SIMULTANEITY; SEEING VERSUS OBSERVING

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References: Griffiths, David J. (2007), Introduction to Electrodynamics, 3rd Edition; Pearson Education - Chapter 12, Post 5.

The standard thought experiment for proving that the simultaneity of two events depends on the observer is that of a railway car of length L travelling down a straight track at some speed v. In the centre of the car is a light bulb which is switched on just as the bulb passes the origin of an observer standing beside the track. To an observer inside the car, the light appears to reach both ends of the car at the same time, namely $L/2c$.

The observer beside the track, however, sees the light hit the back end of the car before it hits the front end, because to this observer, the light still travels with speed c, and the back end of the car is moving towards the light source while the front end is moving away from it. To this observer, the distance the light must travel to reach the front end is

$$d_f = \frac{L}{2} + vt_f \tag{0.1}$$

where t_f is the time taken for the light to reach the front end. This time must also be equal to the distance travelled divided by c, so

$$t_f = \frac{\frac{L}{2} + vt_f}{c} \tag{0.2}$$

$$t_f = \frac{L}{2(c-v)} \tag{0.3}$$

A similar calculation for the back end gives

$$t_b = \frac{L}{2(c+v)} \tag{0.4}$$

Since $t_f \neq t_b$ if $v > 0$, the observer beside the track does not see the light hitting both ends of the car at the same time.

Griffiths draws a distinction between what someone 'sees' and what he 'observes', which to my mind, is a bit confusing since seeing and observing are essentially the same thing. He defines 'seeing' as the unprocessed data you receive about some phenomenon, and 'observing' as what you conclude about that phenomenon after interpreting the data. His point, however, is valid: you need to make sure that you interpret what you see to draw the correct conclusion. For example, if two cannons at different distances from you are fired in succession so that the bangs they make when fired happen to arrive at your location at the same time, it is incorrect to interpret this as showing that the cannons were *fired* at the same time. Clearly you have to take into consideration the distance each cannon is from you and divide that by the speed of sound to determine when it was fired.

Example. Suppose there are synchronized clocks at 1 million km intervals in a straight line, with the first clock sitting right beside you. The nth clock is $n\times10^{9}$ m away from you, so the light signal will take time $t_{n}=\left(n\times10^{9}\right)/c$ to reach you. When the clock next to you reads 12 noon, the time you will see on the nth clock will read t_{n} seconds before noon, although if you allow for the travel time, the actual time registered by that clock when your clock reads 12 noon is also 12 noon.

For the 90th clock down the line, you will see it read

$$t_{90}=\frac{90\times10^{9}}{3\times10^{8}}=300\text{ s} \tag{0.5}$$

before 12 noon, or 11.55 AM. Thus you 'see' the time on the 90th clock as 11.55 AM but you 'observe' it to be 12 noon.

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