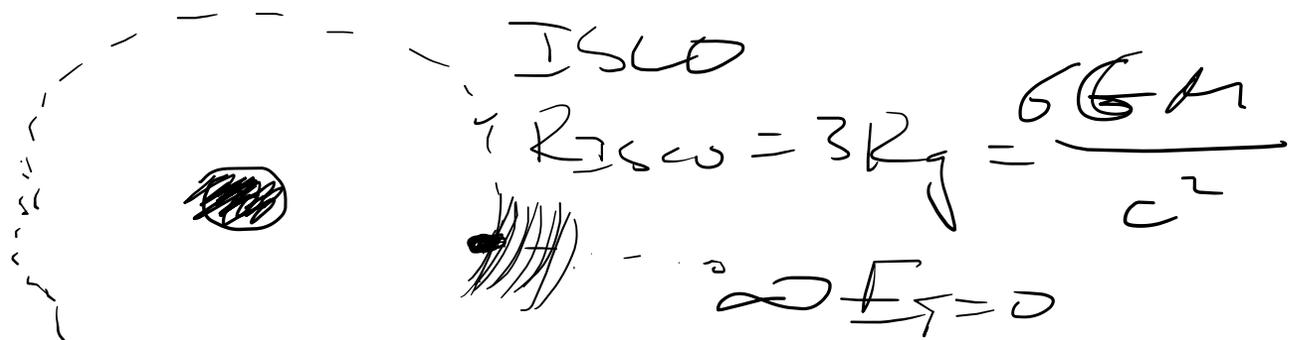




Майнор. Астрофизика.

Семинар 11. (25.11)

①



$$L = \frac{1}{2} \frac{GM\dot{M}}{R_{ISCO}} = 1, \dots 10^{46} \frac{\text{erg}}{\text{s}}$$

$$L_{Edd} = 1, \dots 10^{38} \frac{M_{\odot}}{M_{\odot}}$$

$$M = 10^8 M_{\odot}$$

②

$$m = 6^{\text{cm}}$$

$$L = L_{\odot}$$

$$d = ?$$

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

$$M_{\odot} = 4,8$$

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

③

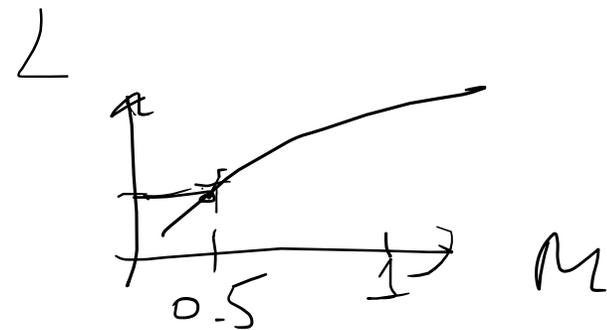
$$L \sim M^a$$

1. $a = 3$
2. $a = 3 \frac{1}{3}$
3. $a = 4$

} \Rightarrow

$$\frac{L}{L_{\odot}}$$

$$\frac{f_1}{f_2} = \frac{L_1}{L_2}$$



4

$$\frac{I \omega^2}{2}$$

$$\omega = \frac{2\pi}{P}$$

$$I \sim (1 \pm 3) \cdot 10^{45} \text{ g cm}^2$$

$$I \sim k M R^2$$

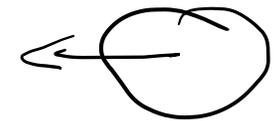
$$0,1 \frac{I \omega^2}{2 P^2} = \frac{B^2}{8\pi} \cdot \frac{4}{3} \pi R^3$$

~~star~~

$$0,1 k \frac{2\pi^2 M R^2}{P^2} = \frac{B^2 R^3}{6}$$

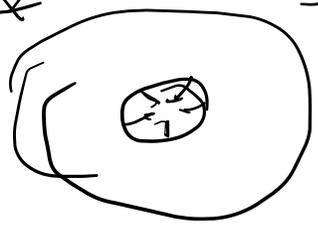
$$P \sim 1 \dots \text{e}$$

5

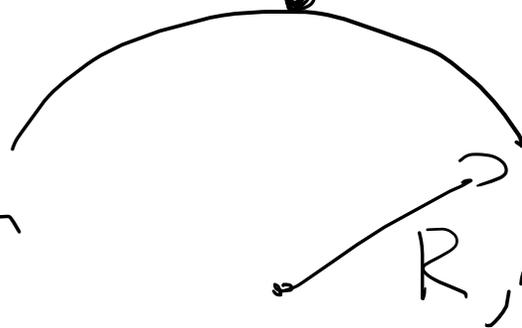
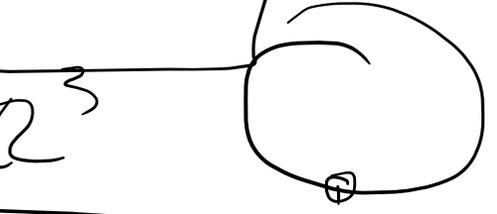


~~$R \sim M^{1/3}$~~
 ~~$f_{\text{WD}} \sim \rho$~~

~~$R \sim M^{0,8}$~~
 ~~$\omega \approx \dots$~~



$$R_{\text{WD}} \sim \text{few} \cdot 10^3 \text{ km}$$



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



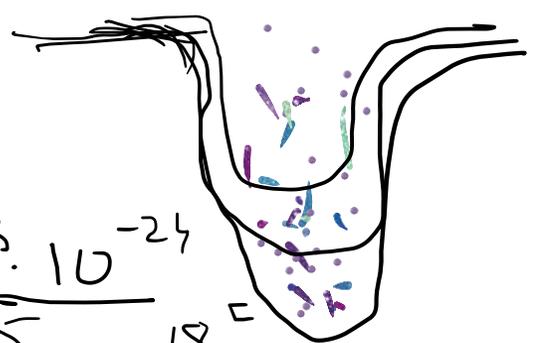
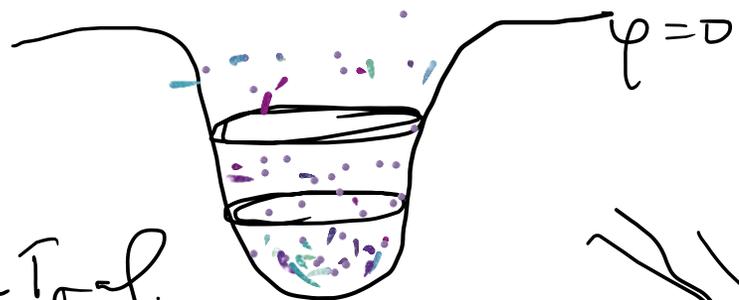
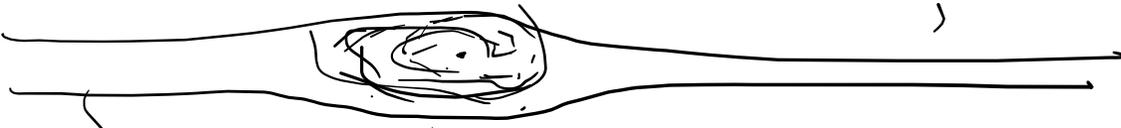
Майнор. Астрофизика.

Семинар 11. (25.11)

① Топеруи заг р Танакуне

$$M \approx 10^{12} M_{\odot}$$

$$M_{*} \sim 10^6 M_{\odot}$$



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

$$\frac{3}{2} kT \approx \frac{GMm}{r}$$

$$T = \frac{2GMm}{3kr}$$

$$= \frac{4}{1,5 \cdot 1,38 \cdot 3,1} \frac{10^{14}}{10^7} \approx 6 \cdot 10^6 \text{ K}$$

температура \sim температур

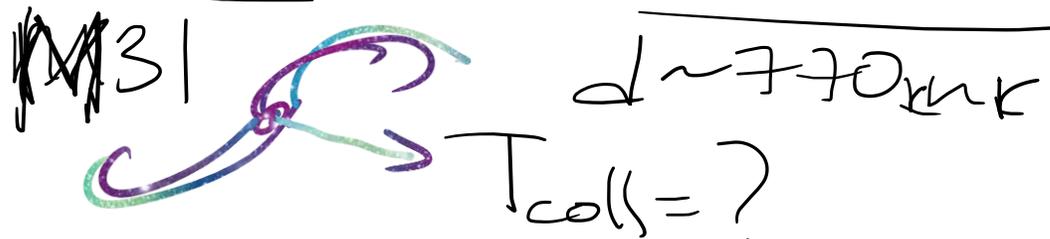
$$M \sim 10^{12} M_{\odot}$$

$$r \sim 100 \text{ kpc}$$

$$\frac{2 \cdot 10^{-7} \cdot 10^{12} \cdot 2 \cdot 10^{33} \cdot 10^{-24}}{1,5 \cdot 1,38 \cdot 10^{-16} \cdot 10^5 \cdot 3,1 \cdot 10^{18}}$$

$$\approx 6 \cdot 10^6 \text{ K}$$

② Нагемне МЗІ на Танактуры



$M \sim 10^{12} M_{\odot}$

$$S_{\text{gal}} = \pi R_G^2$$

$$N_* \cdot S_* = N_A \cdot \pi R_*^2$$

$$S_{\text{gal}} = \pi \cdot (3,1 \cdot 10^{18} \cdot 10^4)^2 = \pi \cdot 10^{45} \text{ cm}^2$$

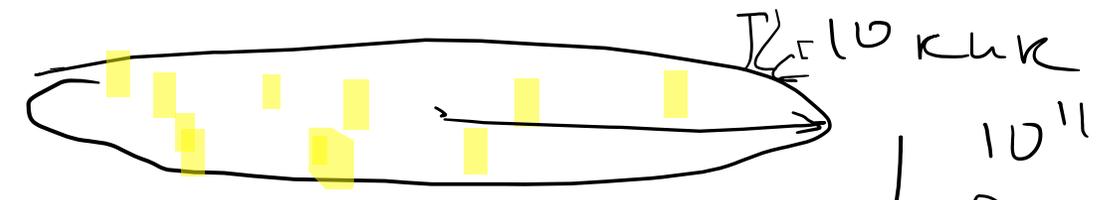
$$10^{11} \cdot \pi \cdot (7 \cdot 10^{10})^2 = 10^{11} \cdot \pi \cdot 5 \cdot 10^{21} = \pi \cdot 5 \cdot 10^{32} \text{ cm}^2$$

$$T_{\text{coll}} = \frac{1}{2} P_{\text{orb}}$$

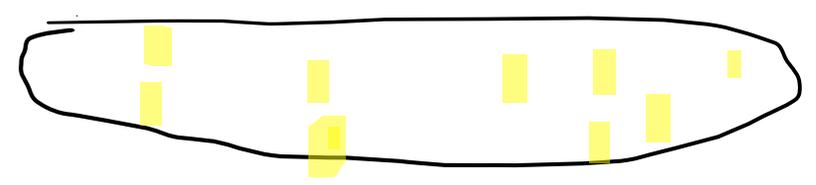
$$a = \frac{1}{2} d$$

$$T_{\text{coll}} = \frac{1}{2} \left[\frac{4\pi^2 a^3}{G \cdot 2 \cdot M} \right]^{1/2}$$

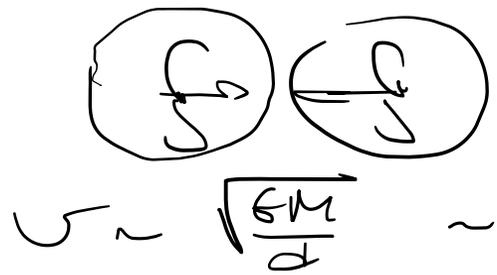
$$= \frac{1}{2} \left[\frac{4\pi^2 d^3}{8 \cdot G \cdot 2M} \right]^{1/2} = 7,6 \text{ млрд лет}$$



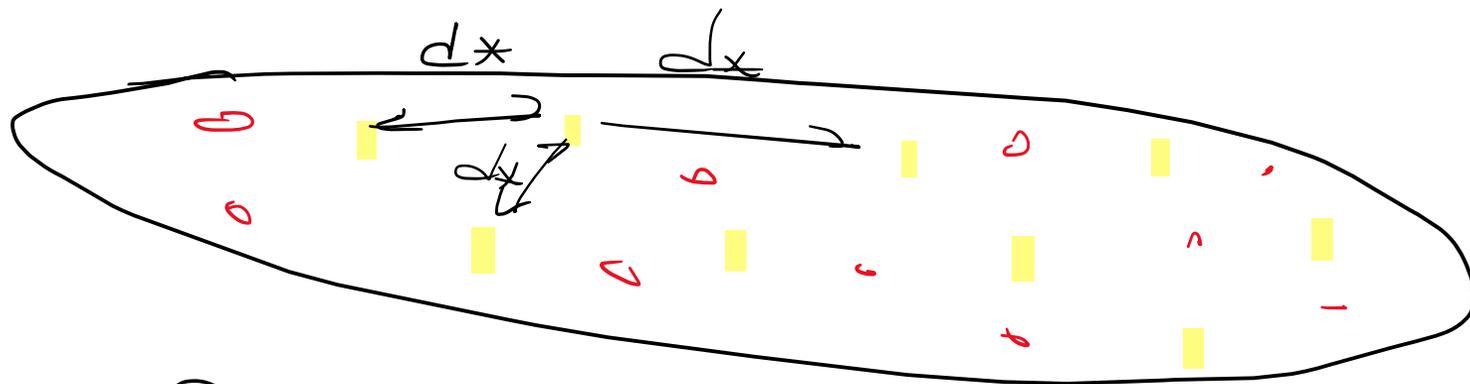
10^{11} зв
 $R_* \sim R_{\odot}$



$d_* \ll R_*$



$$\sqrt{\frac{10^{-7} \cdot 10^{12} \cdot 2 \cdot 10^{33}}{1.5 \cdot 10^4 \cdot 3 \cdot 10^{18}}} = \sqrt{\frac{10^{38}}{2 \cdot 10^{22}}} = \frac{1}{\sqrt{2}} \cdot 1000 \frac{\text{m}}{\text{s}}$$



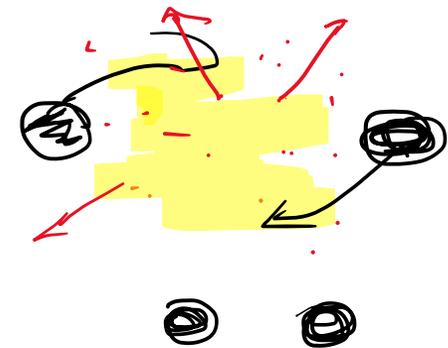
$$\frac{F}{\tau} = \dots \quad \tau = \frac{1}{2} \frac{6 M_1 M_2}{a} \frac{5c^5}{32G^4} \frac{a^5}{\mu^2 M^3} =$$

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

$$\mu = \frac{M_1 M_2}{M}$$

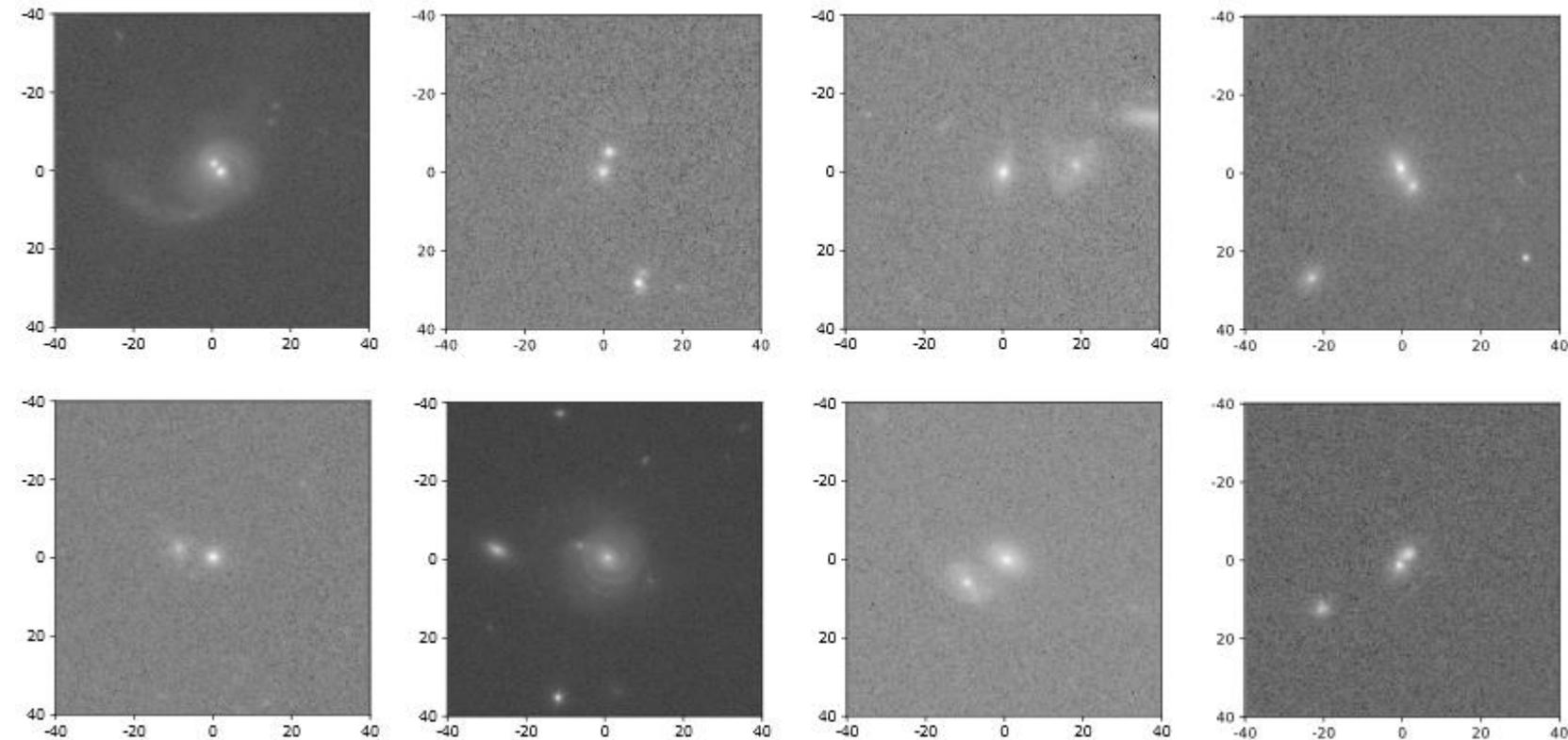
$$M_1 = M_2 = 10^9 M_\odot \quad a = 1 \text{ kpc}$$

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



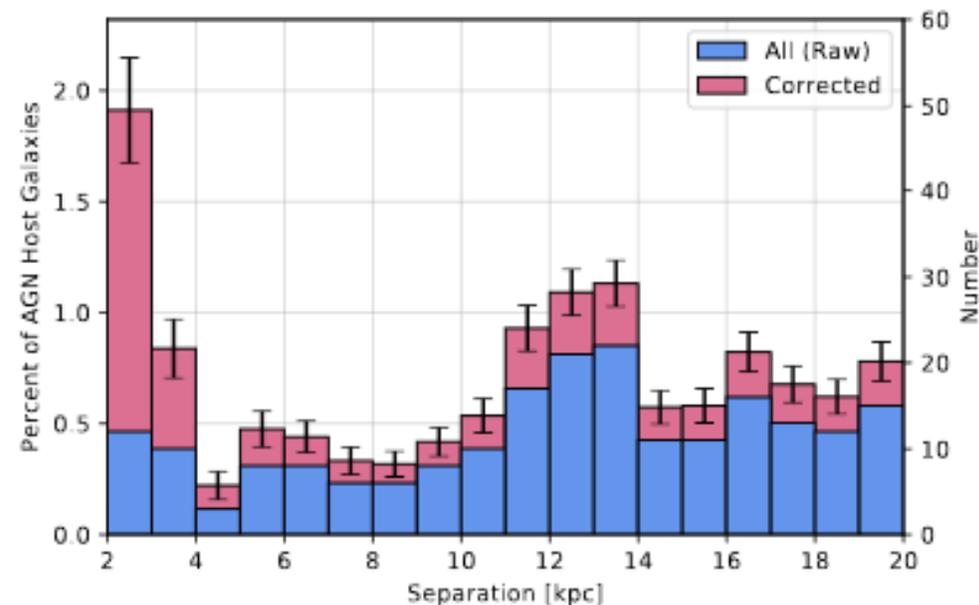
$$\tau = 10^{10} \text{ sec} \Rightarrow a = ?$$

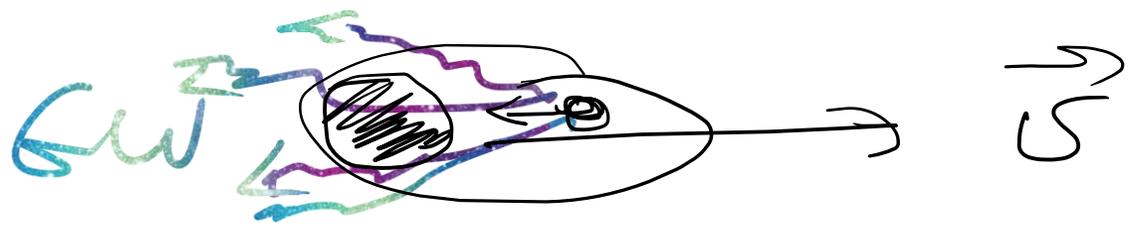
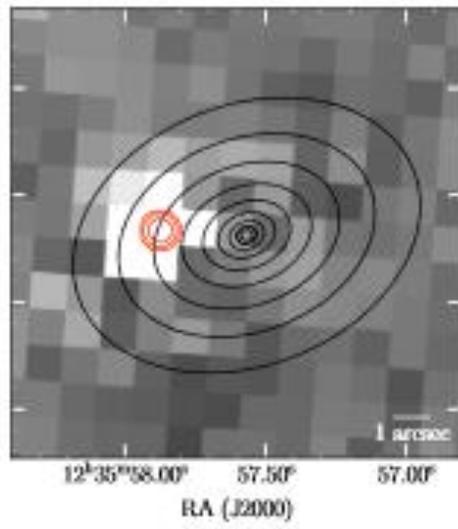
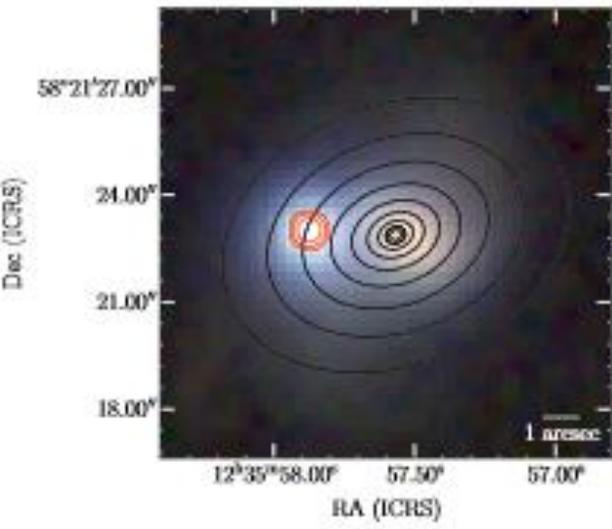
$$a = \left[\frac{64G^3 \mu M^2}{5c^5 \tau} \right]^{1/4} \approx 1 \text{ kpc}$$



2011.10051

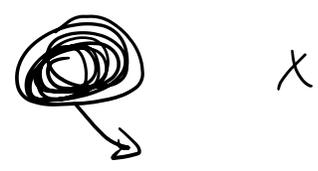
Была создана однородная выборка из 220 галактик с двойными или смещенными активными ядрами с расстоянием между черными дырами менее 20 кпк. Наблюдения на Космическом телескопе имени Хаббла.



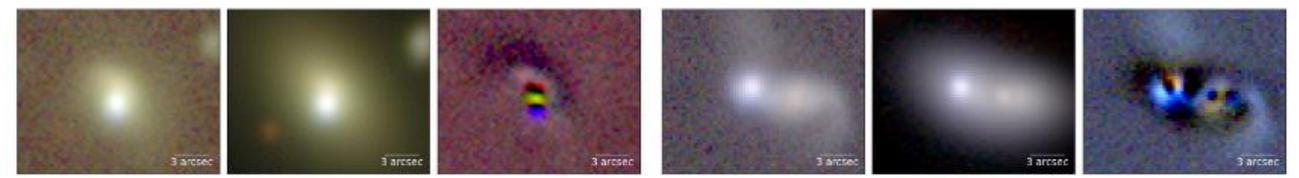


2011.11656

Gal-look parameters

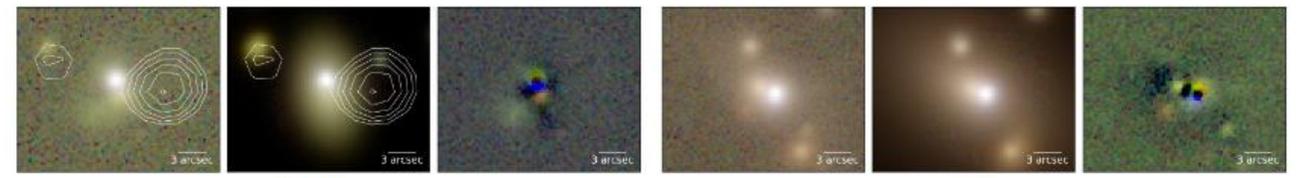


$v \sim 100 \div 1000$
 km/s



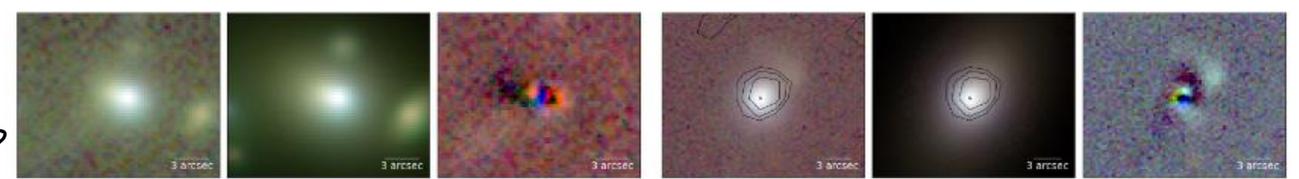
(a) ZTF19aautrth

(a) ZTF19aadgijf



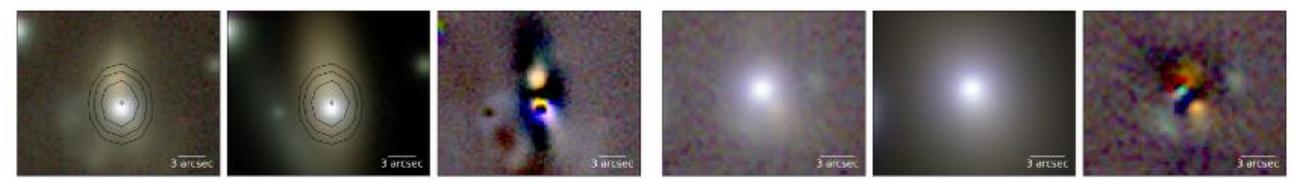
(a) ZTF18aaxmrom

(a) ZTF19aayrjxs



(a) ZTF18aalsidi

(a) ZTF18accptjn



(a) ZTF18absvcae

(a) ZTF18aaoeobb