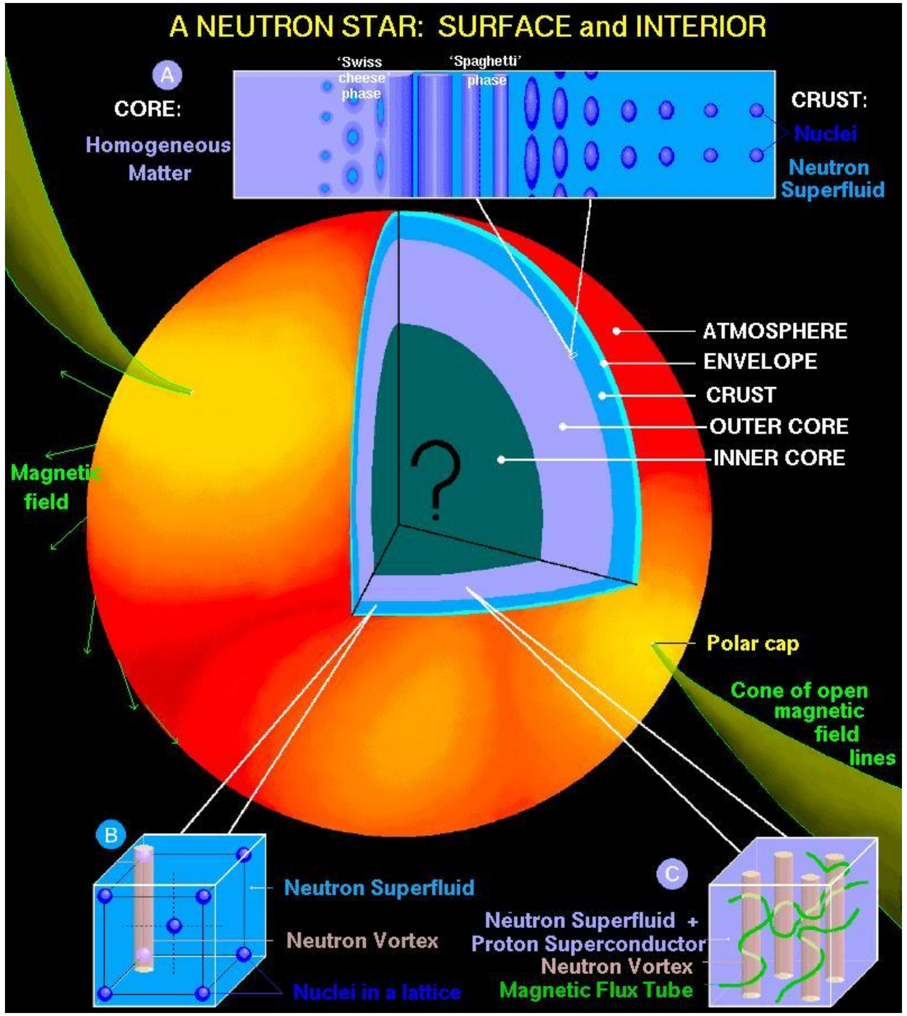
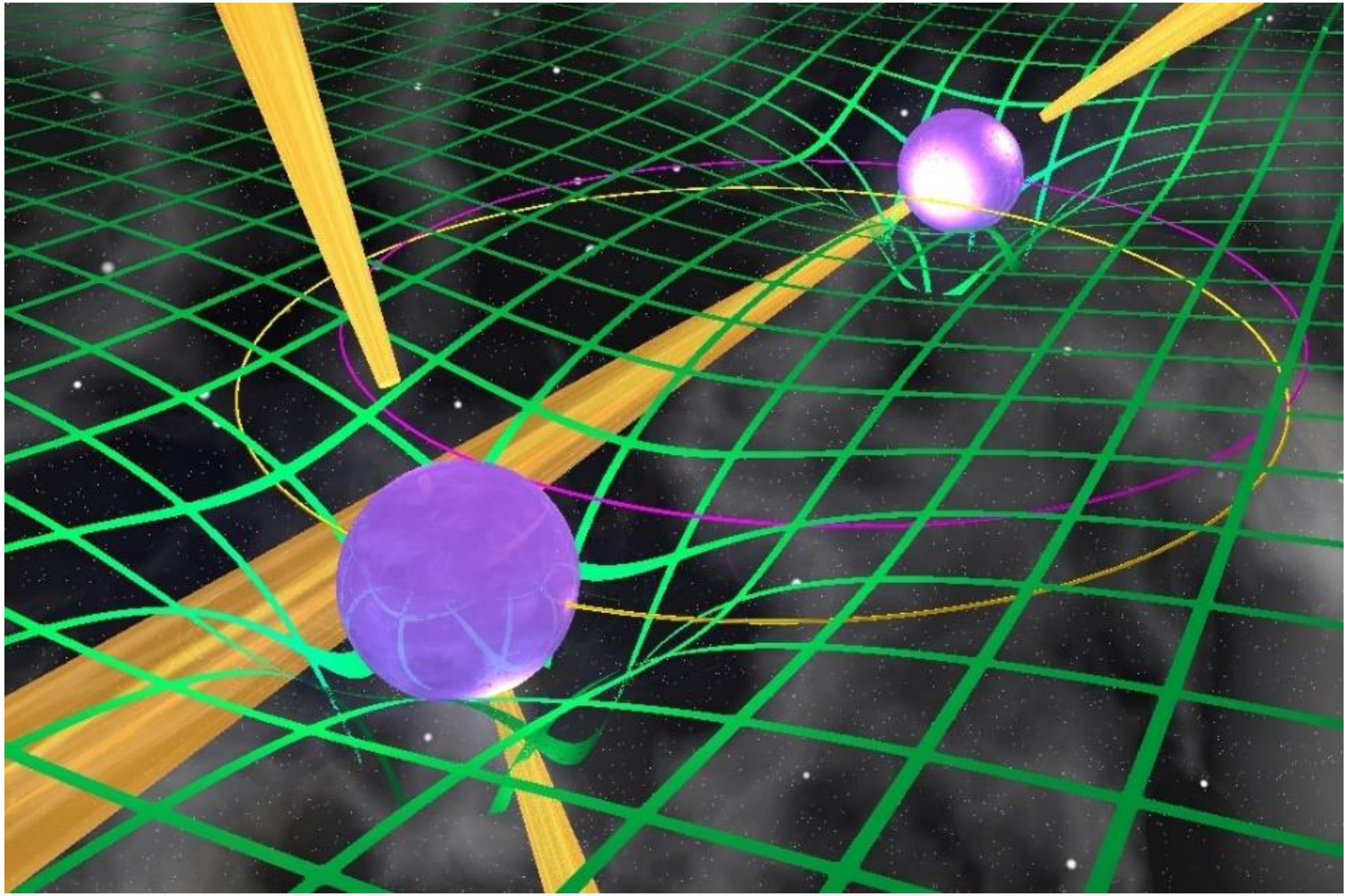


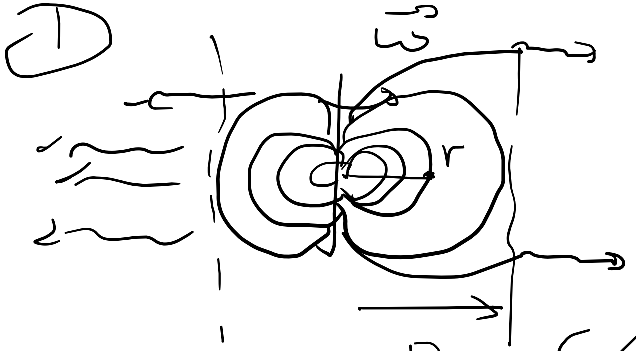


# Современная феноменология нейтронных звезд и черных дыр.

<u>Семинар 4</u>

22.03.2021

1)




$v \sim \omega r$

$c = \omega R_\ell$

$R_\ell = c/\omega$

$$P_m = \frac{\mu^2}{8\pi R^6} = \frac{E}{V}$$

$$\mu \sim BR^3 \qquad P_m = \frac{B^2}{8\pi}$$

$$V \sim \frac{4}{3}\pi R_\ell^3 \sim R_\ell^3$$

$$L_m \simeq \frac{E}{t} \qquad t \sim \frac{R_\ell}{c} = \frac{1}{\omega}$$

$$L_m \simeq P_m \cdot V \cdot \omega \sim \frac{\mu^2}{R_\ell^6} R_\ell^3 \omega = \frac{\mu^2}{R_\ell^3}\omega \sim \boxed{\mu^2 \omega^4}$$

$$\dot{E}_{rot} \sim \mu^2 \omega^4 = \frac{2}{3}\frac{\mu^2 \omega^4}{c^3}\left(1 + \sin^2 \chi\right)$$


$$E_{rot} \sim \frac{I\omega^2}{2}$$

② Радиусы

$R_{NS}$, $R_g = \dfrac{2GM}{c^2}$

а) $R_{б}$


$$R_{б} = \frac{2GM}{(v^2 + c_s^2)}$$

б) $R_{co}$

$$\omega R_{co} = \sqrt{\frac{GM}{R_{co}}}$$

$$R_{co} = \left(\frac{GM}{\omega^2}\right)^{1/3} = \left(\frac{10^{-7} \cdot \cancel{1{,}5} \cdot 2 \cdot 10^{33}}{\cancel{1{,}5} \quad 4\pi^2}\right)^{1/3} P_{1sec}^{2/3} \sim$$

$$\sim \left(\frac{10^{25}}{2}\right)^{1/3} P_{1sec}^{2/3} \sim 2 \cdot 10^{8}\,\text{cm}\; P_{1sec}^{2/3}$$

b) $R_A$, $\quad R_A < R_G$ (accr., prop)

$$\frac{\mu^2}{8\pi R_A^6} = \frac{\dot{M} v_\infty}{4\pi R_A^2}\left(\frac{R_G}{R_A}\right)^{1/2}$$

$$\dot{M} = 4\pi R^2 \rho v$$

$$v = v_\infty \left(\frac{R_G}{R}\right)^{1/2}$$

$$R_G = 2GM/v_\infty^2$$

$$R_A = \left(\frac{\mu^2}{\dot{M}\sqrt{2GM}}\right)^{2/7}$$

2) $$\frac{L_m}{4\pi R_{sh}^2 \cdot c} = \frac{\dot{M}}{4\pi R_G^2} v_\infty$$

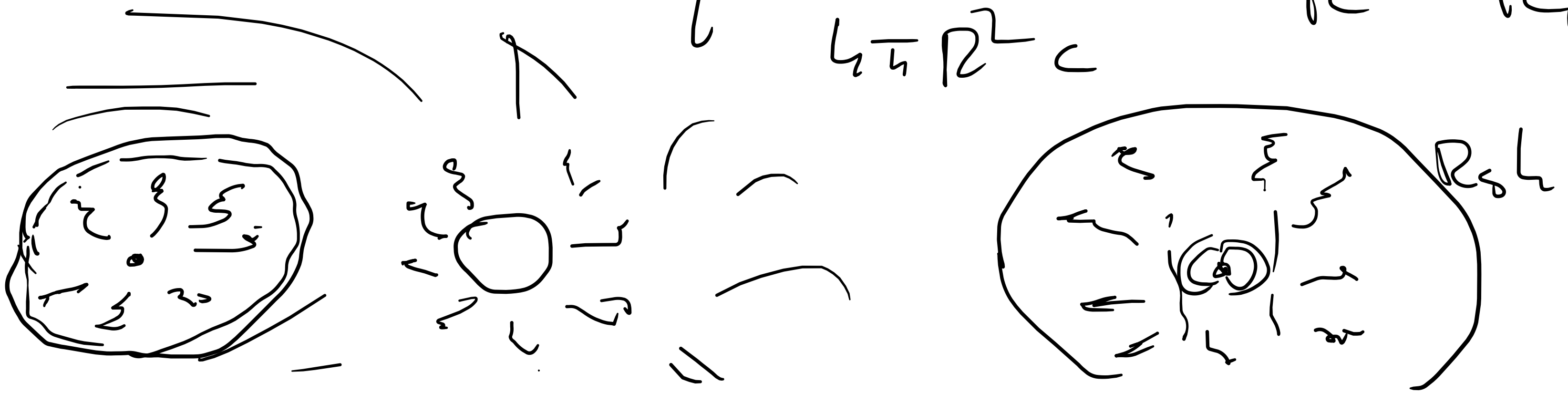
$$L_m = k_t \frac{\mu^2}{R_e^3}\omega$$

$$R_{sh} = \left(\frac{k_t \mu^2 (GM)^2 \omega^4}{\dot{M} v_\infty^5 c^4}\right)^{1/2}$$

③ $$P_w = \begin{cases} \dfrac{\dot{M} v_\infty}{4\pi R_G^2} & R > R_G \\ \dfrac{\dot{M} \cdot v_\infty}{4\pi R^2} \left(\dfrac{R_G}{R}\right)^{1/2} \sim R^{-5/2} & R < R_G \end{cases}$$

$$\dot{M} \simeq \pi R_G^2 \cdot \rho v$$

④ $$P_m = \begin{cases} \dfrac{\mu^2}{8\pi R^6} & R < R_e \quad \sim R^{-6} \\ \dfrac{L_m}{4\pi R^2 c} & R > R_e \quad \sim R^{-2} \end{cases}$$




$P_\infty = \text{const}$

(5) $P \to A$ $\quad R_A = R_{\omega}$

$$\left(\frac{GM}{4\pi^2}\right)^{2/3} P_A^{2/3} = \left(\frac{\mu^2}{\dot{M}\sqrt{2Gm}}\right)^{2/7}$$

$$\left(\frac{GM}{4\pi^2}\right)^{7} P_A^{7} = \left(\frac{\mu^2}{\dot{M}\sqrt{2Gm}}\right)^{3}$$

$\dot{M} \sim R_G^2 \rho v$

$R_G \sim v^{-2}$

$\dot{M} \sim \rho v^{-3}$

$$P_A \sim \mu^{6/7} \dot{M}^{-3/7} \sim \mu^{6/7} \rho^{-3/7} \underset{\uparrow}{v}^{9/7}$$

(7) $\rightarrow$ teorut

$R_G = R_A$

1) $R_A$ $\quad \underline{\underline{R_A > R_G}}$

2) $v_{crit}$

$$\frac{2GM}{v^2} = \left(\frac{\mu^2}{\dot{M}\sqrt{2GM}}\right)^{2/7}$$

$$\dot{M} \sim v^{-3}\rho$$

$$v^{-2} \sim \mu^{4/7}\rho^{-2/7}v^{-6/7}$$

$$v^{-14} \sim \mu^{4}\rho^{-2}v^{-6}$$

$$v^{-8} \sim \mu^{4}\rho^{-2}$$

$$v \sim \mu^{-1/2}\rho^{1/4}$$