Answer on Question #69698, Physics / Astronomy | Astrophysics

Explain how we estimate the effective surface temperature of the Sun.

Answer:

According to Wien's Law,

$$\lambda_{max} = \frac{2\ 900\ 000}{T}$$

λ_{max} = $wavelengt\ of\ maximum\ intensity$, b = $Wien\ '\ s\ constant$ = 2,900,000 $nm.K$,
T = $temperature\ in\ Kelvin$

The color at a wavelength of 500nm that corresponds to in the visible-light spectrum is green. The human eye is most sensitive for peaks at this wavelength. This wavelength is the peak length of thermal emission from the Sun.

$$T = \frac{2\ 900\ 000}{\lambda_{max}}$$

Then,

$$T = \frac{2\ 900\ 000}{500} = \mathbf{5\ 800\ K}$$

A main sequence star has mass 2 × 10^31 kg and radius 3 × 10^9 m. Obtain an estimate of the average temperature throughout the star.

Answer:

The average temperature <T> will lie between T_c and T_s.

We can use the virial theorem to find <T>

$$2KE_{tot} + PE_{tot} = 0$$

$$2\left(\frac{3}{2}Nk < T >\right) - \frac{3}{5}G\frac{m_H M^2}{R} = 0$$

Where, N = M/μm_H, let μ = 1

$$< T > = \frac{1}{5}G\frac{m_H M}{kR}$$

G = 6.7·10^{-11} N m^2 / kg^2 (constant of gravitation), m_H = 1.7·10^{-27} kg (mass of hydrogen atom), M = 2·10^{31} kg (mass of the Star), k = 1.4·10^{-23} J / K (Boltzmann constant), R = 3·10^{9}m (radius of the Star)

Then,

$$< T >= \frac{1}{5}\times 2\cdot 10^{-11}\times\frac{1.7\cdot 10^{-27}\times 2\cdot 10^{31}}{1.4\cdot 10^{-23}\times 3\cdot 10^{9}} = \mathbf{3.24\cdot 10^{6}K}$$