letter to the editor

Let's stop centripetal force

In a recent note[1] Wörner argues in favor of "centripetal force" and against centrifugal force. From a pedagogical point of view, rejecting centrifugal force is a missed opportunity, because all students know the expression. I don't need more than five minutes or two slides to explain its origin. My high school students are satisfied and happy not to have to deal with the complications of rotating coordinate systems.

Now the "centripetal force": imagine you are riding a bicycle at a constant velocity. Part of the tire is moving at constant speed on a circle. The net force is directed towards the axle of the wheel; i.e., it is centripetal. For a bystander on the road, the same piece of tire moves on a cycloid. The net force is almost never directed to the axle. The "centripetal force" disappears when the inertial frame is changed; it is not even Galilei invariant.

We can do better if we use Newton's second law in Euler's version: $a = F/m$. Dynamic elements (force and mass) and kinematic elements (acceleration and choice of coordinates) are well separated. If we use vectors and split acceleration into components normal and tangential to the path, we get:

$$\vec{a}_n + \vec{a}_t = \vec{F}_{net}/m$$

The tangential acceleration $a_t = dv/dt$ changes the speed of the particle, and the normal acceleration $a_n = v^2/\rho$ alters the direction. v is the orbital speed and ρ is the local radius of curvature of the orbit. This representation is not new but is less common.

The net force on a body in uniform circular motion is centripetal. Renaming it "centripetal force" led some of my students to believe that it is a real force like the electric force. This misconception disappeared when I stopped mentioning that name at all. Now I stick with centripetal acceleration and net force, which is closer to the fundamental principles.

References

1. C. H. Wörner, "Let's stop centrifugal force," *Phys. Teach.* **61**, 425 (2023)

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