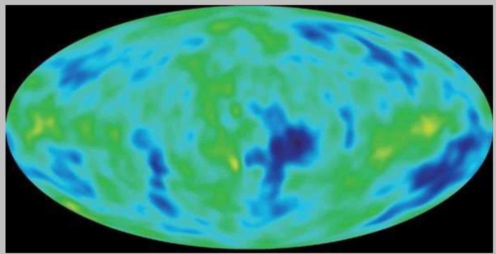
2006 Nobel prize in Physics :

John Mather, George Smoot

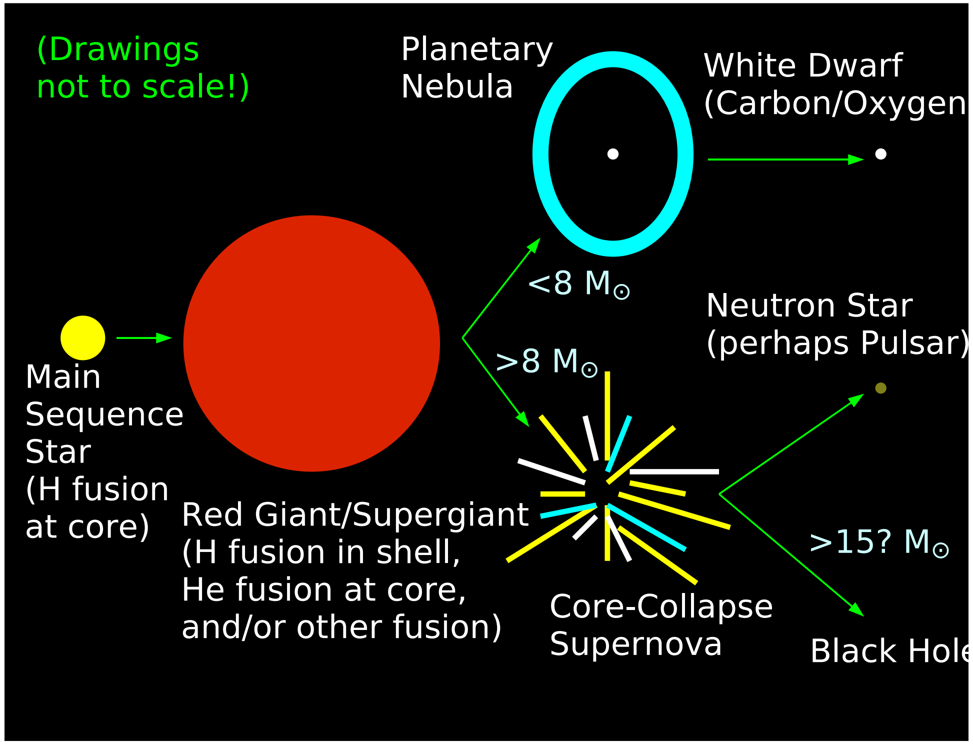
"for their discovery of the blackbody form and anisotropy of the cosmic microwave background radiation"

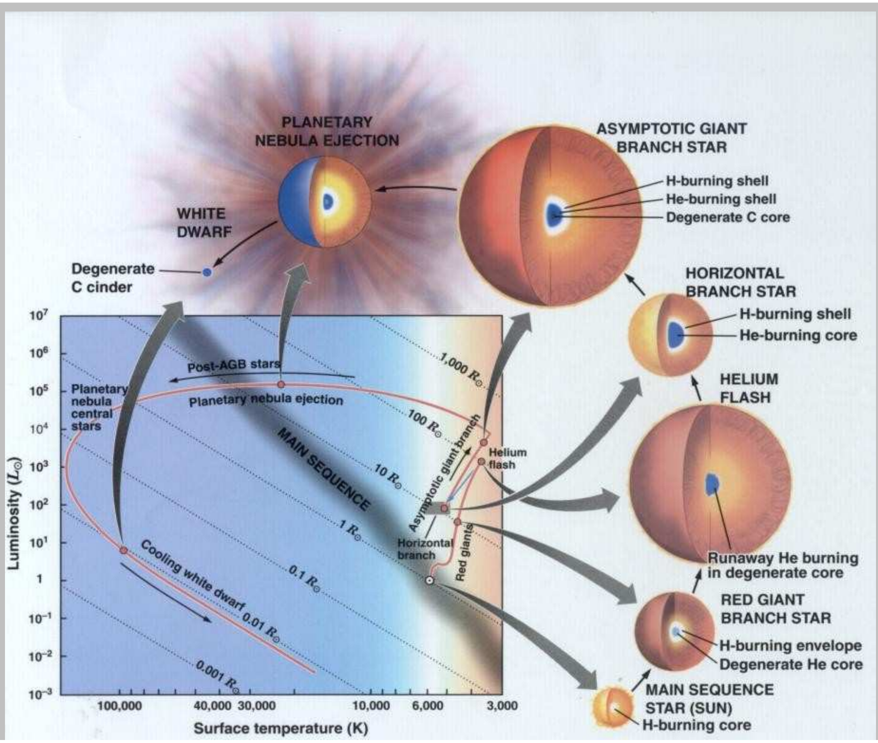


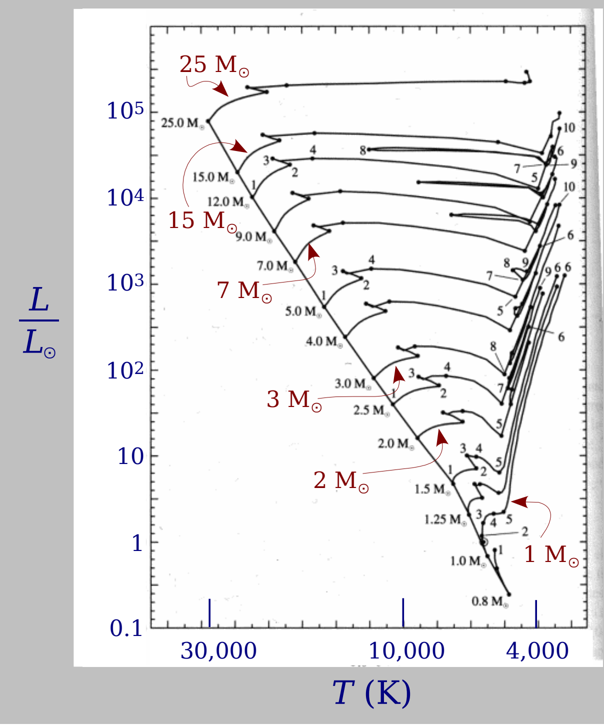
Cosmic Microwave Background (CMB) Fluctuations

COBE spacecraft

The observed CMB is one of the strongest individual pieces of evidence for the Big Bang







A cluster of stars forms. All the stars form at the same time.

Rank order the phenomena/objects below in the order in which they will appear in this cluster.

- A Giant/Supergiant – Planetary Nebula – Supernova
- B Giant/Supergiant – Supernova – Planetary Nebula
- C Supernova – Giant/Supergiant – Planetary Nebula
- D Planetary Nebula – Supernova – Giant/Supergiant
- E It could be any of the above

From your answers to question #1 :

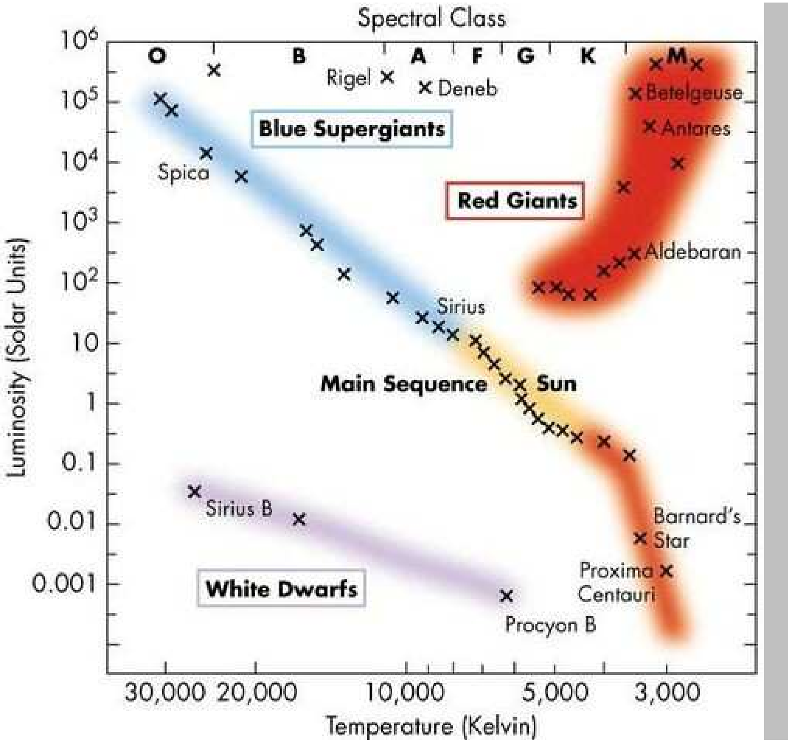
As stars evolve, they move along the main sequence from O to K along the spectral type. Some stars will die as well.

Note : stars to not move along the main sequence. They do move into the Giant region of the H-R diagram, which is a reddening. However this problem was specifically asking about *main-sequence* O-stars and *main-sequence* K-stars.

From your answers to question #1 :

...because 90% of the stars in our Galaxy are main sequence stars that are very hot and have a larger mass. Because they have a larger mass (a larger radii) and are hotter, the 0-Stars have a greater luminousity. The K-stars are like the white dwarf stars that are cooling off (no longer generating internal energy at core through hydrogen fusion) a...

- Larger mass does not imply larger radius! (Consider the Sun as a Red Giant ; still has mass 1 $M_\odot$, less than the mass of a 3-solar mass A-type main sequence star.)
- K-stars can be main-sequence, red giants, or cooled white dwarves (see H-R diagram)



From your answers to question #1 :

...as time passes, stars increase in mass. When stars finally reach the Main Sequence stage, many have 1 solar mass. Therefore, there would be more stars will masses greater than or equal to 1 solar mass because after many years they will have evolved into bigger stars.

- Stars do *not* increase in mass as time passes. (Where would the mass come from?)
- Main sequence is where stars “start”. (They are protostars before that, but main sequence is 90% of the lifetime, and the giant stage is after that.)

From your answers to question #1 :

If you count them up, you would expect to find a number of O-stars and K-stars that is exactly equal to R-initial. Most stars in the main sequence have the same lifetime, so all of the existing stars in our galaxy would create the expected R-initial (ratio). As more time goes by, the ratio will change as more K-stars expand into red giants and become more luminous.

- Stars on the main sequence do not all have the same lifetime. More massive stars have much shorter lifetimes than less massive stars.
- Just a note : when a star (of any sort) becomes a red giant, it is no longer a main-sequence star....

Question 2

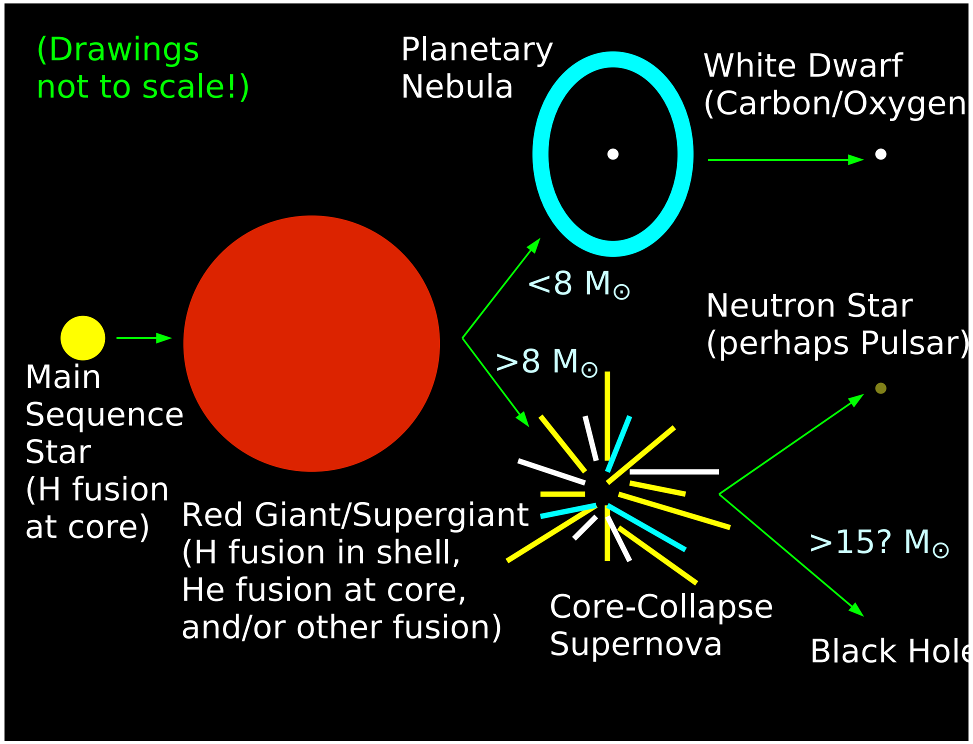
Consider two stars that have the same temperature. All I will tell you about these stars is that one of them is a red giant, and the other is a main-sequence red dwarf.

(b) Based on what you now know about stars, can you say which star is older? If so, which one? If not, why not?

Situation 1 : 1 $M_\odot$ red giant formed 10 billion years ago, just now a red giant ; 0.5 Mo red dwarf formed 1 billion years ago. Red giant older.

Situation 2 : 3 $M_\odot$ red giant formed 400 million years ago, just now a red giant ; 0.5 Mo red dwarf formed 12 billion years ago. Red dwarf older.

The red giant is *further along in its life*, but lengths of stars' lives vary!



The Theory of Stellar Evolution