# Re: Can this relativity paradox (center of mass problem) be resolved?

***Source:*** http://sci.tech−archive.net/Archive/sci.physics.relativity/2007−06/msg03487.html

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- *From*: "Neil Bates" <neil_delver@xxxxxxxxxxxxxxx>
- *Date*: Sat, 30 Jun 2007 13:33:45 −0400

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"Bilge" <dubious@xxxxxxxxxxxxxxx> wrote in message
news:slrnf8bj6c.fno.dubious@xxxxxxxxxxxxxxxxxxxxxxx

> On 2007−06−28, Neil Bates <neil_delver@xxxxxxxxxxxxxxx> wrote:
>
>> Now: in Newtonian mechanics, this is no problem, since the mass
>> distribution
>> stays the same. But if the center of mass−energy moves in a body without
>> a
>> momentum compensation, that is a problem: it moves the centroid of the
>> momentum vectors laterally in frames in which the body moves, without
>
> No, the problem is trying to reconcile an inconsistency by comparing
> quantities which are only meaningful in newtonian mechanics. The

No, they are meaningful in relativity, just need reformulating, which has
been done, per below.

> center of mass is only meaningful in newtontian mechanics, because
> mass is locally conserved as a consequence of the galilean boost
> symmetry (i.e., vt minus the initial position is an invariant).
>
> To make the comparison between newtonian mechanics and special
> relativity,
> you need to use the center of momentum. In newtonian mechanics, the
> center of momentum is the same as the center of mass and it can only be
> that way because mass is locally conserved. In special relativity, the
> center of mass is not a useful concept, since the mass is not a locally
> constant function.

You should read Penrose's book, The Road to Reality , where he explains (pp. 433−434 etc.) that indeed center of mass is supposed to be retained in SRT. Of course, that requires adjusting the Newtonian definition, but not tossing the point as irrelevant. In the case I bring up, there is more mass−energy on one side than the other, no acceleration of the system, and no significant internal motions (maybe that's what you worry about) − and we can stop the scratching later and consider the momentum then anyway.

> compensation. That would violate conservation of angular momentum, L (remember that L = sum of r X p of any kind, and is not just about rotation.)

> In order to push against the rod, the rod pushes back against you, so you must impart an angular momentum to whatever is holding you in place. (You did assume that you had a closed system and small doesn't literally mean zero).

You are looking at the wrong basis for angular momentum here. I don't mean the angular momentum around the axle of the lever, I mean the angular momentum seen from motion relative to the chamber. If you move a momentum vector sideways, that changes the angular momentum in that frame. I will try to show this in a diagram, for the frame where the chamber moves at v as shown. In this case, to prevent confusion with rotation around the axle, the view is along the floor and the axle lies along y:

```
y
^ ^ ^ |
| p1 | v | p 2 |
|
#−−−−−−−−[]−−−−−== (z)−−−−−> x
# []
_#________[]_____ floor
```

As mass−energy increases on the left side and decreases on the right side, then p1 gets bigger and p2 gets smaller. Hence,
Sum r cross p = L_z becomes more and more negative. This is true in relativity, at ordinary velocities v << c, since the "mass" used for calculation is small (m = E/c^2) but multiplied by v in p = gamma*m(rest)*v.

> So, where does the compensation come from? It can't be any force etc. that would make sense in the classical version, since that

> > would
> > over−correct in such a case.
>
> That is one reason to suspect the classical case of being incorrect.
> You cannot get energy from nothing and since the mass is locally
> conserved,
> where did any of the energy originate? In newton's era, there wasn't
> enough
> known to perform such an analysis (and newton did not define energy; that
> came much later). The reason classical theory contains potential energy
> functions is to gloss over this issue when describing forces.

The classical case has no problem. There is a loss dE/dt = f dot dr on one side (considering the reaction force on the pusher, the sign actually comes out correct as is.) There is an equal opposite gain (at the same time, which is relevant!) on the other side, again f dot dr with the applied force on the floor giving a positive. It's fine, actually, and then if the chamber is moving, there is no shifting of the net momentum vectors because energy has no momentum in Newtonian mechanics.

> [...]
>
> > This problem is related to the right−angle lever paradox, since an
> > "energy
> > current" is involved. (My answer to that one, also implied by some who
> > should know: There are tangential momentum vectors from the stress
> > correction to momentum and energy, produced by the shear forces in the
> > RAL.
>
> The right angle level paradox is strictly due to simultaneously choosing
> incompatible descriptions for different points on the lever without
> realizing
> it. Simultaneity is relative, so whether or not the ends are stationary
> depends upon whether or not you define the plane t=0 such that they
> are.

Not quite. This is what almost everyone forgets about problems involved applying forces to anything: We have to consider the "reaction momentum and energy" created in the system applying forces/doing the work. That means, it "costs" dp/dt = − f, for a force which I apply to a system, it "costs" energy dE/dt = − f dot v, it "costs" change of angular momentum dL/dt = − r cross f.
(Actually, if we properly consider the force as that imposed *on my hand* etc. when I push instead of force on the thing I am pushing, then we just strip the negative signs, and work directly for the quantities showing the work etc. *on* the system doing the pushing.) To get conservation, we need

for the other/part of/the system to have the opposite rates of change, given that's the whole shebang. Hence, it costs change of angular momentum to *apply* the unequal torques in the case of the right−angle lever paradox, and no amount of well−intentioned and quasi−convincing sophistry about covariant formulations etc. will change the fact that the compensatory angular momentum has to be expressed somehow. As I said, it can be found in the orthodox but overly obscure stress correction to energy and momentum (from the shear stress inside the lever.) However, those stress formulae do not give the right correction to my paradox.

> [...]
>
> > Again, no overt mechanical adjustment that would overcompensate and make the
> > classical situation fail can be used, since that would make Newtonian mechanics inconsistent. Hence, this needs further work, IMHO.
>
> Newtonian mechanics is only consistent to the extent that you don't ask about too many details. For example, chemistry is a problem, since newtonian mechanics does not allow for any equivalence between mass and energy. Try explaining why the mass of the hydrogen atom is less than the sum of its constituents, without relativity. The only way to attempt it is to assume the photon propagates infinitely fast and carries off some fraction of the mass. The potential energy function is what you use to gloss this over and get agreement with experiment. However, that leaves constants like `c' unexplained (and inconsistent with classical theory).

Right, but my point isn't dependent on those loose ends. I am just saying, that if there was a bit of push to one side in this chamber example, then Newtonian mechanics would fail *in a way* that it isn't supposed to.

tyrannogenius

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