

Answer on Question #50909, Physics, Astronomy | Astrophysics

d) The average temperature of the interior of a sun-like star is of the 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.

Answer:

Will use temperature, mass relation from wiki:

http://en.wikipedia.org/wiki/Mass%E2%80%93luminosity_relation

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

Will apply it for both stars

For sun:

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

And given star:

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

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

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

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

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

$$M_x = 0.83 \cdot M_s$$

So given star have the 0.83 sun mass.