

Re: Does it move?

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"Old Man" <nomail@nomail.net> wrote in message
news:<ssmdnbk05YpSt6jcRVn-sA@prairiewave.com>...
> "Edward Green" <spamspamspam3@netzero.com> wrote in message
> news:eca320d0.0408311508.39b108e8@posting.google.com...

> > Two point masses M, m interact in some way so that:
> >
> > (1) $dP_M/dt = -dP_m/dt$.
> >
> > (This bypasses the whole issue of the relativistic transformation of
> > force).
> >
> > The masses are constrained to move along the x -axis, with coordinates
> > X, x .
> >
> > Define a new coordinate:
> >
> > (2) $x_{com} == [1/(M+m)][MX + mx]$
> >
> > This is the non-relativistic definition of the position of the center
> > of mass. But for our purposes, note that M, m are the rest masses, X, x
> > the position coordinates, and that this algebraic combination is
> > defined at all times, regardless.
> >
> > We know in Newtonian physics that, subject to the constraint of eq.
> > (1), the velocity of the center of mass
> >
> > (3) $x'_{com} == [1/(M+m)][MX' + mx']$
> >
> > always remains zero, given that the particles started at rest. So in
> > this case the center of mass can never move, regardless of the
> > acceleration profile.
> >
> > But the relation which enforces this immobility of x_{com}
> >
> > (4) $x' = -(M/m)X'$
> >

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> > *breaks down when the light particle reaches relativistic speeds, and*
> > *in this case xcom acquires non-zero velocity. We can therefore arrange*
> > *situations in which xcom moves between start and finish.**

> *Since $p_M = -p_m$, then*
>
> $d(p_M)/dt + d(p_m)/dt = 0$

Notice this was my equation (1) -- I've already assumed that.

> *This defines the center-of-momentum which cannot accelerate, and, if*
> $p_M = -p_m = 0$ *initially, then the center of momentum has zero velocity.*

I noticed this "definition" in your earlier post, but was unable to see how it defined anything. The "center of <blank>" is a coordinate position, is it not? You have not defined a coordinate of anything, but simply restated the condition that the sum of momenta is constant.

Perhaps you mean we should work in the `_frame_` where $p_{total} = 0$. I concur. I did.

> *However, Ed's definition of center-of-mass is incorrect.*

Aha! I anticipated that particular ill-founded objection, but not, apparently, forcefully enough! Ed's definition of center-of-mass is a function of X and x, the coordinates of the particles. It could only rise to the level of "incorrect" if I attributed some further incorrect significance to this function. But I was careful to urge that it be regarded merely as a function whose variation we were interested in. The physical meaning of this function is irrelevant to determining its variation, is it not? And the variation in this function is sufficient to answer the question "does it move".

> *In the CP frame,*
> *the total rest mass is the relativistic mass, $E = E_M + E_m$ wherein*
>
> $E_m = m c^2 / \sqrt{1 - (v_m/c)^2} = [p_m / v_m] c^2$
>
> $E_M = M c^2 / \sqrt{1 - (v_M/c)^2} = [p_M / v_M] c^2$
>
> *The center-of-mass is now defined in terms of energy*
>
> $X_{cm} = [X * E_M + x * E_m] / [E_M + E_m]$
>
> *The coveted result is $d(X_{cm}) / dt = 0$.*

Does it work? Let's see.

$$X_{cm} = [1/E_{tot}] [X*(p_M/v_M) + x*(p_m/v_m)]$$

$$d(X_{cm})/dt = [1/E_{tot}] [p_M + p_m] = 0$$

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Hmm... chagrin. :-)

Now we have a flat out logical contradiction, since I'm not convinced there was an error in my derivation under the stated assumptions, yet you have produced a starkly different result under these same assumptions! For the record, let's restate the contradiction, maintaining our various notations.

Under the assumption $p_M + p_m = 0$, and over a certain interval

I claim to show: x_{cm} may have a non-zero variation;
You claim to show: X_{cm} must have zero variation; but:
At the endpoints of the interval of interest $x_{cm} = X_{cm}$.

Therefore the claims are incompatible, and one must contain a mathematical error (since we are merely evaluating the variation in two well defined mathematical expressions under stated conditions).

One thing I notice is that proof of your claim assumes constant velocities. We are only justified in writing

$$\begin{aligned} d/dt X_{cm} &= d/dt [X * E_M + x * E_m] / [E_M + E_m] \\ &= [p_M + p_m] / [E_M + E_m] = 0 \end{aligned}$$

in case the energies are constant. During the intervals in which the particles are accelerated, the expression becomes more complicated, and the conservation of momentum is not so obviously enough to ensure its vanishing. In fact, following Sherlock Holmes, maintaining confidence in my earlier simple derivation, I conclude that this extra source of variation, however improbably, is precisely what accounts for the variation in X_{cm} required to match up with x_{cm} at the endpoints of the interval, as it must.

Ed does not want the Nobel prize (not for this, anyway ;-).

Ed does not propose that relativity violates conservation of momentum.

Ed does not even propose that his restatement of Macmillan's thought experiment makes relativity appear to violate conservation of momentum.

Unless, that is, unless Old Man's X_{cm} come with the free theorem (collect them all) that X_{cm} does not move in the center of momentum frame. Since Ed believes he has in fact demonstrated that X_{cm} could move in the center of momentum frame (Old Man's counter claim notwithstanding) in accordance with the stated assumptions, Ed will concede that he would then be claiming that the stated assumptions appear to violate conservation of momentum.

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Ed believes however that he can see his way clear to a fallacy in the stated assumptions, which will clear this conundrum.

Can Old man guess what it is?