

Astrophysical Dynamics — HS 09-10
Exercises Class 6 (due Dec 8)

1

Consider two *Zero Age Main Sequence* (ZAMS) stars of $0.3M_{\odot}$ and $20M_{\odot}$, respectively.

a) How long do you expect them to stay on the Main Sequence? And what are their luminosities? (*Hint: suppose that the characteristic lifetime on the Main Sequence is given by how long it takes to the star to convert 10% of its mass from H to He.*)

b) Based on the different nuclear fusion processes that are dominant for different star masses, which kind of energy transport mechanisms do you expect to be relevant in their cores? Explain qualitatively why.

2

Consider a spherical self-gravitating system described by a polytropic equation of state $P \propto \rho^{\Gamma}$. Using a simple scaling argument, show that hydrostatic equilibrium in this system implies:

a) $M \propto R^{-3}$ when $\Gamma = 5/3$

b) $M = \text{constant}$ when $\Gamma = 4/3$

Case **b)** means that there is *only one allowed mass at equilibrium* for such a polytrope. This is a fundamental concept especially in the theory of compact objects, as you will see soon...