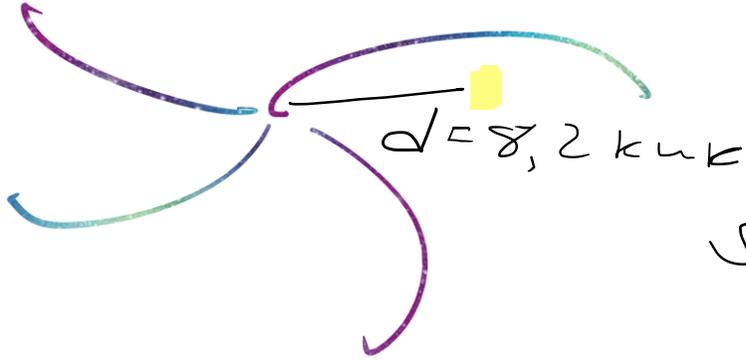




Майнор. Астрофізика.

Семинар 10. (18.11)

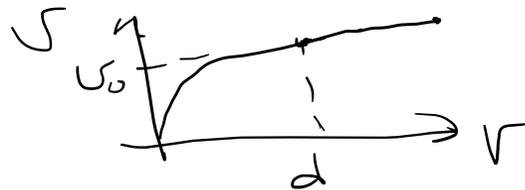
① Минимум скорости в ГТ.



$$v_0 \approx 220 \text{ km/s}$$

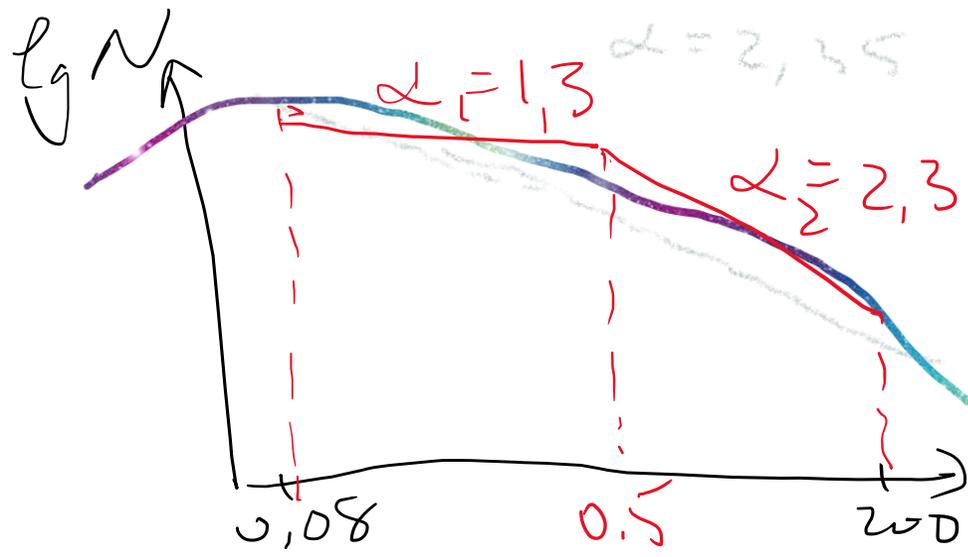
$$v_0 = \sqrt{\frac{GM(r)}{r}}$$

$$M(d) = \frac{v_0^2 \cdot d}{G}$$



$$M_G = \frac{2v_0^2 d}{G} =$$

$$= \frac{2 \cdot 4,84 \cdot 10^{14} \cdot 1,5 \cdot 8,2 \cdot 10^3 \cdot 3,1 \cdot 10^{18}}{10^{-7}} = 3,7 \cdot 10^{44} = 1,85 \cdot 10^{11} M_{\odot}$$



$$\frac{dN}{dM} \sim M^{-\alpha}$$

$$M_{min} = 0,08 M_{\odot}$$

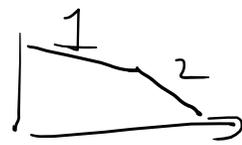
$$M_{max} = 200 M_{\odot}$$

$$N_* = M_G / \langle M \rangle$$

$$\langle M \rangle = \frac{M_G}{N_*}$$

~~$$\frac{dN}{dM} = A \cdot M^{-\alpha_1}$$~~

$$\frac{dN}{dM} \sim M^{-\alpha}$$



0,5 M₀

$$M_G = A \cdot \int_{0,08 M_0}^{0,5 M_0} M \cdot M^{-\alpha_1} \cdot dM + A \cdot \int_{0,5 M_0}^{200 M_0} M \cdot M^{-\alpha_2} \cdot dM$$

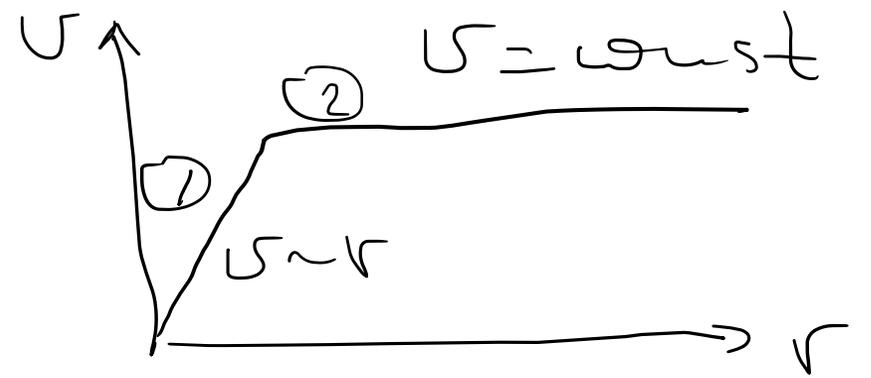
$$N_* = A \int_{0,08}^{0,5} M^{-\alpha_1} dM + A \int_{0,5}^{200} M^{-\alpha_2} dM$$

$$\langle M \rangle = \frac{M_G}{N_*} = \frac{\int M^{1-\alpha_1} dM + \int M^{1-\alpha_2} dM}{\int M^{-\alpha_1} dM + \int M^{-\alpha_2} dM} = 0,82 M_0$$

$$N_A = \frac{M_G}{\langle M \rangle} = \underline{\underline{225 \cdot 10^9}}$$

② Paczyński, $u \sim v$ PT.

$$v = \sqrt{\frac{GM(r)}{r}} \quad M(r) \sim \langle \rho \rangle r^3$$



1. $\sqrt{\frac{GM(r)}{r}} \sim r$ $\frac{GM(r)}{r^2} \sim r^2$ $M(r) \sim r^3$

2. $\frac{GM(r)}{r} \sim \text{const}$ $\Rightarrow \langle \rho \rangle \sim r^{-2}$ $\langle \rho \rangle = \text{const}$

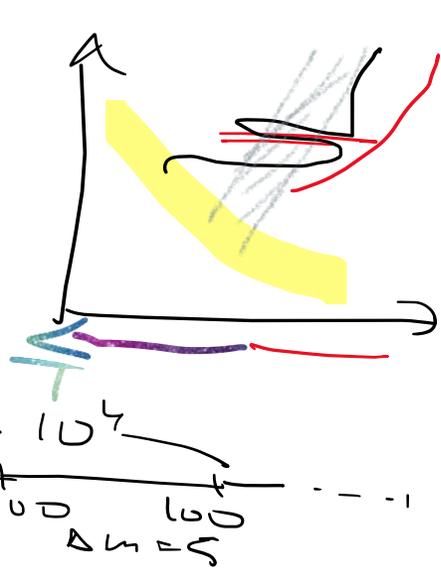
③ Чеполунг

$$d = 778 \text{ км}$$

$$L = 10^5 \text{ Л}$$

парал

$$M_0 = 4,8$$



$$f = \frac{L}{\sqrt{4} d^2}$$

$$M_c < M_0$$

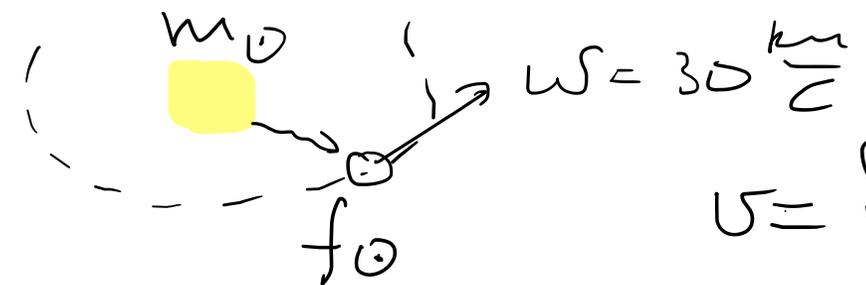
$$\Delta M = M_0 - M_c = 12,5 \Rightarrow M_c = -7,7$$

$$m_1 - m_2 = -2,5 \lg \frac{f_1}{f_2} \quad \frac{f_1}{f_2} = \frac{d_2^2}{d_1^2}$$

$$m_c - M_c = +2,5 \lg \left(\frac{778000}{10} \right)^2$$

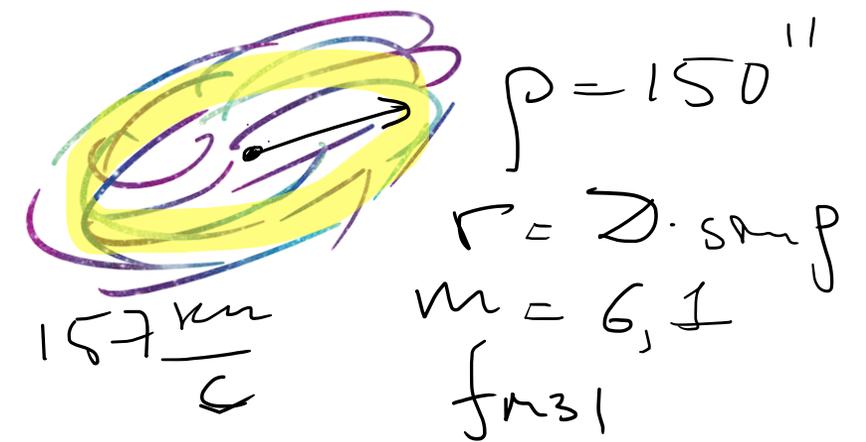
$$m_c = 2,5 \lg (77800)^2 - 7,7 = 5 \cdot \lg 77800 - 7,7 \approx 16,95$$

④ \odot_{pik} , 1922 Apr



$$w = 30 \frac{\text{km}}{\text{s}}$$

$$v = \sqrt{\frac{GM}{r}}$$



$p = 150''$
 $r = \text{D. star}$
 $m = 6,1$
 f_{m31}

$$v_0 = 157 \frac{\text{km}}{\text{s}}$$

$$\left(\frac{v_0}{w}\right)^2 = \frac{M_{31}}{M_0} \frac{ae}{r} = \frac{M_{31}/M_0}{r/ae} = \frac{M}{r}$$

$$[D] = ae.$$

$$i = \frac{f_{m31}(D)}{f_0(ae)}$$

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

$$\frac{i}{L(r)} = \frac{1}{D^2}$$

$$[L(r)] = L_0$$

gg. cler.

$$E = \frac{L(r)}{M}$$

$E = 0.38$ gal Tancutur

$$M_0 - m_{31} = 2,5 \text{ lg } \frac{f_{m31}}{f_0} = 2,5 \text{ lg } i$$

$$\text{lg } i = 0,4 (m_0 - m_{31})$$

$$i = 2,512^{(m_0 - m_{31})}$$

$$\frac{i}{L(r)} = \frac{1}{D^2} \Rightarrow D^2 = \frac{L(r)}{i}$$

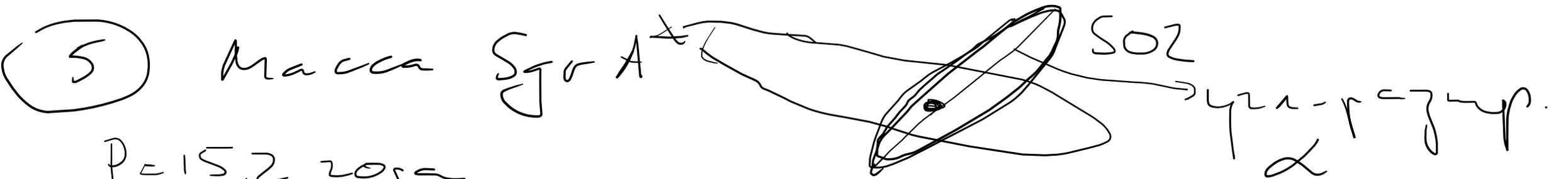
$$L(r) = F \cdot M \quad M = r \left(\frac{v_0}{\omega} \right)^2$$

$$r = D \cdot \sin \varphi$$

$$\cancel{D^2} = \frac{1}{i} F \cdot \cancel{D} \cdot \sin \varphi \left(\frac{v_0}{\omega} \right)^2$$

$$D = \frac{F \sin \varphi}{i} \left(\frac{v_0}{\omega} \right)^2 = 450000 \text{ mK}$$

$$L = 2512 \quad (n_{10} - n_{31})$$



$$P = 15,2 \text{ rogi}$$

$$a = 0,005 \text{ we}$$

$$P^2 = \frac{4\pi^2}{GM_{\text{SgrA}}} a^3$$

$$a = \alpha \cdot d$$

$$M_{\text{SgrA}}^* = \frac{4\pi^2 a^3}{G P^2} = 10^2 = 10^6 M_{\odot}$$

6

Относ. грав. потенциал BH

Потенциал грав. $\alpha \sim R_{sh} \sim M$

Надг. грав. потенциал $= \frac{\text{Потенциал } \alpha}{\text{расст.}} \sim \frac{M}{d}$

Sgr A*

8,5 ккк

$4 \cdot 10^6 M_{\odot}$

$\sim 10^{-5}$

$R_{sh} = \frac{26m}{c^2}$

M31*

778 ккк

$< 10^8 M_{\odot}$

$< 2,5 \cdot 10^{-6}$

$\alpha = \frac{R_{sh}}{d}$

M87

16,4 Мкк

$6,5 \cdot 10^9 M_{\odot}$

$7,8 \cdot 10^{-6}$

$\alpha'' = \alpha \cdot 206265$

Cygnus X-1

1,9 ккк

$14,8 M_{\odot}$

$1,5 \cdot 10^{-10}$

супермассивный

$> 10 \text{ ккк}$

$10 M_{\odot}$

$\approx 1,5 \cdot 10^{-10}$

$\frac{1900}{17}$

$\frac{10}{14,8} = 2 \cdot 10^{-8}$