# The Significance of the Inertial Forces in Electromagnetism

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**Abstract. The centrifugal force and the Coriolis force will be described. There is a controversy over whether these forces are real or fictitious. This controversy will be examined in conjunction with its significance to electromagnetism.**

## Centrifugal Force

**I**. Centrifugal force acts on all moving bodies, causing them to accelerate away from any point that does not lie along their path of motion. It is closely related to kinetic energy and it is best observed in rotating systems, as for example in a centrifuge.

## Coriolis Force

**II**. When a body is in motion, a Coriolis force acts transversely to any point that does not lie along its path of motion, providing that there is at least some radial motion relative to that point. In other words, the motion must be partially transverse and partially radial, relative to the point in question. It is best observed in rotating systems where it arises in conjunction with the conservation of angular momentum. Atmospheric cyclones, precessing gyroscopes, and eccentric planetary orbits provide an excellent context for the study of the Coriolis force.

## Real or Fictitious?

**III**. Centrifugal force and Coriolis force are inertial forces. Inertial forces are real forces because they can cause physical reactions with other bodies, they can

act in tandem with other forces, they can defy gravity, and they can cause a rotating rattleback to reverse its angular momentum [1]. Nevertheless, it is taught in schools and universities that they are not real forces. The reason for this is primarily because Newton's first law says that a body continues in its state of uniform motion unless acted upon by a force, yet centrifugal force is deemed to be a consequence of a body following its uniform straight-line inertial path. This confuses those who think that no real forces should be involved in the uniform straight-line inertial path. Had Newton however stated that the inertial forces don't count in the first law of motion, this would have had a significant impact on the debate.

With respect to any chosen origin, the centrifugal acceleration that is involved in the uniform straight-line inertial path, is only one of two components of the total radial acceleration, and these two components always sum to zero. This is another reason why some believe that centrifugal force is only a consequence of geometry, and not a real force. A similar situation arises in the transverse direction where an equal and opposite inertial force cancels out the Coriolis force, resulting in the conservation of angular momentum. Yet within a rotating system, both the centrifugal force and the Coriolis force can manifest themselves as real forces with real effects, and contrary to popular belief, we don't need a rotating coordinate system in order to observe these inertial forces in action. It's therefore the physical cause of the inertial path itself that needs to be investigated in order to see whether cause and effect are opposite to what is generally understood. Might the uniform straight-line inertial path, rather than causing the inertial forces, actually be the consequence of a moving body physically interacting with an all-pervading medium? And might the motion generate a uniform centrifugal pressure on all sides, leading to a cylindrically symmetric field pattern in the likeness of the magnetic field that surrounds an electric current? If so, then the inertial forces would only physically manifest themselves when the equilibrium is disturbed by an external force, such as when a body is moving in a radial force field like a gravitational field, or during physical contact with a constraint when a reactive centripetal force is induced which curves the path of motion.

The reason why this is never discussed in the textbooks is because it would lead us into the territory of the *luminiferous aether* which is a banned topic in modern physics.


## Centrifugal Force and Magnetic Repulsion

**IV**. Consider two rotating electron-positron dipoles sitting side by side in their mutual equatorial planes, with their rotation axes parallel to each other such that they are both rotating in the same direction. Each dipole comprises an electron in circular orbit around a positron. As the electron of one dipole passes the

positron of the other dipole in the opposite direction, at the point of closest approach it might be argued that there would be an electrostatic force of attraction acting between these two oppositely charged particles. However, if the electrostatic force would have been due to tension in a primary electric fluid field connecting the two particles, then if their mutual transverse speed were high enough, the flow lines connecting them would break causing the two split regions of fluid to sweep past each other in opposite directions. The side pressure from these flow lines would therefore induce a centrifugal force which would push the two rotating dipoles apart. This would be so if an electron is a sink and a positron is a source in this primary electric fluid, which would of course be the aether. If the circumferential speed of these dipoles is $v$, then the mutual transverse speed between the dipoles will be $2v$. Centrifugal acceleration takes the form $a = r\omega^2$ where $r$ is the separation distance and $\omega$ is the angular speed, and since $v = r\omega$, then the centrifugal force acting between two rotating electron-positron dipoles will take the form $\mathbf{F} = 2m\mathbf{v}\times\boldsymbol{\omega}$ where $m$ is the particle mass. This looks like the Coriolis force. It's a standard result that the vorticity $\mathbf{H}$ (= curl $\mathbf{v}$) of the orbiting electrons and positrons will satisfy $2\boldsymbol{\omega} = \mathbf{H}$, therefore the repulsive force acting between the two dipoles will take on the form, $\mathbf{F} = m\mathbf{v}\times\mathbf{H}$, as first derived by Maxwell in the form $\mathbf{F}/\text{volume} = \mu\mathbf{v}\times(\text{curl }\mathbf{v})$, where curl $\mathbf{v} = \mathbf{H}$, and where $\mu$ related to the density of his sea of molecular vortices. See equation (5) in Part I of his 1861 paper ***"On Physical Lines of Force"*** [2]. Maxwell equated the circumferential velocity $\mathbf{v}$ with the magnetic intensity, which means that $\mathbf{H}$ is also a measure of magnetic intensity. This would lead us to conclude that a sea of rotating electron-positron dipoles, pressing against each other with centrifugal force while striving to dilate, must be the foundations of both electromagnetic theory, and also of the inertial forces on the large scale [2], [3], [4], [5].

The corollary is that magnetic attraction is simply electrostatic attraction channelled along a double helix of rotating electron-positron dipoles, with a vorticity equal to $\mathbf{H}$. The broken flow lines in the equatorial plane mentioned above, would spiral upwards and downwards through the double helix, and the Newton's rotating bucket effect would kick in between adjacent double helices.
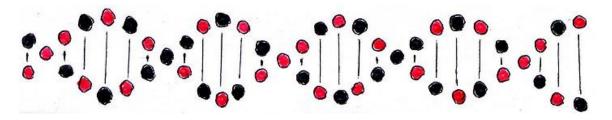


**Figure 1**. A close-up view of a single magnetic tube of force. Attraction along the tube is caused by electrostatic attraction between the electrons and positrons. Repulsion laterally between adjacent magnetic tubes of force is caused by centrifugal force. Within each rotating electron-positron pair, the orbital speed is what determines the speed of light [6].

# Conclusion

**V**. The magnetic Gauss force of attraction acting between the unlike poles of two bar magnets, or indeed in the case of paramagnetic attraction, acts in a direction along the lines of force. Work is done by this force. This force would equate to Coulomb's law of electrostatics, providing that the magnetic lines of force comprise of a double helix alignment of rotating electron-positron dipoles.

This is not however the established theory. The force nowadays that is believed to apply in the case of two attracting ferromagnets is the magnetic force, $\mathbf{F} = q\mathbf{v} \times \mathbf{B}$, where $\mathbf{B} = \mu\mathbf{H}$, and this does not act along the lines of force. $\mathbf{F} = q\mathbf{v} \times \mathbf{B}$ is in fact the centrifugal force which acts sideways from the field lines and which is the cause of magnetic repulsion. The field lines between two like magnetic poles spread outwards such that they meet laterally and don't connect with each other, and hence push each other apart with centrifugal force.

The $\mathbf{F} = q\mathbf{v} \times \mathbf{B}$ force does not therefore account for magnetic attraction between bar magnets, and it certainly doesn't account for paramagnetic attraction. The Gauss force responsible for magnetic attraction has disappeared from the textbooks. It would have provided the linkage between electric charge and magnetic charge. It would have been Coulomb's law of electrostatics acting along a double helix of electrons and positrons.

In the case of a charged particle moving through a magnetic field, $\mathbf{F} = q\mathbf{v} \times \mathbf{B}$ becomes a Coriolis force, or compound centrifugal force, resulting from a differential centrifugal pressure on either side of the component of the motion that is perpendicular to the lines of force, as explained in section **IV** of ***"The Double Helix and the Electron-Positron Aether"*** [7]. Just as in the case of the Coriolis force, $\mathbf{F} = 2m\mathbf{v} \times \boldsymbol{\omega}$, no work is done by the magnetic force. The general solution for the motion of a charged particle in a magnetic field is a helix.

The $\mathbf{F} = q\mathbf{v} \times \mathbf{B}$ force can therefore be a centrifugal force or a Coriolis force according to the context, and it operates in a sea of fine-grained rotation, rather than in a single rotating system on the large scale.

# References

**[1]** Tombe, F.D., ***"The Rattleback and the Gyroscopic Force"*** (2010)
https://www.researchgate.net/publication/299287781_The_Rattleback_and_the_Gyroscopic_Force

**[2]** Maxwell, J.C., ***"On Physical Lines of Force"***, Philosophical Magazine, Volume XXI, Fourth Series, London, (1861)
http://vacuum-physics.com/Maxwell/maxwell_oplf.pdf
Equation (77) in Maxwell's paper is his electromotive force equation and it exhibits a strong correspondence to the inertial forces. The transverse inertial terms $2mv_r\omega$ (where $v_r$ is the radial speed) and $m\partial v_t/\partial t$ (where $v_t$ is the transverse speed equal to $r\omega$) correspond to the

magnetic force $\mu\mathbf{v}\times\mathbf{H}$ ($\mathbf{H} = 2\boldsymbol{\omega}$) and the Faraday term $-\partial\mathbf{A}/\partial t$, with $m$ corresponding to $\mu$, and where $\mathbf{A}$ is the electromagnetic momentum. Gauss's law serves for the force of attraction in electrostatics, magnetism, and gravity.

**[3]** 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*

**[4]** O'Neill, John J., *"PRODIGAL GENIUS, Biography of Nikola Tesla"*, Long Island, New York, 15th July 1944, quoting Tesla from his 1907 paper *"Man's Greatest Achievement"* which was published in 1930 in the Milwaukee Sentinel,
*"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"*.
http://www.rastko.rs/istorija/tesla/oniell-tesla.html
http://www.ascension-research.org/tesla.html

**[5]** Lodge, Sir Oliver, *"Ether (in physics)"*, Encyclopaedia Britannica, Fourteenth Edition, Volume 8, Pages 751-755, (1937)
This quote is 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"* (Sir Oliver Lodge, 1937)
The article then goes on to cite Lord Kelvin, **"The Vortex Theory of Ether,"** *Phil. Mag.* (1887) and *Math. and Phys. Papers*, vol. iv. and passim; also G. F. FitzGerald, *Proc. Roy. Dub. Soc.* (1899), or *Collected Papers*, pp. 154, 238, 472.
http://gsjournal.net/Science-Journals/Historical%20PapersMechanics%20/%20Electrodynamics/Download/4105

**[6]** Tombe, F.D., *"The 1855 Weber-Kohlrausch Experiment"* Section **III**, just after equation **(5)** (2019)
https://www.researchgate.net/publication/332411168_The_1855_Weber-Kohlrausch_Experiment_The_Speed_of_Light

**[7]** Tombe, F.D., *"The Double Helix and the Electron-Positron Aether"* (2017)
https://www.researchgate.net/publication/319914395_The_Double_Helix_and_the_Electron-Positron_Aether