Equation Sheet - Astrophysics I - Fall 2014

$$\Delta\theta = 1.22\lambda/D \qquad \mathrm{SNR} = N_{\mathrm{star}}/\sqrt{N_{\mathrm{total}}} \qquad N_{\mathrm{total}} = N_{\mathrm{star}} + p \times n_{\mathrm{sky}}$$

$$d = 1/p \qquad D = \theta d \qquad \lambda\nu = c \qquad E = h\nu$$

$$B_\nu = \frac{2h\nu^3}{c^2}\frac{1}{e^{h\nu/kT}-1} \qquad \lambda_{max}T = 0.29\,\mathrm{cm\,K} \qquad \mathrm{h}\nu_{\mathrm{max}} = 2.8\mathrm{kT}$$

$$L = 4\pi r_*^2\sigma T^4 = f4\pi d^2$$

$$M_1 r_1 = M_2 r_2 \qquad \omega^2 = \frac{G(M_1+M_2)}{a^3} \qquad (M_1+M_2)\sin^3 i = \frac{\tau(v_{1obs}+v_{2obs})^3}{2\pi G}$$

$$\frac{dM}{dr} = 4\pi r^2\rho(r) \qquad \frac{dP}{dr} = -\frac{GM\rho}{r^2} \qquad \frac{dL}{dr} = 4\pi r^2\rho\epsilon \qquad \frac{dT}{dr} = \frac{3L\kappa\rho(r)}{16\pi r^2 acT^3}$$

$$l = 1/n\sigma = 1/\rho\kappa \qquad P_{gas} = nkT = \frac{\rho}{\bar{m}}kT \qquad E_K = \frac{f}{2}kT \qquad P_{rad} = \frac{1}{3}aT^4$$

$$E_G = 2\mu c^2(\pi\alpha Z_A Z_B)^2 \qquad \alpha = \frac{e^2}{\hbar} \approx 1/137$$

$$F = q_1 q_2/r^2 \qquad \lambda = h/p \qquad \Delta x \Delta p_x > h$$

$$dN = \frac{2s+1}{\exp\left(\frac{E-\mu(T)}{kT}\right)+1}\frac{d^3p dV}{h^3} \qquad n_e = \frac{8\pi}{3h^3}p_f^3$$

$$P = \frac{1}{3}\int n(p)pv dp \quad P_e = \left(\frac{3}{8\pi}\right)^{2/3}\frac{h^2}{5m_e}n_e^{5/3} = \left(\frac{3}{\pi}\right)^{2/3}\frac{h^2}{20m_e m_p^{5/3}}\left(\frac{Z}{A}\right)^{5/3}\rho^{5/3}$$

$$P_e = \frac{8\pi c}{3h^3}\frac{p_f^4}{4} = \left(\frac{3}{8\pi}\right)^{1/3}\frac{hc}{4m_p^{4/3}}\left(\frac{Z}{A}\right)^{4/3}\rho^{4/3}$$

$$r_{wd} \approx \frac{h^2}{20m_e m_p^{5/3}G}\left(\frac{Z}{A}\right)^{5/3}M^{-1/3} \qquad r_{wd} = 2.3\times10^9\ \mathrm{cm}\left(\frac{Z}{A}\right)^{5/3}\left(\frac{M}{M_\odot}\right)^{-1/3}$$

$$M_{\mathrm{ch}} = 1.4M_\odot$$

$$E_{rot} = \frac{1}{2}I\omega^2 \qquad I = \frac{2}{5}Mr^2 \qquad L = \frac{B^2r^6\omega^4}{6c^3}\sin^2\theta$$

$$r_s = \frac{2GM}{c^2} = (3\,\mathrm{km})\frac{M}{M_\odot}$$

$$(ds)^2 = \left(1 - \frac{2GM}{rc^2}\right)(cdt)^2 - \left(1 - \frac{2GM}{rc^2}\right)^{-1}(dr)^2 - (rd\theta)^2 - (r\sin\theta d\phi)^2$$

$$\frac{F_{tide}}{m} = \frac{2GM_2\Delta r}{r^3}$$

$$dE_{th} = \frac{1}{2}\left(\frac{GMdM}{r} - \frac{GMdM}{r+\Delta r}\right) \qquad \frac{dE}{dt} = \frac{1}{2}GM\dot{M}\frac{dr}{r^2} = 2(2\pi r)\sigma T^4 dr$$

$$T(r) = \left(\frac{GM\dot{M}}{8\pi\sigma}\right)^{1/4} r^{-3/4} \quad L \approx \frac{GM\dot{M}}{2r_{in}} \quad L_E = \frac{4\pi cGMm_p}{\sigma_T} = (1.3{\times}10^{38}\,\mathrm{erg/s})\frac{M}{M_\odot}$$

$$\rho_J = \frac{3}{4\pi M^2}\left(\frac{3kT}{G\bar{m}}\right)^3$$

$$R_{rec} = \alpha(T)x^2n^2 \qquad R_{ion} = n_{photon}n(1-x)\sigma_{ion}c \qquad r_{strom} = \left(\frac{3Q_*}{4\pi\alpha n^2}\right)^{1/3}$$

$$\frac{n_2}{n_1} = \frac{g_2}{g_1}e^{-h\nu/kT}$$

$G = 6.67 \times 10^{-8}\,\mathrm{erg\,cm\,g^{-2}}$ $\quad h = 6.63 \times 10^{-27}\,\mathrm{erg\,s}$ $\quad c = 3.0 \times 10^{10}\,\mathrm{cm/s}$
$k = 1.38 \times 10^{-16}\,\mathrm{erg/K} = 8.62 \times 10^{-5}\,\mathrm{eV/K}$
$\sigma = 5.67 \times 10^{-5}\,\mathrm{erg\,cm^{-2}\,K^{-4}}$ $\quad a = 4\sigma/c = 7.6 \times 10^{-15}\,\mathrm{erg\,cm^{-3}\,K^{-4}}$
$m_p = 1.67 \times 10^{-24}\,\mathrm{g}$ $\quad m_e = 9.1 \times 10^{-28}\,\mathrm{g}$
$e = 4.8 \times 10^{-10}$ statcoulombs $\quad 1$ statcoulomb $= 1\ \mathrm{erg}^{1/2}\ \mathrm{cm}^{1/2}$
$\sigma_T = 6.7 \times 10^{-25}\,\mathrm{cm}^2$
$1\,\mathrm{pc} = 3.086 \times 10^{18}\,\mathrm{cm}$
CGS units: erg $= \mathrm{g\ cm^2\ s^{-2}} =$ dyne cm
Sun:
$M_\odot = 2.0 \times 10^{33}\,\mathrm{g}$ $\quad R_\odot = 7.0 \times 10^{10}\,\mathrm{cm}$ $\quad L_\odot = 3.8 \times 10^{33}\,\mathrm{erg/s}$
$T_{E\odot} = 5800\,\mathrm{K}$ $\quad \bar{\rho}_\odot = 1.4\ \mathrm{g\ cm^{-3}}$ $\quad T_{C\odot} = 15 \times 10^6\,\mathrm{K}$ $\quad \rho_{C\odot} = 150\,\mathrm{g\,cm^{-3}}$