

**Astrophysics — ASTR-4220**  
**Class 20**  
**Post Main Sequence Evolution**

**Background**

While it is on the main sequence, a star burns hydrogen in its core. The helium produced does not undergo further burning because the core temperature ( $\sim 10^7$  K) is much lower than the minimum temperature for helium burning ( $\sim 10^8$  K).

**Exercise**

1. (5 pts) — Describe qualitatively how the temperature varies with radius,  $r$ , for radii inside the inert helium core. Refer to Fig. 9.3 on the screen.
2. (10 pts) — Give a physical explanation.

**Solution**

1. (5 pts) — The core is *isothermal*: the temperature is independent of  $r$ .
2. (10 pts) — Consider the structure equation for energy transport:

$$\frac{dT}{dr} = -\frac{1}{K} \frac{L(r)}{4\pi r^2}, \quad (1)$$

where  $K$  is the thermal conductivity. It says that the temperature gradient is proportional to the flux of thermal energy,  $L/4\pi r^2$ , which must be transported to larger radii. For  $r$  values inside the helium core  $L(r) = 0$ . There is no thermal energy to transport so the temperature is constant.