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GPS and General Relativity

by Miles Mathis

I have gotten many emails over the years on this, but I haven't had much to say until now. It didn't seem as important as the other things I was working on at the time. As usual I find myself caught in the middle of two factions: the mainstream which believes GR is true and complete, and the anti-Relativists who believe Relativity is a big scam. I am not on either side, since I think Relativity is true but incomplete. I have shown the mainstream equations and solutions are incomplete and faulty, but I have also shown how to correct them. For this reason, I tend to alienate both sides of this and every other argument. But since I am interested in truth, not popularity, this doesn't worry me too much. I say what I think and let the chips fall where they may.

I recently got confirmation from an ally that GPS does not use GR. He told me that a highly placed individual who works in the field confirmed it to him, adding that those in the field were expected to pretend they used GR when they don't. This isn't the first time I have heard this. I have had similar confirmation of it from insiders. Unfortunately, all these people wish to remain anonymous, which makes science difficult to do. In a healthy science, the truth would be the main concern and no one would fear speaking out. As we all know, that is not the real world.

At any rate, I will show you why GPS doesn't need to use GR, showing at the same time why this fact is not proof against Relativity.

In my simplified field equations, I have shown you how to do a stripped-down form of General Relativity by looking at time differentials in a gravity field. That is what I will do here. A time differential is just the time it takes light to travel the distance in the given problem. In the GPS problem, the satellite is at an altitude of something like 10,000 miles. That is about 16 million meters. So the signal travels twice that*, or about 30 million m. Light travels that far in .1s, so that is our time differential. It could also be called our margin of error in the GPS problem. If we don't use General Relativity, we will have an error of .1s. But what does that mean? We aren't (normally) measuring time with GPS, we are measuring location. That is why it is called Global *Positioning*. How do we get a location error from a time error?

GPS is said to have an *accuracy* of about 100 nanoseconds, but that is GPS time they are talking about there. That is not what I am talking about here. When I say that GPS has an initial margin of error of .1s, my claim has no connection to this *accuracy* number. This margin of error I am talking about is a margin of error caused by the fact that light does not have an infinite speed. The accuracy number is not determined that way. It doesn't come out of Relativity, it comes out of more mundane factors like atmospherics, ephemeris, and multipath errors.

So, to move on. It turns out that a location error is actually a distance error, in the math of Relativity. To see what I mean, think of how GPS is used by golfers. In golf, you use GPS to give you a distance from where you are to the hole or pin. So if there is a GPS error, it will give you the wrong distance to the pin. The distance between the two locations will be off. If the GPS is off by .1s, how do we translate that to distance error? Quite simply. I have solved other problems by using the equation x=ct as a time to length transform. I have shown that equation is false in the proofs of Special Relativity, since it contradicts Einstein's postulate 2; but it *can* be used as a transform from x to t, helping us solve some problems. Because light goes 300 million meters in a second, for light the second is much larger than the meter. That is a very simple transform right there, although no one has ever recognized it as such.

But here that doesn't really help us, because if we use that transform we just get the number 30 million meters. We find that for light, .1s is equivalent in the field to 30 million meters. So we are just going in circles. We know that in the GPS problem our margin of error can't be 30 million meters. So we must not be doing the math right. However, we can still use this logic to solve the current problem, provided we dig a bit deeper. In other words, we *can* use the equation x=ct as our transform, but we have to tweak it. We have to use it in conjunction with velocity equations.

To do that, we simply have to recognize that GPS is used not on light, but on normal objects at rest (or nearly at rest relative to light). These normal objects aren't going c, they are going v, and that v is very near zero relative to c. Therefore, we can say that these objects—like golfers and pins—are going more than 300 million times *slower* than light. In short, 1 second is not equal to c meters, it is equal to 1/c meters. Or, to be more precise, we divide .1 by 300 million, instead of multiply. This gives us a margin of error in the current problem of 3.3×10^{-10}m. By ignoring General Relativity, GPS is wrong by about a third of a nanometer here. Since GPS is known to be accurate only to about 5cm (with full augmentation), and since even "post-mission measurements" claim only an accuracy of 1mm or so, the GR margin of error is well below those limits. This is true even when light has to travel much further than the 30 million meters we gave it above. It could go a million times further than that and still not impact the current accuracy.

That is why GR can be ignored in GPS. It isn't because Relativity is wrong, it is because Relativity is negligible.

Some will say, "Oh, that doesn't work, because v isn't 1/c, it is just zero or near zero. Big difference." But is it a big difference? No. Again, it is a negligible difference at our scale. The difference between zero meters and 1/3 of a nanometer is negligible. Finding a location to within one ten billionth of a meter is good enough for most purposes. GPS isn't used for locating molecules. As this is true for distance, it is also true for velocity. The velocity 1/c is near enough zero for our purposes.

If you don't understand my shortcut math here, just remember that an object at rest is not really going 300 million times slower than light. You may have noticed that I said above that an object at rest is going "more than" 300 million times slower than light. An object going **1 m/s** is going 300 million times slower than light. Our proposed objects are not going 1 m/s, they are going *zero* m/s. Therefore, 3.3×10^{-10} is much closer to zero than 1 is. To solve in this way, you don't use 1 m/s to stand for velocity, you use 1/c. You have to because of the way the equations for velocity are written. You can't solve using zero, can you? You have to express v as a fraction of c, and zero isn't a fraction of anything.

I could write the math in any number of other ways, but it is best to explain the concepts, like this. Once you understand the concepts, you can write the solution in any math you like. If you prefer big fancy math with flashing lights and whirling sirens, go to it: I am not stopping you.

This means that if GPS is used on objects that are going very fast, the margin of error increases. For instance, if GPS is used on an airplane approaching a city, the airplane is moving fast but the city is not. The airplane and city are therefore not at rest relative to one another, and the margin of error in GPS will be more than .3 nanometers. The error will still be negligible, but it will rise with rising speed. If the airplane reaches a speed some appreciable fraction of c, then the distance error will not be negligible. If we were tracking high-speed electrons using GPS, we might need to use General Relativity, but not otherwise.

So you see the problem is once again a failure to understand Relativity. Neither the mainstream people nor the anti-Relativists actually do. The mainstream theorists think we need GR for GPS, but that is because they are using the wrong equations, as usual. And the anti-Relativists think the fact that we don't need GR for GPS means GR is completely wrong. As I have shown here and elsewhere, GR isn't completely wrong. It is mainly correct in theory but the proofs and equations have many faults.

I may have to pull apart the current equations, which propose to show that GR should be used in GPS, before anyone comprehends what I am talking about. I have found that no one tends to believe me until I do that. But I couldn't find those equations on the internet and I am not an insider. If someone wants to send me the equations or send me a link, I will see what I can do.

*The GPS receiver on the ground would either have to send a message up and back or receive at least two messages from the satellite. That is the minimum amount of information necessary to calculate a distance. In practice, the receiver gets a stream or line of messages, but in theory a perfectly smart receiver could calculate a distance from only two messages or two single receptions. Therefore, we can use a doubled distance to represent the time differential. This nicety doesn't really impact our solution here, since—as I show—even if we use a million messages, the margin of error doesn't become significant.