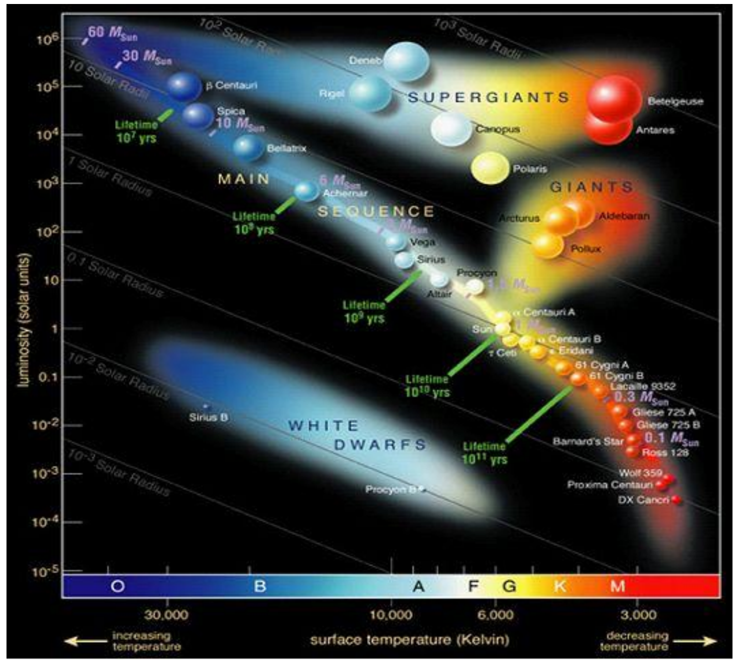
Stellar Classification

For millennia, humans have marveled at the night sky's diverse assortment of pinpoints of light. In the absence of light pollution from urban civilization, the heavens continue to show their true colors even in modern times. Hundreds, if not thousands, are unveiled. Not only are their numbers revealed, the relative sizes, colors, and especially brightnesses of the stars become accentuated. Since antiquity, figures such as Ptolemy—the same intellectual whose geocentric theory of the universe outlived him by centuries—cataloged the stars according to their appearances in the night sky.



Above: HR Diagram (http://www.bramboroson.com/astro/apr1.htm)

To this day, professional astronomers, for the most part, are under the same limitations as notable astronomers like Johannes Kepler, Isaac Newton, and William Herschel: the **light** we see from stars is *the* primary source of information for us to explore the physical properties of these heavenly bodies. Amazingly, astronomers have nevertheless have been able to derive masses, radii, temperatures, brightnesses, distances, and other fundamental quantities for stars from studying the physics of light on Earth.

One of the most active fields of stellar astrophysics is the study of the lifetimes of stars, also known as stellar evolution. In the early twentieth century, astronomers Ejnar Hertzprung and Henry Norris Russell introduced the image above [appropriately known as the Herztprung-Russell (HR) diagram]. This plot of stars is not a map of where stars are located; rather it reveals how the observed and documented stars in the sky group together as they are plotted in terms of surface temperature and their true brightness.

The hotter a star's surface temperature is the bluer in color it is. On the other end of the spectrum, the stars with yellow (e.g. the Sun) to red color are significantly cooler. Perhaps the most notable trend in this plot is the fact that most stars observed lie on a diagonal band called the **Main Sequence**. Stellar evolution theory suggests that stars spend a majority of their lifetime on this band. Where along the main sequence a star will be found depends mainly on the mass of the star in question. A star that is seven times the mass of our own sun, for example, will spend its lifetime near the blue, hot end of the main sequence belt. During this **main sequence lifetime,** the star is in a state of balance; it is stable because it is fusing elements like hydrogen against the force of its own gravity.

It should be noted that as stars age (in astronomical times, this could range from millions to billions of Earth years), their location on the HR diagram changes. This is because as a star "dies" and uses up its available fuel to shine, it ceases to be in balance. As supported by theory and observations, extreme physical processes follow, and a “dead” star may end up as an exotic remnant like a white dwarf star, a neutron star, or, in the limit, a black hole—which fate a star meets depends, again, on how massive it is. The Sun, as an example, is a relatively low-mass star and will become a white dwarf star in about five billion years. Exactly how these later stages of evolution occur remains an active and exciting research question in astrophysics.

Sources

- Stellar Sizes: A video comparison
  http://youtu.be/HEheh1BH34Q
- Introductory websites for students on stellar classification
  - For elementary:
    http://www.enchantedlearning.com/subjects/astronomy/stars/startypes.shtml
  - For secondary:
    http://outreach.atnf.csiro.au/education/senior/cosmicengine/stars_types.html