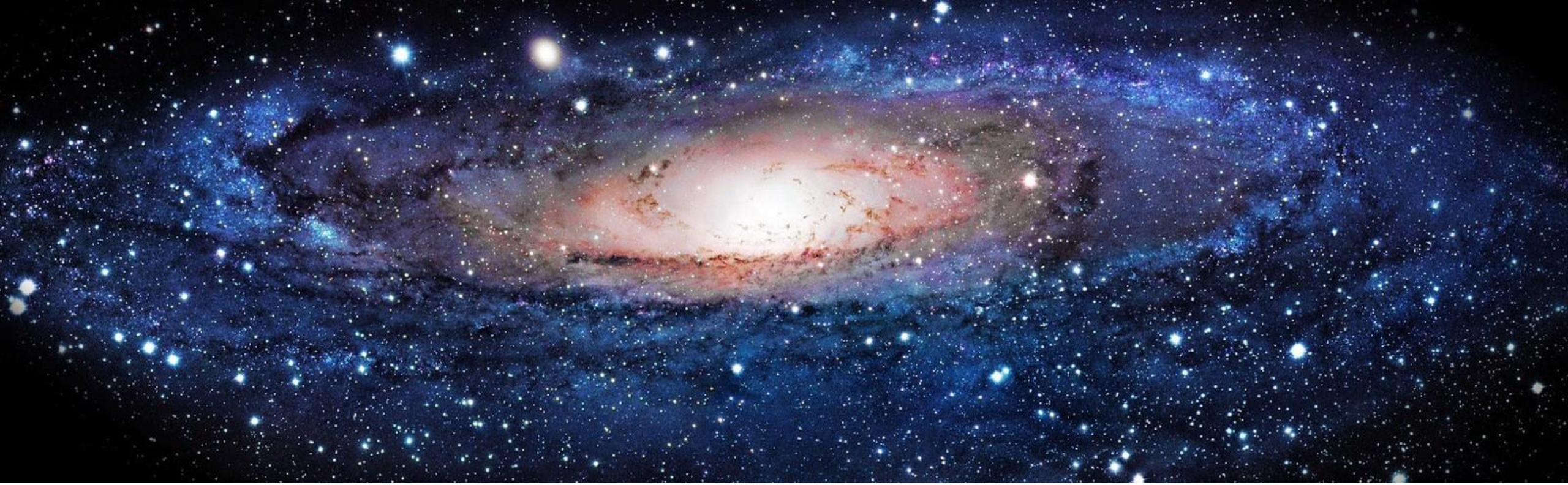
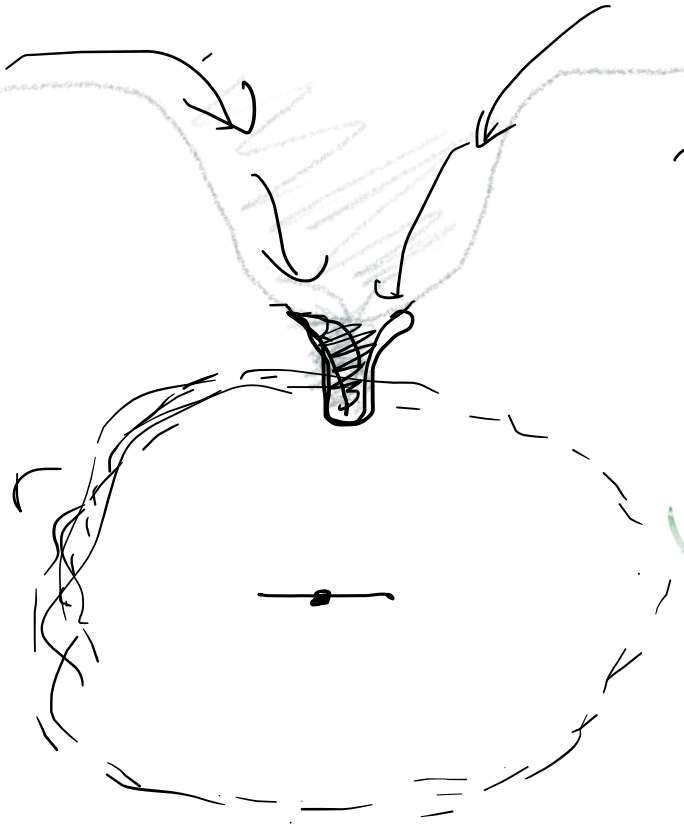
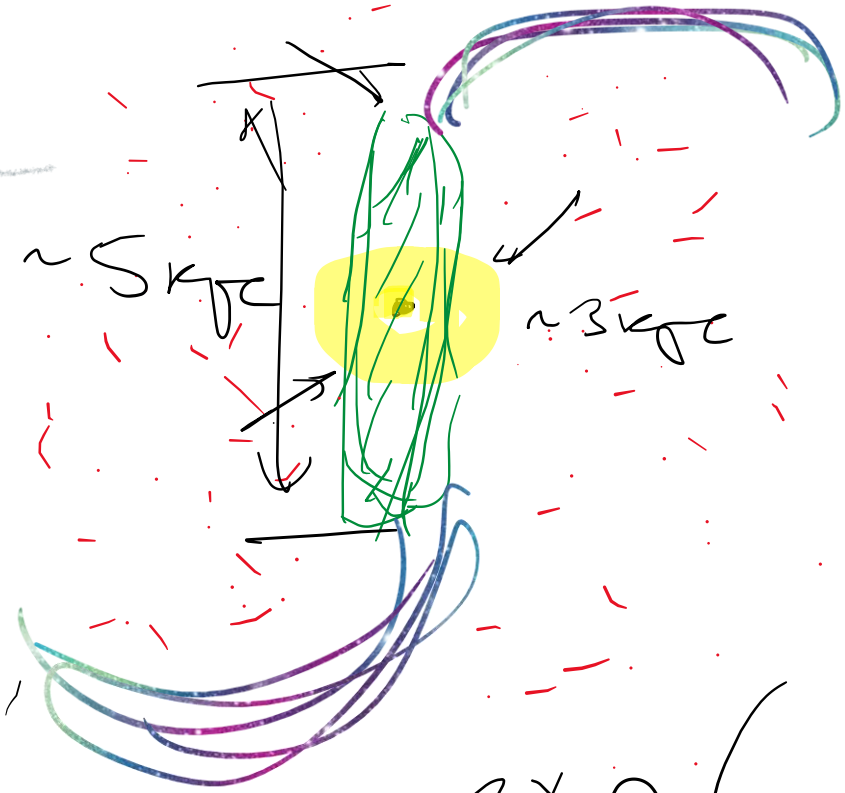


# Модуль. Астрофизика.

Семинар 7. (11.12)

① Кривая вращения


① $\frac{M(r)}{r} \sim r^2$

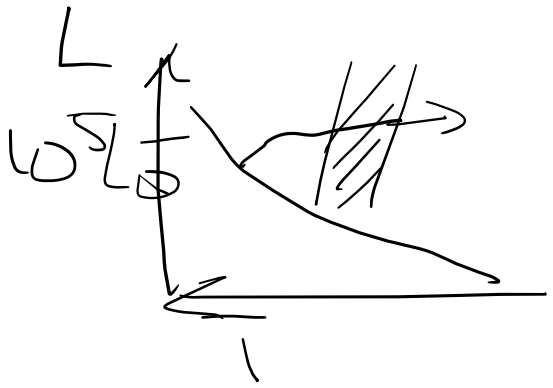
$\rho \simeq const$

$\exp\left(-r/5\text{кпс}\right)$

② $\frac{GM(r)}{r} \simeq const$ $\rho \sim r^{-2}$

(2) Черенда (РМЗ)

$d = 778$ кпс $= 2{,}5 \cdot 10^{24}$ см




$\Delta M = -12{,}5$ $\quad M_y = -7{,}7$

$m_1 - m_2 = -2.5 \lg f_1/f_2$

абс. фот.

$\frac{f_1}{f_2} \sim \frac{d_2^2}{d_1^2}$

$m_2 = -7{,}5 + 2{,}5 \lg \left(\frac{d}{10\,\text{пс}}\right)^2 =$

$= -1.5 + 5 \lg 77800 \simeq 16{,}95^m$

$D \sim 2{,}5$ м

(3) Öpik ApJ (1922)

NASA ADS Öpik

$v^2 = \frac{GM}{R}$


$\left(\frac{v_0}{w}\right)^2 = \frac{M}{r}$

i - наклон

$r = D \cdot \sin\rho$

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

$E \equiv \frac{L(r)}{M}$ - эксцесс

$v_0 = 157 \frac{км}{с}$

$\rho = 150''$

$i \equiv \frac{f_{m31}(D)}{f_\odot(ae)}$

$m(\rho) = 6{,}1^m$

$m_\odot - m_{31} = 2{,}5 \lg\left(\frac{f_{m31}}{f_\odot}\right) = 2{,}5 \lg i$

$i = 2{,}512^{m_\odot - m_{31}}$

Öpik

w - скор. звезды относ. Солнца

$v_0$ - гелиоцентр. [км/с]

$r \longleftrightarrow \rho$

[r] = а.е.

$[M] = M_\odot$

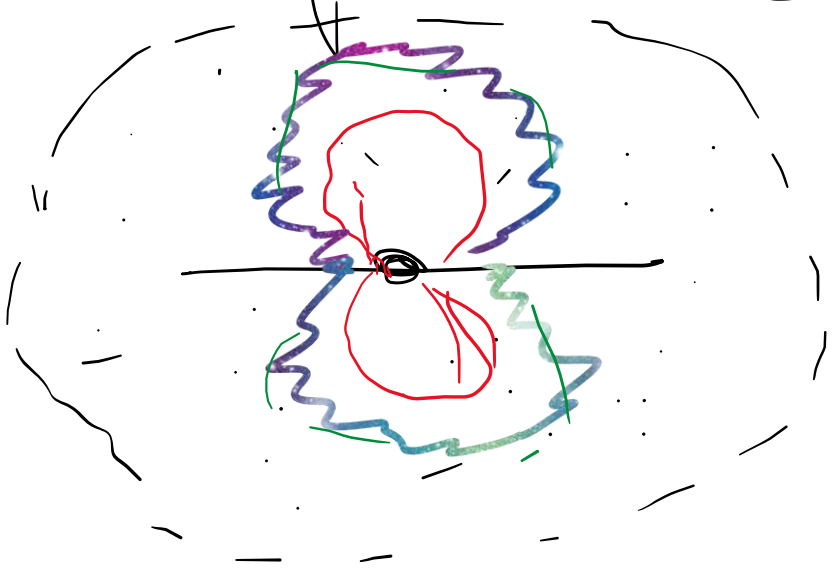
$$\frac{i}{L(r)} = \frac{1}{D^2} \qquad D^2 = \frac{L(r)}{i} \qquad L(r) = E \cdot M$$

$$M = r\left(\frac{U_0}{\omega}\right)^2 \qquad r = 2 \cdot \delta_{max} \qquad E = 0{,}38$$

$$L \sim M^{3\frac{1}{3}}$$

$$D = \frac{E \cdot U_0^2 \delta_{max}}{i \omega^2} = \ldots \quad ae = 45000 \text{ нк}$$

4) Горячий газ



$M_G \simeq 10^{12} M_\odot$

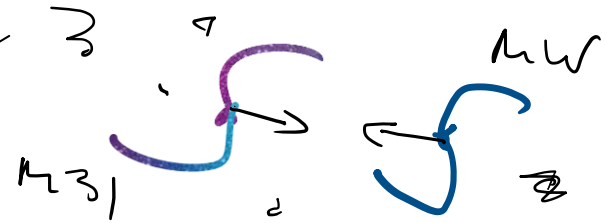
$r = 100$ кпк

$$|Q| = \frac{1}{2}|U|$$

$$\frac{3}{2} kT = \frac{GM}{r} m$$

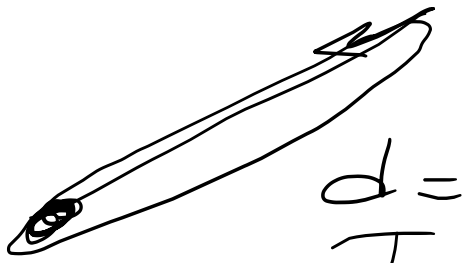
$$T = \frac{2GMm}{3kr} = 2 \cdot 10^6 K$$

(5) Падение М31




$M_1 \simeq M_2 \simeq 10^{12} M_\odot$

$d \simeq 750$ кпк

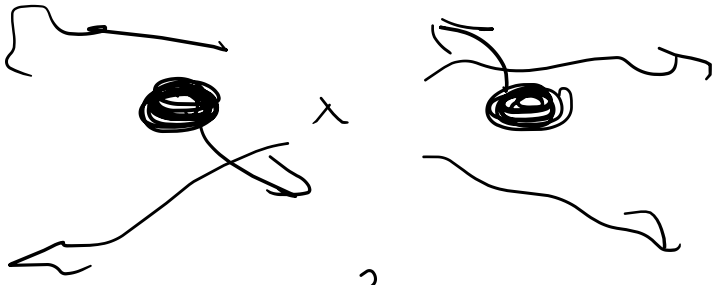


$d = 2a$

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

$$T_{fall} = \frac{1}{2}\left[\frac{4\pi^2 d^3}{8G \cdot 2M}\right]^{1/2} = 7{,}6 \text{ млрд лет}$$

## (6) GW + BH



$$E = -\frac{1}{2}\frac{GM_1M_2}{a}$$

$$\frac{dE_{GW}}{dt} = -\frac{32G^4}{5c^5}\frac{\mu^2M^3}{a^5}$$

$$\mu = \frac{M_1M_2}{M}$$

$$\frac{E}{\tau} = \frac{32G^4}{5c^5}\frac{\mu^2M^3}{a^5}$$

$$M = M_1 + M_2$$

$$M_1M_2 = \mu M$$

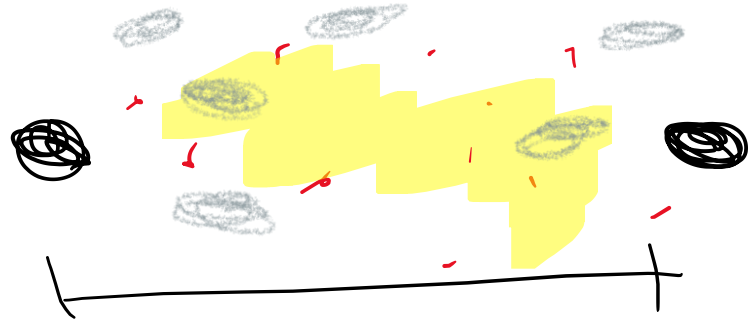
$$\tau = \frac{1}{2}\frac{GM_1M_2}{a}\frac{5c^5a^5}{32G^4\mu^2M^3} =$$

$$= \frac{5c^5a^4}{64G^3\mu M^2}$$

$$M_1 = M_2 = 10^9\,M_\odot$$

$$a = 1\text{ km}$$

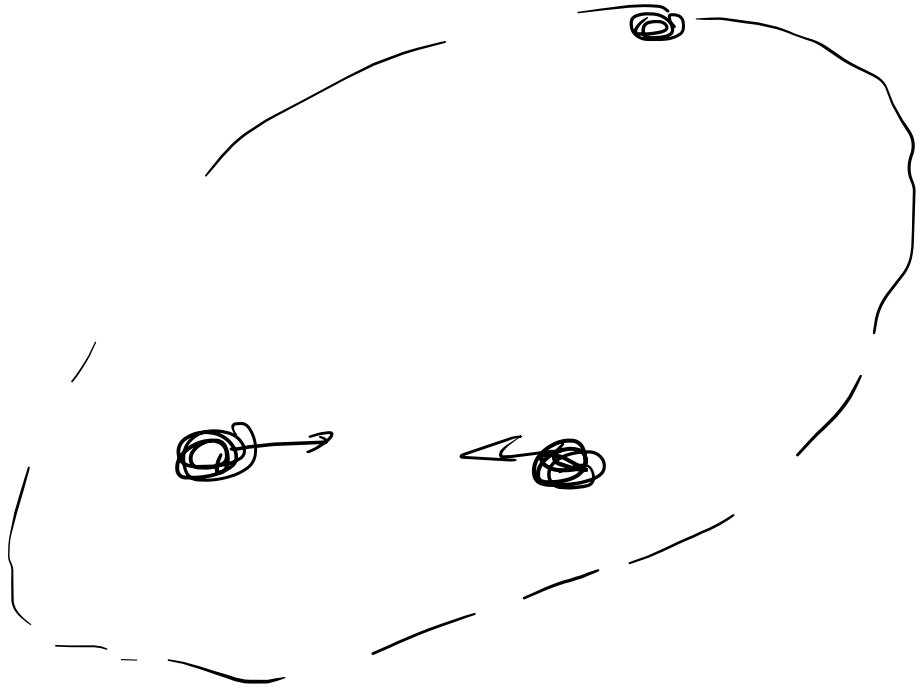
$$\tau \sim 10^{24}\text{ sec}$$

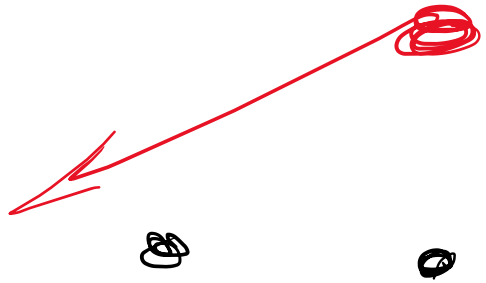



$\tau = 10^{10}$ ani

$M_1 = M_2 = 10^9 M_\odot$

$a \simeq 0{,}6$ kpc





7 Гравитационно-волновое

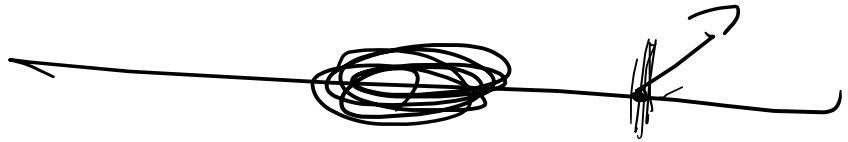

$v = v\left(q = \frac{m_1}{m_2}, \vec{\omega}_1, \vec{\omega}_2\right)$

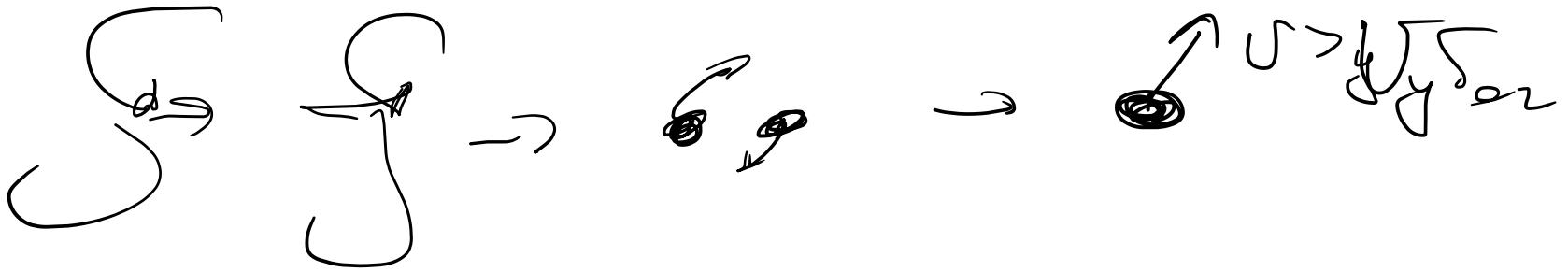
$v \approx 100 - 1000 \frac{km}{c}$

$$v_{нач} = \sqrt{\frac{2GM}{r}}$$

$$M = M(r)$$

$$v_{удар} \approx 500 \div 700 \frac{км}{с}$$





$v > v_{удар}$