The Sun

$\frac{dT}{dR}$ is **not** constant

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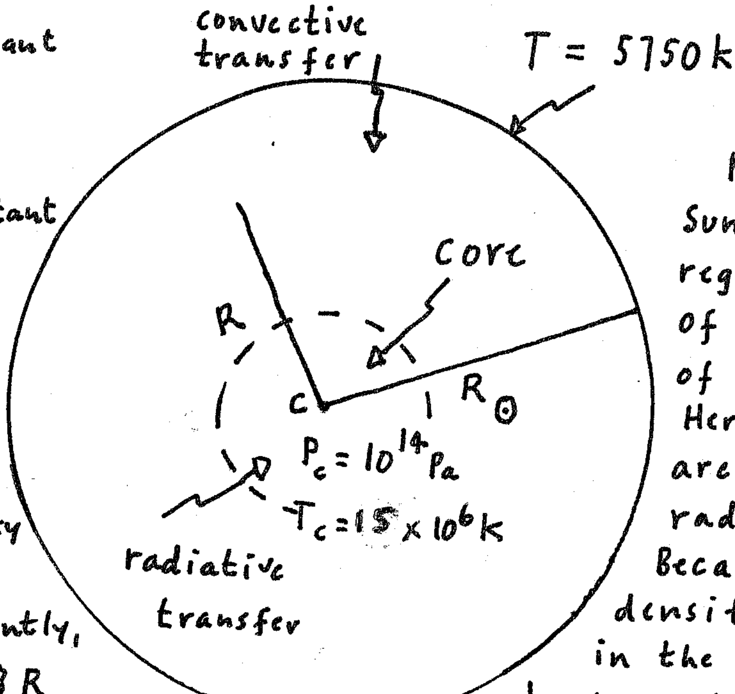

Nuclear fusion in the Sun occurs in the central region, with a radius of about one-quarter of the whole star. Here, high-energy photons are produced, and they radiate outwards. Because of the high density of the gases in the innermost parts of the star, these photons are absorbed and re-emitted as a lower-energy photons on the route outwards. As a result, the whole process can take one million years.

The gas in outer parts of a star is cooler and this increases the opacity (the resistance to radiation). Consequently, beyond about $0 \cdot 8 R_{\odot}$, convection takes over. Rising currents of hot gas give rise to the granular appearance of the Solar surface.

Mass, Luminosity and Lifetime

As long as a protostar has a mass between $\sim 0 \cdot 08 M_{\odot}$ and $60 \rightarrow 100 M_{\odot}$, fusion will commence and a star will become a main-sequence star. The star will spend most of its life in this region of the Hertzsprung-Russell diagram.

The lifetime of a star in the main-sequence is linked to its luminosity and mass because:

(i) The greater its mass, the longer it will last before its supply of Hydrogen is consumed.

(ii) The greater its luminosity, the sooner the supply of Hydrogen will be exhausted.

When stars form from clouds of gas in space, their composition is initially $\sim 73\%$ Hydrogen, 25% Helium and 2% other elements, by mass. During their main-sequence lifetime, energy is produced by the proton-proton chain, until the Hydrogen reserve runs low. Our Sun is around 5×10^9 years old. It has more Hydrogen in its core; nevertheless, it still has enough Hydrogen to maintain its present level of energy production (thereby resulting in a loss of mass rate $\sim 4 \cdot 3 \times 10^9 \, kg \, s^{-1}$) for another five billion years.

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