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A BRIEF COMMENT ABOUT AIRY'S EXPERIMENT

Abstract

People have objected that Airy's failure to detect an increase in the aberration angle when filling the telescope tube with water negates the arguments posed in my paper "**Somme Remarks About Starlight Aberration**" *.
So, for the sake of completeness it deserves an explanation.

Let's make a brief retrospect of what has been said and adhering to the KISS principle of keeping it simple. Any generalization accounting for different directions of incoming light is a valid but useless complication and serves only to blur the explanation inasmuch that it ends up leading to the same final results.
I have proposed the simple picture of picking a star in the zenith and a laboratory on the Earth represented by a closed box, moving with the Earth in a direction orthogonal to the direction of the incoming star light. The hypothetic box has a small window facing directly to the star. When at rest, the star light will enter the window with speed **c** and shine straight on the back wall on a site directly opposing the window. Once the box starts to move with velocity **v** in a perpendicular direction to the direction of the incoming light, the star light will continue downward with velocity **c** ignoring the box's translation but when hitting the back wall, the box isn't in the same position anymore and the light ray will land farther aft in relation to the box's moving direction.
There is no conflict about light speed limit. Light continues to travel at speed **c**, in a rectilinear direction, straight down across the moving system but, due to the system's proper movement, the incoming light simply lands farther behind the previous landing site, and Eddington's model of rain drops, if you like it or not, is still the only applicable model Fig, (1).
For an observer inside the moving system, light would be seen to move at an **apparent** $c' = \sqrt{c^2 + v^2}$ and the angle of starlight aberration is

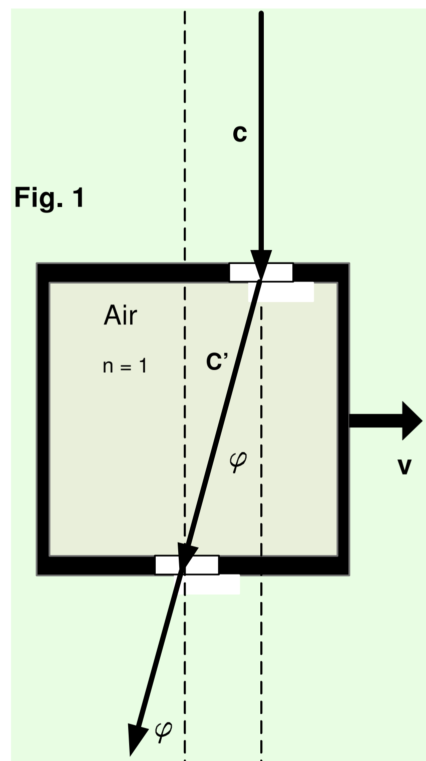


Fig. 1

$$\varphi = \operatorname{atan}\left(\frac{v}{c}\right) \qquad \varphi = 20.489\,\text{arcsec}$$

Once this has been firmly established, let's see what happened when Airy filled the the telescope wit water. In the case of Airy's experiment, Fresnel drag is not involved since the observer and the water filled telescope are co-moving so, the relative speed is zero. There is a simple explanation for Airy's failure. The light ray that enters the water filled telescope has to quit somewhere down the telescope tube in order to be observed since Airy was not immersed in a water pool when he performed his experiment. In so doing, two things happen:

1) The light rays hit the the telescope coming straight down with velocity **c** coming from a vacuum/air medium with a refractive index $n_1 = 1$ and, having to propagate through water whose refractive index is about $n_2 = 1.333$ will be slowed down to $\frac{c}{n_2}$ and, as shown in diagram **Fig.2**, travel down along the tube with an angle

$$\theta = \operatorname{atan}\left(\frac{v}{c} \cdot n_2\right) \qquad \theta = 27.312 \cdot \text{arcsec}$$

<== deviation angle inside water

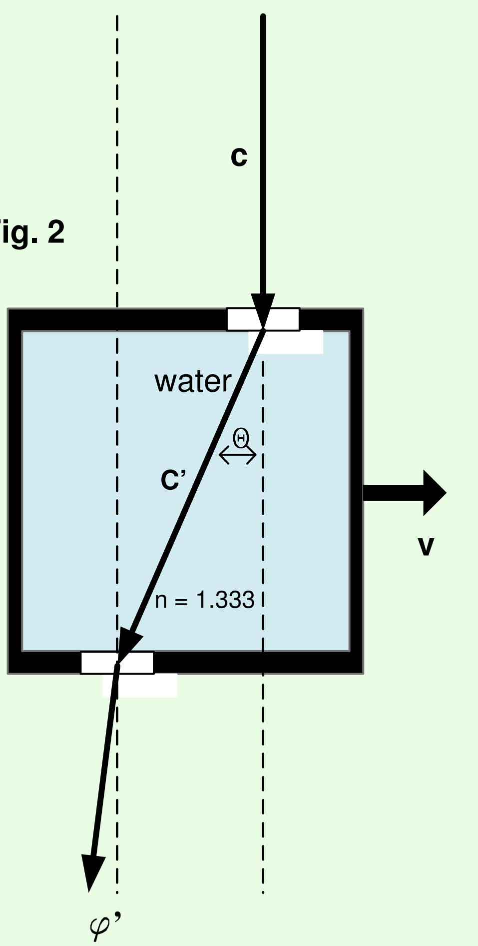
2) Yet somewhere down the tube, the light rays must leave the water in order to be observed. Here we have to apply Snell's law

$$\frac{\sin(\varphi_1)}{\sin(\varphi_2)} = \frac{n_2}{n_1} = \frac{v_1}{v_2}$$

to get

$$\sin(\varphi') = \frac{n_1}{n_2} \cdot \sin(\theta)$$

Fig. 2



applying Snell's formula

$$\varphi' = \operatorname{asin}\left(\frac{\sin(\theta)}{n_2}\right)$$

$\varphi' = 20.489394320554 \cdot \text{arcsec}$ <= actual telescope tilt angle

Comparing to the normally air filled case φ above

$\varphi = 20.48939439909 \cdot \text{arcsec}$

φ' is correct to seven decimal places

Note that those two figures diverge very slowly with increasing **n**. For a dense medium with n = 5 φ' will be 20.489391972936 arcsec. Still correct to five decimal places!

* **Somme Remarks About Starlight Aberration**
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