

Re: GPS calculations

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"Henri Wilson" <H@..> skrev i melding news:3a0jl0d0l2usb2s61je64lplrgbkhvtlrh@4ax.com...

> *On Tue, 28 Sep 2004 14:49:01 -0500, EJP <nospam@hackers.are.bad> wrote:*

>

> *>xxein wrote:*

> *>> For those confused by 46 us/day and 38 us/day, It depends on wether*

> *>> you think the satellites orbit once a day or twice a day.*

> *>>>*

> *>>> It seems there is a lot of confusion both on this ng and the general*

> *>>> science archives.*

> *>>>*

> *>>> End.*

> *>>*

> *>>There is no confusion amongst those who know what they're talking*

> *>>about. The correction is 38 usec a day, based on a perturbative*

> *>>treatment which allows you to separate the "SR" and "GR" compoenents.*

> *>>If you do this, you get a 45 usec advance from the gravitational*

> *>>potential difference and a 7 usec slowing form the SR component,*

> *>>giving a net correction of 38 usec. This was calculated *long**

> *>>before the satellites were launched and match observation exactly.*

> *>>*

> *>>Since the orbital period of GPS satellites is about 12 hours,*

> *>>the correction per period is about 19 usec. I'm not sure*

> *>>where your 46 usec comes from, except that it's close to the*

> *>>45 that one gets from a partial calculation.*

> *>>*

> *>>The calculation is actually pretty simple. I've appended it*

> *>>below. This version is a bit long because I was arguing with*

> *>>some kook that claimed all sorts of "extra" factors had been*

> *>>added, and I was showing that you can calculate the whole thing*

> *>>if you know the altitude and period of the satellite and*

> *>>the radius of the Earth.*

> *>>*

> *>> -E*

> *>>*

> *>>*

> *>>=====Details of GPS Calculation=====*

> *>>The altitude of the GPS sats are about 20,000 km, so their*

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> > radius is 27,000 km. The observed period is 12 hours. From this you
> > can work out that the velocity is
> >
> > $v = 2\pi R/T = 3.93 \times 10^3$ m/s
> >
> > This means that $\beta = v/c = 1.31 \times 10^{-5}$. The velocity at the
> > surface
> > of the earth is negligible compared to this, so the SR clock correction
> > would come from
> >
> > $\gamma = 1/\sqrt{1-\beta^2} \sim 1 + .5\beta^2 \sim 1 + (8.5 \times 10^{-11})$
> >
> > so the orbiting clock would tick "slowly" by $1/\gamma$, or a fractional
> > change of
> >
> > 8.5×10^{-11}
> >
> > and the clock would lose $(86400) \times (8.5 \times 10^{-11}) = 7 \times 10^{-6}$ s/day
> >
> >
> > Now, move on to GR. Use
> >
> > $v = \sqrt{GM/R}$ to get $GM = 4.2 \times 10^{14}$
> >
> > The GR gravity-only time dilation "gamma" is (look it up)
> >
> > $\gamma = 1/\sqrt{1 - 2GM/(Rc^2)} \sim 1 + GM/(Rc^2)$
> >
> > So the difference between a clock ticking on Earth ($R=R_e=6.7E6$) and one
> > ticking in orbit
> > ($R=R_o=27E6$) would be
> >
> > $1 + GM/(R_e \cdot c^2)$
> > ----- $\sim 1 + (GM/c^2)(1/R_e - 1/R_o)$
> > $1 + GM/(R_o \cdot c^2)$
> >
> > since the earth clock is deeper in the gravitational well, it would tick
> > slowly and relative to it, the GPS clock would tick fast by a factor
> >
> > $(GM/c^2)(1/R_e - 1/R_o) = 5.23 \times 10^{-10}$
> >
> > so the clock would gain
> >
> > $86400 \times (5.23 \times 10^{-10}) = 45 \times 10^{-6}$ s/day
> >
> > so the net gain would be $45 - 7 = 38$ microseconds, which is (strangely
> > enough) EXACTLY the value they use, see
> > <http://www.phy.syr.edu/courses/PHY312.98Spring/projects/GPS/GPS.html>
> >
> >
> > So what is it about movement or gravity wells that actually affects the way a

- > *clock ticks?*
- >
- > *You CDEFs all talk crap.*
- >
- > *Just because light increases speed and incurs a doppler shift as it falls down*
- > *a gravity well, you think 'clock ticks' do the same.*
- >
- > *Maybe PA's famous tick fairies are at it again....!*

Sure, Henri.

You don't get it, so it has to be crap..

But isn't it strange that the crap is exactly right?

Oh, that's right.

GR is invariably right to an amazing precision by pure coincidence.

So GR must OBVIOUSLY be wrong.

The ballistic theory, OTOH, invariably gets it wrong.

But that is of course due to fog – or something – like the measured data are wrong and the unobserved data are right – or something else – well – anyway, the ballistic theory MUST obviously be correct.

Right?

Paul