CORIOLIS EFFECT

This animation forms part of a pair of rotation effect animations that complement each other. The other rotation effect animation is called centrifugal effect.

This animation focuses on the underlying characteristic that the various cases where the Coriolis effect is at play have in common.

- Rotational-vibrational coupling
- The fluid dynamics of Meteorology and Oceanography
- The Foucault pendulum

The above cases and others are discussed in separate articles. For a first introduction to the physics of atmosphere and its winds go to the rotation of Earth effect that is taken into account in Meteorology.

Also available: a 3D simulation (Java applet), called inertial oscillation, which presents the rotation-of-Earth effect that is essentially the same as the rotation effect in this animation.

View

The two circles with quadrants represent a disk. The left view shows the disk from a stationary point of view. The view on the right is the same disk, as seen from a co-rotating point of view. It's the view you would get if a video camera is suspended above the disk, co-rotating with it.

The green arrow represents a force that is acting upon the moving object. This force is at all times pointing towards the center of rotation. The strength of the centripetal force increases in proportion with the distance to the center. That is, at twice the distance the force is twice as strong. In short, the object experiences a proportional centripetal force.

Controlling the animation

The two elements underneath the two disks are sliders. While the animation is playing the two sliders are temporarily not displayed. To see what is changed with each of the sliders check the checkbox 'show circle and epi-circle'.

The button 'reset' halts the animation and returns the position of the object to the starting point, but the settings are kept. 'Reset all' preserves nothing; it resets to the same state as when the webpage loaded.

Evolution of the display

The motion of the object is frictionless.

As stated above, the force is a proportional centripetal force. A proportional centripetal force is very symmetrical and the motion under the influence of that force has distinctive properties.

All trajectories have the same period of revolution. Further away from the center a stronger centripetal force is required, and a proportional centripetal force provides just that. So no matter how close to the center or how far: for every object the time to complete a circumnavigation is the same. It also does not matter whether the trajectory is circular or ellipse-shaped, the period is always the same. The obvious choice of rotating coordinate system is the one that matches that invariant period.

Decomposition of the motion

Check the boxes for 'traces' and 'circle and epi-circle'. Then you see another elegant way of decomposing the ellipse-shaped trajectory in two components: a circle and an epi-circle. The center of the epi-circle moves in uniform circular motion around the central axis, the object moves in uniform circular motion along the epi-circle. When the overall rotation is counterclockwise (as in this example) then the motion along the main circle proceeds counterclockwise and the motion along the epi-circle proceeds clockwise.

Eccentricity

The motion along the epi-circle represents the *eccentricity* of the trajectory.

Transformation to a co-rotating coordinate system removes the motion along the main circle; the eccentricity remains. Also, note that as seen from a co-rotating point of view the motion along the epi-circle cycles *twice* for every cycle of the system as a whole.

The most efficient way to describe the acceleration with respect to the co-rotating system is to follow the decomposition in circle and epi-circle. Check the box for 'Coriolis & centrifugal'. The centrifugal vector is proportional to the distance to the central axis of rotation, the Coriolis vector represents the acceleration that corresponds with the uniform circular motion along the epi-circle.

The main circle and the epi-circle are indeed perfect circles and the motion along them is uniform.

Similar for all directions of motion

A defining characteristic of the Coriolis effect is that the acceleration with respect to the rotating system is the same for any direction of velocity.

As mentioned at the start: the strength of the centripetal force is proportional to the distance to the central axis of rotation. So whenever the object is circumnavigating slower than the rotating system the object experiences a surplus of centripetal force, and then this surplus pulls the object closer to the central axis of rotation.

Centripetal force and inertia

The rotation effect represented here arises from the centripetal force and inertia together.

When the object is pulled closer to the central axis of rotation the centripetal force is doing work. When the object has reached its point of closest approach its subsequent motion is dominated by its inertia; the object's velocity has become so large that its inertia carries it away from the central axis again. During motion *away* from the central axis the energy conversion is accounted for in the form of the centripetal force doing *negative work*.

Addition of another force

In this simulation there is only one force affecting the trajectory of the object; the centripetal force. Imagine what would happen if there are other forces affecting the object. For example the object can be deflected with a gust of air. With another force added the dynamics will be determined by the sum of the two influences.

For example, a temporary gust of air directed against the object will shift it from one ellipse-shaped trajectory to another, and *during* that shift the Coriolis effect will continue to be at play.

Source : http://www.cleonis.nl/physics/graphlets/coriolis_effect.php