Title: PHYS 781 - Lecture 15

Date: Oct 24, 2014 12:00 PM

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Abstract:

$$f(\bar{x},\bar{p}) = \frac{1}{(2\pi\hbar)^3}\frac{g_s}{e^{\beta(\varepsilon-\mu)}+1} \qquad \beta = \frac{1}{kT}$$

$$\mu = \epsilon_F \quad T=0$$

$$g_e = 2$$

$$f(\bar{x},\bar{p}) = \begin{cases} g/(2\pi\hbar)^3 & \varepsilon < \varepsilon_F \\ 0 & \varepsilon > \varepsilon_F \end{cases}$$

$$N = \int_V \int_0^{p_F}\int_0^{\pi}\int_0^{2\pi} f(\bar{x},\bar{p})\, \underline{d^3p}\, d^3x$$

$$\sin\theta\, p^2\, dp\, d\theta\, d\varphi$$

$$= \frac{V\, 4\pi\, g_s}{(2\pi\hbar)^3}\frac{p_F^3}{3}$$

$$n_e = \frac{N}{V}$$

$$\boxed{n_e = \frac{p_F^3}{2\pi^2}}$$

$$\frac{}{(2\pi\hbar)^3} \quad \frac{\pi}{3}$$

$$\mathcal{E} = \frac{E}{V} = 4\pi \int_0^{p_F} p^2 \underline{\epsilon(p)} f(\bar{x},\bar{p})\, dp$$

$$= 4\pi \int_0^{p_F} p^2 \sqrt{m^2+p^2} \quad dp$$

$dE = -P\,dV$

$$P = \int \frac{v|p|}{3} f(\bar{x},\bar{p})\, dp$$

$$v = \frac{p}{E}$$

$$= \int \frac{p^2}{3} \frac{1}{\sqrt{p^2+m_e}} f(\bar{x},\bar{p})\, d^3p = \frac{8\pi}{(2\pi)^3 3} \int_0^{p_F} \frac{p^4}{\sqrt{m_e^2+p^2}} dp$$

$$\frac{dP}{dr} = -\frac{GM\rho}{r^2}$$

$$M = 4\pi \int_0^r \rho(r')\, r'^2\, dr'$$

$$\rho = 2 n_e m_p$$

$$\frac{dP}{dr} = \frac{-16\pi G}{r^2} \int_0^r n_e(r')\, m_p\, r'^2\, dr' \,(2 n_e m_p) \rightarrow \frac{-16\pi G m_p^2 n_e}{r^2} \int_0^r n_e(r')\, r'^2\, dr'$$

$P_F'(0)=0$

$P_F(0)=P_{F_0}$

$$P_F'(r) = -\frac{4G\,N(r)\sqrt{m_e^2+p_F^2}}{r^2\,p_F}$$

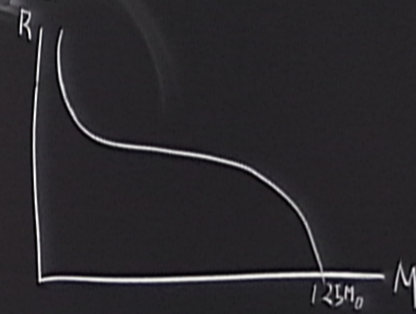
$$P_F(r+dr) = P_F(r) + dr\,P_F'(r)$$

$2m_p N(r)/M_0 \,,\ r/R_0$

$$N(r) = \int_0^{dr} 4\pi n_e(r')\,r'^2\,dr'$$

$dr = 10^{-(5-1a)} R_0$ $\quad N($

$10^a \; P_{F_{scale}}$



$$\frac{\ldots}{(2\pi\hbar)^3}\ \frac{\pi}{3}$$

$$\Gamma = \frac{2q^2 w_{12}^2 f_{12}}{3mc^3}$$

$$C_{ij} = \int_{v_0}^{\infty} n_e(v)\, v\, \sigma_{ij}(v)\, dv$$

$$= \frac{2N_e}{k_B T}\left(\frac{2}{\pi m k_B T}\right)^{1/2} \int_{E_{ij}}^{\infty} \sigma_{ij}(E)\, e^{-E/k_B T}\, E\, dE$$

<u>where</u>:

$$\sigma_{ij}(E) \cong \frac{8\pi}{\sqrt{3}}\left(\frac{E_0}{E}\right)\left(\frac{E_0 f_{12}}{E_{ij}}\right)\pi a_0^2\, G$$

$$E_0 = \frac{mq^4}{2\hbar^2}$$

$$E_{ij} = \frac{1}{2} m v_0^2$$

$$\sigma \approx \pi \lambda^2 = \frac{\pi \hbar^2}{2m^2 v^2}$$

$$C = n \sigma v$$

$$C = \int \frac{n_H \pi \hbar^2}{2m^2 v} f(v)\, dv \rightarrow \frac{n_H \pi \hbar^2}{2m^2} \int_0^\infty \left(\frac{m}{2\pi k_B T}\right)^{3/2} 4\pi v\, e^{-\frac{m v^2}{2 k_B T}}$$

$$C = n_H \hbar^2 \left(\frac{\pi^7}{2m^3 k_B T}\right)^{1/2}$$

$$\frac{\Gamma}{C} = \frac{q^2 \nu_{ul}^2 f_{12}}{3 c^3 n_H \hbar^2} \sqrt{\frac{8\pi a}{\pi}} \left(k_B T\right)^{1/2}$$