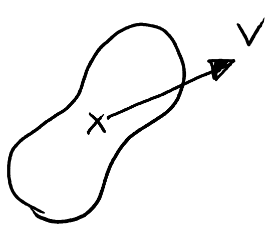
ROTATIONAL MOTION

our universe seems to be filled with spinny things: galaxy, solar system orbits, Earth, hurricaines + tornadoes, flushing toilets

Why? CONSERVATION OF ANGULAR MOMENTUM

Back to outer space:



isolated rigid object

→ Constant velocity motion of CENTER OF MASS = average location of mass

+

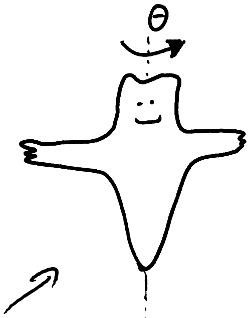
→ rotations about center of mass

* These two motions can be treated INDEPENDENTLY *
(also true when forces are present)

Rotational motion of rigid bodies completely analogous to translational motion

Representing rotational motio

analogous translational quantity:



Spinny troll

describe orientation by

$\theta(t)$ ⟷ position x

angular velocity:

omega → $\omega = \frac{d\theta}{dt}$ $\frac{\text{radians}}{\text{sec}}$ ⟷ velocity $v = \frac{dx}{dt}$

angular acceleration

alpha → $\alpha = \frac{d\omega}{dt}$ ⟷ acceleration $a = \frac{dv}{dt}$

Noether: object in environment w. rotational symmetry about some axis

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ANGULAR MOMENTUM CONSERVED

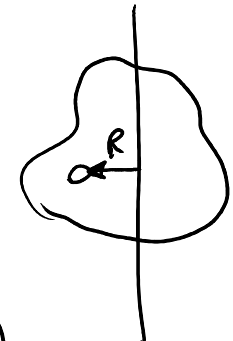
$$L = I\omega$$

like $p = mv$

- L ← angular momentum about axis
- I ← MOMENT OF INERTIA
- ω ← angular velocity

MOMENT OF INERTIA tells us how hard it is to get object to spin

I - proportional to mass
- proportional to $(\text{size})^2$

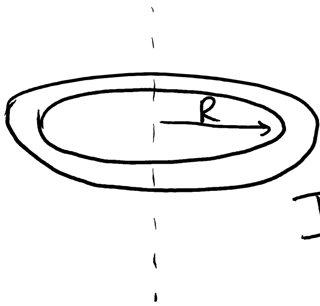


defined as

$$I = M \times (\text{average } R^2)$$

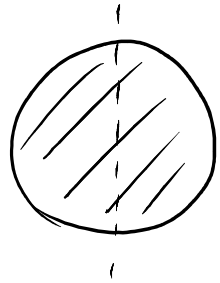
↖ distance to axis

e.g.



ring

$I = MR^2$

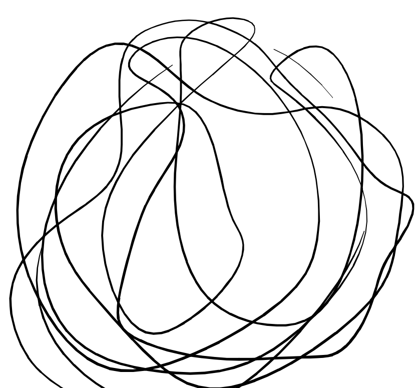


Solid sphere

$I = \frac{2}{5} MR^2$

For non-rigid object, I can change

e.g. gravitational collapse



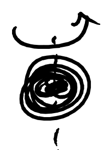
slight overall rotation

I decreases

⟶

L constant

so ω must increase



significant rotation.