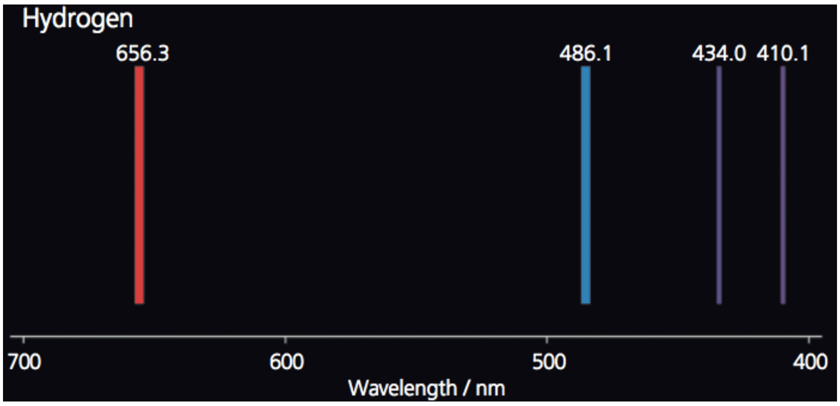
<u>Stellar Spectroscopy</u>

Understand the 3 types of Stellar spectroscopy
Explain why wavelengths of light are absorbed by electrons, creating absorption lines.
Determine which stellar class a star belongs to, from data given.

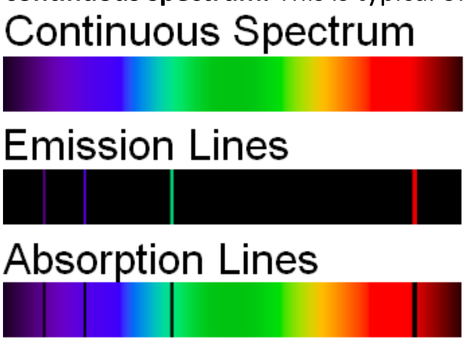
Spectroscopy

Stellar spectroscopy is a method of analysing the spectrum of stars. Spectroscopy gives rise to three types of spectra:

› an emission line spectrum
› an emission continuous spectrum
› an absorption spectrum.

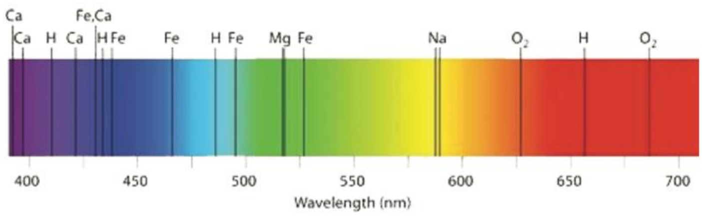


After heating, electrons are raised to new energy levels, and eventually return to lower energy levels. The atoms then emit photons at precise characteristic energies corresponding exactly to the spacing of the energy levels within the atoms of the gas. The spectrum recorded is of bright lines on a dark background, an emission **line spectrum** with the intensity and position of these lines corresponding to particular electronic transitions in the atoms of the gas. In the time it takes atoms to drop down to a lower energy level, further atomic collisions have occurred. This results in a blurring of the emission spectrum and the loss of any detail about the atoms in the gas, giving rise to a **continuous spectrum.** This is typical of the emission spectrum obtained from the region of a star, the **photosphere.**



The photosphere acts as a source of visible light. This light then passes through the outer layers of the Sun, which are much cooler and composed mainly of hydrogen gas. Photons of the characteristic energies of the transitions in the gas will be absorbed and atomic electrons raised to an excited state (perhaps to the second level or shell, n = 2, or even higher shells, n = 3, 4, 5, 6 and so on). As electrons fall back to the rest level, n = 1 (the ground state), or intermediate levels, photons are emitted, but in random directions. The resulting spectrum comprises dark lines (undetected photons) characteristic of an

The absorption lines for hydrogen in the visible part of the spectrum result from electrons moving from the rest excitation level (n = 2) to higher energy levels. This leads to a series of dark lines called the **Balmer series**. The intensity of the absorption lines depends on the particular temperature of the star's photosphere.
Other dark lines in a star's absorption spectrum are characteristic of other particular elements within the gas in the outer layers. A full analysis of the absorption lines also reveals the state of the atoms, that is, whether they are neutral or ionised, which also depends on the temperature. The absorption spectrum therefore not only enables identification of the elements present in the star



Spectral class	Colour	Temperature range / K	Prominent absorption lines	Example star
O	Blue	25 000–50 000	He^+, He, H	10 Lacertae
B	Blue	11 000–25 000	He, H	Rigel, Spica
A	Bluish white	7500–11 000	H (strongest), ionised metals	Sirius, Vega
F	White	6000–7500	Ionised metals	Procyon
G	Yellow-white	5000–6000	Ionised and neutral metals	Sun, Capella
K	Orange	3500–5000	Neutral metals	Aldebaran
M	Red	< 3500	Neutral atoms, TiO	Betelgeuse, Antares

but also allows the temperature of the star to be determined accurately.
The relative strength of particular absorption lines, and hence temperature, gives the spectral class of a star. We can further

define the classification by temperature with a description of the prominent spectral absorption lines, as shown in the table shown.