Euler's Disk

P2-9800

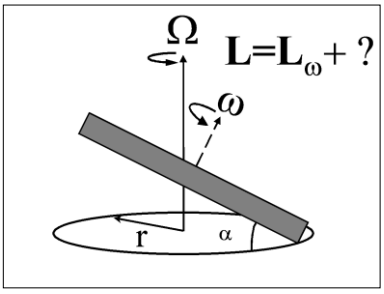
BACKGROUND:

Reading the literature on Euler, one finds he was very interested in the math and physics of "spolling" (spin and roll) rigid bodies (hoops, etc.) - hence the name "Euler's Disk." Anyone setting up the rather simple equations of motion for the toy will most likely use Eulerian angles and Euler's equations of motion to yield some classic results. Professor H. K. Moffatt, a fluid dynamicist at Cambridge University has shown (using elements of fluid mechanics) that the toy might lose some of its energy by squeezing out the air between its rolling edge and the mirror base. The equation for a perfect fluid, modified by Navier and Stokes to include viscous effects, is the work of Leonard Euler.

USING EULER'S DISK:

Conservation of Energy:

When Euler's Disk is spun, the disk contains both potential and kinetic energy. The potential energy is given to the disk when it is placed upright on its side. The kinetic energy is given to the disk when it is spun on the mirrored base. Euler's Disk would spoll (spin and roll) forever if it were not for friction and vibration.



Angular Momentum:

Another way of describing how Euler's Disk operates is by considering the disk's angular momentum. Like a top, Euler's Disk uses its angular momentum to hold itself upright. As the disk spolls around in a circle it is held in place by a balance of the gravitational force pulling the disk down and the force applied by the mirror base which holds the disk up. Again, if it were not for friction and vibration, the disk would rotate for a very long time.

To Infinity:

Using Euler's equations of motion - and several assumptions - one can show that as the disk loses energy, the soaring pitch produced by the rolling point of contact increases towards infinity, as the inverse square root of the angle alpha. This result is a beautiful example of the rather subtle and elegant motion of the toy. The curious student will be amazed at the number of interesting problems one can solve concerning the motion of this little toy. Very recently, Professor H.K. Moffatt of Cambridge University has written several interesting articles in the Journal of Nature concerning how Euler's Disk might lose a portion of its energy through viscous dissipation. Several universities have spun the toy in a vacuum to see how much longer (if at all) Euler's Disk will spoll. It turns out that it does go longer. Several other papers on the motion of Euler's Disk are available from the inventor in .pdf format.

THE SOUND OF EULER'S DISK::

Listen to the sound Euler's Disk makes as it spins faster and faster! What do you think accounts for this unique sound?

~Joseph Bendik

Joseph Bendik is a graduate from the University of California at Berkeley. He is available for (free) lectures concerning the physics and history of Euler's Disk - as time permits. For more information log on to http://www.eulersdisk.com/