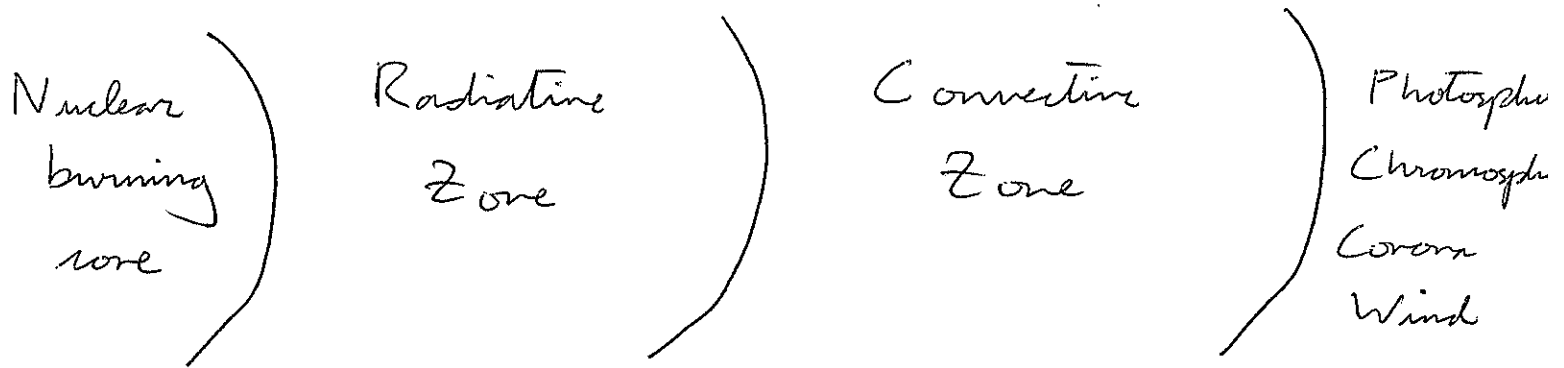


Ay 20 #10 - Equations of Stellar Structure

Zones of the Sun:



$$\rightarrow r : \frac{dP}{dr}, \frac{dM_r}{dr}, \frac{dL_r}{dr}, \frac{dT}{dr}$$

We are interested in tracing P (pressure), M_r & L_r (mass & radiation flux), and T (temperature) with radius. These depend on the physics determining pressure (ρ, T , composition), opacity (ρ, T , composition), and the generation of energy (ρ, T , composition).

You've seen all the equations:

$$\text{Hydrostatic equilibrium: } \frac{dP}{dr} = - \frac{GM_r \rho}{r^2}$$

$$\text{Mass profile: } \frac{dM_r}{dr} = 4\pi r^2 \rho \quad (\text{problem set 3})$$

Radiation flux through spherical shell:

$$\frac{dL_r}{dr} = 4\pi r^2 \rho \epsilon \quad \begin{array}{l} \text{energy generation / time} \\ \text{/ density.} \end{array}$$

Temperature gradient in 1D (plane parallel)

LTE star: $\frac{dT}{dr} = - \frac{3 \bar{\kappa}_R \rho L_r}{64 \sigma \pi T^3 r^2}$ (radiation dominated)

Temperature gradient with adiabatic convection:

$$\frac{dT}{dr} = - \left(1 - \frac{1}{\gamma}\right) \frac{\mu m_H}{k} \frac{G M_r}{r^2}$$

To gain some familiarity with these equations...

- * What is a crude estimate of the pressure at the center of the Sun?
- * How would you then estimate the temperature?
- * Finally, what about density?