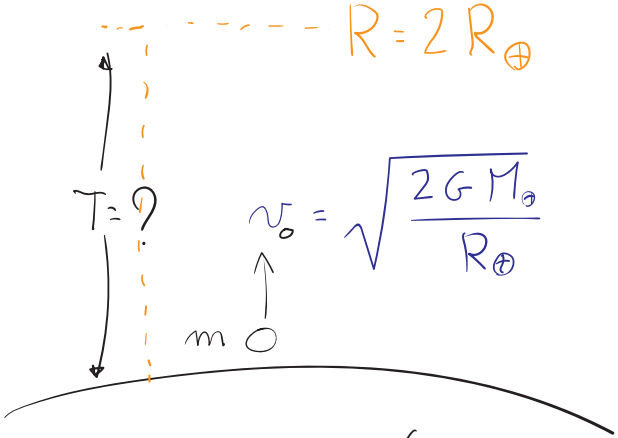
Università
degli Studi
di Padova

Fisica 1

Lezione 39: Esempi

Prof. Giubilato

Esercizio



$R_\oplus \simeq 6.4 \cdot 10^6$ m

$M_\oplus \simeq 6 \cdot 10^{24}$ Kg

T necessario per arrivare a $2R_\oplus$

$g_{2R_\oplus} < g_0$

$E_K = \frac{1}{2} m v_0^2$

$U_g = -G \frac{M_\oplus}{R_\oplus} m$

$E_K + U_g = \phi$

Partenza

$$\frac{1}{2} m v_0^2 - G \frac{M_\oplus m}{R_\oplus} = \phi \qquad \frac{1}{2} v_0^2 = G \frac{M_\oplus}{R_\oplus}$$

Salendo

$$\frac{1}{2} m v^2(r) - G \frac{M_\oplus m}{r} \qquad v(r),\ R_\oplus \le r \le 2R_\oplus$$

$$\Downarrow$$

$$v^2(r) = \frac{2GM_\oplus}{r} \qquad v(r) = \sqrt{\frac{2GM_\oplus}{r}}$$

$$v(r) \to \frac{dr}{dt}$$

$$\frac{dr}{dt} = \sqrt{\frac{2GM_\oplus}{r}} \Rightarrow dt = \sqrt{\frac{r}{2GM_\oplus}}\, dr$$

$$\frac{dr}{dt} = \sqrt{\frac{2GM_\oplus}{r}} \Rightarrow dt = \sqrt{\frac{r}{2GM_\oplus}}\, dr$$

$$T = \int_{\varnothing}^{T=?} dt = \int_{R_\oplus}^{2R_\oplus} \sqrt{\frac{r}{2GM_\oplus}}\, dr = \frac{1}{\sqrt{2GM_\oplus}} \int_{R_\oplus}^{2R_\oplus} r^{1/2}\, dr$$

$$= \frac{1}{\sqrt{2GM_\oplus}} \left[\frac{2}{3} r^{3/2}\right]_{R_\oplus}^{2R_\oplus}$$

$$= \frac{2}{3\sqrt{2GM_\oplus}} \left[\sqrt{(2R_\oplus)^3} - \sqrt{R_\oplus^3}\right]$$

$$\simeq 700\,s$$

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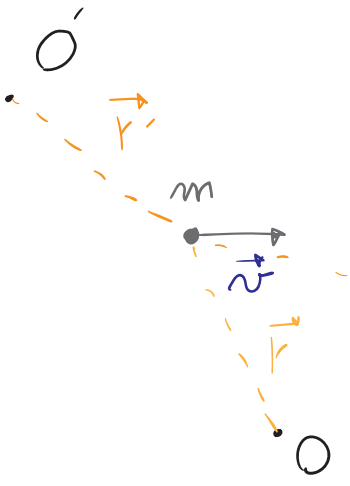
posizione $\vec{x}$

$\downarrow d/dt$ $\quad \uparrow \int dt$

$\vec{v}$

$\downarrow d/dt$ $\quad \uparrow \int dt$

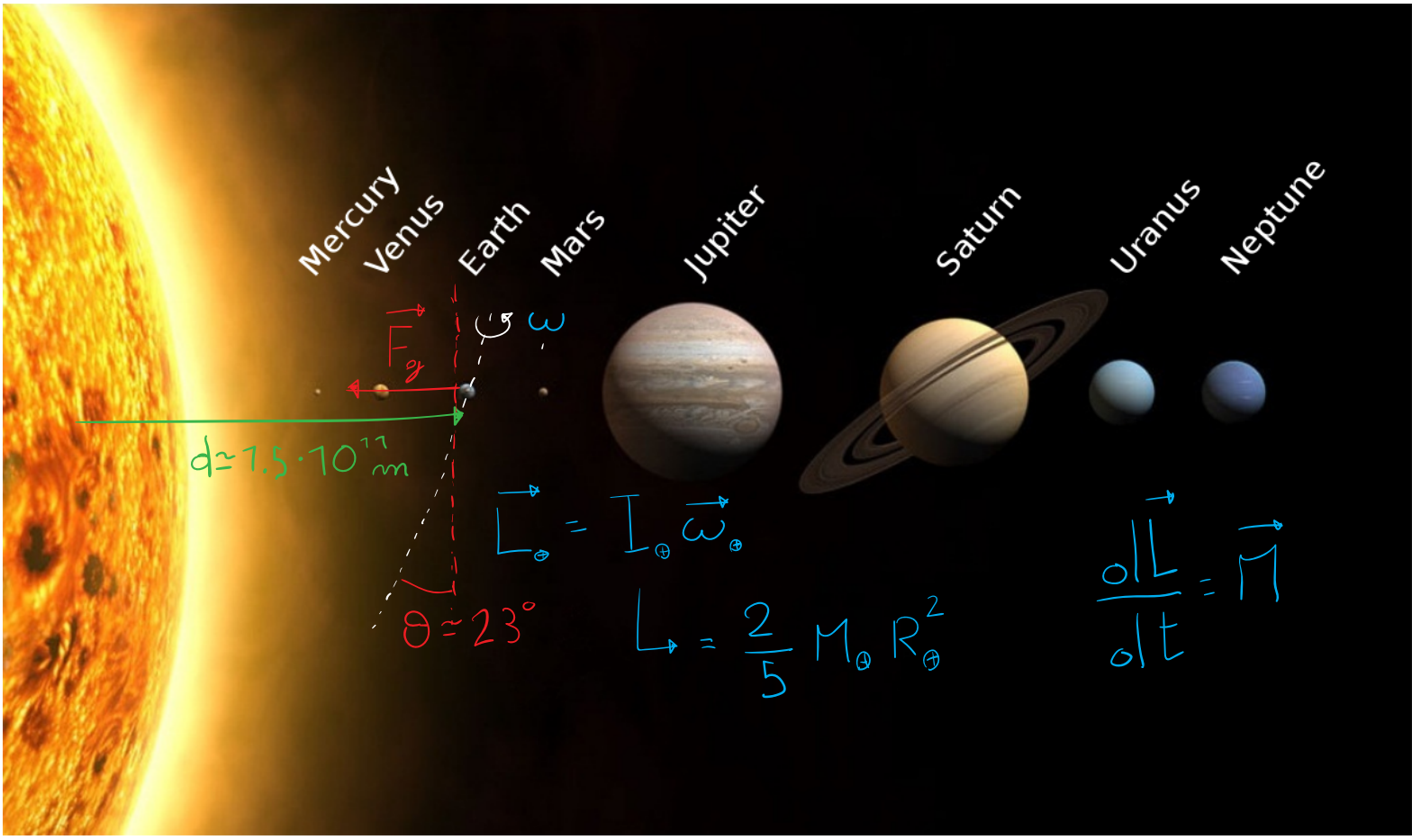
$\vec{a}$



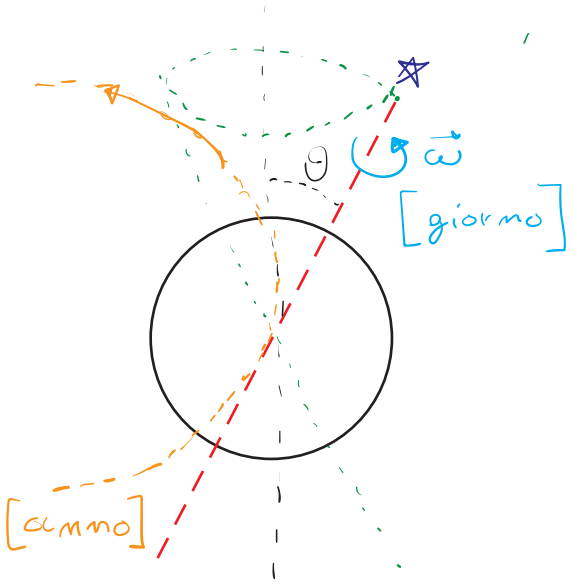
$$\vec{P} = m\vec{v}$$

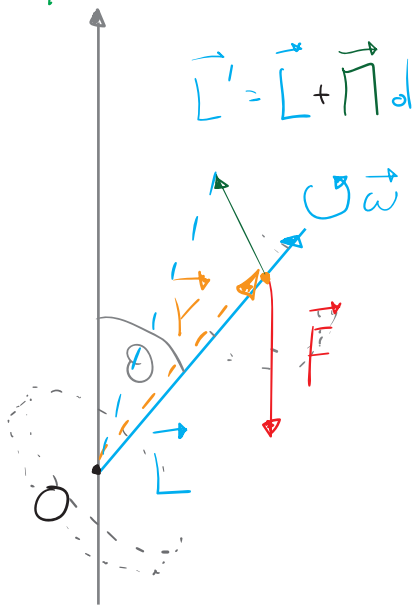
$$\vec{L} \neq \vec{L}'$$

$$\frac{d\vec{L}}{dt} = \vec{M}$$



Anno Platonico $\simeq 26{,}000$ → precessione degli equinozi

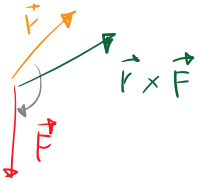


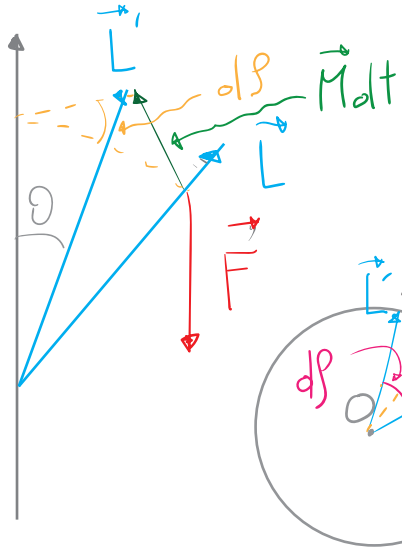


$\frac{d\vec{L}}{dt} = \vec{M}$

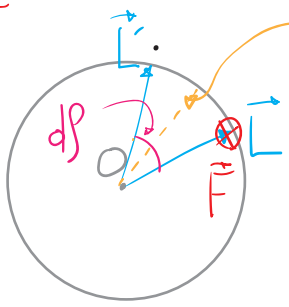
$d\vec{L} = \vec{M}\,dt$

$\vec{M} = \vec{r} \times \vec{F}$





$d\vec{L} = \vec{M}\,dt = L \sin\theta\, d\varphi$



$\frac{d\vec{L}}{dt} = \vec{M} = \frac{d}{dt}\left(L \sin\theta\, d\varphi\right) = L \sin\theta\, \Omega$

Velocità precessione

$\frac{d}{dt}\varphi$

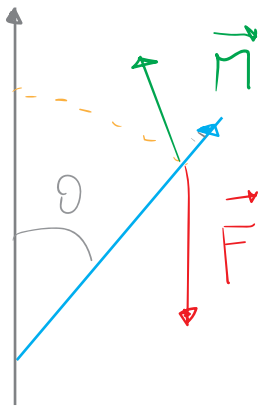
Velocità precessione

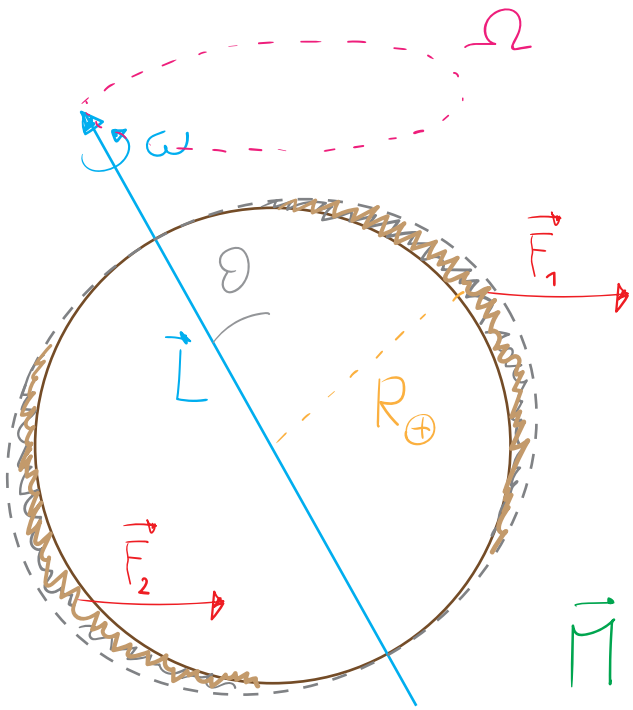
$$\frac{d\vec{L}}{dt} = \vec{M} = \frac{d}{dt}\left(\vec{L}\sin\theta\, d\varphi\right) = \vec{L}\sin\theta\,\Omega$$

($d\varphi$: d su dt)

$$\hookrightarrow \Omega = \frac{\vec{M}}{\vec{L}\sin\theta}$$

$$\vec{L} \dashrightarrow I\vec{\omega}$$





$d \simeq 1.5 \cdot 10^{11}\ m$
↳ Terra - Sole

$M_\odot \simeq 2 \cdot 10^{30}$

$M_b \simeq 10^{27}\ Kg$

$$|\vec{F}_1| = G\frac{M_\odot M_b}{d^2}$$

$$|\vec{F}_2| = G\frac{M_\odot M_b}{(d+2R_\oplus)^2}$$

$$\vec{M} = (\vec{F}_1 - \vec{F}_2)\sin\theta\, R_\oplus$$

$$|F_2| = G\frac{M_\odot M_b}{d^2\left(1+\frac{2R_\oplus}{d}\right)^2} =$$

$$= F_1 \frac{1}{\left(1+\frac{2R_\oplus}{d}\right)^2} \simeq F_1(1-2x)$$

(x: $2R_\oplus$ su d)

↳ $(1+x^2+2x) \xrightarrow{x\to\phi} \simeq 1+2x$