth, already demonstrated, which is frequently used in the development of this new special acoustical relativity theory, is the commonly known theorem or principle of relative velocity [18].

Recapitulation: The genesis of a special relativity theory may well be a transformation of coordinates. A theory with fewer postulates, none if possible, would be more reliable. The experimental result is very important, even with the best of theories.

6. How come Lorentz transformations do not do what Albert Einstein says they do?

Returning to the original work of 1905, Einstein's thesis is that the transformations he deduces, which turn out to be the Lorentz transformations, transform a spherical wave front $x^2 + y^2 + z^2 = c^2t^2$ for the observer at rest into another spherical front $x'^2 + y'^2 + z'^2 = c^2t'^2$ for the observer in uniform relative motion [1, 2, 14, 19, 20]. In Albert Einstein's words: "Thus, our wave is also a spherical wave with velocity of propagation c when observed in the moving system" [1, 2, 16]. To some extent this statement by Einstein [1, 2, 19, 20] is explicable. On the face of it, the algebraic expression $x'^2 + y'^2 + z'^2 = c^2t'^2$ seems to be the equation of a sphere. In a way, it is hard to realise that this expression is not a spherical wave front; instead, it is an ellipsoid of revolution because the expression for t' in Lorentz transformations depends on the x coordinate. When taking points on the spherical wave front $x^2 + y^2 + z^2 = c^2t^2$ with different x values, t' will also be different and this has the consequence that in a sphere, if the radius is varied in a certain way, a revolution ellipsoid can be obtained. Thus, the Lorentz transformations do not transfigure a spherical wave front into another spherical wave front as Einstein stated [1, 2, 19, 20]. Actually, the transformations of Lorentz transform the spherical front into an ellipsoid of revolution and this implies that the speed of light, according to the Lorentz transformations, is not a constant [16]. For the o' observer, the signal advances faster in the direction $-x'$ than in the directions x' and y'. How can one see this?

The wave front represented in equation (1) under the transformations of Lorentz is transfigured into... let us see in what:
For this exercise, as might be otherwise, it is proposed that the relative velocity be

$$v_0 = 0.8660254 \quad c \tag{3}$$

From Fig. 2, with $c = 1$ the Lorentz transformations are

$$x' = 2\left(x - 0.8660254 \quad t\right) \tag{4}$$

$$y' = y \tag{5}$$

$$z' = z \tag{6}$$

$$t' = 2\left(t - 0.8660254 \quad x\right) \tag{7}$$

This transformation is then applied to several points on the spherical wave front in the coordinate system a rest, so that for $t = 1$

$$x^2 + y^2 + z^2 = 1 \tag{8}$$

Such points on the wave front for the observer o are shown in Fig. 3a. For point 1

$$(x, y, z) = (1, 0, 0), \; t = 1 \tag{9}$$

Under Lorentz transformations, it becomes point $1'$ in Fig. 3b with coordinates

$$(x', y', z') = (0.2679492, 0, 0), \; t' = 0.2679492 \tag{10}$$

The points, 2, 3, 4 and 5, on the plane $y\,z$ have coordinates

$$(x, y, z) = (0, \pm 0.7071067, \pm 0.7071067), \; t = 1 \tag{11}$$

They are transformed into points, $2'$, $3'$, $4'$, and $5'$ with coordinates

$$(x', y', z') = (-1.7320508, \pm 0.7071067, \pm 0.7071067),$$

$$t' = 2 \tag{12}$$

Finally, the point 6

$$(x, y, z) = (-1, 0, 0), \; t = 1 \tag{13}$$

It becomes the point $6'$ with coordinates

$$(x', y', z') = (-3.7320508, 0, 0), \; t' = 3.7320508 \tag{14}$$

All these points with their respective images are shown in Fig. 3. It is clear that the intermediate positions at these points, if considered, would complete the image of a centred quadric surface, which is definitely not a sphere. As can be seen in Fig. 3, the Lorentz transformations acting on an electromagnetic wave front, whose geometry is spherical according to an observer at rest, do not transform this spherical wavefront into another spherical front, but rather into an ellipsoid of revolution, Fig. $3b$) [1, 2, 19, 20].

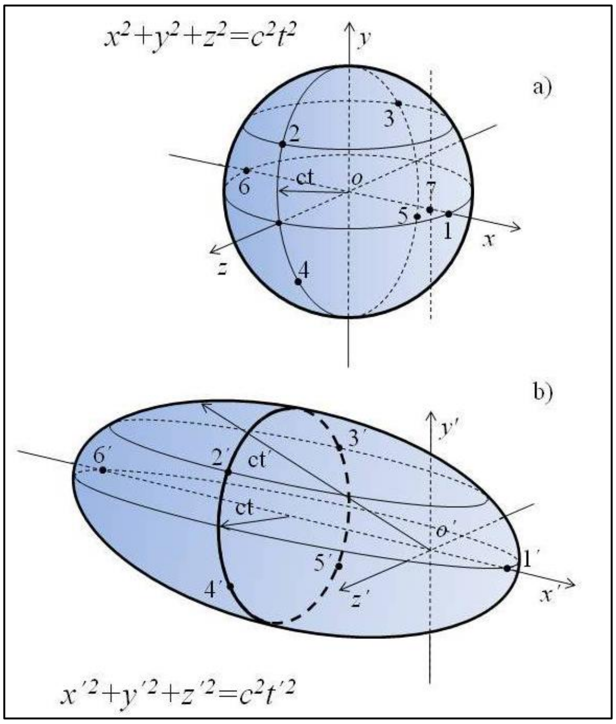

Fig 3: Lorentz transformations turn the spherical wave front shown in a) into an ellipsoidal wave front. Some image points $1' - 6'$ produced by the transformation are exhibited in b).

With this exercise, it is shown that according to the uniform relative moving o' observer, the propagation velocity of the wave front is not the same in all directions: It is larger backwards, according to its perspective [16]. This proves that the Lorentz transformations do not do what Einstein says they do: To transform a spherical wave front into another spherical wave front for the o' observer and preserve the constancy of the velocity of light [1, 2, 14, 16, 19, 20].
It can be concluded that a new set of mathematical transformations for a theory of special relativity acoustics is required, which does transform a spherical wave front into another spherical wave front.

7. The new coordinate transformations, case A

The case of an observer o' moving away from a sound source at rest, with uniform velocity v_0.
Source: Always will be a sound source, something that emits pulses of its own or by some reflection effect. It could be the ticking of a clock or the regular beating of a human heart.
In $t = 0$, it is assumed that the observer o', moving with uniform velocity towards the positive direction of the $x's$ axis, coincides at the origin with another observer o at rest next to the source. At that instant, the source emits a pulse with a spherical wave front. The observer o perceives that spherical wave front as centred on the origin, with radius $v_s t$. Here, v_s is the speed of sound.

Note: Only cases with $v_s > v_0$ will be considered, otherwise, physically there would be no communication between the observers with uniform relative movement. In a way, this is equivalent to saying that there is no mobile that is faster than the speed of light.
Once the first pulse is produced, the spherical wave front, for the observer at rest, is represented by equation (1).

It is now necessary to establish, firstly, the transformation of coordinates that allows to determine what form has the wave front that is perceived by the observer in uniform motion o'.
It is intended that the procedure be systematic, that is, an algebraic form is proposed for the transformation of coordinates, then the aim is to make it operative, according to the theorem of relative speed, for both observers. In Fig. 4, a proposal for the transformation of coordinates and a representation of a pulse emitted by the source in $t = 0$, whose equation is precisely the expression $x^2 + y^2 + z^2 = c^2 t^2$, are exhibited. The vertical axis, on which the points indicated on the wave front are determined, is at the distance $x = v_0 t$ in Fig. 4.

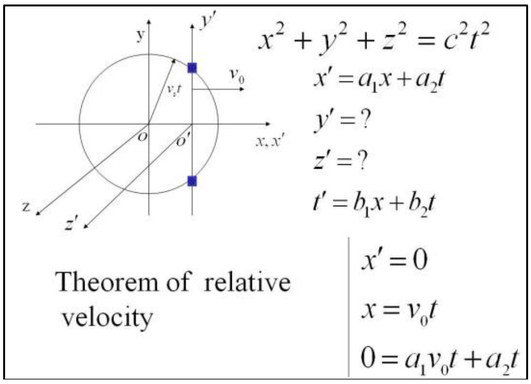

Fig 4: The pulse emitted by the source at $t = 0$ and the proposed coordinate transformation that transforms this spherical wave front into another spherical front, perceived by the moving observer, are shown. The parameters to be determined are: a_1, a_2, b_1 and b_2.

In this theory of special relativity acoustics, we mainly use a theorem that has the function of normalising the analysis and the demonstration in each case, namely, the principle or theorem of relative velocity [18]: If an observer o perceives that another observer o' is moving away with speed $\bar{v} = v_0 \hat{i}$, then it turns out that for the observer o', it is the observer o that moves away with speed $\bar{v}' = -v_0 \hat{i}'$ [18]. This theorem states that

$$\bar{v} = -\bar{v}' \tag{15}$$

Therefore, in a properly chosen Cartesian system, one has that

$$\hat{i}' = \hat{i}$$

The fundamental question at this stage is: How does the observer o' perceive this wave front of Fig. 4, which the observer o perceives in spherical form? The answer will be provided precisely by the coordinate transformation to be established. A procedure to obtain the corresponding coordinate transformation consists of proposing the respective expressions for the variables, as shown in Fig. 4. In this figure, the contributions to x' from x and t have coefficients a_1 and a_2, respectively. The same can be seen for t', for which contributions are characterised by the coefficients b_1 and b_2. The proposed expressions are linear in character, since homogeneity properties are attributed to space and time. Nor is an independent (constant) term included, since there is a coincidence in $t = 0$ of both observers. The expressions for y' and z' are intentionally postponed since there will be unexpected expressions, according to the conditioning, that we have previously received in our academic preparation.
Now, aim to find the values that must have the mentioned coefficients, so that this transformation reproduces the perception of the observer o', that is to say, those values corresponding to a_1, a_2, b_1 and b_2 that are in agreement with the philosophy, and are as much of the principle of relative speed as of the approach to the problem itself.
In Fig. 4, the points on the spherical wave front of radius $v_s t$, in the first place, are highlighted on the vertical axis passing through o'. On the one hand, these points are characterised by having x' coordinate equal to zero. On the other hand, they also have the characteristic that their x coordinate is the distance that separates o and o' and at the time t, according to the observer o. Therefore, for these points $x = v_0 t$.
Substituting these conditions, as shown in Fig. 4, we obtain that

$$0 = a_1 v_0 t + a_2 t$$

So

$$a_2 = -a_1 v_0 \tag{16}$$

With this expression for a_2 substituted in x' and t', the transformation with three parameters to be determined, is now expressed as.

$$x' = a_1 (x - v_0 t)$$
$$t' = b_1 x + b_2 t \tag{17}$$

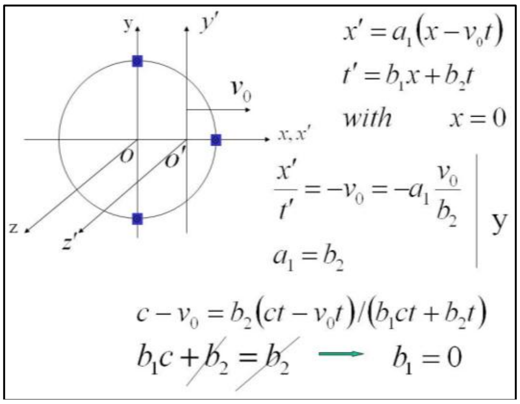

Fig 5: The pulse emitted by the source at $t = 0$ and the transformation, is now exhibited in terms of only three parameters. The points on the wave front, marked on the vertical axis passing through o, have coordinate $x = 0$.

In Fig. 5, the new expressions for x' and t' are shown.
Using the proposed theorem [18], according to o', these points on the vertical axis passing through the origin o move away from it in the direction of the x axis with a velocity $-v_0$; therefore, the quotient x'/t' denoting the

x' component of the velocity with which these points move, according to o', turns out to be

$$x'/t' = -v_0 = -a_1 v_0 / b_2 \quad (18)$$

Where we have taken the quotient of expressions (17) for $x = 0$.

From equation (18) we obtain that

$$a_1 = b_2 \quad (19)$$

In the same Fig. 5, it can be seen on the wave front that the point (x, o, o) moves away from o with speed v_s, but for the observer o' this same point moves away from it more slowly, that is, with speed $v_s - v_0$.

Therefore, since the x coordinate for this point is $x = v_s t$, the quotient x'/t' now turns out to be

$$x'/t' = v_s - v_0 = b_2(v_s t - v_0 t)/(b_1 v_s t + b_2 t) \quad (20)$$

In this expression (20), cancelling t, the quotient of the right limb and $v_s - v_0$ in both limbs, one has

$$b_1 v_s + b_2 = b_2 \quad (21)$$

and from this it is concluded that

$$b_1 = 0 \quad (22)$$

Now, in the upper right part in Fig. 6, the transformation of coordinates in terms of only the b_2 parameter is presented.

And, we are looking for the expressions for y' and z'.

For this purpose, the aforementioned theorem or principle as applied, for example, to the highlighted point on the upper part of Fig. 6 [18] is used. It can be seen that the relative velocity of o' with respect to this point, measured by o is

$$\bar{v}_{p-o'} = v_0 \hat{i} - v_s \hat{j} \quad (23)$$

where $\hat{i}$ and $\hat{j}$ are unit vectors in the x and y directions, respectively.

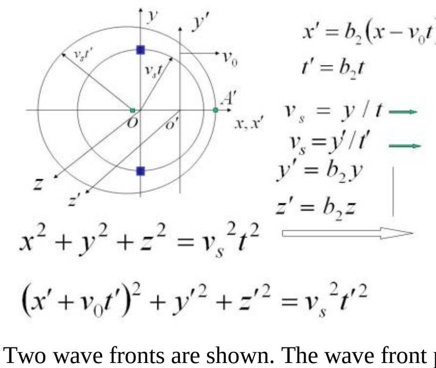

Fig 6: Two wave fronts are shown. The wave front perceived by the observer o appears with radius $v_s t$ and the spherical wave front perceived by o' with radius $v_s t'$. Expressions of the transformation proposed for x', t', y', z' and the equations of both perceptions are exhibited.

The velocity of o' with respect to the indicated point in the upper part of Fig. 6, according to the aforementioned theorem [18], must be equal to minus the speed of the point indicated with respect to o'. Noting that, from the other point of view, the speed of the indicated point, measured by o' is

$$\bar{v}'_p = -v_0 \hat{i} + v_s \hat{j} \quad (24)$$

It can, therefore, be assumed that, according to o, for the point in question, the component of the velocity in the $\hat{j}$ direction is

$$v_s = y/t \quad (25)$$

and in the perception of o', according to equations (23) and (24), we have that the velocity component y' is exactly the same, i.e.

$$v_s = y'/t' = b_2 y/(b_2 t) \quad (26)$$

Likewise, we can establish the corresponding velocity component, with an entirely similar reasoning, for the z component. For all of this, the coordinate transformation at is sought is then

$$x' = b_2(x - v_0 t)$$
$$y' = b_2 y$$
$$z' = b_2 z$$
$$t' = b_2 t \quad (27)$$

With this coordinate transformation (27) substituted in the expression for the spherical wave front (1), this wave front perceived by the observer o

$x^2 + y^2 + z^2 = v_s^2 t^2$ is transfigured into

$$(x' + v_0 t')^2 + y'^2 + z'^2 = v_s^2 t'^2 \quad (28)$$

This equation represents a sphere with its centre displaced by the distance $v_0 t'$ to the left of o'.

Note that the centre of this spherical wave front of equation (28) is neither the origin o nor the origin o', unlike Einstein's conception of the wave front that is centred on the origin. As will be seen, this distance turns out to be greater than $v_0 t$. In addition, since the velocity of the wave front point A' for the observer o' is $v_s - v_0$, the time t' must be greater than t. Therefore, the coefficient b_2 must be greater than 1. It should be precisely the quotient of the velocities perceived by both observers, since in that proportion t' will be greater than t. So

$$b_2 = v_s/(v_s - v_0) \quad (29)$$

In Fig. 6, among other things, is shown the difference in the perception that both observers have with respect to the speed of propagation of the acoustic signal. For the observer o, the sound wave propagates with speed v_s in all directions, including the point corresponding to A'. Whereas, for the observer o', the various points of the wave front have different speeds of propagation. This is only a part of his perception. The propagation speed is the same v_s with respect to the centre of the wave front that is located to the left of o'. For example, the A' point, on the x axis, according to o' the speed at which that point is displaced is $v_s - v_0$.

Then, the coordinate transformation that reproduces the image that o' perceives, from the perception of o, can finally be written as

$$x' = \frac{v_s}{v_s - v_0}(x - v_0 t)$$
$$y' = \frac{v_s}{v_s - v_0} y$$
$$z' = \frac{v_s}{v_s - v_0} z$$
$$t' = \frac{v_s}{v_s - v_0} t \qquad (30)$$

An important point that has already been noted, is that both t and t' are represented by the radii of the wave fronts perceived by o and o' respectively. This turns out to be variables that, in principle, are non-bounded, unlike the period of a source, the ticking of a clock or the beating of a heart, which are bounded, and they are well-defined time intervals, given the characteristics of the source, that are determined.

One consequence that can be immediately anticipated, from expressions (29) and (30), is that t' must be greater than t. In other words, propagation of the wave front, to the observer o' in uniform motion, seems to be delayed, for it takes longer to move, as shown in Fig. 6.

It follows that when it is a time interval between two events, in this case the period, the law of transformation for that interval differs from the fourth expression of equations (30).

8. Doppler Effect in case A

Next, the Doppler Effect is studied, in the development of this first case of resting source and moving observer.

A second pulse emitted by the source; the observer o' will also see it takes longer to advance, with respect to the perception of observer o. This is because the observer physically moves away with a speed v_0. As the second pulse travels, the moving observer will be at a distance, which at the second pulse will take some additional time to travel, see Fig. 7.

According this circumstance, any rhythm, for example, the beating of a heart, to the observer o' will seem slower, more leisurely.

In Fig. 7, two wave fronts centred on the origin o are shown. The largest radius $v_s t$ represents the first pulse emitted at $t = 0$. The smaller radio wave front represents the second pulse emitted at $t = T$, where T is the period of the source, according to the perception of observer o. The time value t shown in the figure is the time t_a at which the wave front reaches observer o'.

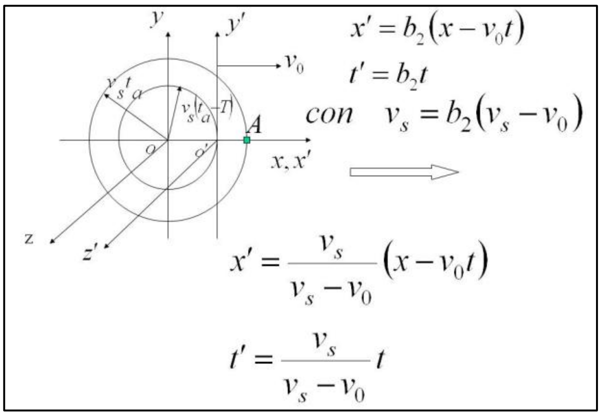

Fig 7: Two consecutive pulses emitted by the source at the time $t = t_a$ are shown. The first emitted in $t = 0$ and the second at $t = T$. Part of the coordinate transformation, and the relationship between the velocity of the wave front perceived by o and that perceived by o', are also shown.

That is, according to the o observer, after the second pulse is emitted, some time elapses for that second pulse to reach the observer who is moving away from the source at uniform velocity v_0.

Thus, in the reference frame of the observer o, the time taken travelling the second pulse $t_a - T$ allows the corresponding wave front to travel the distance

$$v_s(t_a - T) = v_0 t_a \qquad (31)$$

The distance travelled by the second pulse, is equal to the distance travelled by the observer o' $(v_0 t_a)$ since the coincidence of both observers is in the origin up to the moment of the encounter. From this last expression (31) we obtain that

$$t_a = v_s T / (v_s - v_0) \qquad (32)$$

However, to determine the encounter time according o', the expression (32) must be multiplied by b_2, this is due to the fourth expression of (30), i.e.

$$t'_a = T' = \left(\frac{v_s}{v_s - v_0} \right)^2 T \qquad (33)$$

In this expression, t'_a represents the value of t' at the moment the wave front makes contact with observer o' and, of course, it must be the period T' of the source according to

the perception of observer o'. In the transformation (33), the source period perceived by a moving observer, it can be seen that this is another law of transformation, different from that of the fourth expression of the system (30). The rhythm of a clock or the interval of time between the beats of a heart, turn out to be another concept of time that is very different to the time that defines the equations of the transformation of coordinates.
Now, we find the expressions for the transformation of frequencies that both observers perceive. Taking the reciprocal in both members of the expression (33), we have

$$f' = \left(\frac{v_s - v_0}{v_s} \right)^2 f \tag{34}$$

In this equation f and f' denote the frequencies, perceived by o and o', respectively.
This result indicates that whenever an observer moves away from a sound source at rest, the frequency he perceives is smaller than that which he appreciates when he is also at rest.
The traditional Doppler factor in textbooks is written with the bracket to the first power, i.e. [21].

$$f' = \left(\frac{v_s - v_0}{v_s} \right) f \tag{35}$$

Here, the frequency has been calculated using the speed of sound instead of according to the known manner, with the speed of light. From this expression, we can see that in the traditional development of the study that is undertaken on the Doppler Effect, differentiation between the two concepts of time, that has previously been established, does not appear.
Therefore, this new theory of special relativity acoustics predicts an important modification to the previous Doppler factor.
In Fig. 8, are the graphs for the Doppler Factors corresponding to both versions, the traditional graph and the other graph that predicts this new theory. The difference in the figure is important.

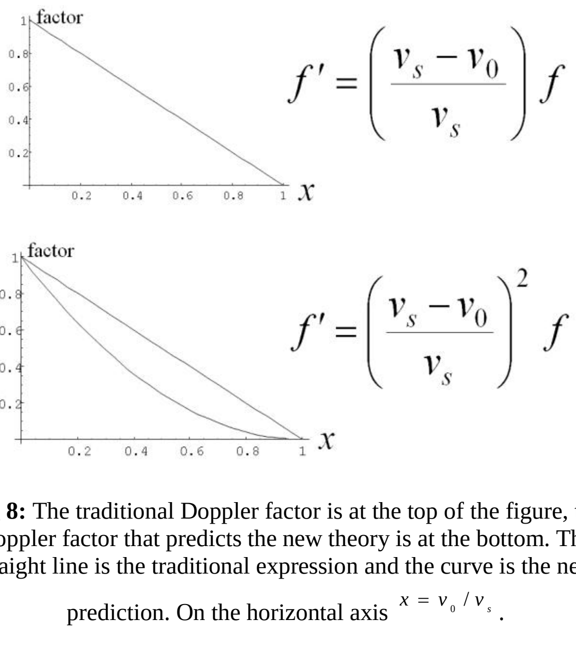

Fig 8: The traditional Doppler factor is at the top of the figure, the Doppler factor that predicts the new theory is at the bottom. The straight line is the traditional expression and the curve is the new prediction. On the horizontal axis $x = v_0 / v_s$.

9. The new coordinate transformations, case B
The case of a sound source (v_f) and observer (v_0), both in uniform relative motion with $(v_f > v_0)$.
In this case, how does the perception of both observers change?
Emission centres "Sowed": When the sound source moving with velocity v_f emits a pulse at the point of emission, wherever it is, the disturbance is planted and propagated by the medium with a velocity that is independent of the speed of the source.
The second case to be studied consists of three observers: an observer o that is supposed to be at rest with respect to the medium, another observer o_f next to a sound source with uniform relative motion with velocity v_f, and a third observer o_0 that is also in uniform relative motion with velocity v_0. Both, v_f and v_0, are measured with respect to the medium. Note that subscripts are now used for moving systems. The scenario description is as follows:
In $t = 0$, it is assumed that the observer o_f, along with the moving sound source, coincides at the origin with the other two observers o and o_0. Both observers o_f and o_0 are moving in the positive direction of the x axis of the reference frame at rest, in which the origin assumes the presence of the observer o. At the point of coincidence of the three observers the source emits a pulse. This pulse, according to the resting observer, generates a spherical wave front. The observer o perceives that spherical wave front centred on the origin with radius $v_s t$. Here, as before, v_s is the speed of sound, it is the signal velocity.
Again, one can physically have the condition $v_f > v_s$. In this case, the so-called shock waves would occur. However, here also, only the situations with the condition $v_s > v_f > v_0$ are considered.
Now, in order to systematise the explanation, the idea of a third observer has been introduced. As already explained, there are now two observers in motion and the third is at rest with respect to the medium.
The fact of having the sound source which now has its own motion could raise concern about the following questions.
Does the uniform movement of the source affect the propagation of the signal?
How fast does the wave front propagate, now that the source is in motion?
It can be seen that Albert Einstein included in one of his two postulates the argument that the velocity of the emitter has no effect on the propagation velocity of the electromagnetic waves [1, 2].
Here in this new theory, it is not necessary to include such a postulate. It is a well-known fact that the propagation of sound, particularly its velocity, does not depend on the velocity of the emitter. In this way, it responds to the previous questioning and it will be possible to see in the development of the new theory that this fact does have implications. It does affect the predictions of the new theory, in comparison with those that result from the constancy of the speed of light in Einstein's theory.

In a way, it can be seen that the source, when moving with uniform speed v_f, produces the impression that it is "sowing" the emitting centres, in different places. From each of these places, propagation begins properly. If the frequency of planting is constant, these emitting centres are "planted", separated by a fixed distance. All of these factors are typical of wave movements.

Using the above results, once the source emits a pulse on, the first emitted pulse is "seeded" at the origin, therefore the emitted wave front, for the observer, at rest with respect to the medium, turns out to be

$$x^2 + y^2 + z^2 = v_s^2 t^2 \tag{36}$$

For equation (36), it should be kept in mind that the variables without index (x, y, z, t) are in the reference frame at rest with respect to the medium.

To take account of the movement of the source, it is necessary to focus on the second pulse emitted by the moving source at $t = t_2$, see Fig. 9.

The equation of the second pulse as observed by o is shown in the upper right-hand part of Fig. 9:

$$(x - v_f t_2)^2 + y^2 + z^2 = v_s^2 (t - t_2)^2 \tag{37}$$

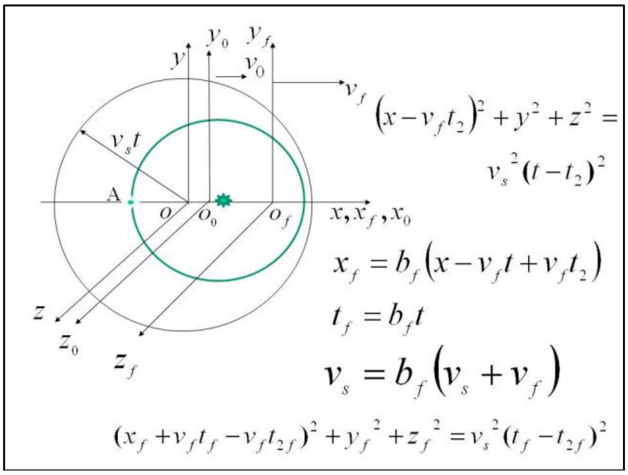

Fig 9: The first pulse emitted at $t = 0$, seeded at the origin o with radius $v_s t$ and the second pulse emitted at $t = t_2$, seeded at the point marked with an asterisk, are both shown. On the right side the equation of the second pulse as perceived by the observer o and part of the coordinate transformation that transfigures that perception in the wave front that perceives o_f, whose equation is shown in the lower part, are exhibited.

The observer's perception o_f is based on the wave front (37). In this perception, the moving observer o_0 has no influence. He is just another observer.

With the procedure established in the case A, with relative ease, one can find the most important part of the transformation that transfigures the perception of o to obtain the perception of o_f:

$$x_f = b_f(x + v_f t_2 - v_f t)$$
$$t_f = b_f t \tag{38}$$

From this last expression, x is obtained that is replaced in equation (37) to obtain the perception of o_f, the observer that travels along with the source:

$$(x_f - v_f t_{2f} + v_f t_f)^2 + y_f^2 + z_f^2 = v_s^2 (t_f - t_{2f})^2 \tag{39}$$

This is the equation of a sphere centred on the point marked with an asterisk, shifted to the left of o_f in Fig. 9.

The speed of the wave front for the observer at rest o is v_s and for the observer who travels with the source, the farthest part perceived by o, travels away with velocity $v_s + v_f$. For this reason, the signal will take less time to travel and t_f should be smaller than t. So,

$$b_f = \frac{v_s}{v_s + v_f} \tag{40}$$

Now, to obtain the perception of the observer o_0, from the second pulse emitted by the source, also in movement with respect to the medium, we consider the same mechanics followed here. The main part of the transformation is written as

$$x_0 = b_0(x + v_f t_2 - v_0 t)$$
$$t_0 = b_0 t \tag{41}$$

In these expressions, the subscript coordinates (x_0, y_0, z_0, t_0) are in the frame of reference of the observer in motion with respect to the medium o_0.

Of this latter expression (41), x is cleared and replaced in equation (37). The wave front equation perceived by the moving observer o_0 turns out to be

$$(x_0 - v_f t_{02} + v_0 t_0)^2 + y_0^2 + z_0^2 = v_s^2 (t_0 - t_{02})^2 \tag{42}$$

This expression is the equation of a sphere with its centre shifted to the right of the observer o_0, marked with an asterisk in Fig. 9.

Now, the speed perceived by the observer o_0 from the part of the wave front that is directed towards him is $v_s + v_0$. Therefore, the time t_0 in equations (41) must be smaller than t, i.e.

$$b_0 = \frac{v_s}{v_s + v_0} \tag{43}$$

Note that equation (40) and (43) are not equal, in this case $b_0 > b_f$.

Now, the coordinate transformation that transfigures the perception of observer o_0 into the perception of observer o_f is to be found. In other words, we aim to find the formula that transforms equation (42) into equation (39). With relative ease, one can see that the transformation is written as

$$\begin{aligned} x_f &= b_{0f}\left(x_0 + v_f t_{02} - v_f t_0\right) \\ t_f &= b_{0f} t_0 \end{aligned} \tag{44}$$

Finding out x_0 from equation (44) and substituting in equation (42), the perception of the observer o_f, equation (39) is found. The observer o_f perceives that the part of the wave front closest to the observer o_0 travels to meet this observer at a greater speed $v_s + v_f$ than what observer o_0 perceives; therefore the time t_f must be smaller than t_0, then

$$b_{0f} = \frac{v_s + v_0}{v_s + v_f} \tag{45}$$

One way to verify equation (45) is to replace it in equation (44) and then substitute t_0 from equation (41). The result is equation (38) which partially checks the procedure.

10. Doppler Effect, case B

Next, we aim to study the Doppler Effect, in this case of observer and sound source, both in relative uniform motion with respect to the medium.

In Fig. 10, the image of Fig. 9 for an earlier time, i.e. for $t = t_e$ is shown, when the encounter of the second wave front with the moving observer o_0 occurs.

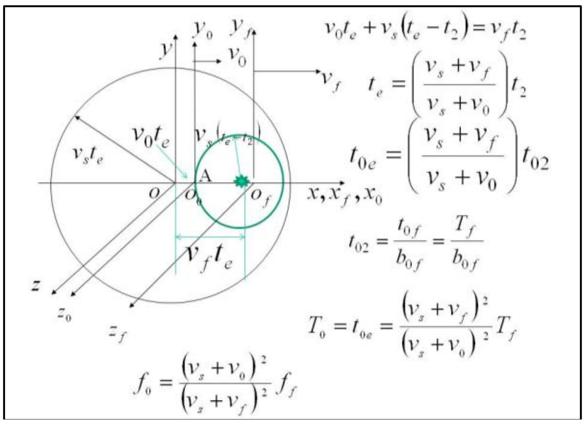

Fig 10: The first pulse emitted in $t = 0$, with radius $v_s t_e$ is shown. In $t = t_2$ the second pulse of Fig. 9 is emitted, when the source was at the point marked with an asterisk. Both wave fronts for the moment the second front meets the observer o_0 are also exhibited.

Now, the next important event in this analysis is studied. The moment $t = t_e$ that the second pulse, emitted in $t = t_2$, encounters the observer o_0, also in motion.

According to Fig. 10, for the observer o at rest, the distance the second pulse is travelling is $v_s(t_e - t_2)$. For this observer, the time t_e determines the moment in which the second pulse is brought into contact with the moving observer o_0. Consequently, this distance must be such, that added to the advance of the observer o_0, must equal the distance that the source has shifted until the moment of the emission of the second pulse. That is to say

$$v_0 t_e + v_s\left(t_e - t_2\right) = v_f t_2 \tag{46}$$

From expression (46) we obtain

$$t_e = \frac{v_s + v_f}{v_s + v_0} t_2 \tag{47}$$

Factoring equation (47) by b_0 from equation (43), we obtain the relation between these times as perceived by the observer o_0

$$T_0 = t_{0e} = \frac{v_s + v_f}{v_s + v_0} t_{02} \tag{48}$$

In this expression appears T_0, which is the true period of the source perceived by the observer o_0. Making it clear, the observer at rest o, perceives that in time $t = t_2$ the source emits the second pulse. This time, for him is the period of the source. Applying the transformation to t_2 to find the perception of the observer o_0 gives the time t_{02} that appears in equation (48).

Why is this time not the period of the source that perceives o_0? The answer is that until a later time t_{0e} this observer encounters the pulse. Therefore, this time t_{0e} is the true period of the source he perceives. In this case, the sowing of the pulse is not at the origin o_0 but at a distance marked with the asterisk in Figs. 9 and 10. This distance causes the coincidence of the observer to be lost with the seeding point of the second pulse, which employs a certain time to meet the observer o_0 in the same frame of reference. The observer o_f who travels along with the source, perceives the period T_f of the source as if both were at rest.

Hence from equations (38) and (44)

$$t_{2f} = T_f = b_{0f} t_{02} \tag{49}$$

Then equation (48) is written as

$$T_0 = t_{0e} = \frac{v_s + v_f}{v_s + v_0} \frac{T_f}{b_{0f}} \tag{50}$$

Replacing b_{0f} from equation (45)

$$T_0 = t_{0e} = \frac{(v_s + v_f)^2}{(v_s + v_0)^2} T_f \tag{51}$$

This expression indicates that the own period of the source, now in movement, seen by another observer also in movement, is perceived very differently.

According to the initial condition for this case $(v_f > v_0)$, it can be seen that the period T_0 of the source according to the moving observer o_0 seems to be greater than T_f, the period of the source. On the other hand, the expression (47), for $v_f = 0$, is not reduced to the first case A because now the moving observer encounters the signal from the opposite side.

Taking the reciprocals of both members of equation (51), we obtain that the corresponding frequencies are also related in a more complex way, that is to say

$$f_0 = \frac{(v_s + v_0)^2}{(v_s + v_f)^2} f_f \tag{52}$$

The Doppler factor shown here, corresponding to the case of both observer and source in motion, indicates that the frequency perceived by the observer o_0, in this case $v_f > v_0$ is smaller than the frequency that he would appreciate by being next to the source, both at rest with respect to the medium.

It should be noted here that according to these expressions, in the extreme case of both observer and source in uniform motion with respect to the medium with $v_f \approx v_0$, that is, when the relative movement between source and observer o_0 tends to zero, the frequency perceived by the observer o_0 tends also to be the frequency that would he would perceive if both were at rest with respect to the means.

In Fig. 11, the graph for the Doppler factor equation (52), when $v_f = 2v_0$, is shown. The Doppler factor, according to the curve shown, indicates that the frequency of emission of pulses f_0, seems smaller to the moving observer, when compared to the frequency of the source. In Fig. 11, the corresponding value on the axis of the abscissa is $x = v_0 / v_s$.

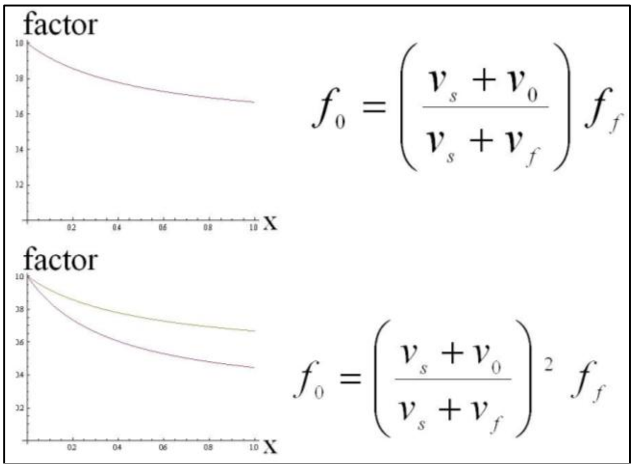

Fig 11: The curves for the traditional and the new Doppler factor for the case where $v_f = 2v_0$ are shown. The lower graphs represent the traditional Doppler factor. Below that is a prediction from the new theory with the same analytical expression, but squared.

11. Conclusions

On Einstein's conception: "An electromagnetic source at rest and an observer in uniform relative motion; both, source and observer coincide in the origin at $t = 0$. At that moment the source emits a pulse, whose wave front is considered spherical with radius equal to ct. The observer o' moving towards the positive direction of the x axis also perceives a spherical wave front with radius equal to ct'". According to equation (2), this wave front would be centred at the origin. This description implies that the moving observer can capture the physical phenomenon and carry it with him. Physically, this cannot be so. The motion of the observer causes the wave front to lag behind him, and in the end his particular perception is a spherical one that is displaced backward, with its centre slightly to the left of the coordinate origin o', as shown Fig. 6.

On the constancy of the speed of light: In the theory of the special relativity of Albert Einstein, the Lorentz symmetry is a fundamental part. As can be shown with relative ease, the Lorentz invariant is violated. Somehow, it would be assumed that the perception of an observer at rest would be reproduced, through the Lorentz transformations, as the perception of another observer in uniform relative motion. It is not that the Lorentz transformations are really incorrect but, they do not do what Einstein says they do: Transform a spherical wave front that perceives the observer at rest into another spherical wave front for the observer in uniform relative motion. The uniform moving observer does not perceive a spherical wave front. This result is a difficult conclusion: With the Lorentz transformations, the speed of light is not the same for both observers. For one of the observers, the speed of light is not equal in all directions, as shown with the ellipsoid in Fig. 3. This certainly has tragic consequences for Einstein's theory of special relativity.

Sound: An observer moving away from sound sources or reflecting bodies, which are at rest with respect to the medium; will observe that this universe is functioning at a slower pace than his heart. He will notice that everything happens with delay and the greater its uniform speed with respect to the medium, the greater this delay effect will be.

In other words, hearts at rest will seem lazy to this moving observer, compared to their own heart. As previously explained, these phenomena are a direct consequence of the Doppler effect and it can be affirmed that this differentiated perception of time, so far, does not involve any anything mysterious or hidden. None of these effects will be permanent, for as soon as the moving observer stops the rhythm of the two hearts will now be identical. Not only that, once recovered, the two hearts will have to differentiate in other things to these perceptions. These differences, if existing from the beginning, are permanent, and apparently there would only be an effect of perception, when any of the two hearts move. What could be reality is maintained, the effect of the movement seems to generate only a particular perception, and it would be a matter of approaches to this perception.

The quadratic Doppler factor: Among the unexpected consequences of this new acoustic theory, the so-called Doppler factor, which normalises the relation between the frequencies perceived by observers with uniform relative motion and, in general, movement with respect to the medium; in this new theory, it is found that there are also differences between the pre-established Doppler factors and those obtained with these new formulations. This will undoubtedly have consequences when using the Doppler Effect, for example in medicine, underwater activities, cosmological calculations and many other applications in different fields of knowledge. Probably, these differences found with respect to traditional knowledge have not previously been detected because, reasonably, the relative movements are produced at a very low speed for the source and the observer in movement. Notwithstanding, the corresponding experiments would have to be carried out to verify, according to the Scientific Method, the different formulations established in this new theory.

On the transformation of coordinates: As was observed, during the development of the different formulations, in each of the cases, the transformation of coordinates turns out to be a mathematical function whose domain is the set of points on a spherical wave front. Otherwise, any form other than spherical would be involving phenomena of anisotropy and inhomogeneity of space and time, which should be particularly noted. The coordinate transformation is a function that maps a spherical wave front onto another spherical wave front. Therefore, applying this function to arbitrary points in space may not give congruent results. It should be remembered that the points which are subject to the transformation have a temporal coordinate that is intimately linked to the radius of the wave front. A point inside the wave front would somehow imply the past, just as a point on the outside of the wave front would be related to the future (a longer time). What would be the meaning of a point with coordinates $(x, y, z, t) = (0,0,0, t \neq 0)$, transformed into the point $(0,0,0, b_2 t)$, and would it make any sense? This point and its transfiguration do not satisfy the equations for the wave fronts perceived by the observers: In relation to this argument, it must be remembered that the transformation in each treated case in the new theory was precisely obtained from the fact that it transforms a spherical wave front, normalised by the principle of relative velocity. It was found that this front becomes another spherical wave front. Therefore, it can be considered that if a point does not or may not belong to a wave front, then it is very likely to be outside the coordinate transformation. It is also very important to note that the mathematical expression of the transformation transfigures times linked to the radius of the wave front and not to the periods.

A relativistic effect, with respect to simultaneity: It was commented previously, with respect to simultaneity, that the position of the observer in the same frame of reference is important, whether it is in motion or not. According to the position of the sound source, which could be the aforementioned trumpeters on a discovered mobile platform, the position of the observer who is also in motion is determinant. If the observer is moving in the back of the platform, some distance backward, he will ideally experience a larger frequency than that perceived by the observer in the front of the platform. The fact is that the wave fronts, planted by the trumpeters, propagating through the air try to reach the front observer (small frequency), while the backward observer who is close to wave fronts receives a greater velocity (larger frequency). In other words, even though the source and the observer do not have relative motion, a change of frequency is produced due to the motion of both, source and observer, with respect to the medium.

Relativistic Consequences: Energy: For the energy in this new theory, the fact of using fundamentally the principle of relative speed, in the development of different formulations, turns out to be definitive: In order to determine the different perceptions of the observers in relative movement for energy, one must use this principle and remember that the energy density that is transmitted with the disturbance depends on the frequency of the wave motion.

Mass (inertia): There is still much speculation about the origin of this property of matter, which is inertia. In this new theory, until now, the concept of mass has not been considered. Therefore, it is not expected that two observers with uniform relative motion could perceive different values for the mass of the same body.

Length: In Einstein's theory of relativity there exists, for example, the contraction of bodies observed from frames of reference in motion. In this new theory, a length can be represented by means of two separated sound sources, separated precisely by the distance that it is intended to represent. It is also possible to represent a distance using the wavelength of a sound source. In both cases, with one or two sound sources, the length perceived by an observer in uniform relative motion must obey the established physical relationship, between speed and frequency, i.e.: $v_s = \lambda f$. It should be noted that a moving observer perceives different values for the propagation velocity of different parts of the same wave front. That is, in some case it will have $v_s - v_0 = \lambda' f'$. Therefore, the lengths represented precisely by the wavelengths λ and λ' will have to be in accordance with these physical laws.

Time: Considering the different expressions that have been found, in the development of this new theory, with respect to time, it can be affirmed that the relative movement has nothing to do with the aging or rejuvenation of a resting twin and a travelling twin. Any perception that time goes to a different "velocity" turns out to be precisely a relative effect that is only a perception and not a phenomenon that can transcend the circumstance. In conclusion, the uniform relative motion does not produce any force that can modify the physical or chemical processes, as they could be those involved in the metabolism of some observer. As previously argued, there is no such thing as “time dilation” that does properly exist and that can influence the vital processes. The passing of everyday life is that it is constituted by movements or changes in matter, which have their own speed of change. These changes cannot really be influenced by “something” that we call time. According to these considerations, it can be affirmed that, unlike whatever sometimes happens in science fiction, it is not possible to travel arbitrarily in time. Furthermore, as shown, the mathematical coordinate transformations only transform the time related to the propagation velocity of the signal. They do not directly transfigure the source period. Time and space are different, both conceptually and philosophically.

What does it mean when $t' > t$ in any of the formulations obtained?

It means that a moving observer perceives that the wave front uses a greater time in arriving at some pre-established position, since to him the speed seems different.

What does it mean when $f' < f$ in some of the studied cases?

It means that the source, for the moving observer, works slower, or emits pulses faster in its particular case. Any mechanism designed to last in operation for a specified number of cycles or some organism such as the fly which is used in research, would seem to last longer or live longer, according to the perception of a particular observer. Do they really last longer? Or is it just a matter of approaches?

It would seem to be the latter only!

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