Universal Specificity Investigation 2: Implications of a Universally Stationary Frame

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The prior investigation into universal specificity (or specificity for short) found that time properly conceptualized is the interval over which change occurs, and is not a property of the Universe apart from physical changes to things in the Universe. Additionally, it was revealed that changes to this interval over which change occurs implies a change in conditions that caused it. For example, when an hourglass or grandfather clock relocates to a different altitude, the interval over which the sands drops or the pendulum swings changes because of the difference in gravitational force at the two altitudes. Additionally, it was found that a universally stationary frame (USF) must exist because the law of identity would be violated otherwise; and now the implications for such a frame existing will be investigated.

1. Implications of a USF

Recall that all observations are beyond reproach, and that specificity agrees with most (if not all) predicted observation relativity makes. However, specificity rejects many of the conclusions made in relativity, and many causes of those observations posited by relativity. This would be akin to accepting Ptolemy's planetary model as a model that makes accurate predictions of the relative motion of planets, but not accepting the conclusion that planets actually orbit around nothing (i.e., epicycles) [1].

As an example of such disagreement, specificity makes use of the law of identity, and asserts that distant events occur at specific instances in time and space. Specificity holds that the sequence of distant events only appear relative because of a model error in relativity involving an errored premise that light is constant in all directions for all inertial frames—its only constant in the USF. This implies that events at distance have a certain sequence in which they occur and their simultaneity is not relative, but only appear relative. The one frame that predicts the true sequence, by assuming that light is constant in all directions for this frame, is the USF we seek.

All of this implies the following:

- The speed of light is constant only in the USF, while light's relative speed might be more or less than that in all other frame in certain directions [2].
- The speed of light appears to remain constant in any other frame due to the miscalibration of measuring instruments caused by time dilation and length contraction.

Rotating USF X-Axis to Align with Velocity

In order to see these implications consider any object traveling any speed less than c with respect to the USF, in any arbitrary direction. The USF x-axis could easily be rotated such that the velocity of the object aligns with it, as shown in Figure 1 for two dimensions.

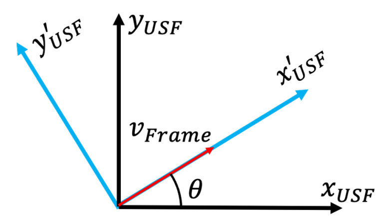

Figure 1. Velocity aligns with any arbitrary USF x'-axis.

The equation for this rotation is the traditional rotation of axis, and its formulation is presented in matrix form in Equation (1).

$$\begin{bmatrix} x'_{USF} \\ y'_{USF} \end{bmatrix} = \begin{bmatrix} \cos\theta & \sin\theta \\ -\sin\theta & \cos\theta \end{bmatrix} \begin{bmatrix} x_{USF} \\ y_{USF} \end{bmatrix} \tag{1}$$

The Null Result of the Michelson–Morley Experiment

Now consider the Michelson–Morley experiment [3], whose apparatus is illustrated in Figure (2). In this experiment light would arrive from a direction, and split in two orthogonal directions relative to the apparatus's reference frame (ARF), reflect off mirrors and return to be combined again such that any interference in the combined rays (caused by differing arrival times) can be detected. The length of both paths is made to be identical (measured in the ARF).

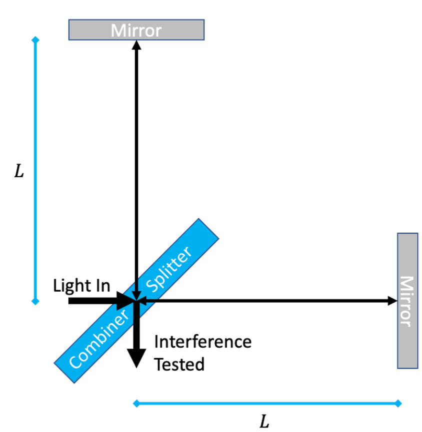

Figure 2. Michelson–Morley experiment schematic.

If light traveled at a constant c only in the USF, it was hypothesized that this instrument would detect interference patterns if it were traveling some positive velocity in the USF. To ensure some velocity in the USF, this instrument was tested against distant stars from various directions, at various points in earth's orbit. It failed to detect interference patters regardless of which part of earth's orbit this experiment was conducted, and regardless of which direction measurements were taken. Many consider this proof that the speed of light, c, is constant in all directions for all reference frames, as Maxwell's equations seemed to suggest, to the point where it became orthodox. The existence of a USF implies the speed of light can only be constant in the USF, so many take this to mean a USF does not exist.

If a USF exists, then we have to make sense of this experiment, and the first consider is what the average (to the mirror and back) speed of light was expected to be.

Quantifying the Average speed of Light

Specificity quantifies the average speed of light in the ARF consistent with classical mechanics. As an example, consider two cases. In the trivial case, the ARF is not moving relative to the USF, as shown in Figure (3a), and in the more interesting case the ARF is moving, as shown in Figure (3b). The dashed lines are the trajectory each light takes to the mirror and back.

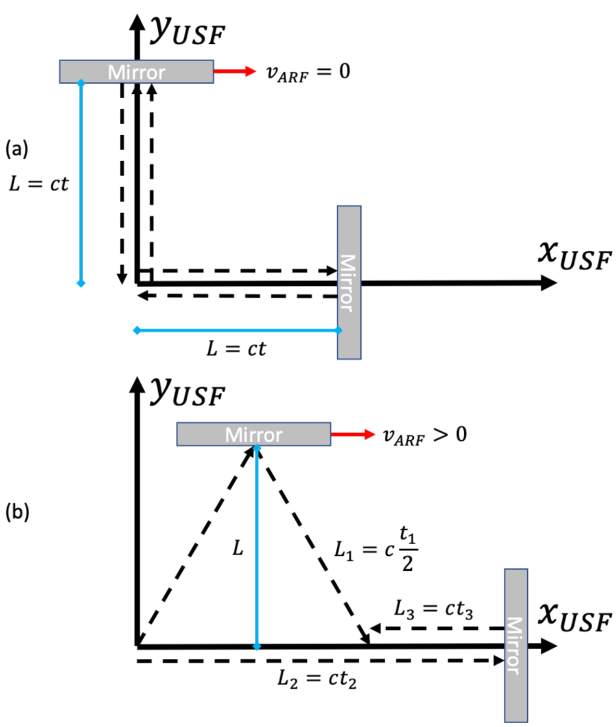

Figure 3. (a) Stationary apparatus. (b) Moving apparatus.

In the trivial case it is easy to see the average speed of light in the ARF, since the ARF is the USF, which means the speed of light is by definition c in all directions; therefore, the average is c.

In the more interesting case, the average speed of light in the ARF is more complicated to derive. While the apparatus is moving relative the the USF, observers in the USF see the light that is reflecting off the y-axis mirror following a "saw tooth" shaped path, as shown in Figure 3; however, this is not what observers in the ARF see. To them, only the y-component of the "saw-tooth" is observed; therefore, the light appears to be going straight up and down along the ARF's y-axis. The average speed of light along this axis is $c_{\perp} = \sqrt{c^2 - v_{ARF}^2}$ based on trigonometric laws illustrated in Figure (4).

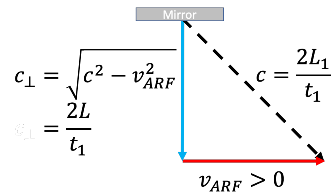

Figure 4. Trigonometric derivation of $c_{\perp}$.

The average speed of light in the x-axis, as seen in the ARF, is even more complicated to derive, as shown in Equation (2).

$$
\begin{aligned}
L_2 = ct_2 = L + v_{ARF}t_2 &\implies t_2 = \frac{L}{c - v_{ARF}} \\
L_3 = ct_3 = L - v_{ARF}t_3 &\implies t_3 = \frac{L}{c + v_{ARF}} \\
\therefore\ c_{||} = \overline{v} = \frac{2L}{t_2 + t_3} &= \frac{2L}{\frac{L}{c-v_{ARF}} + \frac{L}{c+v_{ARF}}} \\
&= \frac{2}{\frac{1}{c-v_{ARF}} + \frac{1}{c+v_{ARF}}} \\
&= \frac{2(c+v_{ARF})(c-v_{ARF})}{(c+v_{ARF}) + (c-v_{ARF})}] \\
&= \frac{2(c^2 - v_{ARF}^2)}{2c} = c - \frac{v_{ARF}^2}{c} \\
&= c\left(1 - \frac{v_{ARF}^2}{c^2}\right) \\
\text{Let}: \ \gamma &= \frac{1}{\sqrt{1 - \frac{v_{ARF}^2}{c^2}}} \\
\therefore\ c_{||} &= \gamma^{-2}c \ \blacksquare
\end{aligned}
\tag{2}
$$

Comparing $c_{||}$ to $c_{\perp}$ gives us Equation (3).

$$
\begin{aligned}
c_{||} &= \gamma^{-2}c \\
c_{\perp} &= \sqrt{c^2 - v_{ARF}^2} = c\sqrt{1 - \frac{v_{ARF}^2}{c^2}} = \gamma^{-1}c \\
\therefore c_{||} &= \gamma^{-1}c_{\perp} \ \blacksquare
\end{aligned}
\tag{3}
$$

The average speed of light in the ARF is not equal for both the x-axis and the y-axis, when the apparatus is moving in the USF. Within the ARF, light travels slower in the x-axis (on average) than in the y-axis by a factor of γ^{-1}.

The Average Effective Speed of Light

Given the existence of a USF, the only way for the light to arrive at the combiner at the same time is for the distance along the x-axis to contract by a factor of γ^{-1}, as shown in Equation (4).

$$
\begin{aligned}
t_1 &= t_2 + t_3 \\
\frac{2L}{c_\perp} &= \frac{L_x}{c - v_{ARF}} + \frac{L_x}{c + v_{ARF}} \\
\frac{2L}{\gamma^{-1}c} &= \frac{L_x(c + v_{ARF}) + L_x(c - v_{ARF})}{c^2 - v_{ARF}^2} \\
\frac{\gamma 2L}{c} &= \frac{2L_x c}{c^2 - v_{ARF}^2} = \frac{2L_x}{c}\frac{1}{1 - \frac{v_{ARF}^2}{c^2}} = \frac{\gamma^2 2L_x}{c} \\
\therefore\ L_x &= \gamma^{-1}L \blacksquare
\end{aligned} \tag{4}
$$

Indeed, this is the exact value given to length contraction commonly mentioned in relativity and originally derived by Lorentz in his Lorentz Ether Theory [4][5]. This length contraction makes the average *effective* speed of light, c_0, in any reference frame the same in all directions, quantified in Equation (5).

$$c_0 = \gamma^{-1}c \tag{5}$$

Apparent Speed of Light is c

The only remaining question to be answered in order to make sense of the null results in the Michelson–Morley experiment is why would a relatively slower traveling light not be detected? But its not. The duration of travel is measured to be the same in any ARF that has any speed relativity to the USF. The cause is due to a miscalibration of all temporal instruments in the ARF. It truly does take longer, but the duration for all changes lengthens in the ARF, meaning the recorded times for the truly longer period appear shorter than they are by the same factor. The net effect is the duration appears the same even though its longer. This miscalibration of time is called time dilation. Time dilation is given by Equation (6), where dt is the rate change of time measured in a clock stationary in the USF, and dt' is the rate change of time measured by an identical clock in the moving reference frame.

$$dt = \gamma dt' \tag{6}$$

To see why the miscalibrated instruments in the ARF measure the average speed of light to be c, first consider what calibrated instruments measure in the ARF, as shown in figure (5).

Now for the y-axis, we can apply time dilation to convert calibrated time, t_1, to miscalibrated time, t_1', while the length remains calibrated, as shown in Equation (7).

$$
\begin{aligned}
L &= \frac{t_1}{2}\sqrt{c^2 - v_{ARF}^2} \\
L' &= \frac{\gamma t_1'}{2}\sqrt{c^2 - v_{ARF}^2}
\end{aligned} \tag{7}
$$

On this basis we can now derive the apparent average speed of light in the y-axis, $c_\perp'$, as shown in Equation (8).

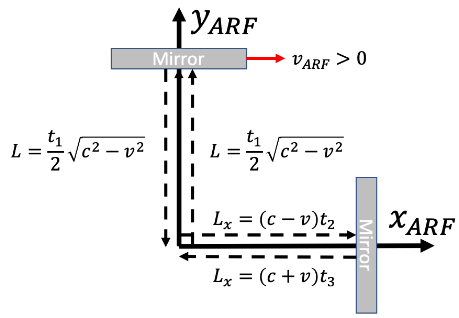

Figure 5. **Apparatus in ARF with calibrated Length.**

$$
\begin{aligned}
L' &= \frac{\gamma t_1'}{2}\sqrt{c^2 - v_{ARF}^2} \implies c_\perp' = \gamma\sqrt{c^2 - v_{ARF}^2} \\
\therefore c_\perp' &= \gamma c\sqrt{1 - \frac{v_{ARF}^2}{c^2}} = \gamma c \gamma^{-1} = c \blacksquare
\end{aligned} \tag{8}
$$

Now for the x-axis, we can apply time dilation to convert calibrated time, t_1, to miscalibrated time, t_1'; and we can apply length contraction to convert calibrated length, L_x, to miscalibrated length, L', as shown in Equation (9).

$$
\begin{aligned}
L_x &= t_2(c - v_{ARF}) \\
\gamma^{-1}L' &= \gamma t_2'(c - v_{ARF}) \implies t_2' = \frac{L'}{\gamma^2(c - v_{ARF})} \\
L_x &= t_3(c + v_{ARF}) \\
\gamma^{-1}L' &= \gamma t_3'(c + v_{ARF}) \implies t_3' = \frac{L'}{\gamma^2(c + v_{ARF})}
\end{aligned} \tag{9}
$$

On this basis we can now derive the apparent average speed of light in the x-axis, $c_{||}'$, as shown in Equation (10).

$$
\begin{aligned}
c_{||}' = \overline{v}' &= \frac{2L'}{t_2' + t_3'} = \frac{2L'}{\frac{L'}{\gamma^2(c - v_{ARF})} + \frac{L'}{\gamma^2(c + v_{ARF})}} \\
&= \frac{2}{\frac{1}{\gamma^2(c - v_{ARF})} + \frac{1}{\gamma^2(c + v_{ARF})}} \\
&= \frac{2(\gamma^2(c + v_{ARF}))(\gamma^2(c - v_{ARF}))}{\gamma^2(c + v_{ARF}) + \gamma^2(c - v_{ARF})} \\
&= \frac{2\gamma^2(c^2 - v_{ARF}^2)}{2c} = \gamma^2\left(c - \frac{v_{ARF}^2}{c}\right) \\
&= \gamma^2 c\left(1 - \frac{v_{ARF}^2}{c^2}\right) = \gamma^2 c \gamma^{-2} = c \blacksquare
\end{aligned} \tag{10}
$$

The total effect of time dilation, and x-axis length contraction, is that not only do the light traveling both paths arrive at the combiner at the same time, but also their apparent average speed in any direction for any inertial reference frame is always c, as Maxwell's equations suggested.

2. Conclusion

In conclusion, an existing USF has many implications, among which are: the average speed of light relative to any moving frame is not constant; the average speed of light is different in both the x-axis and y-axis (axes parallel and perpendicular to velocity respectively) in a moving frame; and length contraction allows the light to travel less distance in the x-axis to make up for the slower average speed of light in the x-axis. This causes the round trip times of light for both paths to be identical in the Michelson–Morley experiment regardless of the apparatus' velocity in the USF; therefore, the average effective speed of light is identical in any direction for any inertial reference frame, and less than c for any moving frame.

The average effective speed of light being slower than c, means light's travel time over the same distance takes longer; and the reason this longer duration is undetectable is because of a phenomenon known as time dilation. This causes the apparent average speed of light to always be c in all directions for any inertial frame, as Maxwell's equations suggested. The next investigation in this series will look into the nature of time dilation and its cause.

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