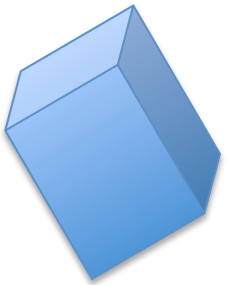
Rigid Body Dynamics

- from particles to rigid bodies…

Newton's equations of motion



Newton-Euler equations of motion

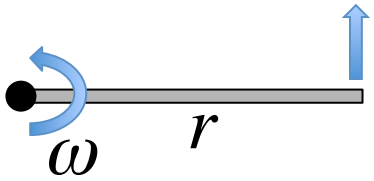
Preliminaries

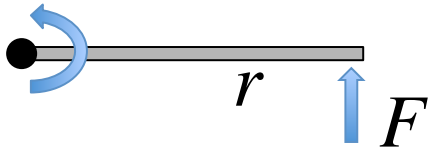
- cross product via a matrix multiply

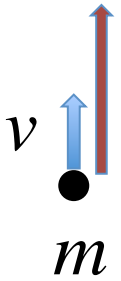
$$\tilde{a} = \begin{pmatrix} 0 & -a_z & a_y \\ a_z & 0 & -a_x \\ -a_y & a_x & 0 \end{pmatrix}$$

Kinematics of Rotation

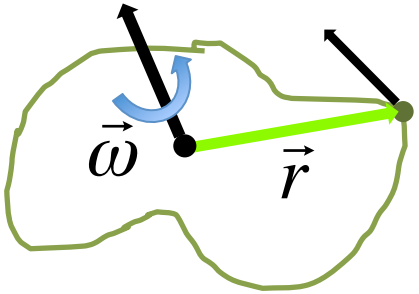
- Intuitively, with scalars:

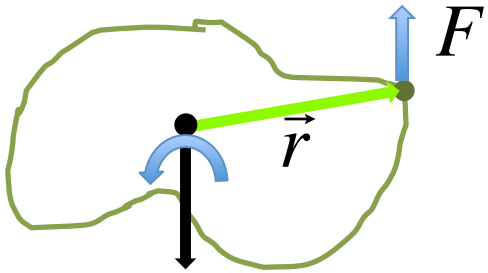


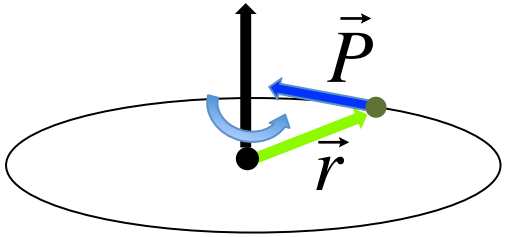




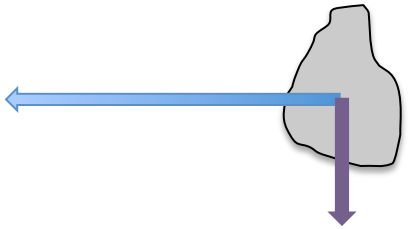
- More generally:





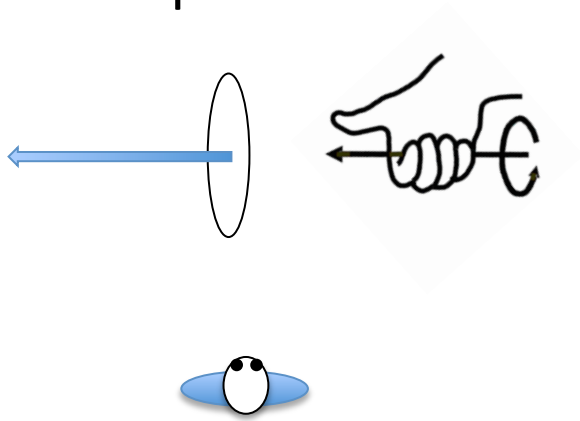


Newton’s Law

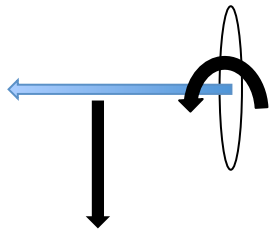


Euler's Law

top view



side view



Angular Momentum of a Set of Particles

Intertia Tensor

Newton-Euler Equations of Motion

Updating the Inertia Tensor

Simulation Loop

linear position
linear velocity
angular orientation
angular velocity

for each timestep

setup

solve eqns of motion

integrate