Equations list for Radiative Transfer

Important: This is just a "random" list of equations from the script without context. Please only use them when you know what they mean and in which context you can use them.

$$\frac{dI_\nu}{ds} = j_\nu - \alpha_\nu I_\nu \tag{1}$$

$$S_\nu = \frac{j_\nu}{\alpha_\nu} \tag{2}$$

$$\alpha_\nu = \rho\kappa_\nu \tag{3}$$

$$j_{ij,\nu} = \frac{h\nu_{ij}}{4\pi} N_i A_{ij} \phi_{ij}(\nu) \tag{4}$$

$$\alpha_{ij,\nu} = \frac{h\nu_{ij}}{4\pi} (N_j B_{ji} - N_i B_{ij}) \phi_{ij}(\nu) \tag{5}$$

$$A_{ij} = \frac{2h\nu_{ij}^3}{c^2} B_{ij} \tag{6}$$

$$B_{ji} g_j = B_{ij} g_i \tag{7}$$

$$C_{ij} = N K_{ij}(T) \tag{8}$$

$$C_{ji} = C_{ij} \frac{g_i}{g_j} e^{-(E_i - E_j)/k_B T} \tag{9}$$

$$Z(T) = \sum_i g_i e^{-E_i/k_B T} \tag{10}$$

$$n_i = \frac{1}{Z(T)} g_i e^{-E_i/k_B T} \tag{11}$$

$$\phi(\nu) = \frac{1}{\pi} \frac{\gamma_{i,\mathrm{coll}}}{(\nu - \nu_i)^2 + \gamma_{i,\mathrm{coll}}^2} \tag{12}$$

$$\gamma_{i,\mathrm{coll}}(p,T) = \gamma_{i,\mathrm{coll}}(p_0,T_0) \frac{p}{p_0} \left(\frac{T_0}{T}\right)^{n_i} \tag{13}$$

$$\phi(\nu) = \frac{c}{a_{\mathrm{th}} \nu_i \sqrt{\pi}} \exp\left(-\frac{c^2(\nu - \nu_i)^2}{a_{\mathrm{th}}^2 \nu_i^2}\right) \tag{14}$$

$$a_{\mathrm{th}} = \sqrt{\frac{2kT}{m}} \tag{15}$$

$$g = 2J + 1 \tag{16}$$

$$E = h\nu_0 v + \frac{\hbar^2}{2I} J(J+1) \tag{17}$$

$$\begin{aligned} &\sum_{j>i} \Big[n_j A_{ji} + (n_j B_{ji} - n_i B_{ij}) J_{ji} \Big] - \sum_{j<i} \Big[n_i A_{ij} + (n_i B_{ij} - n_j B_{ji}) J_{ij} \Big] \\ &+ \sum_{j \neq i} \big[n_j C_{ji} - n_i C_{ij} \big] = 0 \end{aligned} \tag{18}$$

IMPORTANT: See backside of this sheet for natural constants!

Natural constants in CGS units:

$$k_B = 1.38 \times 10^{-16} \frac{\text{erg}}{\text{K}} \tag{19}$$

$$h = 6.626 \times 10^{-27} \text{ erg} \cdot \text{s} \tag{20}$$

$$c = 2.9979 \times 10^{10} \frac{\text{cm}}{\text{s}} \tag{21}$$

$$m_p = 1.67 \times 10^{-24} \text{ g} \tag{22}$$

$$\sigma_{\text{SB}} = 5.6703 \times 10^{-5} \frac{\text{erg}}{\text{cm}^2\text{K}^4\text{s}} \tag{23}$$

$$e = 4.8032 \times 10^{-10} \text{ statcoulomb} \tag{24}$$

$$1\text{eV} = 1.6 \times 10^{-12} \text{ erg} \tag{25}$$