Fundamental Torque and the Rattleback

Frederick David Tombe,
Belfast, Northern Ireland, United Kingdom,
Formerly a Physics Teacher at
College of Technology Belfast, and
Royal Belfast Academical Institution,
sirius184@hotmail.com
29th February 2008, Manila, Philippines
(21st January 2009 Amendment, Manila)

Abstract. Modern classical mechanics has failed to explain the preferred direction of spin and the reversal torque in the rattleback. This is because three of the hydrodynamical aethereal forces are denied, and the relevant torque is probably to be found amongst these three forces.

The three denied aethereal forces are the centrifugal force (G2), the Coriolis force vXH (G3), and the angular ∂A/∂t force (G4). The vXH force and the ∂A/∂t force occur in tandem on the fine-grain level in electromagnetic induction. On the large scale, G3 accounts for the force that prevents a pivoted gyroscope from toppling over. On the fine-grain level G2 accounts for magnetic repulsion, and on the large scale it accounts for why the Moon doesn't fall to the Earth.

Equation (5) in Maxwell's 1861 paper 'On Physical Lines of Force' will be examined in order to try and ascertain which of the G forces might be responsible for the torque that brings a spinning rigid body into line with its preferred axis of symmetry and also with its preferred direction of spin if it has one.

The Rattleback

I. The one-directional rattleback is a semi-ellipsoidal top which has a shape asymmetry and a preferred direction of spin. If we spin it contrary to its preferred direction of spin, it will slow down and begin to oscillate up and down. It will then begin to spin in the opposite direction. Two-directional rattlebacks can exist when one direction of spin leads to an up and down angular oscillation on one axis whereas the other direction of spin leads to an angular oscillation on a different axis. See,

http://www.youtube.com/watch?v=puaif3OTJL4&feature=related

In either case, a torque must exist for the purposes of reversing the angular momentum. Since gravity (G1) and the normal reaction of the surface are both in the vertical plane, then that torque cannot arise from either of these two sources.

Static friction is necessary for the full operation of the rattleback. Rattlebacks do not work very well on ice or soapy surfaces. But this static friction cannot be supplying the torque. Motor cars need static friction, but that friction does not supply the torque that turns the wheels. The rolling oscillation stage is a necessary transitional stage in the reversal process but we still need to identify the actual torque.

So next we look to the Coriolis force which we'll call G3. On first examination, G3 seems ideal. The Coriolis force is a force that only changes the direction of kinetic energy without involving potential energy. That is exactly what happens in the rattleback. The kinetic energy changes from a rotational motion to an up and down angular oscillation and then back to a rotational motion again in the opposite direction.

The problem is, that in order for a G3 force to be invoked, we need more than just a simple rotation. We need to have a motion that is itself in a state of rotation. This state of affairs occurs while the rattleback is both rotating and rocking. But at the turning point when it is only rocking, there is no basis for a G3 force to exist despite the fact that the reversal pattern shows glimmerings of a G3 force.

So what about the angular G4 force $\partial \mathbf{A}/\partial t$?

Angularly Accelerating Aether

II. In the article entitled ‘Gravitation and the Gyroscopic Force’ at,

http://www.wbabin.net/science/tombe5.pdf

it was explained how there exists three aethereal based forces in addition to gravity and how one of these forces, the Coriolis force (G3), must be involved in preventing a pivoted gyroscope from toppling over.

So by analogy with the gyroscope and with electromagnetic induction, we should immediately look to another of these three aethereal forces, the angular ∂**A**/∂**t** force G4, in order to solve the rattleback mystery. This angular ∂**A**/∂t force works in tandem with G3 in electromagnetic induction. In particular, the ∂**A**/∂t force is the force that reverses the direction of a bar magnet that is rotating on an axis that is perpendicular to its magnetic axis.

It therefore seems reasonable to assume that the G4 force may be involved in the rattleback reversal torque either exclusively or in tandem with G3, as if it were a large scale version of magnetic force.

There are however some problems with G4.

The Lorentz Force

III. The ∂**A**/∂t force appears in the ‘Lorentz Force’ equation (77) in Maxwell’s 1861 paper ‘On Physical Lines of force’ at,

http://vacuum-physics.com/Maxwell/maxwell_oplf.pdf

Maxwell derived the ∂**A**/∂t force from what he considered to be a momentum **A**. However, if this momentum **A**, which Maxwell believed corresponded to what Faraday termed the *electrotonic* state, does actually refer to the momentum of the aether, then it follows that the ∂**A**/∂t is the G4 force and that it must be caused by an angularly accelerated flow of aether.

It has been discussed in an earlier article entitled ‘The Link between Electric Current and Magnetic Field at,

http://www.wbabin.net/science/tombe7.pdf

how the ∂**A**/∂t force in electromagnetic radiation is likely to be caused by G2 and maybe G3. In other words, the term ∂**A**/∂t as it appears in the Lorentz force may not refer to G4 at all but rather to the angular acceleration of a particle that is being driven by another of the fundamental forces.

And it is highly unlikely that spinning a rigid body against its preferred axis of symmetry is going to cause an interior angularly accelerated flow of aether. Let us take a look at an earlier and less well known version of the Lorentz Force that appears at equation (5) in Maxwell’s 1861 paper to see if we can detect the source of naturally occurring instances of angular acceleration.

It is interesting to note that equation (5) does not contain the G4 term. Instead of G4, we have G2 and also the hydrostatic pressure gradient term which we will call G5.

The first term on the right hand side of equation (5) is G1. This also occurs in modern versions of the Lorentz force. The second term on the right hand side of equation (5) is G2. The third and fourth terms on the right hand side of equation (5) are G3 and the fifth term is G5.

Maxwell’s use of the ∂**A**/∂t force in equation (77) was based on his attempt to find a momentum to account for the electromotive force in Faraday’s law of electromagnetic induction at equation (54). But this momentum only ties in with the magnetic forces at equation (5) if ∂**A**/∂t is a particle acceleration that is driven by one of the aethereal forces in equation (5).

The Nature of the Aether

IV. We don’t know what the aether is. We only know that it is space itself, and that it is compressible, stretchable, and dynamical. We can associate compression with pressure and repulsion, and we can associate stretching with tension and attraction. Either of these will be grouped under G5. Hence as two elements of aether move apart from each other, we might expect a tension to occur which will cause an attraction, and when two elements of aether are coming together, we might expect a pressure to occur which will cause a repulsion. We therefore have at least some of the elements of planetary orbital theory and simple harmonic motion.

If we now allow for sources and sinks in the aether, with unseen forces injecting the aether in through the sources and drawing it out through the sinks, we will have the basis for G1. G1 would correspond to a pressure caused by radial outflow of the aether, or to a tension caused by radial inflow. This is positive and negative charge.

G2 and G3 follow on naturally from the G1 condition, as convective forces that occur as a result of cutting across aether flow in a vortex. G2 would be the irrotational case of tangential motion relative to radial flow, whereas G3 would be the rotational case of radial motion relative to tangential flow. G2 and G3 are therefore very closely connected to each other physically.

G2 (centrifugal force) is a very interesting phenomenon. It is an expression of the fact that any two objects with mutual tangential velocity will have a mutual radial outward acceleration. In the apparently unpressurized state, this effect merely causes inertia and planetary orbits. But what about the case where two mutual orbital systems come close together side by side? This scenario is never observed on the large scale in nature, but it is a crucial aspect of Maxwell's molecular vortex approach to the magnetic field.

In theory, if two mutual orbital systems come side by side, there should be a centrifugal force repelling them apart as a result of the mutual tangential speeds. And if the two systems are constrained to remain in close proximity to each other, we might then expect there to be an actual build up of aether pressure between the two systems. Therefore there is an element of uncertainty as to whether magnetic repulsion is actually caused purely by G2, or whether it is caused by G5, or a combination of both. The same questions surround the source of $\partial \mathbf{A}/\partial t$ in electromagnetic induction. At any rate, in addition to positive and negative charge, this points to vitreous and resinous charge associated with pressure and rarefaction in the aether in conjunction with fine-grained centrifugal force. In the case of electron-positron dipoles, it has been suggested in other articles in this series, that vorticity in the aether will congest the sinks and widen the sources, and that centrifugal force and positive charge might even be one and the same thing on the electron-positron dipole scale.

One theory of electromagnetic radiation might be that a pressurized pulse of pure aether acts tangentially and causes a torque on the rotating electron-positron dipoles. This will cause an angular acceleration which in turn will increase the centrifugal pressure at the far side of the dipoles, with this increased pressure having originally come from the input pulse of aether. In other words the aether is acting like a spring, and the electron-positron dipoles are acting like the mass on the end of a spring that takes up the potential energy in the form of kinetic energy. By analogy with a row of masses connected together with springs, the electromagnetic wave is a pressurized pulse of aether that relaxes as it angularly accelerates the electron-positron dipoles. But the difference with the mechanical analogy is that the aether actually flows in a vortex pattern through a line of rotating dipoles. The $\partial \mathbf{A}/\partial t$ will in actual fact not be caused by G4 but by a very subtle interplay of G2/G3 and G5.

The Spinning Swastika

V. The rattleback that uses the turtles to adjust the shape symmetry is using the principles that are involved in the shape of a swastika. The preferred direction of spin is when the turtles are pointing forwards. See,

http://www.youtube.com/watch?v=PydoEA5Jx5s

If we accept that G4 is not the solution to the problem, it is still very difficult to accurately account for this preferred direction of spin and reversal torque using either G2, G3, or both.

We can see how a G2 force could produce a torque in a spinning swastika. Due to the perpendicular extensions, the centre of mass of a limb is in the space to the side of the central section of the limb and so there will be a component of centrifugal force acting such as to create a torque that would cause angular acceleration in the direction of the extensions. But this only appears to happen when the rotation axis is in the plane of the swastika. This corresponds to the rocking stage in the rattleback.

When the swastika is rotated on an axis perpendicular to its plane, no torque will act to speed up or slow down the swastika, as might have been expected according to the above principle.

However, in the case of the rattleback spinning opposite to its preferred direction, a rocking effect will be induced, but only providing that static friction is present. So whatever the torque is that produces this rocking effect, its presence can be justified in terms of G2, but its direction is perpendicular to that which would be expected. The ninety degrees shift in direction from that which would be expected based on G2 principles indicates one of the main hallmarks of G3. And interestingly, if the G2 force were to behave exactly as expected during the spinning stage, as it does during the rocking stage, then a spinning swastika or rattleback would either slow down with no accounting for the lost energy, or speed up indefinitely with no accounting for where the energy comes from.

By doing what it does, the rattleback conforms to the law of conservation of energy, and it engages in a continual precession of its rotation axis until its direction of rotation has completely reversed. And it only chooses to do this if static friction is available to permit rolling to occur.

The torque that is involved is clearly a fundamental aethereal torque that is induced when a rigid body is spun contrary to its preferred axis of symmetry and/or contrary to its preferred direction of spin if it has such a preferred direction based on shape asymmetry.

We can see glimmerings of both G2 and G3 in the rattleback phenomenon, but the reversal torque cannot seem to be exclusively ascribed to either of them. We know that G2 and G3 are very closely related. A possible explanation in section **VII** of 'The Cause of Coriolis Force' at,

http://www.wbabin.net/science/tombe55.pdf

takes the view that the Coriolis G3 force that is involved in a rattleback is the right angle deflection that is encountered at a centrifugal barrier in a vortex field. The explanation involves a gyroscopic molecular version of Ampère's Circuital Law in conjunction with an electron-positron wind, and a centrifugal barrier being caused by the asymmetrical shape of the rattleback.