

## Impuls síly

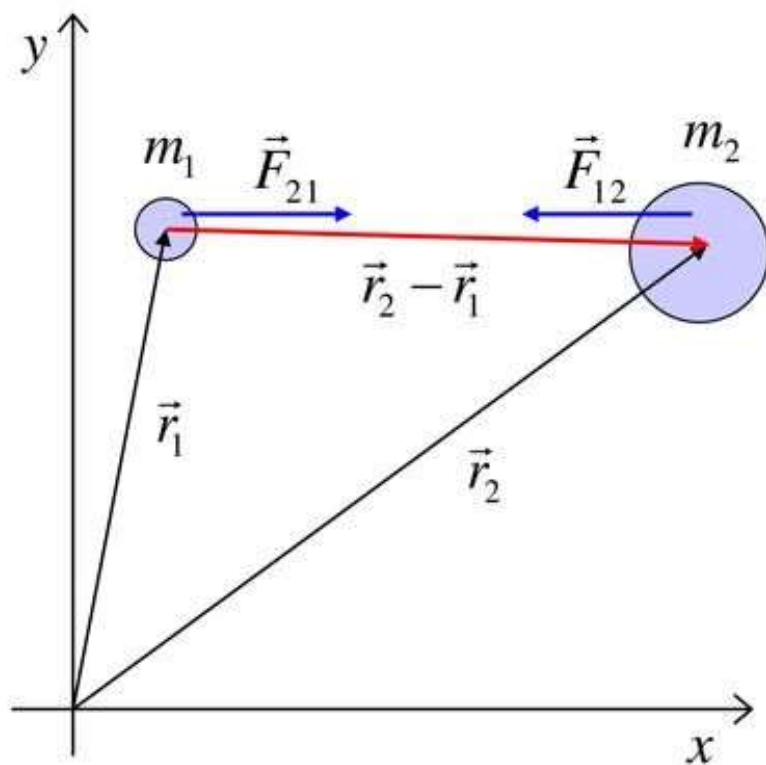
**Impuls síly:** 
$$\vec{I} = \int_{t_1}^{t_2} \vec{F} dt$$

- pokud je síla konstatní 
$$\vec{I} = \vec{F} \Delta t$$

- souvislost s hybností: 
$$\vec{F} = \frac{d\vec{p}}{dt} \Rightarrow \vec{I} = \Delta\vec{p}$$

## Gravitační zákon

$$\vec{F}_{12} = -\kappa \frac{m_1 m_2}{|\vec{r}_2 - \vec{r}_1|^2} \frac{\vec{r}_2 - \vec{r}_1}{|\vec{r}_2 - \vec{r}_1|}$$



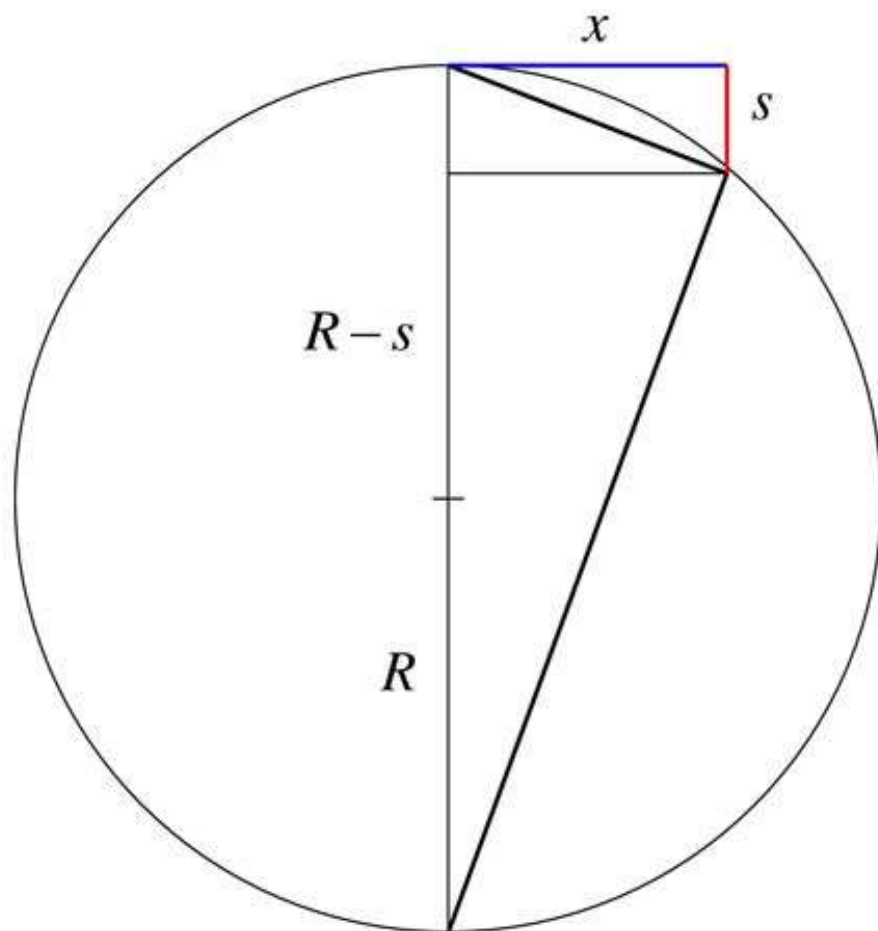
**velikost gravitační síly**

$$F = \kappa \frac{m_1 m_2}{r^2}$$

$$r \equiv |\vec{r}_2 - \vec{r}_1|$$

$$\kappa = 6.670 \times 10^{-11} \text{ Nm}^2 \text{ kg}^{-2}$$

## Gravitační zákon



$$\frac{x}{s} = \frac{2R-s}{x}$$

$$x = \sqrt{2Rs}$$

$$R = 6378 \text{ km}$$

$$s = 4.9 \text{ m}$$

$$v = 7.9 \text{ km/s}$$

1. kosmická rychlost

## Gravitační zákon

$$F = \kappa \frac{m_1 m_2}{r^2}$$

**těleso na Zemi:**

$$R = 6378 \text{ km}$$

za 1 s pád o 4.9 m

**Měsíc:**

$r = 380\,000 \text{ km}$ ,  $T = 29 \text{ dní}$   $\rightarrow$  za 1 s spadne o  $\approx 1.2 \text{ mm}$

za 1 s pád o  $4.9/60^2 \text{ m} \approx 1.4 \text{ mm}$

## Gravitační zákon

$$F = \kappa \frac{m_1 m_2}{r^2}$$

### Geostacionární orbit:

$$v_I = \sqrt{2 \frac{R^2}{r} s}$$

$$R = 6378 \text{ km}$$

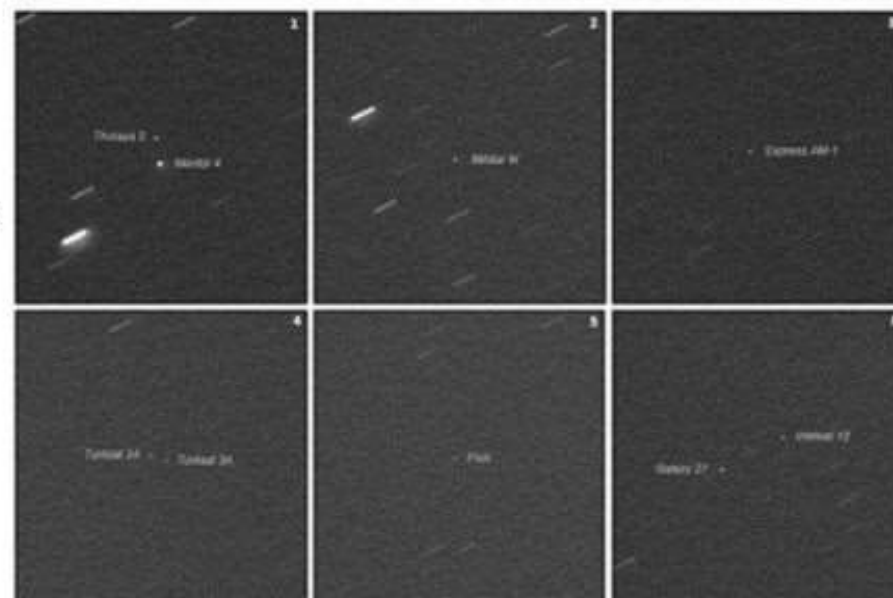
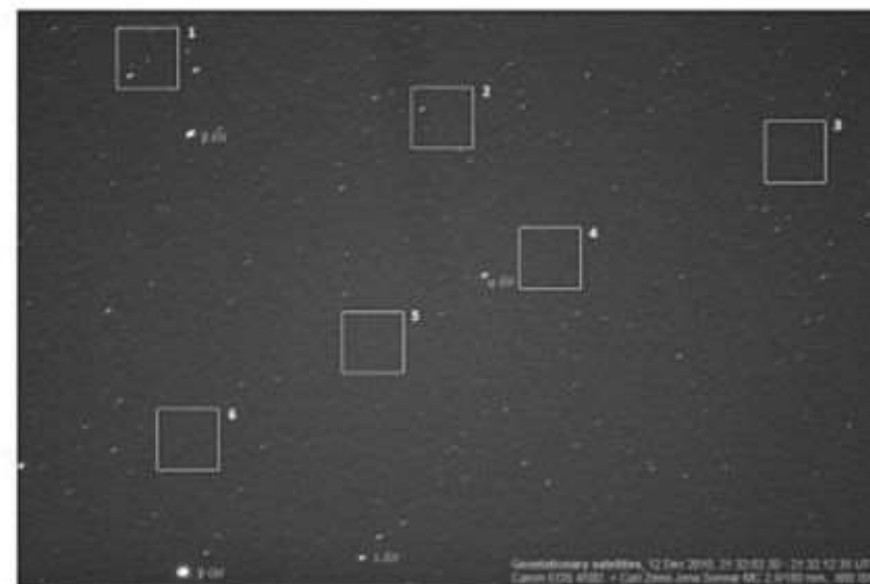
$$s = 4.9 \text{ m}$$

$$\frac{v_I}{r} = \omega \quad \longrightarrow \quad r = \sqrt[3]{2 \frac{R^2}{\omega^2} s}$$

úhlová rychlost otáčení Země:  $\omega = 7.3 \times 10^{-5} \text{ s}^{-1}$

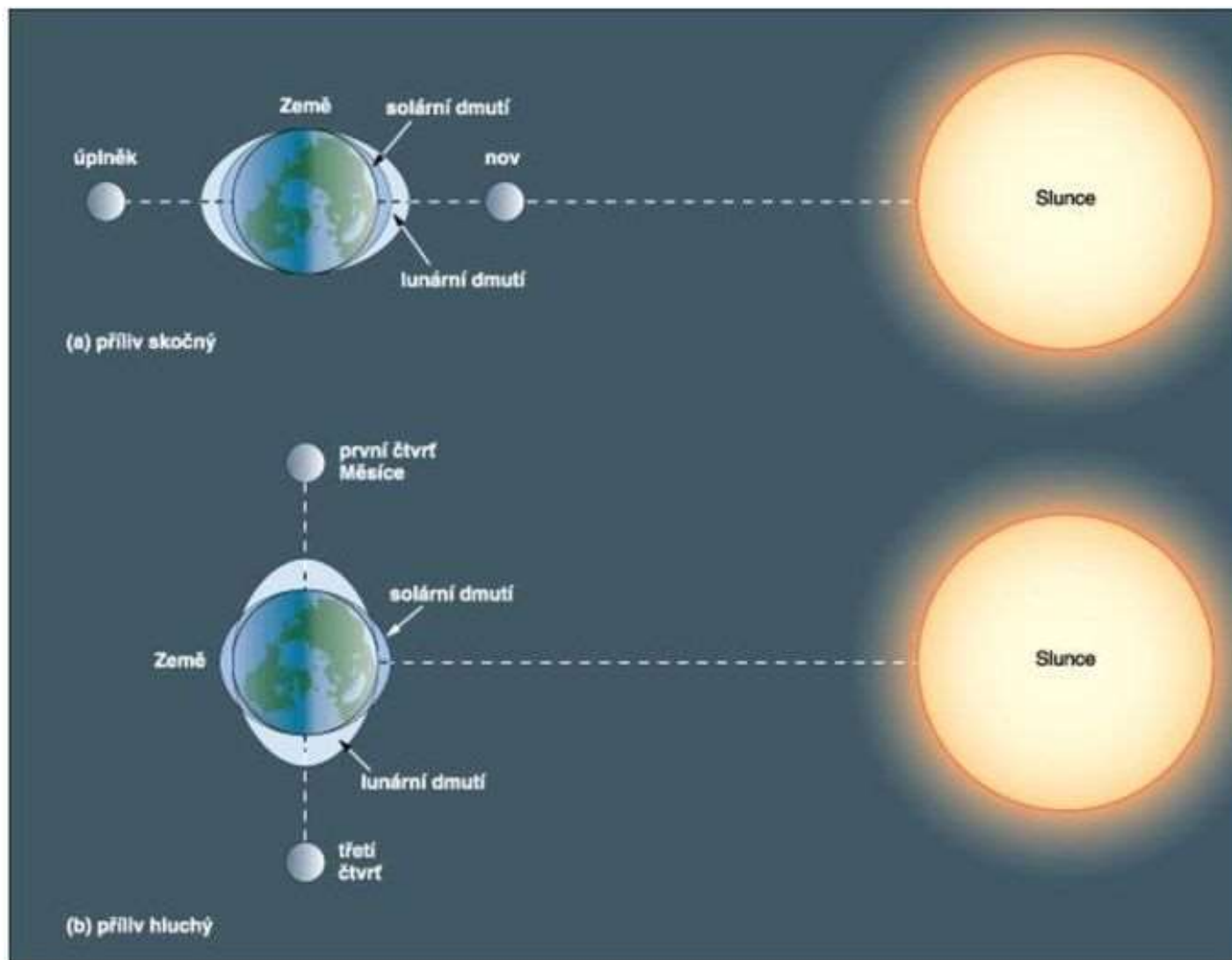
$$r = 42300 \text{ km}$$

výška nad Zemí:  $\approx 35800$  km



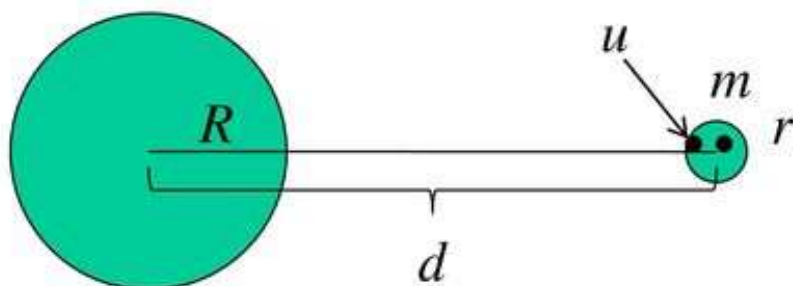
# Gravitační zákon

## Příliv a odliv



# Rocheův limit

Slapové síly  $M$



$$\text{slapová síla: } F_s = \kappa \frac{uM}{(d-r)^2} - \kappa \frac{uM}{d^2} \xrightarrow{r \ll R < d} F_s = \kappa \frac{2uMr}{d^3}$$

$$\text{přitažlivá gravitační síla satelitu: } F_g = \kappa \frac{um}{r^2}$$

$$F_s = F_g \longrightarrow d_{Rch} = r \left( 2 \frac{M}{m} \right)^{\frac{1}{3}}$$

$$M = \frac{4}{3} \pi R^3 \rho_M$$

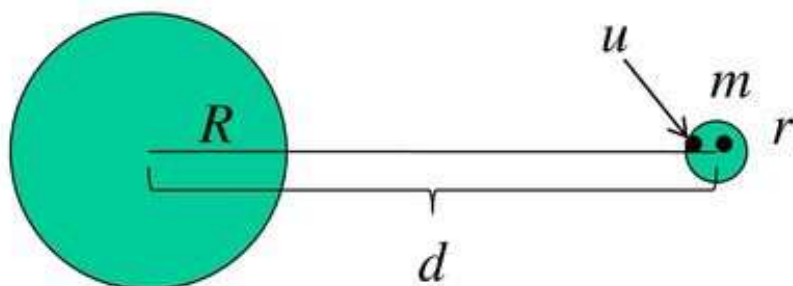
$$m = \frac{4}{3} \pi r^3 \rho_m$$

$$d_{Rch} = R \left( 2 \frac{\rho_M}{\rho_m} \right)^{\frac{1}{3}} \approx 1.26 R \left( \frac{\rho_M}{\rho_m} \right)^{\frac{1}{3}}$$

**Rocheův limit**

# Rocheův limit

Slapové síly  $M$



slapová síla:  $F_s = \kappa \frac{uM}{(d-r)^2} - \kappa \frac{uM}{d^2}$

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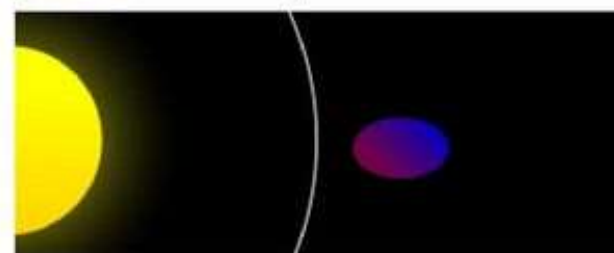
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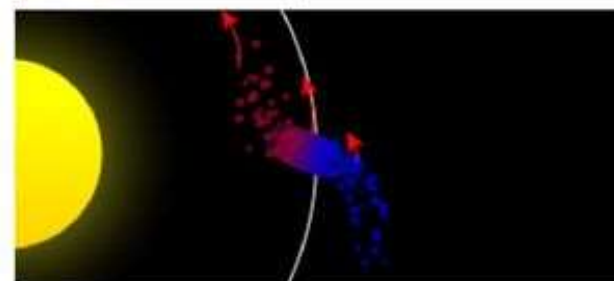
$$d \gg R_{Rch}$$



$$d > R_{Rch}$$

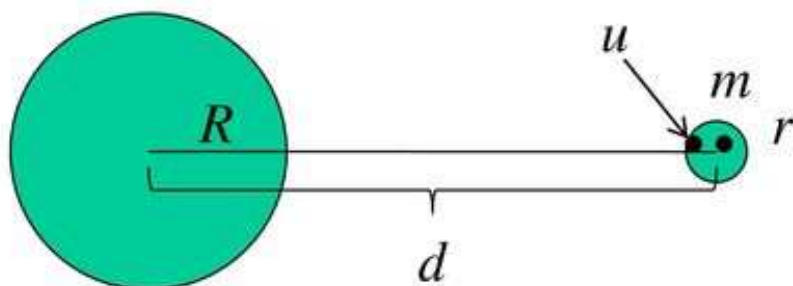


$$d = R_{Rch}$$



# Rocheův limit

Slapové síly  $M$



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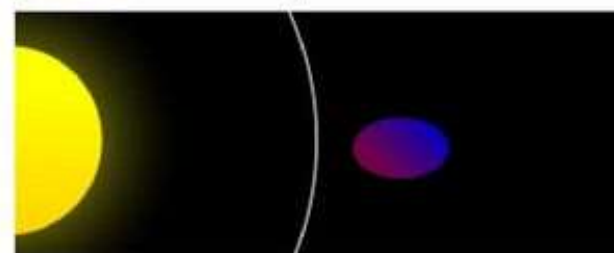
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$$d \gg R_{Rch}$$



$$d > R_{Rch}$$



$$d = R_{Rch}$$



**příklad:**

Země:  $\rho_M = 5.52 \text{ g cm}^{-3}$

$R = 6378 \text{ km}$

Měsíc:  $\rho_m = 3.34 \text{ g cm}^{-3}$

$d_{Rch} = 9496 \text{ km}$