Hi this is Steve Nerlich from Cheap Astronomy www.cheapastro.com and this is *Old balding astronomers feel good knowing mnemonics.*

As you maybe aware, the standard spectral classes of stars are termed o, b, a, f, g, k and m which has inspired generations of astronomy students to create mnemonics of a haiku-type nature – ranging from the traditional *Oh be a fine girl, kiss me* to more recent derivatives such as *Outrageously, Bill always felt guiltless kissing Monica*.

The OBAFGKM letters form the x axis of the Hertzsprung–Russell diagram which maps all known star types by their colour (measured by spectral type, that is OBAFGKM) against their absolute magnitude, that is their size, or alternatively by their luminosity. Although luminosity is a fairly straight-forward concept, the measurement of absolute magnitude, builds on the system of measuring apparent magnitude – which was established by Hipparchus well over 2,000 years ago – and just won't die.

Quite reasonably and sensibly, Hipparchus assigned the value of 1 to the 20 brightest stars he could visualise, 2 to another group of slightly dimmer stars, 3 to a yet dimmer group – all the way down to category six for the very faintest stars visible to his naked eye.

But over time this sensible system began to morph into something much stranger as advancing technologies allowed for more accurate measurements to be made – and one day someone decided that rather than just coming up with a new system, we'd rejig Hipparchus' so dimmer stars got bigger numbers – starting from a zero point – which was determined to be the star Vega. But then, as it became apparent (small astronomy joke there) as it became apparent there were stars brighter than Vega, they were assigned negative numbers. I mean, huh?

And then someone suggested we should really start thinking of the universe as a big space rather than a bunch of dots in the sky. So the concept of absolute magnitude was introduced where a star's brightness is normalised for its distance, so that a really bright star that is apparently dim to us on Earth because it's so far away, is re-calculated to be really bright – that is absolutely bright.

Again, all very sensible and reasonable, but did we have to apply the same baffling out-of-date magnitude scale to this? I mean would Hipparchus really be honoured by this dogged adherence to his ancient classification system or would he be scratching his beard thinking WTF. *Oh brother, another fact gratuitously killing meaning*.

Anyway, the OBAFGKM spectral classes proceed from left to right on the Hertzsprung–Russell diagram. O class stars are very hot, very blue stars with surface temperatures at nearly 30,000 Kelvin – and are relatively short-lived stars found in stellar nurseries such as Alnitak, or Zeta Orionis, a hot blue supergiant in the Orion nebula.

B stars are a bit cooler – at about 10 to 20,000 Kelvin although they may also be blue, or blue/white – like Rigel. A class stars are white stars with surface temperatures of less than 10,000 Kelvin and good example is Sirius, the brightest star in the night sky.

Moving on through the spectral classes, F class stars are less than 7,000 Kelvin – like Canopus and G class stars are getting down to only 5,000 Kelvin, and starting to look a bit yellow like, ooh I don't know, the Sun? And then there's K class stars that are starting to look a bit red and are only around 4,000 Kelvin – like Arcturus or Aldebaran. And finally, you've got your M class stars which are distinctly red and for which the fabulous Antares is a red supergiant poster boy example.

The majority of stars on the Hertzsprung–Russell diagram can be found along a diagonal band starting from really large stars in the O class down to tiny red dwarfs in the M class. This band of stars on the diagram is known as the main sequence – and from birth most stars will be found on this main sequence of the diagram – and all share the common feature of actively fusing hydrogen into helium, either through the Carbon-Nitrogen-Oxygen cycle for stars bigger than 1.5 times the mass of the Sun – or the proton-proton chain for stars less than 1.5 times the mass of the Sun – which of course includes the Sun.

Stars that have burnt through most of their hydrogen are not found on the main sequence. Instead they are clustered into two other groups of the Hertzsprung–Russell diagram. Stars below about 23% of the mass of the Sun just shrink down to join a cluster of white dwarfs which are found towards the bottom left of the diagram, while bigger stars up to ten solar masses – including the Sun – swell up temporarily into red giants.

To explain, a star like the Sun in the main sequence is in hydrostatic equilibrium between the gravitational compression of its own mass and the outward push of photons and solar wind particles produced from fusion in the star's core. As hydrogen in the core begins to run low that outward push diminishes and the core collapses inwards – and the compression resulting, greatly increases its temperature.

Then, although fusion in the core has largely ceased, the higher temperature radiated by the core is enough to initiate hydrogen fusion in a shell of stellar material around the core – so that for a temporary period you have a large hot shell undergoing active fusion heating a diminished amount of outer stellar mass – meaning the hydrostatic equilibrium that previously existed goes out the window.

The nett result is the star swells up, though its surface – now at much greater distance from the core, gets cooler and redder – and hence now becomes one of that clump of red giants to the right side of the Hertzsprung–Russell diagram.

When the Sun goes red giant, it will swell up to about two hundred times its current size – but when its residual hydrogen does run out, much of the outer layers of that red giant will just dissipate into space and all that will be left is a white dwarf.

So towards the end of their lives, little stars just become white dwarfs while stars up to ten times the mass of the Sun pass through the red giant stage first before they also become white dwarfs.

Of course, for any stars above ten solar masses – their lives end dramatically with a supernova blast – generally leaving behind either a neutron star or a black hole. But to reiterate this only applies to stars that are *overtly big, actually freakingly giant, killer masses*.

There are also two newer spectral classes proposed to go even further to the right of the standard OBAFGKM classes, being class L and class T – which are sometimes called cool red and brown dwarves – and which have only become detectable in recent times as they radiate only low levels of visible spectrum light. Some modern folks like to build mnemonics with these extra letters, like *Often boring astronomy facts, generally kill my leisure time* – but somehow it's just not the same.

Thanks for listening. This is Steve Nerlich from Cheap Astronomy, www.cheapastro.com. Cheap Astronomy offers an educational website where *our bits are frugal, given knowledge matters*. No ads, no profit, just good science. Bye.