Problems

Problem 5.1. Determine $\log g$ for the Sun using conventional units. Here, the "conventional units" are cgs.

Problem 5.2. Show that in the pressure scale height in the Sun is about 290 km at the point that $T = T_{\rm eff} = 5770$ K. Assume that $\mu \approx 0.6$.

Problem 5.3. Consider a atmosphere with constant temperature T, constant mean molecular mas μ, and in which the opacity varies with density as a power-law $\chi = \chi_0(\rho/\rho_0)^\alpha$.

(a) Show that the density at the point $\tau = 2/3$ varies with α as

$$\rho(\tau = 2/3) \propto g^{1/\alpha}. \tag{5.21}$$

(b) Atmospheres typically have $1 \leq \alpha \leq 2$. What does this tell you qualitatively and quantitatively about the relative densities in the atmospheres of main sequence stars ($\log g \approx 5$), giants ($\log g \approx 3$), and supergiants ($\log g \approx 1$) at a given temperature?

Real atmospheres are not isothermal and do not have uniform mean molecular mass. Nevertheless, the temperature and mean molecular mass typically change by a factor of 2 at most across an atmosphere, whereas the density changes by orders of magnitude. Thus, the results derived here remain approximately correct.