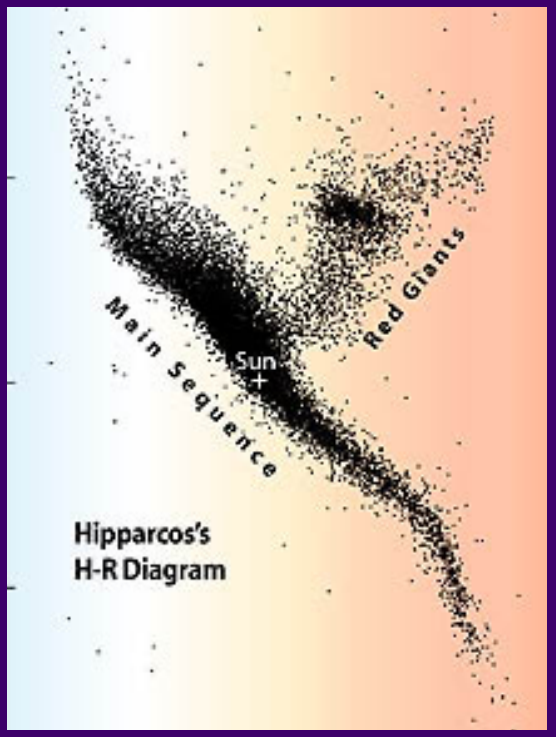
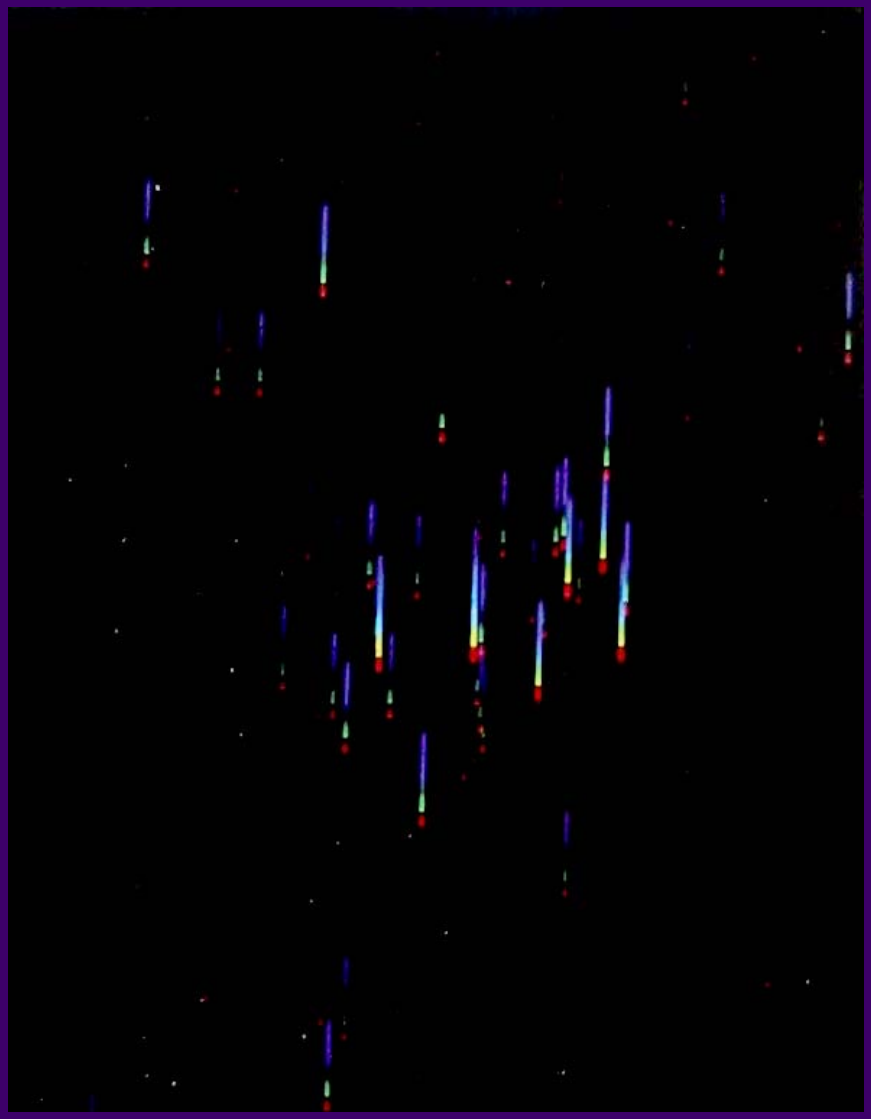


Classifying the Stars

Today:

- Stellar spectra: temperatures and compositions
- Are hotter stars brighter? (H-R diagrams)
- Determining sizes of stars
- Classifying stars, looking for patterns

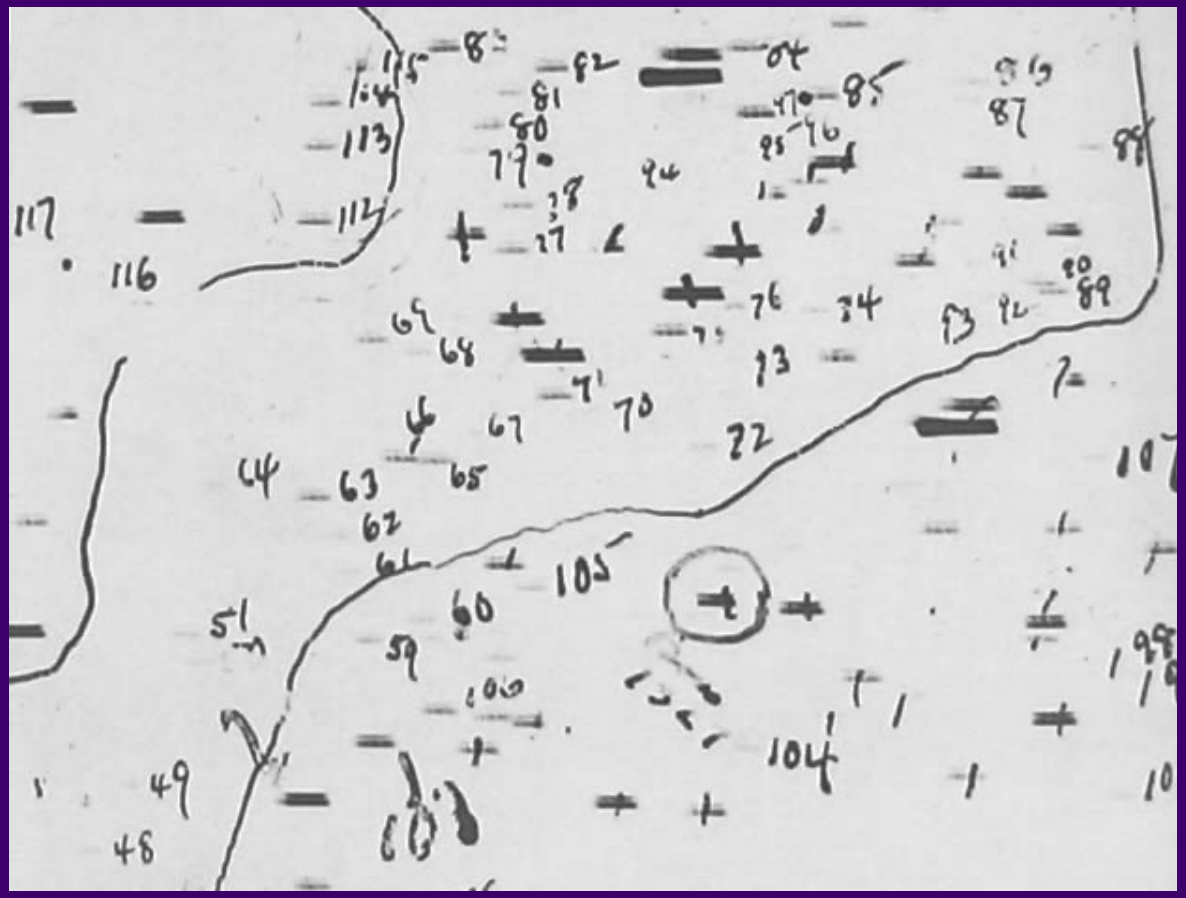
Pleiades Spectra



Edward Pickering and Harvard “computers,” 1890’s - 1920’s

Annie Jump Cannon

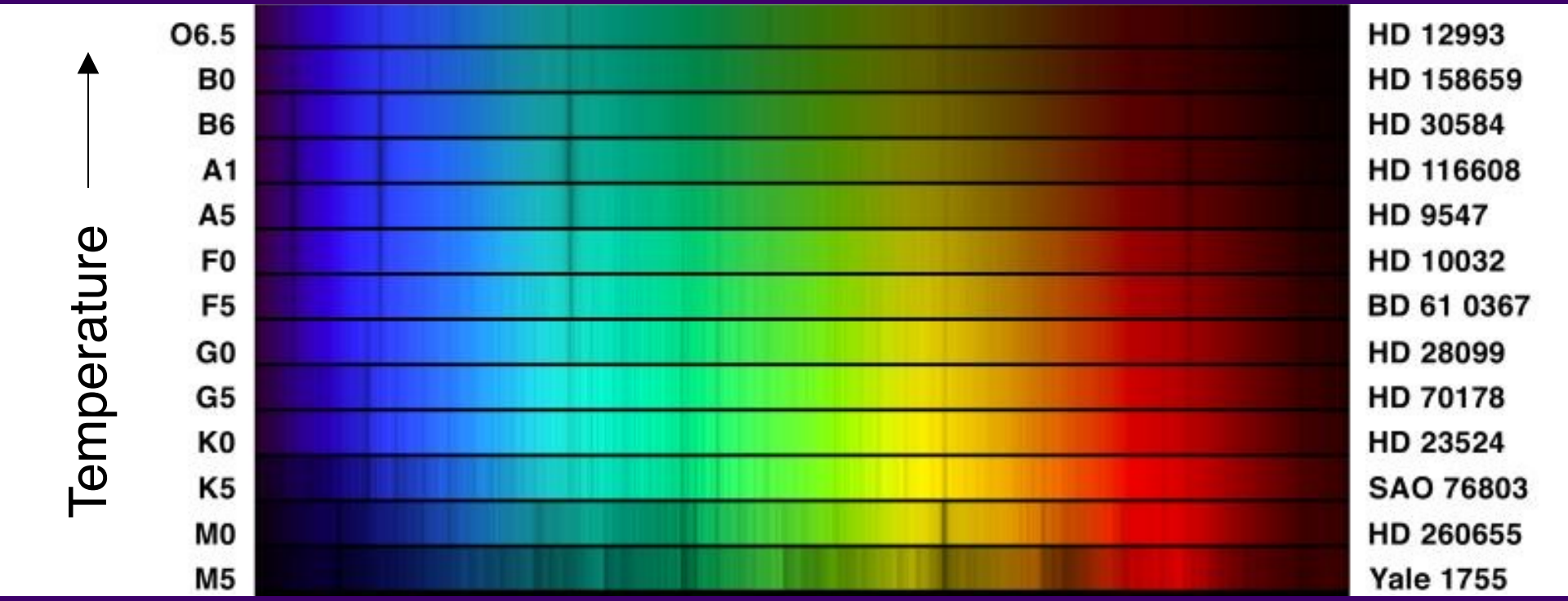
Classifying stellar spectra



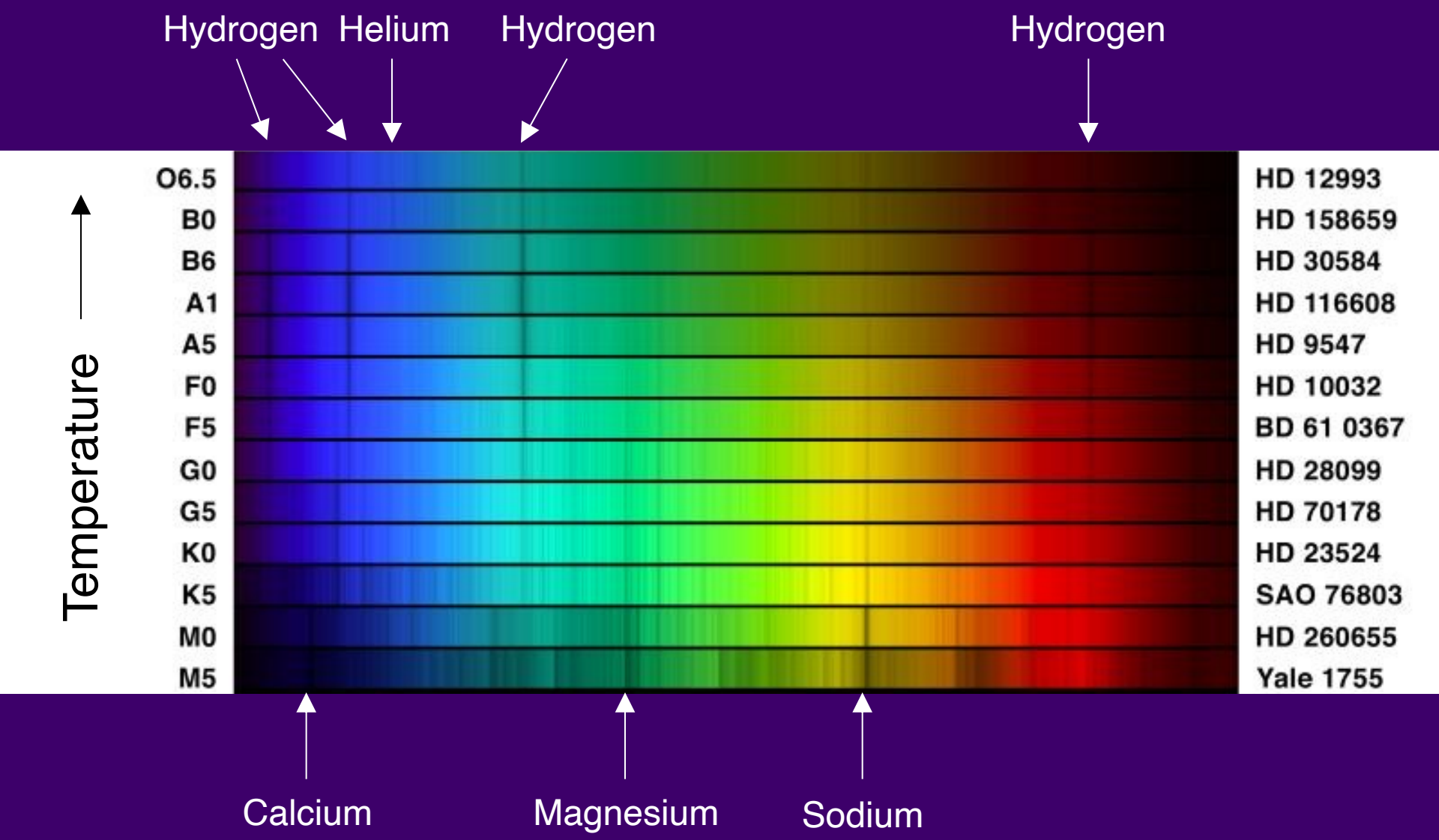
Annie Jump Cannon

Classifying Stellar Spectra

"OBAFGKM"



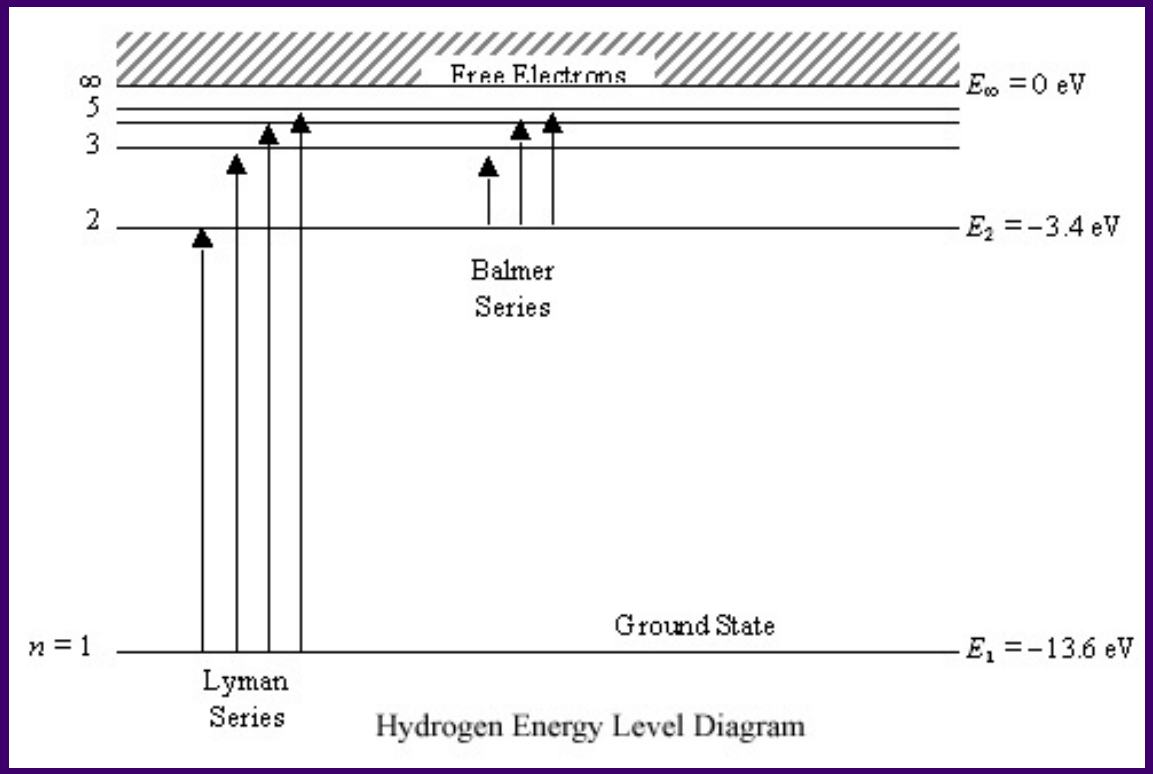
What are the stars made of?



“We understand the possibility of determining [celestial bodies’] shapes, their distances, their sizes and motions, whereas never, by any means, will we be able to study their chemical composition.

--Auguste Comte (philosopher), 1835

How does temperature affect spectral lines?

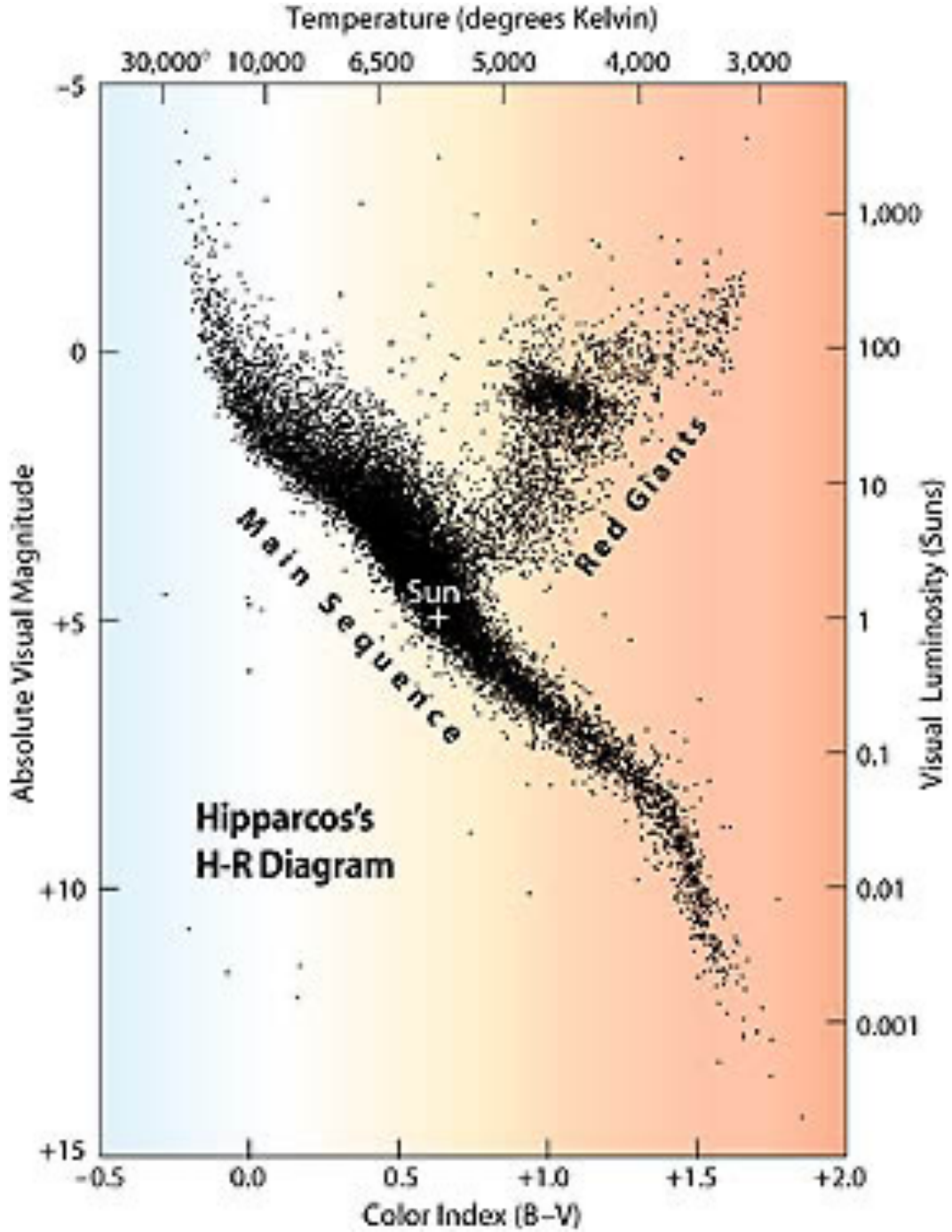


Cecilia Payne at Harvard, 1924

In the sun, only one H atom in a million is in level 2, ready to absorb visible light!

The Universal Recipe of the Stars

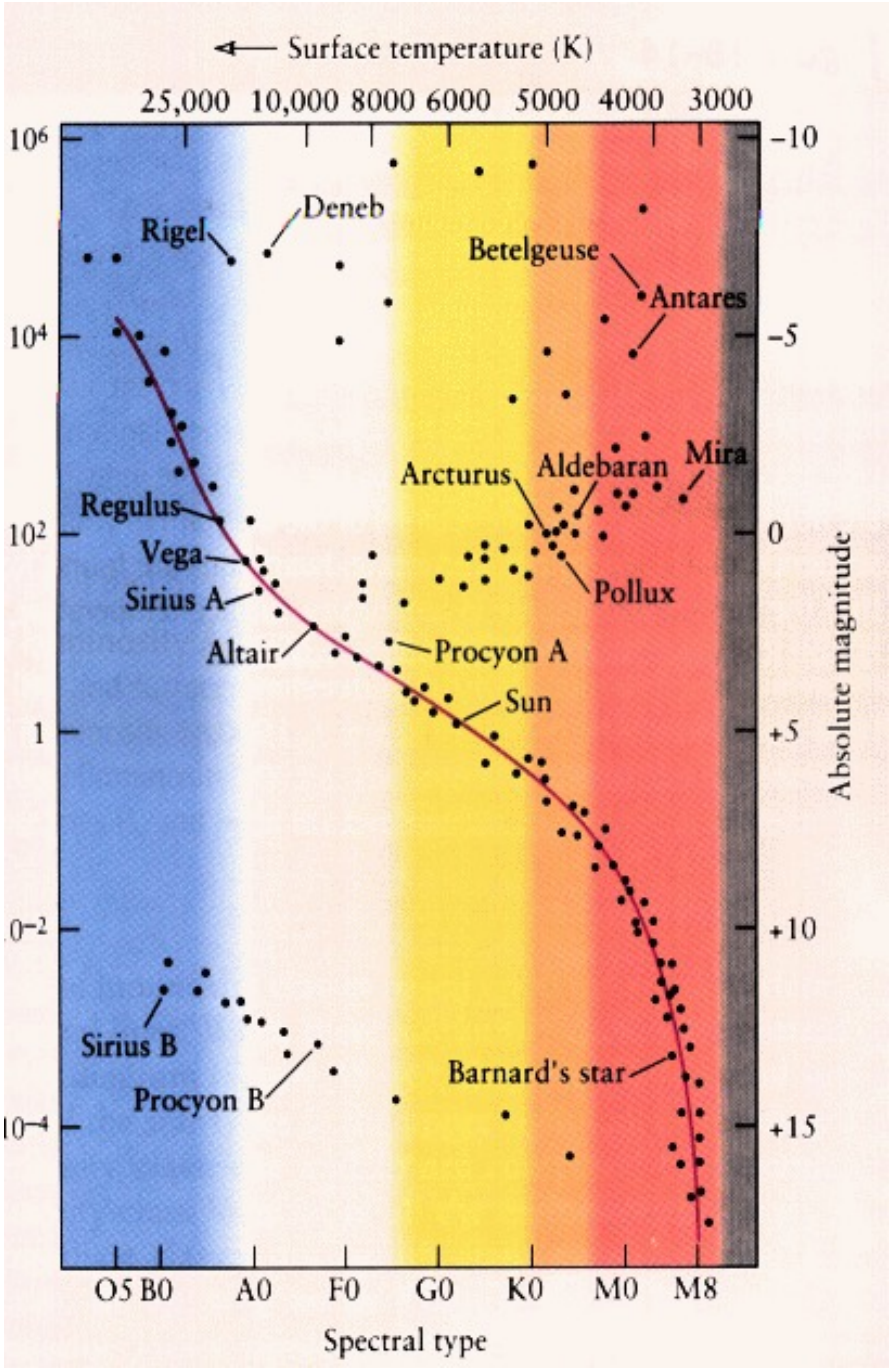
- 74% hydrogen (by mass)
- 25% helium
- 1% other elements (for most stars)



Are hotter stars brighter?

Plot known stars on "Hertzsprung-Russell (H-R) diagram". Luminosity increases vertically; temperature increases to the *left*.

Most stars' dots lie along a diagonal ("main sequence"), the hotter the brighter.



H-R Diagram Patterns

Luminosity =

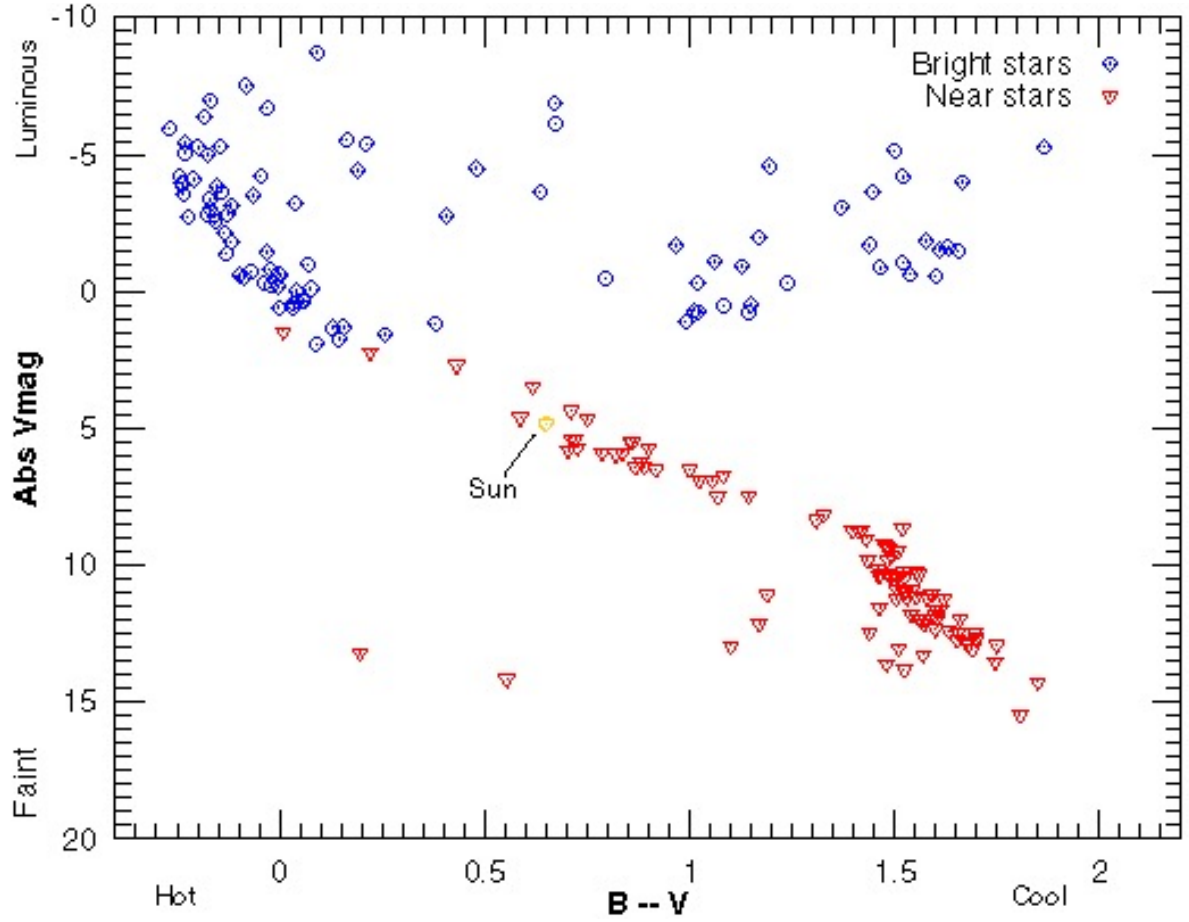
(constant) x
(surface area) x
(temperature)^4

For a given size, hotter implies brighter.

A bright, cool star must be unusually large (“red giant”).

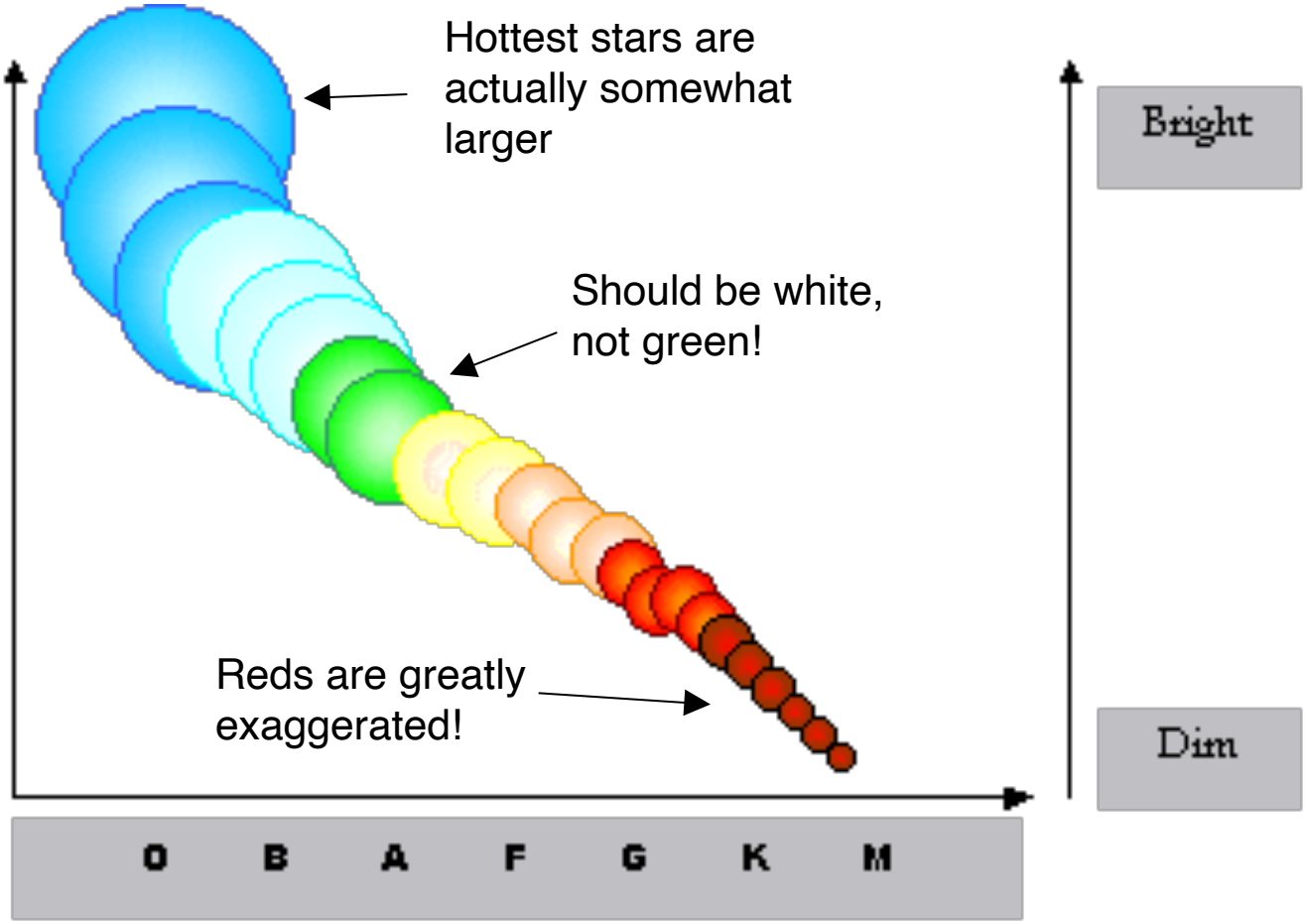
A faint, hot star must be unusually small (“white dwarf”).

H-R Diagram Patterns



Most of the stars near us are fainter (and cooler) than the sun; most of the familiar stars in the night sky are brighter than the sun.

Sizes of Main-Sequence Stars

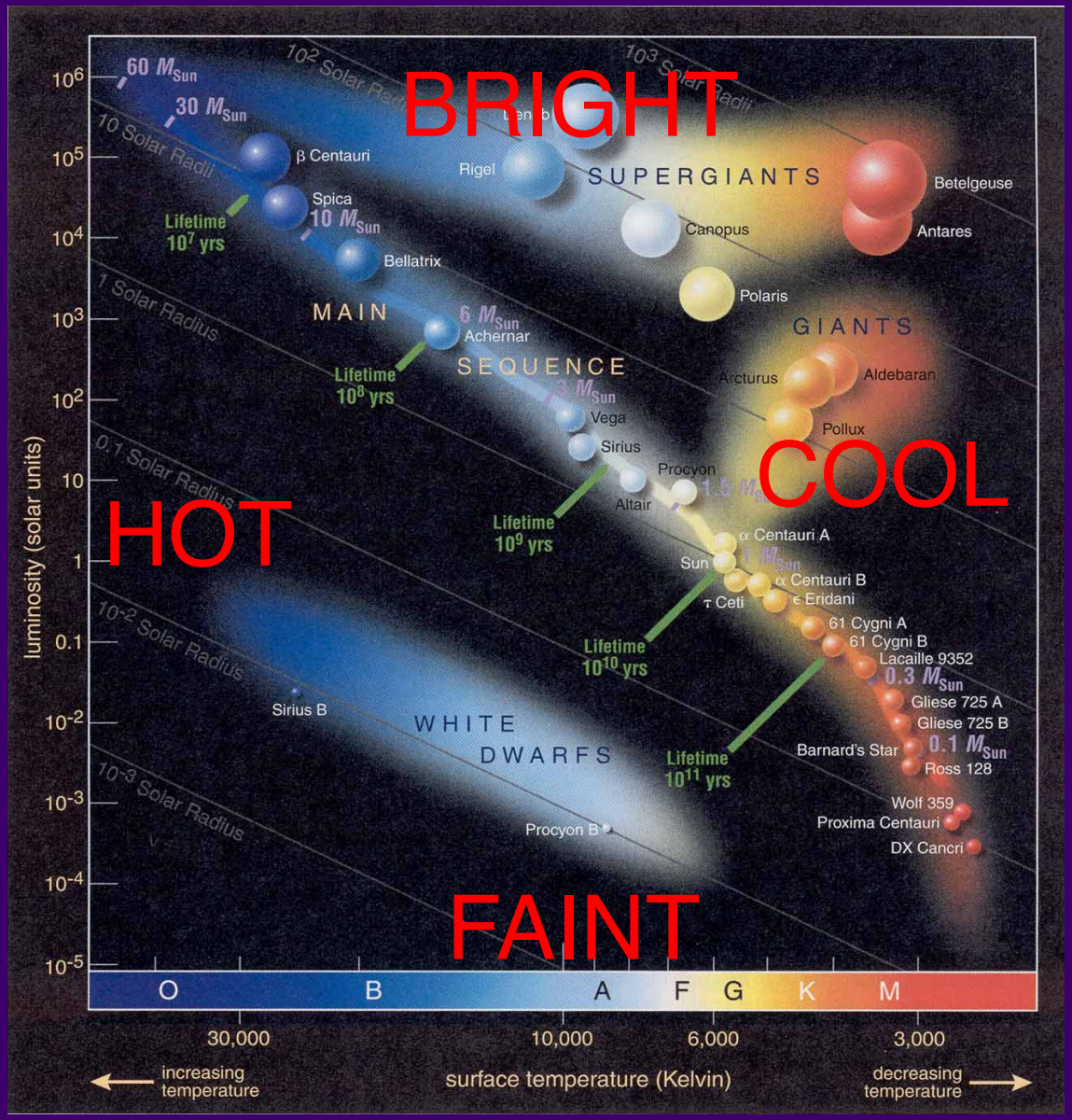


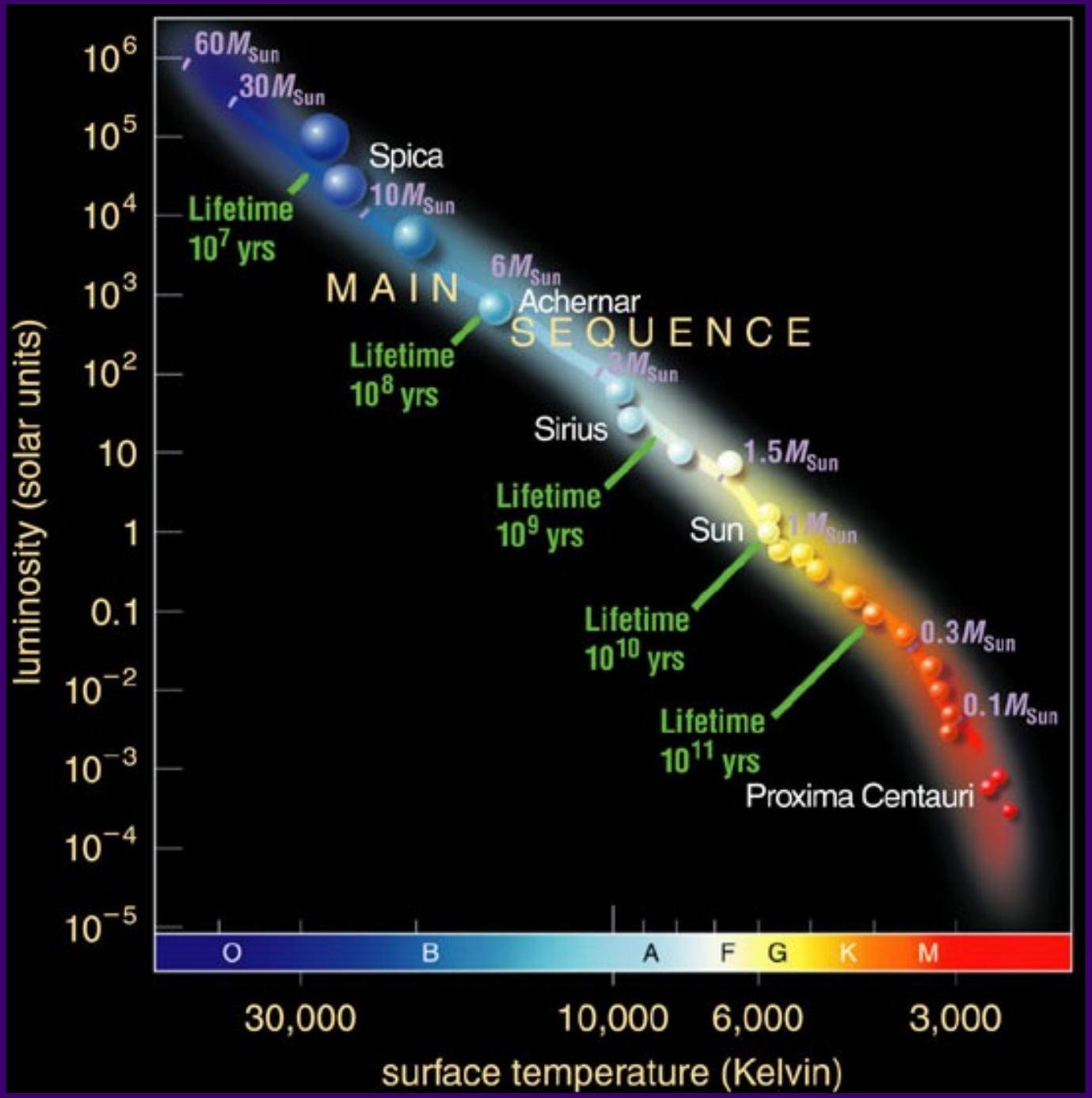
Summary of Stellar Properties

Distance	Measure using parallax (if close enough)
Velocity	Proper motion and Doppler shift
Luminosity	Calculate from apparent brightness and distance
Temperature	From overall color or spectral class
Composition	From detailed analysis of spectral lines
Size	Calculate from temperature and luminosity

The Hertzsprung-Russell Diagram

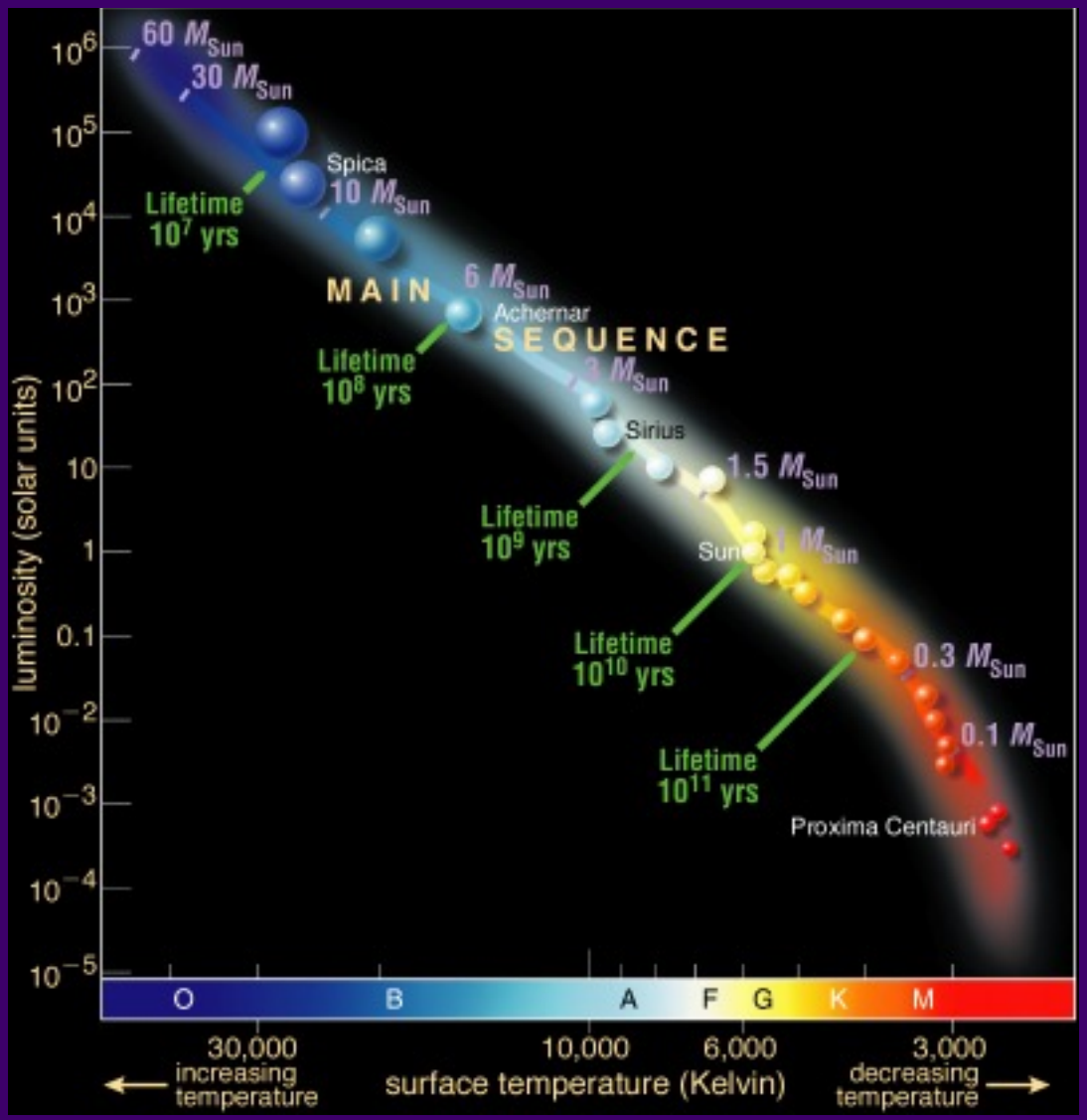
- A very useful diagram for understanding stars
- We plot two major properties of stars:
  - Temperature (x) vs. Luminosity (y)
  - Spectral Type (x) vs. Absolute Magnitude (y)
- Stars tend to group into certain areas



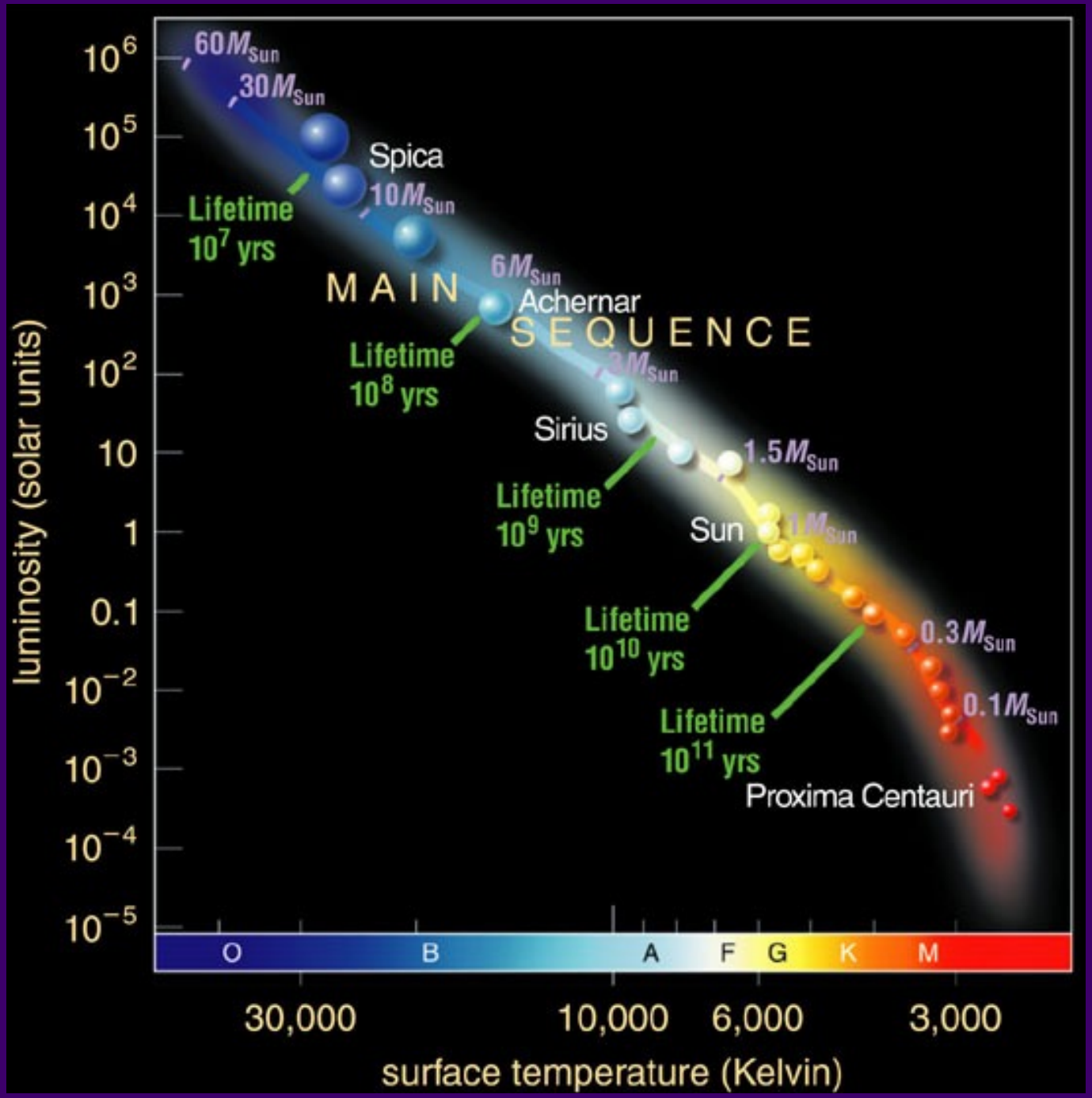


Normal hydrogen-burning stars reside on the ***main sequence*** of the H-R diagram

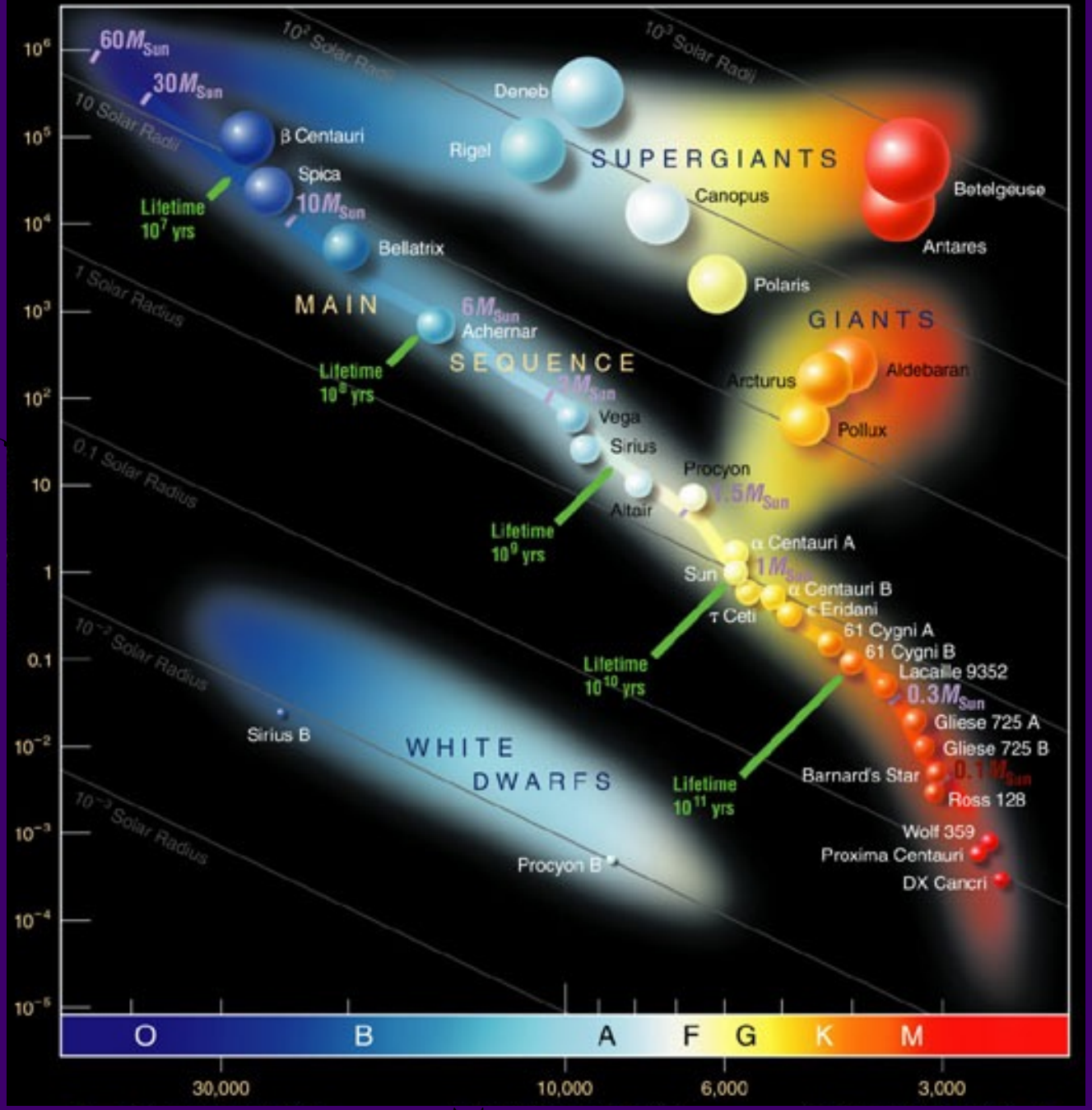
The Main Sequence (MS)



90% of all stars lie on the main sequence!



Stars with low temperature and high luminosity must have large radius



H-R diagram depicts:

Temperature

Color

Spectral Type

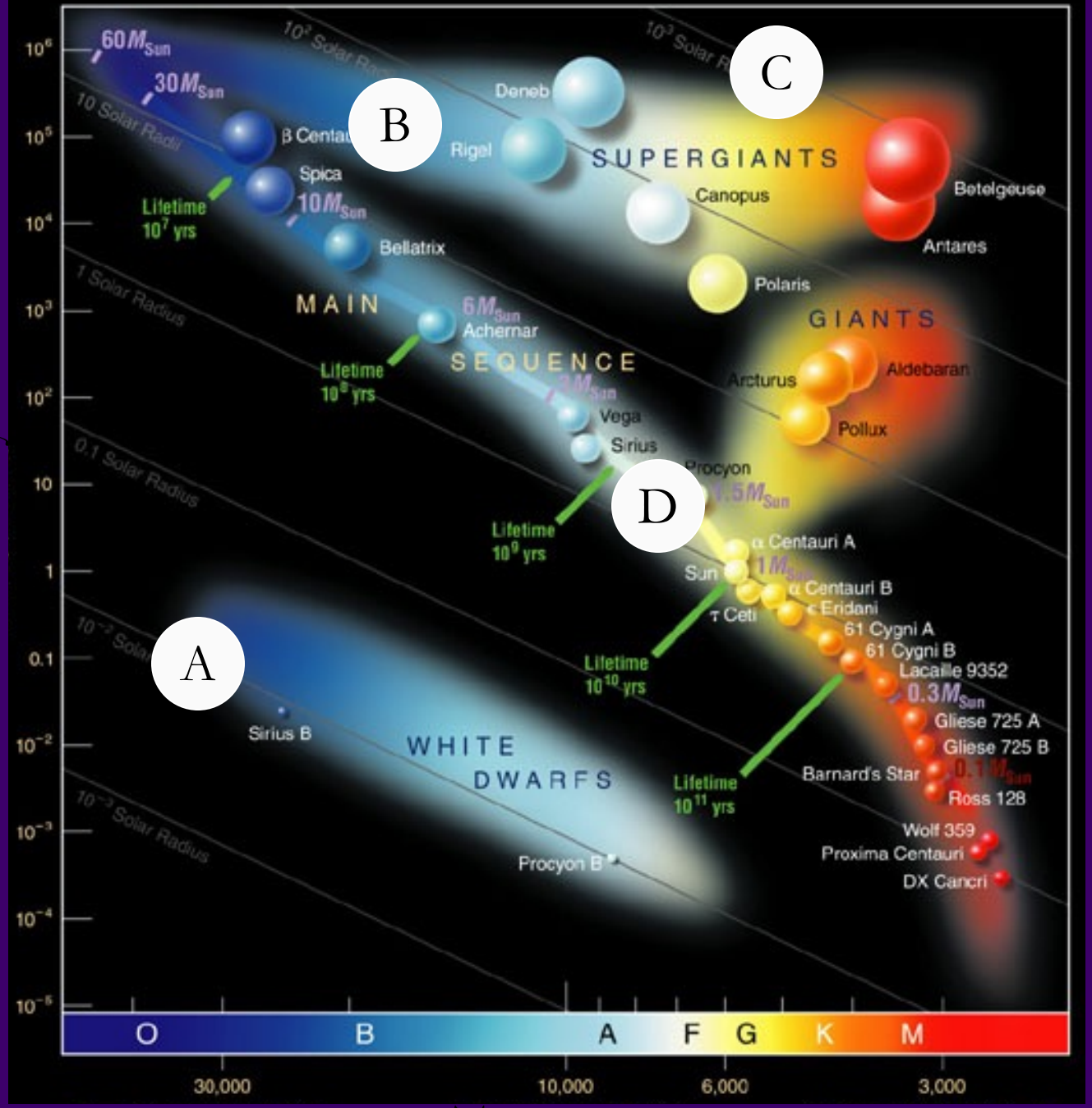
Luminosity

Radius

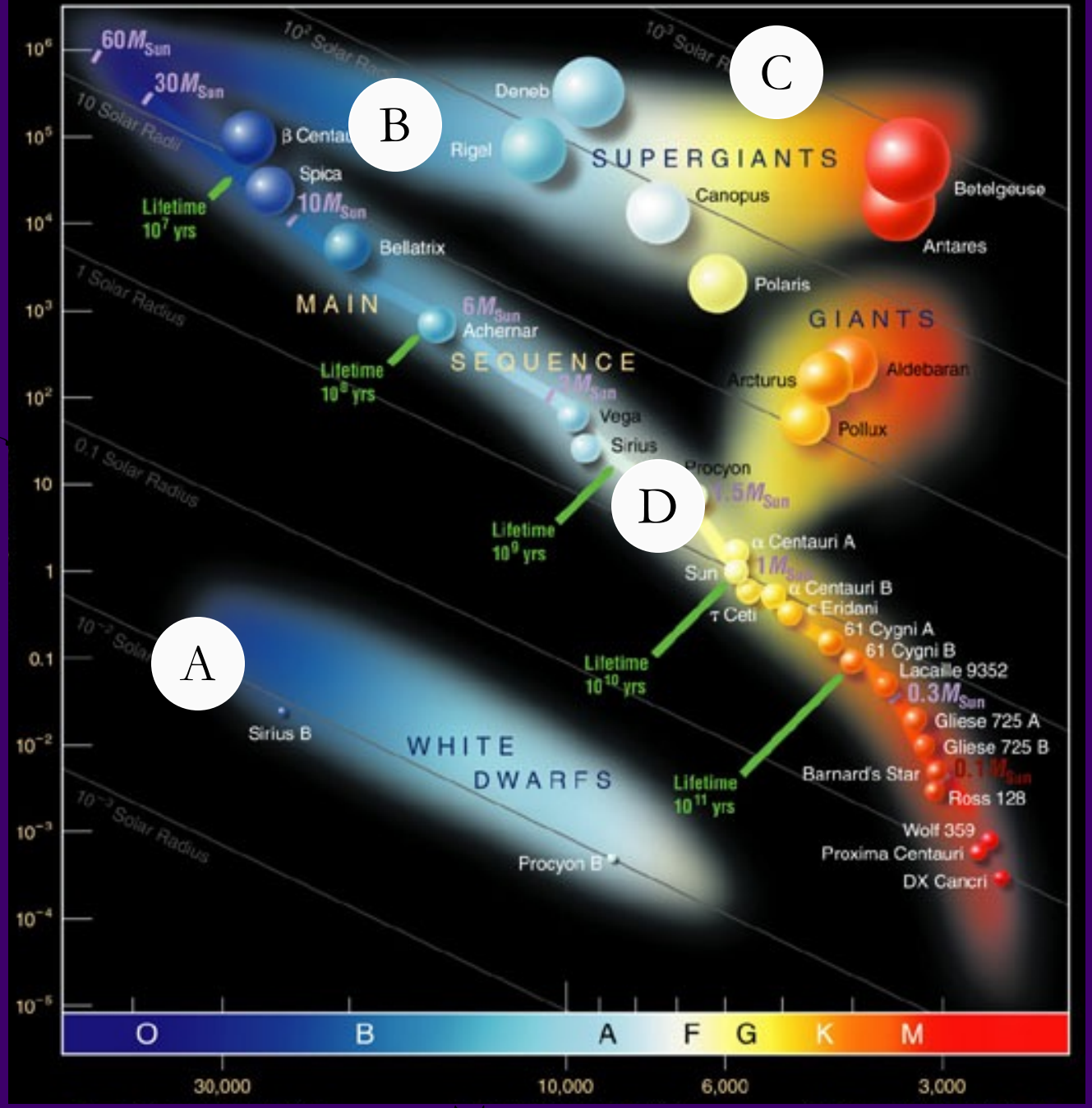
***Mass**

***Lifespan**

***Age**

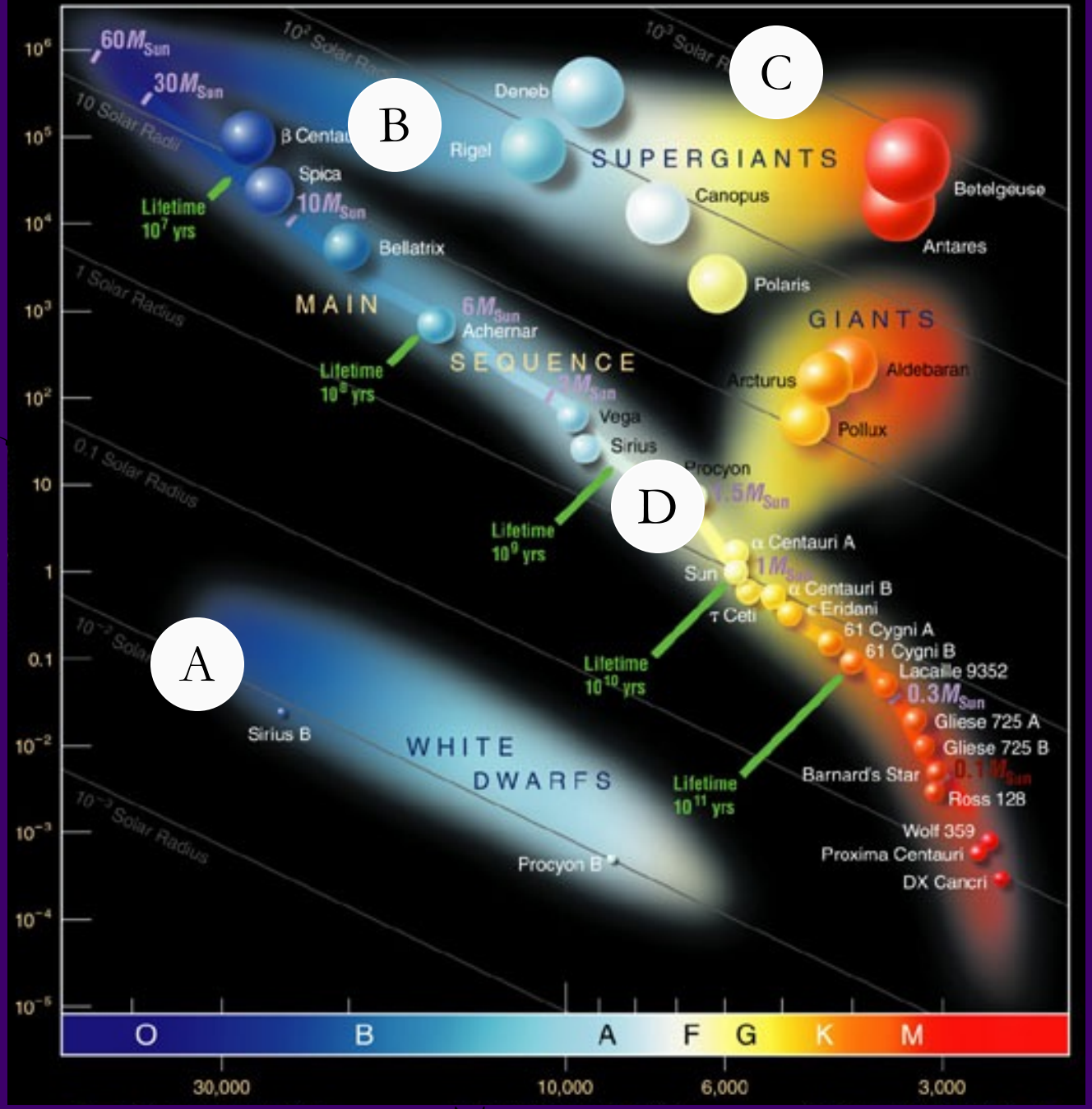


Which star is the hottest?

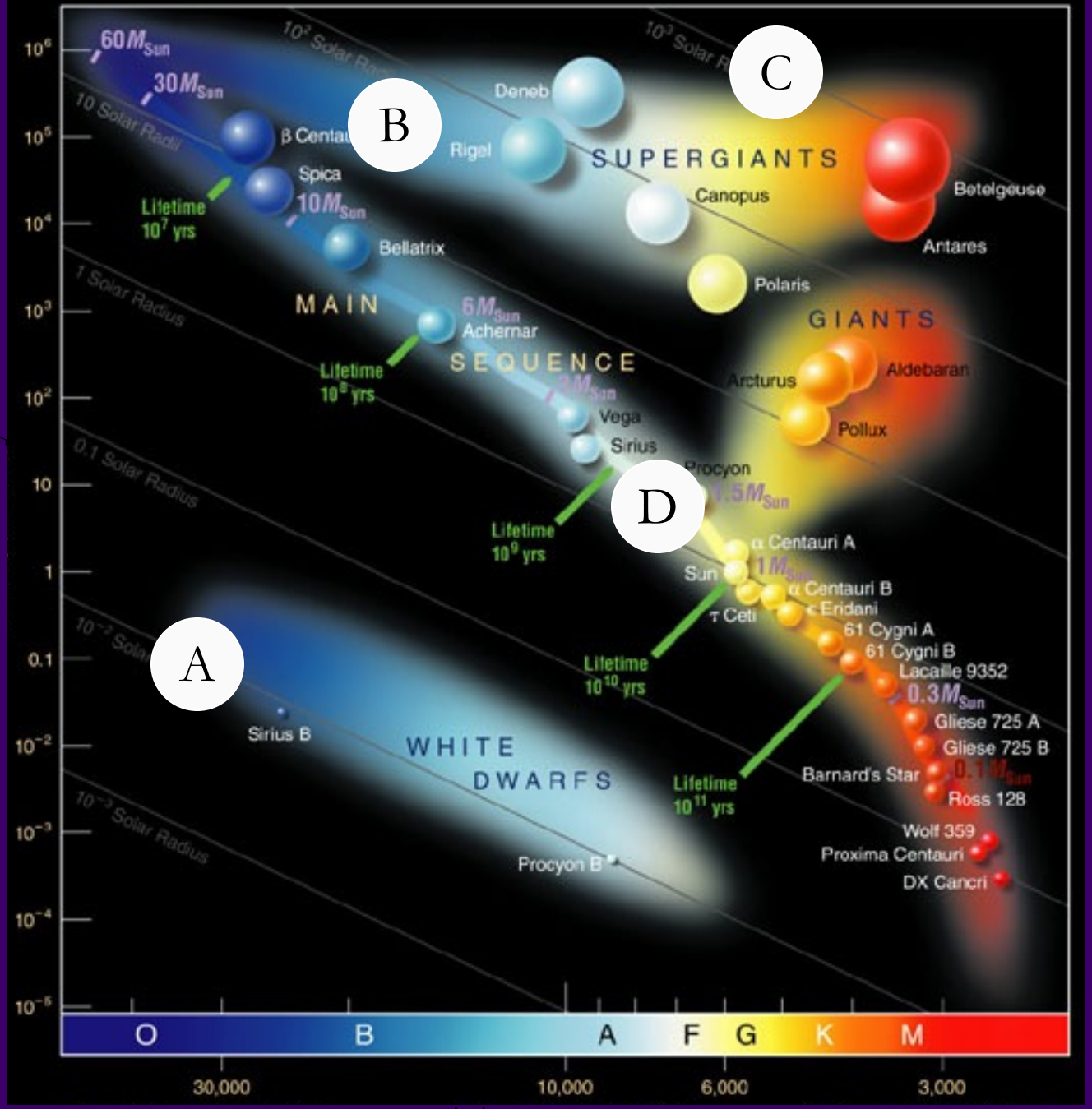


Which star is the hottest?

A

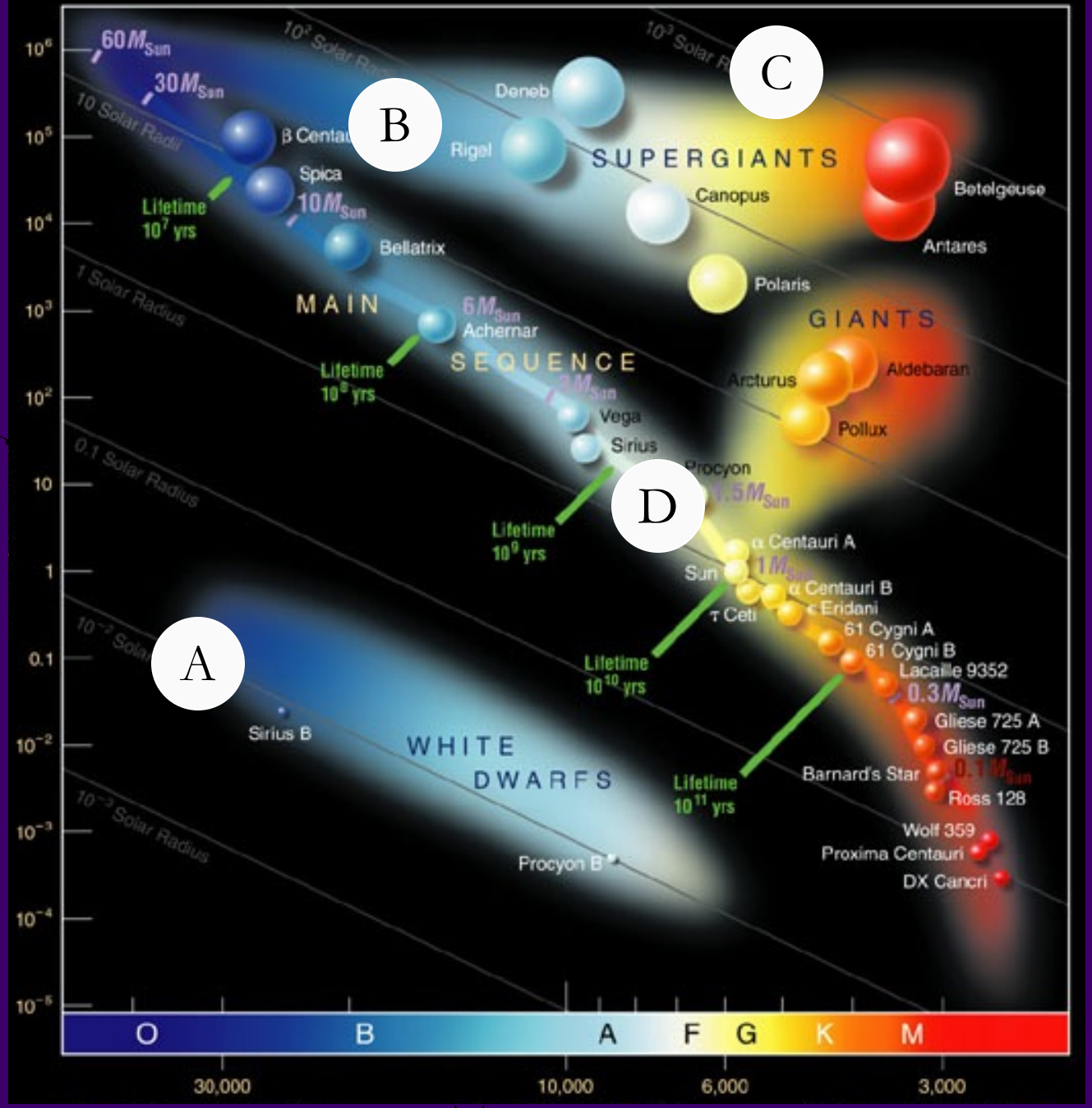


Which star is the most luminous?

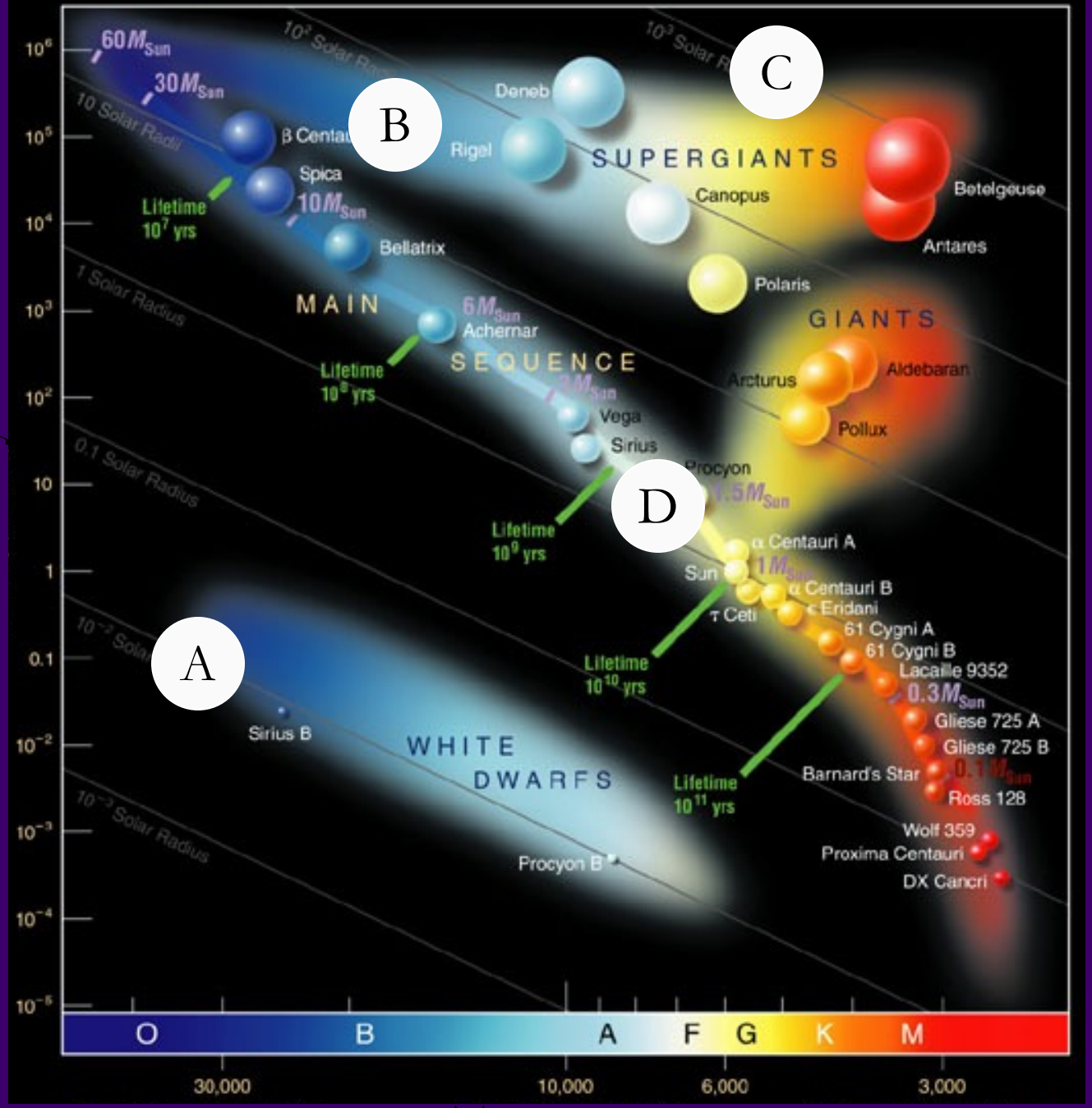


Which star is the most luminous?

C

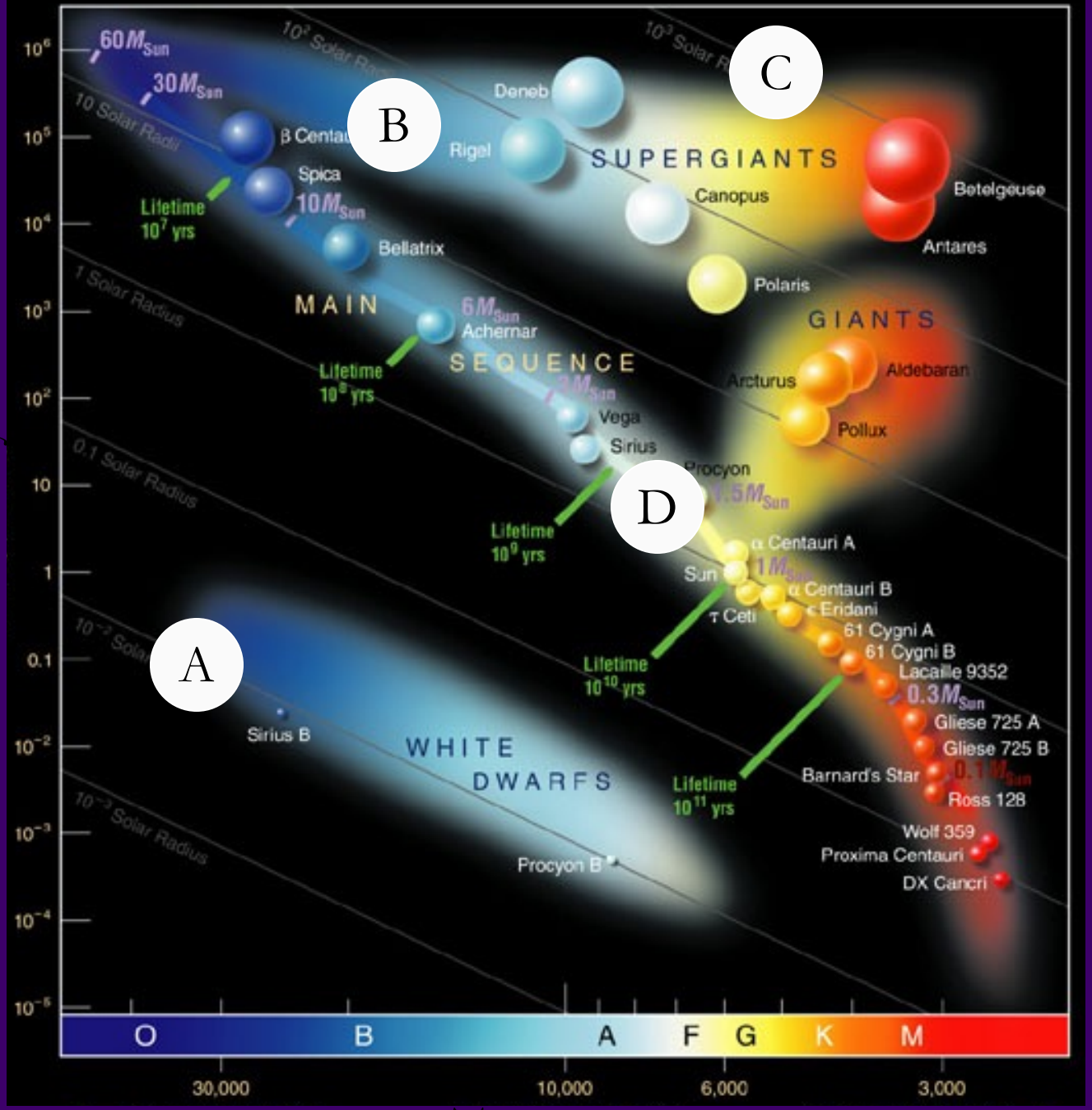


Which star is a main-sequence star?

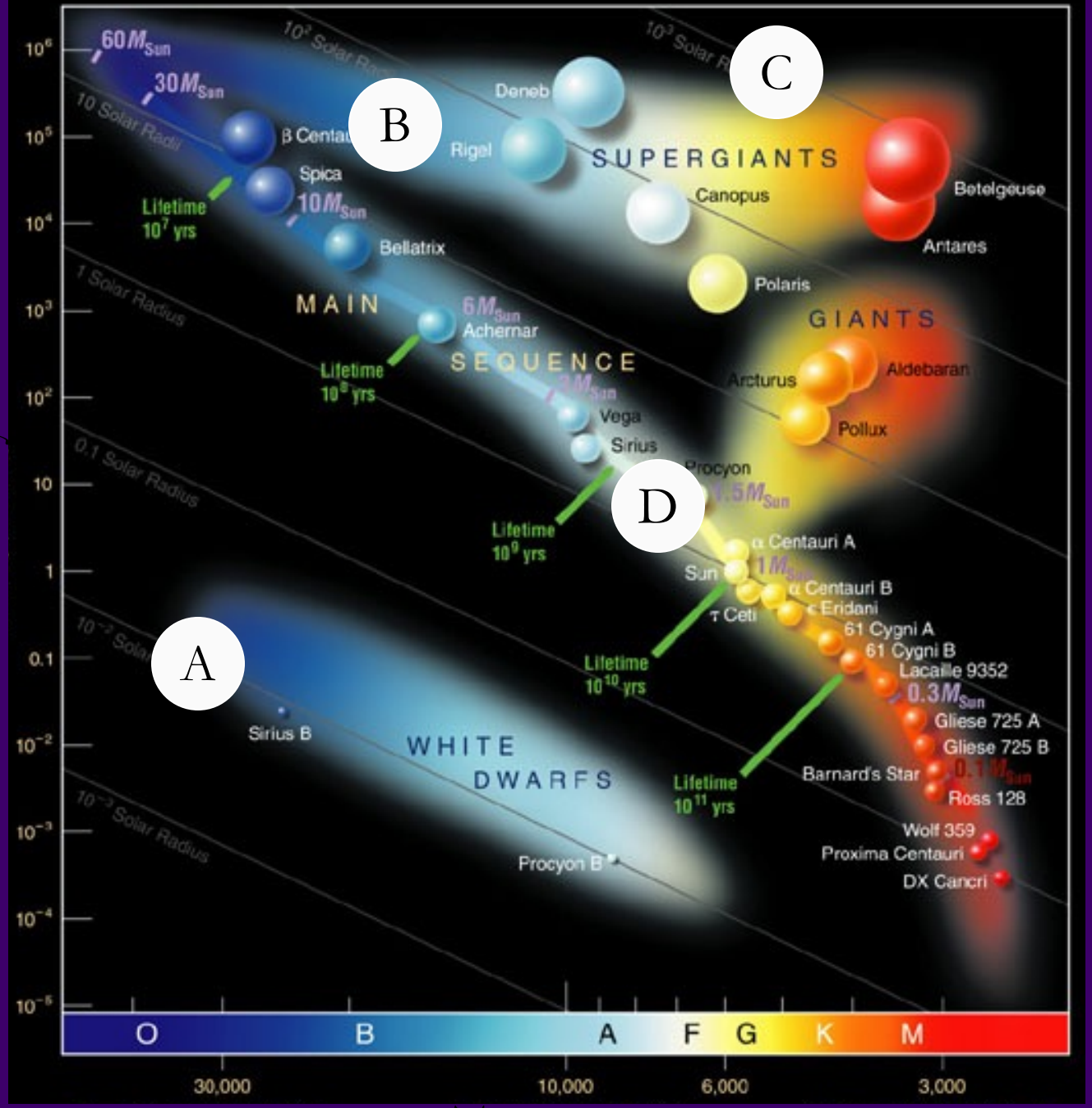


Which star is a main-sequence star?

D

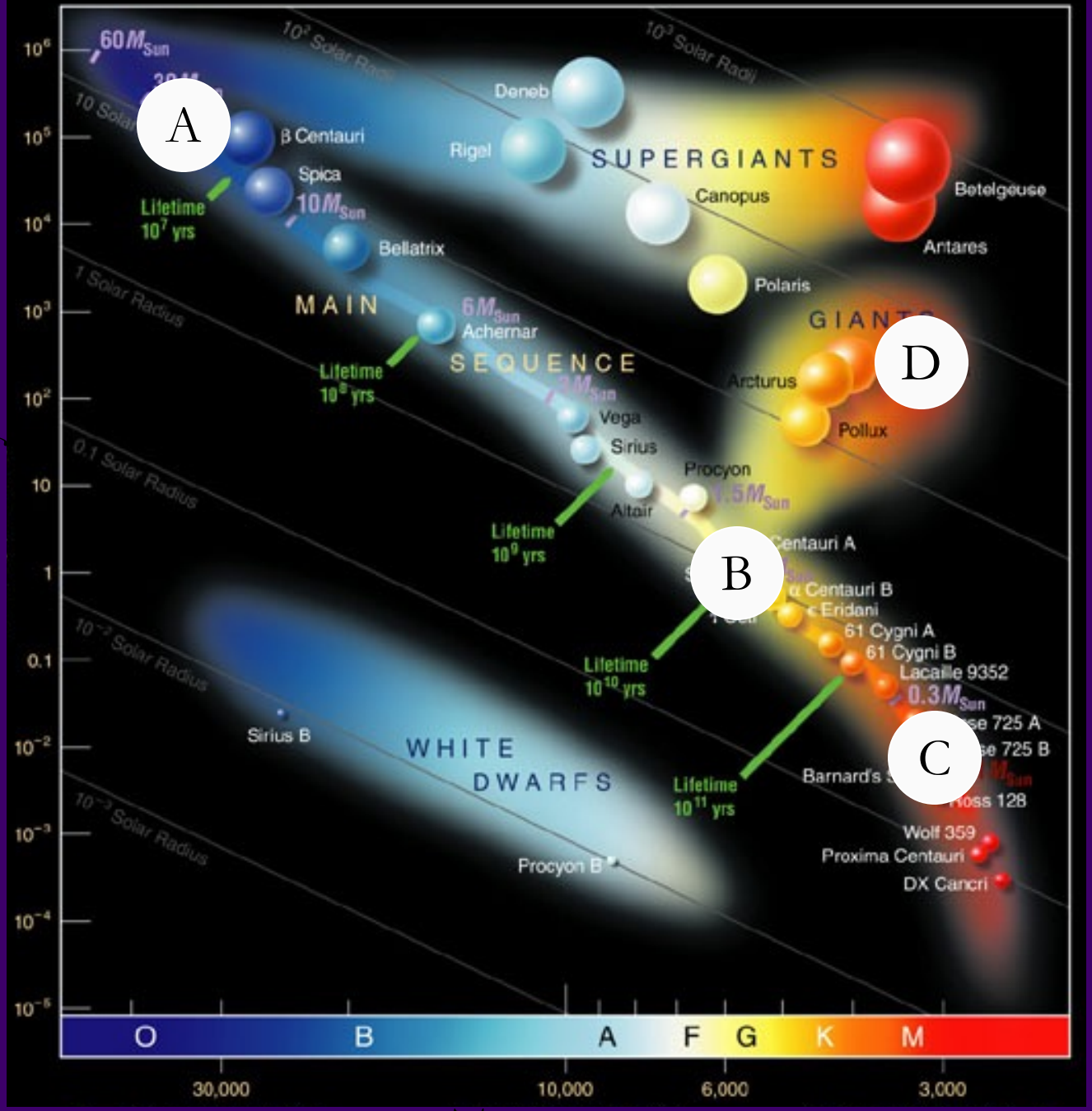


Which star has the largest radius?

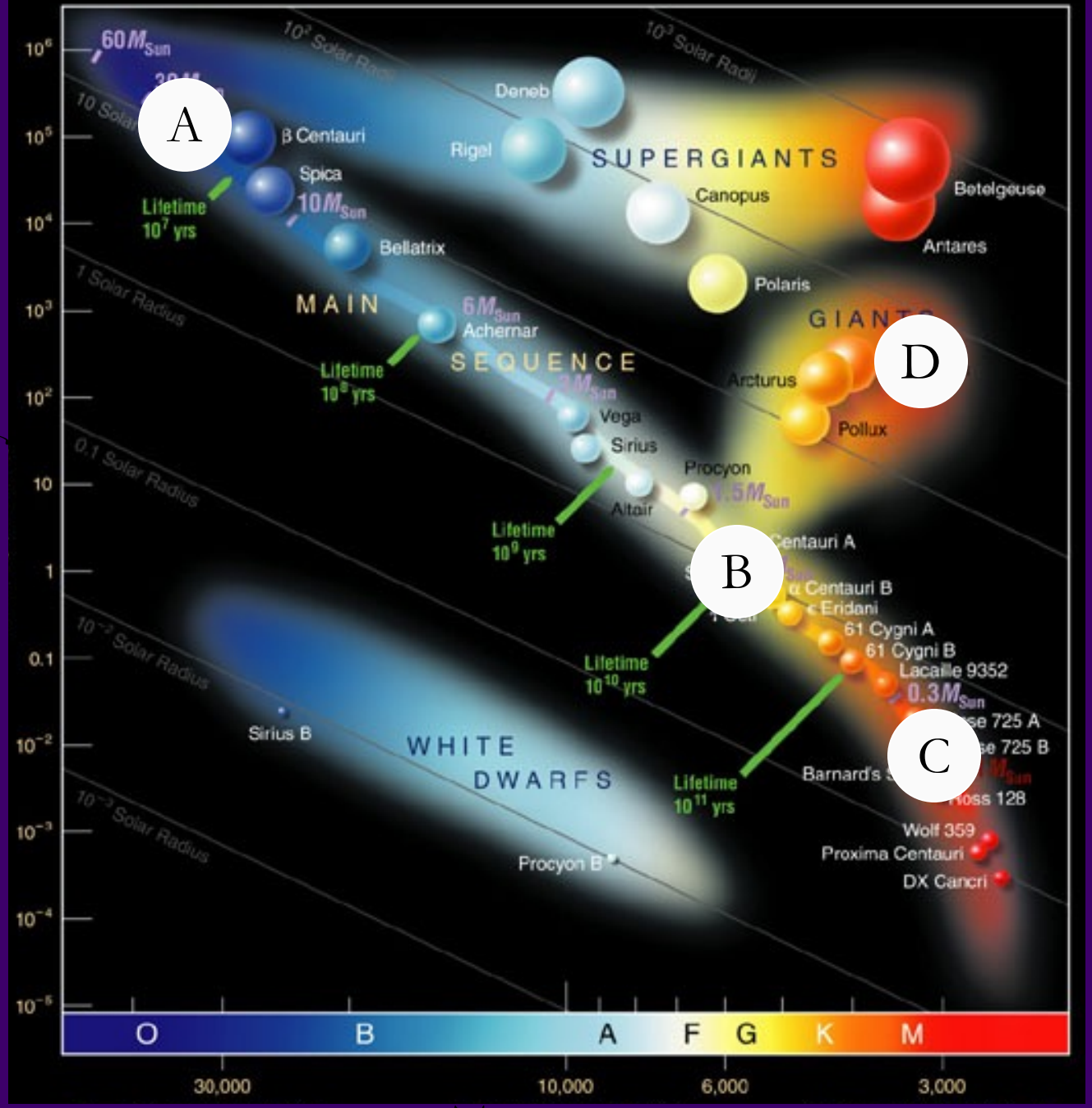


Which star has the largest radius?

C

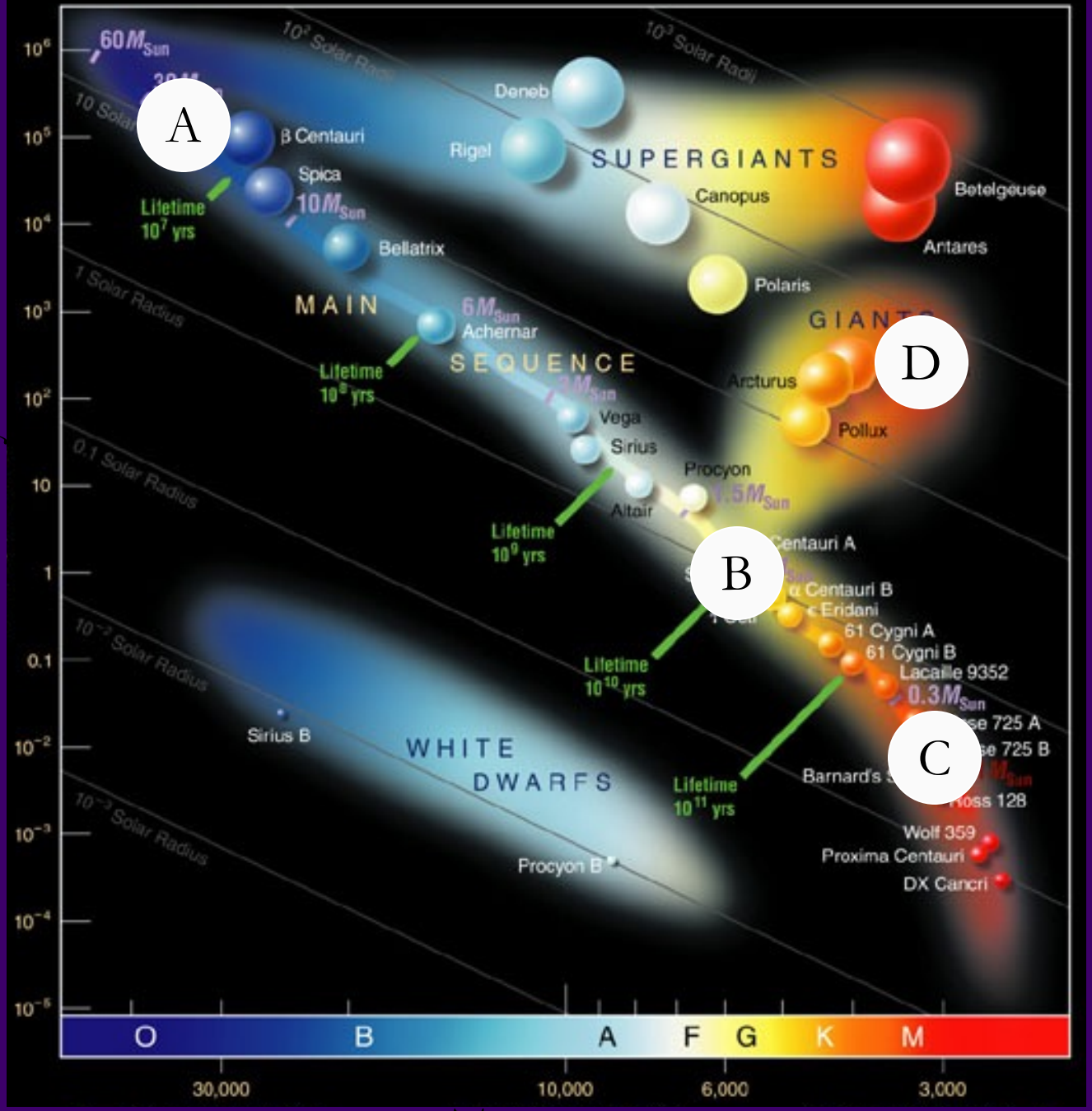


Which star is most like our Sun?

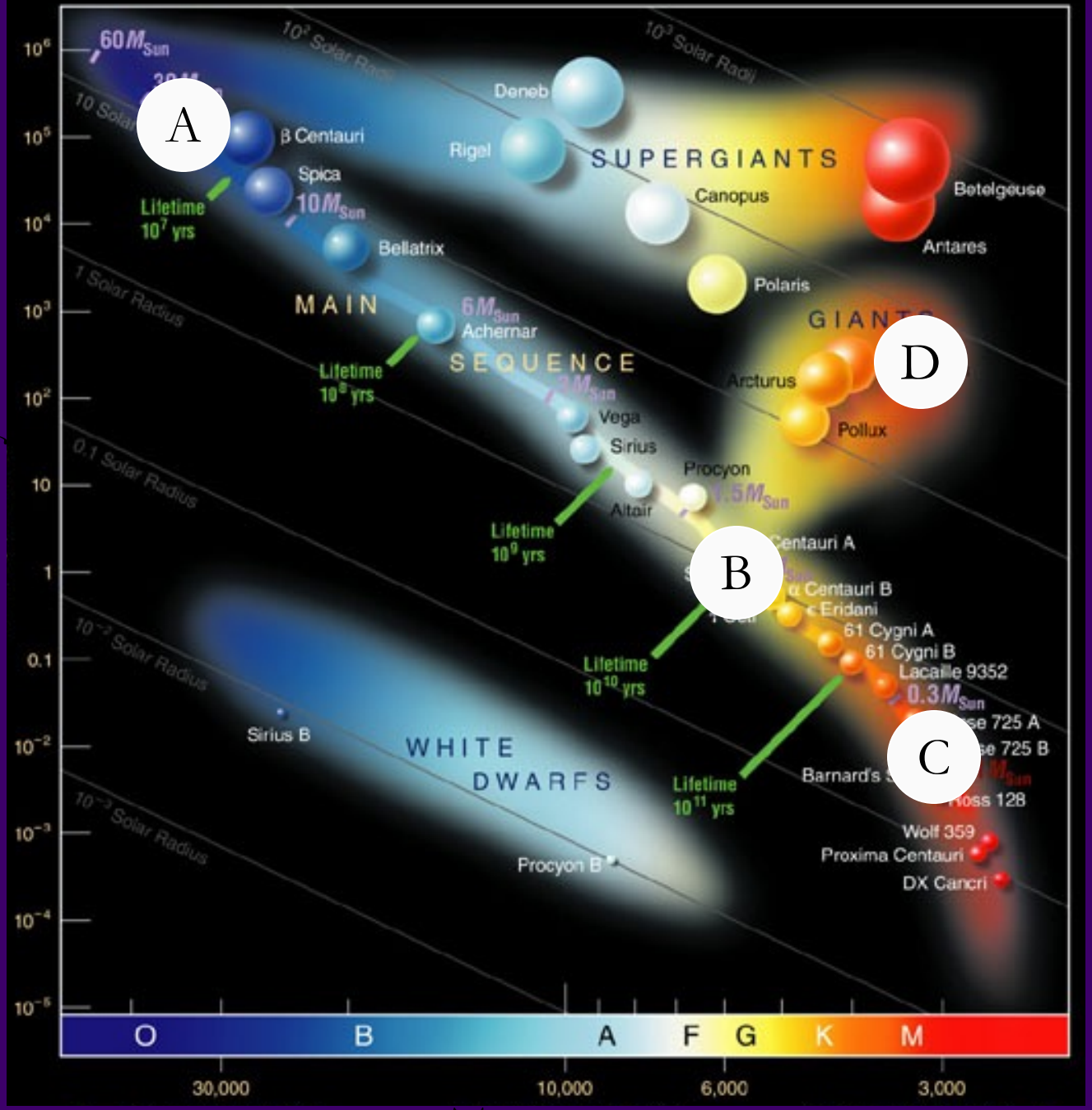


Which star is most like our Sun?

B

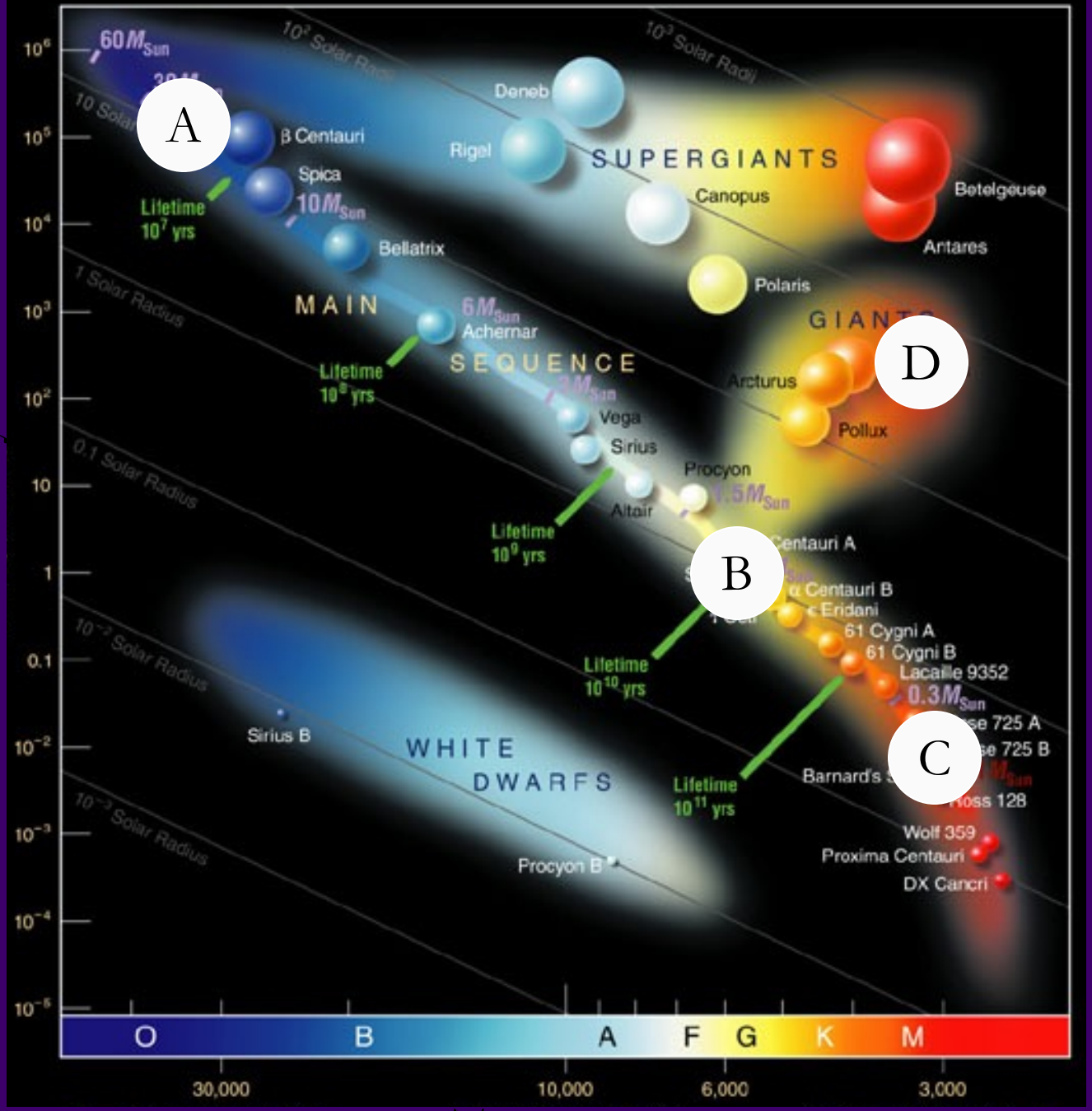


Which of these stars will have changed the least 10 billion years from now?

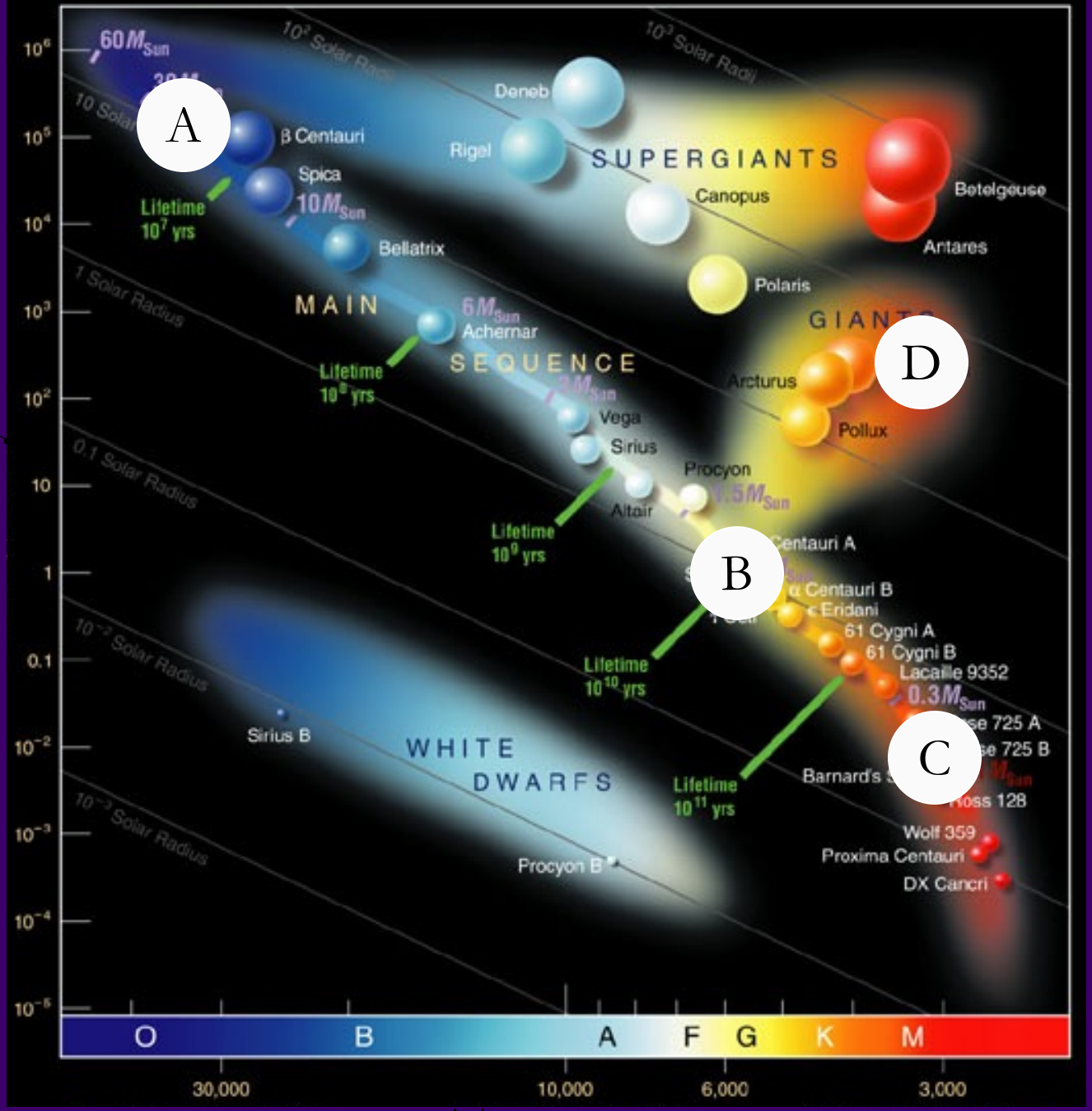


Which of these stars will have changed the least 10 billion years from now?

C



Which of these stars can be no more than 10 million years old?



Which of these stars can be no more than 10 million years old?

A

Regions of the H-R Diagram