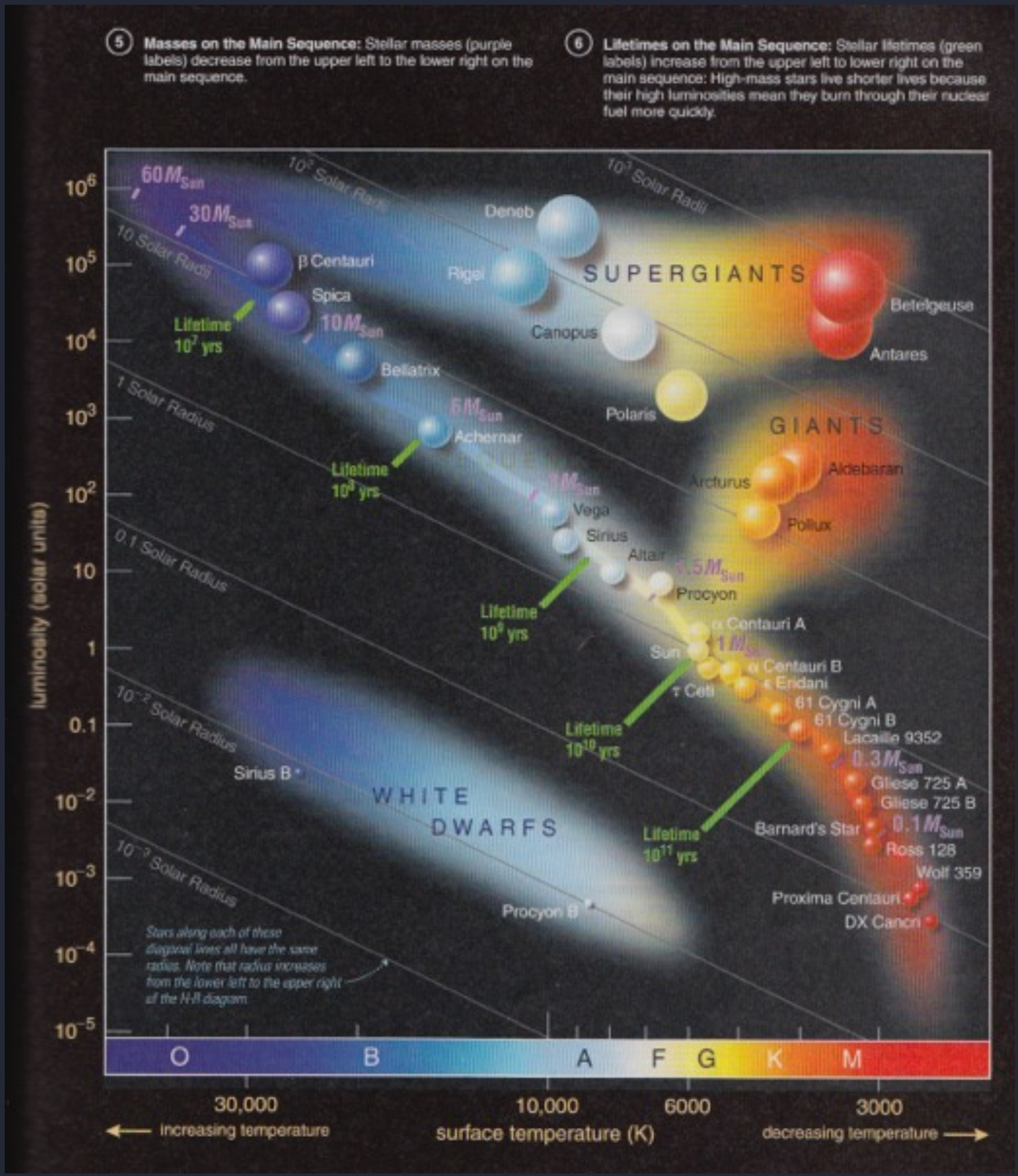
Astro 1: Introductory Astronomy



David Cohen

Class 12: Thursday, February 27

Spring 2014

stellar spectra: as a function of temperature

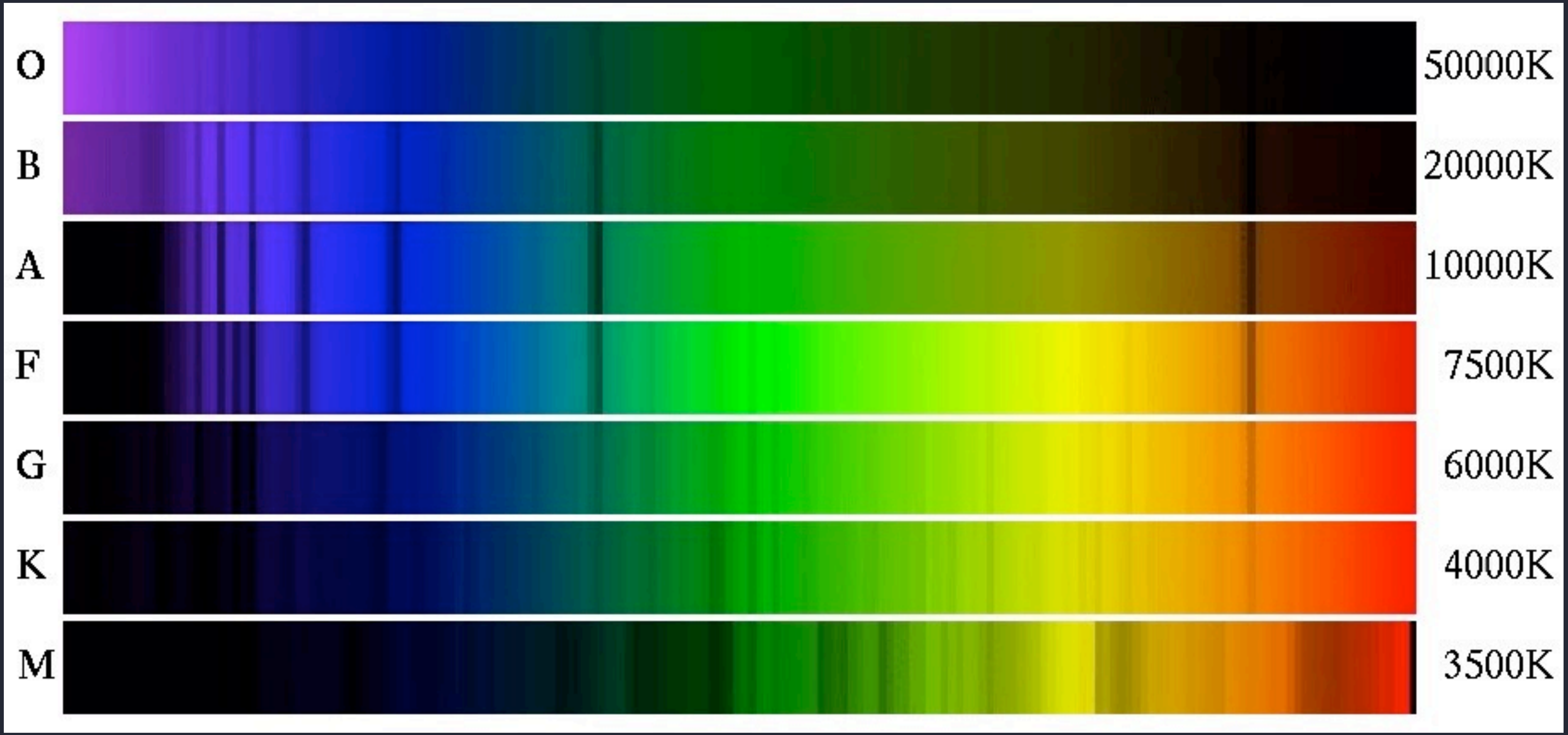
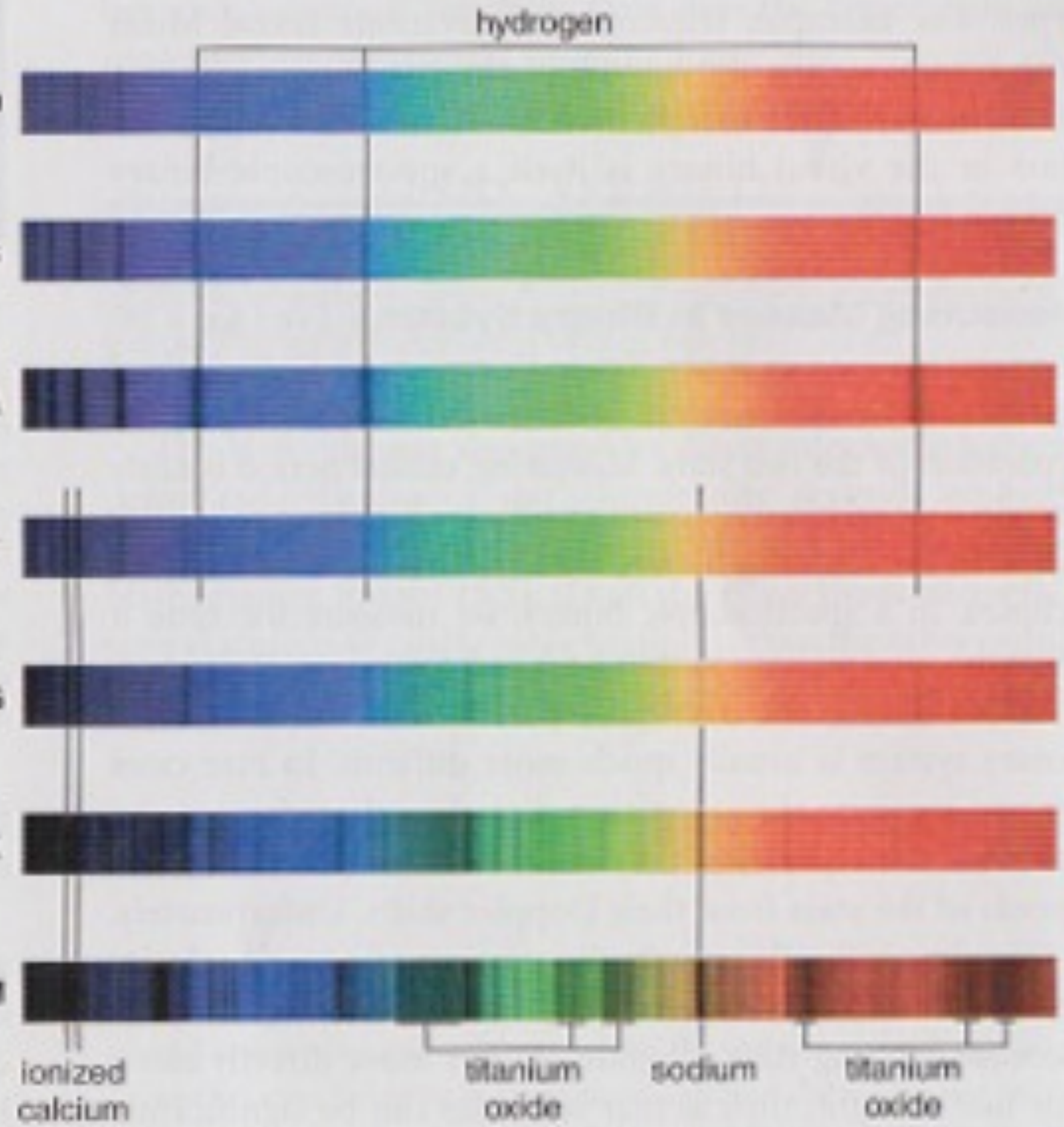


Table 15.1: the basis of the spectral type sequence, the empirical temperature scale of stars

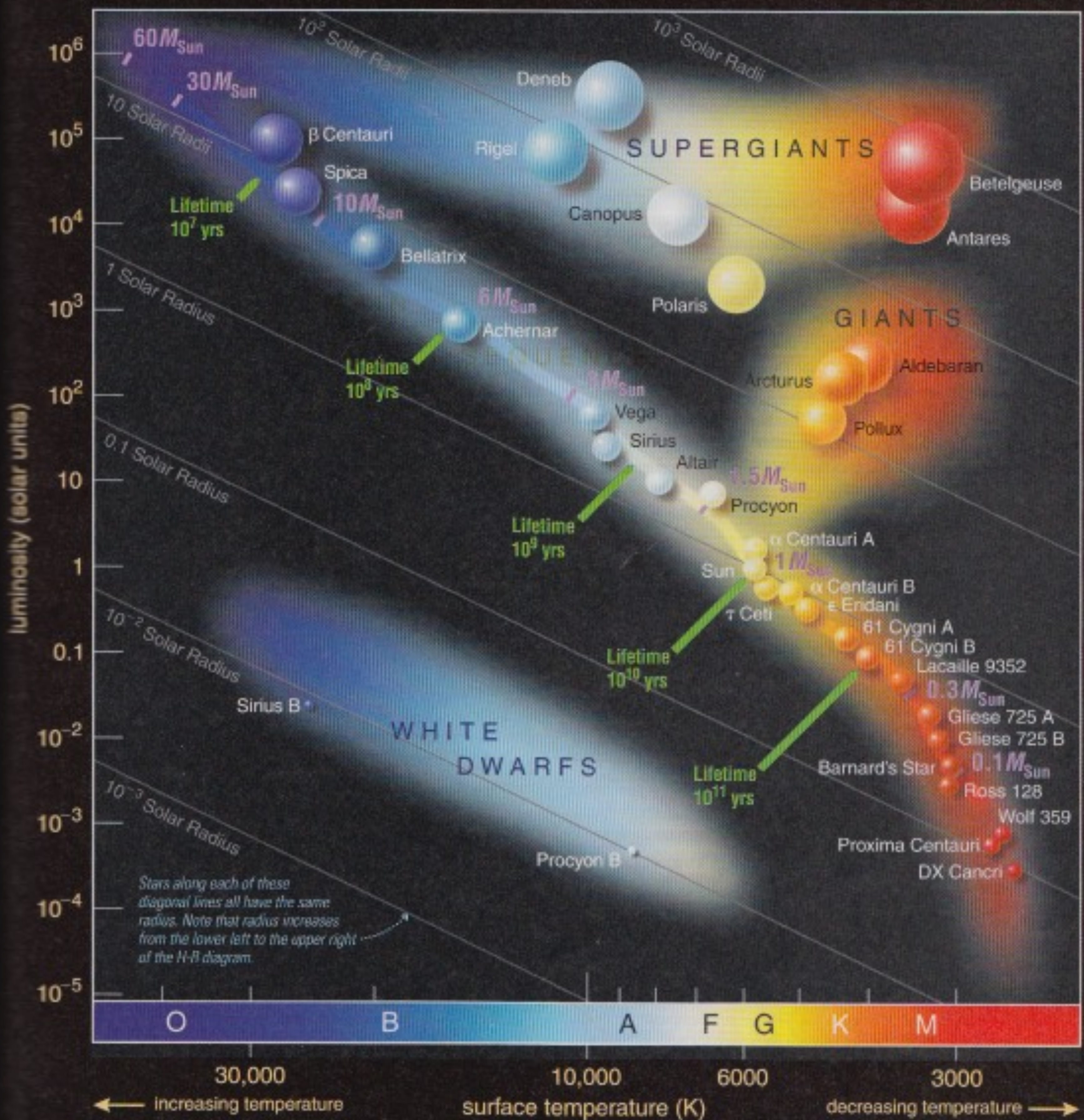
Key Absorption Line Features	Brightest Wavelength (Color)		Typical Spectrum
Lines of ionized helium, weak hydrogen lines	<97 nm (ultraviolet)*	O	
Lines of neutral helium, moderate hydrogen lines	97–290 nm (ultraviolet)*	B	
Very strong hydrogen lines	290–390 nm (violet)*	A	
Moderate hydrogen lines, moderate lines of ionized calcium	390–480 nm (blue)*	F	
Weak hydrogen lines, strong lines of ionized calcium	480–580 nm (yellow)	G	
Lines of neutral and singly ionized metals, some molecules	580–830 nm (red)	K	
Strong molecular lines	>830 nm (infrared)	M	



Where are these stars on the HR diagram? ...it depends on knowing their distances (why?)

⑤ **Masses on the Main Sequence:** Stellar masses (purple labels) decrease from the upper left to the lower right on the main sequence.

⑥ **Lifetimes on the Main Sequence:** Stellar lifetimes (green labels) increase from the upper left to lower right on the main sequence: High-mass stars live shorter lives because their high luminosities mean they burn through their nuclear fuel more quickly.

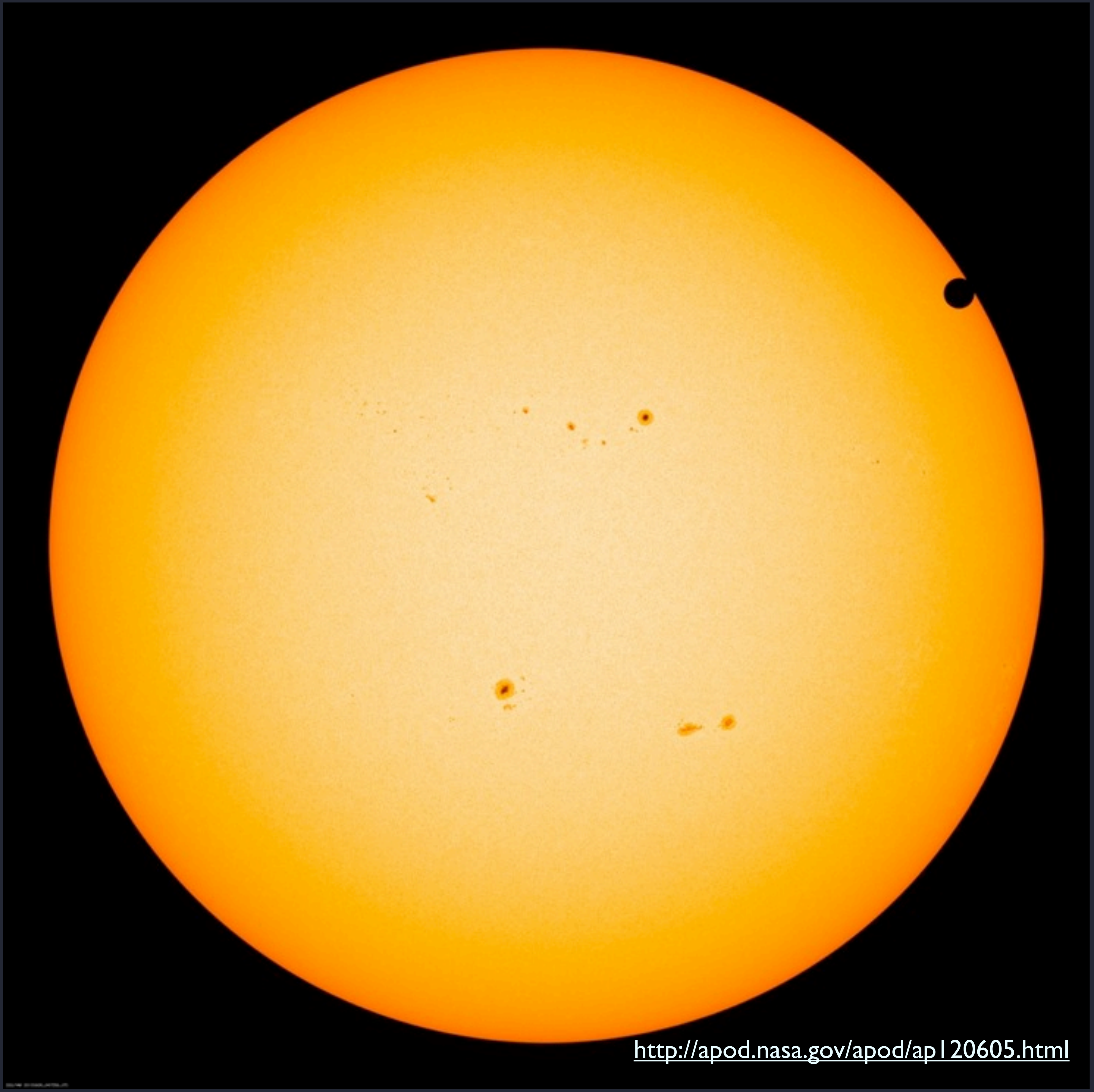


The following slides show the events in a low-mass star's life

large cloud of interstellar gas and dust - giving birth to millions of stars

Hubble Space Telescope: Carina Nebula

http://apod.nasa.gov/apod/ap110110.html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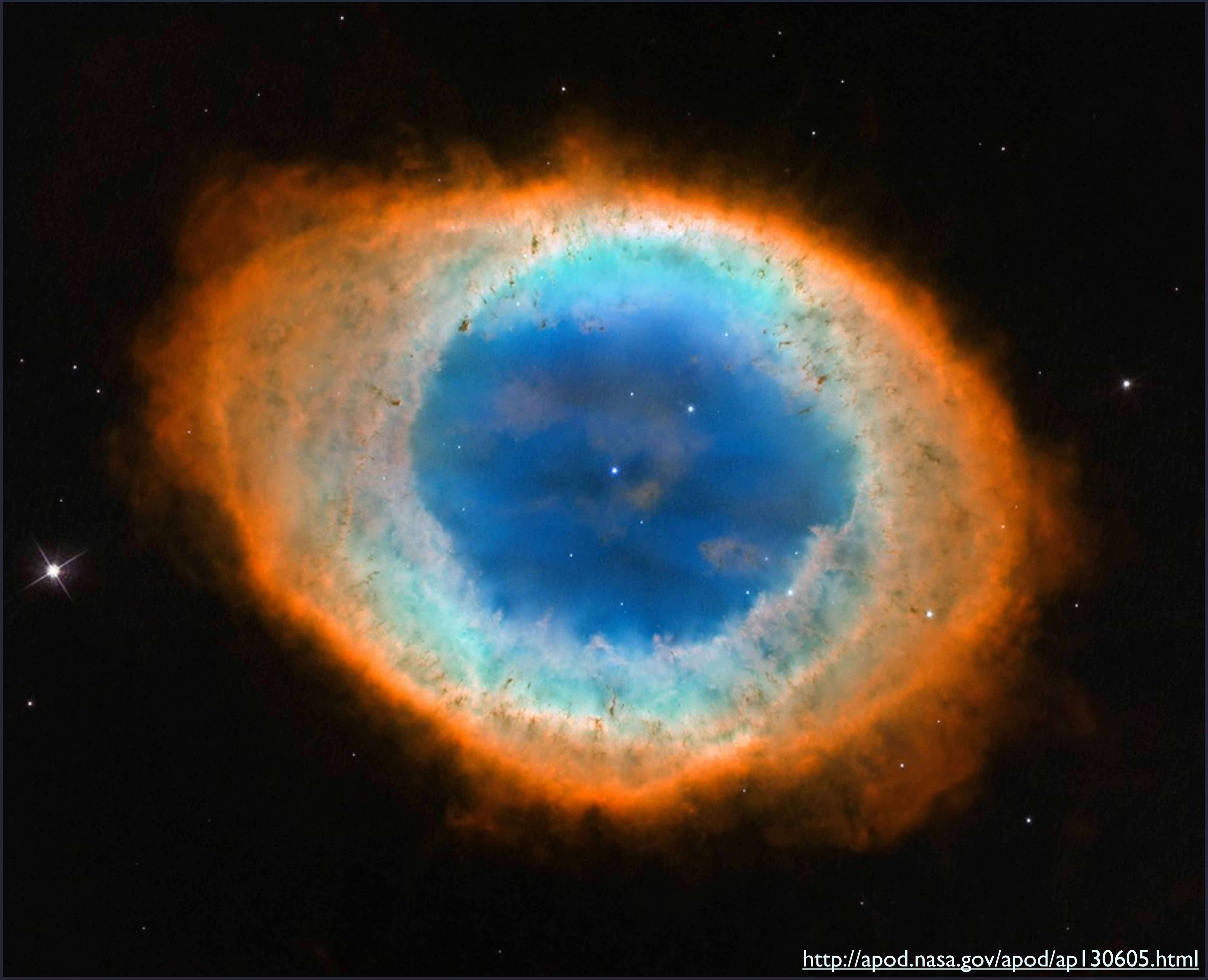
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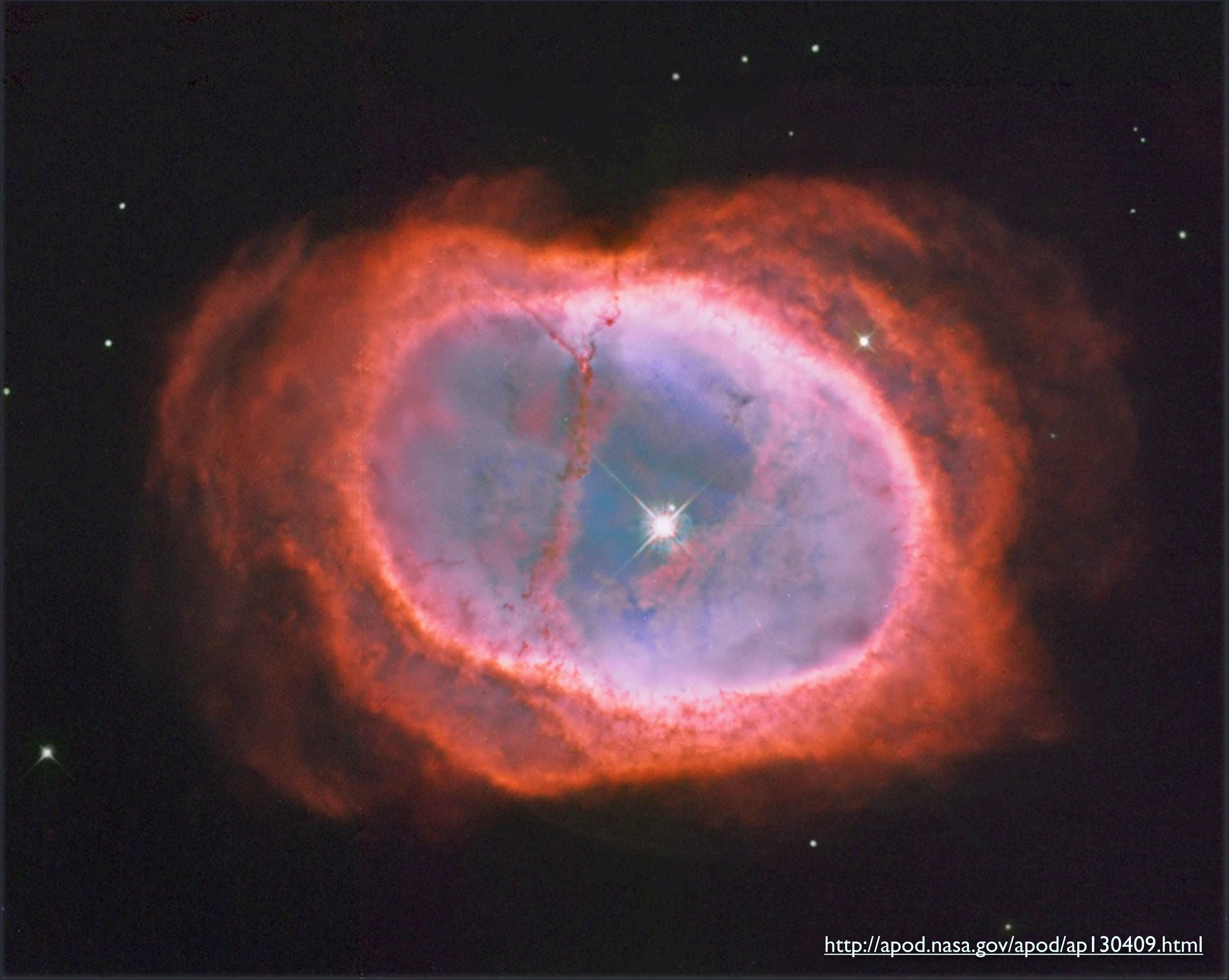

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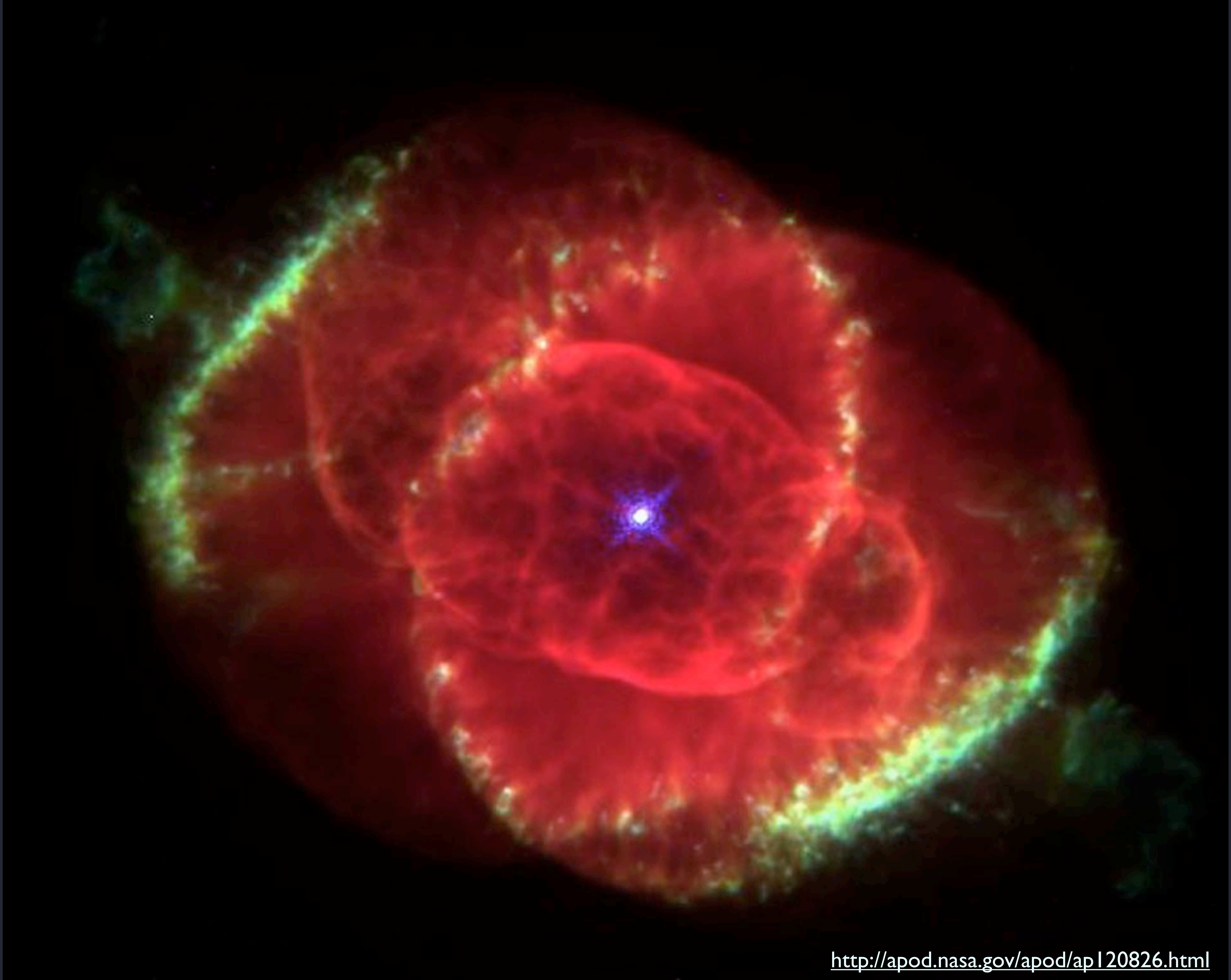


http://apod.nasa.gov/apod/ap120826.html

large cloud of interstellar gas and dust - giving birth to millions of stars: the brightest stars are the most **massive** stars

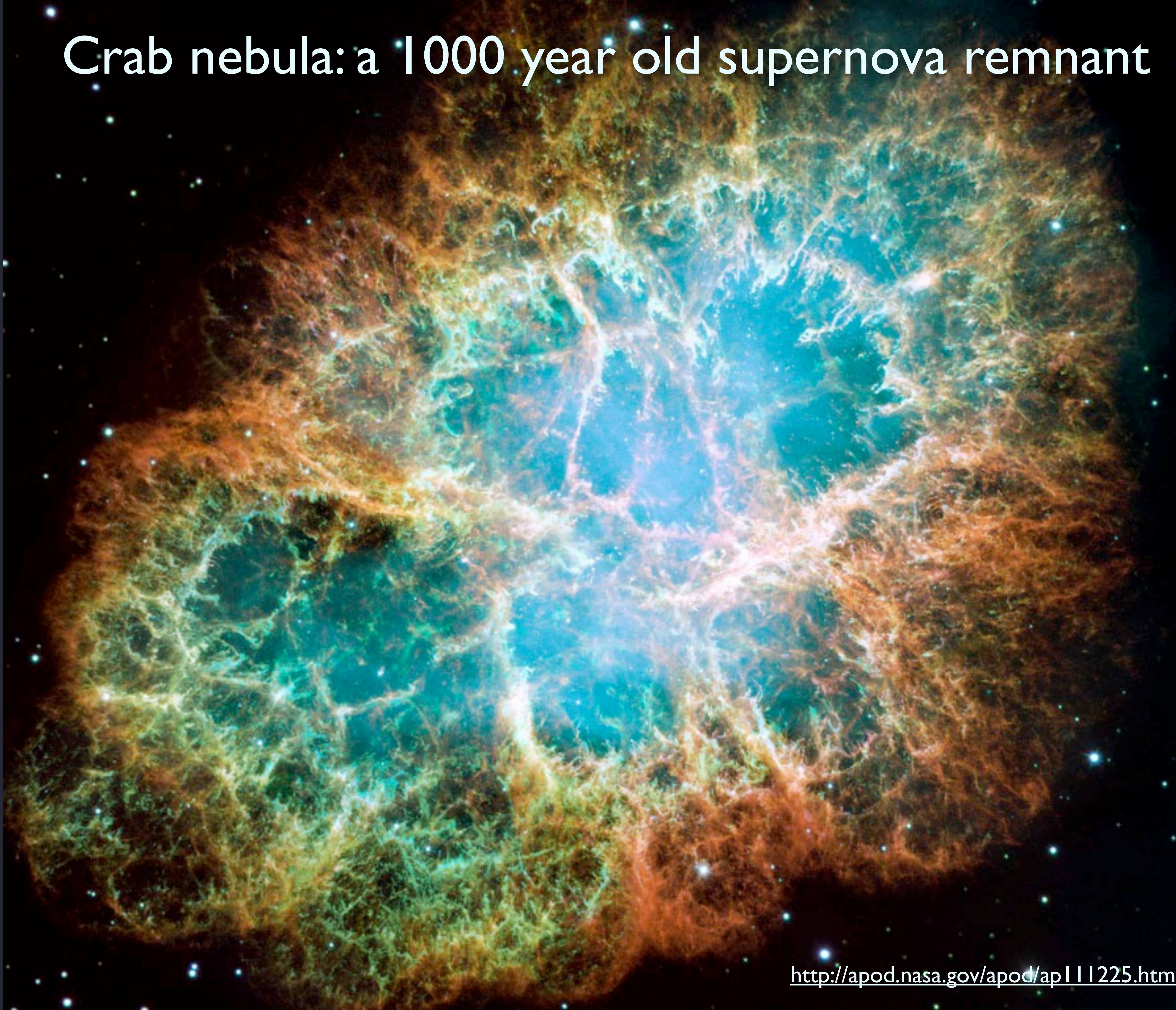
Hubble Space Telescope: Carina Nebula

all the most luminous stars are massive

strong stellar wind ejects much of the massive star's surface into space before its death

http://apod.nasa.gov/apod/ap120816.html

Crab nebula: a 1000 year old supernova remnant



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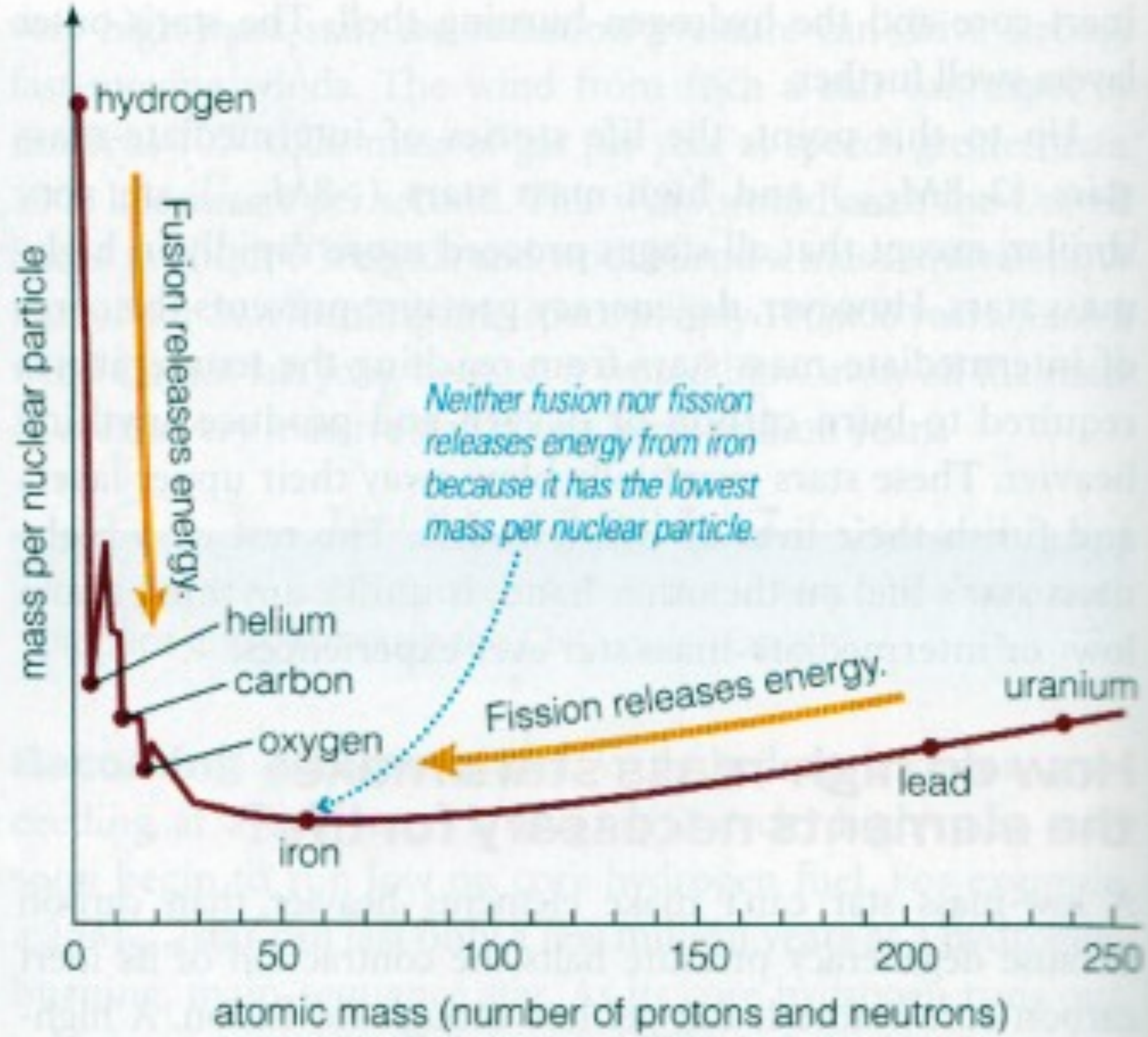


FIGURE 17.14 Overall, the average mass per nuclear particle declines from hydrogen to iron and then increases. Selected nuclei are labeled to provide reference points. (This graph shows the most general trends only. A more detailed graph would show numerous up-and-down bumps superimposed on the general trends. The vertical scale is arbitrary, but shows the general idea.)

reactions that go down the curve produce energy - iron is the end of the line for nuclear energy production

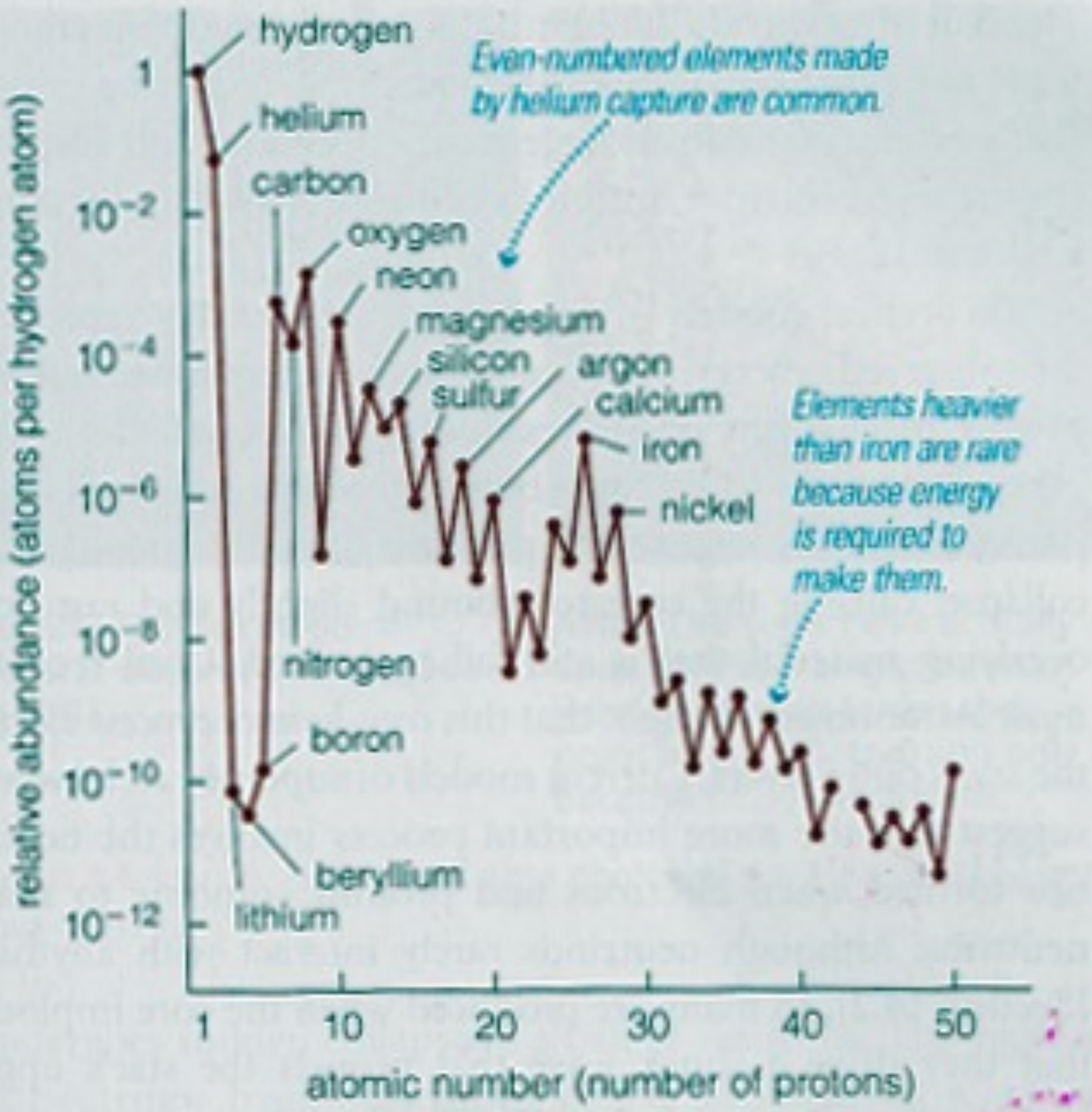


FIGURE 17.15 The observed abundances of elements in the Milky Way, relative to the abundance of hydrogen (set to 1 in this comparison). For example, the graph shows a nitrogen abundance of about 10^{-4}, which means there are about 10^{-4} = 0.0001 times as many nitrogen atoms as hydrogen atoms.

the amounts (or “abundances”) of each element - strong evidence that we understand how elements are produced, primarily in massive stars

We didn't get to the following in class, but you've read about it, and we've touched on the physics: main sequence lifetimes of stars are directly related to their luminosities and masses (with luminosities dominating: high luminosity stars use up their fuel quickly and have short lives)

We can use this fact to figure out how old star clusters are

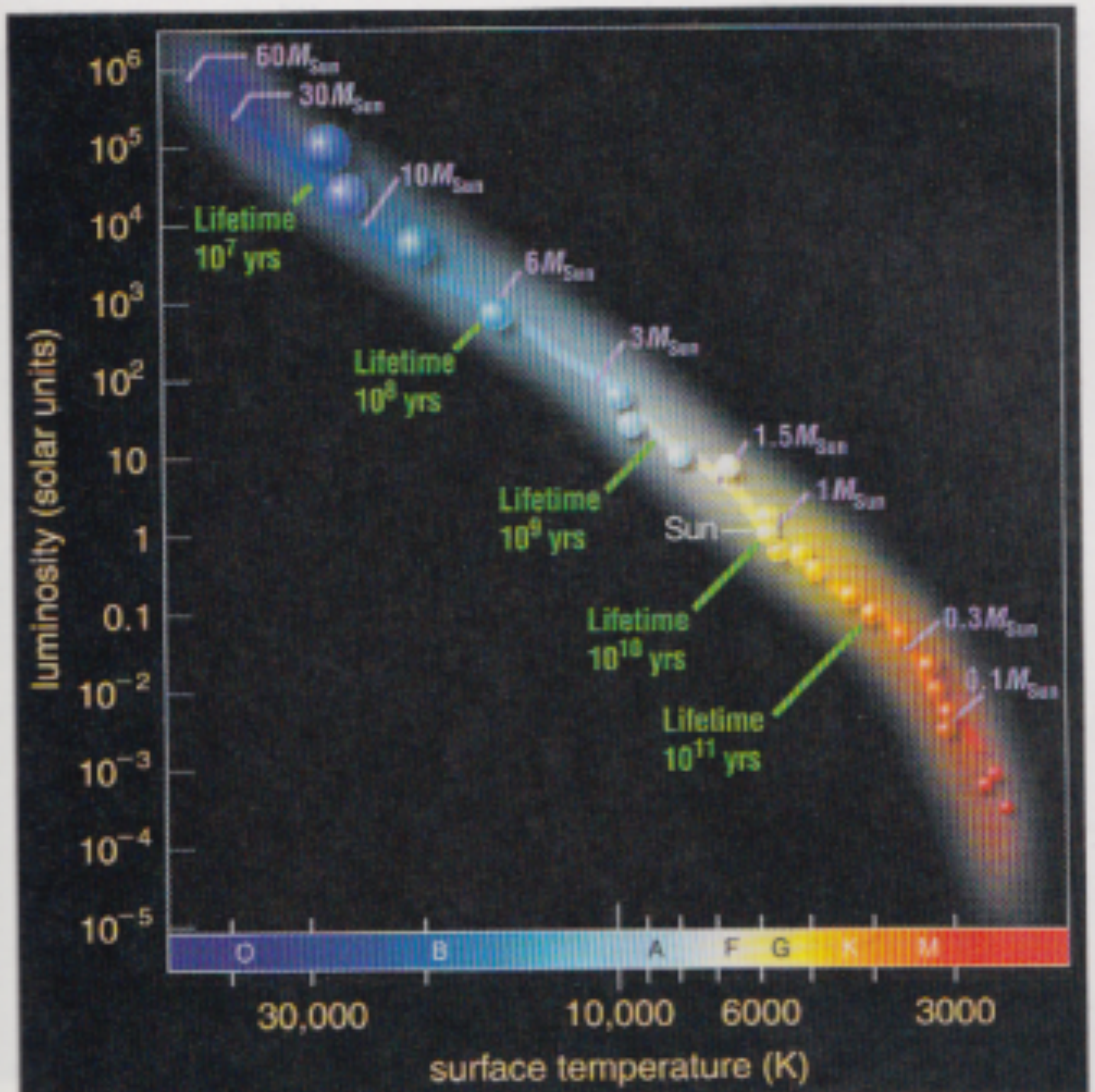
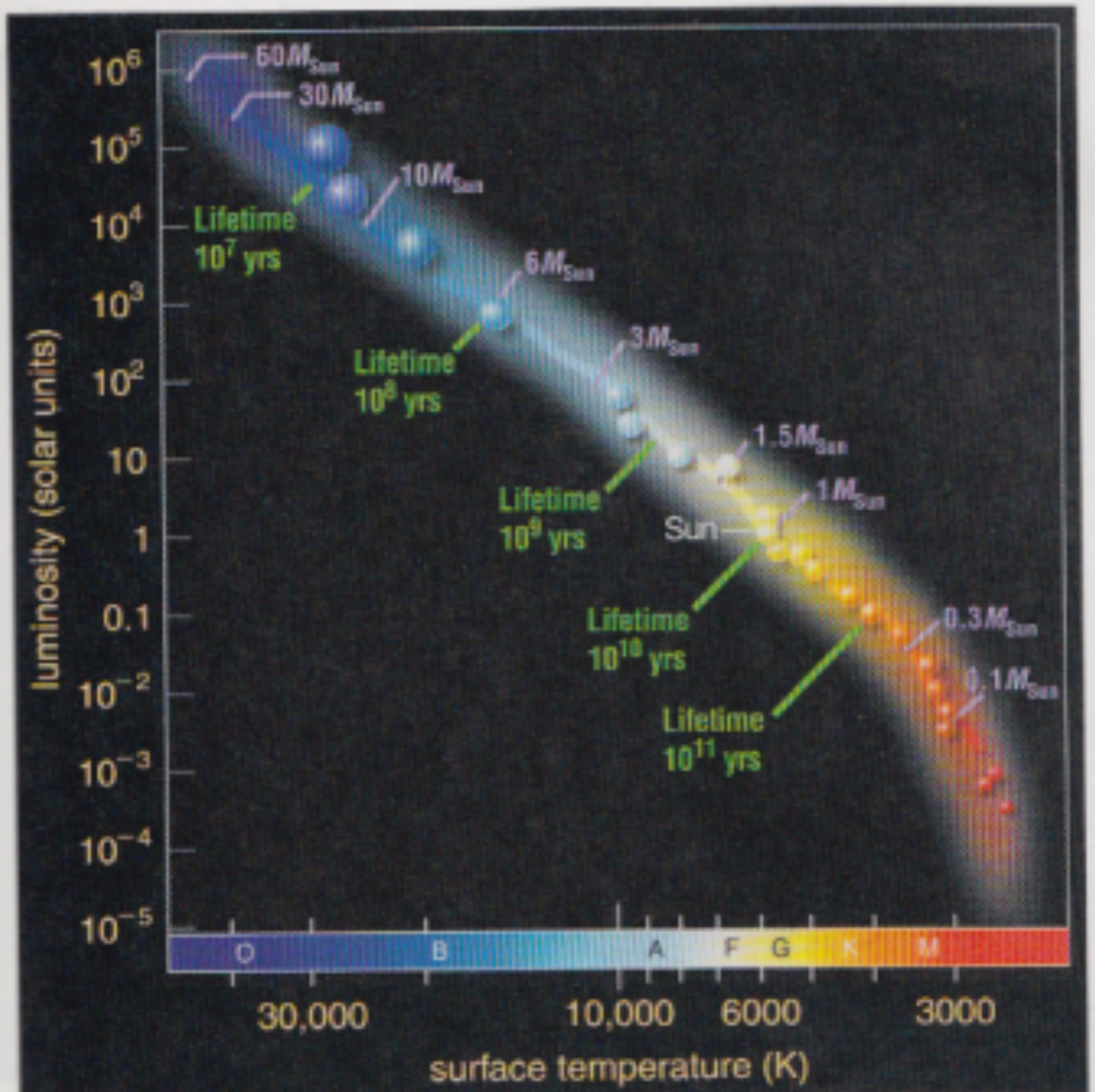


FIGURE 15.11 The main sequence from Figure 15.10 is isolated here so that you can more easily see how masses and lifetimes vary along it. Notice that more massive hydrogen-burning stars are brighter and hotter but have shorter lifetimes. (Stellar masses are given in units of solar masses: $1M_{Sun} = 2 \times 10^{30}$ kg.)

http://apod.nasa.gov/apod/ap130501.html



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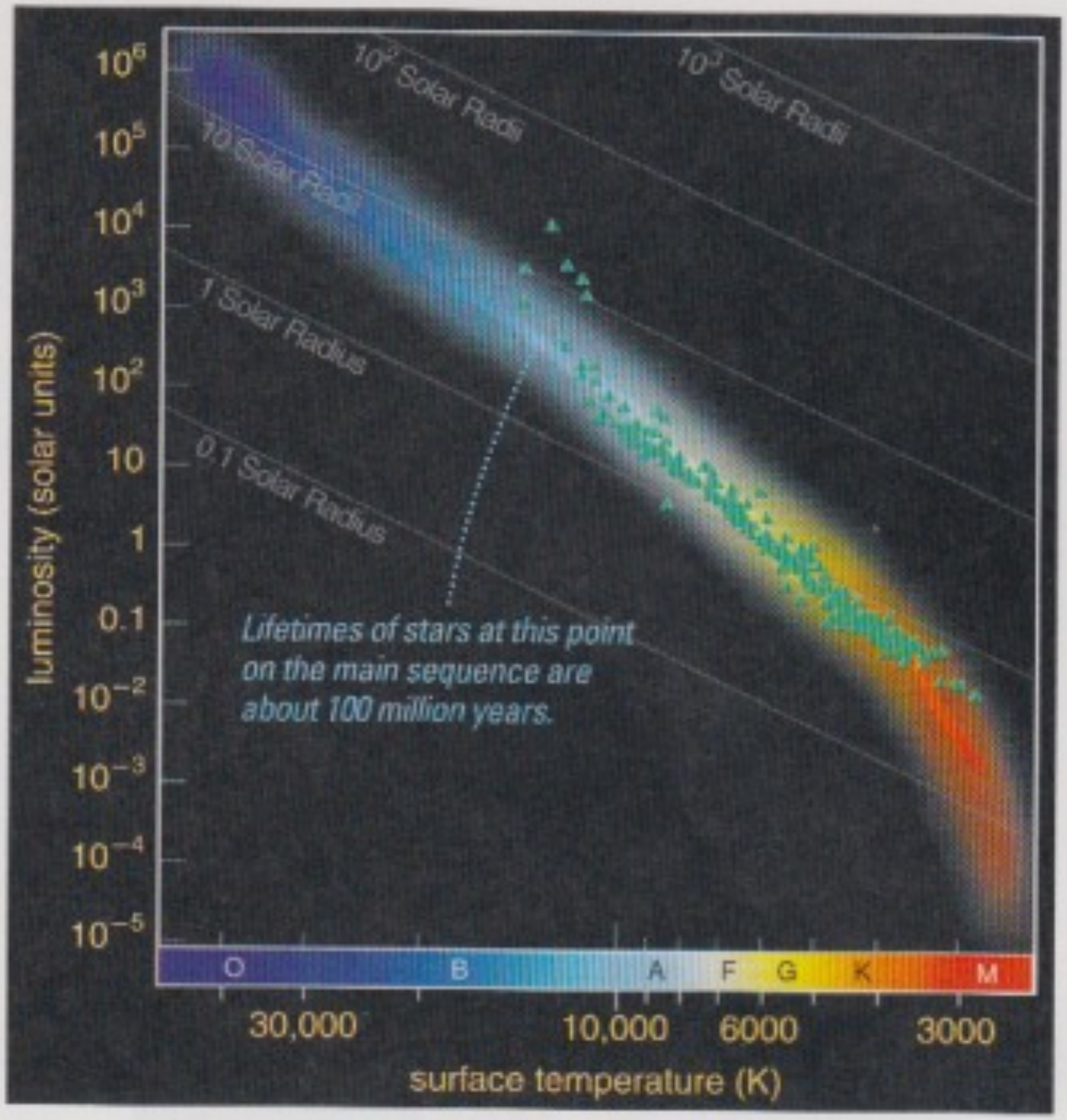
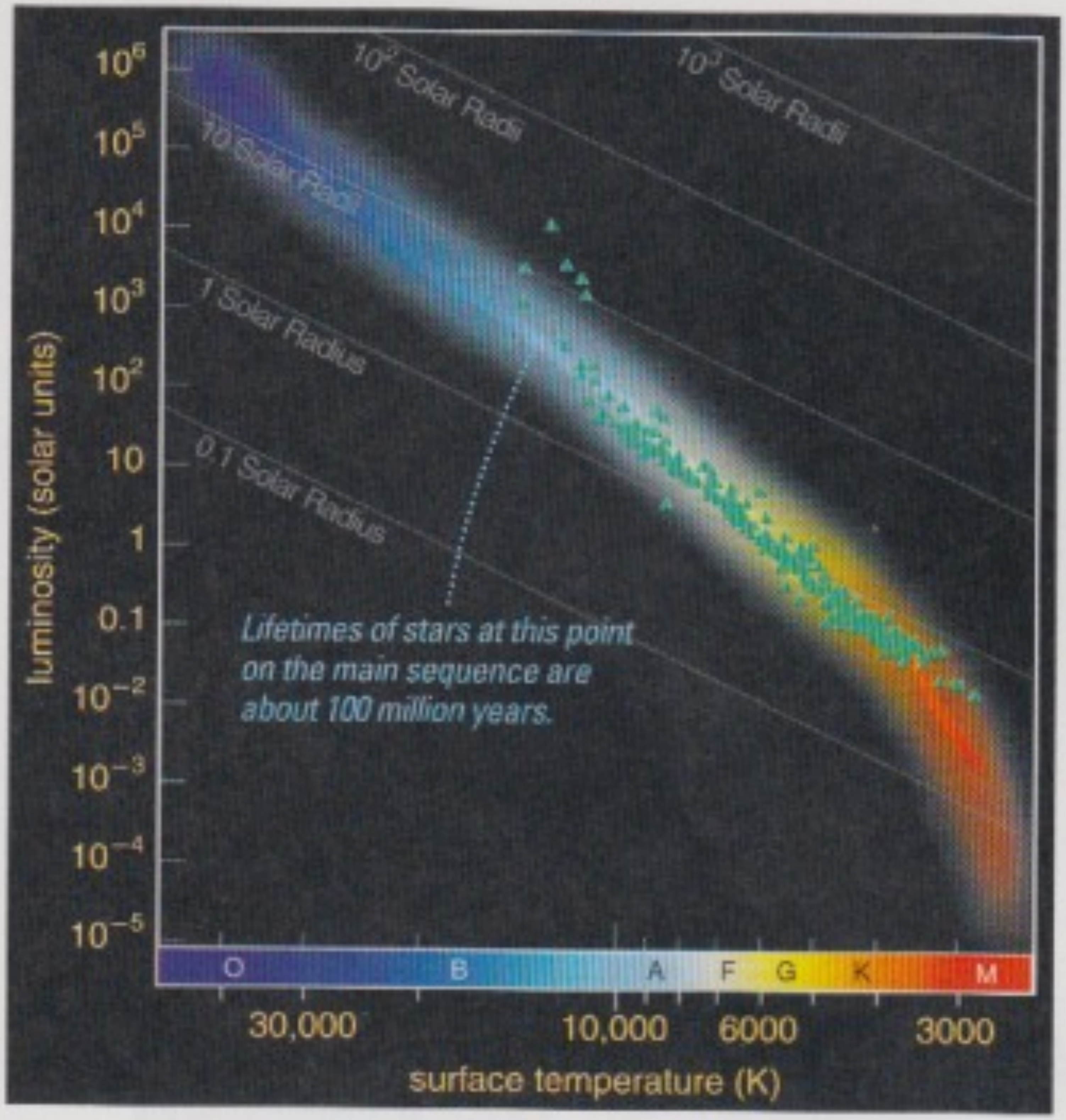


FIGURE 15.18 An H-R diagram for the stars of the Pleiades. Triangles represent individual stars. The Pleiades cluster is missing its upper main-sequence stars, indicating that these stars have already ended their hydrogen-burning lives. The main-sequence turnoff point at about spectral type B6 tells us that the Pleiades are approximately 100 million years old.



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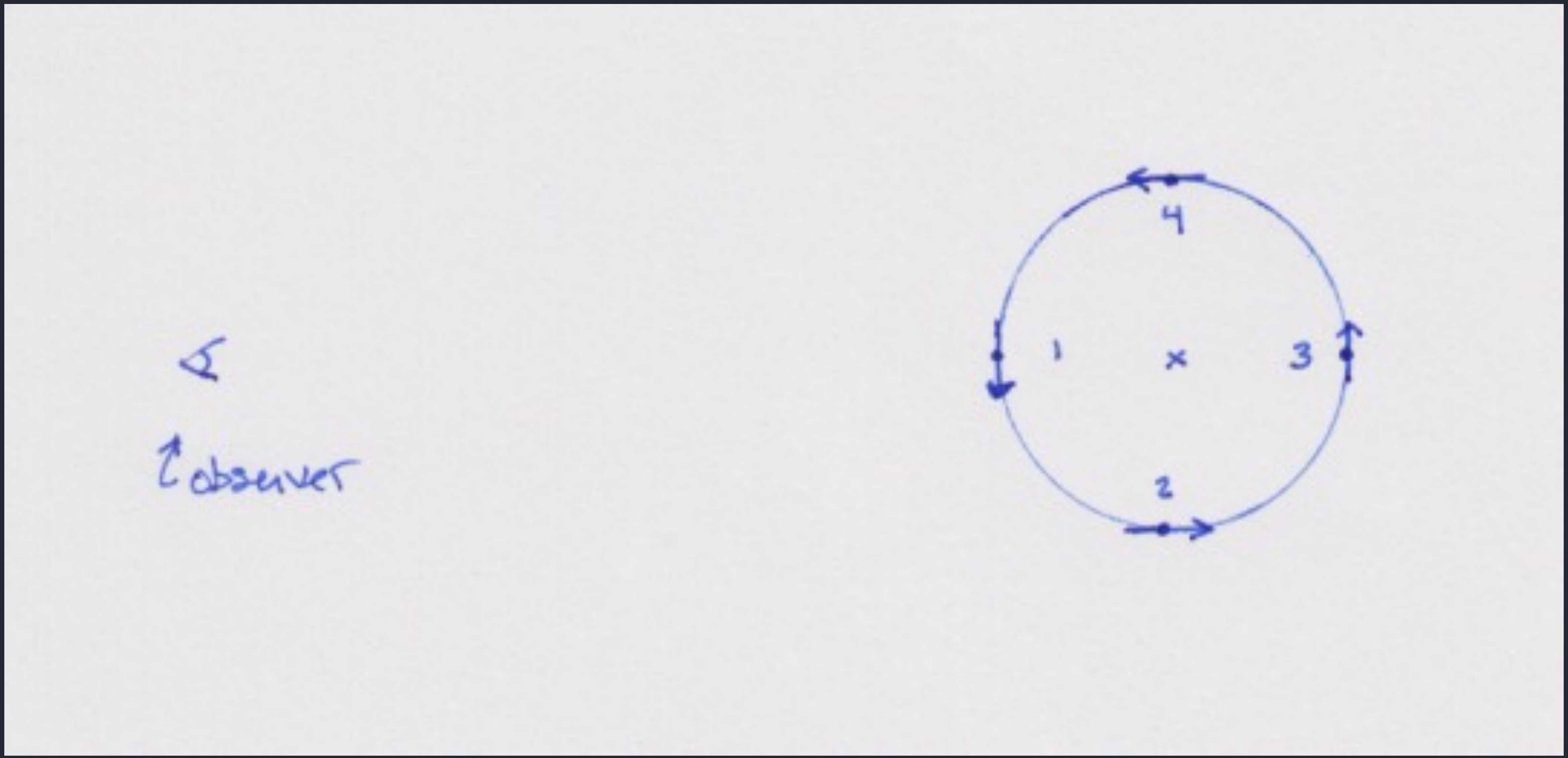
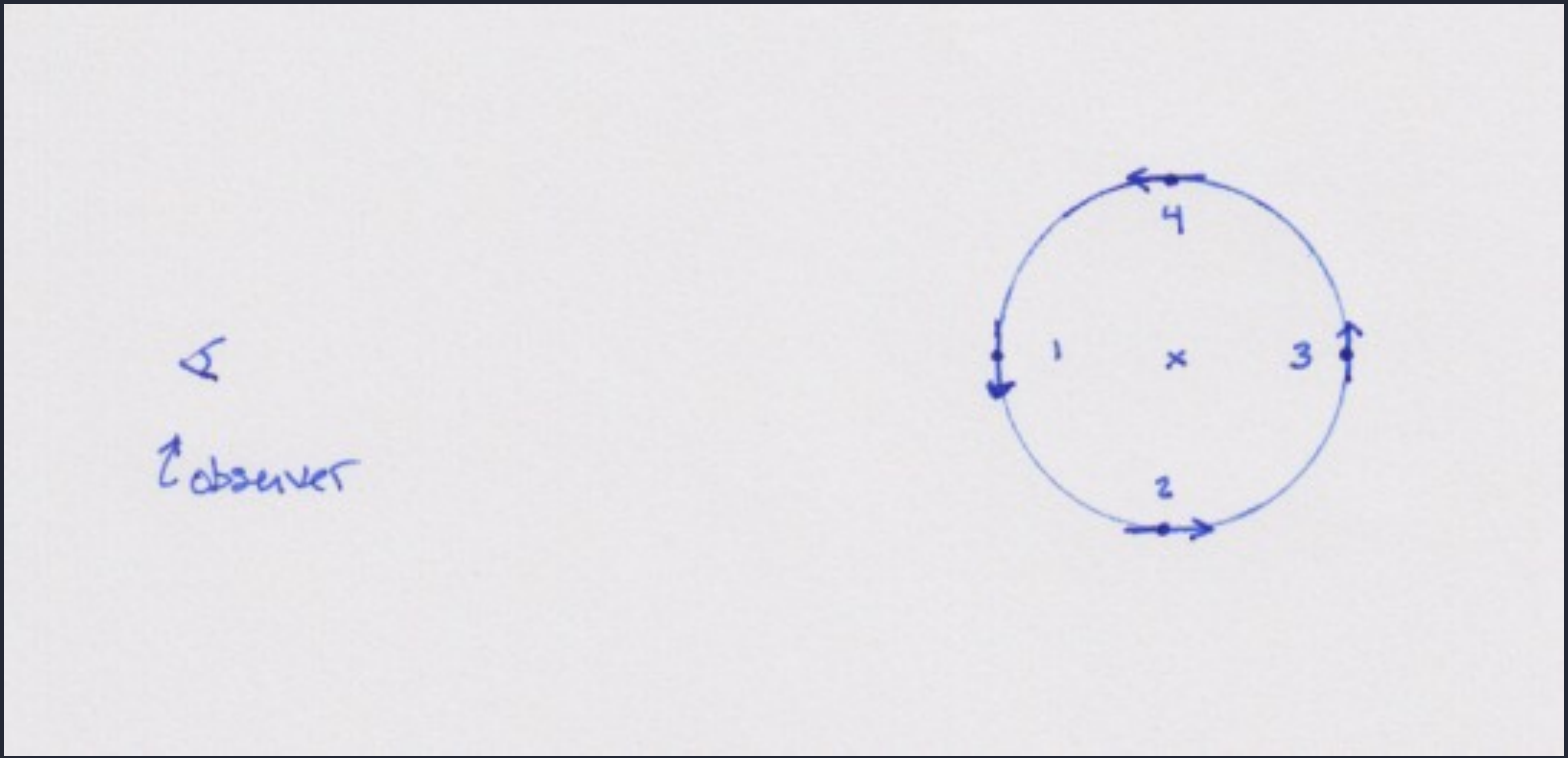
the following slides show a star orbiting in a binary system and ask you some questions about its Doppler shift (and eventually, about its companion and their masses) - see if you can answer them

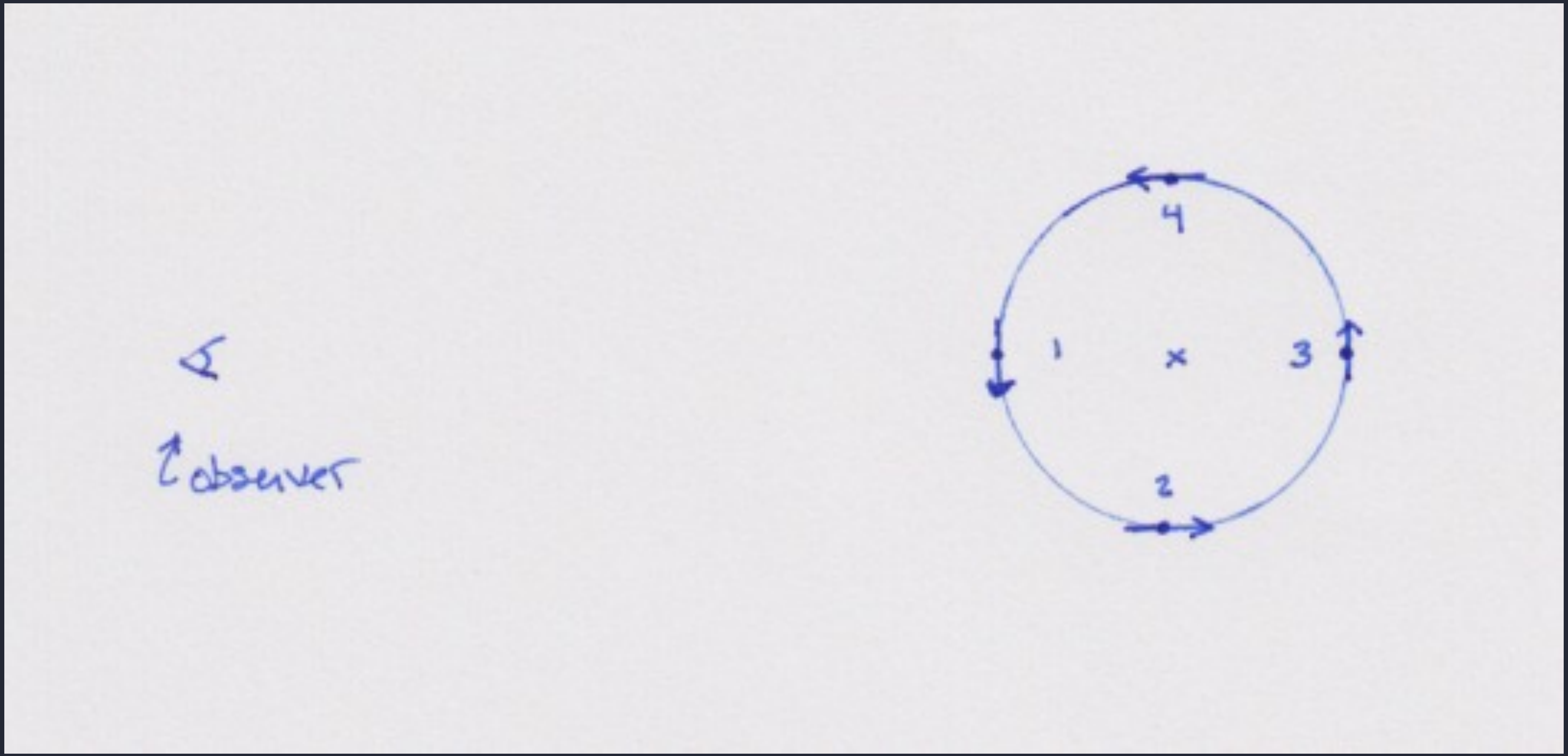
At which position (1, 2, 3, or 4) does the star have the biggest blueshift?



At which position (1, 2, 3, or 4) does the star have the no Doppler shift?

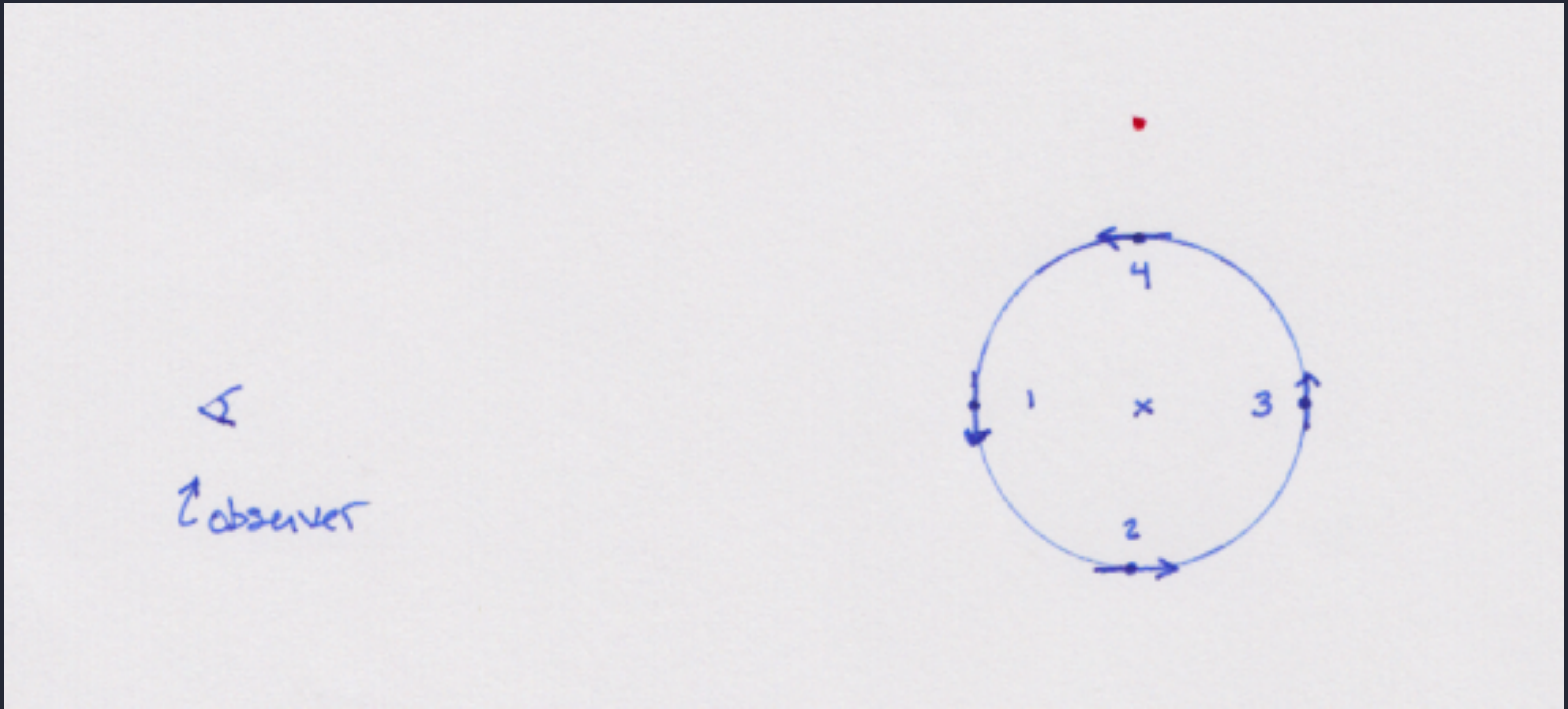


what about the other star in the binary system? See the next slide.

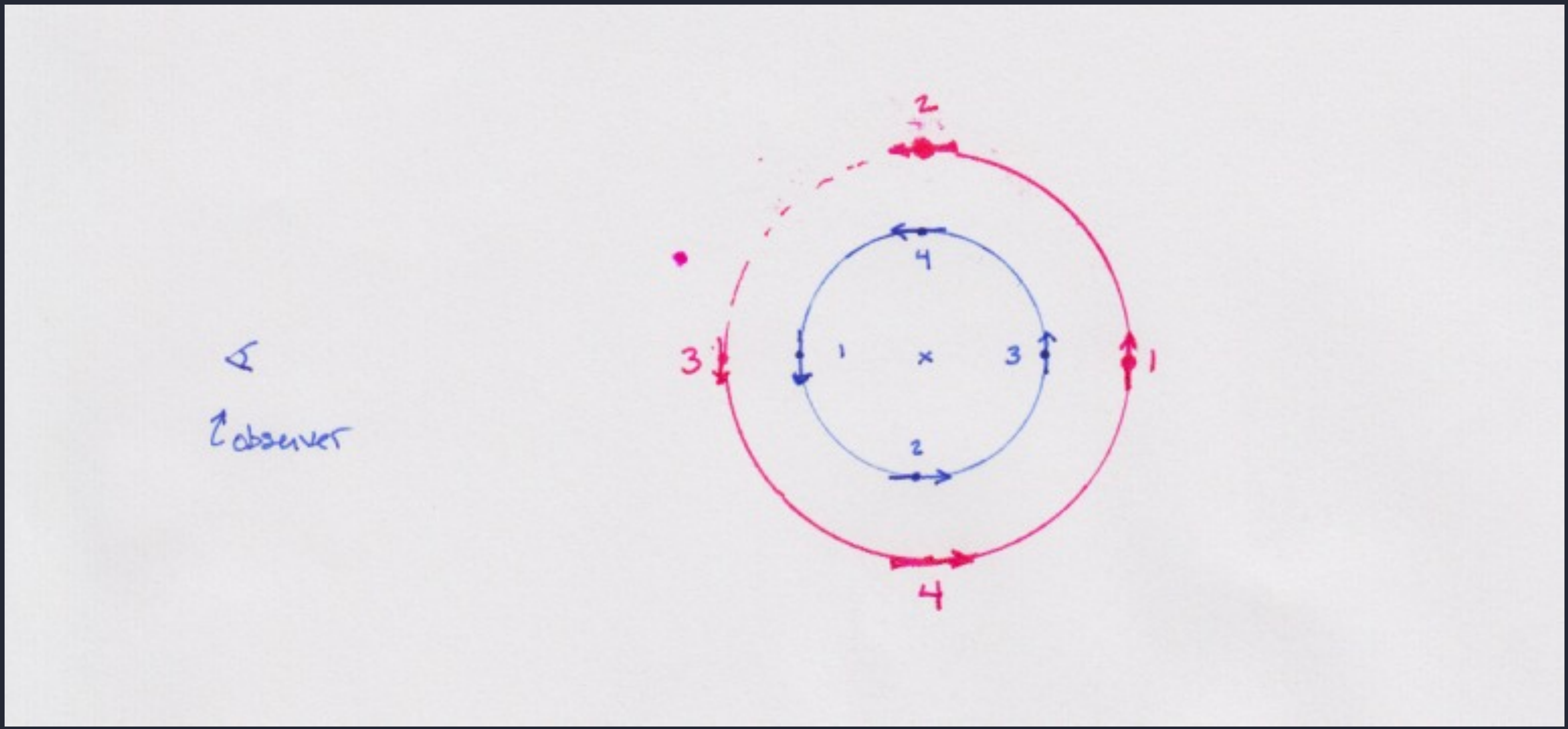


the “x” is the center of mass of the system

What position for the blue star does the red star's position correspond to? 1, 2, 3, or 4?



What is the mass of the red star relative to the blue star (roughly)?



The same **spectroscopic binary**, on two successive nights