Revision sheet: Stars

Stars form from the ISM which can be enriched from previous generations of stars. The chemistry of a star therefore depends on that of its ancestors.

Kirchoff's laws tell us how gas can show a continuous, emission or absorption spectrm

Redshift is for objects moving away from us (wavelength is longer), blueshift is moving towards (wavelength is shorter).

The ISM consists of dust and gas. There are HI, HII and molecular clouds which have different temperatures and densities.

Dust reddens distant objects, scatters blue light and makes things look fainter.

Stars form from molecular clouds which have to collapse under gravity. The protostar forms in a coccoon of dust, these objects often have disks and jets associated with them.

Stars first appear on the HR diagram along the birth-line, i.e. the point at which they become visible after shedding their cocoon.

Stars spend most of their life burning H into He either via the p-p chain or CNO cycle (if $T > 16$ million K), which is more efficient. Later, they may fuse heavier elements (e.g. He to C via the triple alpha process) all the way up to Fe, if they are massive enough.

There is a lower limit to stellar masses because a temperature of 10 million degrees must be reached in order to start the p-p chain. However, even without fusion, low mass objects can glow because of gravitational compression.

There is an observed upper cut-off in stellar masses for several reasons, e.g. massive stars are rare and hard to observe, they only live brief lives and massive protostellar clouds tend to fragment into smaller pieces.

Hydrostatic equilibrium is balance between gravity and thermal pressure and it acts like an internal temperature pressure thermostat.

Whilst they burn H, stars are on the main sequence. They start at the zero age main sequence and move towards higher L and lower T.

Some mass is 'lost' in fusion reactions, the mass defect, as it is converted to energy ($E = mc^2$).

As the H starts to run out in a star's core, many become red giants as a reaction to the thermostat in their cores. The star now leaves the main sequence. Before they start to burn He, mid-mass stars undergo a He flash, due to the build-up of degenerate matter in their interiors.

More massive stars are shorter-lived, rarer, hotter and more luminous than low mass stars.

The way a star ends its life depends on its mass. Sun-like stars undergo eruptions of planetary nebulae and become white dwarfs (if they are below the Chandrasekhar limit).

Massive stars can explode as supernovae (there are 2 types) either when they reach Fe in their core or if they accrete matter from a binary companion.

Gamma ray bursts are the most powerful supernova explosions and so can be found at very large distances, although their energy flux is brief.

Massive stars leave remnants such as neutron stars, pulsars (fast rotating neutron stars) or black holes, depending on their mass. These can be detected by various means: effect on a binary, Xrays or synchrotron emission.

Black holes have escape velocities greater than c, so that nothing can escape from within the event horizon. However, black holes do not suck things in!

Massive objects like black holes can warp space and time, causing light to bend.

Equations specific to these chapters

$\frac{\Delta\lambda}{\lambda} = \frac{v}{c}$ Units must be consistent
$E = mc^2$, where E is in Joules and c is 3×10^8 m/s
$\lambda \times T = 3 \times 10^6$ Wien's law