

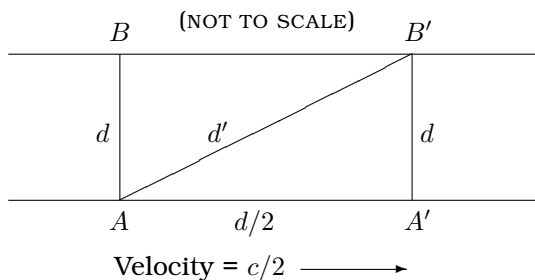
Frames of Reference

DARRIN YEAGER

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About AD 1900 scientists believed everything had been figured out; there was little left to do. Sure, some details had to be filled in, but for the most part we understood the world around us. Then along comes this Einstein guy and messes up the whole thing! Einstein is famous for two basic things — Relativity and Quantum Physics — plunging scientists into a world of doubt and uncertainty. Let's look at *one* of these two (Relativity) and see why it troubles people so. The other (Quantum Physics) is extremely interesting in it's own right, but is a subject for another time (no pun intended!).

First, consider the following diagram (I'll explain it in a moment), and remember, *there will only be one line of Physics in the following discussion*, so if you are of the type thinking "I can't understand physics stuff", hang on.



First, consider you and a friend are riding motorcycles, represented by A and B. You are traveling from point A to point A' at 1/2 the speed of light, or $c/2$. At point A you shine a flashlight toward your friend, at point B. (Notice the picture is not to scale).

From your point of view, *neither of you is moving since your speed is the same*. This is familiar to anyone who has ridden in a car. If someone pulls up alongside you as you are traveling down the road, if they match your speed, it appears to both of you as if you are both sitting still in a parking lot. In either case, both you and your friend see the light travel along the path noted by d . For you both, *your forward motion*

is irrelevant to your perception of the event as you are both in the same reference frame.

Now, consider someone standing along side the road, watching you both go by. Since you and your friend are moving, they see you travel from A to A'. What path would the light take to them? Looking at the picture above, the answer is d' . This should also be familiar to anyone who has ridden in a car. Imagine throwing a ball out the window of a moving car. Since the car is moving, as you throw the ball, it still travels forward as it falls, doesn't it?

Before we continue, be sure you understand the diagram and the previous two paragraphs. Neither assume any understanding of relativity or physics, just some recalling of your experiences, however, they are critical to understand before continuing.

OK, now the fun begins! Once again, we must recall some of our experiences. Suppose you travel in a car at 60mph for 1/2 hour. How far have you traveled? How do you know? The answer is the following equation: $d = v * t$ (distance equals speed multiplied by time). Thus 60mph * 1/2 hour = 30 miles. But you already knew this. (See, you know much more about physics than you thought!) Perhaps you did not know the equation, but once again, anyone who has traveled in a car has experienced this.

Now, lets apply the previous equation to our paths d and d' above. Then we thus have $d = v * t$ and $d' = v' * t'$. Fair enough? (Remember, d, v, t are for you and your friend riding the motorcycles, and d', v', t' are for your friend watching you go by). Notice by looking at the picture, that $d' > d$. In the interest of completeness, I shall now prove $d' > d$. For readers who do not wish to proceed in mathematical exactness, you may proceed to equation 1.

Good, you don't trust me, so let's dive in. Using some geometric properties of a right triangle (the famous Pythagorean theorem where $a^2 + b^2 = c^2$) yields the following:

Which simplifies to the following shocking result:

$$(d')^2 = \left(\frac{d}{2}\right)^2 + d^2 \quad t' > t \quad (5)$$

Lets perform the squares to get:

$$(d')^2 = \frac{5d^2}{4}$$

Taking the square root of both sides yields:

$$d' = \frac{\sqrt{5}d}{2}$$

Now the square root of 5 is about 2.2. Thus $d' > d$, which is what I asked you to believe. We don't really care about the *exact* ratio (it will vary depending on the velocity of the motorcycles), all we are interested in is for the moving motorcycles, $d' > d$.

Now, let's look at all we know:

$$d = v * t \quad (1)$$

$$d' = v' * t' \quad (2)$$

$$d' > d \quad (3)$$

Combining inequality 3 with equations 1 and 2 yields the following inequality:

$$v' * t' > v * t \quad (4)$$

OK, I promised only one line of real physics, and here it is:

Every observer measures the same value c for the speed of light (Tipler, Physics, Third Edition Volume 2, page 1107)

Now, that wasn't so bad, was it? This was Einstein's proposal. Simply put, it just means everyone measures the speed of light as equal. What does that mean for our little example? That $v' = v = c$. Thus, inequality 4 becomes:

$$c * t' > c * t$$

Now, remember what t represents, *time*. This means for our observer watching us go by, their time is *longer*. Does this mean for our friends on motorcycles they experience a "slowdown" of time? NO! If we take two atomic clocks (extremely accurate) and place one on a motorcycle, put the other with the person standing along the road, synchronize them, then let the motorcycles ride by, when they come back we notice the clocks are no longer synchronized! *It is the very nature of time itself that has changed, not the accuracy of the clocks.*

OK, so you understand a little about relativity — what does this have to do with the Bible? First off, does this alter your understanding of the old earth verses young earth discussions? Time is not an absolute property — it varies. This is one reason why I don't engage in that debate. But foremost, the Bible is clear — the cosmos was created in six 24 hour periods (Exodus 20:11), not billions of years. Why is that verse there? As a refutation of evolutionary theory.

When studying the creation account in Genesis you must consider at a minimum the following points:

- Relativity — time is not absolute. It varies.
- New theories about the speed of light slowing down.
- The Hebrew must be studied for original meaning. Translating it into English can lose some of it's important nuances.

Also consider the following:

But, beloved, do not forget this one thing, that with the Lord one day is as a thousand years, and a thousand years as one day (2 Peter 3:8 NKJV).

Relativity is a recent discovery (1900's), so how would Peter have known about it thousands of years ago? Only by inspiration of the Holy Spirit. Yet another reason to take your Bible seriously.

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