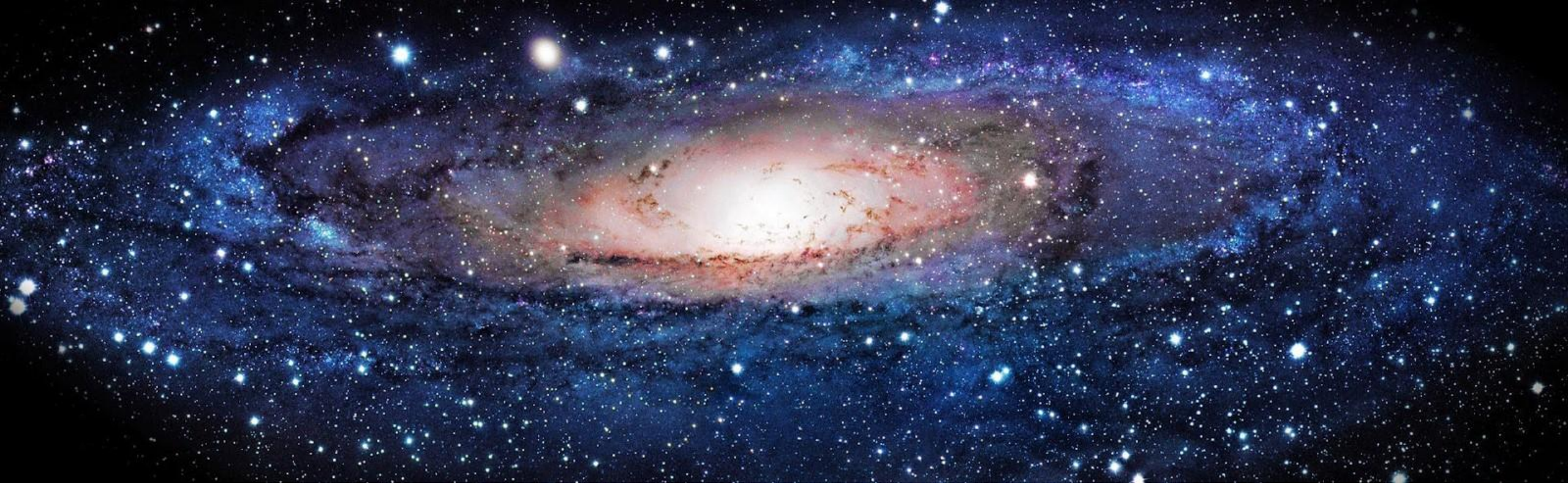


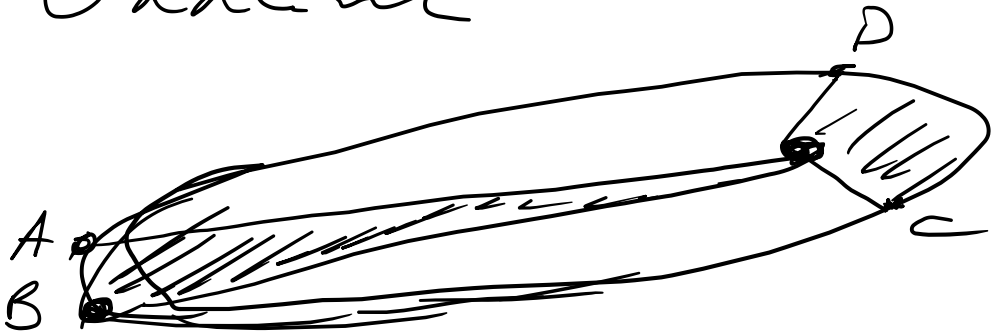
Астрофизика и космология.

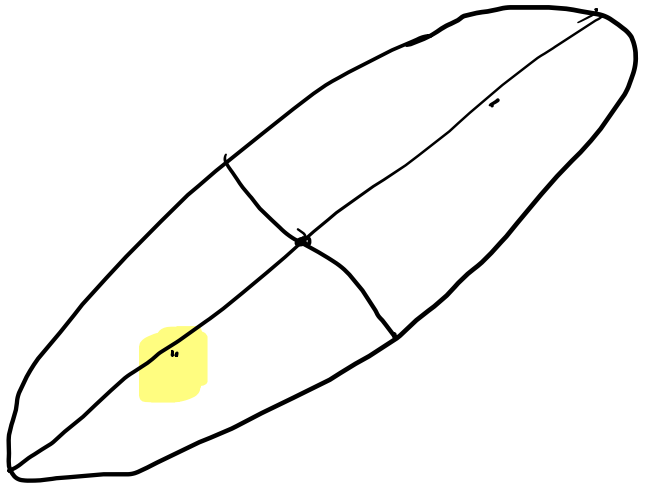
Семинар 2. (23.01)

Законы Кеплера

1. Эллипс

2.





3. $\frac{T_1^2}{T_2^2} = \frac{a_1^3}{a_2^3}$

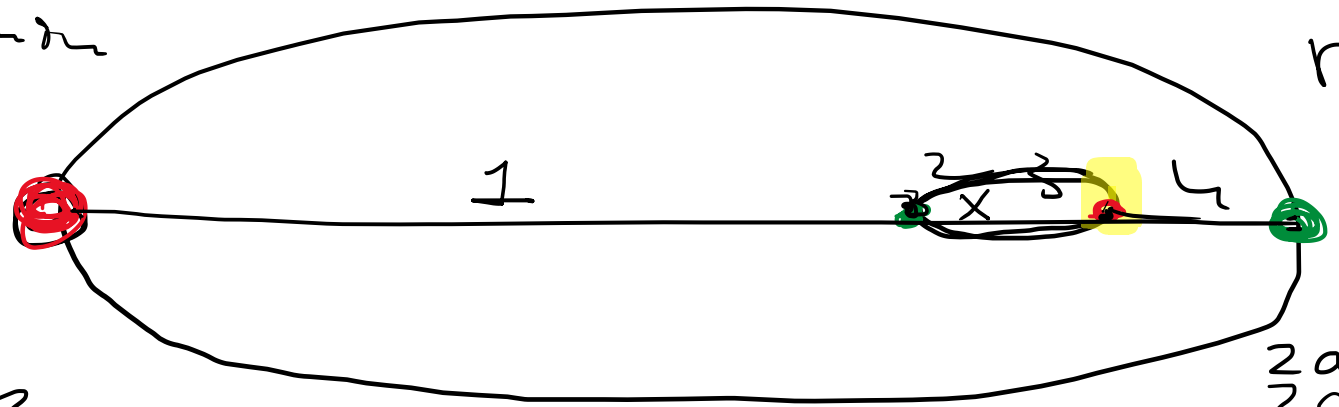
$T^2 = a^3 \frac{4\pi^2}{G(M_1 + M_2)}$

$2a = r_{max} + r_{min}$

$a = \frac{r_{max} + r_{min}}{2}$

$a = a_1 + a_2$

$a_1 M_1 = a_2 M_2$



$r_{max} = 1+2+3$

$r_{min} = 4+2+3$

$2a = 1+2+3+2+3+4$

$2a_1 = 4+1+2+3$

$2a_2 = 2+3$

$e = 1$

P_{orb}

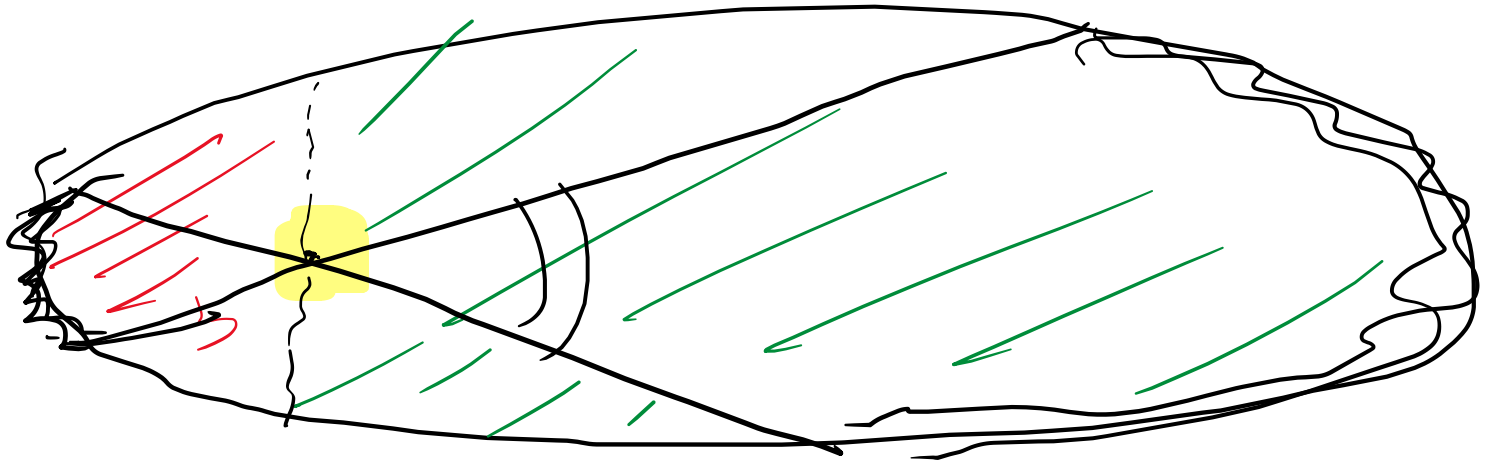
$T_{fall} = \frac{1}{2} P_{orb}$

$2a = h$

$$P_{orb}^2 = a^3 \frac{4\pi^2}{GM}$$

$$4T_{fall} = \frac{h^3}{8} \frac{4\pi^2}{GM}$$

$$T_{fall} = \frac{1}{2}\sqrt{\frac{h^3 \pi^2}{2GM}}$$



$$dS = r^2 d\varphi = \ell \cdot dt \qquad (*)$$

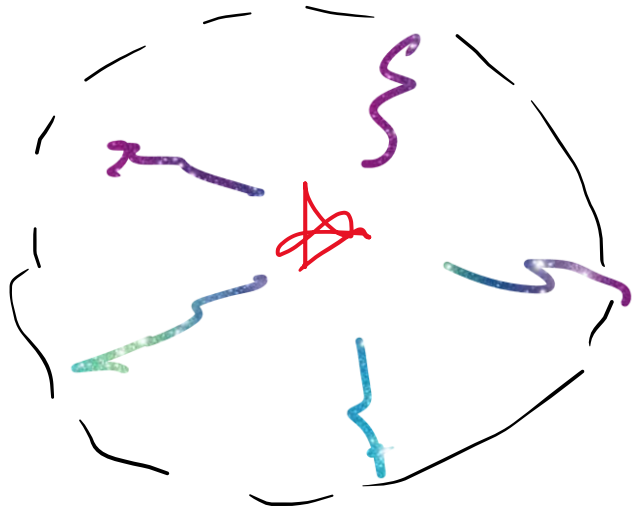
$$\ell \equiv \frac{|\vec{\mathcal{L}}|}{2m} \qquad \vec{\mathcal{L}} = \vec{r} \times \vec{p} = \vec{r} \times (m\vec{v}) = \text{const}$$

$$dS = \frac{1}{2} r \cdot \sin\varphi \cdot v \cdot dt = \frac{1}{2} |\vec{r} \times \vec{v}| \, dt = \frac{\mathcal{L}}{2m} dt$$

$$\text{из } (*) \quad dt = d\varphi \cdot r^2 / \ell$$

$$dQ = f \cdot dt$$

↑ work



$$f = \frac{L}{4\pi r^2}$$

L - clear work

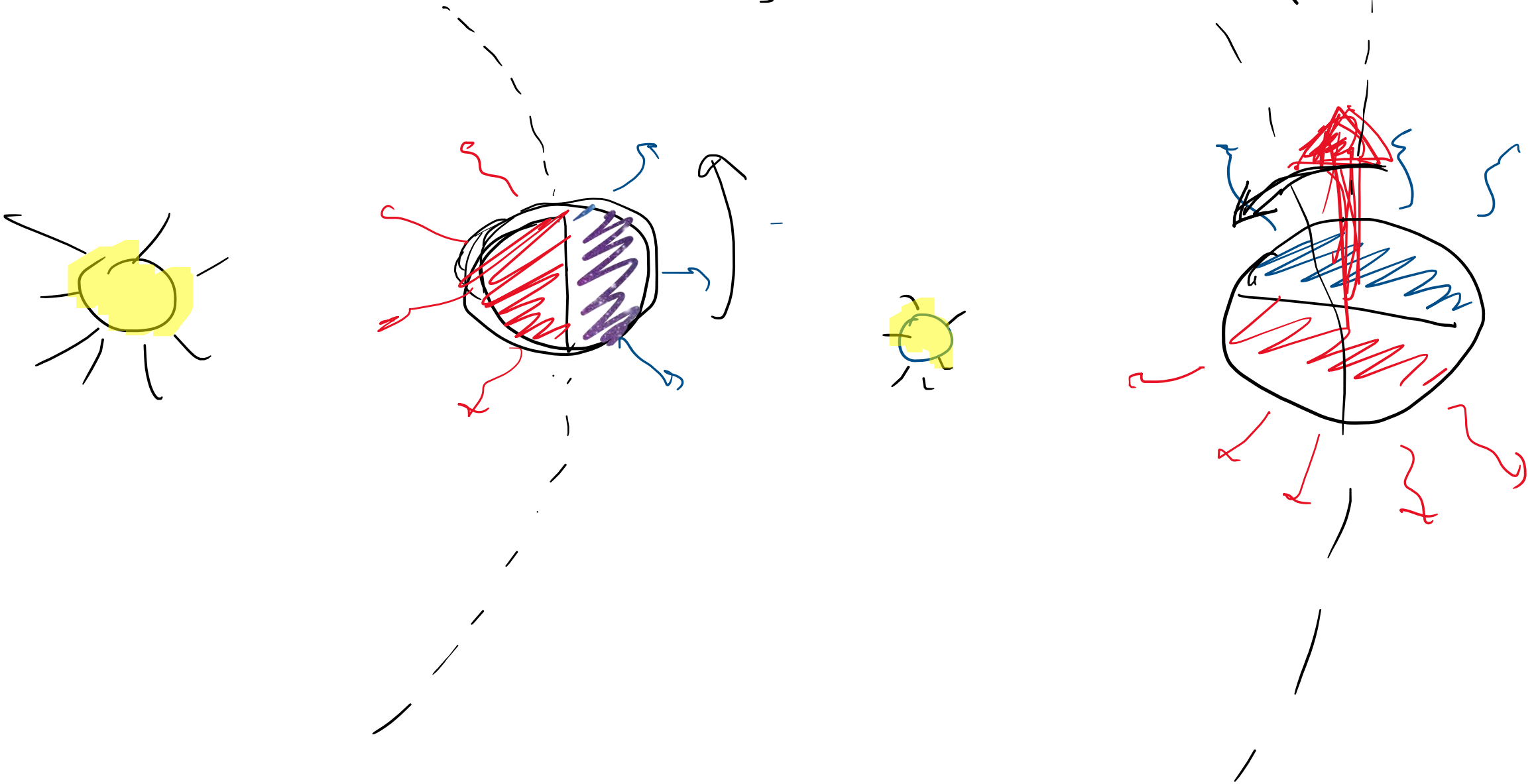
$$[L] = Dp^2/c$$

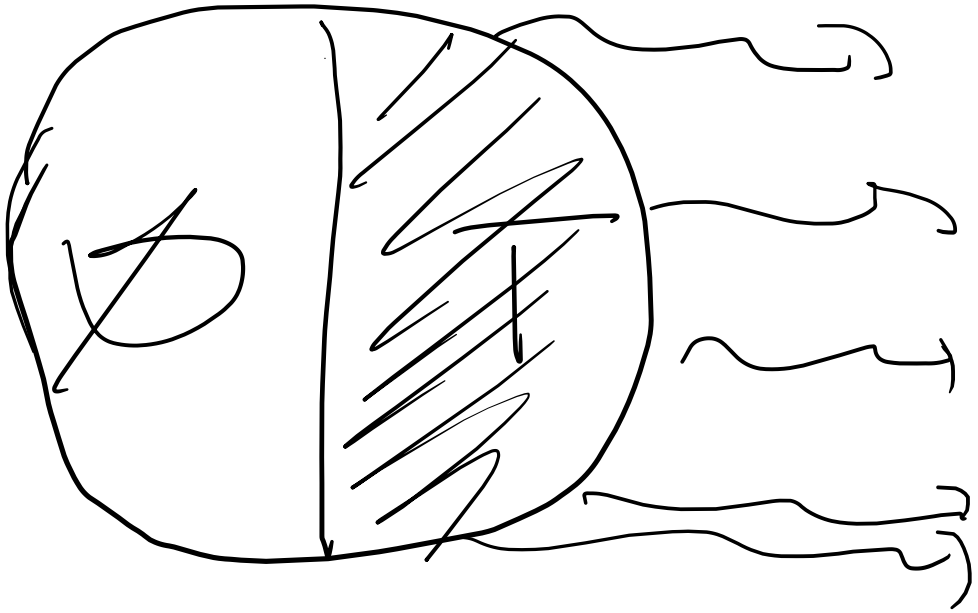
$$[f] = \frac{Dp^2}{cm^2 \cdot c}$$

$$dQ = \frac{L}{4\pi r^2} dt = \frac{L}{4\pi r^2} \frac{d\varphi \cdot r^2}{\omega} = \frac{L}{4\pi\omega} d\varphi$$

$$dQ \sim d\varphi$$

Effet de serre

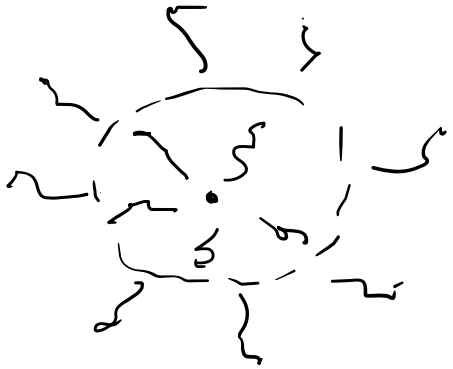




$$S_4 = 1\,km^2 = 10^{10}\,cm^2$$

$$L = S_4\,\sigma T^4$$

$$T = 330\,K$$



T_{eq} : $L = 4\pi R_*^2\,\sigma T_*^4 =$

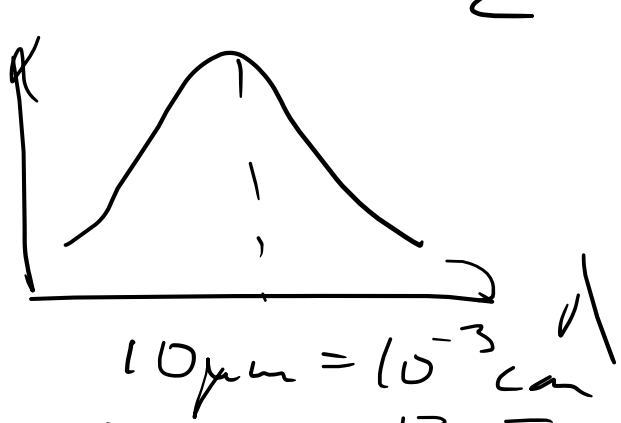
$= 4\pi r^2\,\sigma T_{eq}^4 = const$

$T_{eq} \sim r^{-1/2}$

$T_{eq}(1ae) \simeq 5800K \cdot \left(\frac{150\cdot 10^6\cdot 10^5\,cm}{696000\cdot 10^5\,cm}\right)^{-1/2}$

$$L = 10^{10} \cdot 5.67 \cdot 10^{-5} (330)^4 \simeq 5.67 \cdot 10^{15} \frac{\text{эрг}^2}{c}$$

$$E = N \cdot h\nu \qquad L \equiv \dot{E}$$



$$\dot{N} = 2 \cdot 10^{28} \text{ фот/сек}$$

$$p = \frac{h\nu}{c} \qquad \frac{\Delta P}{\Delta t} = 10^5 \frac{\text{г} \cdot \text{см}}{c^2}$$

$$\underline{\underline{mv}} = V \cdot \rho \cdot v = \frac{4}{3} \pi 10^{15} \text{ см} \cdot 4 \frac{\text{г}}{\text{см}^3} \cdot 30 \cdot 10^5 \frac{\text{см}}{c} \sim 5 \cdot 10^{22} \frac{\text{г} \cdot \text{см}}{c}$$

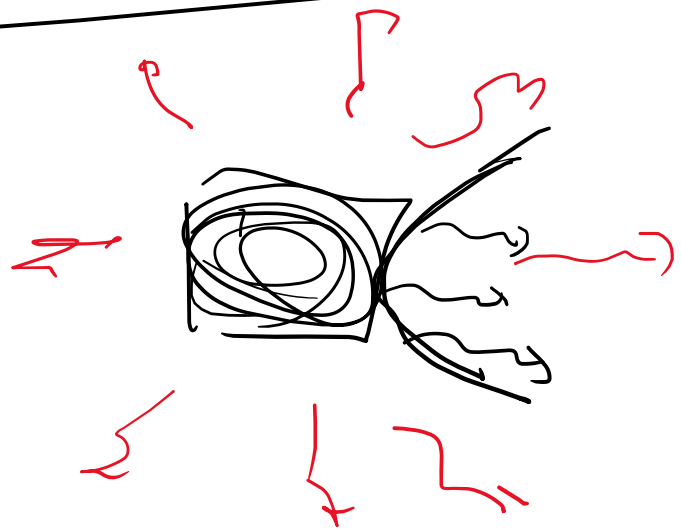
$$\Delta t = 5 \cdot 10^7 \text{ сек} \sim 1,5 \cdot 10^{10} \text{ сек}$$

$$1 \text{ год} = 3,15 \cdot 10^7 \text{ сек}$$

$L \sim S \sim R^2$

$p \sim mV \sim R^3$

Pioneer



YORP

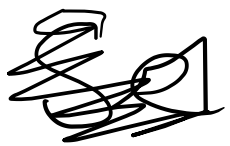
$\frac{h\nu}{c}$

1409.4412 Veras et al

$$\frac{dw}{dt} = \frac{\gamma}{2\pi\rho R^2} \left(\frac{f}{a^2\sqrt{1-e^2}} \right)$$

$\gamma \sim 0.001 \div 0.01$

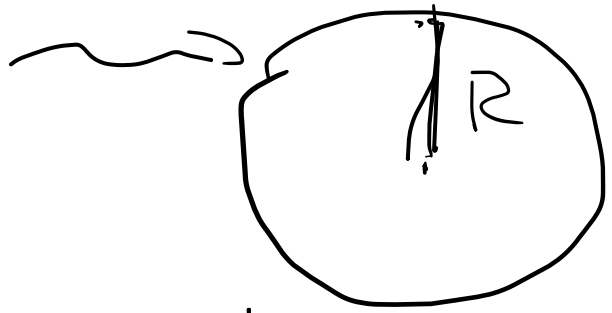
$f \sim 2$



$\frac{h\nu}{c}$ $(I\omega)$ I - момент инерции

$I \sim MR^2$ $M \sim \rho R^3$

$\frac{d(I\omega)}{dt} \sim \frac{F}{c} \cdot R^2 \cdot R$



F - мотор $\frac{F}{c}$ - gala.

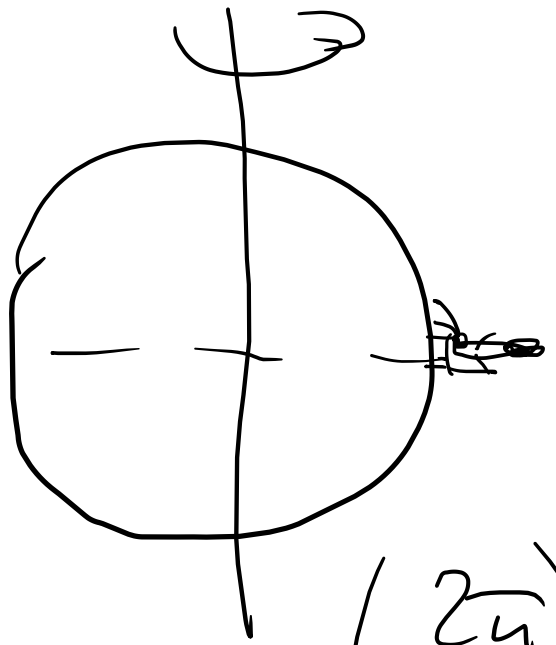
$F = \frac{L}{4\pi a^2}$

$MR^2 \frac{d\omega}{dt} \sim \frac{F}{c} R^2 \cdot R$

$\rho R^3 \frac{d\omega}{dt} \sim \frac{F}{c} R$

$\frac{d\omega}{dt} \sim \frac{F}{c\rho R^2} \sim \frac{L}{\rho R^2 a^2}$

Пред. черновик



$$v = \omega R$$

$$v_1 = \sqrt{\frac{GM}{R}}$$

$$\omega R = \sqrt{\frac{GM}{R}}$$

$$\left(\frac{2\pi}{P}\right)^2 R^2 = \frac{GM}{R}$$

$$\frac{4\pi^2}{P^2} = G\frac{M}{R^3} = G\frac{\frac{4}{3}\pi\rho}{\frac{4}{3}\pi R^3} = \frac{4}{3}\pi G\rho$$

$$P \sim \frac{1}{\sqrt{\rho}}$$

$$P = \sqrt{\frac{3\pi}{G\rho}}$$

$$= \sqrt{\frac{3\pi \cdot 1{,}5}{10^{-7} \cdot 6}} =$$

$$= \sqrt{3 \cdot 10^7} =$$

$$= 6 \cdot 10^3 \text{ сек}$$

$$= 1{,}5 \text{ часа}$$