# Star Temperature and Size

## Temperature from the Line Spectrum: The Spectral Class

If $\lambda_{peak}$ isn't known, thanks to the work of Cecilia Payne-Gaposchkin (1900-1979), the spectral class can be used to estimate the temperature. This is done by interpolation between the minimum and maximum temperatures of each spectral class:

**Temperature from Spectral Type**

$$T = T_{max} - \left\{ (\text{subclass}) \times \left( \frac{T_{max} - T_{min}}{10} \right) \right\}$$

Here the subclass is the number given with the spectral type (*e.g.* the 2 in Sol's G2), $T_{max}$ is the highest temperature in the spectral class and $T_{min}$ is the lowest.

## Size of an Opaque, Spherical Star: The Stefan-Boltzmann Law:

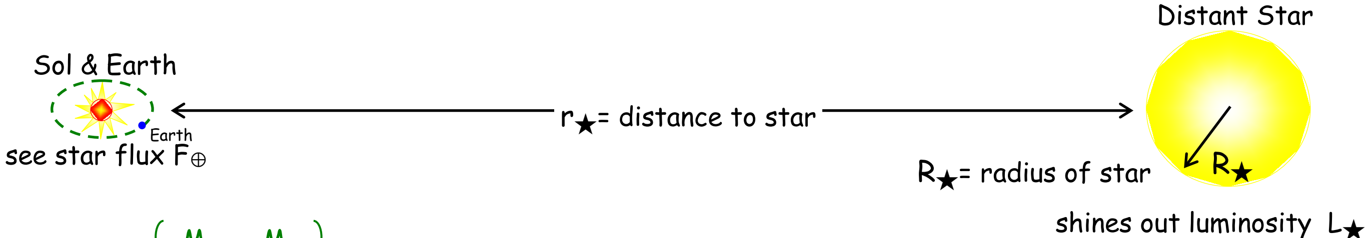
The Stefan-Boltzmann law relates the luminosity of a star to its temperature and its emitting surface area ($4\pi R^2$)

**Radius from Luminosity and Temperature**

$$R_\star = \sqrt{\frac{L_\star}{4\pi\sigma T^4}}$$

where $R_\star$ is the *radius of the star* in m, $\sigma = 5.67 \times 10^{-8}$ W/M$^2$K$^4$, $R_\odot = 6.96 \times 10^8$ m, and $r_\oplus = 1.496 \times 10^{11}$ m.

| Star | Field Guide to the Stars and Planets Table A2 | | | | Calculated | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | *FG* A3 | Luminosity | | Size | | |
| | V | $M_V$ | $r_\star$ ly | Spec. Type | T K | $L_{\star,SOL}$ In $L_{sol}$ | $L_\star$ In Watts | $R_\star$ Billions of m | $R_\star/R_\odot$ (number) | $R_\star / r_\oplus$ % |
| Polaris ($\alpha$ UMi) | 2.0 | -4.1 | 431 | F5 I | | | | | | |
| Rigel ($\beta$ Ori) | 0.12 | -6.6 | 773 | B8 I | | | | | | |
| Sirius ($\alpha$ CMa) | -1.46 | 1.5 | 9 | AI V | | | | | | |
| Aldebaran ($\alpha$ Tau) | 0.85 | -0.8 | 65 | K5 III | | | | | | |
| Betelgeuse ($\alpha$ Ori) | 0.5 | -5.0 | 522 | M2 I | | | | | | |
| Procyon ($\alpha$ CMi) | 0.38 | 2.8 | 11 | F5 IV | | | | | | |




$$L_\star = 10^{\left(\frac{M_{SOL} - M_\star}{2.5}\right)}, \quad r_{\star,m} = r_{\star,ly} \times (9.46 \times 10^{15}) \text{ Meters}, \quad L_{SOL} = (3.827 \times 10^{26}) \text{ Watts.}$$