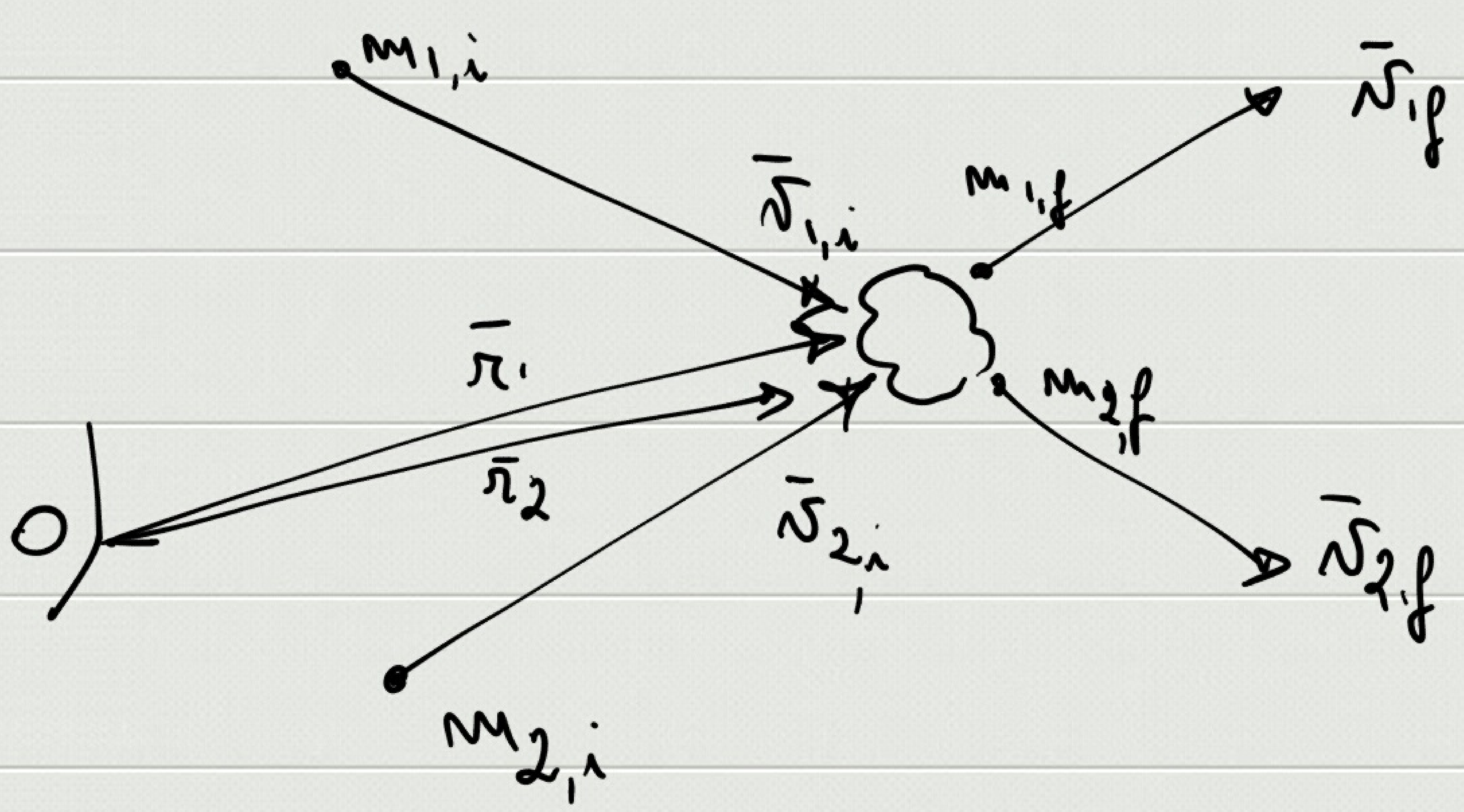
Urti: interazioni in un tempo breve

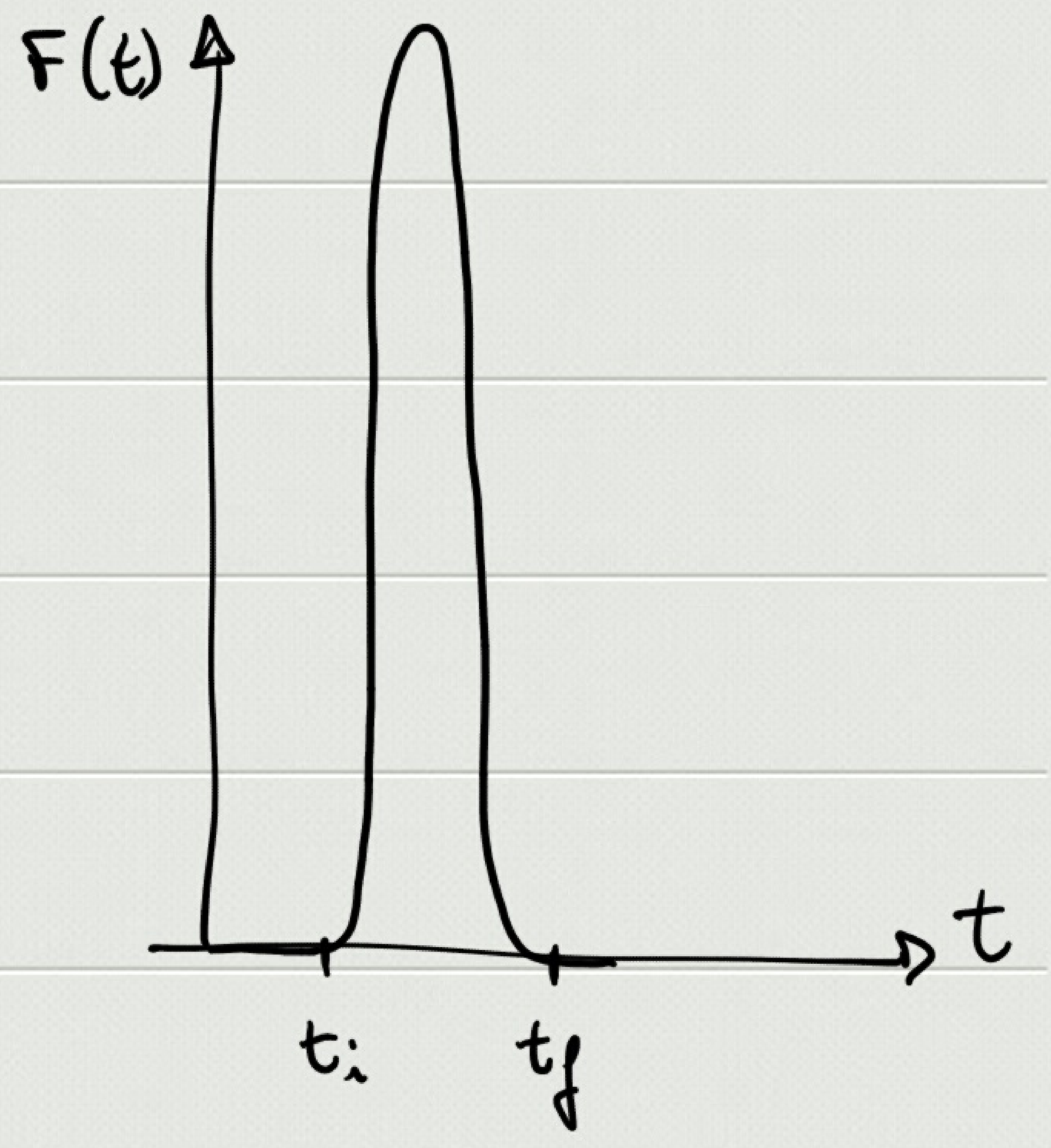


Nell'urto $\bar{r}_1 \simeq cost$ $\bar{r}_2 \simeq cost$

Intervallo di tempo dell'urto: $[t_i, t_f] \rightarrow \boxed{\Delta t = \tau}$

Forze nell'urto:

- interne: $\bar{F}_{12}$, $\bar{F}_{21}$
- impulsive $\longrightarrow$



Variazione della quantità di moto

$$\bar{P}_i = m_1 \bar{v}_{1i} + m_2 \bar{v}_{2i}$$

$$\bar{P}_f = m_1 \bar{v}_{1f} + m_2 \bar{v}_{2f}$$

Sistema isolato: $\left.\begin{array}{l}\boxed{\bar{R}^E = 0} \\ \quad \overset{!}{=} m_{TOT}\, \bar{a}_{cm}\end{array}\right\} \bar{v}_{cm} = \text{cost}$

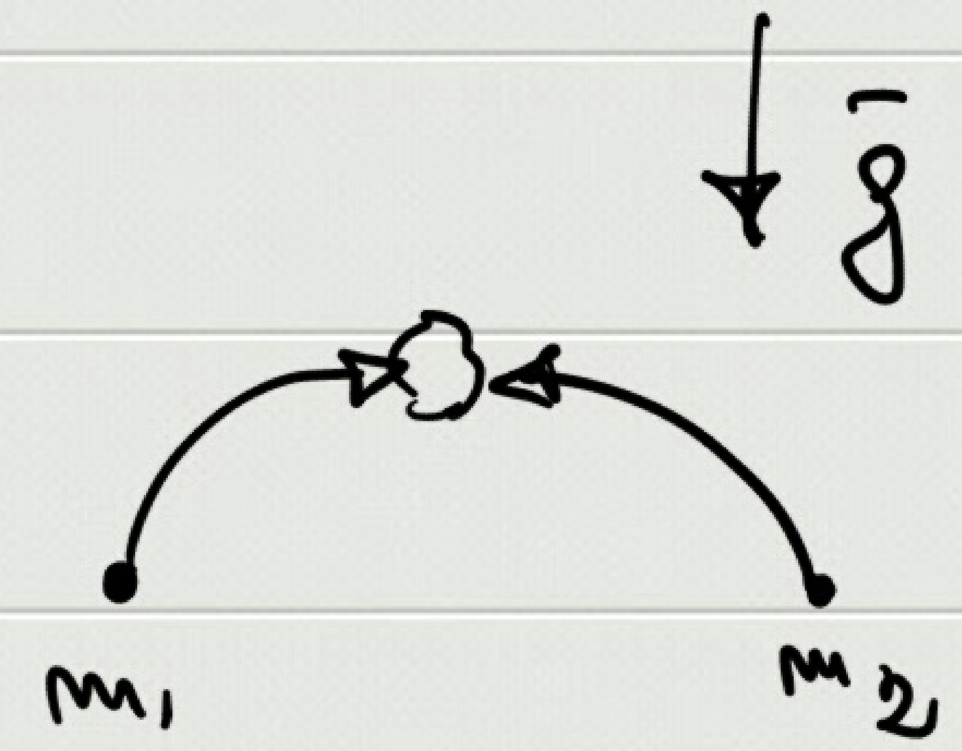
$$\boxed{\bar{P} = \underline{m_{TOT}\, \bar{v}_{cm} = \text{cost}}}$$

$$\bar{P}_i = m_1 \bar{v}_{1i} + m_2 \bar{v}_{2i} = m_1 \bar{v}_{1f} + m_2 \bar{v}_{2f} = \bar{P}_f \qquad *$$

$$\Delta \bar{p}_1 = m_1 \bar{v}_{1f} - m_1 \bar{v}_{1i} = \bar{J}_{21} = \int_{t_i}^{t_f} \bar{F}_{21}\, dt \neq 0$$

$$\Delta \bar{p}_2 = m_2 \bar{v}_{2f} - m_2 \bar{v}_{2i} = \bar{J}_{12} = \int_{t_i}^{t_f} \bar{F}_{12}\, dt \neq 0$$

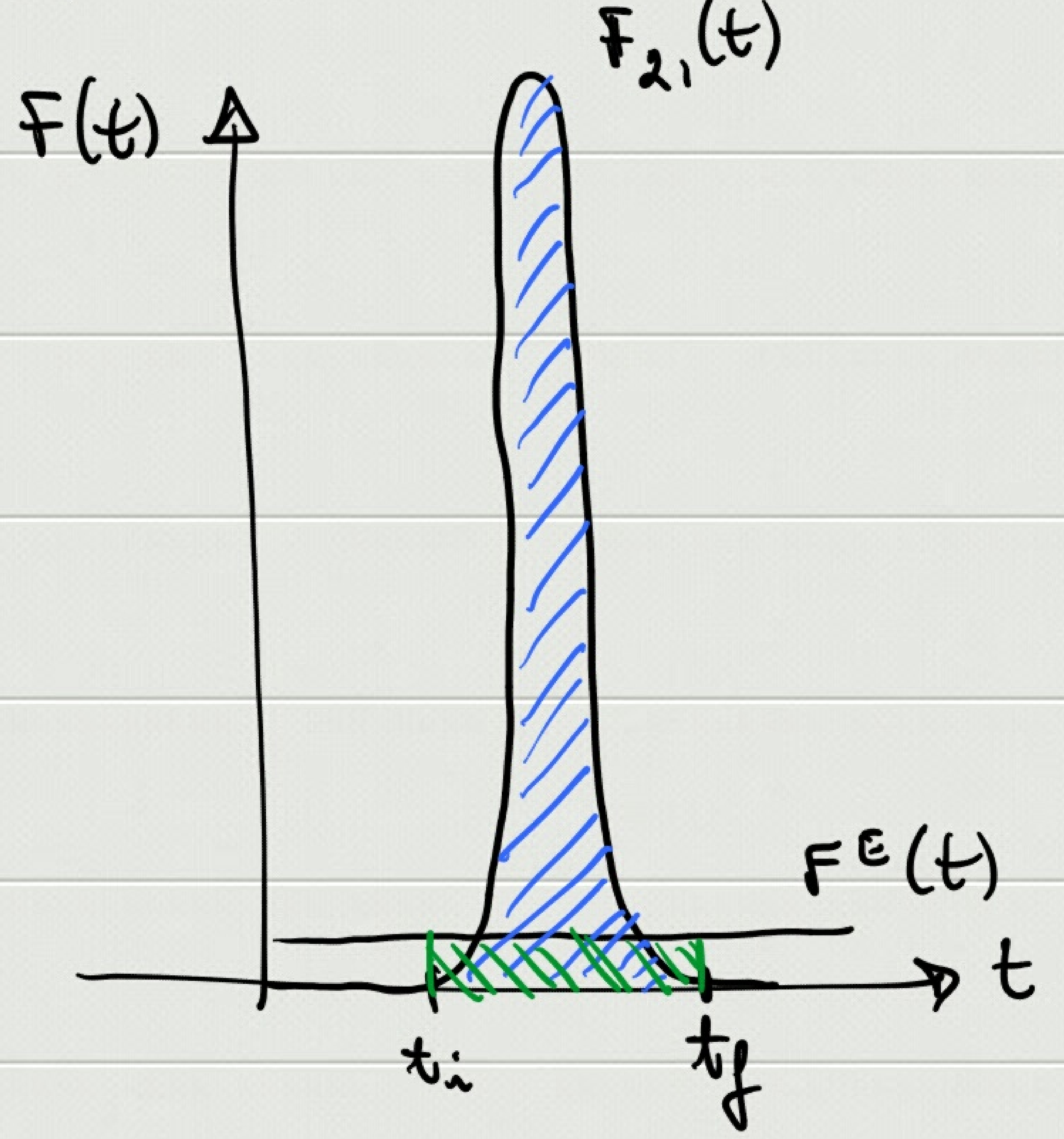
$$\bar{F}_{12} = -\bar{F}_{21} \implies \boxed{\Delta \bar{p}_1 = -\Delta \bar{p}_2}$$



$$\boxed{\bar R^E \neq 0}$$

$\bar p \neq cost$

$$\Delta \bar p_1 = \Delta \bar p_1^I + \Delta \bar p_1^E = \bar J_{21} + \bar J_1^E =$$



$$= \int_{t_i}^{t_f} \bar F_{21}(t)\,dt + \int_{t_i}^{t_f} \bar F^E(t)\,dt =$$

$$\int_t^{t+\Delta t} f(t)\,dt = \langle f \rangle_{\Delta t}\,\Delta t$$

$$= \left[\langle \bar F_{21} \rangle_\tau + \langle \bar F^E \rangle_\tau\right]\tau \simeq \langle \bar F_{21} \rangle_\tau\,\tau$$

$\bar R^E \neq 0$ ma forze esterne "normali" (non impulsive)

$$\Rightarrow \boxed{\bar P = cost}$$

$\bar{R}^E \neq 0$ con forze esterne "impulsive"

$\Rightarrow \bar{P} \neq cost$

Energie

$$\boxed{W_{nc} = \Delta E_m}$$

$E_m = E_k + E_{pot}$

$\bar{r}_i \simeq$ costanti $\Rightarrow$ $E_{pot} = cost \Rightarrow \Delta E_p = 0$

$$\Rightarrow \boxed{W_{nc} = \Delta E_k} \quad \begin{cases} \text{forze cons.} \quad W_{nc} = 0 \quad \boxed{\Delta E_k = 0} \quad (1) \\ \text{forze n.cons.} \quad W_{nc} \neq 0 \quad \boxed{\Delta E_k = W_{nc}} \quad (2) \end{cases}$$

(1) : urti elastici $\quad E_{k,i} = E_{k,f}$

(2) : urti anelastici $\quad (W_{nc} = \Delta E_k)$

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$$E_k \overset{|}{=} E'_k + E_{k,cm} = \left(\frac{1}{2} m_1 v_1'^2 + \frac{1}{2} m_2 v_2'^2\right) + $$
$$+ \frac{1}{2}(m_1+m_2)\, v_{cm}^2$$

$v_{cm}=0$

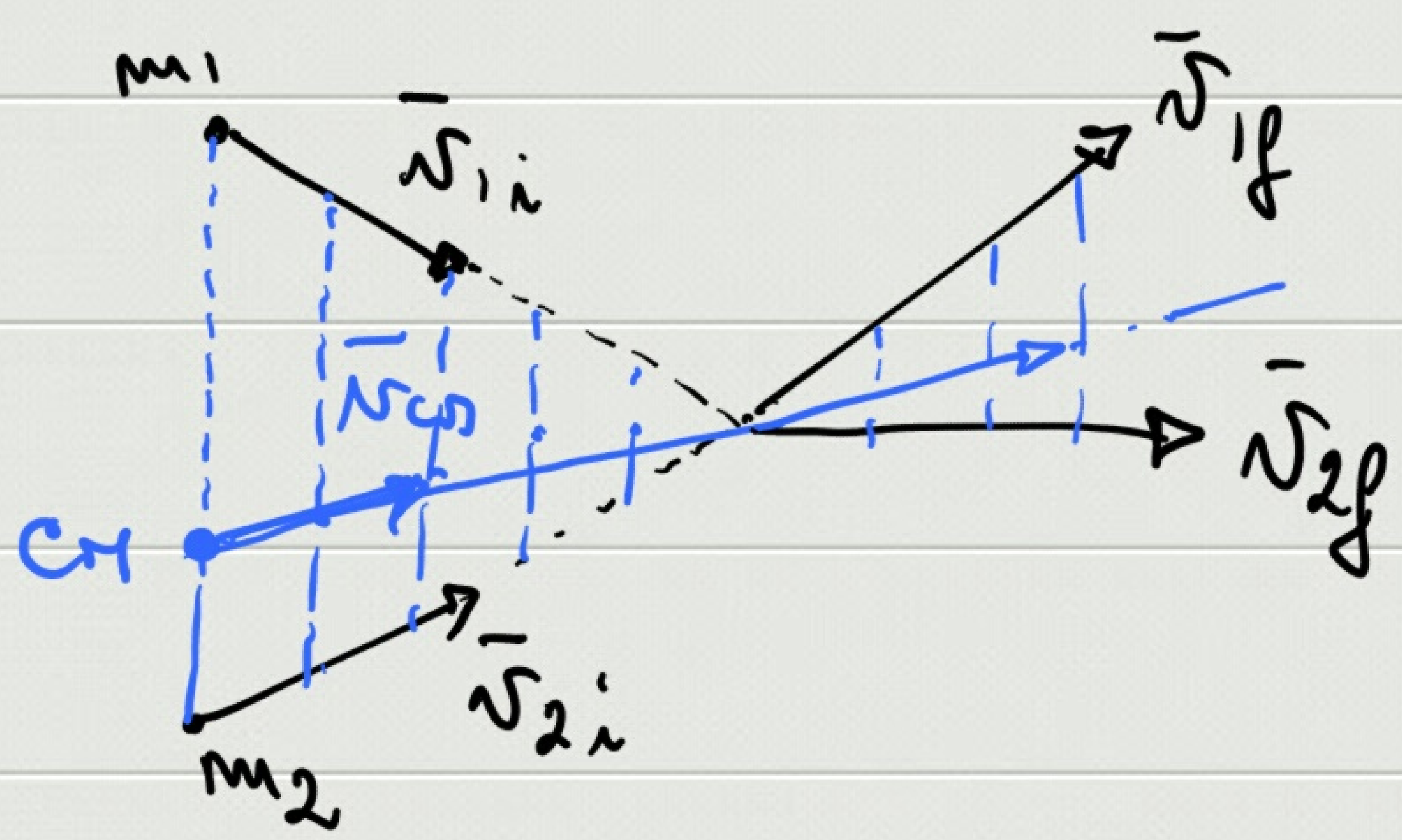
$$\underline{\underline{\Delta E_k}} = \left(E'_{k,f} + E_{k,cm,f}\right) - \left(E'_{k,i} + E_{k,cm,i}\right) \overset{|}{=}$$
$$= \underline{\underline{\Delta E'_k}}$$

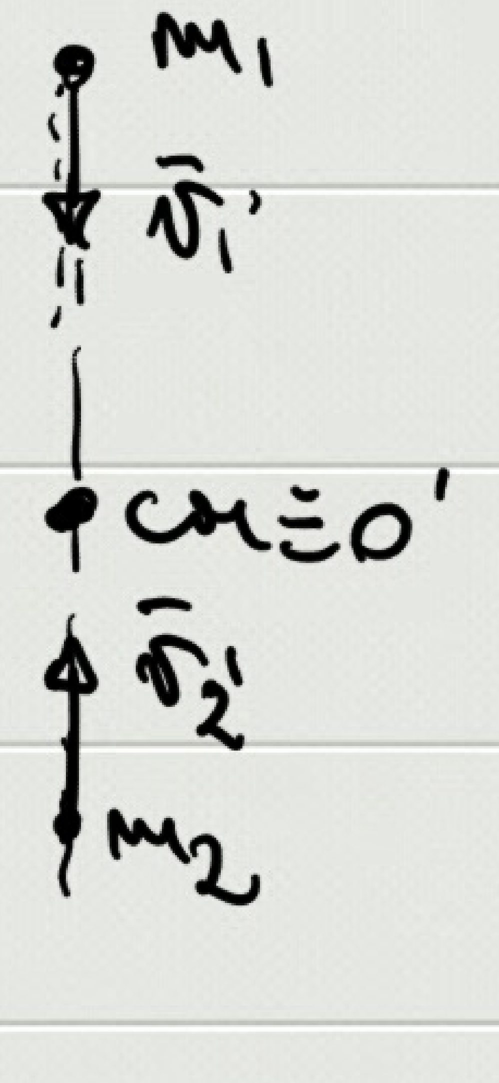
$$\bar{p}' = m_{TOT}\, \bar{v}'_{cm} = 0$$

$\bar{v}'_{cm} = 0$

$$= \sum_i \bar{p}'_i = m_1 \bar{v}'_1 + m_2 \bar{v}'_2 = 0$$

$$\Rightarrow \bar{p}'_1 = m_1 \bar{v}'_1 = -m_2 \bar{v}'_2 = -\bar{p}'_2$$





$(m_2 > m_1)$ SdR inerziale SdR del CM