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# The Coriolis Force in Maxwell's Equations

**(The Compound Centrifugal Force)**

*Frederick David Tombe,*
*Belfast, Northern Ireland, United Kingdom,*
*sirius184@hotmail.com*
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*Abstract.* **The Coriolis force is a consequence of Newton's first law of motion and it can be observed in a radial force field as a transverse deflection of the radial component of the motion by an amount required to conserve angular momentum. It is a physical reality most commonly associated with atmospheric cyclones, but it can also be observed deflecting the effect of gravity on a comet or causing a pivoted gyroscope to defy gravity. In a paper which he wrote in 1835 in connection with water wheels, French scientist Gaspard-Gustave Coriolis referred to its mathematical formula $2mv\times\omega$ as the *"compound centrifugal force".* This is an interesting choice of name which suggests that it is the sum of two centrifugal forces, yet without giving any indication as to how this might be. The physical origins of the Coriolis force will now be traced to differential centrifugal pressure in the dense background sea of tiny aethereal vortices which serves as the medium for the propagation of light.**

## The Magnetic Field

**I**. James Clerk Maxwell explained the magnetic field in terms of a sea of tiny aethereal vortices that press against each other with centrifugal force while striving to dilate. These vortices self align with their mutual rotation axes tracing out magnetic lines of force. A tension along these lines of force accounts for magnetic attraction between unlike poles, with centrifugal repulsion acting sideways from the lines of force causing magnetic repulsion between like poles. Maxwell went on to explain the sideways force acting on an electric current that is moving at right angles through a magnetic field. The explanation is based on the principle that all the vortices within the immediate vicinity are spinning in the same direction, therefore an electric current passing through will not experience the same speed relative to the vortex circulation on one side as it will on the other. The combined effect

will be a compound centrifugal force causing a sideways deflection of the current. Compound centrifugal force will likewise explain the centripetal force which causes a charged particle that is moving in a magnetic field to follow a helical path. This compound centrifugal force appeared in Maxwell's original equations in the form $\mu\mathbf{v}\times\mathbf{H}$ [1].

## The Double Helix

**II**. The quantity $\mu$ in $\mu\mathbf{v}\times\mathbf{H}$ is related to the density of the sea of tiny aethereal vortices. If we consider these vortices to be dipolar, comprised of a sink (an electron) and a source (a positron), then the vorticity or magnetic field strength **H** is equal to $2\boldsymbol{\omega}$, where $\boldsymbol{\omega}$ is the angular velocity of the rotating electron-positron dipoles. When this compound centrifugal force appears in the form $2\mu\mathbf{v}\times\boldsymbol{\omega}$, it becomes identifiable as the familiar *Coriolis force* $\mathbf{F} = 2m\mathbf{v}\times\boldsymbol{\omega}$ [2].

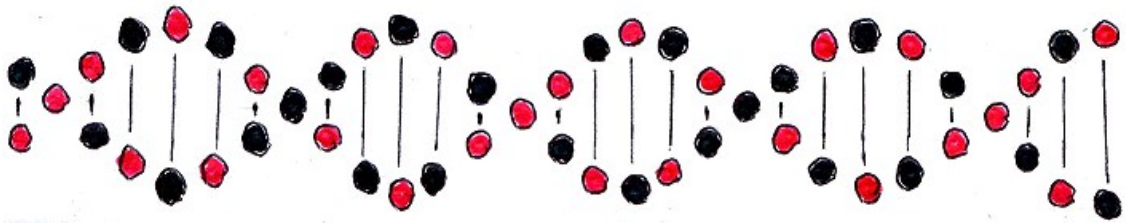

**Fig. 1. Close-up view of a single magnetic line of force. The electrons are shown in red and the positrons are shown in black. The double helix is rotating about its axis with a circumferential speed in the order of the speed of light, and the rotation axis represents the magnetic field vector H**. [3]

## The Gyroscopic Force

**III**. The electron-positron sea passes right through the interstitial spaces within rotating atomic and molecular matter as like water passing through a basket, and so when studying gyroscopes, we need to examine the situation at the molecular level and consider the individual molecules themselves to be miniature gyroscopes. When a gyroscope is spinning, the electron-positron sea which permeates the space between its molecules will be like an electric wind circulating inside it. If we extrapolate Ampère's Circuital Law to the molecular scale, the spinning gyroscope will become comprised of many tiny gyroscopes all aligned with their mutual rotation axes tracing out solenoidal rings around its rotation axis. If we then subject the spinning gyroscope to a forced precession, this will alter the angle of attack of the

electric wind and this will induce the equivalent of the aerodynamic P-factor on the molecules. For example if the applied torque causes a tilt in the molecules relative to the wind on an axis joining 3 O'clock to 9 O'clock, then the wind will act differently at 3 O'clock than it will at 9 O'clock, hence inducing a torque about the 6 O'clock/12 O'clock axis at right angles to the applied torque. The induced torque is therefore a compound centrifugal force (Coriolis force). When a pivoted spinning gyroscope topples under the force of gravity, the induced Coriolis force will deflect the gyroscope sideways. This sideways deflection will not be merely a superimposition on top of the downward motion [4]. Mathematically it will be, but physically it will have curled the effect of gravity. It will be like as if the tiny vortices of the electron-positron sea have introduced a vorticity into the gravitational field. And unless there were such a physical presence as this all-pervading electron-positron sea, there could be nothing for the toppling gyroscope to push against in order to stop it from falling freely.

## Cyclones and Comets

**IV**. In a radial force field such as an atmospheric cyclone or a gravitational field, a Coriolis force arises when an object undergoes both radial and transverse motion at the same time. Eccentric planetary orbits are a good example. The Coriolis Force has the effect of changing the speed of the transverse motion. This means that in the transverse direction, the pressure coming from the tiny vortices in front of the motion is different from the pressure coming from the vortices behind the motion. This is therefore a compound centrifugal force. Such asymmetry does not arise when the motion is purely transverse, such as in a circular orbit, or when the motion is purely radial such as in the case of a falling apple. Geometry alone is responsible for the conservation of angular momentum. The apparent equal and opposite force to the Coriolis force, that shows up in the polar coordinate formulation, should not be confused with the fine-grained centrifugal pressure on that same side of the motion and which forms part of the physical cause of the Coriolis force itself.

## Conclusion

**V**. It's a common error to believe that the Coriolis force is merely an illusion

that arises when making observations from a rotating frame of reference. In fact it's nothing of the sort. The illusion observed from a rotating frame of reference is never a Coriolis force. The Coriolis force is a physically real inertial force sourced in Newton's first law of motion and measured relative to a polar origin. It physically manifests itself in radial force fields by virtue of changing the speed of transverse motion when radial motion is also occurring. It takes on the mathematical form $\mathbf{F} = 2m\mathbf{v}\times\boldsymbol{\omega}$ and it has a physical explanation which lies in the tiny aethereal vortices that comprise the medium for the propagation of light, and it also accounts for the electromagnetic force $\mathbf{F} = q\mathbf{v}\times\mathbf{B}$. It is caused by the centrifugal pressure within the all-pervading background of electron-positron dipolar vortices which fills all of space. It acts at right angles to the direction of motion due to differential centrifugal pressure on either side of the moving object when an asymmetry is introduced into the field. The term *"Compound Centrifugal Force"* originally used for this force back in 1835 by Gaspard-Gustave Coriolis himself was most appropriate, even though it would seem that he had no idea about the underlying physical cause that justified his choice of name.

Unlike in the case of the simple radial centrifugal force, there is no intuitive way of explaining Coriolis force to the public at large. In its most commonly associated context, that being atmospheric cyclones, we might say that as the wind moves into the centre of the cyclone, and where angular momentum already exists due to the rotation of the Earth, a Coriolis force causes the wind to be increasingly deflected sideways in order to conserve angular momentum relative to the centre of the cyclone. More generally we might say that the Coriolis force is an inertial force that maintains conservation of angular momentum in a radial force field, or which causes a centripetal force to act on a charged particle that is moving in a solenoidal (magnetic) force field.

Ultimately, the Coriolis force is tied up with vortex behaviour at the most fundamental aethereal level and the effect transmits itself through all scales of activity.

## References

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