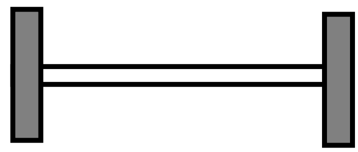
Rotational Inertia (I)

Mass farther out is
harder to get spinning
and to stop



Mass closer in is
easier to get spinning
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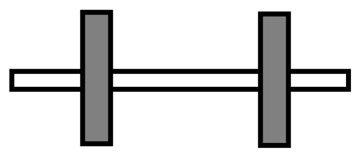

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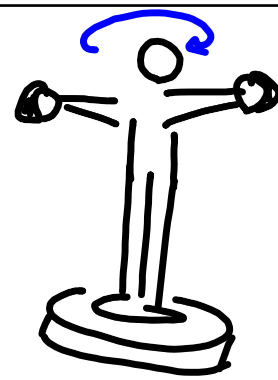


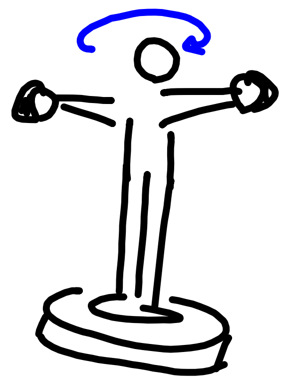
Mass closer in is
easier to get spinning

and to stop

If there are no outside torques,

Mass farther out
slows the rotation.

$I\omega$



Mass closer in
speeds the rotation

$I\omega$

So if you halved your Rotational Inertia, your Angular Velocity would double.

$$I \;\; \omega \longrightarrow \frac{I}{2} \;\; 2\omega$$

It is as if their total is staying constant!

$$(I)(\omega) = \left(\frac{I}{2}\right)(2\omega)$$

Not total... product.

That leads us to a new idea:

Angular Momentum = $I\omega$

And to our first Conservation Law!

The Law of Conservation of Angular Momentum (L)

If there are no outside Torques, the Angular Momentum of a system remains constant.

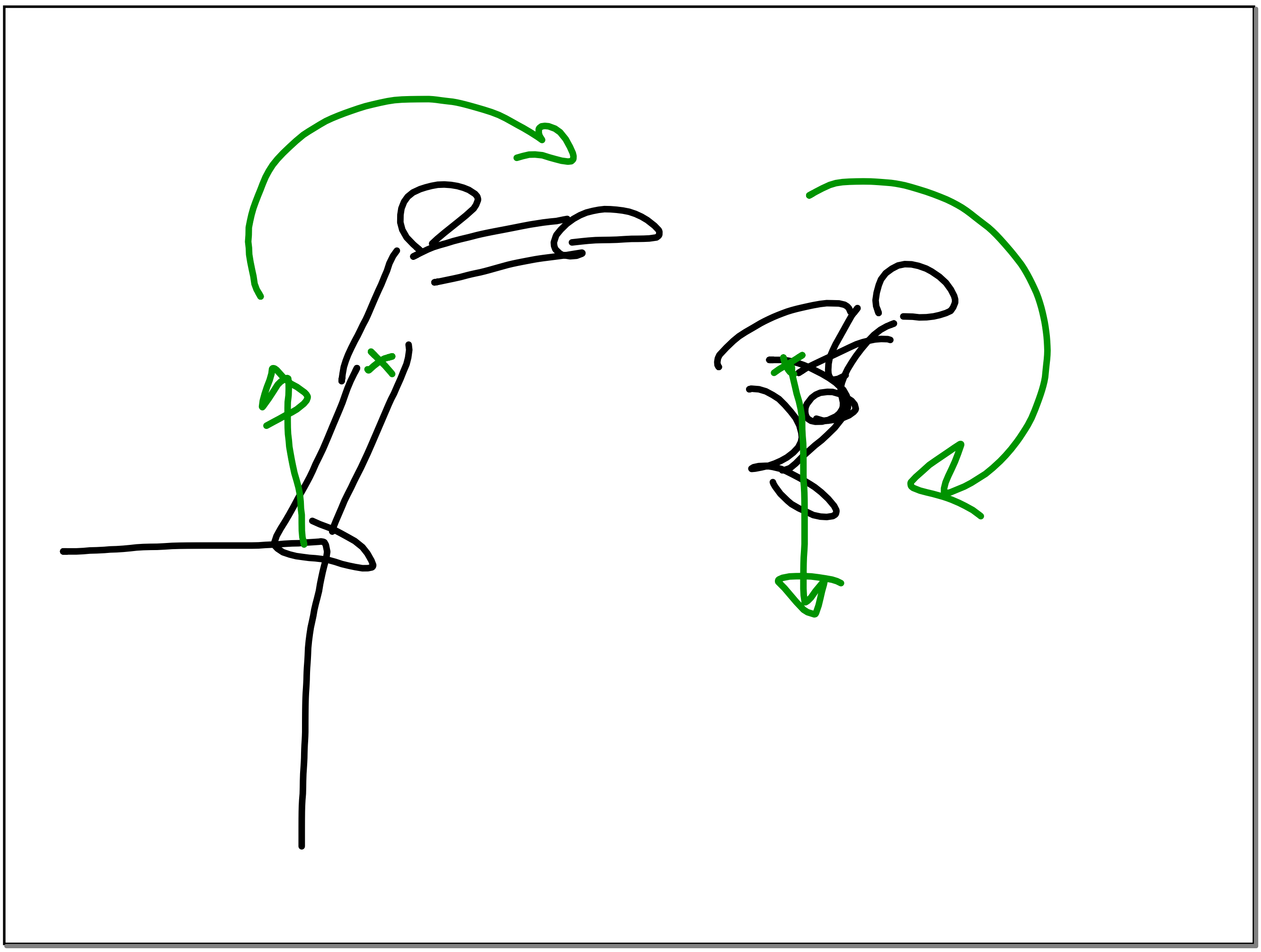
Mass farther out slows the rotation.

$$I\omega = L$$

Mass closer in speeds the rotation

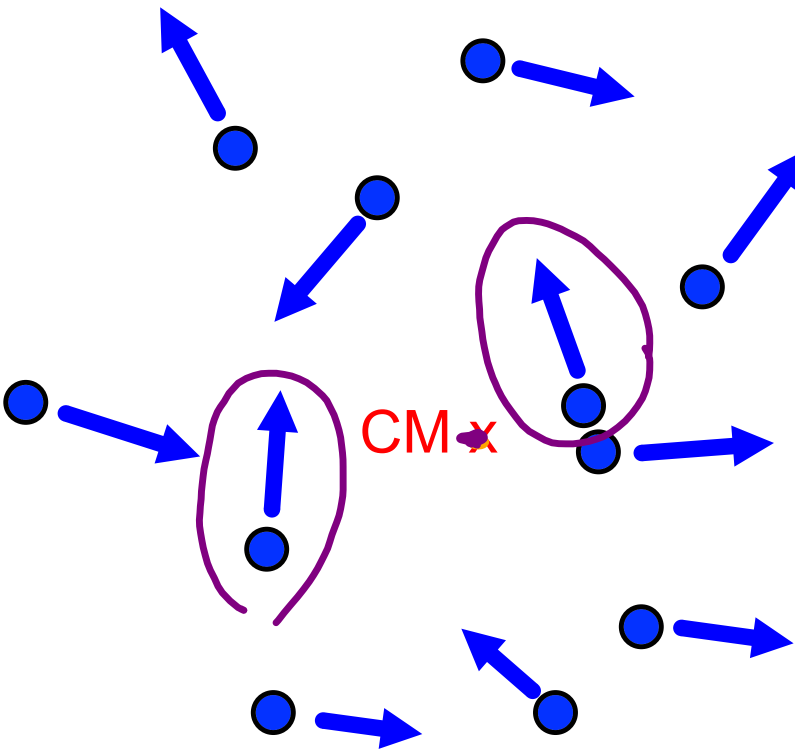
$$I\omega = L$$

Same



Why does water spin fast when it goes down the drain?

Water molecules have random motion



Around the CM, some molecules have CW Angular Momentum and some have CCW Angular Momentum.

What are the chances they all cancel out to zero?

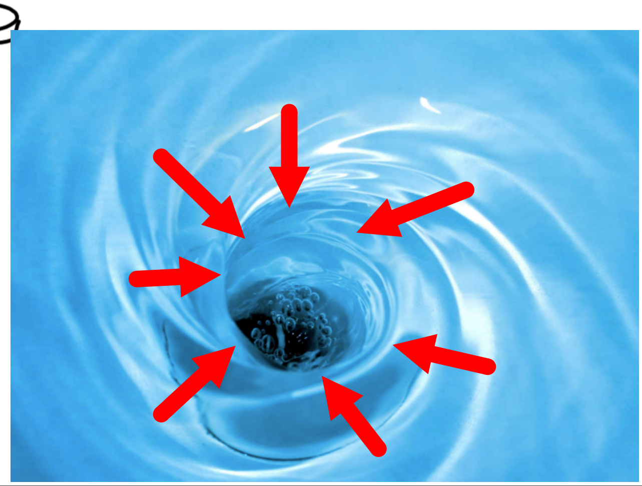
Mass farther out
slows the rotation.

$$\mathbf{I}\,\omega$$

Mass closer in
speeds the rotation

$$I\,\boldsymbol{\omega}$$

As the water pulls inward, the same thing: ω increases!



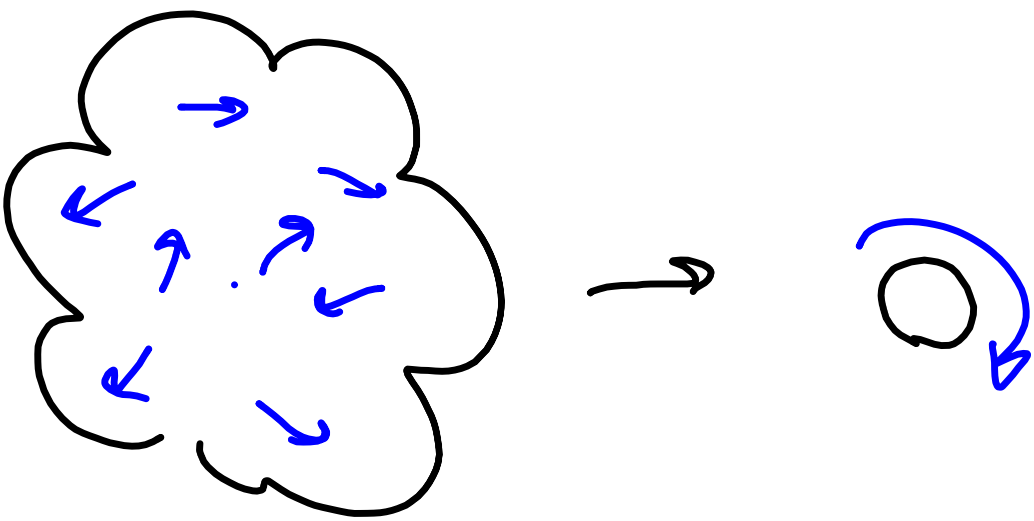
Why are all the planets spinning?

And the sun?

And all the stars?

Stars form from randomly swirling clouds of Hydrogen gas

What are the chances that the CW angular momentum and CCW angular momentum exactly cancel?



And as gravity pulls it inward...

Interesting that the direction of spin of the planets & sun mostly matches the revolution of the planets around the sun.