Re: Simple Sagnac

Source: http://sci.tech−archive.net/Archive/sci.physics.relativity/2005−08/msg00497.html

- *From*: sal <pragmatist@xxxxxxxxxx>
- *Date*: Thu, 04 Aug 2005 23:07:03 −0400

On Thu, 04 Aug 2005 18:57:33 −0700, bsr3997@xxxxxxxxxxx wrote:

> I have no puppeteer. Bruce S Richmond

Well, my sincere apologies, indeed. It seems that I took your post
rather differently from the spirit in which it was given.

Luckily I messed up my filter file or I wouldn't have seen your
followup post. You may rest assured I'll be less trigger happy in the
future.

I'll start over again here, and this time I'll be a bit more polite
.... :−(

> sal wrote:
>>
>> On Wed, 03 Aug 2005 21:59:15 −0700, bsr3997@xxxxxxxxxxx wrote:
>>
>>
>> > sal wrote:
>> >> On Tue, 02 Aug 2005 21:32:21 −0700, bsr3997@xxxxxxxxxxx wrote:
>> >>
>> >>
>> >> > Leaving out the + or − wrt is what caused your time to come
>> >> > out the same in both directions.
>> >>
>> >> No, it's not. It's assuming the signal moves at C/N relative to
>> >> the cable (rather than C relative to the fixed frame), combined
>> >> with vector addition of velocities, which leads to the time
>> >> coming out the same in both directions.
>> >
>> > Ah, so you found your error, And I assume you will correct it on
>> > your web site :)
>>
>> Ah, so you intentionally misunderstand.
>
> Not sure what you are talking about here but I don't intentionally
> misunderstand things. It is not my intention to be a troll. I

> commend you for the effort you have put into building your site. I
> was just trying to correct a few things that I knew were not quite
> right. It wasn't meant as an attack. Sorry if it came off as one.
>
> As for my being a crank, I do not claim that there is anything wrong
> with relativity. And I am not the only one that said there were a
> few questionable things about your page. Bill Hobba questioned the
> use of SR with a rotating system. Your own page says that you can
> not sync clocks in a rotating frame. That should have been a clue
> that something was wrong.

The thing that is wrong was my assertion that "classically" the effect is inexplicable. (More on that, below.) The use I made of relativity is fine, however.

You should, by the way, notice something: Noplace on that page do I use the term "special relativity". It just happens that the only math I used was math which one encounters in special relativity.

> What you have done is show why SR can't be used in rotating frames.

This is debatable and is really a point of semantics.

The semantic issue is: "What is special relativity"? From _general_ relativity ... and from experiments ... we know that acceleration, itself, does not affect time. We also know there's nothing magical about rotation −− it's just linear motion combined with centripetal acceleration.

Einstein's original SR papers didn't deal with acceleration. However, that doesn't mean we can't apply the same techniques to accelerated bodies, and, in fact, knowing what we know about relativity in general, there's no reason not to.

Again, the issue is one of semantics: If, when you say "Special Relativity" you mean "What Einstein discussed in 1905", then accelerated frames are indeed left out. BUT if when I say "Special Relativity" I mean "Relativity in the absence of gravitational fields, and in which we restrict our analysis to use only coordinate systems in which the metric is Lorentz's", then I can study accelerated objects with no problem, and, with due caution, I can even examine accelerated frames.

About any (non−singular) point one can construct a "local Lorentz" frame, or a "momentarily comoving reference frame". This is an inertial frame which coincides with the frame you started with at one particular instant in time and one particular place. If one works through the behavior of a signal moving around the rim of a disk with velocity k relative to the disk's rim, and the rim of the disk is moving at velocity v, one will indeed find that the velocity of the

signal as viewed by an observer in the "stationary" frame is given by the composition of velocities law. That's (a sketch of) the justification for the first part of the page in which I discuss the effect from the "fixed frame".

One can include as much or as little detail as one wants in the analysis; however, if one keeps in mind that the behavior of an accelerated reference frame is _locally_ just like the behavior of an inertial frame which happens to be comoving with it, _AND_ if one keeps in mind that the acceleration here is always transverse to the velocity, one can see immediately that the "local Lorentz frame" is just the frame that's moving tangentially to the disk, and the signal speed must obviously be given by CofV. One can then skip the messy math because the result is obvious up front.

Now, as to the analysis from the point of view of the cable −− we can again note that the acceleration doesn't affect time, and from that we at once see that it's just the same as the "straight" case, save that it's bent. The bend itself is irrelevant. (Magnify the picture enough, and you can't even see the bend; and it's in the "magnified" view that we actually take all the derivatives, which are what we're concerned with here.)

>From there, just picturing it makes it clear that the man walking around the rim carrying a watch must see things just exactly the same way the man walking down a straight moving cable would see them. The fact that he's accelerating inward, again, doesn't affect his watch, and doesn't affect his measurements of tangential lengths. So, the result _must_ come out the same as if the cable where laid out straight.

If we want to be totally complete in our picture, we can also imagine that we're using light pulses to synchronize closely spaced clocks all around the rim of the disk. They're close enough together that we don't have to worry about the acceleration. If we ask ourselves what will happen, it's pretty clear that we'll get exactly the same result that way as we would if we did it on the straight moving cable −− when we get to the "other end" we've got what looks like a time skew relative to the starting point from the point of view of someone in the stationary frame.

Finally, given that the "composition of velocities" approach is clearly correct, that provides a second demonstration that the "wrapped straight cable" approach is correct: The two produce the same answer.

Obviously I didn't include all these extra words on the page. In fact, the original reasoning consisted of just the illustrations; the words on the page all came later, and all the additional stuff about MCRFs and so forth didn't seem likely to contribute at all to the clarity of the page.

I hope this helps a bit with understanding why I didn't feel the need
to use anything beyond CofV and some Lorentz transforms in the
analysis!

> Bilge and Dirk also raised some
> questions. Are they puppets as well?

No, not at all.

>> That was the reason that a purely Newtonian argument with fixed
>> signal speed relative to the cable which leads to no Sagnac ... it
>> wasn't any "mistake" on my web page, nor any mistake in relativity.

Again, there are several ways of approach this "classically".

There's (classic) ballistic theory, which assumes the signal in vacuum
travels at C relative to the emitter, and at C/N in a glass fiber
relative to the fiber. That matches what I called the "classic" case
and it leads to a conclusion of no Sagnac effect.

There's classical aether theory, in which one can assume any degree of
"dragging" of the signal by the medium. On the page I talk about no
dragging (signal moves at fixed velocity relative to the lab frame)
and I talk about "full dragging" (just like the BaT case: signal
moves at C/N relative to the medium).

But the case I did not discuss −− which I really need to add! −− is
the case where there is "partial dragging". That notion dates from
some time in the 1800's and actually explains the Sagnac effect. So,
it _is_ explainable "classically", and I need to update the page to
say so.

****

Now, let me see what else I overlooked in your earlier post...

On Wed, 03 Aug 2005 21:59:15 −0700, bsr3997@xxxxxxxxxxx wrote:

>
> sal wrote:
>> On Tue, 02 Aug 2005 21:32:21 −0700, bsr3997@xxxxxxxxxxx wrote:
>>
>>
>> > sal wrote:
>> >> Thanks for the informative response.
>> >>
>> >> On Sat, 30 Jul 2005 18:19:58 +0000, Daniel Cook wrote:

>> >>
>> [snip]
>> >
>> > Nice web page. A very clear simple explaination of the Sagnac
>> > effect. Just a few quibles.
>> >
>> > Your statement about the inability of Newtonian mechanics to
>> > explain Sagnac is backwards. Sagnac has often been used in this
>> > group in attempts to show that light travels at c+v or c−v in a
>> > moving frame.
>>
>> Which just shows the level of silliness in some of the arguments in
>> this group.
>
> Oh, I see, anything that doesn't agree with your point of view is
> silly.

No, that's not what I meant at all.

I meant it's silly to claim that the Sagnac effect _refutes_ relativity in any way. However, that exact claim is often made. I don't understand why −− the only "proof" I've ever seen that the effect contravenes relativity comes down to proof by assertion. And, after working it out for myself, it obviously doesn't do any such thing.

>> > Why else would it take different times to go in opposit directions
>> > around the ring ;) To claim that the single clock is out of sync
>> > with itself is really grasping at straws. Some might even say
>> > that is absurd ;)
>>
>> SR is intuitively unappealing. That's not news.

I can expand on this. I didn't mean "a single clock is out of sync with itself". That's obviously absurd.

The trick here is to get from (my) figure 4 to figure 5, and see that they're the same thing.

Take a linearly moving cable, with the clocks in sync in the _stationary_ frame. Now, without changing anything −− particularly without changing its linear velocity −− wrap it around the spinning disk.

You get figure 5. And if someone walks around the disk holding a clock, if there are clocks all along the length of the cable that are in sync in the "lab frame", the walker will see them getting farther and farther from his/her clock as he/she moves around the rim.

It's a purely visual argument, but it matches the math.

> What you are doing is not SR.

So what? It's relativity. It's based on pseudo Riemannian geometry, applied in flat space where there is a global Lorentz frame.

> If you look in
> "On The Electrodynamics Of Moving Bodies" you will find, "in a state of
> parallel translatory motion parallel to the axis of X" Do you understand
> what that is saying? Your example deviates from normal SR practice for
> clock sync.

So what?

> Two clocks resting at the same point are supposed to show the same
> time in SR. A slow transported clock is not supposed to go out of
> sync in SR.

So? A clock which is carried around the ring is _NOT_ "slow transported" in the local inertial frame of someone who is situated at one point on the ring!

Consider: When the clock is situated diametrically across from the "ring−stationary observer" the clock is moving at velocity −V in the observer's MCRF. That's not "slow"! So, it's not slow transport, and there's no surprise that the clock goes out of sync.

Just _how_ it goes out of sync is a interesting question which deserves some calculations and graphs of its own. I don't claim to have exhausted the subject −− I have barely scratched the surface.

>> > Sagnac does not prove SR wrong because SR excludes rotations.
>>
>> Untrue. Einstein's SR paper didn't treat acceleration, and
>> accelerated _observers_ are beyond the ability of SR to handle with
>> any grace, but accelerated _objects_ can be handled just fine in
>> most cases without stepping outside the math of SR. (If you want
>> to be nit−picky about it you need to add the "clocks postulate" to
>> SR in order to allow you to conclude anything about accelerated
>> objects.)
>>
>> And the reason Sagnac doesn't disprove SR is that SR predicts the
>> effect, and is, in that sense, confirmed by it, rather than
>> contradicted by it. To handle it strictly within the bounds of SR
>> you must look at it from the fixed frame, but from that point of
>> view it's a trivial bit of algebra to derive the effect.
>

> In SR all frames are equal. Here you are saying that you can do
> something in one frame but not the other. Why is that? Because the
> frames are not equal and you are not working with SR.

So what? I'm happy with GR. I just didn't show any math beyond what
you're familiar with from SR on that page.

In any case the frame which is "different" is the accelerated frame,
and, yes, that's "different", all right.

Accelerated _bodies_ are, as a rule, easily handled in SR.
Accelerated coordinate systems are not.

>> > In "Relativity" Einstein wrote,
>> >
>> > If, relative to K, K' is a uniformly moving co−ordinate system
>> > "devoid of rotation, then natural phenomena run their course with
>> > respect to K' according to exactly the same general laws as with
>> > respect to K. This statement is called the principle of
>> > relativity (in the restricted sense)."
>> >
>> > The signal is partially dragged in media for both classical and
>> > relativistic models, as it must be to agree with experiment.
>>
>> Right. Composition of velocities automatically gives partial
>> dragging. In aether theory partial dragging must be glued on
>> somehow, which is what Fresnel did, 'way back when. In ballistic
>> theory it's even harder to come up with a scenario in which partial
>> dragging makes sense.
>
> When dicussing the Fizeau experiment in "Relativity" Einstein glued
> on dragging by stating, "In accordance with the principle of
> relativity we shall certainly have to take for granted that the
> propagation of light always takes place at the same velocity w with
> respect to the liquid, whether the latter is in motion with
> reference to other bodies or not."

I'd say that's just the principle of relativity at work. Why don't
you think so?

>> > That is what Fizeau proposed and varified experimentally before
>> > SR existed. The media slows the signal to less than c, but slows
>> > it less when the media is moving in the same direction as the
>> > signal. The signal cannot be fully dragged or the signal speed
>> > could exceed c in the stationary frame with a fast moving media.
>>
>> And that reasoning leads almost directly to the Lorentz transforms
>> and the composition of velocities formula, and suddenly you're
>> looking at what's commonly called "Lorentz ether theory" in this

>> newsgroup; it has been stated many times that its predictions are
>> identical to those of SR.
>
> The Lorentz transforms are not needed for a classical explaination,
> nor is LET. And the classical explaination works with absolute
> time, so there are no clocks going out of sync with themselves.

The classical explanation which works requires an assumption of "partial dragging of the aether".

>> Since SR uses no "ether" one must conclude that this is another way
>> to say there is no evidence for the "ether" assumed by the
>> so−called Lorentz ether theory.
>
> And what explanation does SR provide for how light energy gets from
> point A to point B?

Ask God.

While you're at it ask Him what "energy" is to start with.

The proof of a theory is whether its predictions are correct, not whether you feel it gives you an intuitive "explanation" of how things might work.

[snip point of agreement ... yes, we had one...]

>> > Leaving out the + or − wrt is what caused your time to come out
>> > the same in both directions.
>>
>> No, it's not. It's assuming the signal moves at C/N relative to
>> the cable (rather than C relative to the fixed frame), combined
>> with vector addition of velocities, which leads to the time coming
>> out the same in both directions.
>
> Ah, so you found your error, And I assume you will correct it on
> your web site :)

Again, the error is that there were more kinds of "classical analysis" than I allowed for, and classical aether theory with partial dragging can account for the effect.

And someday soon I'll be rewriting part of the page to reflect that.

−−
Nospam becomes physicsinsights to fix the email
I can be also contacted through http://www.physicsinsights.org

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- ***Follow−Ups***:
  - ***Re: Simple Sagnac***
    - ◊ *From:* bsr3997@xxxxxxxxxxx

- ***References***:
  - ***Re: Simple Sagnac***
    - ◊ *From:* Bilge
  - ***Re: Simple Sagnac***
    - ◊ *From:* Dirk Van de moortel
  - ***Re: Simple Sagnac***
    - ◊ *From:* sal
  - ***Re: Simple Sagnac***
    - ◊ *From:* sal
  - ***Re: Simple Sagnac***
    - ◊ *From:* Daniel Cook
  - ***Re: Simple Sagnac***
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