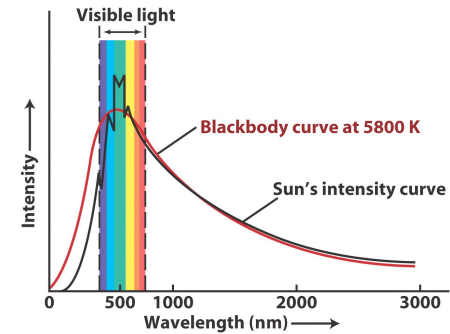


Lecture 4: Temperature, colour and spectral properties of stars

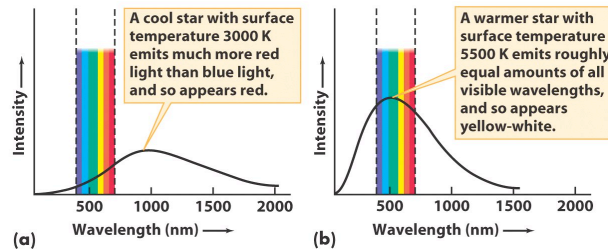
- Blackbody spectra and temperature
- Stellar colours, and photometry
- Spectral lines, and spectral classification of stars

Stars are almost blackbodies



Blackbody intensity curve (spectrum) is: $B_{\lambda}(T) = \frac{2hc^2/\lambda^5}{e^{hc/\lambda kT} - 1} \text{ Wm}^{-2}\text{sr}^{-1}\text{m}^{-1}$

Colour depends on temperature - Wien's Law gives the peak wavelength

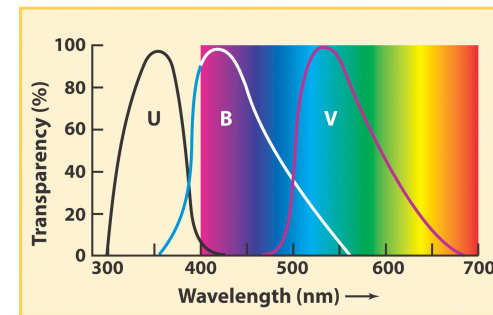


Wien's Law: blackbody spectrum peaks at

$$\lambda_{\text{max}} = 2.9 \times 10^6 / T \text{ nm}$$

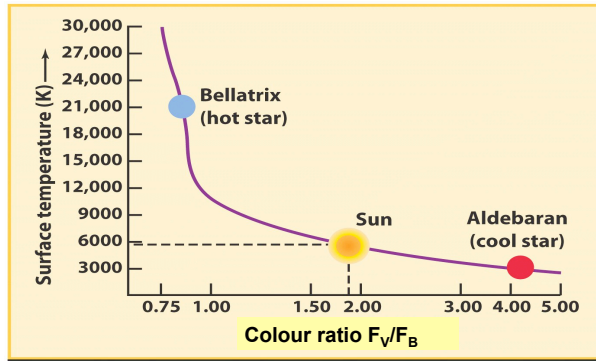
E.g. for the sun $T \approx 6000 \text{ K}$, so that $\lambda_{\text{max}} \approx 500 \text{ nm}$.

Photometry and Colour Ratios



- Photometry measures the apparent brightness (i.e. flux) of a star
- The colour ratios of a star are the ratios of fluxes obtained through different standard filters, such as U, B, and V filters
- These ratios are a measure of the star's surface temperature

...For example

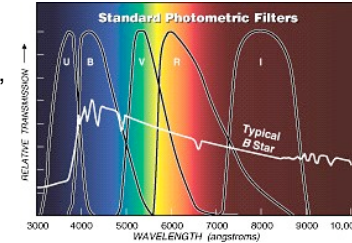


- The ratio of flux in the V and B bands varies monotonically with T .
- A flux ratio corresponds to a magnitude difference (see Lecture 3), so we can also represent the colour by the difference between the magnitudes of a star in two different bands - e.g. B-V.

Standard Johnson system (UBVRI)

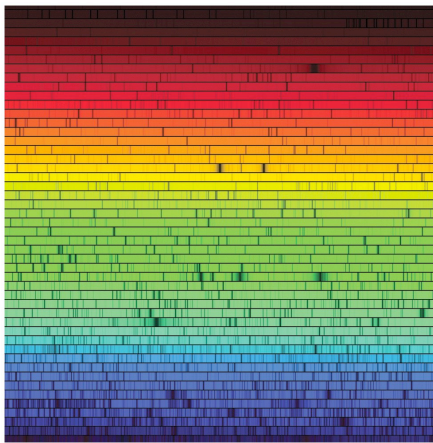
- UBVRI filters defined to have equivalent wavelengths of 365, 440, 550, 640 and 790 nm.
- Relationship between flux and magnitude in a given band is

$$m_A = -2.5 \log f_A + c_A$$



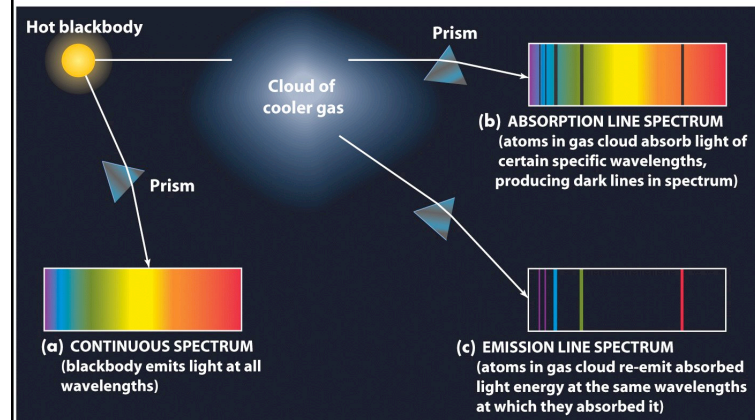
- Zero-points (i.e. the c_A) are defined such that Alpha Lyr (Vega) has $m_U=m_B=m_V\dots=0.03$, and hence has all colour indices zero.
- Colour indices are flux ratios, and hence magnitude differences between different bands - e.g. m_B-m_V .
- This is usually denoted B-V, and is smaller for a blue object (since brighter \Rightarrow less positive magnitude).

Stars are not perfect blackbodies, their spectra typically contain many lines

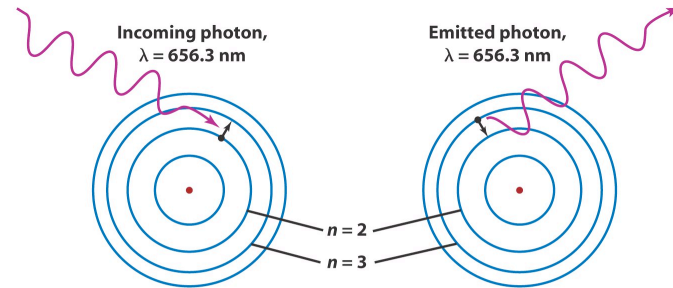
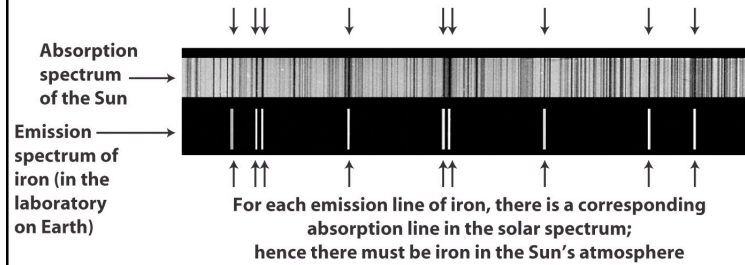


Solar spectrum (folded for display), showing many absorption lines

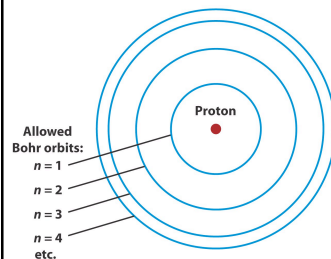
Kirchhoff's Laws



Spectral lines arise from specific elements in stellar atmospheres



Spectral lines are produced when an electron jumps between energy levels within an atom



- The nucleus of an atom is surrounded by electrons that occupy only certain orbits or energy levels
- When an electron jumps from one energy level to another, it emits or absorbs a photon of appropriate energy (and hence of a specific wavelength).
- The spectral lines of a particular element correspond to the various electron transitions between energy levels in atoms of that element.
- Bohr's model of the atom correctly predicts the wavelengths of hydrogen's spectral lines.

