

Re: Another Rotating Cylinder Problem – explain from moving frame view

Source: <http://sci.tech–archive.net/Archive/sci.physics.relativity/2006–04/msg01240.html>

- *From:* "sal" <SpamMeHere@xxxxxxxxxxx>
 - *Date:* 17 Apr 2006 13:10:24 –0700
-

David wrote:

Can anyone explain this rotating disk problem from the point of view of a moving observer?

In the rest frame let there be two rotating disks of diameter D perpendicular to the x axis. Let the distance between the disks be L . Let there be a rotating cylinder of the same diameter and length connecting these two disk. Let the disks be massive and made out of steel and let the cylinder be made out of wax. Let the cylinder and disks rotate at one revolution per second.

Let there be a frame moving along the x axis relative to this rest frame with some V . Let L and V be such that simultaneous events measured in the moving frame at each disk (separation L) are measured as a half– second time interval in the rest frame. At time t_0 as measured in the moving frame a thin straight wire is simultaneously attached to the two disks at the top position of each disk and along the top of the wax cylinder. This is a straight line in the moving frame, but spirals around the cylinder making a half revolution as viewed in the rest frame.

Now very slowly the tension of this wire is increased – the wire is stretched. This means the wire is very slowly approaching a straight line as viewed in the rest frame. As the tension is increased this wire cuts through the wax cylinder. Eventually the wire becomes a straight line and any further stretching of the wire does not change its shape.

As viewed in the moving frame the wire is a straight wire on the surface of the cylinder rotating with the cylinder before we start stretching the wire. Now as the wire is stretched the center point of this wire eventually touches the center of the rotating cylinder (the x –axis) as the wire slices through the wax. Can anyone explain as viewed in the moving frame why the center of this straight wire cuts the wax all the way through to x –axis as the wire is stretched?

Re: Another Rotating Cylinder Problem – explain from moving frame view

You may not realize just how complex this problem is.

You are asking about the forces on and tension in a wire which is in motion, where the forces and tension are measured by a stationary observer.

For starters, you need to at least think about how a stationary observer would even measure the tension in a wire that's in motion. The measurement is surely not going to be the same as the value measured in the wire's rest frame — but we need to go beyond that simple assertion of what it won't be. What will the tension be, as viewed from the stationary frame? And what does it even mean? Until you've determined how you can measure the tension within an object which is in motion, without having the measurement apparatus co-move with the object, you don't have a working definition for "tension" in a moving object.

The rotating lever paradox is difficult, and it involves just a couple of torques; what you've described here is even more complex than that.

So I would suggest backing up and taking a running start. Go back to a simpler problem, and work out an analytic solution to that. Then tackle the more complex problem.

As a general rule, what you need to do is begin by analyzing the problem completely in the most convenient frame-of-reference you can find. Typically, that's the center of mass frame.

Here's an example of a simpler problem, similar to something you've posted in the past; I'll just sketch it (I'm sure you can fill in the details): Start with a spinning rod with a (straight) stripe on it. Viewed in a moving frame the stripe looks like a spiral. In the center of mass frame, let the stripe "fall off" and fly away. Now, describe exactly what appears to happen in the moving frame.

Post the answer. Working that through completely will help a lot with your later problems, I think.

Then take the problem you've posted here, but instead of pulling the wire through the wax, release it so it can fly off. Figure out what happens in the center of mass frame (this may prove harder than you expect, even though it's "just" Newtonian mechanics!). Then map that into the frame in which the cylinder is moving, and tell us what the moving observer would see.

Finally, figure out how to transform tension and force between frames. Figure out the tension and 4-force on the taut wire in the center of mass frame, and transform that to the moving frame. Tell us what you found: post the transformation equations.

Re: Another Rotating Cylinder Problem – explain from moving frame view

The latter is going to be difficult but would be a very useful exercise for you to do, and is a prerequisite for solving the problem you actually posted.

Once you've done that, you can apply your transformations to the "straight" wire in the moving frame and see if you can correctly predict that it will cut through the wax.

I, personally, have no plan to do this for you :-) but I'd be more than happy to look at (and, if possible, help with) any attempt at a solution you can come up with.

If you post an explanation, does the same explanation work when the straight wire is simultaneously attached as measured in the rest frame and then the wire is slowly stretched?

After you post your explanation, we'll be glad to determine if it so applies.

That is, the wire is stretched and stretched but it never cuts into the wax eventhough it spirals around the cylinder as viewed in the moving frame.

This physics result of SR seems non-sensical to me.

Lots of results in SR seem nonsensical. Unfortunately for our "common sense" every such prediction which has been tested has been born out.

God apparently doesn't care tuppence for whether reality behaves according to your — or my — common sense.

Thanks,
David Seppala