V - ON THE ROLE OF « AETHER » PLAYED BY A LATTICE UNIVERSE FOR MOBILE SINGULARITIES

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In a perfect cosmic lattice satisfying $\tau_0 < \tau_{0cr}$, all microscopical topological singularities like dislocation lines and dislocations/disclination loops satisfy Lorentz transformations based on the transversal wave velocity. As a consequence, a localized cluster of topological singularities which interact with each other via their rotation fields is also submitted globally to the Lorentz transformations.
On this base, we discuss the analogies which exist between our theory of the perfect cosmic lattice and the Special Relativity. We discuss among others the role of *«aether»* that the lattice plays vis-a-vis a cluster of singularities in movement interacting via their rotation fields. We show that this notion of *«aether»* gives us a completely new perspective on the theory of Special Relativity, as well as a very elegant explanation to the famous paradox of the twins in Special Relativity.

On the Lorentz transformation applied to a cluster of moving topological singularities that interact via their rotation fields

In chapter 20, we have seen that the displacement of a topological singularity in frame $Ox_1x_2x_3$ of a perfect cosmic lattice satisfying $\tau_0 < \tau_{0cr}$, with velocity $\vec{v}$ in the direction of axis Ox_1, can be described in a frame $O'x_1'x_2'x_3'$ co-moving with the singularity thanks to the Lorentz transformation based on the transversal wave velocity. At constant volume expansion, a cluster of singularities which are moving in the lattice, formed with localized singularities such as dislocation and disclination loops which interact via their fields of rotation, is also subject to the same *Lorentz transformation (20.24), with all its properties as time dilation and length contraction,* because the fields of rotation which give the interactions between the singularities satisfy this transformation.

On the strong mathematical analogy of the Lorentz transformations applied to the cosmic lattice and to the Special Relativity

There exists a strong *mathematical analogy* between the transformation of Lorentz used here for the transmission of information and interaction of the singularities via transversal waves within the cosmic lattice and the Lorentz transformation of the theory of Special Relativity to describe the relativistic dynamic of mobile objects in the universe in relation with the speed of light. But there exists also a serious *difference of physical interpretation* between these two theories, linked to the presence of an ‘aether’ for the topological singularities, which is the lattice itself and that confers a privileged status to the fixed singularities compared to those in movement, while in the theory of Special Relativity, all objects have the same status, hence the famous name of 'relativity'. This essential difference allows us to bring a new light on the phenomena of relativity. We will discuss those in the following.

On the primordial physical differences with Special Relativity: the role of "aether" played by the lattice and existence of an absolute reference frame

The dynamic of the singularities within a cosmic lattice is different from special relativity via the existence of an *absolute frame of reference* for the movement of singularities, and an *'aether'* for the propagation of transversal waves (longitudinal waves do not exist if $\tau_0 < \tau_{0cr}$).
Contrary to special relativity, the lattice can be described from the outside by an observer ***GO*** *(imaginary **G**rand **O**bserver)* which has a universal clock and universal rulers in the absolute frame $Q\xi_1\xi_2\xi_3$. This external observer of the lattice is not subject to any constraint of speed of propagation of information, so that it is the only one who can observe qualitatively and measure quantitatively and precisely the notion *of instantaneity of events within the lattice.*

On the local observers HS (Homo Sapiens)

We could imagine now very different observers, the local observers ***HS*** *(**H**omo **S**apiens)*, which are embedded in the lattice and *made of the topological singularities of the lattice*. These particular observers then have a very different status from the observer ***GO*** since they are *integral parts of the lattice* and they are free to move about the lattice. But these observers are constrained by the fact that they transmit information from one point to another via the finite velocity of transversal waves or longitudinal waves. An ***HS*** observer has no access to an absolute definition of simultaneity of events such as that of the ***GO***, but only possesses a relativistic definition of the simultaneity, which depends on velocity $\vec{V}$ of displacement vis-a-vis the lattice and the local value of volume expansion of the lattice.
For simplicity reasons, the ***GO*** can choose as universal rulers and universal clocks the rulers and clocks of any ***HS*** immobile with respect to the lattice, and which would be found at a point of the lattice which is immobile and with null expansion ($\tau = 0$).
Each ***HS*** is equipped with a local framework which has rulers and a clock which appear immutable for this ***HS***, while the length of it's rulers and the speed at which time is counted depend in reality, in the absolute referential of the ***GO***, on the volume expansion of the lattice at the point where ***HS*** is found and on it's velocity $\vec{V}$ with respect to the lattice. As a consequence, the ***HS*** does not have direct access to the value of the volume expansion or to it's proper value of displacement velocity $\vec{V}$ with respect to the lattice. Only the ***GO*** has access to this type of information!
The Lorentz transformations we have identified are actually ***GO*** tools, which can be used without problems in determining the rulers and local clocks of all ***HS*** attached to the lattice, or simply to calculate the various fields associated with topological singularities moving within the lattice. And the ***GO*** can apply these transformations anywhere on the lattice where it is possible to find a state of homogeneous and constant expansion, which may well be different from the zero expansion since the Lorentz transformations is based on the transmission velocity of transverse waves, which is perfectly determined regardless of the network expansion status $\left(c_t(\tau) = c_{t0}\,\mathrm{e}^{\tau/2}\right)$. From this point of view, our interpretation of the Lorentz transformations is quite far from the interpretation of special relativity, for which these transformations are tools

that can use any ***HS*** observer to switch to another Galilean framework in movement relative to the first, and for which the speed of light is an absolute constant! The main consequences of these essential differences will be analyzed in detail in the following sections.

On the real contraction of the length of an HS observer in movement inside the lattice

The transformations of Lorentz *(20.24)* imply that, for singularities moving at velocity $\vec{\boldsymbol{v}}$ in the direction $\boldsymbol{O}x_1$, the ruler in direction $\boldsymbol{O}x_1$ shortens by a factor γ_t. Indeed, let's consider a vector $\vec{d} = x_1\vec{e}_1$ in the direction $\boldsymbol{O}x_1$ at the instant $t=0$ in the framework $\boldsymbol{O}x_1x_2x_3$ immobile with respect to the lattice. This vector $\vec{d}$ can also be described in the mobile lattice $\boldsymbol{O}'x_1'x_2'x_3'$ by writing

$$\vec{d} = x_1\vec{e}_1 = x_1'\vec{e}_1' \tag{21.1}$$

By using the direct transformation laws of Lorentz *(20.27),* taken at instant $t=0$, we obtain

$$\vec{d} = x_1\vec{e}_1 = x_1'\vec{e}_1' = \frac{x_1}{\gamma_t}\vec{e}_1' \quad\Rightarrow\quad \vec{e}_1 = \frac{1}{\gamma_t}\vec{e}_1' \tag{21.2}$$

We can also use the reverse Lorentz transformation *(20.27),* taken at instant $t=0$, and we obviously obtain the same result

$$\left.\begin{array}{ll} \vec{d} = x_1\vec{e}_1 = \dfrac{x_1'+\boldsymbol{v}t'}{\gamma_t}\vec{e}_1 = x_1'\vec{e}_1' & \Rightarrow \quad \vec{e}_1 = \dfrac{\gamma_t x_1'}{x_1'+\boldsymbol{v}t'}\vec{e}_1' \\ t=0=\dfrac{t'+\boldsymbol{v}x_1'/c_t^2}{\gamma_t} & \Rightarrow \quad t' = -\boldsymbol{v}x_1'/c_t^2 \end{array}\right\} \Rightarrow \quad \vec{e}_1 = \frac{1}{\gamma_t}\vec{e}_1' \tag{21.3}$$

These calculations show that, for the ***GO***, the ruler $\vec{e}_1'$ in the mobile framework $\boldsymbol{O}'x_1'x_2'x_3'$ is effectively shortened by a factor γ_t compared to ruler $\vec{e}_1$ in the mobile framework $\boldsymbol{O}x_1x_2x_3$ in which the singularities move with velocity $\vec{\boldsymbol{v}}$

$$\vec{e}_1' = \gamma_t\vec{e}_1 \tag{21.4}$$

To interpret this shortening of rulers in the direction of movement, one has to imagine the architecture of the cluster as a set of topological singularities, linked by the interactions of their respective rotational fields (figure 21.1). These lattice singularities move with respect to the lattice with velocity $\vec{\boldsymbol{v}}$ in direction $\boldsymbol{O}x_1$, and the finite nature of velocity c_t and their interactions via the rotational field imposes that the complete architecture of the cluster of singularities contract in direction $\boldsymbol{O}x_1$. But this contraction does not affect the lattice, which conserves its state of original volume expansion, which we have represented in figure 21.1 for the case where two identical clusters move with velocities $\vec{\boldsymbol{v}}'$ and $\vec{\boldsymbol{v}}''$, measured with respect to the observer ***GO***.
Thus the relativistic effects on the rulers of observer ***HS***, associated to the collective movement of the singularities vis-à-vis the lattice, have nothing to do with the effects of volume expansion of the lattice, for which the modifications of the lengths of the rulers of ***HS*** will be associated with real variation of the length of the unit cell of the cosmic lattice as we will see later in chapter 24! We should also note that these two effects are cumulative, namely that the rulers of an ***HS*** observer can be contracted or expanded by variation of the volume expansion and again contract by the movement of the singularity cluster with respect to the lattice! In this fashion, the contraction-expansion of the rulers and clocks of an ***HS*** observer depend both on the local expansion

and the velocity $\vec{\mathbf{v}}$ of the ***HS*** with respect to the lattice. Furthermore, in the Lorentz transformation applied by the ***GO*** observer, the value of $\gamma_t = (1-\mathbf{v}^2 / c_t^2)^{1/2}$ depends not only on the velocity $\vec{\mathbf{v}}$ of the ***HS*** with respect to the lattice, but also on the local velocity c_t of transversal waves, which depends on the volume expansion τ of the cosmic lattice since

$$c_t\Big|_{\tau\neq 0} = c_{t0}\Big|_{\tau=0} \mathrm{e}^{\tau/2} \tag{21.5}$$

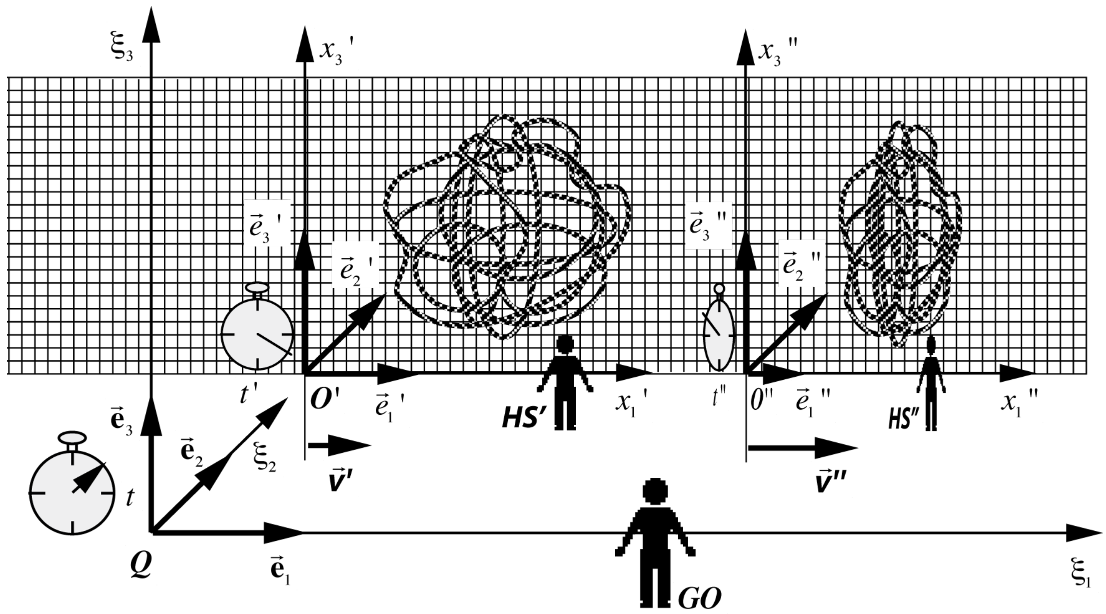

Figure 21.1 *- the mobile Lorentz frameworks of observers **HS'** and **HS''***
*in movement inside the lattice, as observed by the observer **GO***

On the real dilation of time of an HS observer in movement inside the lattice

The phenomenon of slowing down of the clock of the observer ***HS*** which is moving with respect to the lattice has already been explained in chapter 20 with the figures 20.2 and 20.3. Imagine that it is an observer ***HS*** who builds now its own clocks in his framework $\boldsymbol{O}'x'_1 x'_2 x'_3$, by fixing two mirror face to face and at a distance d_0 one from the other, mirrors that have the property of reflecting transversal waves. By sending a transversal wave between the 2 mirrors, ***HS*** can perfectly use, as basis for time measurement, the time lapse $T_0 = 2d_0 / c_t$ that flows between a back and forth of the wave between the two mirrors, because the distance d_0 and velocity c_t of the transversal waves are for him constants. If the observer ***HS*** is initially at rest with respect to the lattice, the ***GO*** can consider the time laps $T_0 = 2d_0 / c_t$ as the basis for its proper time in $\boldsymbol{O}x_1 x_2 x_3$.
Let's imagine now that the ***HS*** observer is moving with respect to the lattice with velocity $\vec{\mathbf{v}}$ in the direction $\boldsymbol{O}x_1$, and that he places two clocks in 'quadrature', meaning that a first clock has 2 mirrors in one direction $\boldsymbol{O}x_1'$ and the second clock has 2 mirrors along $\boldsymbol{O}x_3'$ (or $\boldsymbol{O}x_2'$). In principle, in its framework $\boldsymbol{O}'x'_1 x'_2 x'_3$, the time lapse $T_0 = 2d_0 / c_t$ measure by the ***HS*** with its two clocks is the same.

Let's take now the point of view of the ***GO***. In section 20.1, we have shown that the basic time of the moving clock of the ***HS*** observer in frame $\boldsymbol{O}'x_1'x_2'x_3'$, measured by the ***GO*** in its absolute reference frame $\boldsymbol{O}x_1x_2x_3$, seems to be dilated, expanded as a function of the velocity $\vec{\boldsymbol{v}}$ by a factor of $1/\gamma_t$, identically for the two clocks in 'quadrature'

$$T = \frac{2d_0 / c_t}{\sqrt{1-\boldsymbol{v}^2 / c_t^2}} = \frac{T_0}{\gamma_t} \tag{21.8}$$

This means that a local time t' exists really for an ***HS*** observer, that this local time flows slower for an ***HS*** observer in movement with respect to the lattice, and that this local time t' remains *isotropic in the mobile frame* $\boldsymbol{O}'x_1'x_2'x_3'$, independently of the direction of motion of the ***HS*** observer inside the lattice.

Concerning the dilation or contraction of time, there can also be a coupling between the relativistic effects and the effects of volume expansion. We will see later (chapter 24) that, in the case of a cosmic lattice, an observer ***HS'*** which would be placed in a zone with strong contraction ($\tau << 0$) would have a proper clock strongly slowed down with respect to the proper time of the ***GO***. Furthermore, if it moved with a velocity $\boldsymbol{v}$ close to c_t with respect to the lattice, it's proper time would also be strongly slowed down with respect to the proper time of the ***GO***, not only by the direct effect of volume contraction on the clock, but also by the effect of volume expansion on γ_t since

$$\gamma_t = \left(1-\frac{\boldsymbol{v}^2}{c_t^2}\right)^{1/2} = \left(1-\frac{\boldsymbol{v}^2}{c_{t0}^2}\mathrm{e}^{-\tau}\right)^{1/2} < \left(1-\frac{\boldsymbol{v}^2}{c_{t0}^2}\right)^{1/2} \quad if \quad \tau<0 \tag{21.9}$$

On the Michelson-Morley experiment and the Doppler-Fizeau effect in the cosmic solid lattice

It is clear that the lattice plays, vis-a-vis the singularities and the propagation of waves, the same role as the famous "aether" which was supposed to propagate the luminous waves and was discussed in the early 20th century. The experience of Michelson-Morley, which consisted on measuring, thanks to an interferometer, a difference in the velocity of propagation of luminous waves in the direction of displacement and transversely to the direction of said displacement, gave a negative result. It was concluded at the time that the aether did not exist. But in the two examples above, the calculation proposed in the solid lattice with two local clocks in quadrature shows that the result is identical to that obtained by the experiment of Michelson-Morley, namely that there is no difference in the time it takes for the signal to go through both perpendicular arms, which the ***HS*** interprets as the fact the velocity propagation does not depend on the direction in which it is measured. But in the case we have treated here, there exists an aether made of the cosmic lattice within which the singularities are moving and which are perfectly known by the ***GO!***

We deduce that, in the case of the solid cosmic lattice which acts as an aether, the singularities are moving with velocity $\vec{\boldsymbol{v}}$ and have a proper clock which slows down as the ***GO*** measures a flight time T_0 with the ***HS*** clock immobile with respect to the lattice, but a time $T = T_0 / \gamma_t$ with an ***HS*** clock that would be moving with velocity $\vec{\boldsymbol{v}}$ with respect to the lattice.

Furthermore, it is clear that if the ***HS*** measures the velocity c_t' of a transversal wave in its moving framework $O'x'_1 x'_2 x'_3$, with its own clocks and rulers, it will find exactly the same value as that measured by the ***GO*** in the lattice, since

$$c_t' = \frac{2d_0}{T_0} = \frac{2d/\gamma_t}{T/\gamma_t} = \frac{2d}{T} = c_t \quad \textit{in the direction } Ox_1' \tag{21.10}$$

On the point of view of the HS observers in movement with respect to the lattice

To illustrate the point of view of the ***HS*** observers, and notably the fact that observers linked to the lattice do not have an absolute notion of simultaneity, like the ***GO*** does, we can imagine the following experiment.

In the first experience, we consider two simultaneous events observed by the ***GO*** in the referential $Ox_1x_2x_3$ at instant $t=0$ and at coordinates $x_1^{(1)}=0$ and $x_1^{(2)}=\Delta x_1$, so separated by a distance Δx_1. These two simultaneous events are then observed by an ***HS*** in its framework $O'x'_1 x'_2 x'_3$ moving with velocity $\vec{\boldsymbol{v}}$ in direction Ox_1 with the following space-time coordinates, obtained from relations *(20.27)*

$$\begin{cases} x_1^{(1)}{}' = 0 & \text{and} \quad t_1' = 0 \\ x_1^{(2)}{}' = \dfrac{x_1^{(2)}}{\gamma_t} = \dfrac{\Delta x_1}{\gamma_t} & \text{and} \quad t_2' = -\dfrac{\boldsymbol{v} x_1^{(2)}}{c_t^2\gamma_t} = -\dfrac{\boldsymbol{v}\Delta x_1}{c_t^2\gamma_t} \end{cases} \tag{21.11}$$

We observe that the two events are not measured as simultaneous by the ***HS***, but separated by a non-null time interval $\Delta t' = t_2'$, and the distance measured by the ***HS*** between the two events is equal to $\Delta x_1' = x_1^{(2)}{}' = \Delta x_1 / \gamma_t$ which is superior to the distance Δx_1 measured by the ***GO***, and is a consequence of the contraction of ruler $\vec{e}_1'$ of the ***HS*** in the direction Ox_1.

In a second experiment, let's consider an event taking place at the origin of the referential $Ox_1x_2x_3$ of the ***GO*** and which lasts from $t_1=0$ and $t_2=\Delta t$, so on a time lapse Δt. This event is then observed by an ***HS*** in its framework $O'x'_1 x'_2 x'_3$ moving with velocity $\vec{\boldsymbol{v}}$ in the direction Ox_1 with the following spatiotemporal coordinates, obtained from relations *(20.27)*

$$\begin{cases} x_1^{(1)}{}' = 0 & \text{and} \quad t_1' = 0 \\ x_1^{(2)}{}' = -\dfrac{\boldsymbol{v} t_2}{\gamma_t} = -\dfrac{\boldsymbol{v}\Delta t}{\gamma_t} & \text{and} \quad t_2' = \dfrac{t_2}{\gamma_t} = \dfrac{\Delta t}{\gamma_t} \end{cases} \tag{21.12}$$

We notice that the event seems to be moving in the ***HS*** framework over a distance $\Delta x_1' = \left| x_1^{(2)}{}' \right| = \boldsymbol{v}\Delta t / \gamma_t$, longer than the absolute displacement $\boldsymbol{v}\Delta t$ of the framework $O'x'_1 x'_2 x'_3$ in the lattice, due to the ruler contraction $\vec{e}_1'$ used by the ***HS***, and that the time lapse of the event for ***HS*** is worth $\Delta t' = t_2' = \Delta t / \gamma_t$, and thus seems longer for the ***HS*** than for the ***GO***, which is at first rather strange since the ***HS*** clock moves slower than that of the ***GO***! This phenomenon is due to the flight time of the transversal waves to reach the moving ***HS*** with respect to the lattice. This last experience shows that the time intervals measured by the ***HS*** are relative intervals since they depend on the finite propagation velocity of information within the lattice.

On the relations between two HS observers in movement with respect to the lattice

In figure 21.1 we show two frameworks in translation along the axis Ox_1 at speeds $\vec{\boldsymbol{v}}'$ and $\vec{\boldsymbol{v}}''$

as measured by the ***GO*** observer. One wonders what form the relativity of speeds will take as measured by the ***HS*** , including what is the relative speed $\vec{\boldsymbol{v}}_r$ which is measured by the observer ***HS***' in its framework $\boldsymbol{O}'x'_1x'_2x'_3$ for the movement of framework $\boldsymbol{O}''x''_1x''_2x''_3$ of the observer ***HS"***. For ***GO***, the point $\boldsymbol{O}''$ of the framework of ***HS"*** is moving in $\boldsymbol{O}x_1x_2x_3$ from $x_1^{(1)}$ to $x_1^{(2)}$ in a lapse of time which goes from t_1 to t_2, so that

$$\boldsymbol{v}'' = \frac{x_1^{(2)} - x_1^{(1)}}{t_2 - t_1} \tag{21.13}$$

If ***HS'*** observes the same displacement, it will find a relative velocity $\vec{\boldsymbol{v}}_r$ thanks to transformations *(20.22)* as

$$\boldsymbol{v}_r = \frac{x_1^{(2)}{}' - x_1^{(1)}{}'}{t_2' - t_1'} = \frac{\dfrac{x_1^{(2)} - \boldsymbol{v}'t_2}{\gamma_t'} - \dfrac{x_1^{(1)} - \boldsymbol{v}'t_1}{\gamma_t'}}{\dfrac{t_2 - \boldsymbol{v}'x_1^{(2)}/c_t^2}{\gamma_t'} - \dfrac{t_1 - \boldsymbol{v}'x_1^{(1)}/c_t^2}{\gamma_t'}} \tag{21.14}$$

Some transformations of this relation allow to write it under the form

$$\boldsymbol{v}_r = \frac{\dfrac{x_1^{(2)} - x_1^{(1)}}{t_2 - t_1} - \boldsymbol{v}'}{1 - \left(\dfrac{x_1^{(2)} - x_1^{(1)}}{t_2 - t_1}\right)\dfrac{\boldsymbol{v}'}{c_t^2}} = \frac{\boldsymbol{v}'' - \boldsymbol{v}'}{1 - \boldsymbol{v}''\boldsymbol{v}'/c_t^2} \tag{21.15}$$

The relative velocity of framework $\boldsymbol{O}''x''_1x''_2x''_3$ measured by ***HS'*** corresponds to the classic relativistic composition of velocities. By symmetry, the relative velocity of framework $\boldsymbol{O}'x'_1x'_2x'_3$ measured by ***HS"*** will be given by exactly the same expression with a changed sign!

Let's consider now two simultaneous events in the mobile framework $\boldsymbol{O}''x''_1x''_2x''_3$, with coordinates $x_1^{(1)}{}'' = 0$ and $x_1^{(2)}{}'' = \Delta x_1''$ happening at instant $t'' = 0$. In the immobile referential $\boldsymbol{O}x_1x_2x_3$, the coordinates of these two events become two distinct events in time

$$\begin{cases} x_1^{(1)} = 0 & \text{and} \quad t_1 = 0 \\ x_1^{(2)} = \dfrac{x_1^{(2)}{}''}{\gamma_t''} = \dfrac{\Delta x_1''}{\gamma_t''} & \text{and} \quad t_2 = \dfrac{\boldsymbol{v}''x_1^{(2)}{}''}{c_t^2\gamma_t''} = \dfrac{\boldsymbol{v}''\Delta x_1''}{c_t^2\gamma_t''} \end{cases} \tag{21.16}$$

In the framework $\boldsymbol{O}'x_1'x_2'x_3'$ of ***HS'***, the coordinates of these two events are written

$$\begin{cases} x_1^{(1)}{}' = 0 & \text{and} \quad t_1' = 0 \\ x_1^{(2)}{}' = \left(\dfrac{\Delta x_1''}{\gamma_t''} - \dfrac{\boldsymbol{v}''\Delta x_1''}{c_t^2\gamma_t''}\boldsymbol{v}'\right)/\gamma_t' & \text{and} \quad t_2' = \dfrac{\boldsymbol{v}''\Delta x_1''}{c_t^2\gamma_t''} - \dfrac{\boldsymbol{v}'}{c_t^2}\dfrac{\Delta x_1''}{\gamma_t''} \end{cases} \tag{21.17}$$

which we can write under the form of a spatial distance $\Delta x_1' = x_1^{(2)}{}'$ and a time interval $\Delta t' = t_2'$ between these two events

$$\Delta x_1' = \left(1 - \frac{\boldsymbol{v}'\boldsymbol{v}''}{c_t^2}\right)\frac{\Delta x_1''}{\gamma_t'\gamma_t''} \quad \text{and} \quad \Delta t' = (\boldsymbol{v}'' - \boldsymbol{v}')\frac{\Delta x_1''}{c_t^2\gamma_t''\gamma_t'} \tag{21.18}$$

The two original simultaneous events separated by $\Delta x_1''$ in the framework $\boldsymbol{O}''x''_1x''_2x''_3$ of ***HS"*** become two non-simultaneous events in the framework $\boldsymbol{O}'x'_1x'_2x'_3$ of ***HS'***.

Let's consider now two successive events in the mobile framework $O''x''_1 x''_2 x''_3$, happening at the same place with coordinates $x_1^{(1)}{}''=0$ and happening at instants $t_1{}''=0$ and $t_2{}''=\Delta t''$. In the immobile referential $Ox_1x_2x_3$, the coordinates of the two events become two separate events in space

$$\begin{cases} x_1^{(1)}=0 & \text{and} \quad t_1=0 \\ x_1^{(2)}=\dfrac{\mathbf{v''}t_2{}''}{\gamma_t{}''}=\dfrac{\mathbf{v''}\Delta t''}{\gamma_t{}''} & \text{and} \quad t_2=\dfrac{t_2{}''}{\gamma_t{}''}=\dfrac{\Delta t''}{\gamma_t{}''} \end{cases} \tag{21.19}$$

In the framework $O'x_1{}'x_2{}'x_3{}'$ of ***HS'***, the coordinates of the two events are then written

$$\begin{cases} x_1^{(1)}{}'=0 & \text{and} \quad t_1{}'=0 \\ x_1^{(2)}{}'=\left(\dfrac{\mathbf{v''}\Delta t''}{\gamma_t{}''}-\dfrac{\mathbf{v'}\Delta t''}{\gamma_t{}''}\right)/\,\gamma_t{}' & \text{and} \quad t_2{}'=\left(\dfrac{\Delta t''}{\gamma_t{}''}-\dfrac{\mathbf{v'}}{c_t^2}\dfrac{\mathbf{v''}\Delta t''}{\gamma_t{}''}\right)/\,\gamma_t{}' \end{cases} \tag{21.20}$$

which we can write explicitly in the form of a spatial distance $\Delta x_1{}'=x_1^{(2)}{}'$ and a time interval $\Delta t'=t_2{}'$ between the two events

$$\Delta x_1{}'=\left(\mathbf{v''}-\mathbf{v'}\right)\frac{\Delta t''}{\gamma_t{}'\gamma_t{}''} \quad \text{and} \quad \Delta t'=\left(1-\frac{\mathbf{v'v''}}{c_t^2}\right)\frac{\Delta t''}{\gamma_t{}'\gamma_t{}''} \tag{21.21}$$

The two events happening at the origin of the framework $O''x''_1 x''_2 x''_3$ of ***HS"*** become then two separate events in the space of the framework $O'x'_1 x'_2 x'_3$ of ***HS'***.

On the Doppler-Fizeau effects between singularities in movement

In figure 21.2, we show several experiments of exchange of signals at a given frequency between singularities in movement within the lattice via the transversal waves. By taking the point of view of the ***GO***, it is possible to easily describe these experiences that give rise to the Doppler-Fizeau effect. We suppose that all these experiences take place in a lattice which has a homogenous and constant value for the volume expansion, without which the description of the experiments would become a lot more complex.

First experiment: an observer ***HS'*** in the framework $O'x'_1 x'_2 x'_3$ in movement with velocity $\vec{\mathbf{v}}'$ in the direction Ox_1 with respect to the lattice emits a wave with frequency $f_e{}'$, measured with its proper clock, towards an ***HS*** observer in a referential $Ox_1x_2x_3$ immobile with respect to the lattice (figure 21.2a). The transversal wave emitted in the framework $O'x'_1 x'_2 x'_3$ is written

$$\vec{\omega}=\vec{\omega}_0\sin\left(\omega't'-k'x_1{}'\right) \tag{21.22}$$

with $f_e{}'=\omega'/2\pi$ and $k'=\omega'/c_t$.
In the referential $Ox_1x_2x_3$, the same wave can be obtained by replacing the coordinates t' and $x_1{}'$ of ***HS'*** by coordinates t and x_1 of ***HS***, by using the Lorentz transformations

$$\begin{aligned} \vec{\omega}&=\vec{\omega}_0\sin\left(\omega'\frac{t-\mathbf{v'}x_1/c_t^2}{\gamma_t{}'}-k'\frac{x_1-\mathbf{v'}t}{\gamma_t{}'}\right) \\ &=\vec{\omega}_0\sin\left[\left(\frac{\omega'}{\gamma_t{}'}+\frac{k'\mathbf{v'}}{\gamma_t{}'}\right)t-\left(\frac{k'}{\gamma_t{}'}+\frac{\omega'\mathbf{v'}}{c_t^2\gamma_t{}'}\right)x_1\right]=\vec{\omega}_0\sin\left(\omega t-kx_1\right) \end{aligned} \tag{21.23}$$

We find as a consequence the relations giving ω and k from the values of ω' and k' in the framework $\boldsymbol{O}'x'_1 x'_2 x'_3$

$$\begin{cases} \omega = \left(\omega' + k'\mathbf{v}'\right)/\gamma_t' \\ k = \left(k' + \omega'\mathbf{v}'/c_t^2\right)/\gamma_t' \end{cases} \tag{21.24}$$

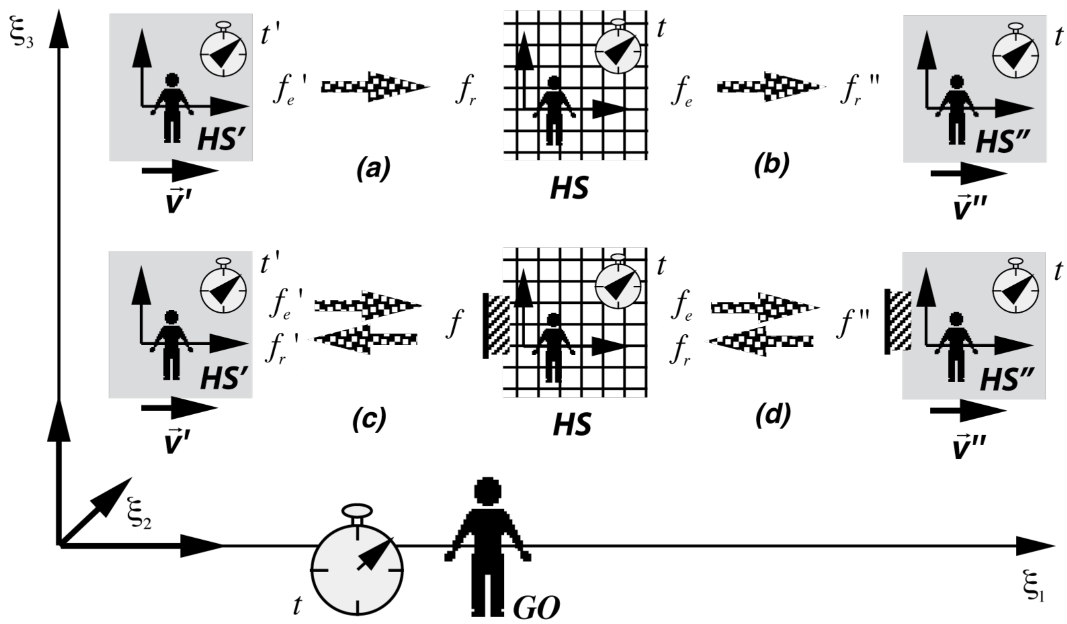

Figure 21.2 *- different configurations of measure of the Doppler-Fizeau effect*

As $k' = \omega'/c_t$ and $f_e' = \omega'/2\pi$, we deduce the relation existing between the frequency f_e' of the signal emitted by ***HS'*** and the frequency f_r measured by ***HS*** on the signal received with its proper clock

$$f_r = \frac{1+\mathbf{v}'/c_t}{\gamma_t'} f_e' = f_e' \sqrt{\frac{1+\mathbf{v}'/c_t}{1-\mathbf{v}'/c_t}} \tag{21.25}$$

For $\mathbf{v}' > 0$, meaning when ***HS'*** gets closer to ***HS***, the frequency f_r of the signal received and measured by ***HS*** is higher than the frequency f_e' of the signal emitted and measured by ***HS'***. This is the *Doppler-Fizeau* effect and one usually talks about a "*blueshift of the signal*". On the contrary, if ***HS'*** is moving away from ***HS*** ($\mathbf{v}' < 0$), the signal is received with a frequency f_r which is inferior to the frequency f_e' of the emitted signal, and one talks about a "redshift of the signal".

It is interesting to rewrite relation *(21.25)* under the following form

$$f_r = f_e' \sqrt{\frac{1+\mathbf{v}'/c_t}{1-\mathbf{v}'/c_t}} = \frac{1}{1-\mathbf{v}'/c_t}\gamma_t' f_e' \tag{21.26}$$

as, in this form, the relationship shows the term $(1-\mathbf{v}'/c_t)^{-1}$ of the purely classic Doppler effect, but which is applied to an emitted frequency $\gamma_t{}'f_e{}'$, which is nothing else than the frequency of the signal emitted by the ***HS'***, but measured by the ***HS*** with its proper clock, or by ***GO*** with a universal clock.

2nd experiment: an ***HS*** observer in the framework $Ox_1x_2x_3$ at rest with respect to the lattice sends a signal with frequency f_e, measured with its proper clock, towards an observer ***HS"*** which moves with velocity $\vec{\boldsymbol{v}}''$ in direction Ox_1 with respect to the lattice (figure 21.2b). With the same type of calculation that in the first case, it is easy to verify that the frequency $f_r{}''$ of the signal received by ***HS"*** and measured by him with its proper clock has the value

$$f_r{}'' = f_e\sqrt{\frac{1-\boldsymbol{v}''/c_t}{1+\boldsymbol{v}''/c_t}} = \left(1-\boldsymbol{v}''/c_t\right)\frac{f_e}{\gamma_t{}''} \qquad (21.27)$$

For $\boldsymbol{v}''>0$, meaning when ***HS"*** is moving away from ***HS***, the frequency $f_r{}''$ of the signal received by ***HS"*** is lower than the frequency f_e of the signal emitted by ***HS***. It is again a *Doppler-Fizeau effect*. In the second form presented in *(21.27)*, the expression of $f_r{}''$ shows a term in $(1-\boldsymbol{v}''/c_t)$ due to the classic Doppler effect, but which is applied to a frequency $f_e/\gamma_t{}''$, which is nothing more than the frequency of the signal emitted by ***HS***, but such as it is measured by the clock of the ***HS"***.

3rd experiment: an ***HS'*** observer in the framework $O'x'_1x'_2x'_3$ moving with velocity $\vec{\boldsymbol{v}}'$ in the direction Ox_1 with respect to the lattice emits a wave at frequency $f_e{}'$, measured with its own clock, towards an observer ***HS"*** which is moving with velocity $\vec{\boldsymbol{v}}''$ in the direction Ox_1 with respect to the lattice (figure 21.2a-b). The frequency $f_r{}''$ of the signal received by the ***HS"*** and measured by him with his proper clock is easily obtained by combining relations *(21.25)* and *(21.27)*. We obtain

$$f_r{}'' = f_e{}'\sqrt{\frac{1+\boldsymbol{v}'/c_t}{1-\boldsymbol{v}'/c_t}}\sqrt{\frac{1-\boldsymbol{v}''/c_t}{1+\boldsymbol{v}''/c_t}} = \left(\frac{1-\boldsymbol{v}''/c_t}{1-\boldsymbol{v}'/c_t}\right)\frac{\gamma_t{}'}{\gamma_t{}''}f_e{}' \qquad (21.28)$$

Under the second form presented in *(21.28)*, the expression of $f_r{}''$ explicitly shows in parenthesis the classic Doppler effect due to the movement of two observers with respect to the lattice as well as the frequency $\gamma_t{}'f_e{}'/\gamma_t{}''$ which is nothing more than the frequency of the signal emitted by ***HS'***, but measured by the clock of the ***HS"***.

4th experiment: an observer ***HS'*** in the framework $O'x'_1x'_2x'_3$ moving with velocity $\vec{\boldsymbol{v}}'$ in the direction Ox_1 with respect to the lattice emits a wave with a frequency $f_e{}'$ measured by its proper clock, which is reflected by a mirror associated to the framework $Ox_1x_2x_3$ immobile with respect to the lattice, and receives the echo of the wave of which he measures the frequency $f_r{}'$, always with its proper clock (figure 21.2c). It is easy to find the value of $f_r{}'$ by using relations *(21.25)* and *(21.27)* in which we introduce the frequency f received and re-emitted by the mirror in the framework of ***HS,*** namely

$$f = f_e{}'\sqrt{\frac{1+\boldsymbol{v}'/c_t}{1-\boldsymbol{v}'/c_t}} = \frac{1}{1-\boldsymbol{v}'/c_t}\gamma_t{}'f_e{}' \quad \text{and} \quad f_r{}' = f\sqrt{\frac{1+\boldsymbol{v}'/c_t}{1-\boldsymbol{v}'/c_t}} = \left(1+\boldsymbol{v}'/c_t\right)\frac{f}{\gamma_t{}'} \qquad (21.29)$$

The combination of these two relations shows us that, in this case, the effect measured by ***HS'*** is purely a *classic Doppler effect*, which is logical since we use the proper clock of ***HS'*** to measure $f_e\,'$ and $f_r\,'$

$$f_r\,' = \frac{1+\mathbf{v}'/c_t}{1-\mathbf{v}'/c_t} f_e\,' \tag{21.30}$$

5th experiment: an ***HS*** observer in the framework $Ox_1x_2x_3$ immobile with respect to the lattice emits a wave at frequency f_e, measured with its proper clock, which bounces on a mirror associated with a framework $O"x"_1\,x"_2\,x"_3$ moving with velocity $\vec{\mathbf{v}}''$ in the direction Ox_1 with respect to the static lattice, and receives the echo of these waves with frequency f_r, measured with its proper clock (figure 21.2d). It is easy to find the value of f_r by using relations *(21.25)* and *(21.27)* in which we introduce the frequency $f\,"$ received and re-emitted by the mirror in the framework of the ***HS”***. The combination of these two relations shows us that, in this case, the effect measured by the ***HS*** is also a purely *classic Doppler effect*, since ***HS*** uses its own clock to measure f_e and f_r

$$f_r = \frac{1-\mathbf{v}''/c_t}{1+\mathbf{v}''/c_t} f_e \tag{21.31}$$

6th experiment: an observer ***HS’*** in the framework $O'x'_1\,x'_2\,x'_3$ moving with velocity $\vec{\mathbf{v}}'$ in the direction Ox_1 with respect to the lattice emits a wave with frequency $f_e\,'$, measured with its own clock, which bounces of a mirror associated with framework $O"x"_1\,x"_2\,x"_3$ moving in direction $\vec{\mathbf{v}}''$ in the direction Ox_1 with respect to the lattice, and receives the echo of said wave for which it measures frequency $f_r\,'$, always with its own clock (figure 21.2c-d). It is easy to find the value of $f_r\,'$ by using twice the relation *(21.28)*. We again find that in this case, the effect measured by the ***HS’*** is purely a classic Doppler effect, since it uses its proper clock to measure $f_e\,'$ and $f_r\,'$

$$f_r\,' = \frac{\left(1+\mathbf{v}'/c_t\right)\left(1-\mathbf{v}''/c_t\right)}{\left(1-\mathbf{v}'/c_t\right)\left(1+\mathbf{v}''/c_t\right)} f_e\,' \tag{21.32}$$

On the impossibility for an HS observer to measure its own velocity with respect to the lattice

We have already seen that a local observer ***HS”*** in its framework $O"x"_1\,x"_2\,x"_3$ mobile with velocity $\vec{\mathbf{v}}''$ with respect to the lattice in the direction Ox_1 is in principle not capable of measuring that velocity $\vec{\mathbf{v}}''$ since its clock and its proper rulers do not change, which has as a consequence that experiments of the Michelson-Morley type do not bring any useful information. We can however ask ourselves if experiments of the type Doppler-Fizeau with another observer ***HS’*** mobile with velocity $\vec{\mathbf{v}}'$ with respect to the lattice in direction Ox_1 could bring more information. In relation with observer ***HS’***, the observer ***HS”*** can perform three types of measurements:

- it can measure the relative velocity $\mathbf{v}_r$ of ***HS’*** with respect to it, given by *(21.15)*

$$\mathbf{v}_r = \frac{\mathbf{v}'-\mathbf{v}''}{1-\mathbf{v}''\mathbf{v}'/c_t^2} \tag{21.33}$$

- it can measure the ratio of frequencies $f_r\,"/\,f_e\,'$ of a given known event which happens in his framework and in the framework of the ***HS’***, given by *(21.28)*

$$\frac{f_r''}{f_e'}=\sqrt{\frac{1+\mathbf{v'}/c_t}{1-\mathbf{v'}/c_t}}\sqrt{\frac{1-\mathbf{v''}/c_t}{1+\mathbf{v''}/c_t}} \tag{21.34}$$

- it can measure the ratio of frequencies f_r''/f_e'' of a given known signal which he sent itself and which is reflected by a mirror in the framework of ***HS'***, given by *(21.32)*

$$\frac{f_r''}{f_e''}=\frac{\left(1+\mathbf{v'}/c_t\right)\left(1-\mathbf{v''}/c_t\right)}{\left(1-\mathbf{v'}/c_t\right)\left(1+\mathbf{v''}/c_t\right)} \tag{21.35}$$

We can show that these three experimental measurements do not allow to the ***HS"*** to determine univocally $\vec{\mathbf{v}}'$ and $\vec{\mathbf{v}}''$. Indeed, the two relations *(21.34)* and *(21.35)* are absolutely equivalent and thus do not allow us to solve the problem. As for relations *(21.33) and (21.34)*, it is easy to show that

$$\frac{f_r''}{f_e'}=\sqrt{\frac{1+\mathbf{v'}/c_t}{1-\mathbf{v'}/c_t}}\sqrt{\frac{1-\mathbf{v''}/c_t}{1+\mathbf{v''}/c_t}}=\sqrt{\frac{1+\mathbf{v_r}/c_t}{1-\mathbf{v_r}/c_t}} \tag{21.36}$$

and thus this system is also not determined, so that the ***HS"*** has no way of finding its relative velocity $\vec{\mathbf{v}}''$ with respect to the lattice by using experiments of the type Doppler-Fizeau.

On the paradox of the twins which is only a paradox in the mind of the observers HS!

The existence of a lattice, and thus of an *«aether»*, allows us to give a very simple and elegant explanation of the famous paradox of the twins in special relativity.

The relation *(21.36)* is very interesting, as it shows that ***HS"*** can deduce the relative velocity $\mathbf{v}_r$ of ***HS'*** with respect to itself by measuring the frequency ratio f_r''/f_e' of a given known event in its framework and in the framework of ***HS'***. For itself, in its framework $\boldsymbol{O}''x''_1x''_2x''_3$, this ratio of frequencies is of relativistic type. But the observer ***HS'***, in its framework $\boldsymbol{O}'x'_1x'_2x'_3$, could in theory perform the same measurement, and it would obtain exactly the same result! Thus, for an ***HS*** observer which does not have access to absolute velocities with respect to the lattice (and thus to the aether), their relativistic principles are exactly the same principles as those of *"Special Relativity"*. Notably, by applying the Lorentz transformations, ***HS"*** will have the impression that ***HS'*** ages less than it, while ***HS'*** will also have the impression that ***HS"*** is aging slower than it. This strange situation is called the *twin paradox* in special relativity.

But this paradoxical conclusion of the twins ***HS'*** and ***HS"*** is only a paradox in the mind of the observers ***HS'*** and ***HS"***. Indeed, for the ***GO*** which can read the relativistic velocities of the ***HS*** with respect to the lattice, it is perfectly clear that it is the ***HS*** which is moving with respect to the lattice which is aging slower than the ***HS*** which remains immobile within the lattice. Thus, if a couple of ***HS*** twins perform the famous experiment of the Langevin twins, namely that one of the twins leaves earth on a rocket with subliminal speeds and comes back towards its twin who stayed at the point of origin, the ***GO*** will be able to say without error that it was the ***HS***, who travelled with respect to the lattice with a great speed, who will be the youngest when they meet after the trip. And the ***GO*** knows perfectly that this effect *is an effect that happened all along the trip, even during the periods where the velocity of the traveling twin will have been constant with respect to the lattice!*

This new interpretation of the twin paradox based on the existence of the cosmic lattice (the “aether”) gives a very logical and elegant answer to numerous questions and interpretations of the twin paradox suggested by Special Relativity and General Relativity [1].

[1] *See for example:*
http://fr.wikipedia.org/wiki/Paradoxe_des_jumeaux
http://en.wikipedia.org/wiki/Twin_paradox