Introduction to Astronomy
Summary Questions Week 6

11 November 2019

1. Stellar spectra consist of a large-scale *blackbody* spectrum and more narrow-band absorption/emission lines. What information does the blackbody spectrum give us about the star?

Solution:

The blackbody spectrum prescribes the flux density as a function of observing frequency (or wavelength) and temperature. Hence, by observing the flux density at a given bandwidth or waveband, we can figure out the *brightness temperature* of the star, which is approximately its temperature.

2. How does the blackbody spectrum change with temperature?

Solution:

The spectrum moves to *lower frequencies* and *lower flux densities* as the temperature *decreases*.

3. What is Hα emission and why is it important?

Solution:

Hα emission is radiation that arises when the *electron of a neutral hydrogen atom decays* from energy level $n = 3$ to energy level $n = 2$. It is also called the *Balmer-alpha* line, as it is the lowest-energy line in the Balmer series, which describes electrons decaying to energy level $n = 2$.

The importance of Hα emission lies in the fact that it is *t*he most easily observed hydrogen recombination line visible from Earth.

4. Why can we see forbidden transitions in astronomy?

Solution:

Because the *densities of gasses in space are so low*, there are *far fewer collisional interactions* between atoms; this combines with the *extremely high total number of particles present in space* to make these unlikely transitions far more likely than on Earth.

5. The Harvard Stellar Classification System uses spectral lines as a proxy for stellar temperature. How do spectral lines depend on temperature and why?

Solution:

Highly ionised atoms can only exist in *really hot* stellar atmospheres and their spectroscopic lines therefore indicate hot stars. *Molecules and weakly ionised atoms* can only survive in *cooler stars. Lines from excited but neutral atoms* (like, e.g. the Ballmer lines) are most prevalent in *moderately warm* stars, since cool stars would not excite these atoms and hot stars would fully ionise them.

6. Why are luminous stars also stars with lower surface gravity (assuming we compare stars of equal mass)?

Solution:

More luminous stars have *more energy produced* in their cores. Since the size of stars is defined by the gravity-pressure balance; and since this larger amount of energy production implies a larger pressure, we expect these stars to be *more voluminous*. This means that the *outer layers* of the star are *further away* from the centre, which means the *surface gravity* is lower. Similarly, this implies that the density and pressure in the atmospheres of these luminous stars, are lower.