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Star Aberration and the Transverse Doppler Effect.

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Abstract:
The transverse Doppler effect and star aberration arise when the source of light or observer move in a direction perpendicular to a line connecting them. Special relativity considers the effect as proof of time dilation, yet it cannot explain the absence of aberration in the case of binary stars in motion. This paper identifies a simple explanation for star aberration and the transverse Doppler effect which contradicts the special theory of relativity.

It should be stated that special relativity considers only two situations under the transverse motion of light source and observer.

1. **The source moves** at speed V in a direction perpendicular to the connecting line and **the observer measures the frequency** of light received. A transverse effect arises and the observer measures the frequency $\nu = \nu_0 \sqrt{1 - \frac{V^2}{C^2}}$ which is less than ν_0. The transverse effect due to the motion of the light source is experimentally confirmed (Ives and Stillwel experiment and others).

2. **The observer moves** at speed V in a direction perpendicular to the connecting line and **measures the angle** at which the light beam from an immovable source approaches. Aberration arises and the observer sees the source shifted by the angle of aberration, $\beta = \frac{V}{C}$. This was discovered by Bradley in 1727.

There are two other possible situations:

3. **The observer moves** at speed V perpendicular to the connecting line and **measures the frequency** of light reaching him from an immovable source.
4. **The source moves** at speed V in a direction perpendicular to the line and the **observer measures the angle** at which the light beam approaches.

It is demonstrated below, that **both these situations contradict the special theory of relativity**.

In case 3 **the moving observer** receives light from an immovable source with a **frequency,** $\nu = \nu_0 \sqrt{1 + \frac{V^2}{C^2}}$ which is **more** than the frequency ν_0. This increase of frequency cannot be explained by any relativistic effect such as time dilation.

In case 4 when the **source moves,** there is **no aberration** and the observer sees the source from the position where the light was emitted. The absence of aberration in the case is confirmed in the observations of binary star systems and obviously contradicts special relativity.

1. The Transverse Doppler Effect when the Source Moves.

If the source **of sound** moves at speed V along the connecting line and if sound propagates in immovable air at speed V_0, the observer measures a frequency of $\nu = \nu_0 \frac{V_0}{V_0 \pm V}$ which, depending on the direction of movement of the source, is more or less than ν_0. If the observer moves at speed V along the connecting line, he receives e sound with a frequency of $\nu = \nu_0 \frac{V_0 \pm V}{V_0}$ which differs from ν_0 as well.

An analogous longitudinal Doppler effect takes place in optics when the observer or light source moves along the perpendicular.

If the observer moves in a direction perpendicular to the source–observer line, there is no change of sound frequency, because his motion does not additionally shift him relative to the wave fronts. Also the transverse effect is absent if the source of sound is in motion. But **in optics,** the transverse effect arises when the source of light is in perpendicular motion. Light approaches the observer with a frequency $\nu < \nu_0$. It is shown below that the transverse effect has a simple kinematic explanation and does not require time dilation.

The process of light propagation is unlike the process of sound waves in air, water or other medium. Light requires no medium. The light beam is a stream of photons which move in the vacuum at speed C relative to the source. Every photon has its own frequency, ν and oscillation period, $T = \frac{1}{\nu}$. The photons move intermittently in a medium. Periodically re-radiated by the atoms of the medium, they move from atom to atom with speed C and relative to the medium with the resultant speed $\frac{C}{n}$ which is less than C. When the photons enter a medium with a different index of refraction n, their speed is modified but equals C on exit, for example, from glass to vacuum.

Usual light sources emit photons with speed C in all directions. If the source does not move relative to the medium, only these photons reach the observer which were emitted by the source in direction 1 (Fig.1,a). Obviously, the photons which were emitted, for example, in directions 2 or 3 do not reach the observer. The observer sees the source in point S in the actual position at the moment of emission.

When source S moves at speed V, all photons receive an additional velocity, $\overline{V}$. Therefore the photons which were emitted by the source in direction 1, move relative to the observer, not with velocity $\overline{C}$ but with velocity $\overline{C_1}$ which is equal to the vector sum of $\overline{C}$ and $\overline{V}$ as shown on Fig.2,b. After re-radiation by the atoms of the medium, the speed of the photons relative to the medium becomes equal to $\frac{C}{n}$ and travel in the direction of the vector, $\overline{C_1}$. These photons do not reach observer O.

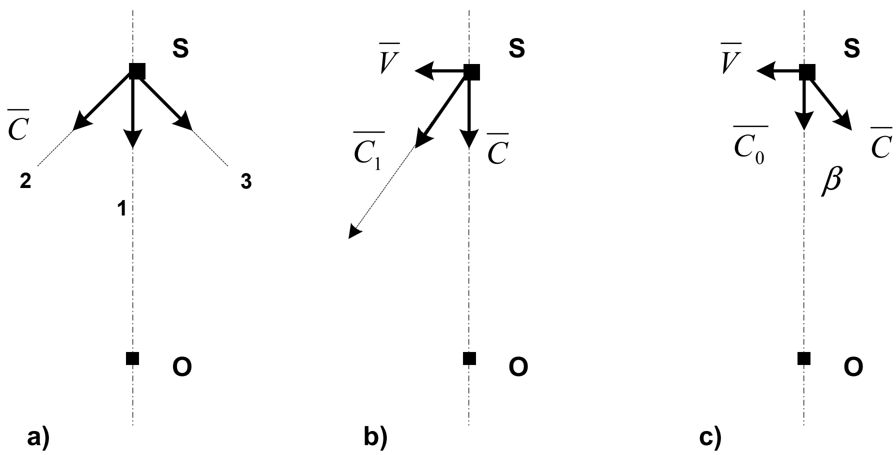

Fig.1

The photons which were emitted previously at angle $\beta = \frac{V}{C}$ to the line connecting source and observer, reach the observer (Fig.1,c). Because the source moves at velocity $\overline{V}$, immediately after emission, these photons move with an initial velocity, $\overline{C_0}$ which is equal to the vector sum of $\overline{C}$ and $\overline{V}$ and are directed along the connecting line. They are then re-radiated by the atoms of the medium and reach the observer with the speed $\frac{C}{n}$. Because the photons move before re-radiation with an initial speed of $C_0 = \sqrt{C^2 - V^2}$ which is less than C, the observer receives the frequency $\nu = \nu_0 \sqrt{1 - \frac{V^2}{C^2}}$ which is less than ν_0. Thus, contrary to special relativity, the transverse Doppler effect when the source moves has a simple kinematic explanation and the hypothesis of time dilation is not required.

2. Star aberration.

In 1727 Bradley discovered that the visible position of a star changes when the speed and the direction of Earth motion change. The greatest aberration takes place for stars located in a direction perpendicular to the velocity of the Earth.

In order to understand how aberration arises, consider the situation when a glass plate moves at speed V in a direction perpendicular to the beam of light (Fig.2).

If, in accordance with wave theory, we consider the light beam as a sequence of moving wave fronts, it does not change direction entering the moving glass plate (Fig.2,a) and there is no aberration.

However the beam of light is not composed of wave fronts but a stream of photons. The photons are likened to the "corpuscles" of Newton, only they have their own frequency and oscillation period. When the glass plate moves at speed V,

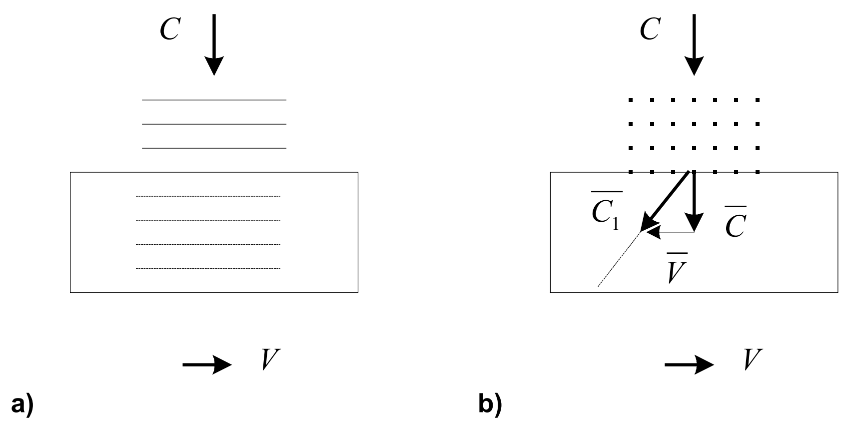

Fig.2

every photon interacts with an atom of glass, not with speed C but with velocity $\overline{C_1}$ which is equal to the vector sum of the velocities $\overline{C}$ and $\overline{V}$. Therefore the photons enter the glass in the direction of the velocity $\overline{C_1}$ (Fig.2,b). That is, every photon changes direction and travels relative to the glass plate at the angle of aberration, $\beta = \dfrac{V}{C}$.

The phenomenon of star aberration is explained in the same way. If the Earth moves at speed V in a direction perpendicular to the line joining them, the photons enter the Earth atmosphere, not with velocity $\overline{C}$, but with velocity $\overline{C_1}$ and therefore change direction relative to the atmosphere. Because of re-radiation by the atoms of the atmosphere, the photons enter the atmosphere with speed $\dfrac{C}{n}$. The observer sees the star, shifted by the angle, $\beta = \dfrac{V}{C}$ from its actual position. Thus, aberration arises as the result of the vector sum of the velocity $\overline{C}$ with which the photons travel from star to Earth and $\overline{V}$, the velocity of the Earth. Star aberration convincingly proves that the observer moving relative to the beam of light meets the photons, not with the speed C but with velocity $\overline{C_1}$ which differs from C both in direction and value. This contradicts special relativity.

3. The Transverse Doppler Effect when the Observer moves.

When the source of light moves in a direction perpendicular to the source – observer line, light reaches the observer with reduced frequency. That is, a transverse effect arises which is explained by time dilation in special relativity.

The above analysis of star aberration shows that an observer moving in a direction perpendicular to the source–observer line receives a different frequency from an immovable source. But this frequency is more than ν_0. The observer moving with a glass plate sees that the photons enter the glass with a speed $C_1 = \sqrt{C^2 + V^2}$ which is more than C and therefore the photons enter the glass, not with the frequency ν_0 but with the frequency $\nu = \nu_0 \sqrt{1 + \frac{V^2}{C^2}}$ which is greater than ν_0.

In this experiment, the source of light is immovable and the observer moves at speed V. If in accordance with special relativity, the movement of the observer is equivalent to the movement of the source, the observer receives from the source moving at speed $-V$, a frequency greater than ν_0. The increase of frequency in the transverse effect obviously contradicts both the statement that the movement of the observer is equivalent to the movement of the source and the hypothesis of time dilation in moving systems.

Experimental proof of the transverse Doppler effect is quite realizable at the present time, using an orbital laser.

4. The Absence of Aberration when the Source Moves

Star aberration arises when the observer moves with the orbital speed of the Earth in a direction perpendicular to the beam of light. If, as special relativity asserts, the movement of the light source is equivalent to the movement of the observer, star aberration has to arise if the source moves. However, the observations of binary stars prove that the visible positions of the stars do not display any additional shifts (aberration) due to their motion.

From 1911-1913, De Sitter convincingly proved that the speed with which light travels from stars to Earth does not depend on the motion of the stars. When one star of a binary system approaches Earth with speed V, the second star moves with the same speed in the opposite direction. But the light from both stars reach Earth with identical speeds. The De Sitter observations are considered the main confirmation of the Einstein's second postulate which states that speed of light does not depend on the movement of the source or observer. However, observations of binary stars prove there is no aberration when the star moves.

The independence of light speed from the speed of the source and an absence of aberration when the source moves (as proven by observations of binary stars) cannot be considered proof of the relativistic postulate of invariability of light speed since both phenomena are easily explained by the influence of the interstellar medium.

If the moving stars and the Earth were in an absolute vacuum, the ballistic W. Ritz hypothesis would be correct and light would travel from stars to the Earth with the speeds $C+V$ and $C-V$. However light travels, not in an absolute vacuum but in a rare gaseous medium. In any transparent medium, light travels with speed $\frac{C}{n}$. In an interstellar medium, the speed of light is nearly equal to C but this does not mean that the medium exerts no influence. When the star moves relative to the interstellar medium with speed V, initially the photons move relative to the medium in all directions with speeds $\overline{C}+\overline{V}$. At relatively small distances from the star, the photons are re-radiated by the atoms of the medium and their speed equals C. Because of re-radiation, the light of the stars moving with speeds $+V$ or $-V$ travel with the same speed C as the light from immovable star. The observer on the Earth sees the stars in the place from which light was emitted. That is, the light reaches the observer without any aberration. Because of re-radiation by the medium, the effect of speed V is not evident. The observer knows that the star is in motion only by the Doppler shift of the frequency.

Thus, the De Sitter observations of binary stars do not constitute proof of the postulate of invariability and the absence of aberration in binary star systems contradicts special relativity.

Conclusion

Star aberration and the transverse Doppler effect arise as a result of a vector summation of the speed of the photons with the speed of the observer or the source of light. These effects have simple kinematic explanations and do not prove that time dilation takes place in moving systems. They therefore contradict special relativity.