Re: "The Right Angle Lever Paradox"

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- *From*: dubious@xxxxxxxxxxxxxxxxxxxxxxxxxxxx (Bilge)

- *Date*: Sat, 01 Jul 2006 20:02:02 GMT

Tom Roberts:

> Bilge wrote:
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> > Koobee Wublee:
> > >Actually, the solution to resolve this paradox is ridiculously simple.
> > >If the lever is not rotating in the rest frame, the forces acting on
> > >each level must be identical (only one shown in Retic's diagram). In
> > >the moving frame, both of these forces on each lever would undergo the
> > >same transformation of observation.
> >
> > Wrong. That is not the resolution.
>
> I interpreted Wublee's response such that it is indeed correct, albeit poorly stated: consider a small portion of one part of either lever −− the total force is zero in the rest frame (because it is not moving), so the external force and the internal forces (from neighboring portions of the lever) must therefore cancel; that means they are equal and opposite, and since anti−parallel forces transform the same, the same conclusion must hold in the moving frame.

You are presuming the result under the (unstated) premise of absolute simultaneity. If the ``frame of the lever'' is defined such that every point on the lever has a spacelike separation, the forces at different points along the lever aren't even relevant to the question[1]. The only forces that are relevant are the ones at the event defined to be the point of rotation.

If you choose the pivot point for that event, then the result is simple. There is no rotation about the pivot, so the torques at the pivot must be zero. Choosing the lever arms as two of the spatial axes with the forces applied at some distance perpendicular to those axes, call them x and y, the torque in the pivot rest frame must be N = x F_y − y F_x = 0. Choosing the origins to be coincident, under a boost in the x−direction, F'_x = F, F'_y = \gamma^−1 F_y and the distance (x'−0) = \gamma^−1 (x − 0), (y' − 0). Hence the forces in the primed frame are _not_ equal, even though the torques are.

[1] Alternatively, you could to define frames such that he points that define the lever frame are causally related, but that requires using one of those funny frames which is poincare invariant (and relativ−istically correct) but is not related to the standard coordinates by a lorentz transform. Since just about everyone objects to such coordinates for reasons that I've noted before, I assume no one is referring to such coordinates.

The poor part of his statement is "the forces" −− _which_ forces???

The only forces that matter are the ones at the event defined as the point about which the rotation is being considered.

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