

# The Centrifugal Force Argument

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**Abstract.** The modern teaching is that centrifugal force only exists in a rotating frame of reference and that the only force that acts in an inertial frame of reference when a body undergoes circular motion is an inward acting centripetal force. On the contrary however it is here proposed that a rotating frame of reference, rather than creating an inertial centrifugal force, actually masks a hithertofore unrecognized inertial centripetal force. When the books are correctly balanced, it will be demonstrated that centrifugal force is a real force, closely related to kinetic energy, and observable in any frame of reference.

## The Inertial Path

I. Consider a particle moving in an inertial frame of reference. We write the position vector of this particle relative to any arbitrarily chosen polar origin as,

$$\mathbf{r} = r\hat{\mathbf{r}} \quad (1)$$

where the unit vector  $\hat{\mathbf{r}}$  is in the radial direction and where  $r$  is the radial distance. Taking the time derivative and using the product rule, we obtain the velocity,

$$\dot{\mathbf{r}} = \dot{r}\hat{\mathbf{r}} + r\dot{\hat{\theta}} \quad (2)$$

where  $\hat{\theta}$  is the unit vector in the transverse direction and where  $\dot{\theta}$  is the angular speed about the polar origin. Taking the time derivative again we obtain the expression for acceleration in the inertial frame,

$$\ddot{\mathbf{r}} = \ddot{r}\hat{\mathbf{r}} + \dot{r}\dot{\hat{\theta}} + \dot{r}\dot{\hat{\theta}} + r\ddot{\hat{\theta}} - r\dot{\theta}^2\hat{\mathbf{r}} \quad (3)$$

which can be rearranged as,

$$\ddot{\mathbf{r}} = (\ddot{r} - r\dot{\theta}^2)\hat{\mathbf{r}} + (2\dot{r}\dot{\theta} + r\ddot{\theta})\hat{\theta} \quad (4)$$

(†see the note at reference [1] regarding Maxwell's equation (77) and equation (4) above)

In the case of uniform straight line motion in an inertial frame, the acceleration is zero. Conservation of angular momentum means that the transverse component vanishes and therefore,

$$\ddot{r} - r\dot{\theta}^2 = 0 \quad (5)$$

The term  $\ddot{r}$ , being positive, is the inertial centrifugal acceleration while the negative term  $-r\dot{\theta}^2$  must be an equal and opposite inertial centripetal acceleration. The centrifugal acceleration acts to change the radial speed whereas the inertial centripetal acceleration acts to rotate the radial direction. Likewise in the transverse direction the two terms cancel each other with one of the terms acting to change the transverse speed while the other term acts to change the transverse direction, hence conserving angular momentum. These curious observations, combined with the fact that the choice of polar origin is entirely arbitrary, points to an inertial mechanism involving a sea of tiny vortices pressing against each other with centrifugal force while striving to dilate and which would cause a velocity dependent inertial pressure to act uniformly all around a body. [1], [2], [3], [4], [5] This inertial pressure must be the same thing as kinetic energy, because we know that centrifugal force is the radial gradient of transverse kinetic energy.

If we swing a weight on the end of a string, the inertial centrifugal force acting on the weight causes the string to become taut. This induces a tension in the string that causes a reactive centripetal force to act on the weight, which in turn cancels the inertial centrifugal force. Hence we are left with a net inertial centripetal force  $-r\dot{\theta}^2$  that causes the weight to undergo circular motion.

## Centripetal Force

**II.** In planetary orbits, conservation of angular momentum causes the transverse term in equation (4) to vanish. This is recognized in Kepler's second law which is the law of areal speeds. Meanwhile the gravity sinks distort the inertial centripetal force mechanism, and so gravity replaces the inertial centripetal force. You might say that a gravity sink replaces the inertial frame of reference with a radial field. Or alternatively you might say that there is no such thing as an inertial frame of reference.

Writing the centrifugal term in the form  $+r\dot{\theta}^2$ , equation (4) becomes,

$$\ddot{\mathbf{r}} = (-k/r^2 + r\dot{\theta}^2)\hat{\mathbf{r}} \quad (6)$$

first presented by Leibniz in the form

$$\ddot{r} = -k/r^2 + l/r^3 \quad (7)$$

where  $k$  is the gravitational constant and  $l$  is the angular momentum constant. The interplay between the gravitational inverse square law attractive force and the inverse cube law centrifugal repulsive force involves two different power laws and this leads to stable orbits that are elliptical, circular, parabolic, or hyperbolic.

## Conclusion

**III.** An inertial frame of reference exists in the absence of either a solenoidal or a radial force field, and the inertial path is a uniform straight line motion. With respect to any arbitrarily chosen polar origin, a body moving in straight line uniform motion will experience a pair of equal and opposite inertial forces, in both the radial and the transverse directions, hence implying that an equal pressure, due to motion, exists all around the body. This pressure is better known as kinetic energy.

In the case of large planetary bodies, the surrounding gravity sinks distort the inertial frame and replace the inertial centripetal force with an inverse square law force of attraction. The trajectories then become elliptical, circular, hyperbolic, or parabolic. The centrifugal force does not form an action-reaction pair with gravity and the two are not in general the same magnitude, however in the special case of a circular planetary orbit, the centrifugal force does exactly cancel with the force of gravity and there remains no net radial force. This situation tends to cause much confusion, because if we superimpose on top of it the coordinate frame that is used for an inertial frame of reference, an apparent centripetal force is observed. This centripetal force is however purely fictitious.

In the case of a weight that is attached to the end of a string that is tethered at the polar origin and undergoing circular motion in an inertial frame, there is a net inertial centripetal force acting on the weight. This net inertial centripetal force, normally hidden from view in the inertial path, is unmasked because the inertial centrifugal force is cancelled by the reaction force due to the tension in the string.

The inverse cube law relationship that appears in the inertial forces hints at dielectric origins since the inverse cube law in distance is characteristic of a dipole field. The tiny aether vortices that fill all of space, and which serve as the medium for the propagation of light, are therefore likely to be dipolar. Gravity

on the other hand is due to a large scale flow of aether that flows through this sea of tiny vortices. The fact that the vortices are dipolar means that the gravitational field will exert a torque on them, causing them to precess about an axis that is aligned along the gravitational lines of force, hence inducing centrifugal force at right angles to these lines of force. A simple mechanical analogy to a single gravitational line of force would be a row of freely rotating propeller blades. When the wind causes the blades to rotate, some air is flung sideways. The cushion of pressurized air, which would therefore exist in the space between two such neighbouring rows of rotating propeller blades, corresponds to the centrifugal pressure that exists between adjacent gravitational lines of force, and which sustains the planets in their stable orbits.

As the large scale aether flow of gravity percolates through the dense sea of tiny aether vortices, these will absorb any large scale vorticity, hence ensuring that the gravitational field is predominantly irrotational.

## References

[1] Clerk-Maxwell, J., “*On Physical Lines of Force*”, Philosophical Magazine, Volume XXI, Fourth Series, London, (1861)  
[http://vacuum-physics.com/Maxwell/maxwell\\_oplf.pdf](http://vacuum-physics.com/Maxwell/maxwell_oplf.pdf)

† Equation (77) in this paper is Maxwell’s electromotive force equation and it exhibits a strong correspondence to equation (4) above. The centrifugal and Coriolis terms in equation (4) correspond to the compound centrifugal term  $\mu\mathbf{v}\times\mathbf{H}$ , while the other transverse term corresponds to  $-\partial\mathbf{A}/\partial t$ . Gauss’s law appears in equation (4) when the centripetal term is replaced with a gravity sink.

[2] Tombe, F.D., “*The Double Helix Theory of the Magnetic Field*” (2006)  
 Galilean Electrodynamics, Volume 24, Number 2, p.34, (March/April 2013)

<http://gsjournal.net/Science-Journals/Research%20Papers-Mathematical%20Physics/Download/6371>

[3] O’Neill, John J., *PRODIGAL GENIUS, Biography of Nikola Tesla, Long Island, New York, 15th July 1944*  
<http://www.rastko.rs/istorija/tesla/oniell-tesla.html>

“Long ago he (mankind) recognized that all perceptible matter comes from a primary substance, of a tenuity beyond conception and filling all space - the Akasha or luminiferous ether - which is acted upon by the life-giving Prana or creative force, calling into existence, in never ending cycles, all things and phenomena. **The primary substance, thrown into infinitesimal whirls of prodigious velocity, becomes gross matter; the force subsiding, the motion ceases and matter disappears, reverting to the primary substance**”.

[4] Lodge, Sir Oliver, “*Ether (in physics)*”, Encyclopaedia Britannica, Fourteenth Edition, Volume 8, Pages 751-755, (1937)

<http://gsjournal.net/Science-Journals/Historical%20PapersMechanics%20/%20Electrodynamics/Download/4105>

In relation to the speed of light, “*The most probable surmise or guess at present is that the ether is a perfectly incompressible continuous fluid, in a state of fine-grained vortex motion, circulating with that same enormous speed. For it has been partly, though as yet incompletely, shown that such a vortex fluid would transmit waves of the same general nature as light waves— i.e., periodic disturbances across the line of propagation—and would transmit them at a rate of the same order of magnitude as the vortex or circulation speed*”

[5] Whittaker, E.T., “*A History of the Theories of Aether and Electricity*”, Chapter 4, pages 100-102, (1910)

“*All space, according to the younger Bernoulli, is permeated by a fluid aether, containing an immense number of excessively small whirlpools. The elasticity which the aether appears to possess, and in virtue of which it is able to transmit vibrations, is really due to the presence of these whirlpools; for, owing to centrifugal force, each whirlpool is continually striving to dilate, and so presses against the neighbouring whirlpools.*”