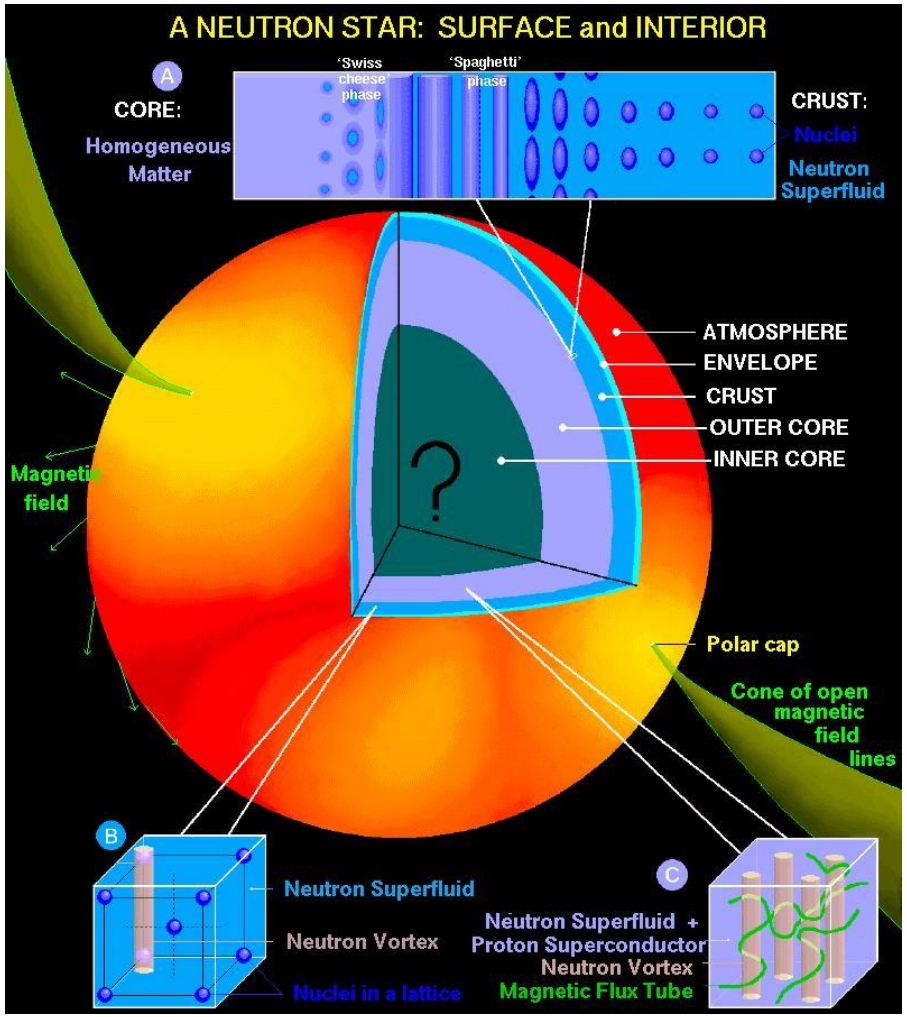
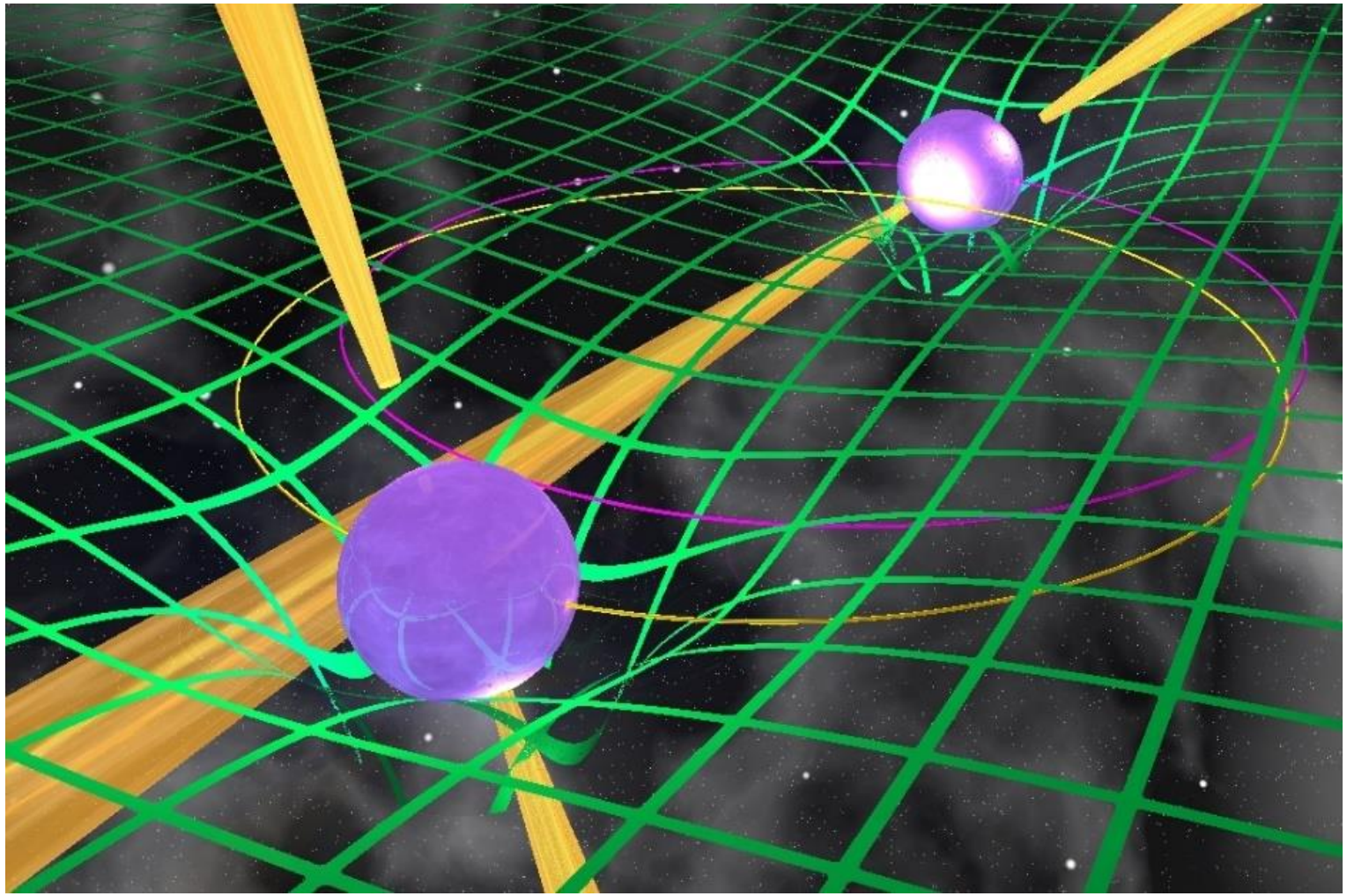


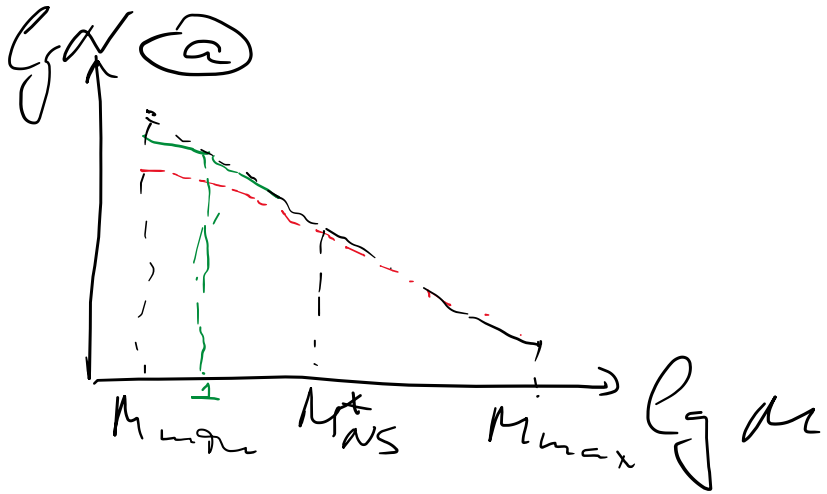


Современная феноменология нейтронных звезд и черных дыр.

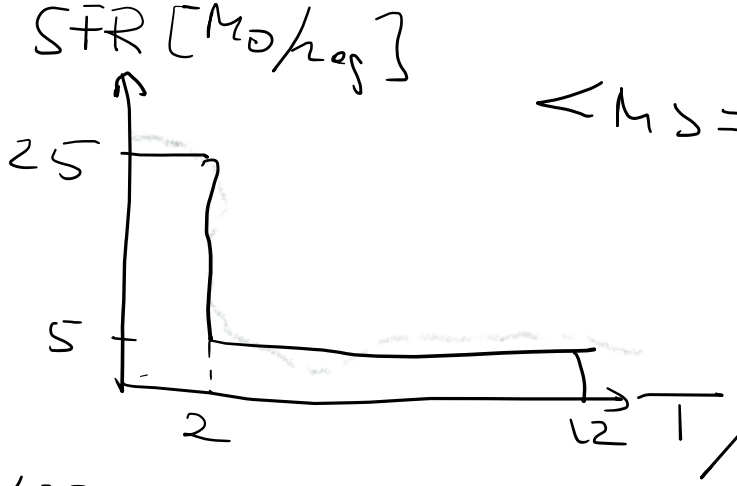
Семинар 1

08.02.2021

① $\frac{dN}{dM} = A \cdot M^{-2.35}$



$M_{TOT} = 5 \cdot 10^{10} + 25 \cdot 2 \cdot 10^9 = 10^{11}\ M_\odot$

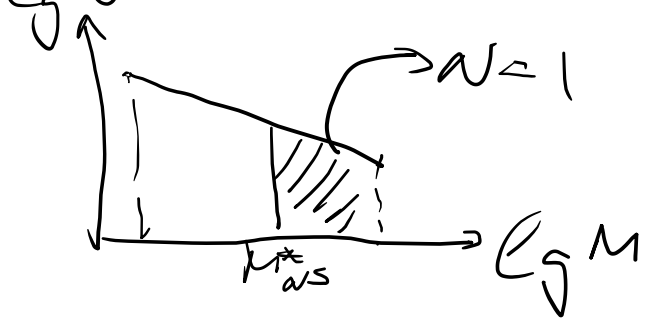


$$\langle M \rangle = \frac{\int_{0.1}^{100} A \cdot M^{-2.35} \cdot M\, dM}{\int_{0.1}^{100} A \cdot M^{-2.35}\, dM} = \frac{\int_{0.1}^{100} M^{-1.35}\, dM}{\int_{0.1}^{100} M^{-2.35}\, dM} =$$

$M^*_{NS} = 10 M_\odot$

$$\frac{N_{NS}}{N_{TOT}} = \frac{\int_{10}^{100} A \cdot M^{-2.35}\, dM}{\int_{0.1}^{100} A \cdot M^{-2.35}\, dM} = \frac{(0.1)^{1.35}}{(10)^{1.35}} = 10^{-2.7} \simeq \frac{1.35}{0.35} \frac{(0.1)^{1.35}}{(0.1)^{0.35}} \simeq 0.4 M_\odot$$

⑧



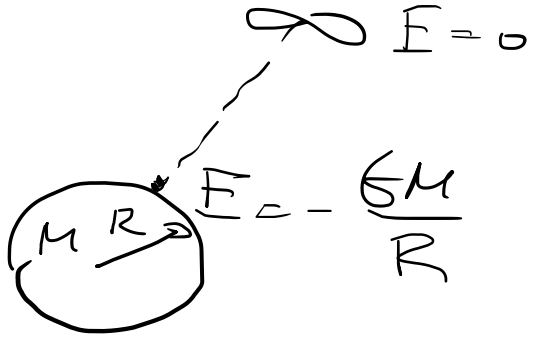
$N_{NS} = N_{TOT} \cdot 10^{-2.7} = \frac{M_{TOT}}{\langle M \rangle} \cdot 10^{-2.7} = \frac{2.5}{10^{0.7}} \cdot 10^9$

$$\int_{10}^{100} A \cdot M^{-2.35}\, dM = 1 = \tilde{N}_{TOT} \cdot \left(\frac{0.1}{10}\right)^{1.35}$$

$N_{TOT} = 5 \frac{M_\odot}{yr} \cdot \frac{1}{\langle M \rangle} \cdot T \qquad 1 = \frac{5}{0.4} \cdot T \cdot 10^{-2.7}$

$T = \frac{0.4}{5} 10^{2.7} \simeq 40$ yrs

(2) Энерг. NS



$\frac{GM_m}{R}$ vs. mc^2

а) Аккр.

$\frac{10^{-7} \cdot 1{,}52 \cdot 10^{33}}{1.5 \cdot 10^{6}} = 2 \cdot 10^{20}$ эрг/г

$L_{Edd} = 10^{38}$ эрг/с $\frac{M}{M_\odot}$

$c^2 \simeq 10^{21}$ эрг/г

$\dot{M}_{Edd} \sim 10^{18}$ г/с $\sim 10^{-8} \frac{M_\odot}{год}$ $\left| \frac{2 \cdot 10^{33}}{3{,}1 \cdot 10^{7}} \right.$

б) Тепл. энерг.

$L = 4\pi R^2 \sigma T^4$, $T = 10^6$ K

$L = 4\pi \cdot 10^{12} \cdot 5{,}67 \cdot 10^{-5} \cdot 10^{24} = 10^2 \cdot 10^{36} \cdot 10^{-5} \simeq \underline{10^{33}}$ эрг/с

$\sim 10^2$

$\lambda_{max} = \frac{0{,}29\,(см)}{T} \sim 3 \cdot 10^{-7}$ см $\sim$ 3 нм

рентген

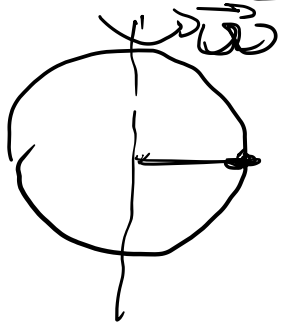
10^6 K $\longrightarrow$ 100 эВ

1 эВ $\rightarrow 10^4$ K

6) Вращение. $\omega = \frac{2\pi}{P}$

$I \sim kMR^2 \sim \underbrace{k}_{\leq 1} \cdot \underbrace{3}_{\sim 1} \cdot 10^{33} \cdot 10^{12} \sim 10^{45}$

$E_{вращ} = \frac{I\omega^2}{2}$



$v_\ell = v_1$

$\omega_{max} R = \sqrt{\frac{GM}{R}}$

$P_{min} = 2\pi \frac{R^{3/2}}{\sqrt{GM}} = \frac{2\pi \cdot 10^{6}}{\sqrt{\frac{10^{-7}}{1.5} \cdot 1.5 \cdot 10^{33}}} = \frac{2\pi \cdot 10^{3}}{\sqrt{2} \cdot 10^{13/2}}$

$P_{min} \sim \frac{1}{\sqrt{\rho}}$

$= \sqrt{2}\pi \cdot 10^{-4}$ с

$\frac{2\pi}{P_{min}} = \frac{(GM)^{1/2}}{R^{3/2}}$

$P_{min} \sim 0.001$

$\omega_{max} \sim 10^4$

$E_{вращ} = \frac{10^{45} \cdot 10^8}{2} = \frac{1}{2} \cdot 10^{53}$ эрг.

2) Магнитное

$\mathcal{E} = B^2/8\pi$

$E_{max} \leq \mathcal{E} \cdot V = \frac{B^2}{8\pi} \frac{4}{3}\pi R^3 = \frac{B^2 R^3}{6}$

$E_{max} < |E_{pot}|$

$B < 10^{15}$ Гс

$\mathcal{E}$ vs. ρc^2

$\rho_B = \frac{\mathcal{E}}{c^2} = \frac{10^{30}}{10^{21} 8\pi} B_{15}^2 \frac{г}{см^3} = 3 \cdot 10^7 B_{15}^2 \frac{г}{см^3}$

$B_{max} = \left[6\frac{GM^2}{R^4}\right]^{1/2} = \left[\frac{6 \cdot 1.5 \cdot 2}{1.5} \frac{10^{-7} \cdot 10^{66}}{10^{24}}\right]^{1/2} = 10^{18}$ Гс