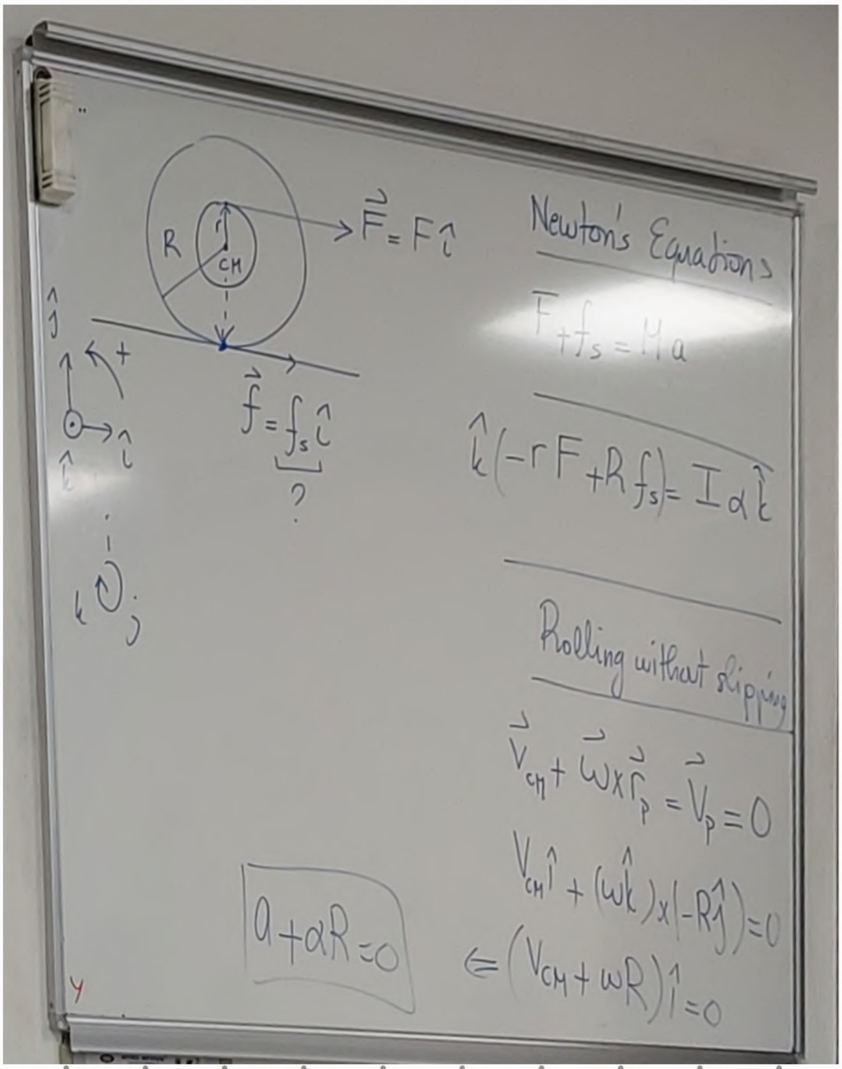
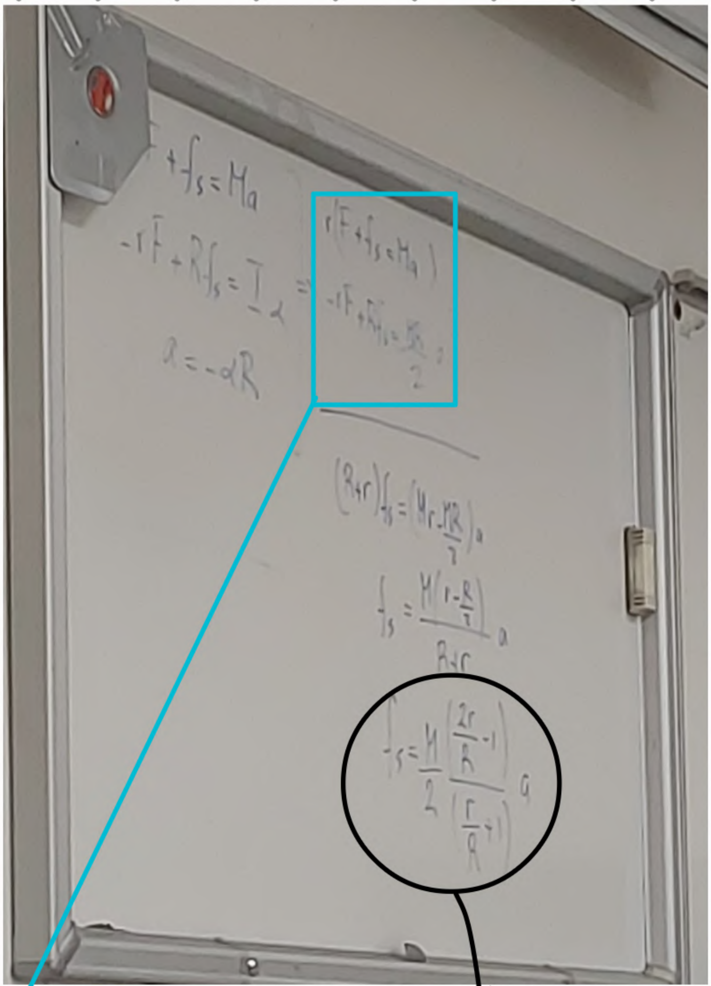
PHYS 301 Lecture 11 04.11.24





$\frac{2r}{R}$

$$F + f_s = Ma$$
$$-rF + Rf_s = I\alpha$$
$$\Rightarrow -rF + Rf_s = \frac{MR}{2}a$$

$r(F + f_s = Ma)$

- says something about the direction of fs.

- "Yoyoyu aşağıdan ve yukardan çekmenin farkı!" (Kablolar yukarıdan geleiliyor ki fs biçimde çalışsın)

Remember always though!:

$$|\vec{f_s}| \leq \mu_s |\vec{N}|$$

Superball Bounces (will be in HWs)

- Perfect spheres that conserve energy, momentum and angular momentum.

- "Do Newton's Laws have an inverse in time"
  Yes.

$$\vec{F}(r) = m\vec{a} = m\frac{d^2\vec{r}}{dt^2}$$

"Does the reverse playback of a <u>movie</u> possible?"

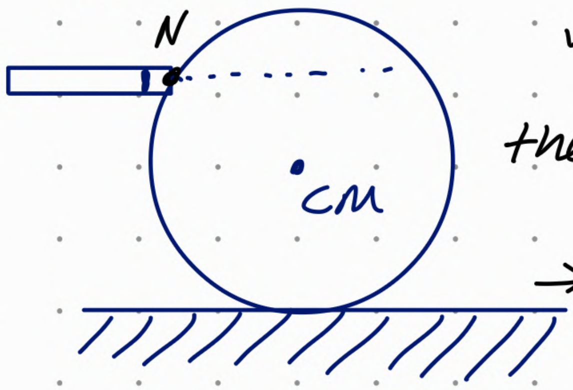
entropy works only in one way (Ek not conserved)

→ Different in entropic/complex system (Glass of water breaking so I can understand the film is played backwards)

→ Not so for mechanic systems.

(Solution is <u>not</u> trivially obvious)

EX:



"What happens when you hit the ball from different points"..

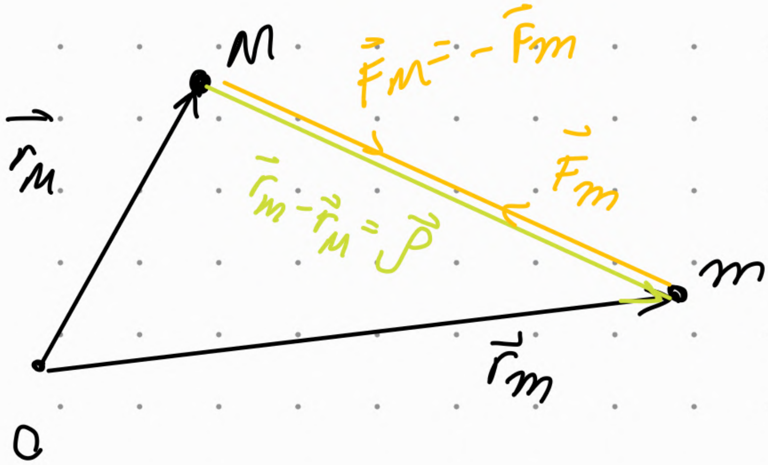
→ You can't simply say "oh there's F_N at N!"

- There is an impulse.

$$\int_{\tau} F dt = \text{Impulse}.$$

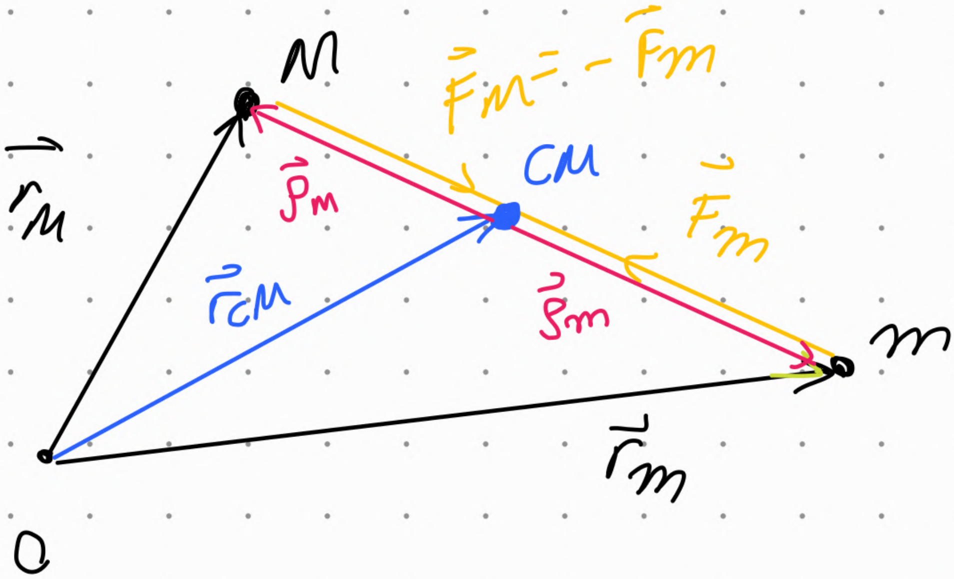
You should work with that.

Kepler Problem



$$\vec{F}_M = -\frac{GMm}{|\vec{r}_M - \vec{r}_m|^2}\hat{\rho}$$

Center of Mass coordinates



- $\vec{r}_M = \vec{r}_{cm} + \vec{\rho}_M \qquad \vec{r}_m = \vec{r}_{cm} + \vec{\rho}_m \Rightarrow \boxed{\vec{r}_{cM} = \frac{M\vec{r}_M + m\vec{r}_m}{M+m}}$

- $\frac{Md^2\vec{r}_M}{dt^2} = \vec{F}_M \; , \quad m\frac{d^2\vec{r}_m}{dt^2} = \vec{F}_m$

$$M\frac{d^2\vec{r}_{cm}}{dt^2} + M\frac{d^2\vec{\rho}}{dt^2} = -\hat{\rho}_M \frac{GMm}{|\vec{\rho}_M - \vec{\rho}_m|^2}$$

$$m\frac{d^2\vec{r}_{cm}}{dt^2} + m\frac{d^2\vec{\rho}_m}{dt^2} = -\hat{\rho}_m \frac{GMm}{|\vec{\rho}_M - \rho_m|^2}$$

$$\Rightarrow M_T\frac{d^2\vec{r}_{cm}}{dt^2} + \frac{d}{dt^2}\underbrace{\left[M\vec{\rho}_M + m\vec{\rho}_m\right]}_{0} = 0$$

$$\boxed{\frac{d^2\vec{r}_{cm}}{dt^2} = 0.}$$

CM doesn't move.

$\vec{\rho}_M - \vec{\rho}_m \equiv \vec{r}_\mu$: relative mass.

$$\Rightarrow M\frac{d^2\vec{\rho}_M}{dt^2} - m\frac{d^2\vec{\rho}_m}{dt^2} = (-\vec{\rho}_M + \vec{\rho}_m)\frac{GMm}{|\vec{\rho}_M - \vec{\rho}_m|^3} = -\vec{r}_M\frac{GMm}{|\vec{r}_\mu|^3}$$

$$M\frac{d^2 r_M}{dt^2} - m\frac{d^2\vec{r}_m}{dt^2} = -\vec{r}_\mu\frac{GMm}{|r_\mu|^3}$$

- $M\vec{r}_M - m\vec{r}_m = A\vec{r}_{CM} + B\vec{r}_\mu$

$$(M+m)\vec{r}_{cm} = M\vec{r}_M + m\vec{r}_m$$

$$\mu\ (\vec{r}_\mu = \vec{r}_M - \vec{r}_m)$$

$$(M+m)\vec{r}_{cM} + m$$

⋮ :((missed some steps)

$$\vec{r}_M = \vec{r}_{cM} + \frac{m}{M+m}\vec{r}_\mu$$

$$\vec{r}_m = \vec{r}_{cM} - \frac{M}{M+m}\vec{r}_\mu$$

$$\mu = \frac{Mm}{M+m}$$

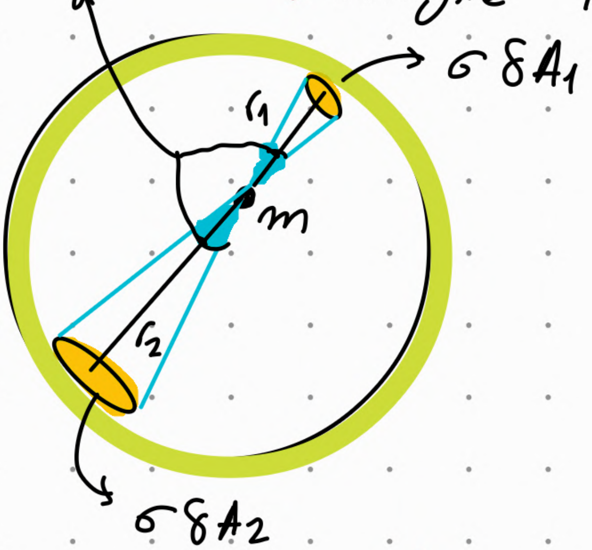
$$\frac{2Mm}{M+m}\frac{d^2\vec{r}_\mu}{dt^2} = -\vec{r}_\mu \frac{GMm}{|\vec{r}_\mu|^3}$$

- You study motion of 2 particles. But you can ignore there's 2 particles, because they "act" like 1.

EXAMPLE / NOTE

small solid angle

- Imagine you are inside a homogen shell sphere



$$mG\sigma\left(\frac{\delta A_1}{r_1^2} - \frac{\delta A_2}{r_2^2}\right)$$

$\delta A_1 = r_1^2\,\delta\Omega$ solid angle

$\delta A_2 = r_2^2\,\delta\Omega$

This forces cancel each other.

So when you sum everything up, you'll see everything will sum up to 0.

This shows Gravitation inside is 0. (You float)

General Central Force Problem

$$\mu \frac{d^2\vec{\rho}}{dt^2} - \hat{\rho} f(|\vec{\rho}|) \vec{F} \qquad \Big| \; \vec{F}(\vec{\rho}) = -\vec{\nabla} V(|\vec{\rho}|)$$

$$E_{Total} = \frac{1}{2}\mu |\vec{\rho}|^2 + V(|\vec{\rho}|)$$

$$\frac{dE_{Total}}{dt} = 0 \qquad \mu \vec{\rho} \times \dot{\vec{\rho}} \equiv \vec{L} \rightarrow \frac{d\vec{L}}{dt} = 0$$

$$\frac{d}{dt} V(x(t), y(t), z(t)) = \dot{x}\frac{\partial V}{\partial x} + \dot{y}\frac{\partial V}{\partial y} + \dot{z}\frac{\partial V}{\partial z}$$

"Motion is contraint on a plane"

→ Defined by (L)

- Parçacığı belirli bir yere koyduk, $\vec{v}_0 / \vec{x}_0$ parçacığın hareket edeceği düzlemi belirler ($\mu\vec{\rho} \times \dot{\vec{\rho}} = \vec{L}$) (Dış etki olmadığı)