HOW GYROSCOPES WORK

...and other assorted mysteries

SORRY ABOUT THE LAST CLASS…

Denial

"It wasn't so bad...I think I got the main point through"

Anger

"It's not fair! Torques are the accepted explanation! Why won't they bite???"

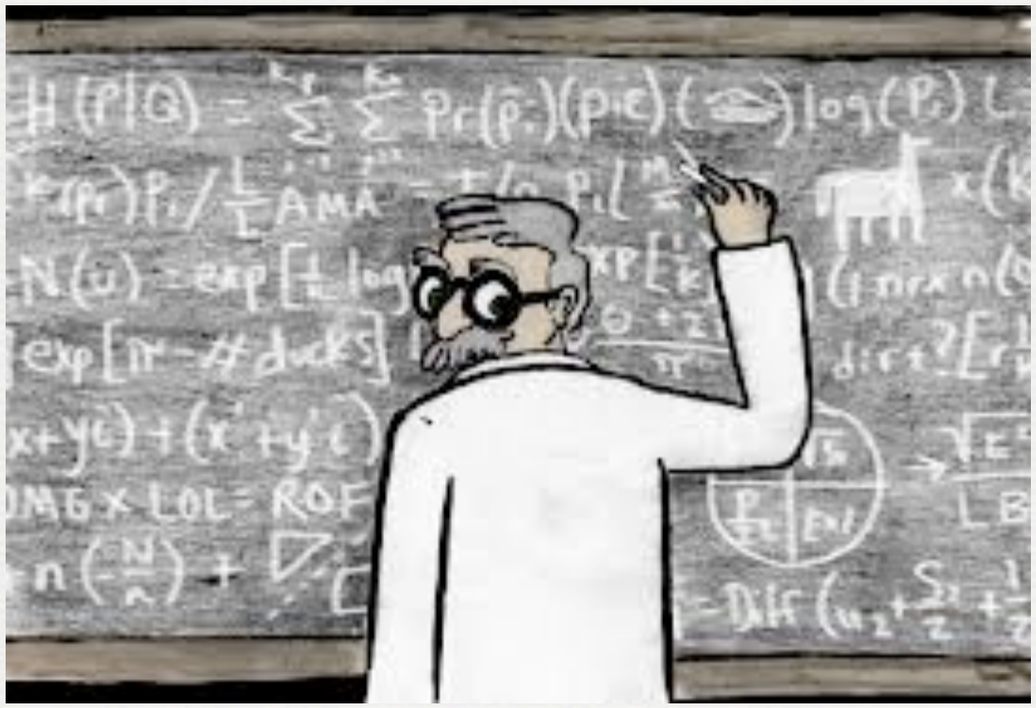
Depression

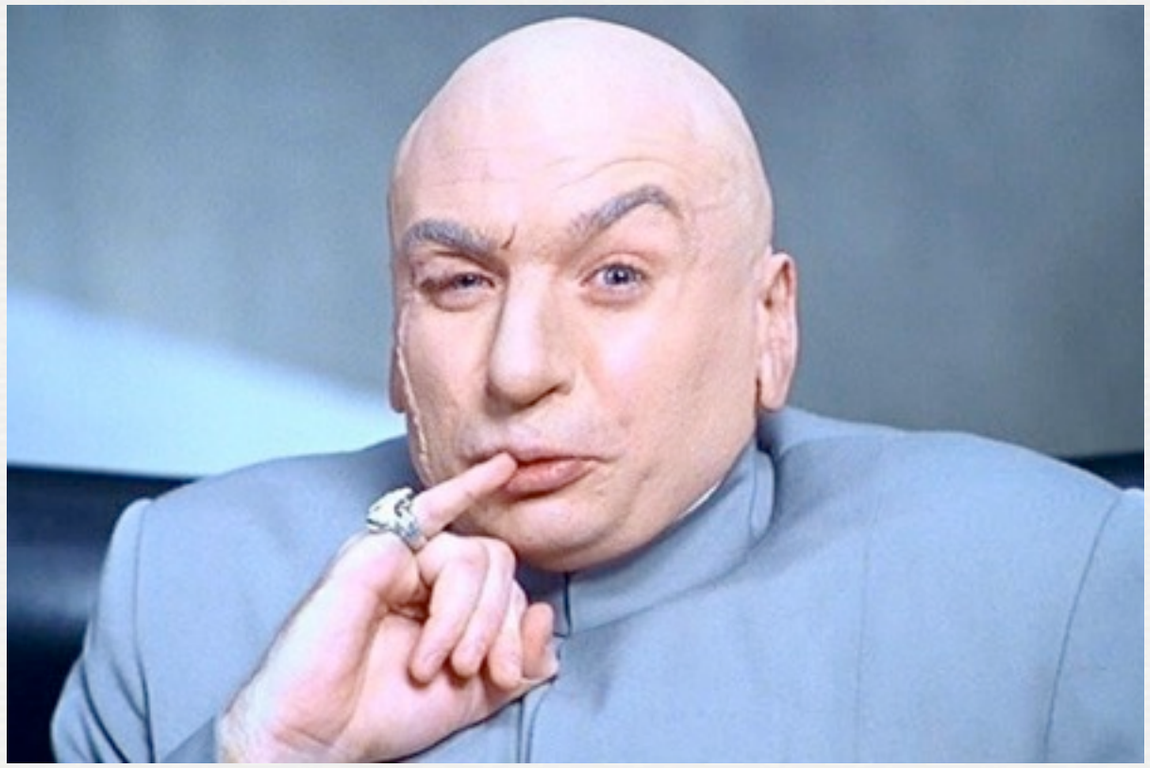
"Man, I suck"

Acceptance and Hope

"Yes, we can!"

SO I STARTED ASKING MY COLLEAGUES...





...and no one had a good explanation!

tell me if you find a good explanation
tell me if you find a good explanation
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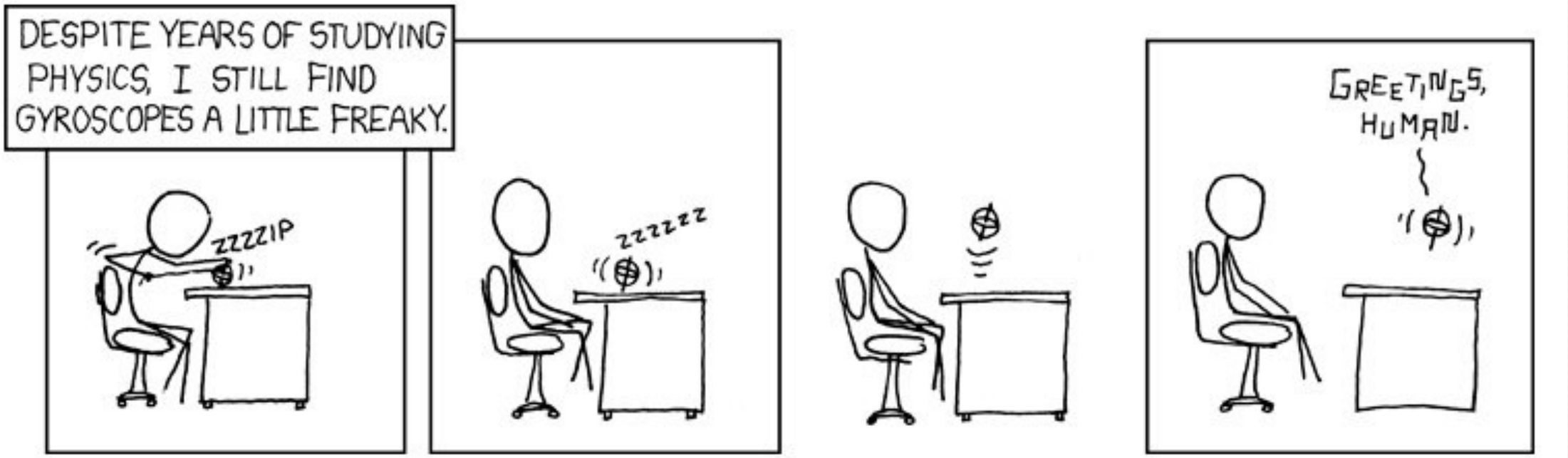
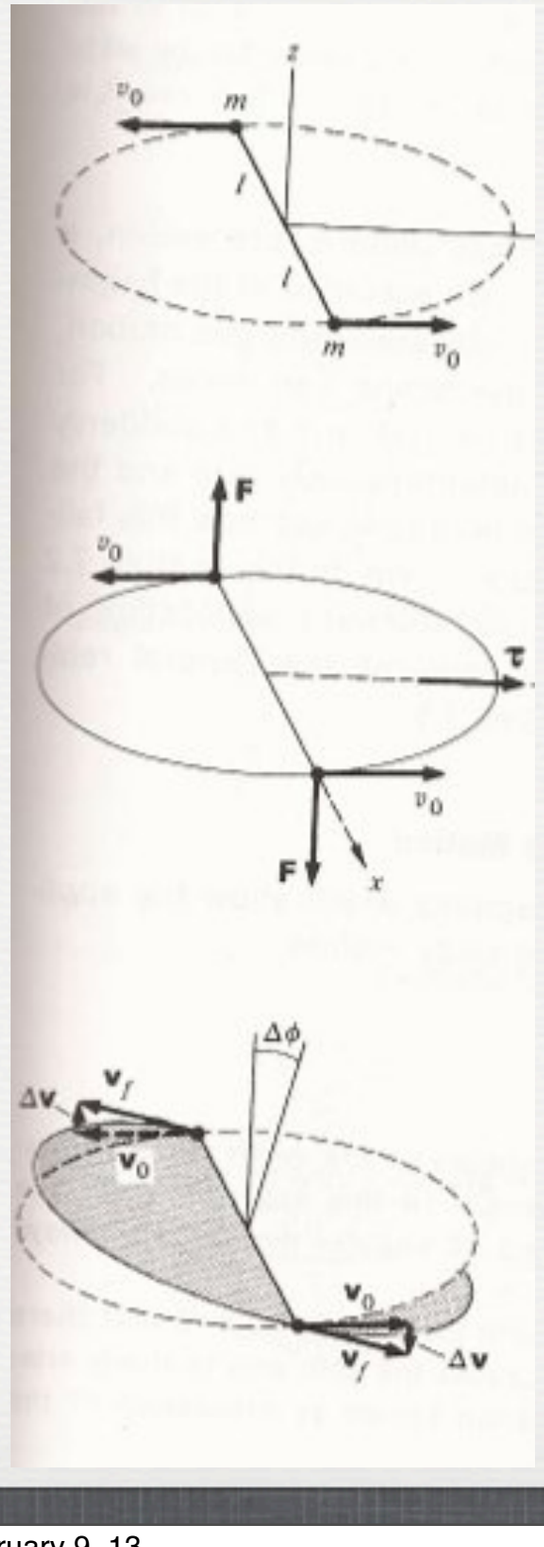
This stuff is hard for us too


DESPITE YEARS OF STUDYING PHYSICS, I STILL FIND GYROSCOPES A LITTLE FREAKY.
ZZZZIP
ZZZZZZ
GREETINGS, HUMAN.

K&K HAS A GREAT PICTURE...



The motion of the particles causes the plane of rotation to tilt in a different direction from the applied force!

Let's see this in a movie...

Mechanical Universe: all videos are online at

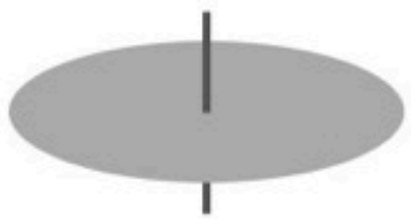
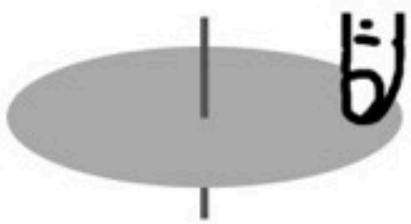
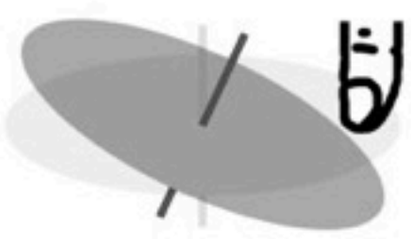
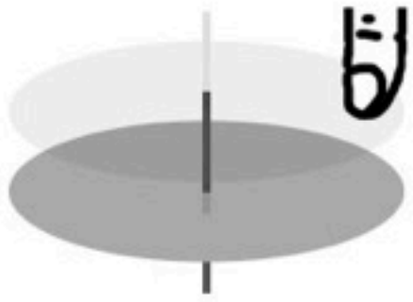
http://www.learner.org/resources/series42.html

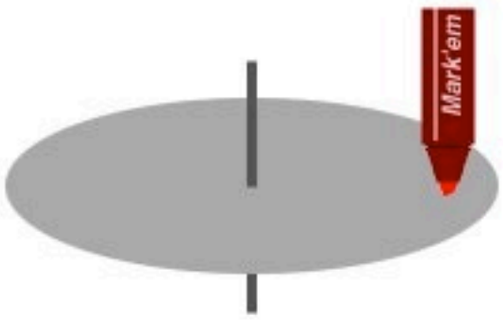
The relevant section for precession is Episode 20, from minute ~9:00 onwards

I also recommend Walter Lewin's online lectures:

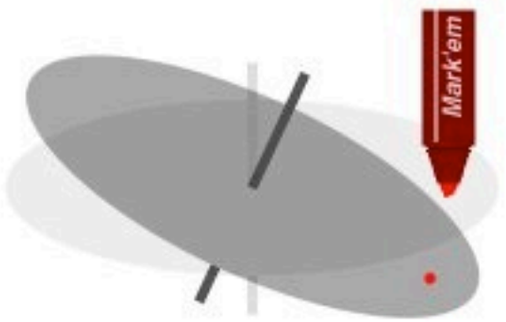
http://ocw.mit.edu/courses/physics/8-01-physics-i-classical-mechanics-fall-1999/video-lectures/

WHY ARE SPINNING OBJECTS STABLE?

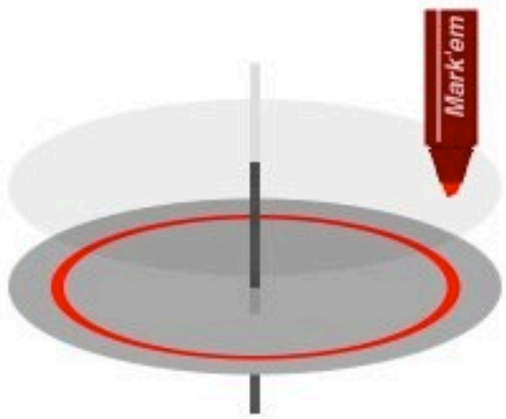
	A gyroscope is at rest in a zero-gravity environment. It consists of a simple smooth (frictionless) disc, and a metal pin running through the center for giving it a spin.
	The disc is not spinning. Using your finger, you push down on a spot near the edge of the disc.
	As expected, the disc tilts around its center, easily changing angular orientation.
	Now we get the disc spinning at a high rate, and do the same experiment again. This time the whole disc moves down, without changing orientation, even though we pushed it near the edge. How did it do that?



Now let's do the experiments again, but this time use a red marking pen. Unlike your finger, the marker leaves red ink wherever it pushes an object.



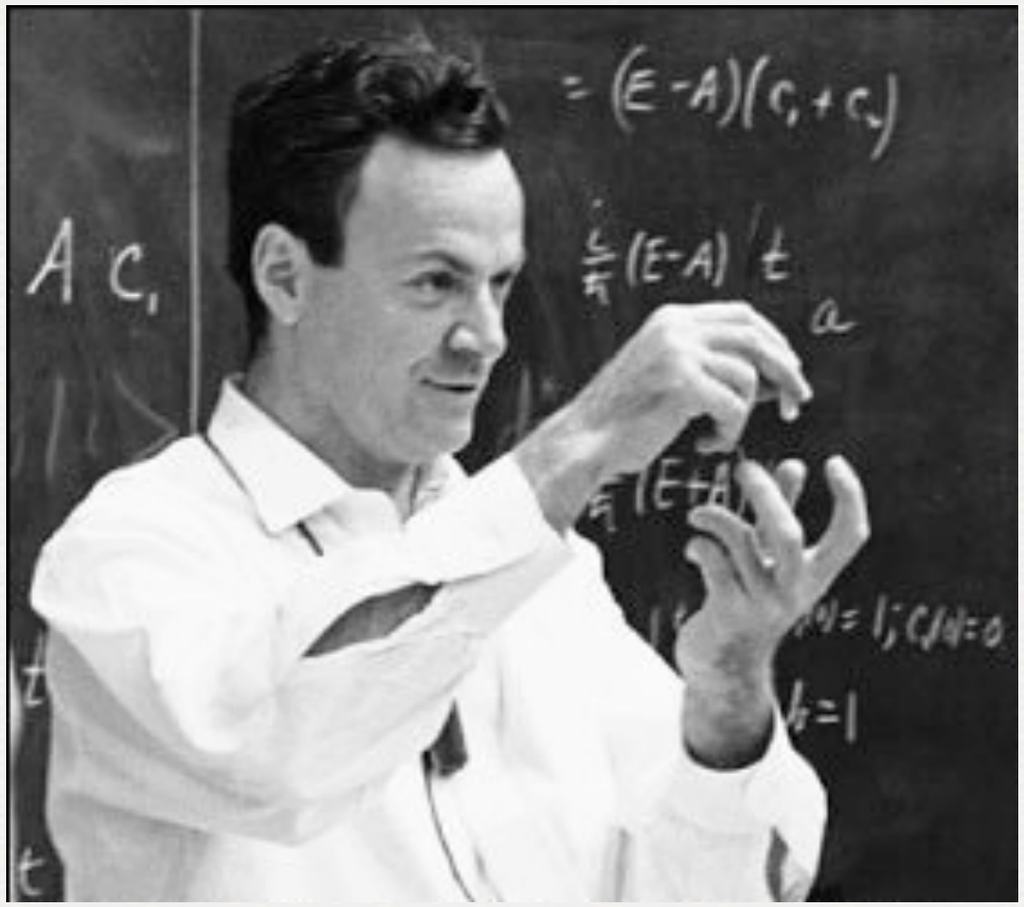
With the disc not spinning, we try the experiment. The disc changes orientation easily, as expected, and the red spot on the disc shows where it was pushed.



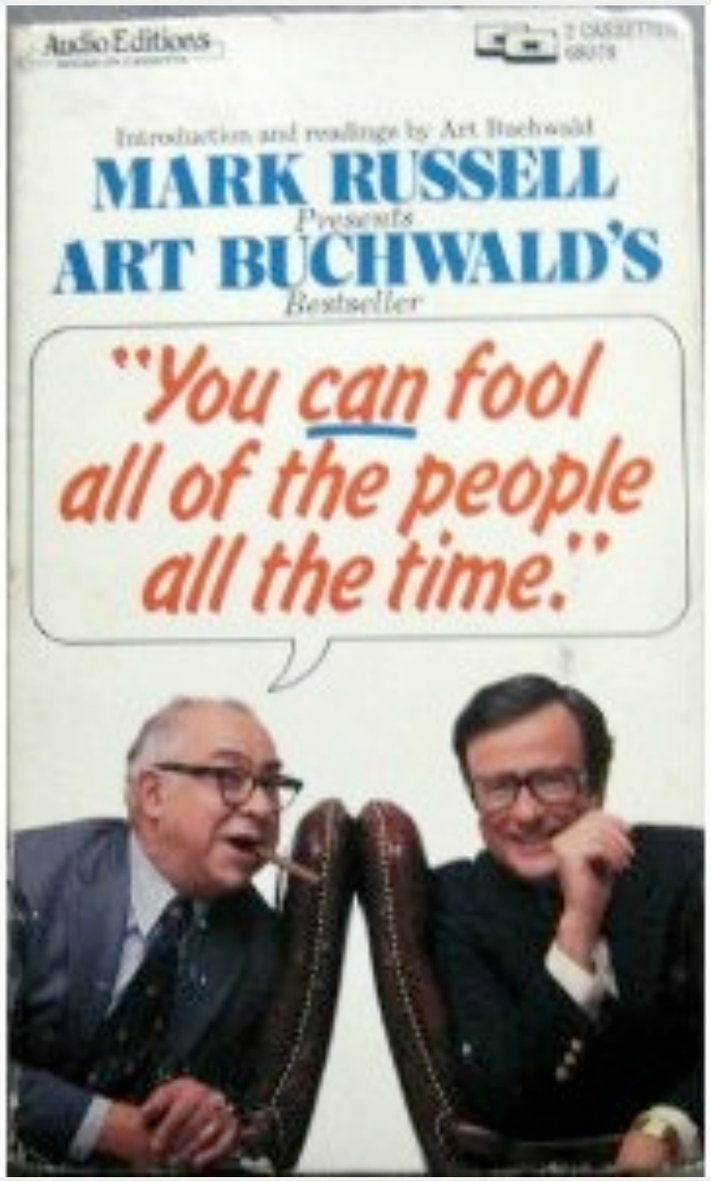
Now we do it with the disc rapidly spinning. As soon as the marker touches the disc, a red circle appears all the way around the disc. This red circle shows *all the points where the disc is being pushed down.* Naturally, no angular orientation change will occur when the disc is being pushed on all the points of a circular path which is centered on the disc. The whole disc will move down, just as you should expect it to move when you push it down on all points of the red circle!

THANK YOU FOR YOUR QUESTIONS!

It is important that besides being able to do the math, we understand things at a basic, intuitive level



...ALSO, THE STANDARD STORY CAN BE WRONG



...for instance, why are bicycles stable?

Bike videos are here:

http://ruina.tam.cornell.edu/research/topics/bicycle_mechanics/stablebicycle/