Introduction to Astrophysics

TEST #2

Apr 24, 2025

1. Derive the 3rd equation of stellar structure and explain how energy production depends on gravitational contraction or expansion of the star.

2. How do we define the mean free path? What is its relevance?

3. How do we justify our assumption that stellar interiors are in local thermodynamical equilibrium?

4. The equation of radiative diffusion,

$$\frac{\partial T}{\partial r} = \frac{3}{16\pi}\frac{\kappa\rho l}{ac}T^{-3}r^{-2}$$

   tells us how temperature varies in the stellar interior if energy transport is driven by radiation. Explain this equation like you would to a high-schooler.

5. Name at least 5 sources of opacity that can be found in stellar interiors and/or stellar envelopes. Give me a one-sentence explanation for each.

6. Derive the expression for Eddington's luminosity and explain its significance. *Note: no need to derive $u(T) = aT^4$. Take that as a given.*

7. Explain convection in words. When will it occur, when will it not occur? Why is convective energy transport more efficient than radiative energy transport?

8. What is the key concept for energy production in thermonuclear reactions? Apply that concept to discuss nuclear binding energies as a function of mass number.

9. Clasically, thermonuclear reactions could never happen because of the extremely high Coulomb barrier. Which two concepts to we need to invoke to explain why H→He reactions are prevalent in the core of the Sun.

10. Discuss the significance of the Gamow peak. Which two physical effects in unison cause the peak?