

## ΤΥΠΟΛΟΓΙΟ

$$L_{\odot} = 3.85 \times 10^{33} \text{ ergs}^{-1}$$

$$f_{\odot} \equiv S = 1.367 \times 10^6 \text{ ergs}^{-1} \text{ cm}^{-2} \text{ (ηλιακή σταθερά)}$$

$$M_{\odot} = 1.9891 \times 10^{30} \text{ kg}$$

$$R_{\odot} = 6.957 \times 10^8 \text{ m}$$

$$R_{\oplus} = 6.371 \times 10^6 \text{ m}$$

$$r_{\oplus} = 1 \text{ AU} = 1.496 \times 10^{11} \text{ m}$$

$$1 \text{ Jy} = 10^{-26} \text{ Wm}^{-2} \text{ Hz}^{-1}$$

$$1 \text{ Parsec} = 3.0857 \times 10^{16} \text{ m}$$

$$h = 6.62607015 \times 10^{-34} \text{ m}^2 \text{ kg/s}$$

$$k_B = 8.610 \times 10^{-5} \text{ eV K}^{-1}$$

$$m_e = 9.1093837 \times 10^{-31} \text{ kg}$$

$$m_p = 1.67262158 \times 10^{-27} \text{ kg}$$

$$e = 1.60217663 \times 10^{-19} \text{ Cb}$$

$$G = 6.6743 \times 10^{-11} \text{ m}^3 \text{ kg}^{-1} \text{ s}^{-2}$$

$$\frac{dI_{\nu}}{ds} = -I_{\nu}(\alpha_{\nu} + \sigma_{\nu}) + \alpha_{\nu} B_{\nu} + \sigma_{\nu} J_{\nu} \text{ (για μέσο που εκπέμπει θερμικά, και για ελαστική σκέδαση)}$$

$$\tau_{\nu}(s) = \int_{s_0}^s a_{\nu}(s') ds'$$

$$B_{\nu}(T) = \frac{2h\nu^3/c^2}{\exp(h\nu/k_B T) - 1}$$

$$x = 3(1 - e^{-x}) \Rightarrow x = 2.82, y = 5(1 - e^{-y}) \Rightarrow y = 4.97, \int_0^{\infty} \frac{x^3 dx}{e^x - 1} = \pi^4/15$$

$$g_1 B_{12} = g_2 B_{21} \quad A_{21} = \frac{2h\nu^3}{c^2} B_{21}$$

$$j_{\nu} = \frac{h\nu_0}{4\pi} n_2 A_{21} \phi(\nu) \quad \alpha_{\nu} = \frac{h\nu}{4\pi} \phi(\nu) (n_1 B_{12} - n_2 B_{21}) \quad S_{\nu} = \frac{2h\nu^3}{c^2} \left( \frac{g_2 n_1}{g_1 n_2} - 1 \right)^{-1}$$

$$\frac{n_1}{n_2} = \frac{g_1 \exp(-E/k_B T)}{g_2 \exp[-(E+h\nu_0)/k_B T]} = \frac{g_1}{g_2} \exp(h\nu_0/k_B T)$$

$$n_{\nu} d\nu = n \left( \frac{m}{2\pi k_B T} \right)^{3/2} e^{-mv^2/2k_B T} 4\pi v^2 dv$$

$$\frac{N_{i+1} n_e}{N_i} = \frac{Z_e Z_{i+1}}{Z_i} \left( \frac{2\pi m_e k_B T}{h^2} \right)^{3/2} e^{-\chi_i/k_B T}$$

$$\frac{1}{\alpha_R} \equiv \frac{\int_0^{\infty} (\alpha_{\nu} + \sigma_{\nu})^{-1} \frac{\partial B_{\nu}}{\partial T} d\nu}{\int_0^{\infty} \frac{\partial B_{\nu}}{\partial T} d\nu}$$

$$\alpha_{bf} = \frac{64\pi^4 m_e^{10}}{3\sqrt{3} c^4 h^6} Z'^4 \frac{g_{bf}}{n^5} \lambda^3 \propto \lambda^3 n^{-5} (\lambda < \lambda_n) \quad \text{όπου } \lambda_n = \frac{ch^3 n^2}{2\pi^2 m_e^4 Z'^2}$$

$$a_{ff}(\lambda, Z', \nu) = \frac{4\pi}{3\sqrt{3}} \frac{e^6}{c^4 h m^2} Z'^2 \frac{g_{ff}}{\nu} \lambda^3$$

$$\alpha_e = \frac{8}{3} \pi \left( \frac{e^2}{mc^2} \right)^2 = 6.654 \times 10^{-29} \text{ m}^2$$

$$\kappa_R \text{ (ή } \sigma_R) = \kappa_e \left( \frac{\lambda_L}{\lambda} \right)^4, \lambda_L = 1026 \text{ \AA}$$

$$\bar{\kappa}_{ff} = 3.68 \times 10^{18} \bar{g}_{ff} (1 - Z)(1 + X) \frac{\rho}{T^{3.5}} \text{ m}^2 \text{ kg}^{-1}$$

$$\bar{\kappa}_{H^-} \approx 7.9 \times 10^{-3} (Z/0.02) \rho^{1/2} T^9 \text{ m}^2 \text{ kg}^{-1}$$

$$\bar{\kappa}_{es} = 0.02(1 + X) \text{ m}^2 \text{ kg}^{-1}$$

$$\text{Balmer series: } \frac{1}{\lambda} = R_H \left( \frac{1}{2^2} - \frac{1}{m^2} \right) \text{ for } m = 3, 4, 5, \dots, R_H = 1.09677583 \times 10^7 \text{ m}^{-1}$$

$$2\Delta\lambda_{1/2} = \frac{2}{c} \sqrt{\frac{2kT}{m}} \ln 2 \lambda_0$$

$$\alpha_{\nu} = \frac{\pi e^2}{mc} f \frac{\Gamma_{\text{rad}} + \Gamma_{\text{coll}}}{4\pi^2} \frac{1}{\{\nu - [\nu_0 + \nu_0(v_l/c)]\}^2 + [(\Gamma_{\text{rad}} + \Gamma_{\text{coll}})/4\pi]^2}$$

$$t_{\text{ff}} = \left( \frac{3\pi}{32 G \rho_0} \right)^{1/2}$$

$$M_J \simeq \left( \frac{5kT}{G\mu H} \right)^{3/2} \left( \frac{3}{4\pi\rho_0} \right)^{1/2}$$

$$\frac{dP_{\text{rad}}}{dr} = -\frac{\bar{\kappa}\rho}{c} F_{\text{rad}}$$

$$\frac{dP}{dr} = -G \frac{M_r \rho}{r^2} \quad \frac{dM_r}{dr} = 4\pi r^2 \rho \quad \frac{dL_r}{dr} = 4\pi r^2 \rho \epsilon$$

$$\begin{aligned} \frac{dT}{dr} &= -\frac{3}{4ac} \frac{\bar{\kappa}\rho}{T^3} \frac{L_r}{4\pi r^2} \gamma \alpha \frac{d \ln P}{d \ln T} < \frac{\gamma}{\gamma-1} \\ &= -\left(1 - \frac{1}{\gamma}\right) \frac{\mu m_H}{k} \frac{GM_r}{r^2} \gamma \alpha \frac{d \ln P}{d \ln T} > \frac{\gamma}{\gamma-1} \end{aligned}$$

$$t_{\text{KA}} \sim M^{-(\beta+7)/(\beta+1)}$$

$$P_{\text{rad}} = \frac{1}{3} a T^4$$

$$P_{\text{ic}} = \frac{3}{4\pi R_{\text{ic}}^3} \left( \frac{M_{\text{ic}} k T_{\text{ic}}}{\mu_{\text{ic}} m_H} - \frac{1}{5} \frac{GM_{\text{ic}}^2}{R_{\text{ic}}} \right)$$

$$\left( \frac{M_{\text{ic}}}{M} \right)_{\text{SC}} \simeq 0.37 \left( \frac{\mu_{\text{env}}}{\mu_{\text{ic}}} \right)^2$$

$$\mu = \frac{\sum_j N_j A_j}{\sum_j N_j}, \quad \mu = \frac{\sum_j N_j A_j}{\sum_j N_j (Z_j + 1)}$$

$$r_{\text{ix}} = \left( \frac{2}{kT} \right)^{3/2} \frac{n_i n_x}{(\mu m \pi)^{1/2}} \int_0^\infty S(E) e^{-bE^{-1/2}} e^{-E/kT} dE, \quad b \equiv \frac{\pi \mu_m^{1/2} Z_1 Z_2 e^2}{2^{1/2} \epsilon_0 h}$$

$$\text{pp-chain (περιληπτικά)} \quad 4p \rightarrow \quad {}^4\text{He} + 2e^+ + 2\nu_e + \gamma$$

$$\text{CNO-cycle (περιληπτικά)} \quad 4p \rightarrow \quad {}^4\text{He} + 2e^+ + 2\nu_e + \gamma$$

$$\text{Triple-alpha (περιληπτικά)} \quad 3{}^4\text{He} \rightarrow \quad {}^{12}\text{C} + \gamma$$

$$\epsilon_{pp} \simeq \epsilon'_{0,pp} \rho X^2 f_{pp} \psi_{pp} C_{pp} T_6^4$$

$$\epsilon_{\text{CNO}} \simeq \epsilon'_{0,\text{CNO}} \rho X X_{\text{CNO}} T_6^{19.9}$$

$$\epsilon_{3\alpha} \simeq \epsilon'_{0,3\alpha} \rho^2 Y^3 f_{3\alpha} T_8^{41.0}$$

$$E_b = \Delta m c^2 = [Z m_p + (A - Z) m_n - m_{\text{nucleus}}] c^2$$

$${}^{44}\text{Ti} \tau_{1/2} = 59.1\text{y}, \quad {}^{56}\text{Ni} \tau_{1/2} = 6.1\text{d}, \quad {}^{65}\text{Ni} \tau_{1/2} = 2.5\text{h}, \quad {}^{56}\text{Co} \tau_{1/2} = 77.2\text{d}, \quad {}^{57}\text{Co} \tau_{1/2} = 271.8\text{d}$$

$${}^{55}\text{Fe} \tau_{1/2} = 2.7\text{y}, \quad {}^{59}\text{Fe} \tau_{1/2} = 44.5\text{d}$$

$$\epsilon_F = \frac{\hbar^2 N^2}{8mL^2} = \frac{\hbar^2}{2m} (3\pi^2 n)^{2/3}$$

$$P_{\text{εκφ,μη σχετικ}} e^- = \frac{(3\pi^2)^{2/3}}{5} \frac{\hbar^2}{m_e} \left[ \left( \frac{Z}{A} \right) \frac{\rho}{m_H} \right]^{5/3}$$

$$P_{\text{εκφ,σχετικ}} e^- = \frac{(3\pi^2)^{1/3}}{4} \hbar c \left[ \left( \frac{Z}{A} \right) \frac{\rho}{m_H} \right]^{4/3}$$

$$P_{\text{εκφ,νετρονια}} = K \rho^\gamma, \quad \gamma = \frac{5}{3}, \quad K = \frac{3^{2/3} \pi^{4/3}}{5} \frac{\hbar^2}{m_n^{8/3}}$$

$$B_p \sin a = \left( \frac{12Mc^3 \Omega}{5R^4 \Omega^3} \right)^{1/2}$$

$$r_g = \frac{2GM}{c^2}$$

$$\Delta \tau = \left( \frac{2}{9GM} \right)^{1/2} (r_1)^{3/2}$$

$$ds^2 = c^2 \left(1 - \frac{2GM}{rc^2}\right) dt^2 - \left(1 - \frac{2GM}{rc^2}\right)^{-1} dr^2$$