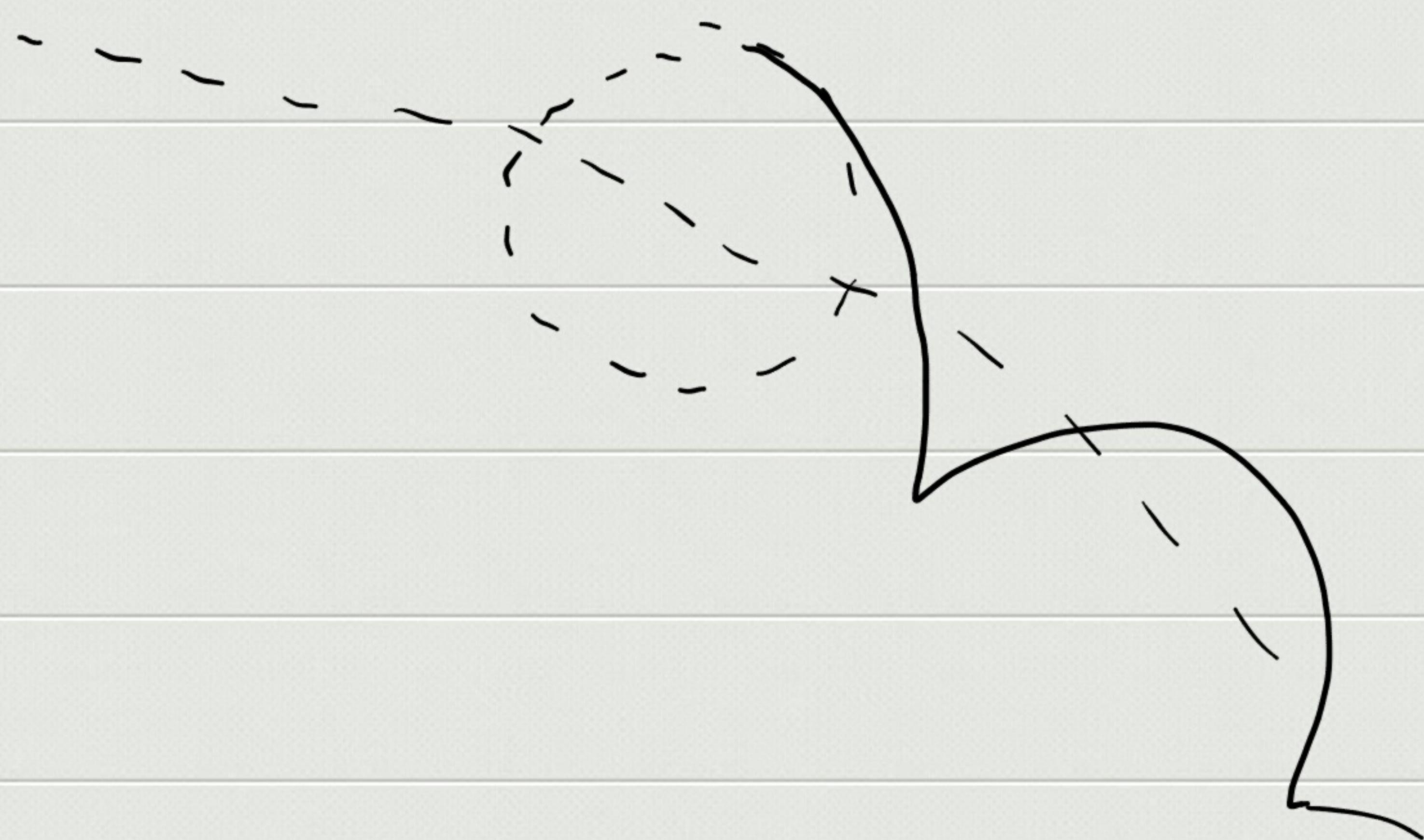


Teoria geocentrica : Tolomeo



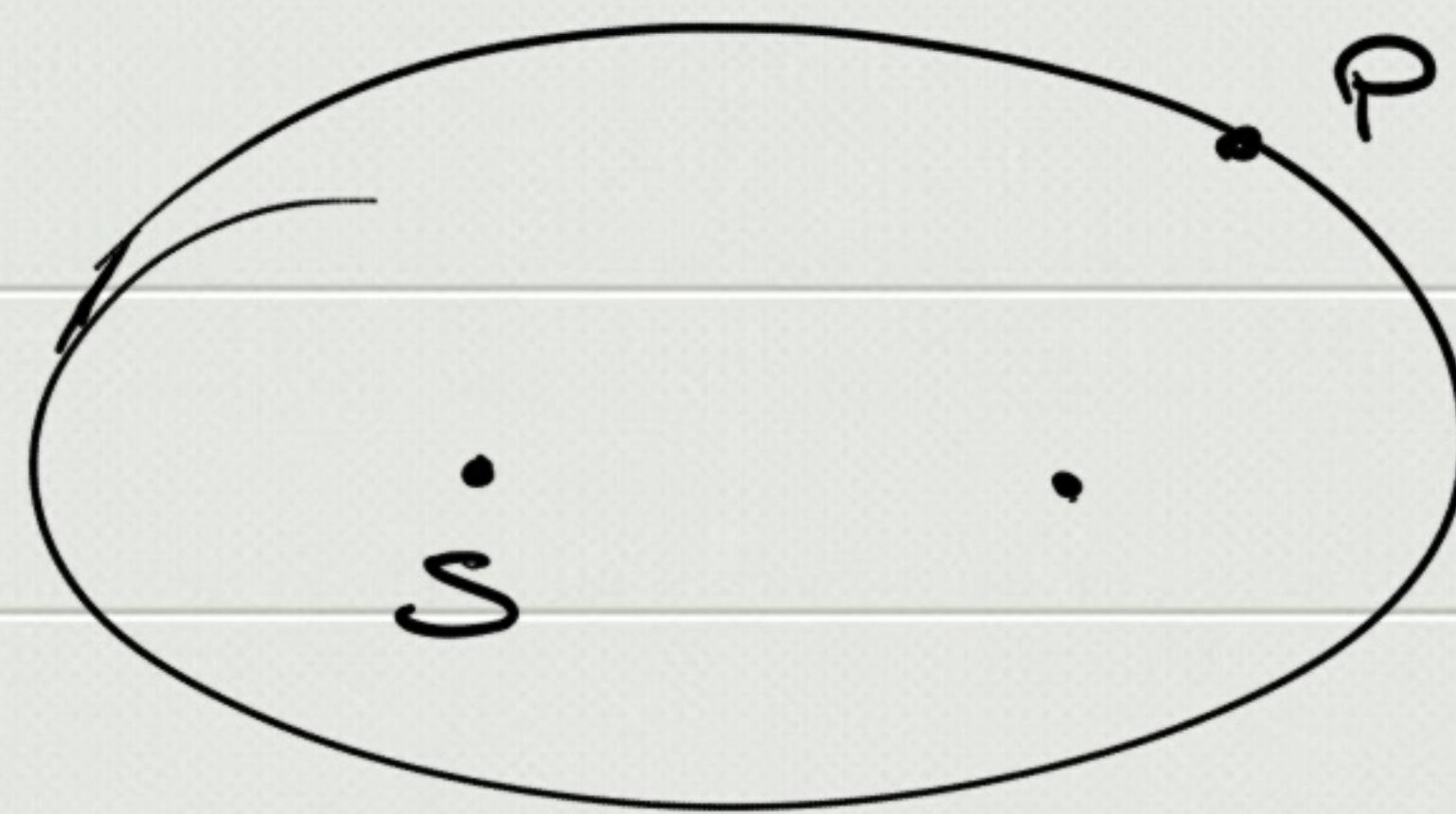
Eliocentrismo

Copernico

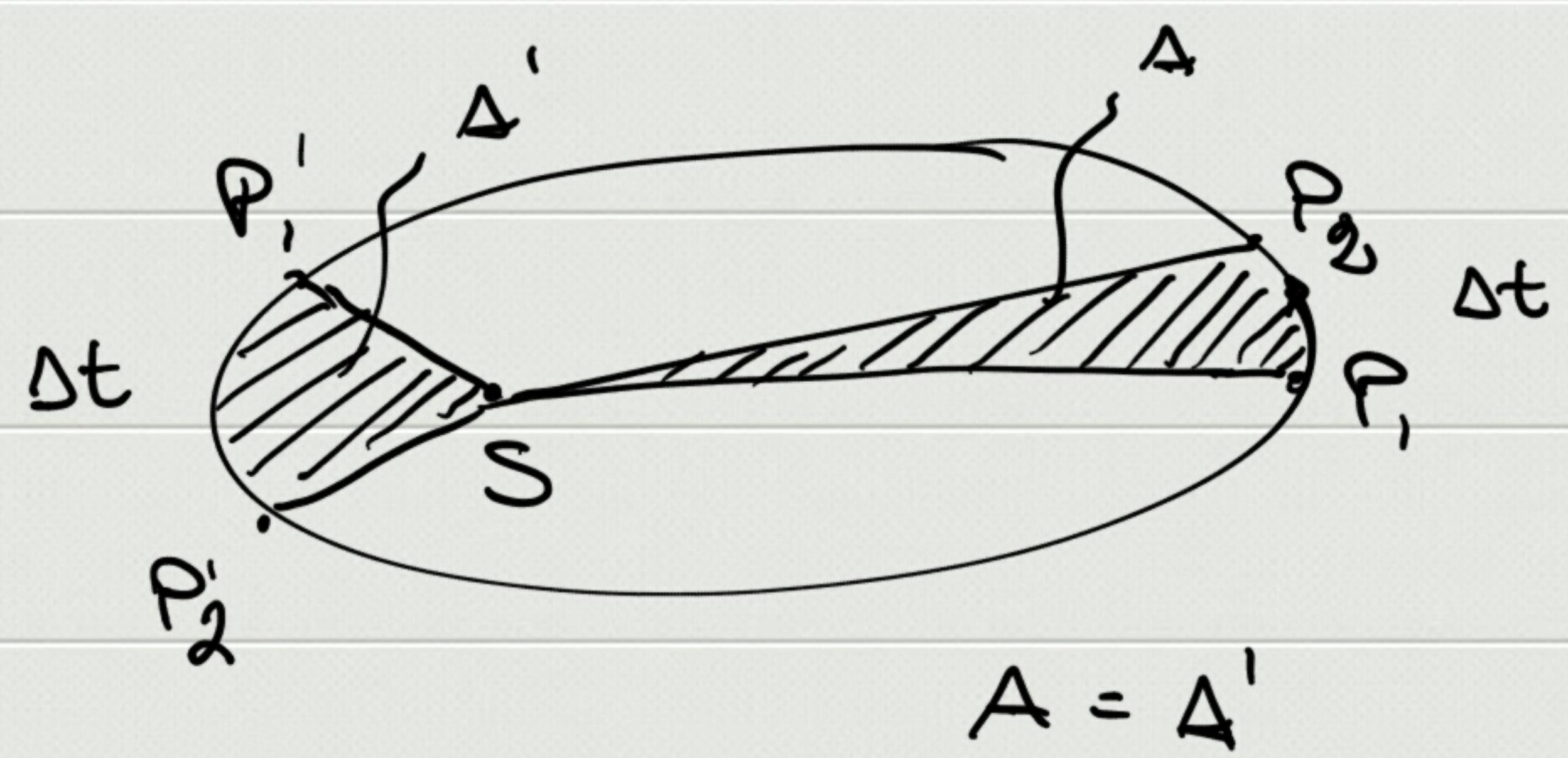
Tycho Brahe : misure
Keplero

Leggi di kepler

1:



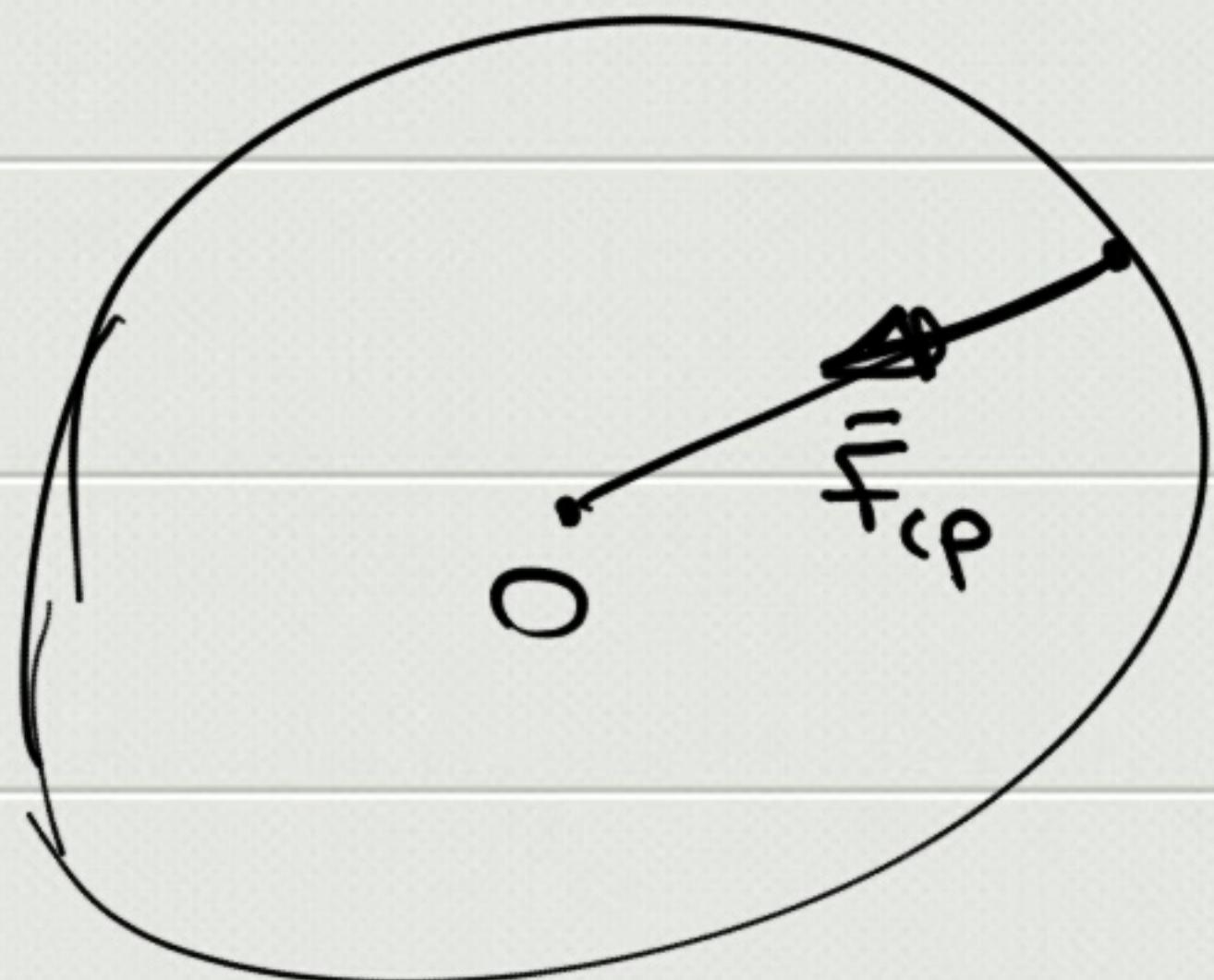
2.



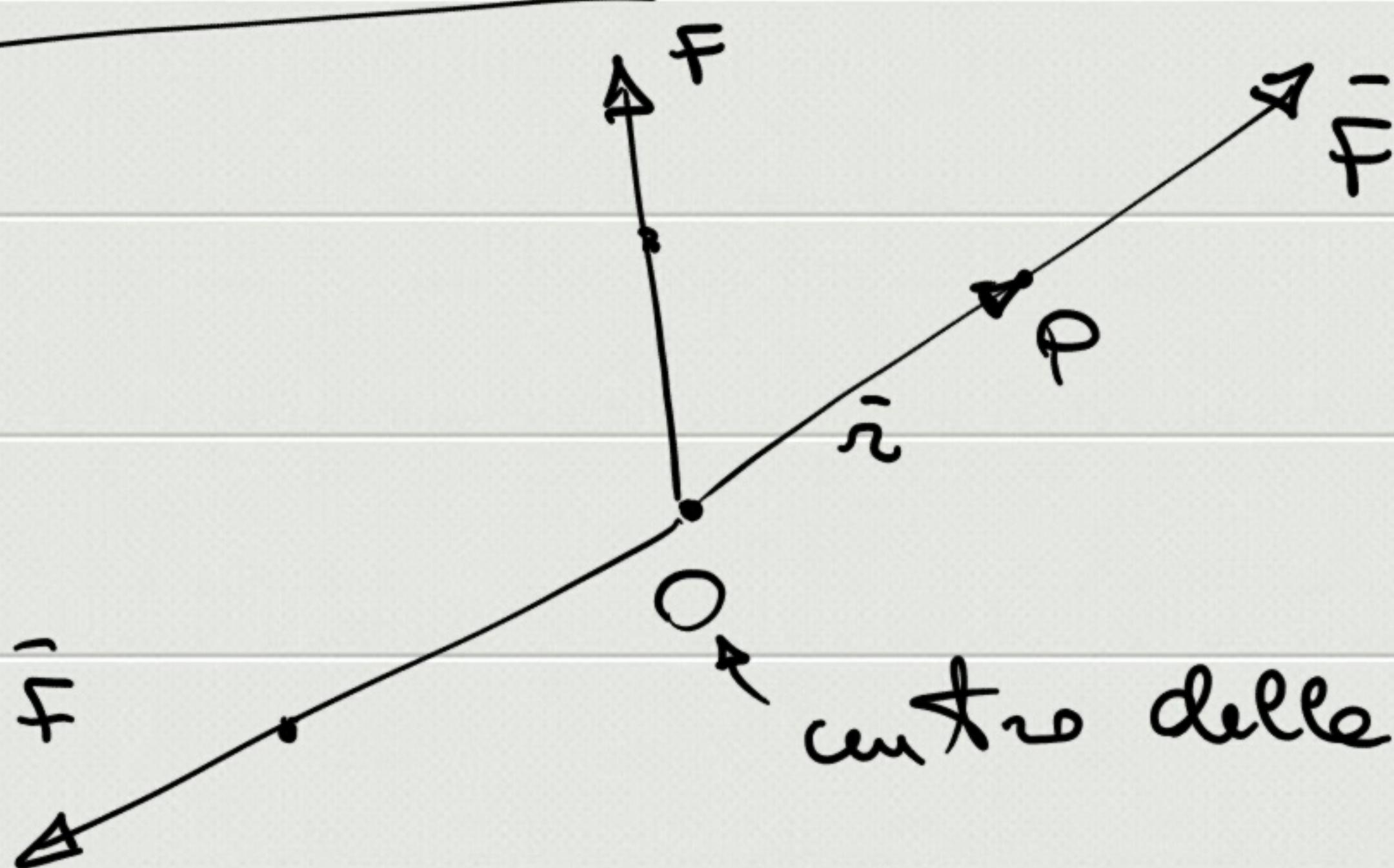
3. $T^2 = k r^3$

Cinematica dei pianeti

⇒ Dinamica ?



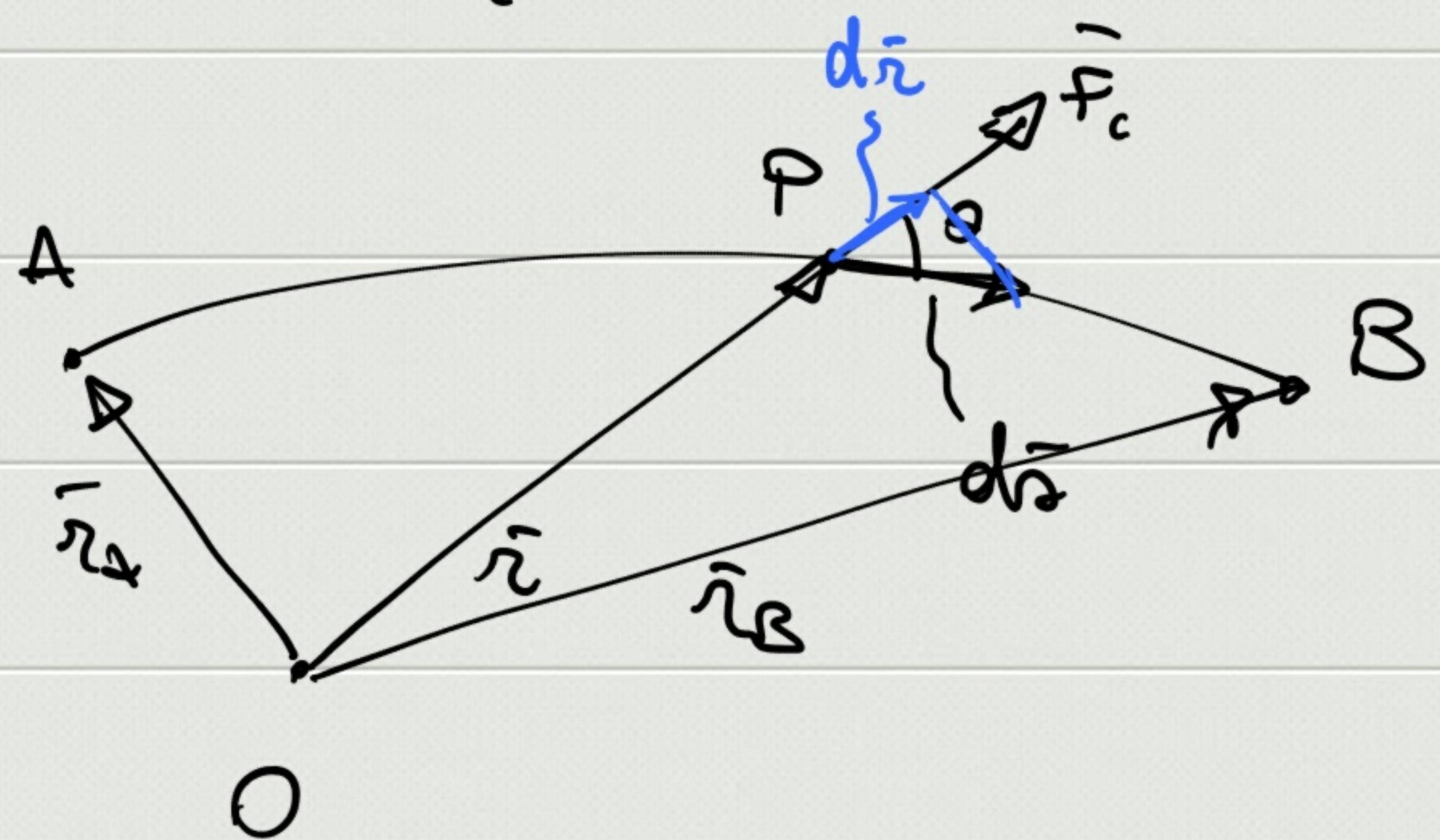
Forze centrali



centro delle forze

$$\bar{F}_{\text{centrale}} = F(r) \hat{v}_r$$

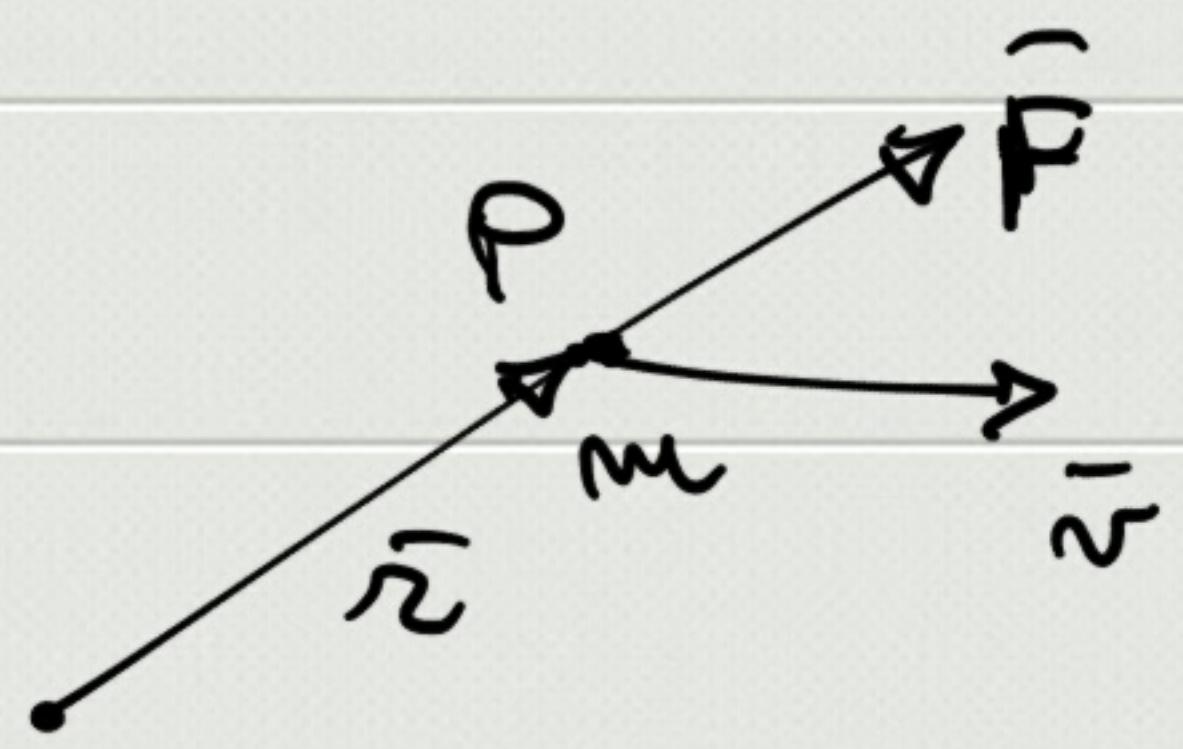
$$\left\{ \begin{array}{ll} F(r) > 0 & \text{repulsive} \\ F(r) < 0 & \text{attrattiva} \end{array} \right.$$



$$W_{A \rightarrow B} = \int_A^B \bar{F} d\bar{s} = \int_A^B F(r) \hat{v}_r d\bar{s} = \int_A^B F(r) dr \cos \theta =$$

$$= \int_{r_A}^{r_B} F(r) dr = f(r_B) - f(r_A)$$

\Rightarrow forza conservativa

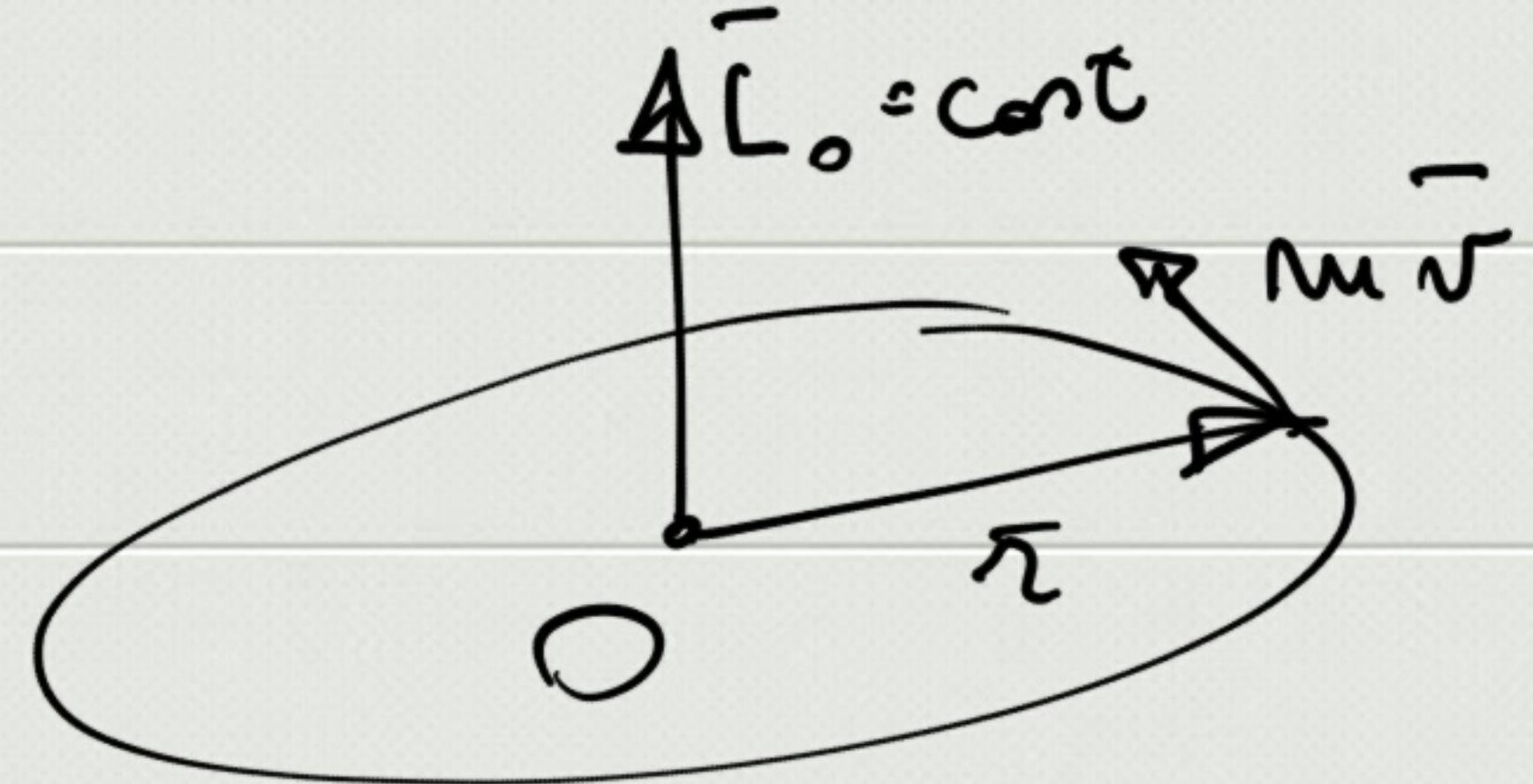


$$\bar{H}_o = \bar{r} \times \bar{F}(r) = 0 \quad \left\{ \begin{array}{l} \\ \frac{d\bar{L}_o}{dt} \end{array} \right. \Rightarrow 0$$

$$\boxed{\bar{L}_o = \bar{r} \times m\bar{v} = \text{const}}$$

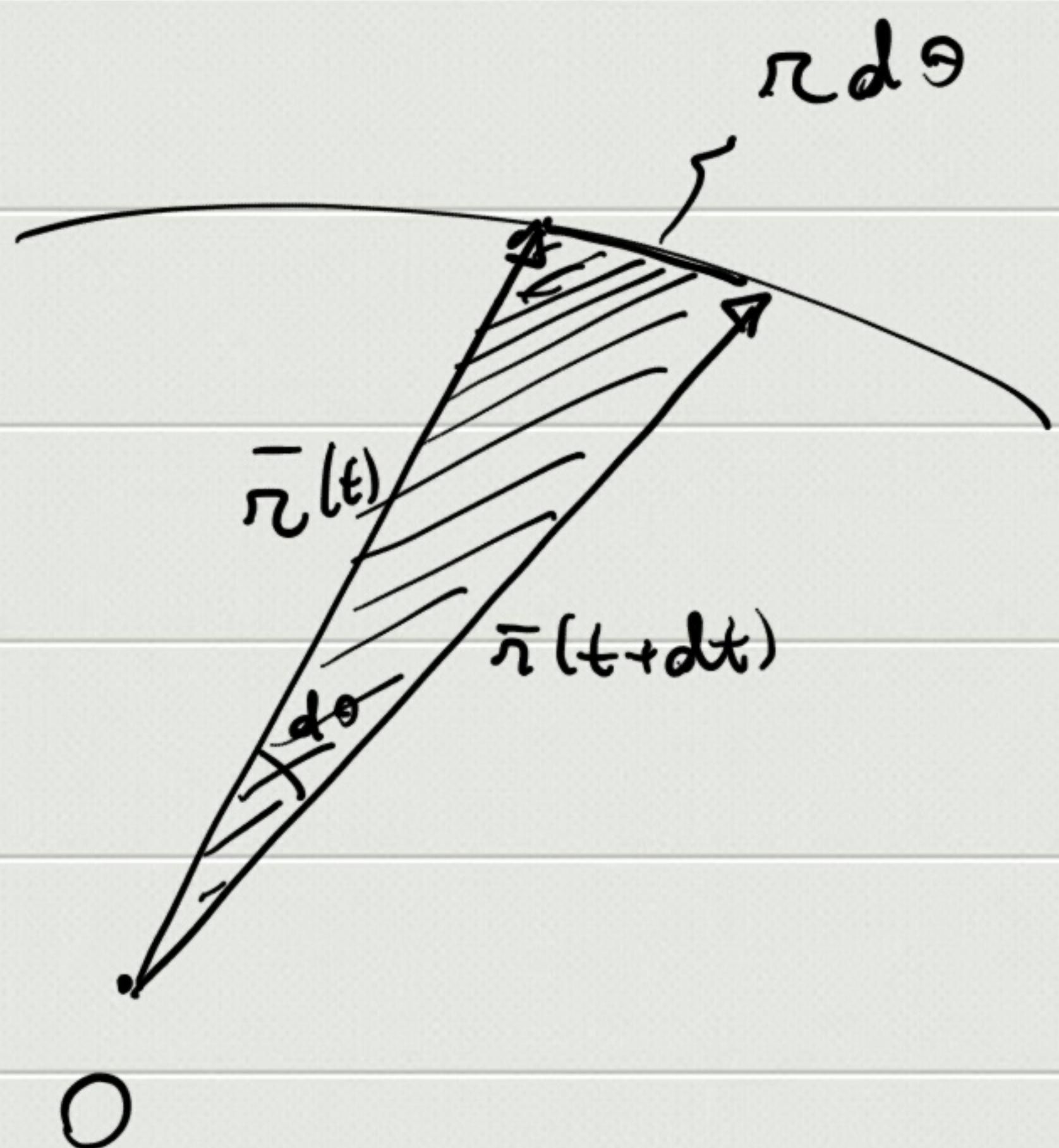
$$\bar{v} = \bar{v}_r + \bar{v}_\theta = \frac{dr}{dt} \bar{u}_r + r \frac{d\theta}{dt} \bar{u}_\theta$$

$$\Rightarrow \bar{L}_o = \bar{r} \times m(\bar{v}_r + \bar{v}_\theta) = \bar{r} \times m\bar{v}_\theta = \text{const}$$



$$|\bar{L}_o| = \text{const} \Rightarrow r m v_\theta = r m r \frac{d\theta}{dt} = m r^2 \frac{d\theta}{dt} = \text{const}$$

$$\Rightarrow \boxed{r^2 \frac{d\theta}{dt} = \text{const}}$$



$$dA = \frac{1}{2} r d\theta \cdot r = \\ = \frac{1}{2} r^2 d\theta$$

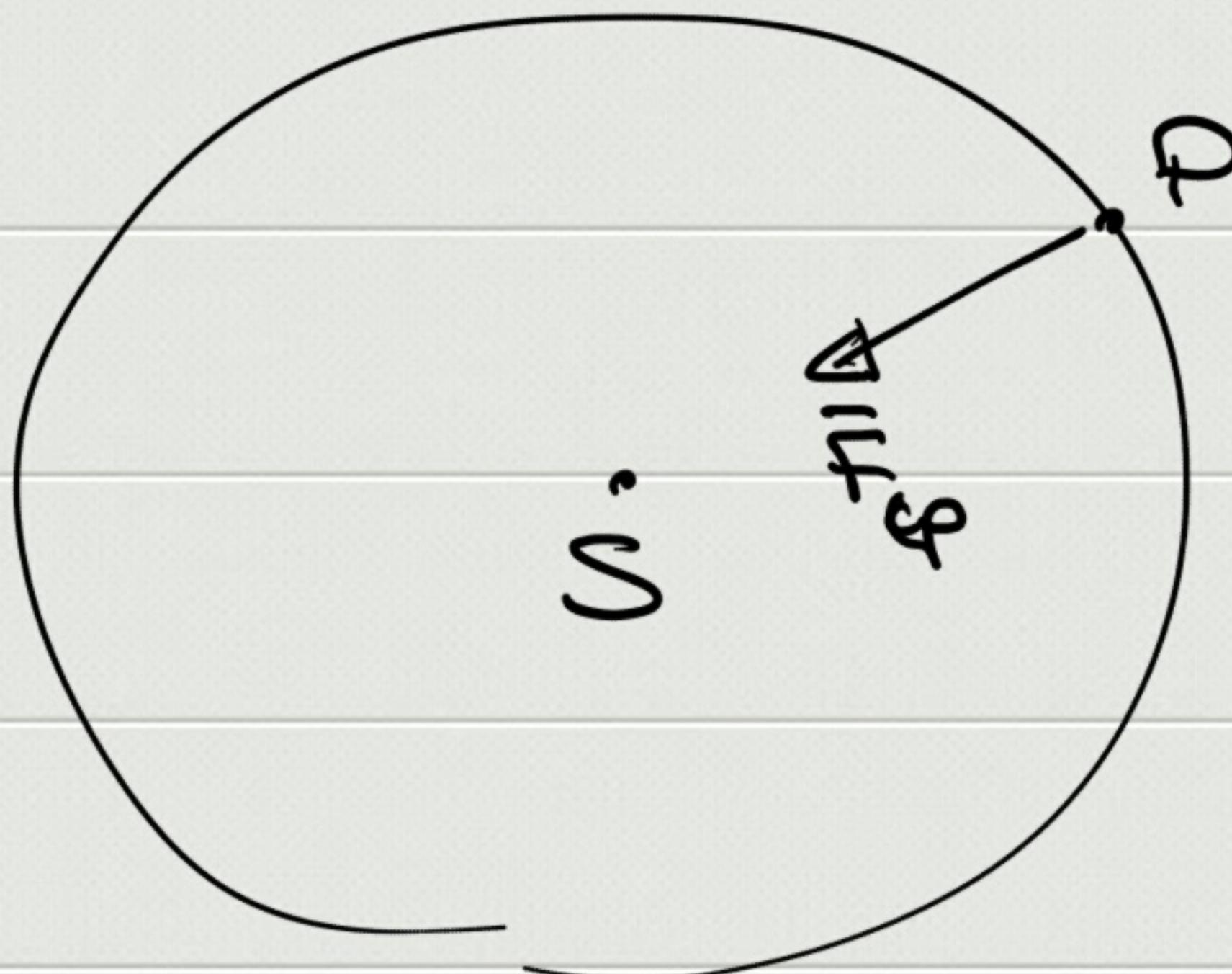
Velocità areale :
$$\left[\frac{dA}{dt} = \frac{1}{2} r^2 \underbrace{\frac{d\theta}{dt}}_{\text{cost}} = \text{cost} \right]$$

Seconda legge di Keplero

\Rightarrow Sole è il centro delle forze

$$* \text{Orbita circular: } r^2 \frac{d\theta}{dt} = \text{cost} \quad \left. \begin{array}{l} \frac{d\theta}{dt} = \text{cost} \\ \downarrow \\ \boxed{\omega} = \frac{2\pi}{T} \end{array} \right\}$$

$\hookrightarrow r = \text{cost}$



\Rightarrow moto circolare

uniforme

$$\Rightarrow \bar{F}_T = 0$$

\Rightarrow forza è solo centrifuga

$$F_{sp} = m_p \omega_p^2 r_{sp} = m_p \frac{4\pi^2}{T_p^2} r_{sp} = \frac{4\pi^2}{k_s} \frac{m_p}{r_{sp}^2}$$

$\hookrightarrow k_s r_{sp}^3$

$$F_{ps} = \frac{4\pi^2}{k_p} \frac{m_s}{r_{ps}^2}$$

$$\Rightarrow F_{sp} = F_{ps} \Rightarrow \frac{4\pi^2}{k_s} \frac{m_p}{r_{sp}^2} = \frac{4\pi^2}{k_p} \frac{m_s}{r_{ps}^2}$$

$$k_p m_p = k_s m_s = \text{cost}$$

$$F_{SP} = \frac{4\pi^2}{k_s} \frac{m_p}{r_{SP}^2} \cdot \frac{\vec{m}_s}{m_s} = \frac{4\pi^2}{k_s m_s} \frac{\vec{m}_s m_p}{r_{SP}^2} = \gamma \frac{\vec{m}_s m_p}{r_{SP}^2}$$

$$\boxed{F_{12} = -\gamma \frac{m_1 m_2}{r_{12}^2} \vec{U}_{12}}$$

legge di gravitazione
universale

$$P = \gamma \frac{M_T M}{r_T^2} = mg \Rightarrow g = \gamma \frac{M_T}{r_T^2}$$

$$\left. \begin{aligned} F_{TL} &= \gamma \frac{M_T M_L}{r_{TL}^2} \\ &= M_L \omega_L^2 r_{TL} \end{aligned} \right\} \Rightarrow \gamma M_T = \omega_L^2 r_{TL}^3 \quad (1666)$$

(1682) Nuove misure di r_T

$$\boxed{\gamma = 6,67 \cdot 10^{-11} \frac{m^3}{kg s^2}}$$