Centrifugal Force

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Abstract. It is nowadays taught that *centrifugal* **force is a fictitious force that can only be observed from a rotating frame of reference. This teaching is based on the argument that when no inward** *centripetal* **force is acting, a particle will proceed in its straight line inertial path. In situations where the physical effects of centrifugal force are detected, this is dismissed as being merely the effects of inertia. Polar coordinates relative to a point origin expose a centrifugal force acting on a particle that is moving in a straight line, but this centrifugal force tends to be masked from view by virtue of the fact that the radial position vector is rotating. This article will examine ways to expose the physical reality of the centrifugal force.**

Introduction

I. If we rotate a pale of water relative to the background stars, the water rises upwards at the sides of the pale, yet no officially recognized upward force is deemed to be acting on the system. The upward effect is dismissed as being due to the tendency of particles to carry on along their straight line inertial path. When a stretchable solid rotates, the tendency of the molecules to proceed in their straight line inertial paths can oppose the inter-molecular bonds. Many different straight line paths will be pursued, which aren't parallel to each other, and as such, the solid will expand outwards. It is taught wrongly, that when the inward acting **centripetal** force yields, only tangential motion ensues, and that no outward radial motion is involved. But outward radial motion clearly does occur as well, albeit that the radial vector is rotating.

Inertia can be identified with kinetic energy, and it seems to be an inflation of pressure which is ignited by some kind of interaction with the all pervading medium for the propagation of light. This inertial pressure can manifest itself as an outward radially directed **centrifugal** force, especially where the pressure is asymmetrical. Centrifugal force is however only induced in connection with the rotation of the radial line itself. This rotation of the radial line then masks the induced centrifugal force from view in the inertial frame of reference, unless the centrifugal force causes a physical reaction and exposes itself, as in the case of the rotating pale of water. When such a physical reaction occurs, we certainly don't need to be in a rotating frame of reference in order to observe it. Other examples of such physical reactions are when a wall of death rider

presses against the wall, or when a weight is being swung in a circle on the end of a string and causes the string to be pulled taut.

The Magnetic Field

II. When a particle moves through a magnetic field, at right angles to the field lines, it experiences a force of the form $\mathbf{F} = q\mathbf{v} \times \mathbf{B}$, which causes it to undergo circular motion. This force could therefore be said to be an inward acting **centripetal** force. No **centrifugal** force appears to be involved, because if the magnetic field were not present, the particle would simply continue in its straight line inertial path. On the other hand, Maxwell has argued that the existence of the magnetic field is due to the presence of a dense sea of tiny molecular vortices, all striving to dilate, and hence pressing against their neighbours with centrifugal force. [1], [2], [3] It could be argued that due to the solenoidal alignment of these vortices, the centrifugal pressure on one side of the moving particle is twice that on the other side. Hence the centripetal force would in fact be a compound centrifugal force with the angular velocity of the tiny vortices being related to the magnetic flux density **B**. The inertia of the particle, which is manifested by the so called fictitious centrifugal force $\mathbf{F} = m\mathbf{v} \times \mathbf{\Omega}$, where $\mathbf{\Omega}$ is the angular velocity, is intricately linked mathematically to the magnetic centripetal force $\mathbf{F} = q\mathbf{v} \times \mathbf{B}$. The ratio of the angular velocity to the magnetic flux density will be determined by the charge to mass ratio.

The Gravitational Field

III. If we now consider a particle moving through a gravitational field, we will not be restricted to circular motion as in the case of the magnetic field. In the gravitational field, we can have hyperbolic, parabolic, elliptical, or circular orbits. As in the magnetic case, it would appear as though the inward centripetal force is the only force acting, because if the gravitational field were not present, then the particle would simply continue in its straight line inertial path. However there is a significant difference between the magnetically induced circular motion on the one hand, and the gravitational orbits on the other hand. In the magnetic case, the centripetal force in question is actually induced by the motion itself, and it acts specifically to deflect that motion, whereas in the gravitational case, the force of gravity is not induced by motion, and it acts exclusively

to change the speed of a particle along the radial line, whether the radial line is rotating or not. It makes no difference to the magnitude of the gravitational force whether or not the radial direction is rotating. In the gravitational case, the deflection is actually caused by the so called fictitious centrifugal force $\mathbf{F} = m\mathbf{v}\times\mathbf{\Omega}$, where $\mathbf{v}$ is transverse velocity, which acts to deflect the transverse motion of the particle into the radial direction in opposition to gravity. The centrifugal force would therefore seem to be similar in mathematical form and physical nature to the magnetic centripetal force $\mathbf{F} = q\mathbf{v}\times\mathbf{B}$.

The centrifugal force acting outwards along the radial line obeys an inverse cube law, and the radial orbital equation as per Gottfried Leibniz (1646-1716) looks like this,

$$d^2r/dt^2 = -k/r^2 + l^2/r^3 \qquad\qquad (1)$$

where k is the gravitational constant and l is related to the angular momentum. The different power laws as between gravity and centrifugal force are crucial for the purposes of orbital stability.

It may be argued that the centrifugal force doesn't exist in the inertial frame of reference, but there is no inertial frame of reference when the gravitational field is present. The gravitational field has changed the geometry of space by introducing a curvature, and two distinct forces, gravity and centrifugal force, are acting along the radial line in opposition to each other. In the special case of a circular orbit, the net force is zero, unlike in the magnetic circular motion in which there is a net centripetal force. Centrifugal force differs in nature from gravity in some respects, one of which is that centrifugal force requires motion and angular momentum for its existence, just like the magnetic centripetal force $\mathbf{F} = q\mathbf{v}\times\mathbf{B}$. In the magnetic case the angular momentum is in the solenoidal magnetic field.

The Conical Pendulum

IV. The conical pendulum is an anti-gravity device in which the upward acting force is induced by motion in the horizontal plane. The bob swings around in a circular path while the string traces out a cone. In the steady state, the circle is horizontal and the upward acting force cancels out with gravity. When the bob angularly accelerates in the horizontal plane, this will induce an upward and outward spiral motion in defiance of gravity. Attempts will be made to explain this anti-gravity effect on the basis that the angular acceleration injects more energy into the system, and that the

bob moves up to a higher energy state. While this is technically true, it still doesn't identify the actual upward acting force. Attempts will also be made to explain the anti-gravity effect in terms of the tension in the string. However, the tension in the string is merely a reactive constraint, and the reaction to gravity cannot exceed the action, while the reaction to the horizontal centrifugal force cannot act vertically. Whereby mathematically we can resolve a force into any direction, there is a limit of up to ninety degrees within which the component can have any physical meaning. So although the vertical component of the tension appears to solve the problem mathematically, we know that the tension is in part dependent on the horizontal centrifugal force, and so that component of the tension cannot possibly contribute to a real upward force. The other component of the tension is due to gravity, and hence that component cannot exceed the magnitude of the gravitational force.

The dynamics of any pendulum is in fact based on the resolution of the active forces tangentially to the string in the vertical plane. The only way to explain the anti-gravity force is by virtue of the component of the centrifugal force tangential to the string. A component of centrifugal force will act on the bob, upwards along the arc of a rotating vertical circle. The conical pendulum principle is used in the fairground in the ride which is known as the chairoplanes. It is a clear cut case of centrifugal force being visible from an inertial frame of reference.

Conclusion

V. Centrifugal force is an outward acting radial force that is induced by absolute rotation relative to the medium for the propagation of light. In the straight line inertial path, it is masked from view in an inertial frame of reference, due to the rotation of the radial position vector, unless it exposes itself by causing a physical reaction. Centrifugal force is the radial effect of inertia and its existence can of course be discerned mathematically in polar coordinates even in the absence of a physical reaction. Inertia in relation to centrifugal force means kinetic energy. Kinetic energy is a very real inertial pressure which is induced by linear acceleration and sustained by motion, through the medium for the propagation of light. It leads to a very real inertial centrifugal force that can push on a surface or pull on a string. Centrifugal force is the radial gradient of transverse kinetic energy. Transverse kinetic energy is better known as centrifugal potential energy or centrifugal pressure. So while electromagnetic radiation on the one hand is the propagation of pure centrifugal pressure through the luminiferous medium, kinetic energy on

the other hand is the centrifugal pressure that is induced when atomic and molecular matter accelerate through the luminiferous medium. Broadly speaking, one might say that kinetic energy and centrifugal force are one and the same thing.

In a magnetic field, a compound centrifugal force causes a particle that is moving at right angles to the field, to deflect at right angles to its motion. In a gravitational field, space is curved, and the centrifugal force becomes isolated as an outward radial force, which deflects transverse motion into the radial direction, and acts in opposition to gravity. Contrary to modern teaching, centrifugal force is not an illusion which arises when we make observations from a rotating frame of reference. A rotating frame of reference can only induce a centrifugal force on an object if it physically drags the object around with it. A hypothetical rotating frame of reference will not induce any outward effect at all.

References

[1] Clerk-Maxwell, J., "On Physical Lines of Force", Philosophical Magazine, Volume 21, (1861)
http://vacuum-physics.com/Maxwell/maxwell_oplf.pdf

[2] ET Whittaker, A History of the Theories of Aether and Electricity; The Classical Theories (London; New York, American Institute of Physics, 1987) p.6
" - - - *All space, according to the young [John] 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 - - -"*.

[3] *"Long ago he* (Tesla) *recognized that all perceptible matter comes from a primary substance, or tenuity beyond conception, filling all space, the Akasha or luminiferous ether, 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."(PRODIGAL GENIUS, Biography of Nikola Tesla, by John J. O'Neill , Freeport, Long Island, New York, 15th July 1944)*
The 1937 Encyclopaedia Britannica article on 'Ether' discusses its structure in relation to the cause of the speed of light. It says, "*POSSIBLE STRUCTURE.__ The question arises as to what that velocity can be due to. 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 order of magnitude as the vortex or circulation speed - - - -*"
It was not made clear from the article whether or not they were referring to Tesla's theory.