

Answer on Question 54973, Physics / Astronomy | Astrophysics

Question:

The average temperature of the interior of a sun like star is of order 10^8 K. Estimate the mass of the star in terms of the solar mass if it has a radius of order 10^{10} cm.

Solution:

We can use temperature, mass relation:

$$T^4 \approx \frac{M^2}{R^4}$$

We can apply this for both stars. For sun:

$$T_s^4 \approx \frac{M_s^2}{R_s^4}$$

For unknown star:

$$T_x^4 \approx \frac{M_x^2}{R_x^4}$$

$$\frac{T_s^4}{T_x^4} \approx \frac{R_x^4 M_s^2}{R_s^4 M_x^2}$$

$$M_x^2 = M_s^2 \frac{T_x^4 R_x^4}{T_s^4 R_s^4}$$

$$M_x = M_s \frac{T_x^2 R_x^2}{T_s^2 R_s^2}$$

$$\frac{T_x^2 R_x^2}{T_s^2 R_s^2} = \left(\frac{10^8 K}{1.57 \times 10^7} \times \frac{10^8 m}{7 \times 10^8 m} \right)^2 \approx 0.83$$

$$M_x = 0.83 M_s$$

Answer: $M_x = 0.83 M_s$