ASTR 531 - Stellar Interiors and Evolution

Problem Set 4

Tom Wagg

May 11, 2022

20.2 - White Dwarf Luminosity

Part a

The luminosity of a white dwarf in the slow cooling phase is given by Eq. 20.10 in the textbook

$$\frac{L}{\mathrm{L}_\odot} \approx 5.2 \times 10^{10} \frac{M}{\mathrm{M}_\odot} \mu_{\mathrm{ion}}^{-7/5} \left(\frac{t}{\mathrm{yr}} \right)^{-7.5} \tag{1}$$

Since we are comparing white dwarfs with the same cooling age, the only relevant factors are the mass and μ_{ion} when comparing a H-rich WD to He-rich and C-rich.

The values of μ_{ion} for these WDs are $1, 4, 12$ respectively. This means that the relative luminosity of the WDs is

$$\frac{L}{L_{\mathrm{H-rich}}} = 1 : 0.14 : 0.03 \tag{2}$$

respectively. This shows that H-rich WDs are the brightest for a given cooling age, following my He-rich and then C-rich WDs.

TODO: Can we assume that the mass is constant?

Part b

TODO: Unsure, maybe larger ions make cooling happen faster? Why?

23.2 - Central Temperature-Density Gradient

The evolution of a star in the T_c–ρ_c diagram becomes less steep at late evolution phases. This means that for a given increase in density, the increase in temperature is not as strong.

TODO: I think this is probably something to do with the mass defect being lower and so the energy/temperature production is lower?