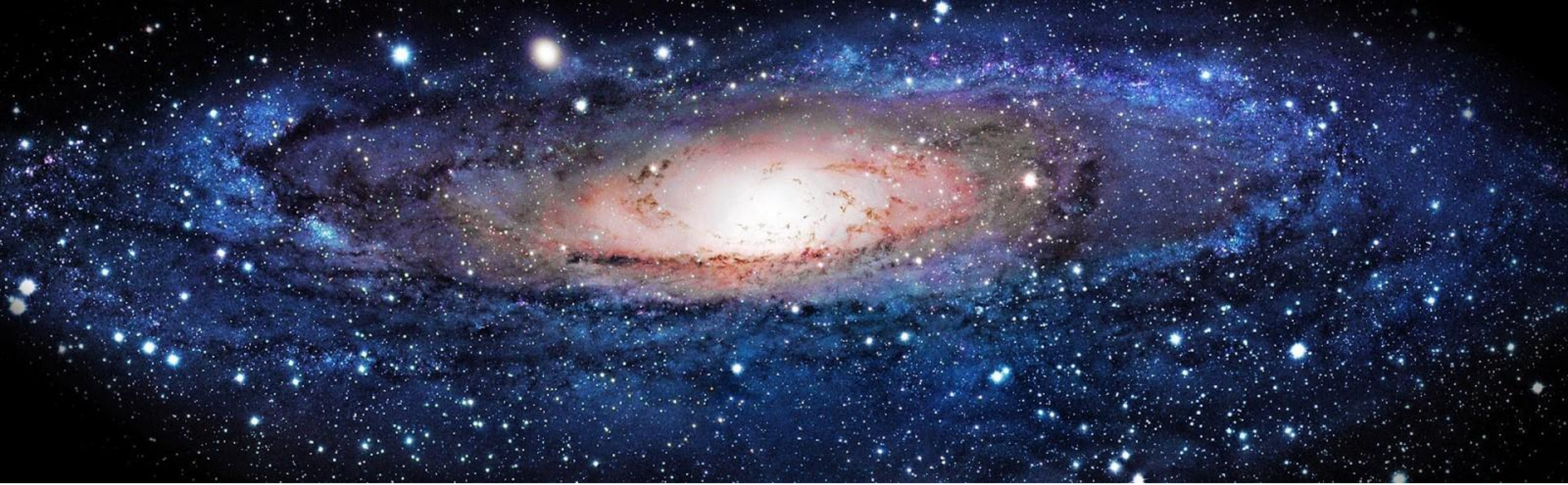
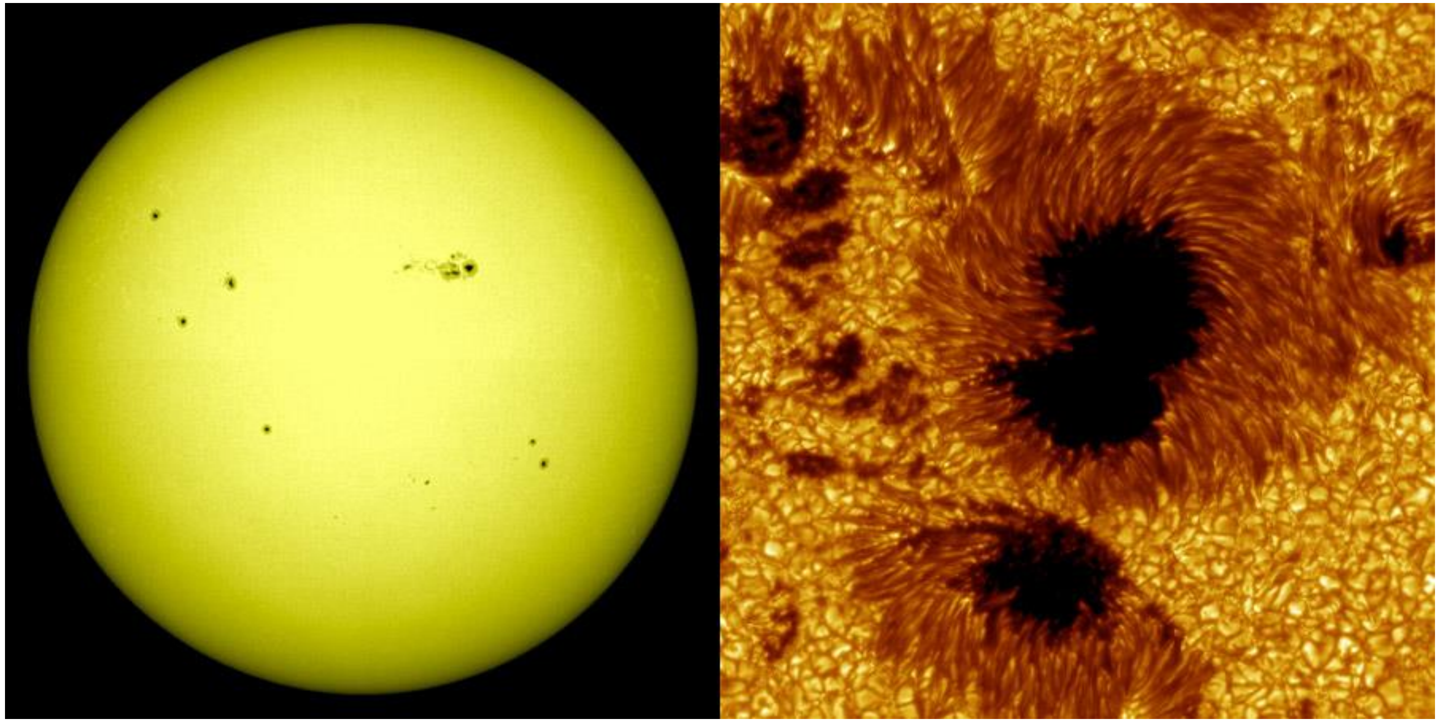


Астрофизика и космология.

Семинар 3. (30.01)

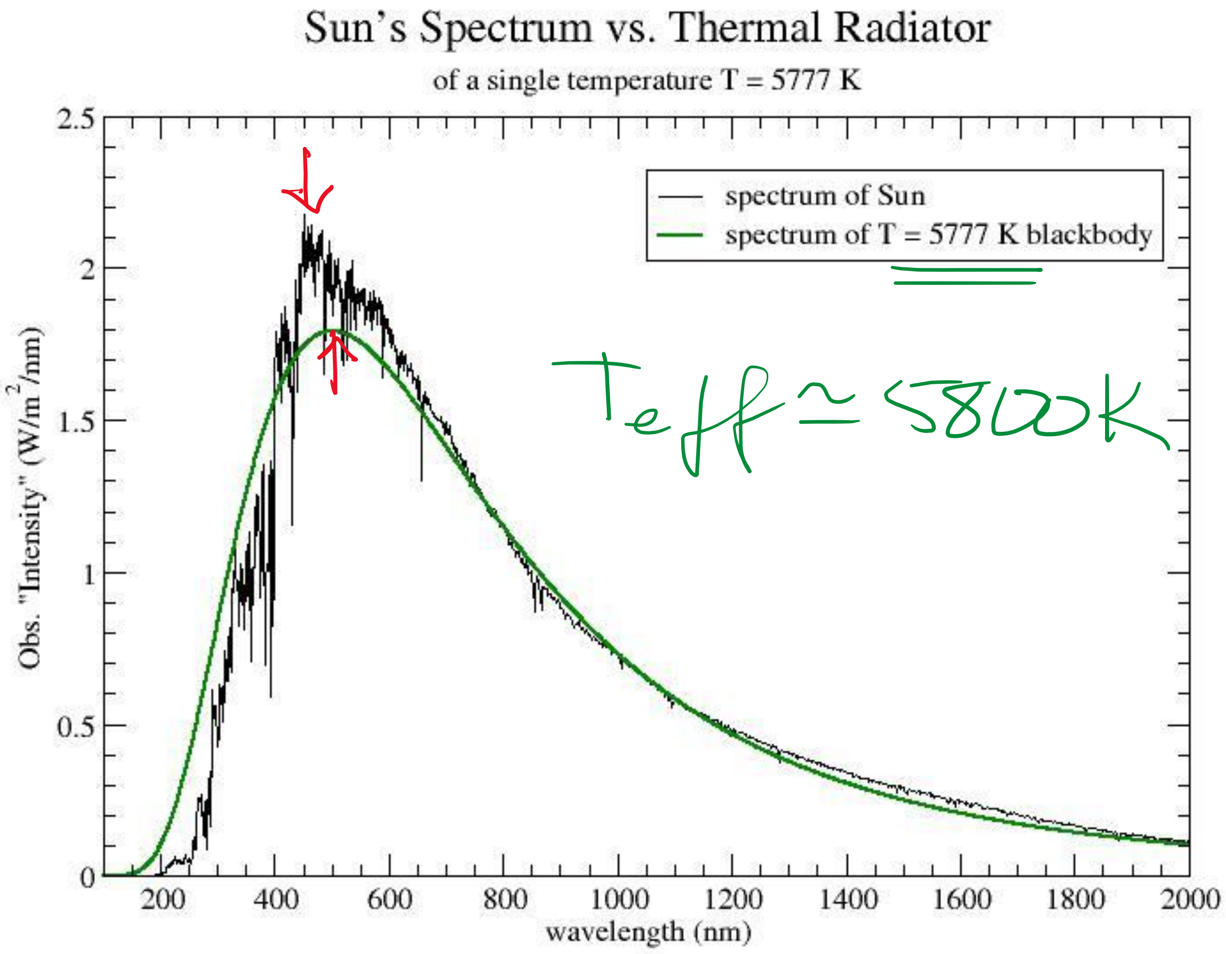


$\Delta T = 1500K$

$T_{eff} = 5800K$

$$\frac{\langle I_u \rangle}{\langle I_g \rangle} \sim \frac{T_u^4}{T_0^4} \simeq 0.3$$

$$\int B_\nu \, d\nu \sim T^4 \int x^3 e^{-x} \, dx \sim T^4$$

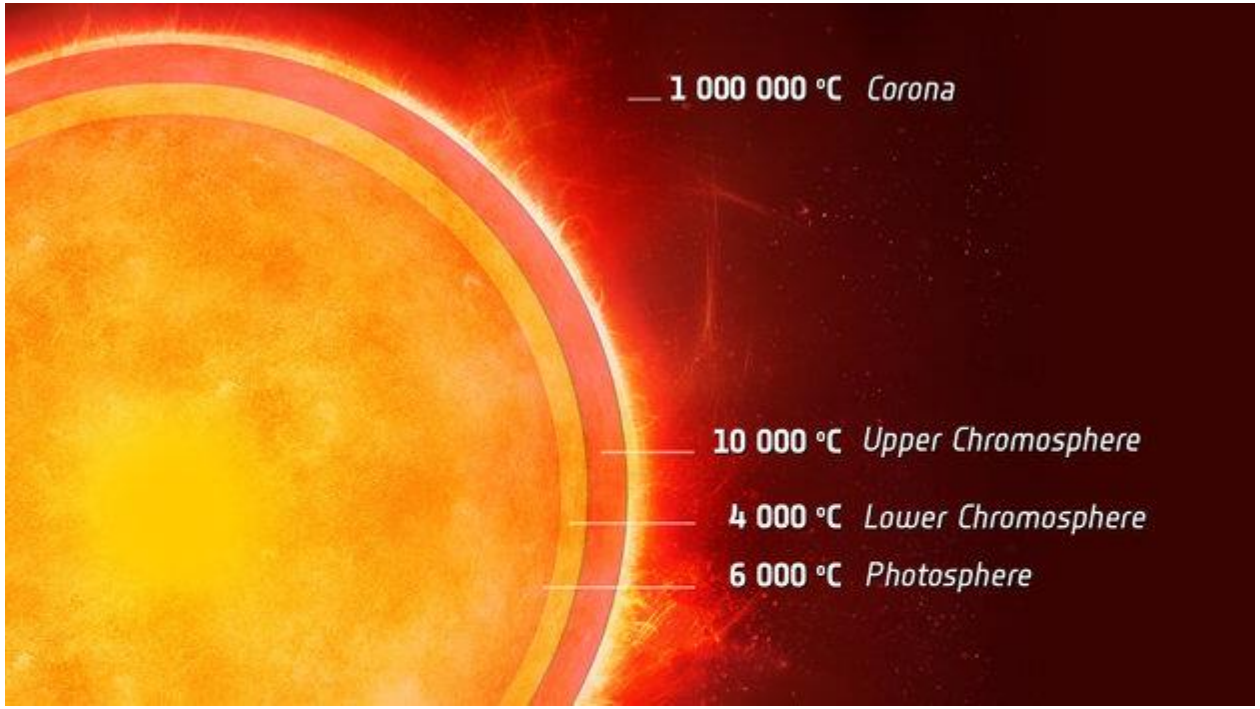


$T_{eff} \simeq 5800K$

$\lambda_{max} = 4600 Å$

$\lambda_{max} = \dfrac{0,29 (cm)}{T}$

$T = \dfrac{0,29}{4,6 \cdot 10^{-5}} \simeq 6300 K$

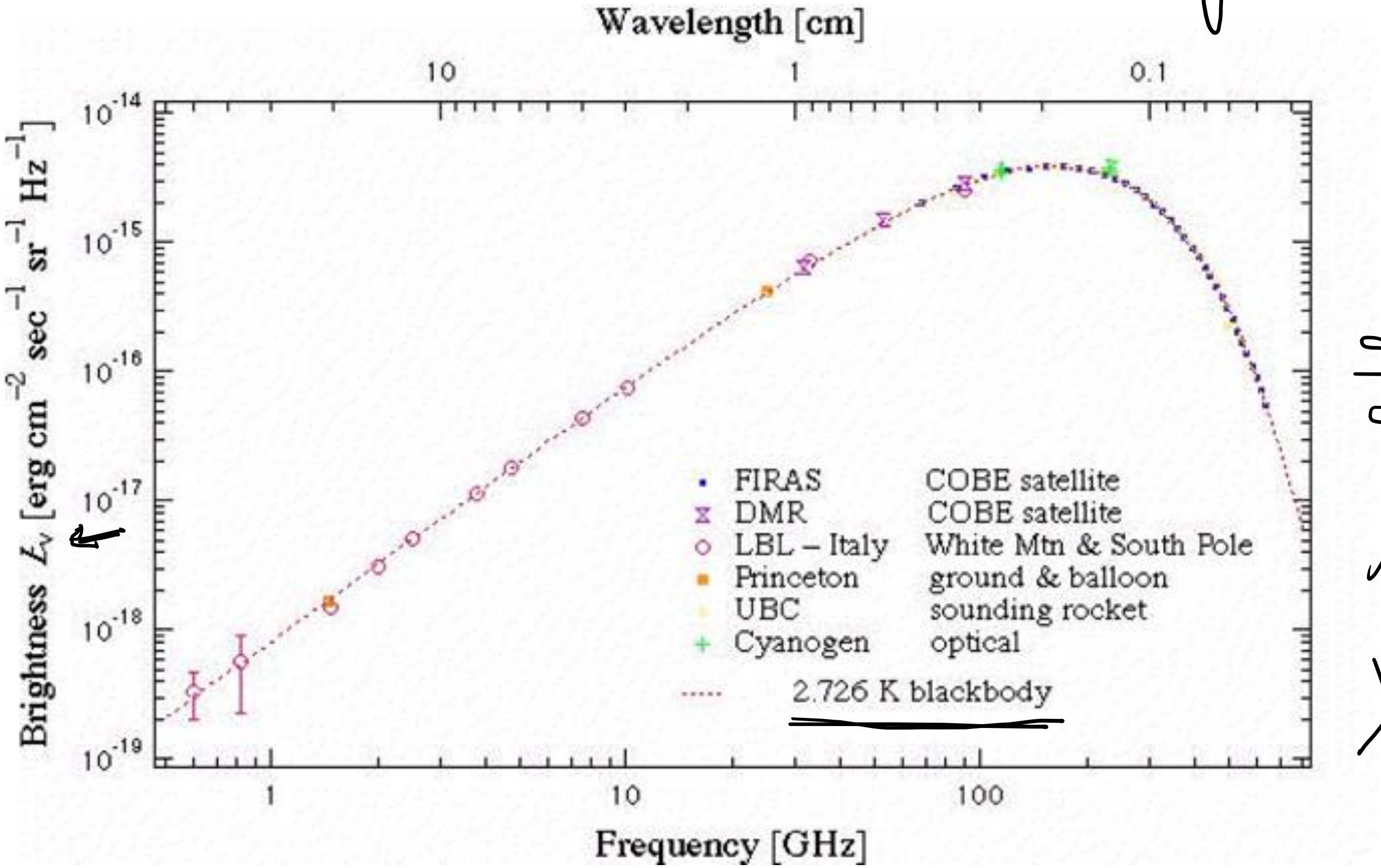


Реликтовое излучение

Cosmic microwave background

$$T = 2,73\ K$$

$$\left.\begin{aligned} B_\nu &= \frac{2h\nu^3}{c^2} e^{-\frac{h\nu}{kT}} \\ \to B_\lambda &= \frac{2hc^2}{\lambda^5} e^{-\frac{hc}{\lambda kT}} \end{aligned}\right\} \text{Вин}$$



$$\frac{dB_\nu}{dt} = 0 \qquad \frac{dB_\lambda}{dt} = 0$$

$$\lambda_{max} = \frac{0,29\ \text{cm}}{T}$$

$$\lambda_{max} = \frac{0,29}{2,73} \simeq 0,1\ \text{cm}$$

$$\mathcal{E}_r = \frac{c}{\pi^2 \hbar^3} \int n p^3 dp \qquad p = \frac{h\nu}{c} \qquad T \approx 3K$$

$$\mathcal{E}_r = \frac{c(2\pi)^3}{\pi^2 h^3} \int n \left(\frac{h\nu}{c}\right)^3 \frac{h}{c} d\nu = \frac{8\pi h}{c^3} \int n \nu^3 d\nu$$

$$n = \frac{1}{e^{h\nu/kT} - 1} \qquad N = \frac{\mathcal{E}_r}{h\nu} = \frac{8\pi h}{c^3} \int \frac{\nu^3 d\nu}{h\nu \left[e^{h\nu/kT} - 1\right]} =$$

$$= \frac{8\pi}{c^3} \int_0^\infty \frac{\nu^2 d\nu}{e^{h\nu/kT} - 1} = \frac{8\pi}{c^3} \frac{(kT)^3}{h^3} \int_0^\infty \frac{x^2 dx}{e^x - 1}$$

$$\int_0^\infty \frac{x^2 dx}{e^x - 1} \simeq \int_0^\infty \frac{x^2 dx}{e^x} = \underbrace{-x^2 e^{-x} \Big|_0^\infty}_{0} - \int_0^\infty (-e^{-x}) 2x dx =$$

$$= 2\int_0^\infty x e^{-x} dx = \underbrace{-2x e^{-x} \Big|_0^\infty}_{0} - \int_0^\infty (-e^{-x}) 2 dx = 2\int_0^\infty e^{-x} dx = 2$$

$$N = 2 \, \frac{8\pi}{c^3} \frac{(kT)^3}{h^3} = \frac{16\pi \cdot (1{,}38)^3 \cdot 27 \cdot 10^{-48}}{27 \cdot 10^{30} (6{,}63)^3 \cdot 10^{-81}} = \frac{16\pi (1.38)^3}{(6{,}63)^3} \cdot 1000 \approx 453$$

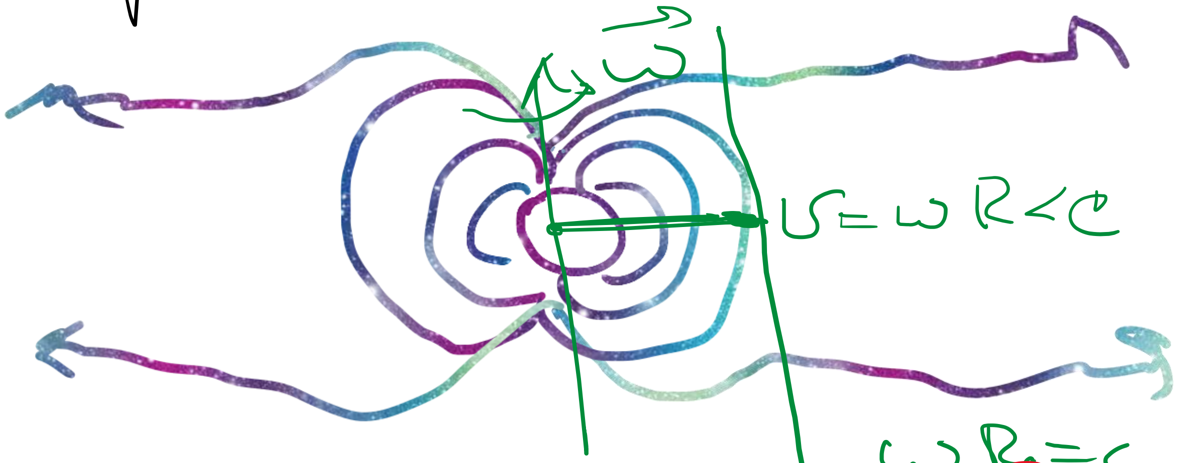
$N \sim 400\ \text{см}^{-3}$ $\quad N \sim \frac{1}{\lambda_{max}^3}$

$\lambda_{max} = \frac{0.29\ \text{см}}{T}$ $\quad N \simeq \frac{1}{2}\frac{1}{\lambda_{max}^3}$

$\boxed{N \sim T^3}$

Фон	пл-ть эн. эВ · см$^{-3}$	n, см$^{-3}$	
Радио	10^{-8}	10^{-2}	
УФ-опт.	$\sim 10^{-2}$	$\sim 10^{-2}$	$E_{ph}(\text{опт}) \sim 1$ эВ
Рентг.	$2 \cdot 10^{-5}$	$3 \cdot 10^{-9}$	
γ	10^{-5}	$\sim 10^{-11}$	
ИК	$4 \cdot 10^{-2}$	0,3	

Ярк. Темп.



$v = \omega R < c$

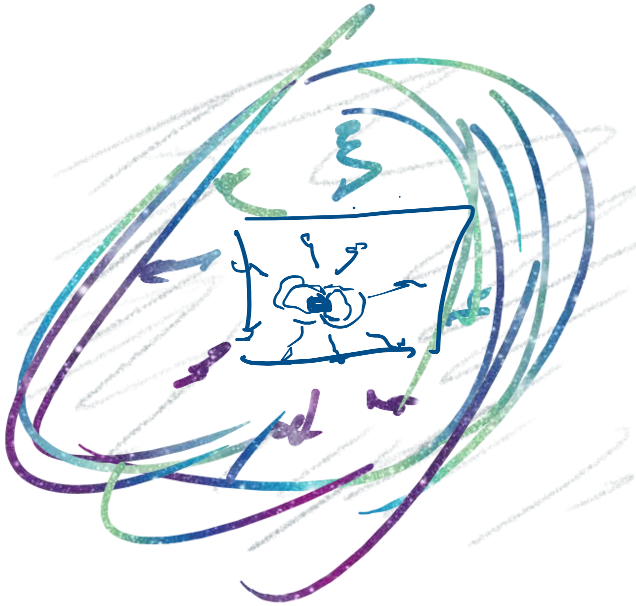
$\omega R_e = c$

$R_{NS} = 10$ км

$$R_e = \frac{3\cdot 10^{10}\cdot 0{,}033}{2\pi} = \frac{10^9}{2\pi} \approx 1{,}6\cdot 10^8 \text{ см}$$

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

$$\frac{2\pi}{P} R_e = c \qquad R_e = \frac{cP}{2\pi}$$



Плерион

$\underline{d} = 2200$ пк

$F = 1\,\text{Jy} = 10^{-23}\,\dfrac{\text{эрг}}{\text{см}^2 \cdot \text{с} \cdot \text{Гц}}$

$T_b = \dfrac{F}{\Omega} \cdot \dfrac{c^2}{2\nu^2 k}$

$T_{b(1)} = \dfrac{10^{-23} \cdot 10^{21} \cdot \cancel{4} \cdot 10^{43}}{2 \cdot \cancel{1} \cdot 10^{12} \cdot \cancel{10^{16}} \cdot \cancel{1{,}38} \cdot \cancel{10^{-16}}} =$

$\simeq \dfrac{1}{2}\,\dfrac{10^{41}}{10^{12}} \simeq 5 \cdot 10^{28}\,K$

$T_{b(2)} = 5 \cdot 10^{24}\,K$

1 пк = 206265 ае.

1 ае = $1{,}5 \cdot 10^{13}$ см

1 пк $\simeq 3{,}1 \cdot 10^{18}$ см

$T_b = \dfrac{c^2}{2\nu^2 k} I_\nu$

$\Omega = S/\cancel{d}^2$ $\quad \nu \simeq 10^8$ Гц

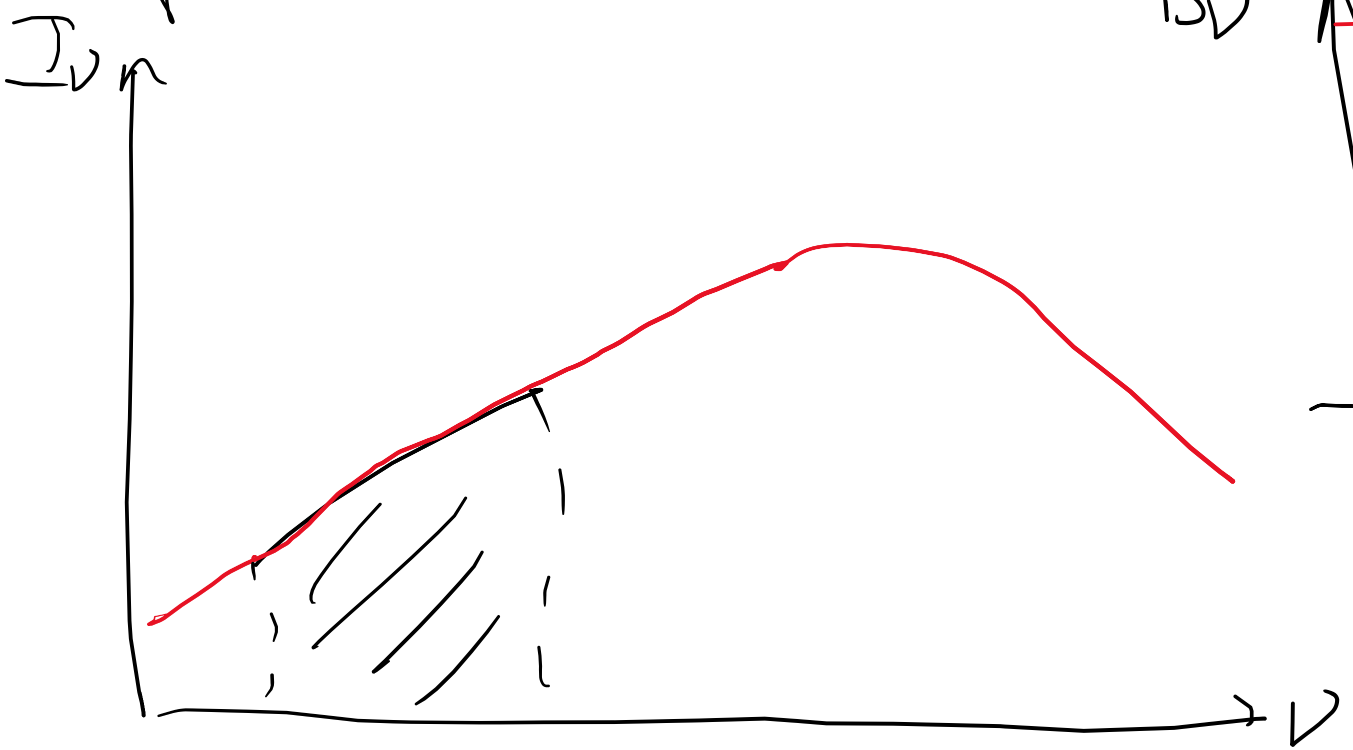
$S = \pi r^2$

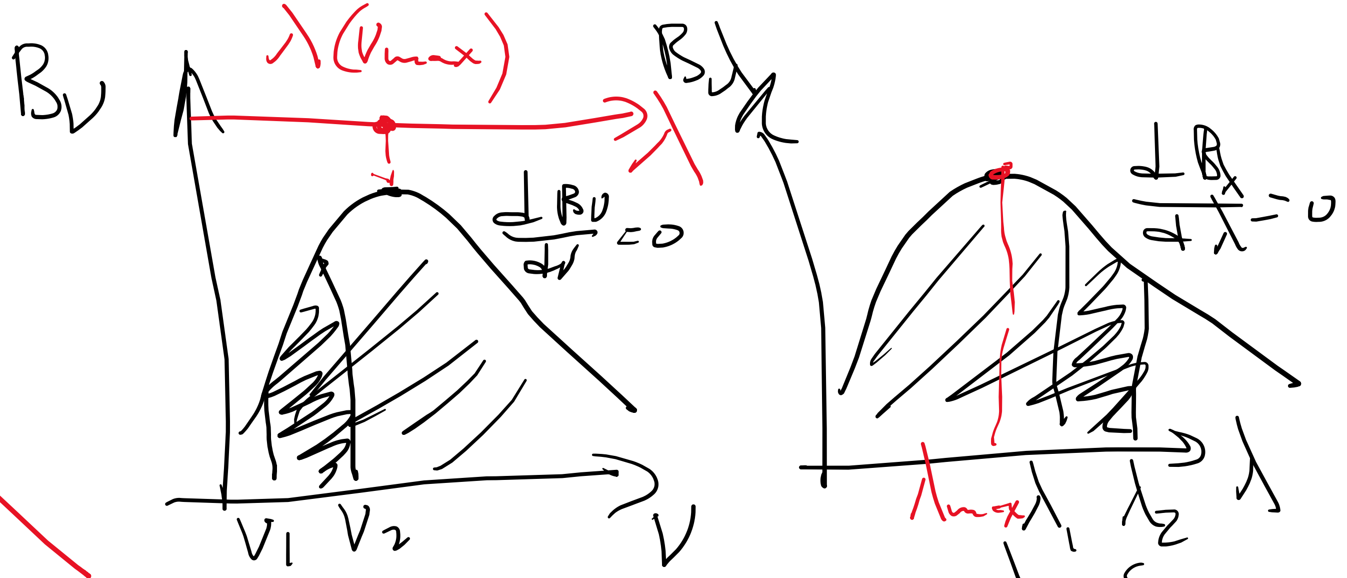
2200 пк =

$= 2{,}2 \cdot 10^3 \cdot 3{,}1 \cdot 10^{18} \simeq 6{,}7 \cdot 10^{21}$

$\approx 4 \cdot 10^{43}$ см^2

Ярк_Темп,





$\lambda_1 = \frac{c}{\nu_1}$ $\quad$ $\lambda_2 = \frac{c}{\nu_2}$

$$B_\nu d\nu = B_\lambda d\lambda$$

$$\lambda_{max} \neq \frac{c}{\nu_{max}}$$

$$\lambda(\nu_{max}) \neq \lambda_{max}$$

Цветовая темп.

$$\text{цвет} = \frac{\text{поток}\,(\nu_1 \div \nu_2)}{\text{поток}\,(\nu_3 \div \nu_4)}$$

$$\text{цвет}(\nu) = \frac{I_{\nu+\Delta\nu}}{I_\nu} \qquad I_{\nu+\Delta\nu} = I_\nu + \Delta\nu \frac{dI_\nu}{d\nu}$$

$\Delta\nu \sim \nu$

$$\text{цвет} = 1 + \frac{dI_\nu}{I_\nu}\frac{\nu}{d\nu} = 1 + \frac{d\lg I_\nu}{d\lg \nu}$$

Планк: $B_\nu \sim \nu^3 e^{-h\nu/kT}$ (Вин)

$$\frac{d\lg B_\nu}{d\lg \nu} = 3 - \frac{h\nu}{kT}$$

Пульсар $I_\nu \sim \nu^{-\Gamma}$

$$\frac{d\lg I_\nu}{d\lg \nu} \sim -\Gamma$$

$\nu \sim 3\cdot 10^8$ Гц $\quad \Gamma = 2$

$$3 - \frac{h\nu}{kT} = -2$$

$$T = \frac{h\nu}{5k} \sim 0{,}003\,K$$