Fabry-Perot Interferometer and Doppler Effect

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The interference pattern of a Fabry-Perot interferometer is conserved in all inertial reference frames. Its constructive pattern requires the wavelength to be proportional to the gap width of the interferometer. The length contraction from Lorentz transformation assumes the gap of the interferometer to be contracted in the direction of the relative motion. The wavelength is also contracted as it is proportional to the gap width. For two observers moving at the same speed, the contracted wavelength appears to be identical. If one of them moves in the opposite direction, they will observe an identical wavelength but two different frequencies due to the Doppler effect. Consequently, they observe two different speeds from the same light.

I. INTRODUCTION

The interference pattern generated by a Fabry-Perot interferometer[1] is widely used to determine the wavelength of the laser.

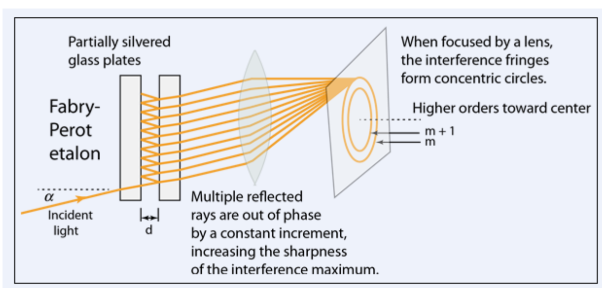

FIG. 1. Fabry-Perot Interferometer

The constructive pattern appears if the difference between two light paths is a multiple of the wavelength of the light. This proportionality between the wavelength and the gap indicates that the length contraction from Lorentz transformation[2] should be applied to the wavelength as well. Such length contraction depends on the speed of the relative motion, not the direction of the motion.

For two observers in motion relative to a stationary Fabry-Perot interferometer, both will observe the same wavelength if they move at the same speed but in the opposite direction.

II. PROOF

A. Fabry-Perot Interferometer

Let a Fabry-Perot interferometer and its light source be stationary relative to a reference frame F_0. Light travels in the x-y plane toward two semi-transparent surfaces which form an interferometer in the y-z plane. Let the wavelength of the coherent light be λ. The distance between two surfaces is L.

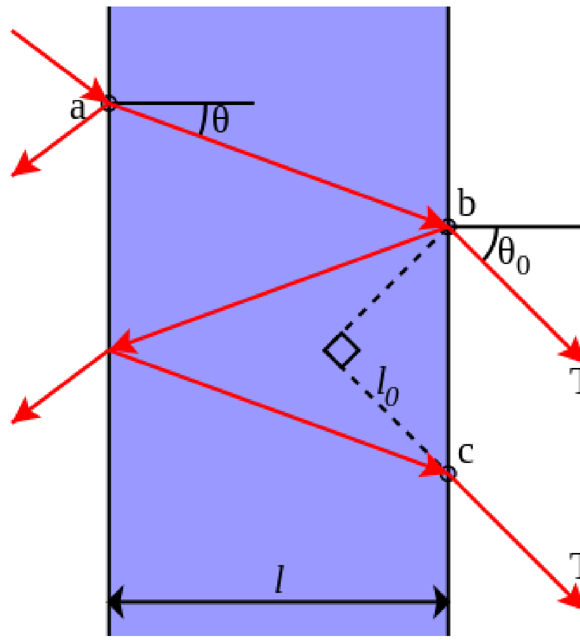

FIG. 2. Fabry-Perot Interferometer

Let the distance from point a to point b be D_{ab}.

$$D_{ab} = \frac{L}{cos(\theta)} \tag{1}$$

Let the distance from point b to point c be D_{bc}.

$$D_{bc} = 2 * D_{ab} * sin(\theta) \tag{2}$$

The condition for the constructive interference between T_0 and T_1 is

$$m\lambda = 2 * D_{ab} - D_{bc} sin(\theta_0) \tag{3}$$

From equations (1,2,3)

$$m\lambda = 2\frac{L}{cos(\theta)}(1 - sin(\theta)sin(\theta_0)) \tag{4}$$

m is a positive integer.

B. Length Contraction

The laws of physics are conserved in all inertial frames of reference.

Let another reference frame F_1 moves at a velocity of (v,0) relative to F_0. The constructive interference in F_1 is represented by

$$m\lambda_1 = 2\frac{L_1}{cos(\theta_1)}(1 - sin(\theta_1)sin(\theta_{01})) \tag{5}$$

Let another reference frame F_2 moves at a velocity of (-v,0) relative to F_0. The constructive interference in F_2 is represented by

$$m\lambda_2 = 2\frac{L_2}{cos(\theta_2)}(1 - sin(\theta_2)sin(\theta_{02})) \tag{6}$$

According to Lorentz transformation, length contraction is independent of the direction of the relative motion.

$$L_1 = L_2 \tag{7}$$

$$\theta_1 = \theta_2 \tag{8}$$

$$\theta_{01} = \theta_{02} \tag{9}$$

From equations (5,6,7,8,9),

$$\lambda_1 = \lambda_2 \tag{10}$$

The wavelength is conserved in both F_1 and F_2.

C. Doppler Effect

To a stationary observer in F_1, the light source of the Fabry-Perot interferometer is moving away with an apparent frequency f_1. To a stationary observer in F_2, the same light source is moving closer with an apparent frequency f_2. According to the Doppler effect,

$$f_1 < f_2 \tag{11}$$

The apparent frequency of the light source decreases in F_1 but increases in F_2.

D. Speed of Light

The speed of light in F_1 is C_1.

$$C_1 = f_1 * \lambda_1 \tag{12}$$

The speed of light in F_2 is C_2.

$$C_2 = f_2 * \lambda_2 \tag{13}$$

From equations (10,11,12,13),

$$C_1 < C_2 \tag{14}$$

The apparent speed of the light decreases in F_1 but increases in F_2.

III. CONCLUSION

The apparent speed of light is different in a different reference frame. The speed of light in the rest frame of the observer depends on the relative motion between the observer and the light source.

A stationary Fabry-Perot interferometer shows that the wavelength of its light is conserved for two observers moving at the same speed but in the opposite direction. Both observers detect an identical wavelength but two different frequencies. Therefore, they observe two different speeds from the same light.

Lorentz transformation is based on the assumption that the speed of light is identical in all inertial reference frames. This is proved to be incorrect by the interference pattern of the Fabry-Perot interferometer. Lorentz transformation has contradicted itself with its length contraction.

Therefore, Lorentz transformation fails to describe physics properly. It is an impractical mathematical description that does not describe the real world. It is not suitable for physics. All theories that are based on Lorentz transformation are proved to be unsuitable for physics.

[1] Fabry, C; Perot, A (1899). "Theorie et applications d'une nouvelle methode de spectroscopie interferentielle". Ann. Chim. Phys. 16 (7).

[2] H. R. Brown (2001), The origin of length contraction: 1. The FitzGeraldLorentz deformation hypothesis, American Journal of Physics 69, 10441054. E-prints: gr-qc/0104032; PITT-PHIL-SCI00000218.

[3] Eric Su: List of Publications, http://vixra.org/author/eric_su