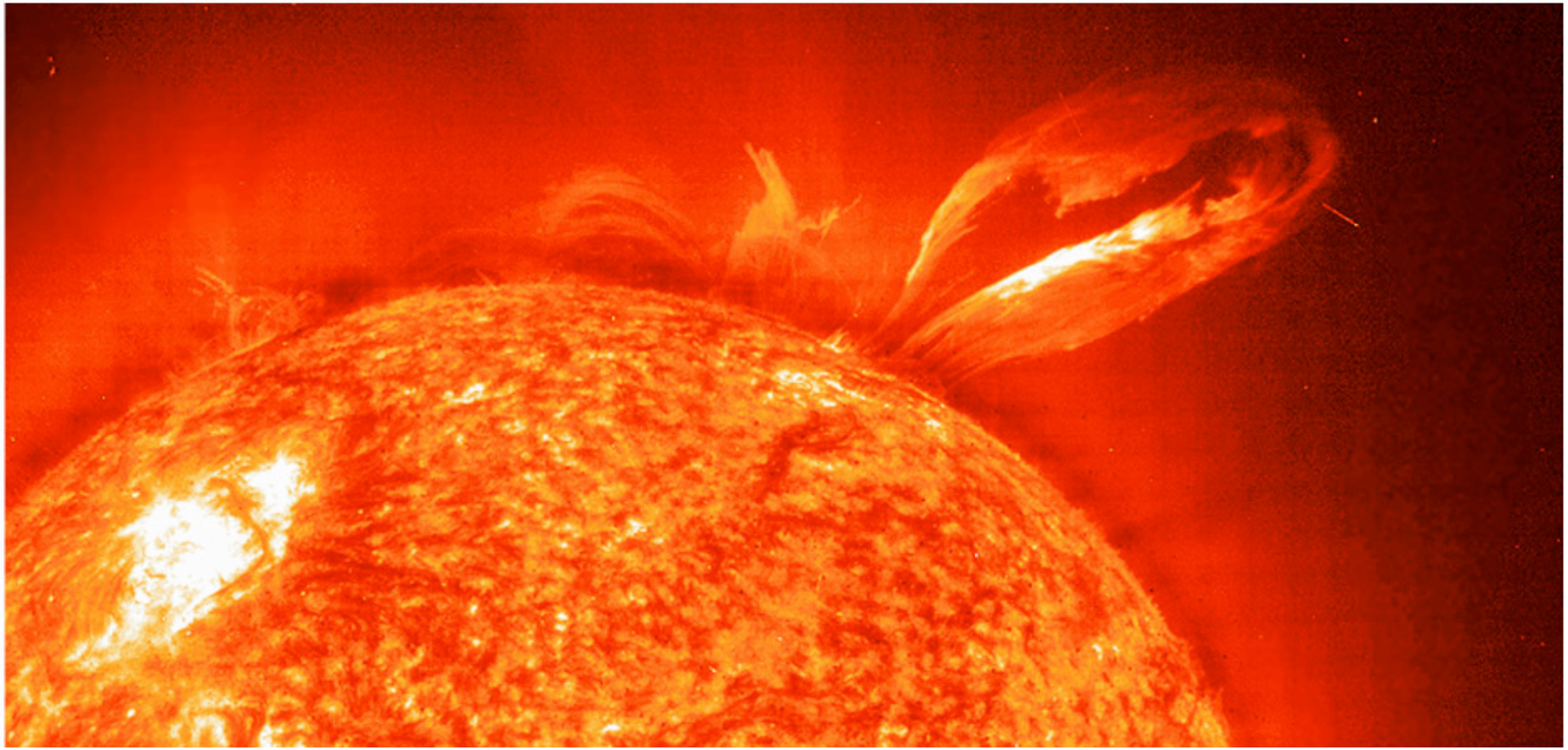
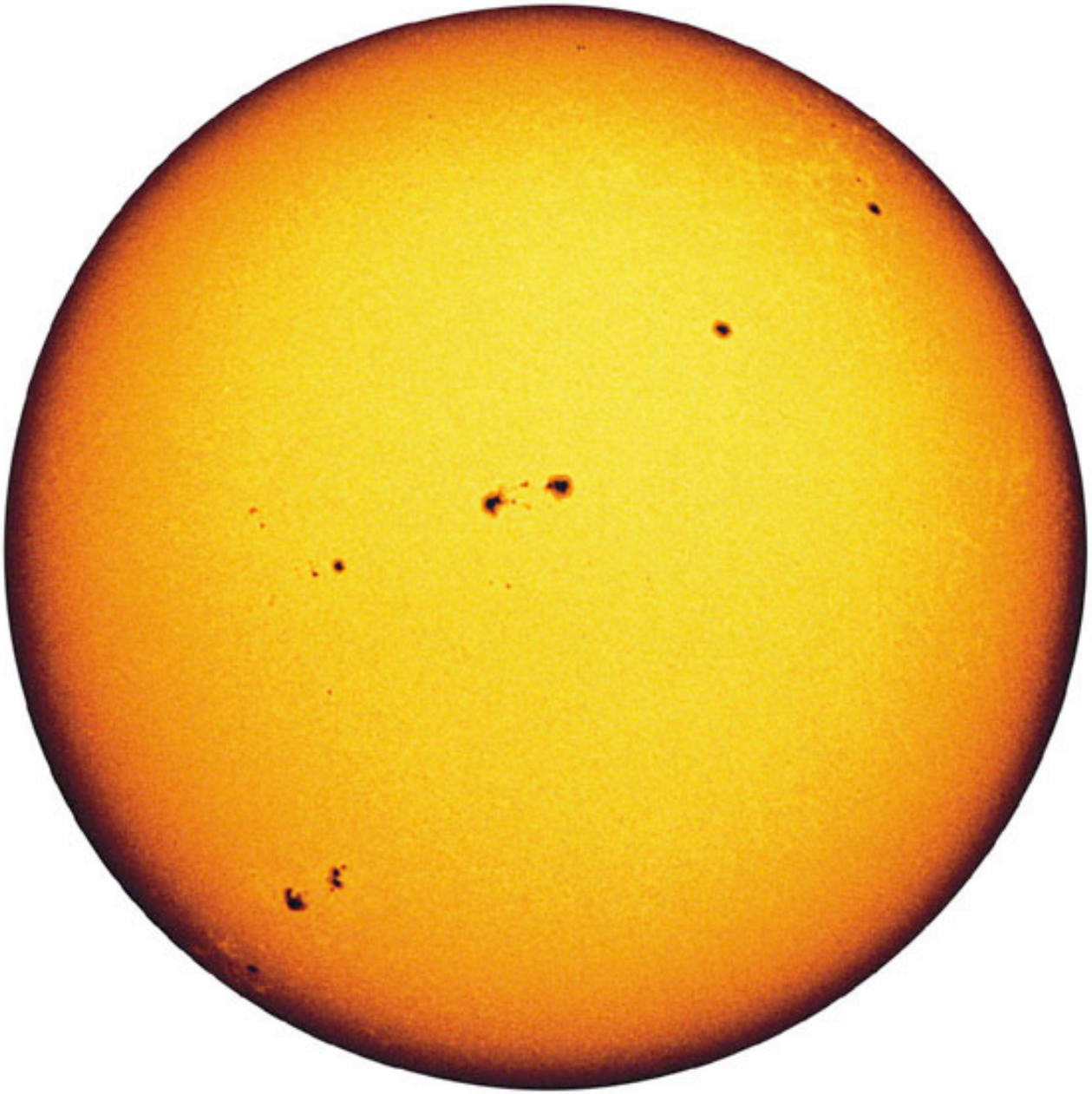
Chapter 14
Our Star





Radius:

6.9×10^8 m

(about 700,000km)

(109 times Earth)

Mass:

2×10^{30} kg

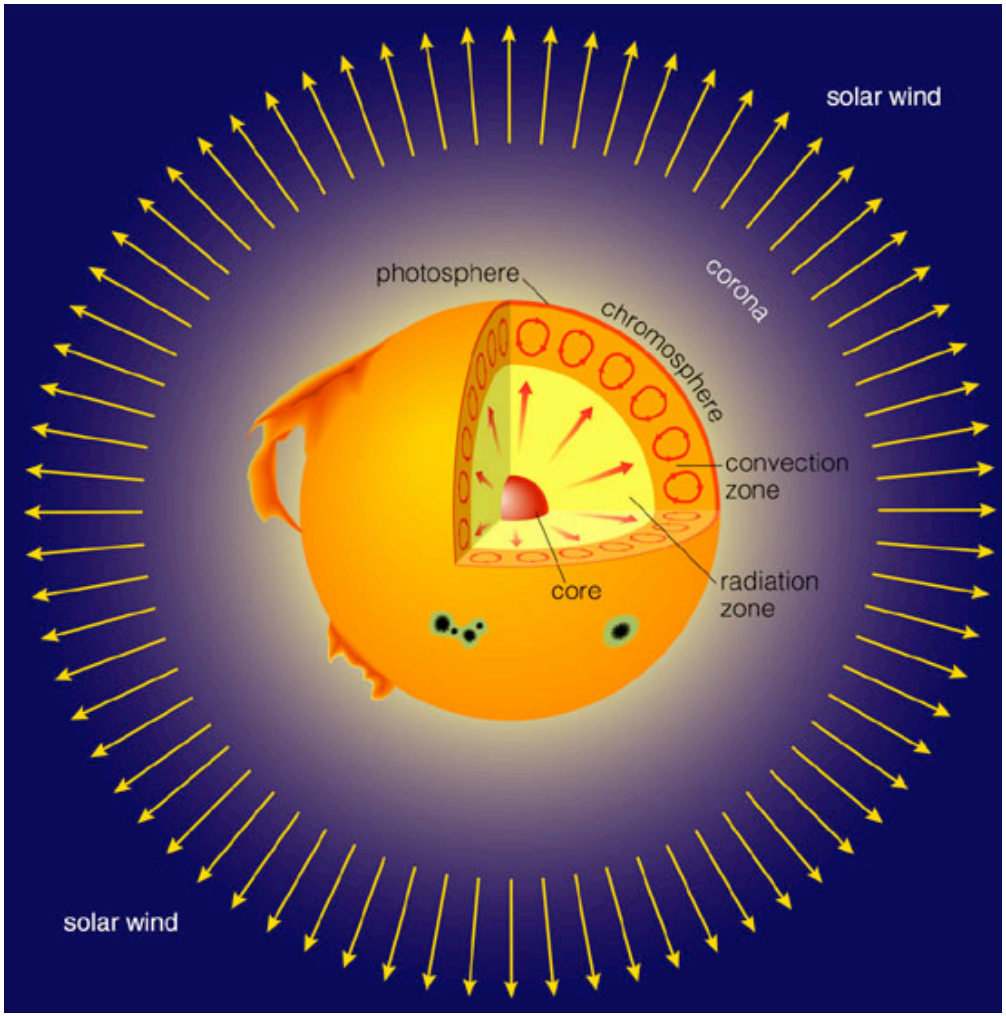
(300,000 Earths)

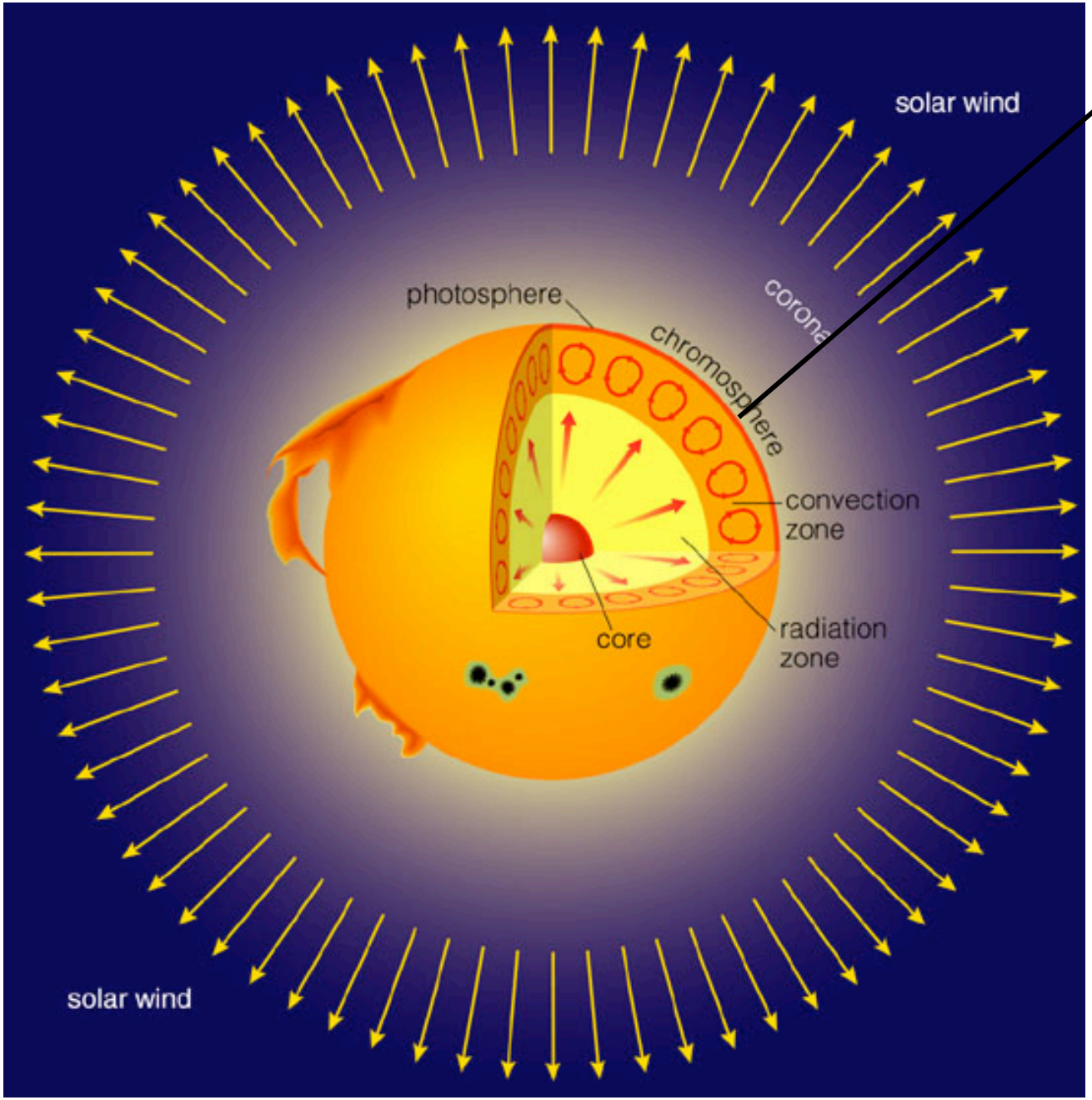
Luminosity:

4×10^{26} watts =

4×10^{33} erg/s

What is the Sun's structure?



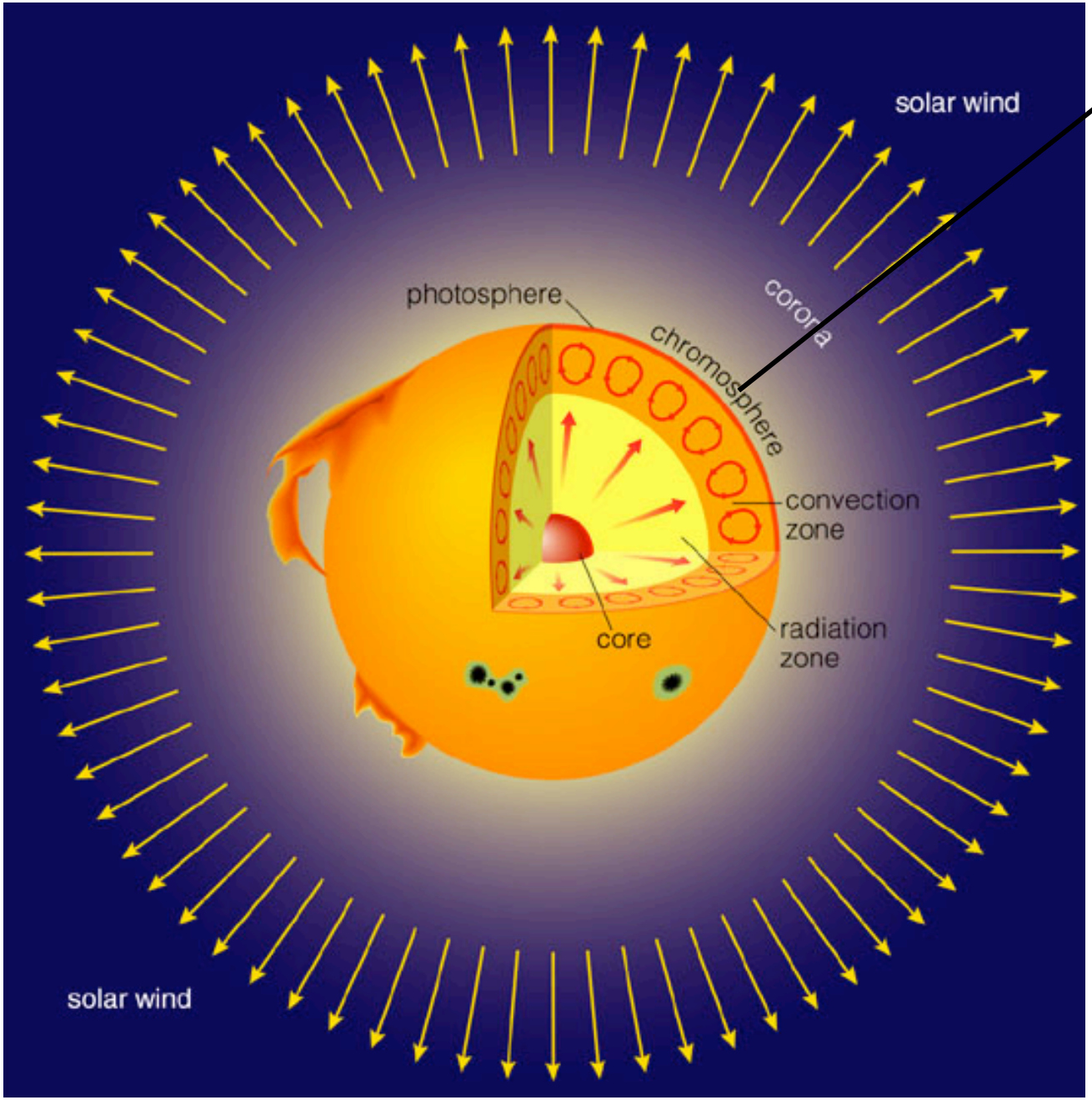


Photosphere:

Visible surface of Sun

~ 6,000 K

Thickness ~300km

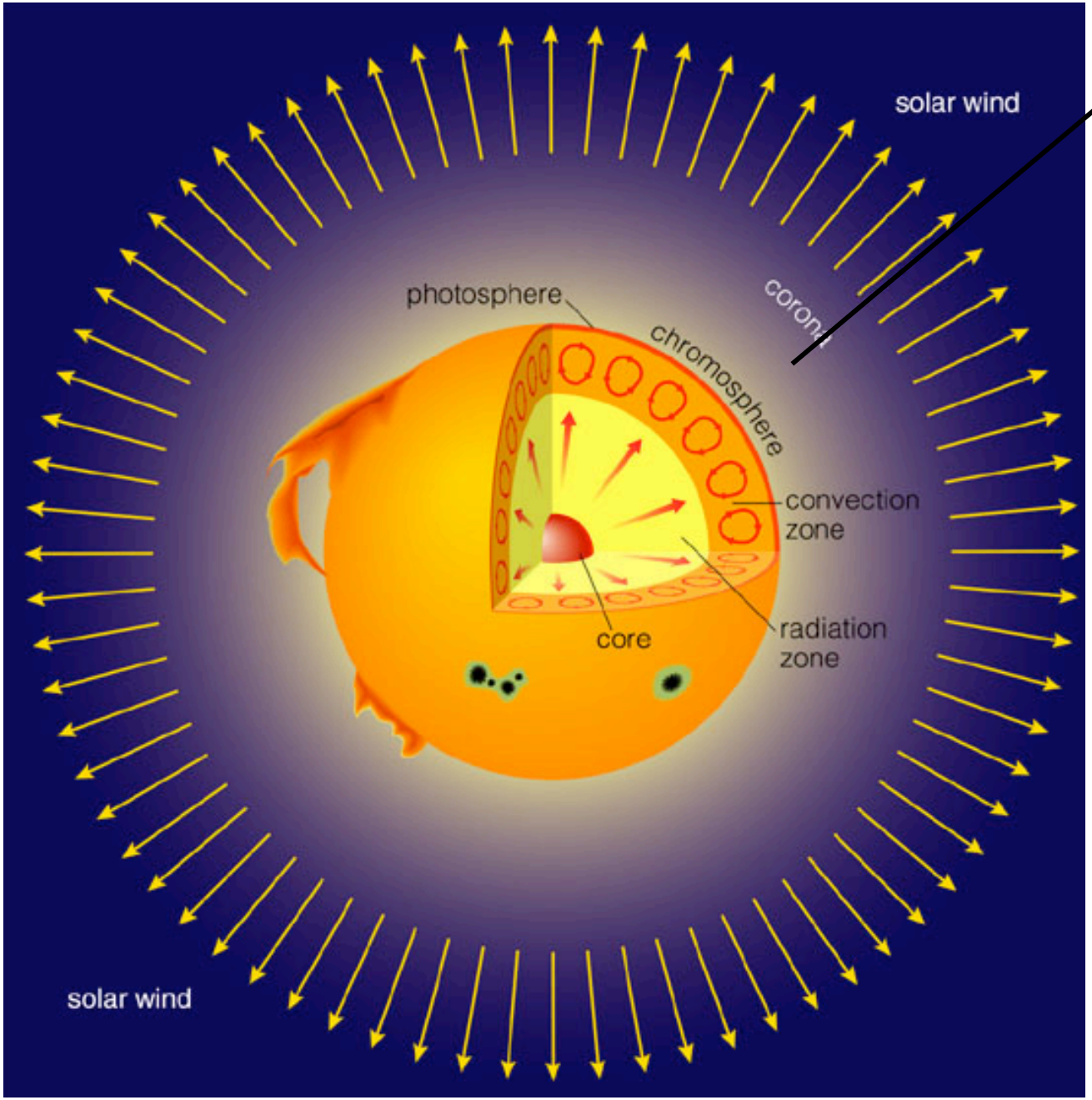


Chromosphere:

Middle layer of solar atmosphere

~ 10^4 - 10^5 K

~2000 km



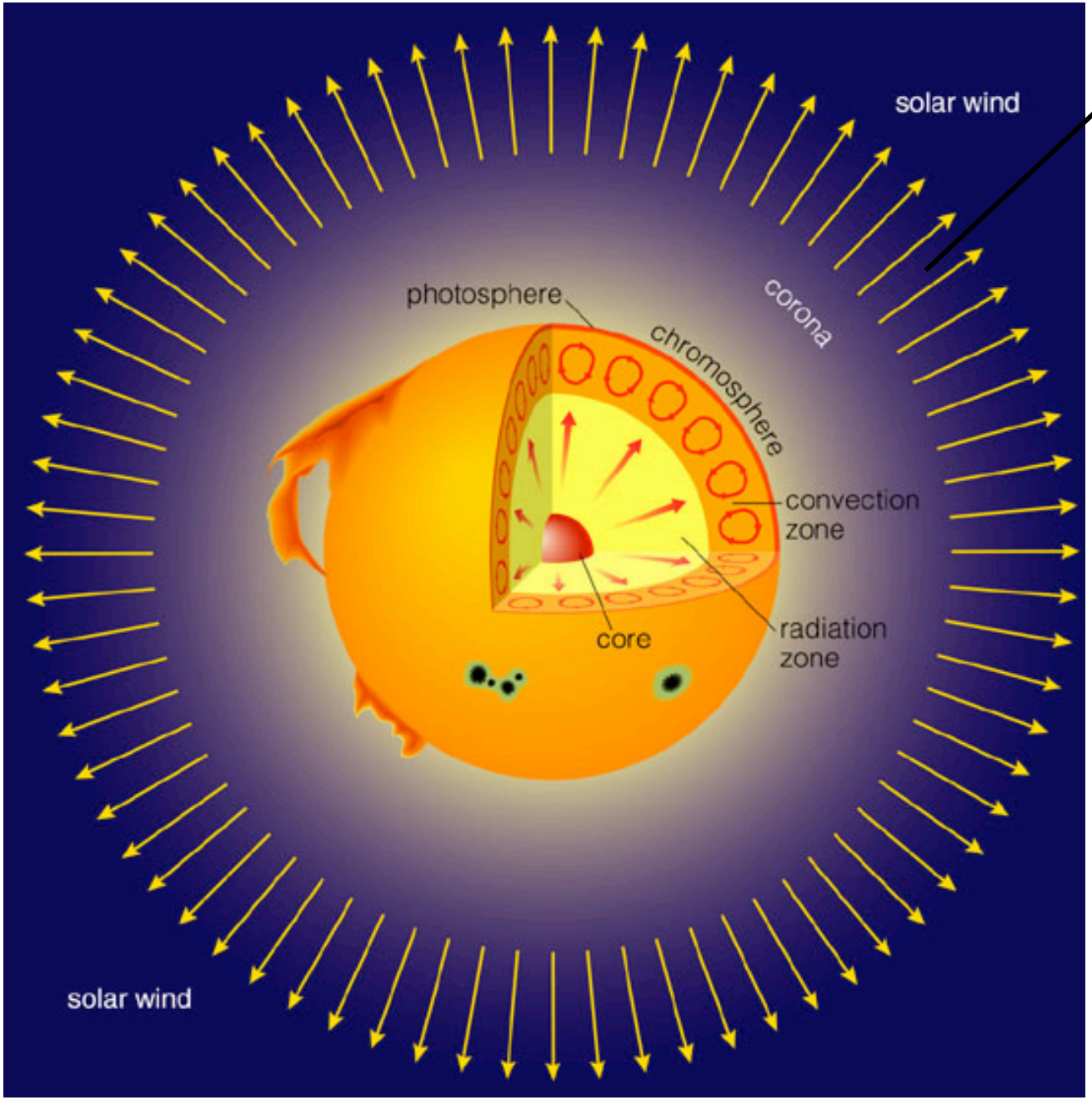
Corona:

Outermost layer of solar atmosphere

~1 million K

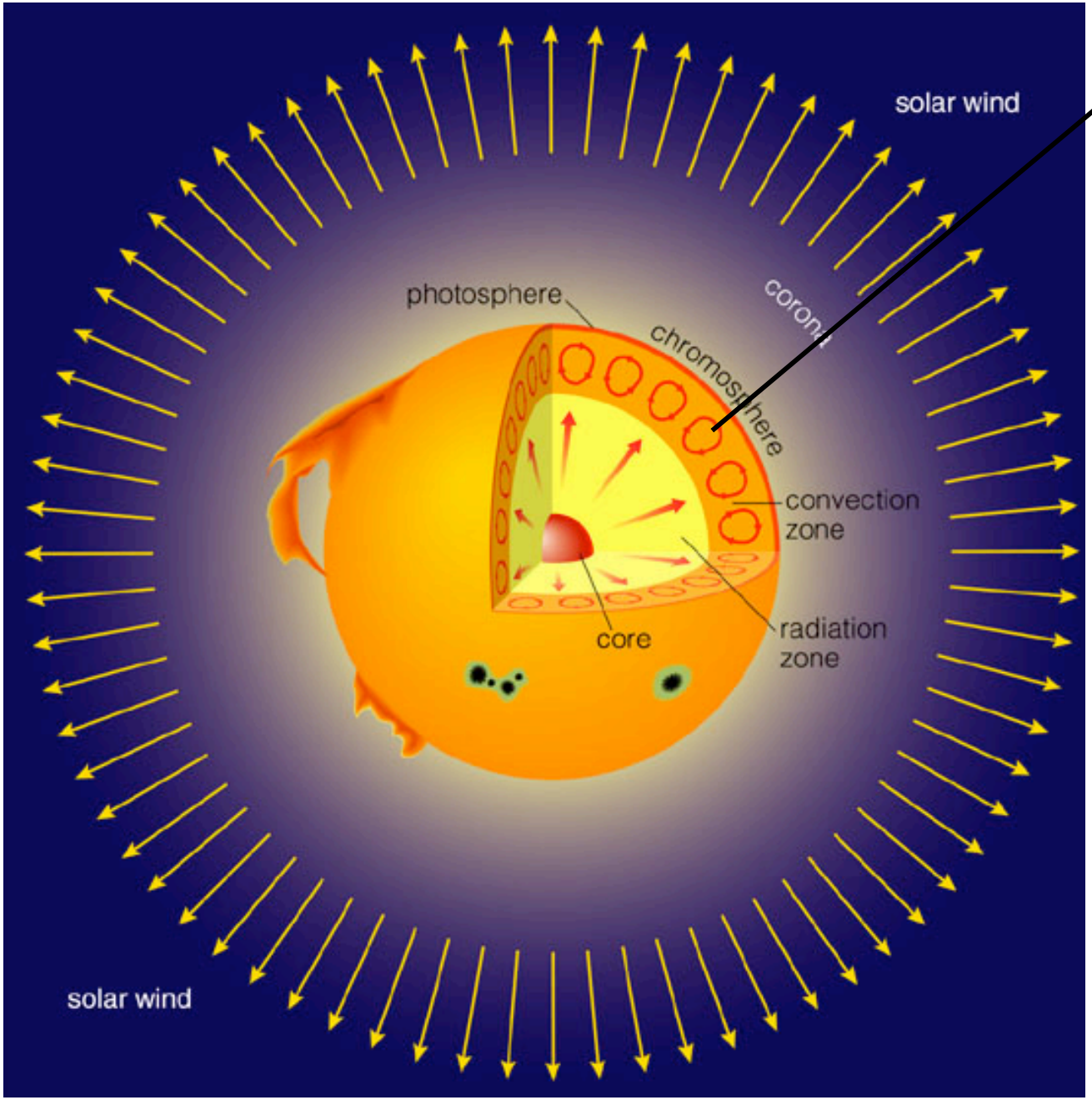
(from about 2000km out to 2 million km ~$3R_{sun}$)

Interactive Figure



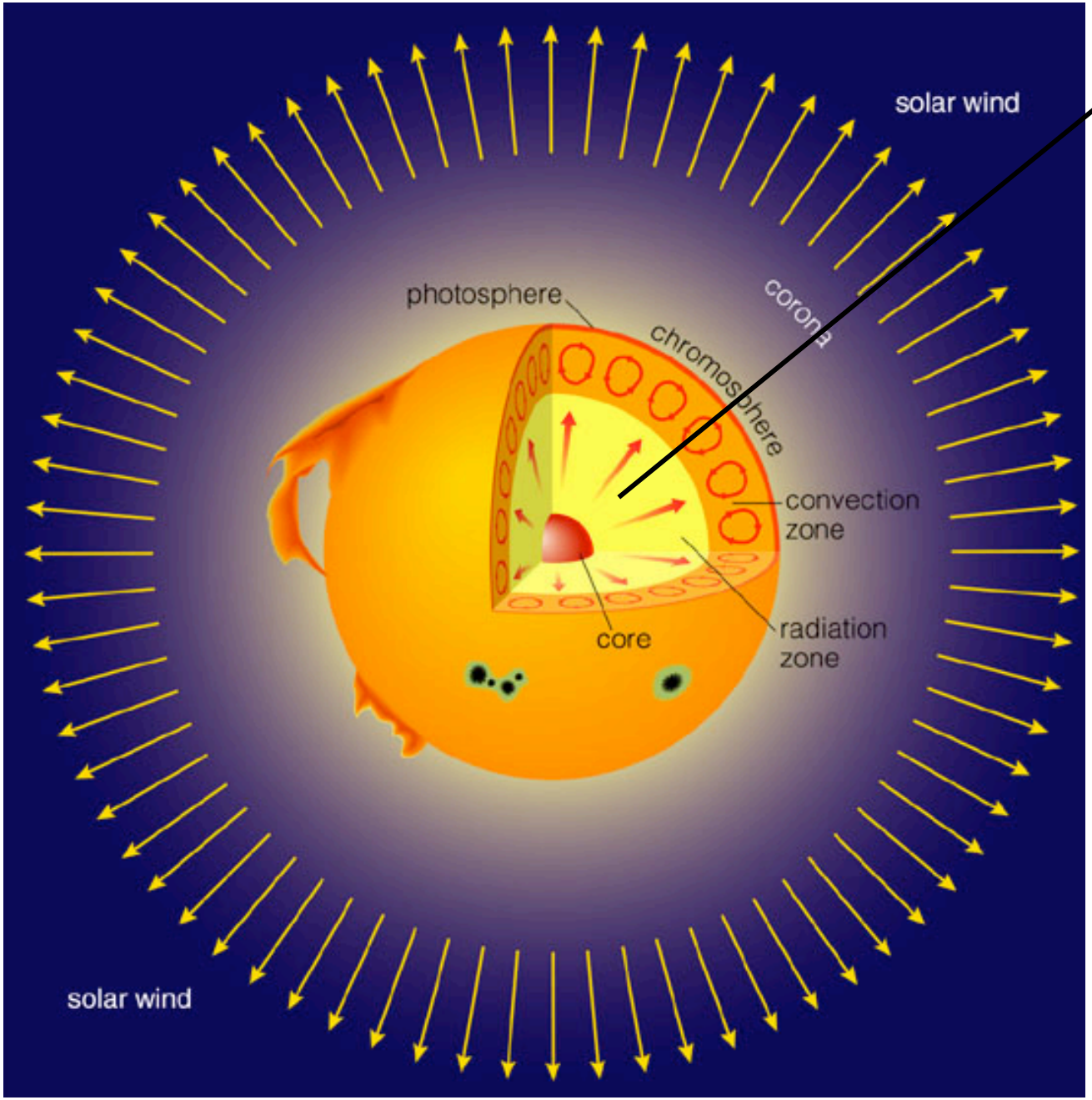
Solar wind:

A flow of charged particles from the surface of the Sun



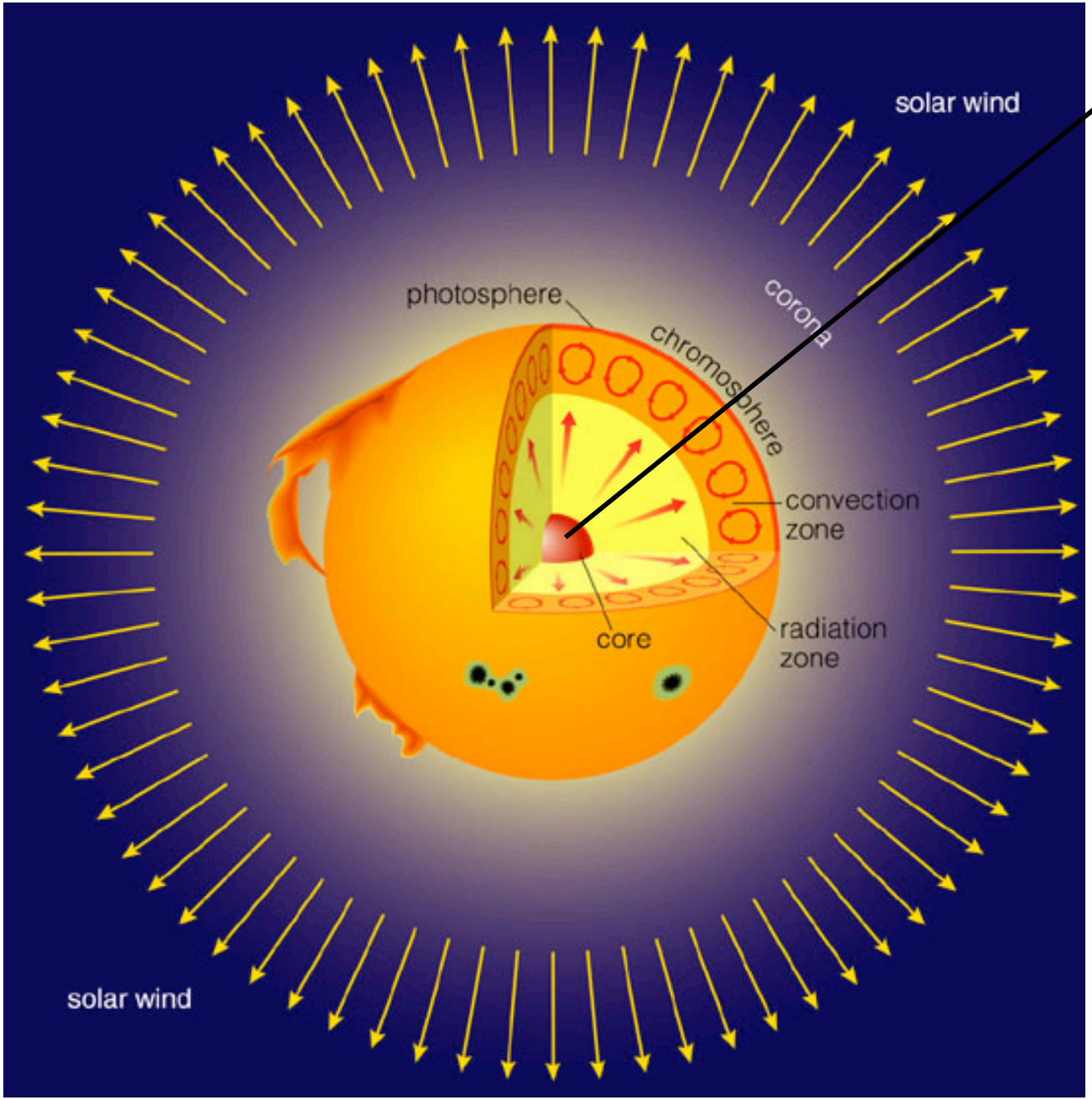
Convection Zone:

Energy transported upward by rising hot gas



Radiation Zone:

Energy transported upward by photons

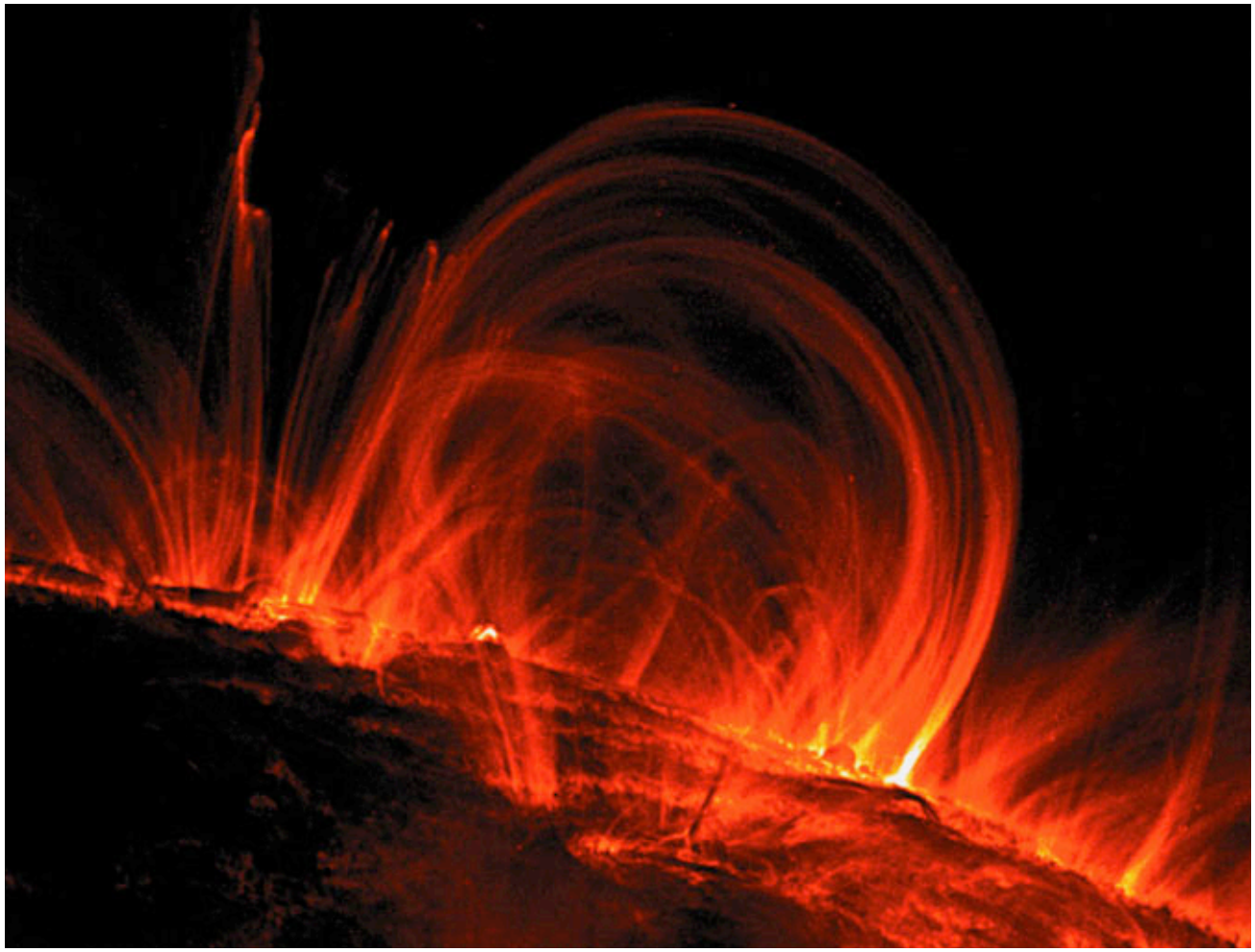


Core:

Energy generated by nuclear fusion

~ 15 million K

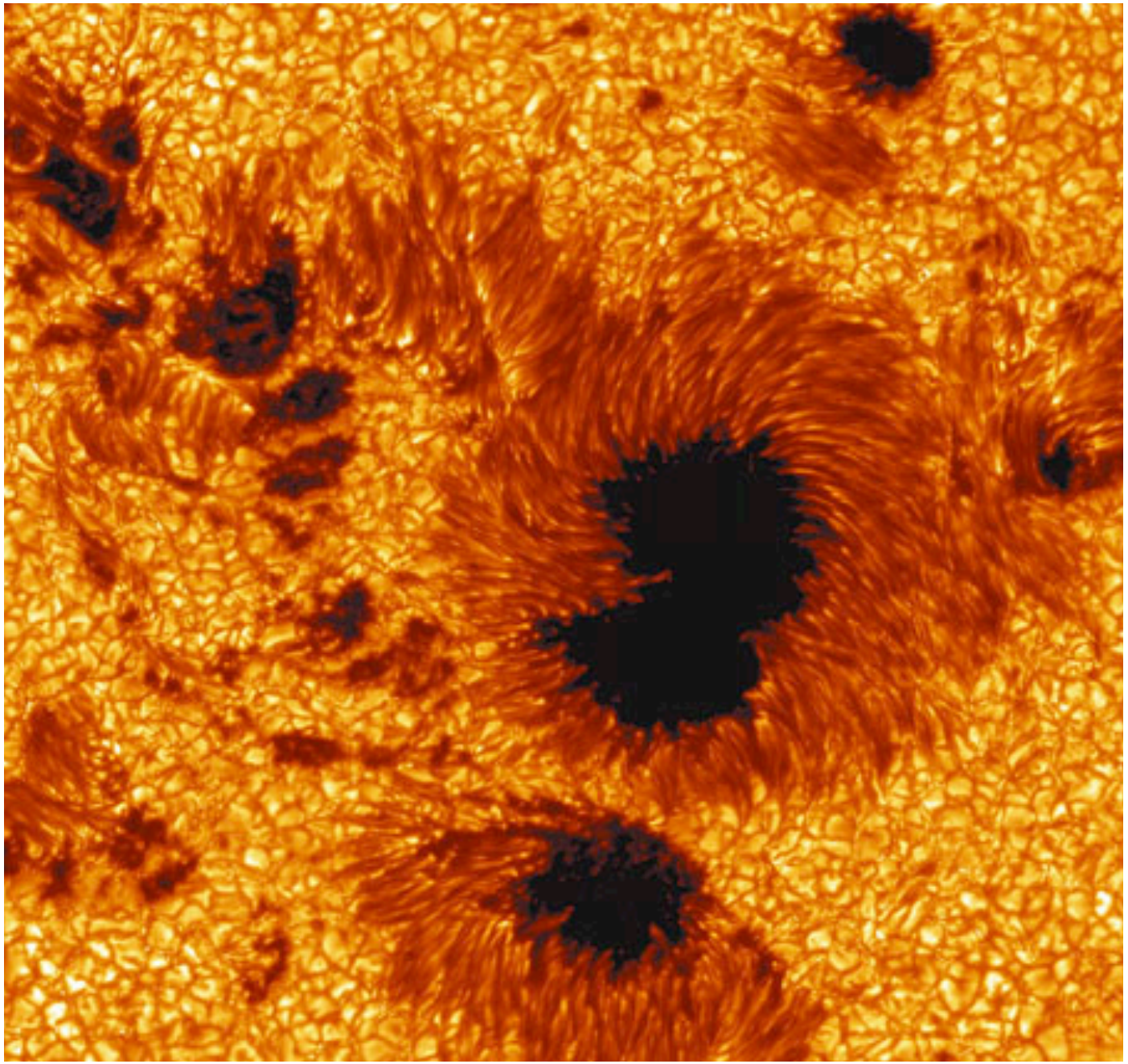
What causes solar activity?



Solar activity is like "weather"

- Sunspots
- Solar Flares
- Solar Prominences

- All are related to magnetic fields

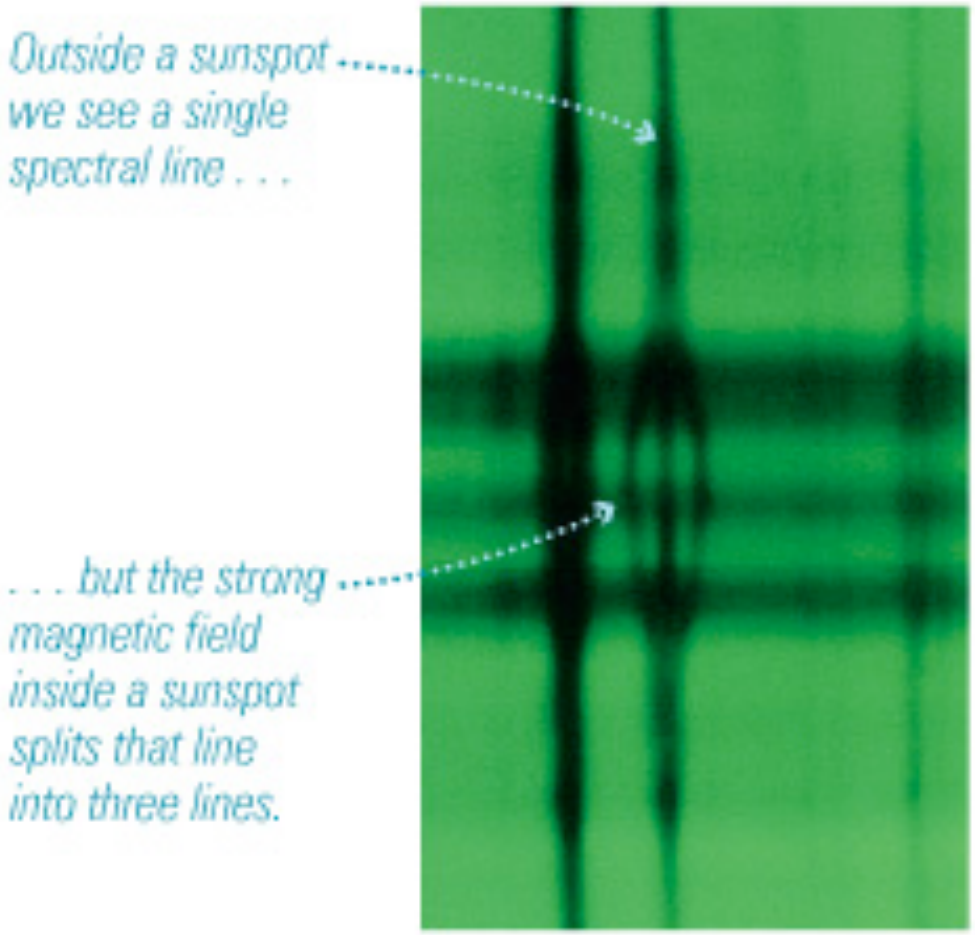


Sunspots

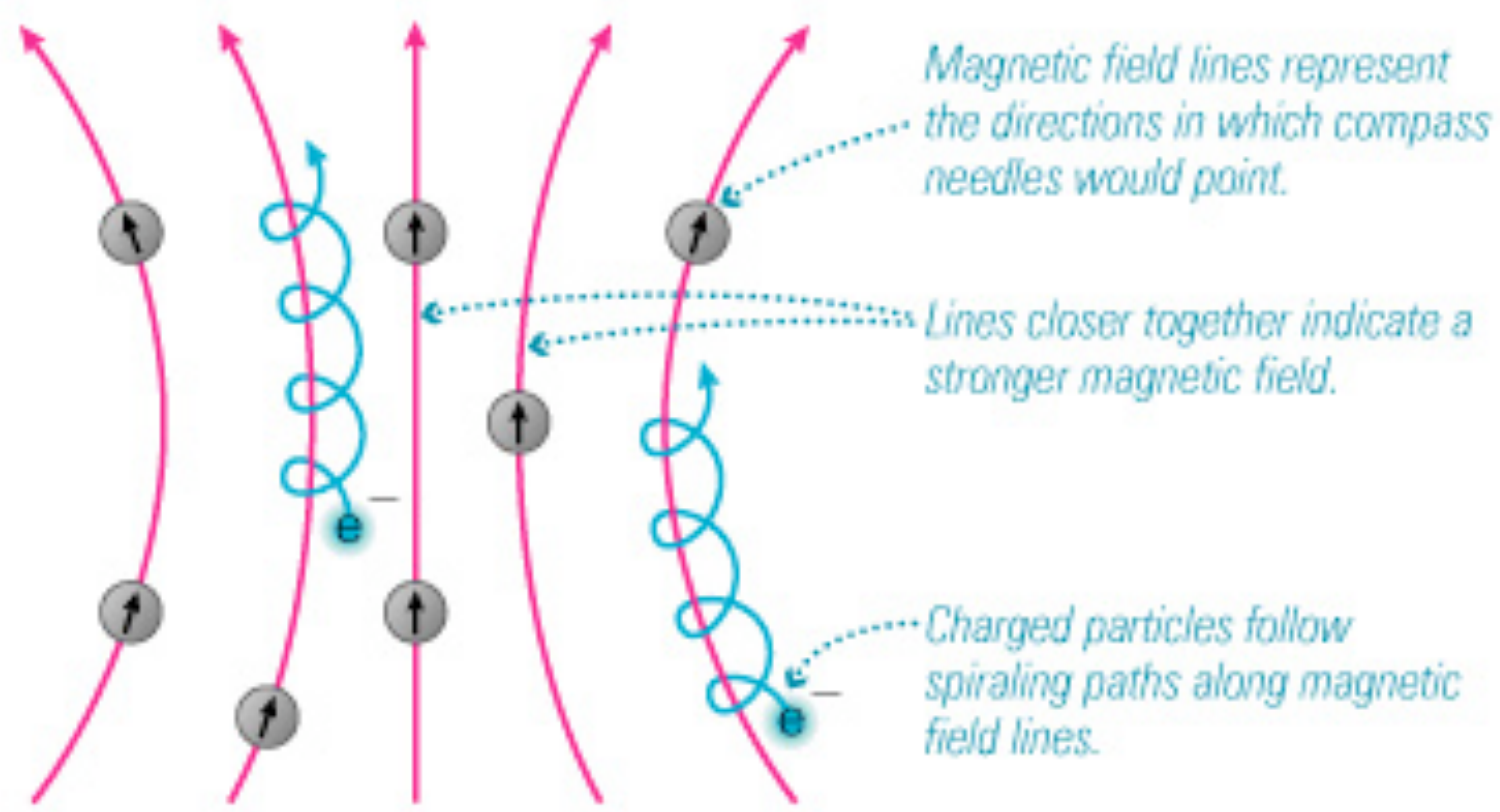
Are cooler than other parts of the Sun's surface (4000 K)

Are regions with strong magnetic fields

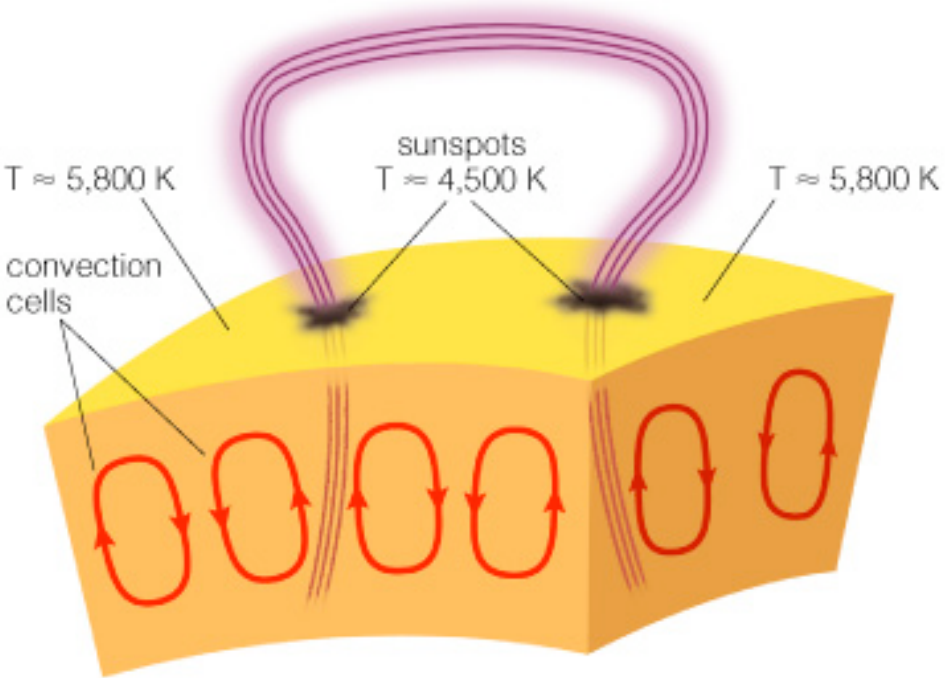
Zeeman Effect

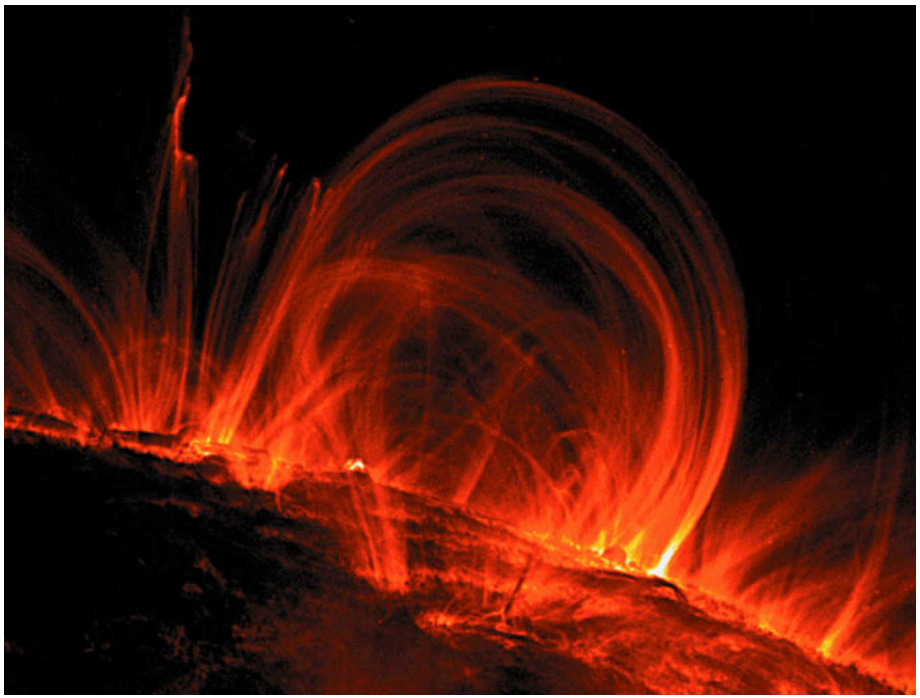


We can measure magnetic fields in sunspots by observing the splitting of spectral lines

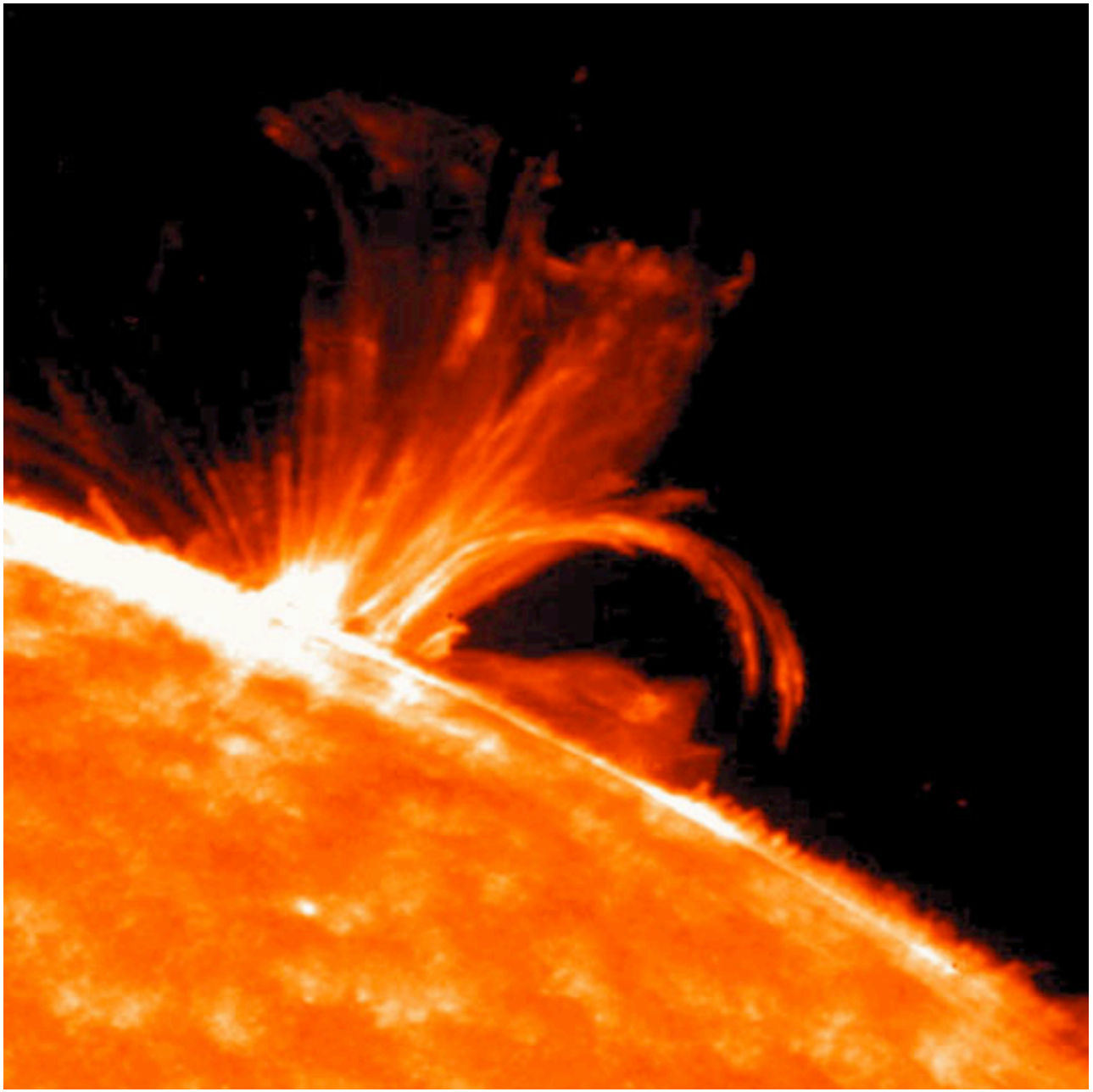


Charged particles spiral along magnetic field lines

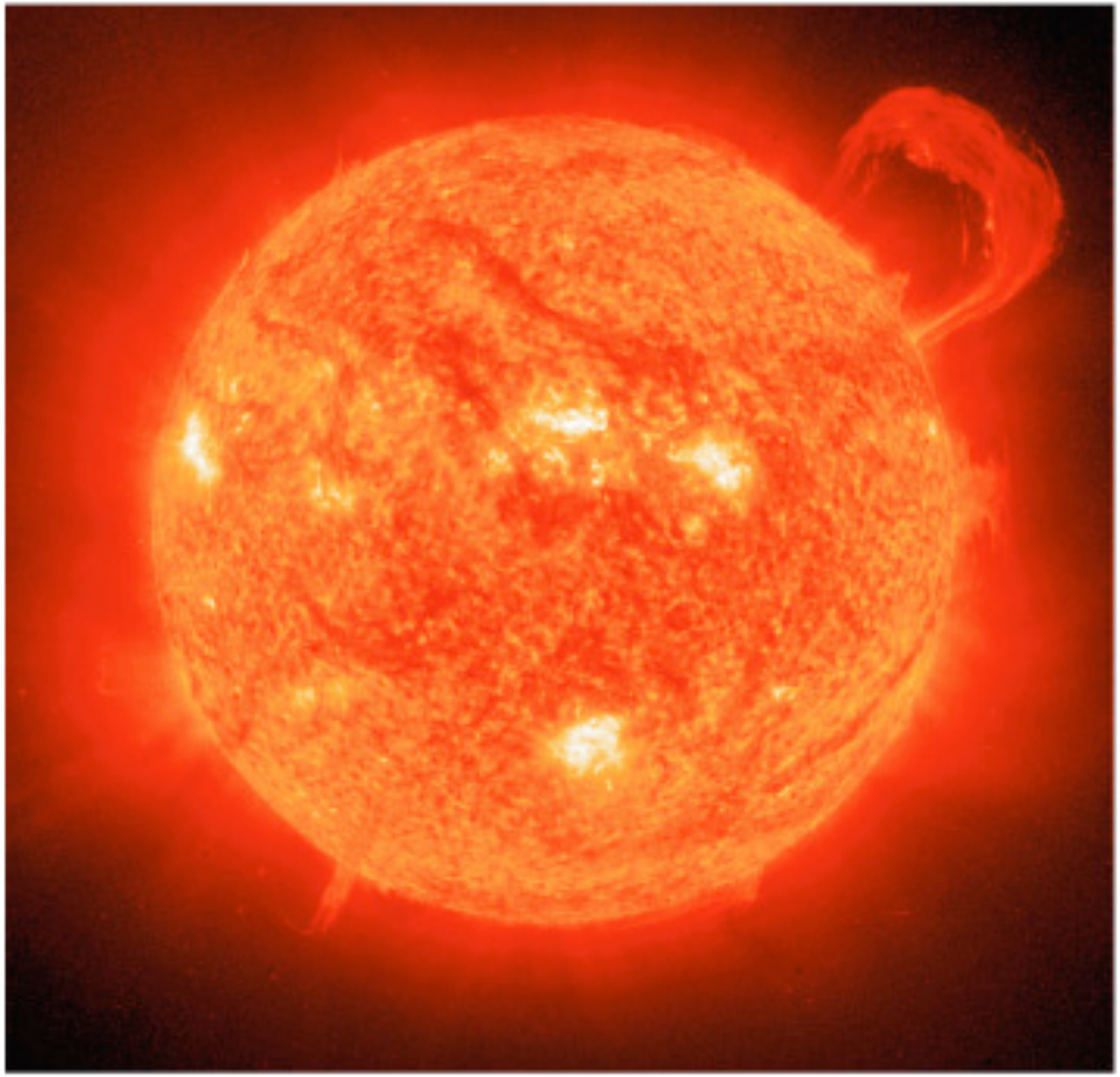




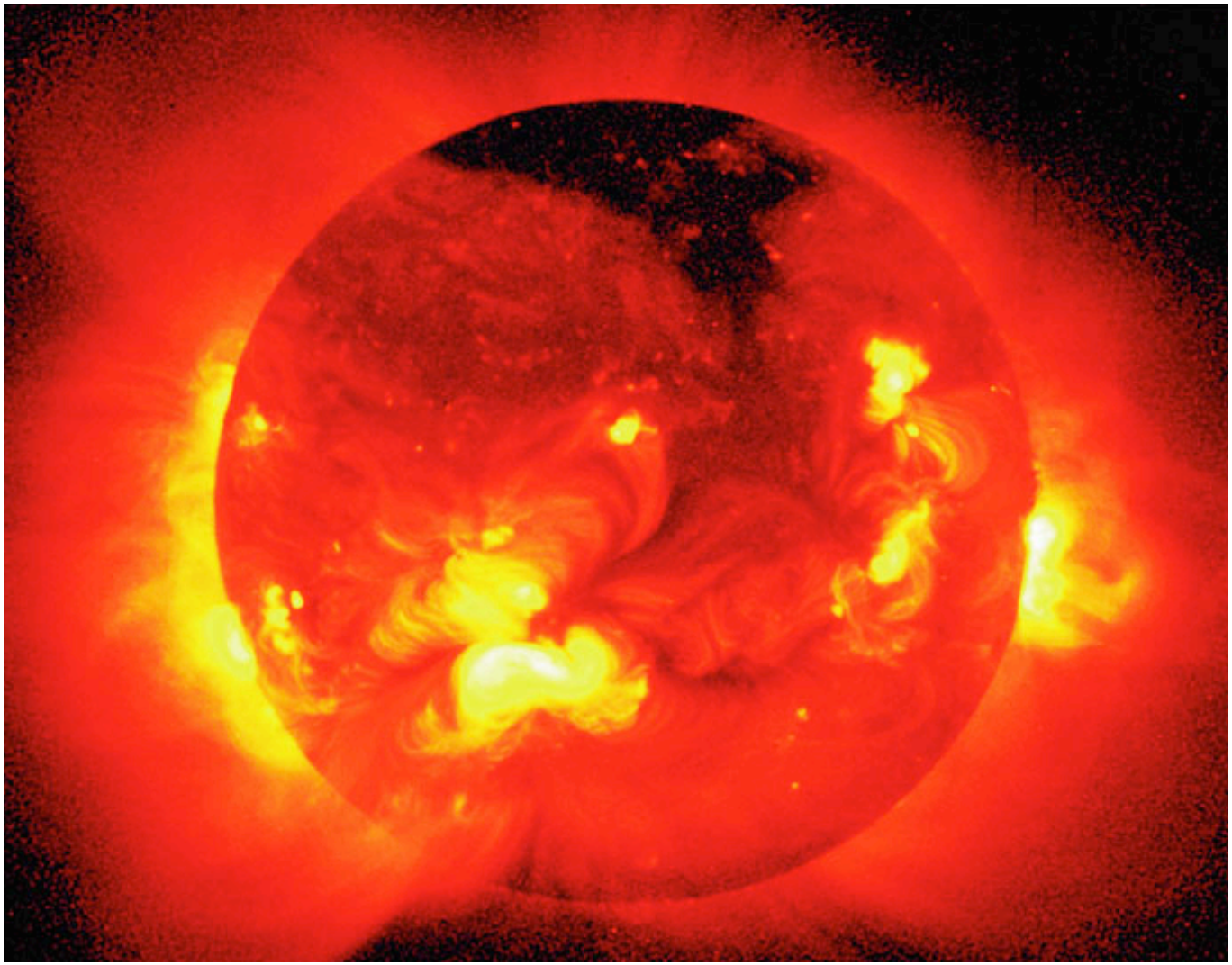
Loops of bright gas often connect sunspot pairs



Magnetic activity causes ***solar flares*** that send bursts of X-rays and charged particles into space

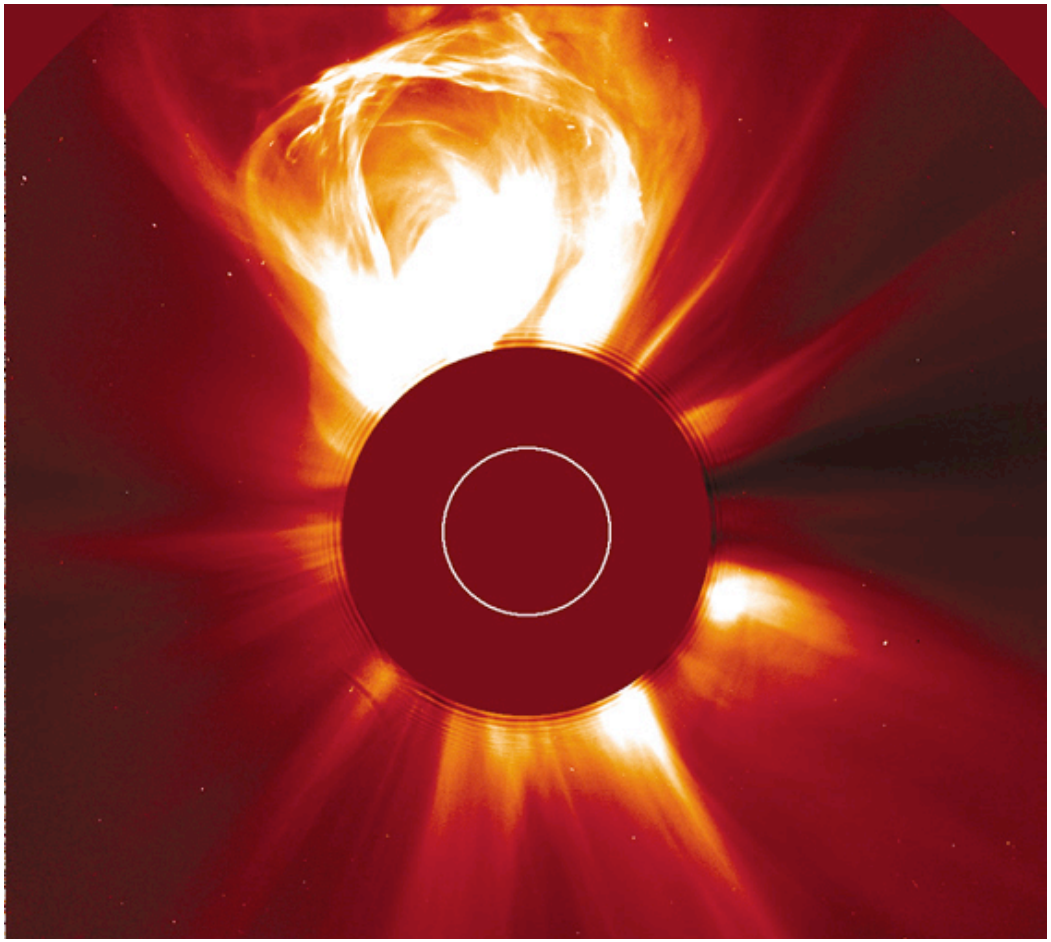


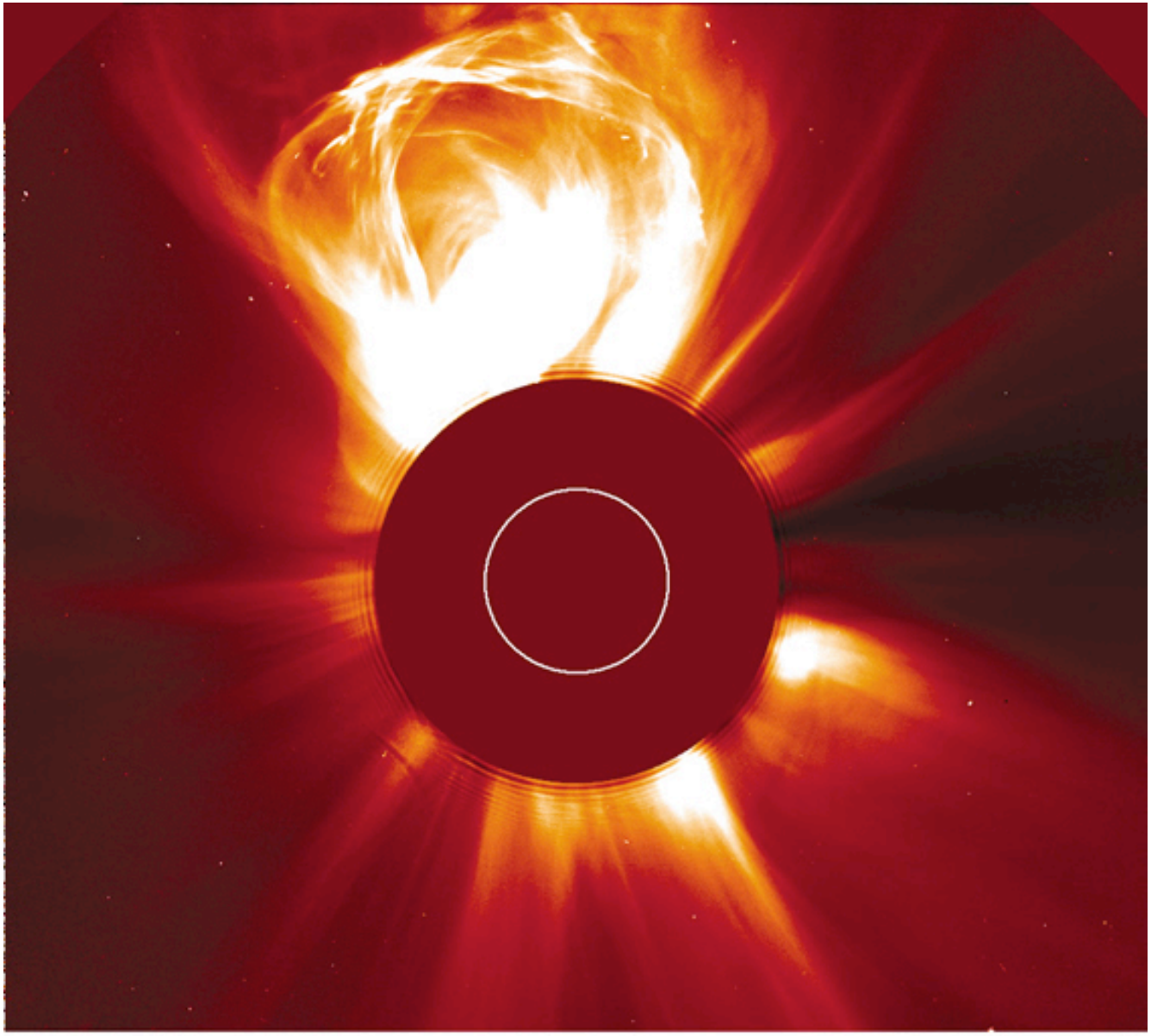
Magnetic activity also causes ***solar prominences*** that erupt high above the Sun's surface



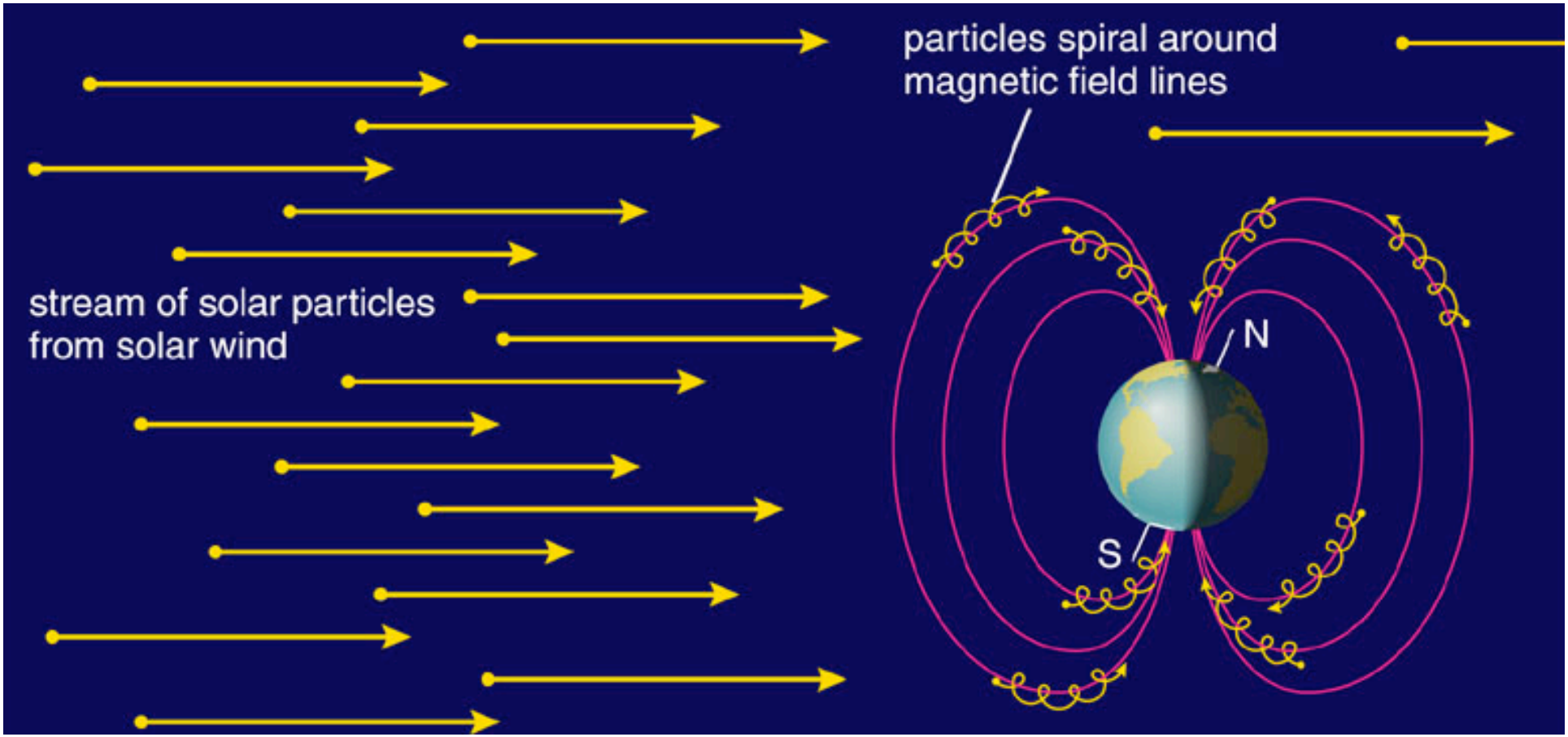
Corona appears bright in X-ray photos in places where magnetic fields trap hot gas

How does solar activity affect humans?



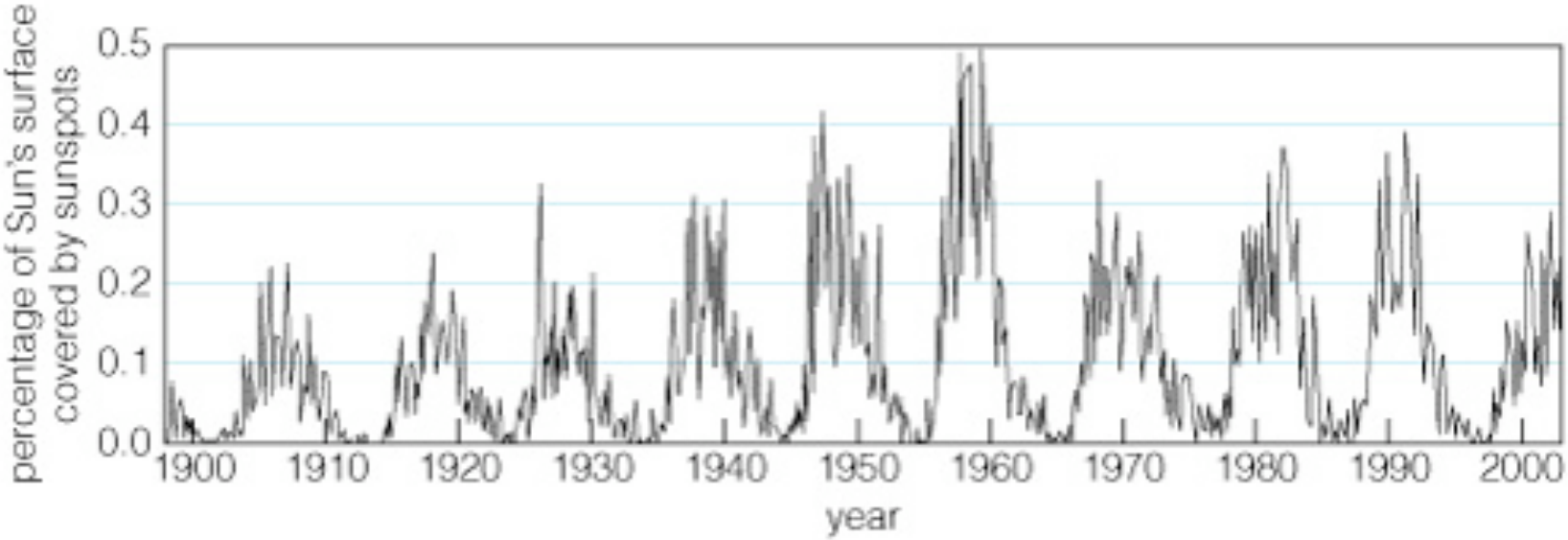


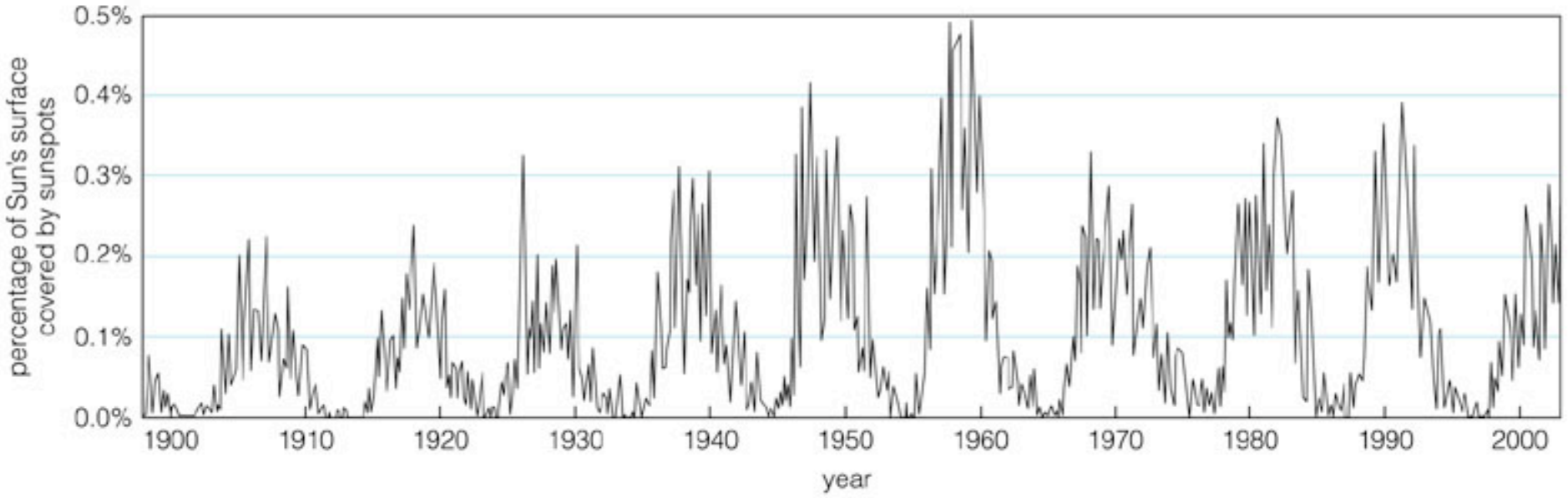
Coronal mass ejections send bursts of energetic charged particles out through the solar system



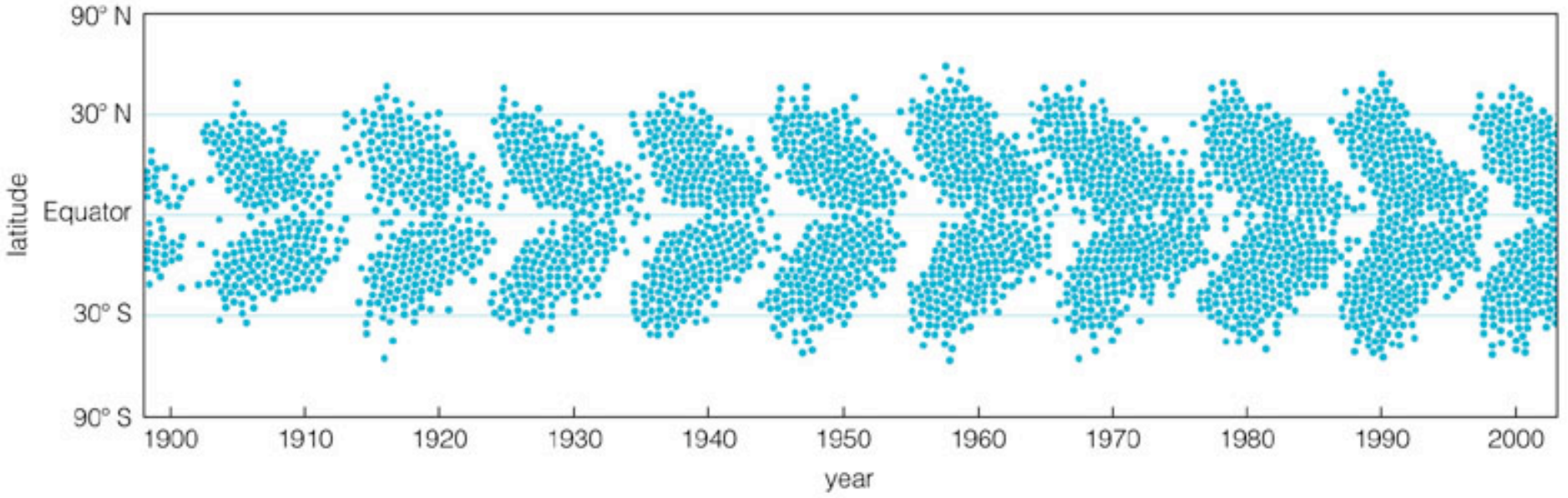
Charged particles streaming from Sun can disrupt electrical power grids and can disable communications satellites

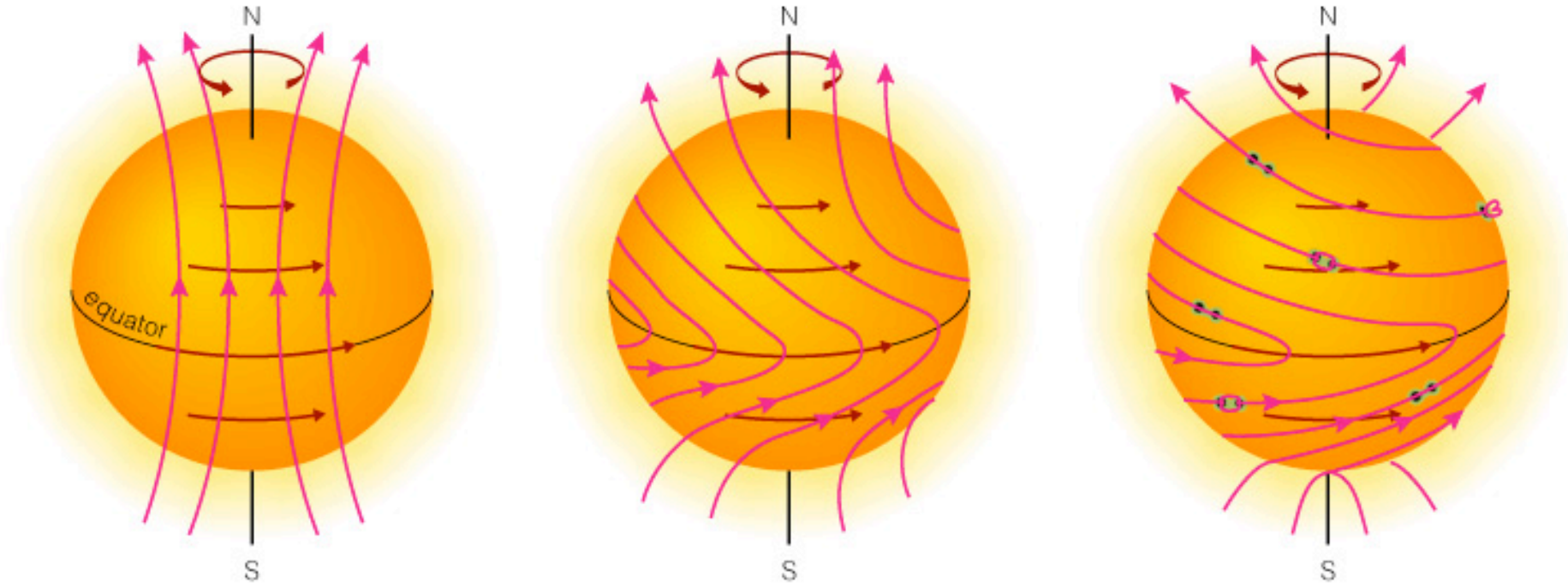
How does solar activity vary with time?





Number of sunspots rises and falls in 11-year cycle



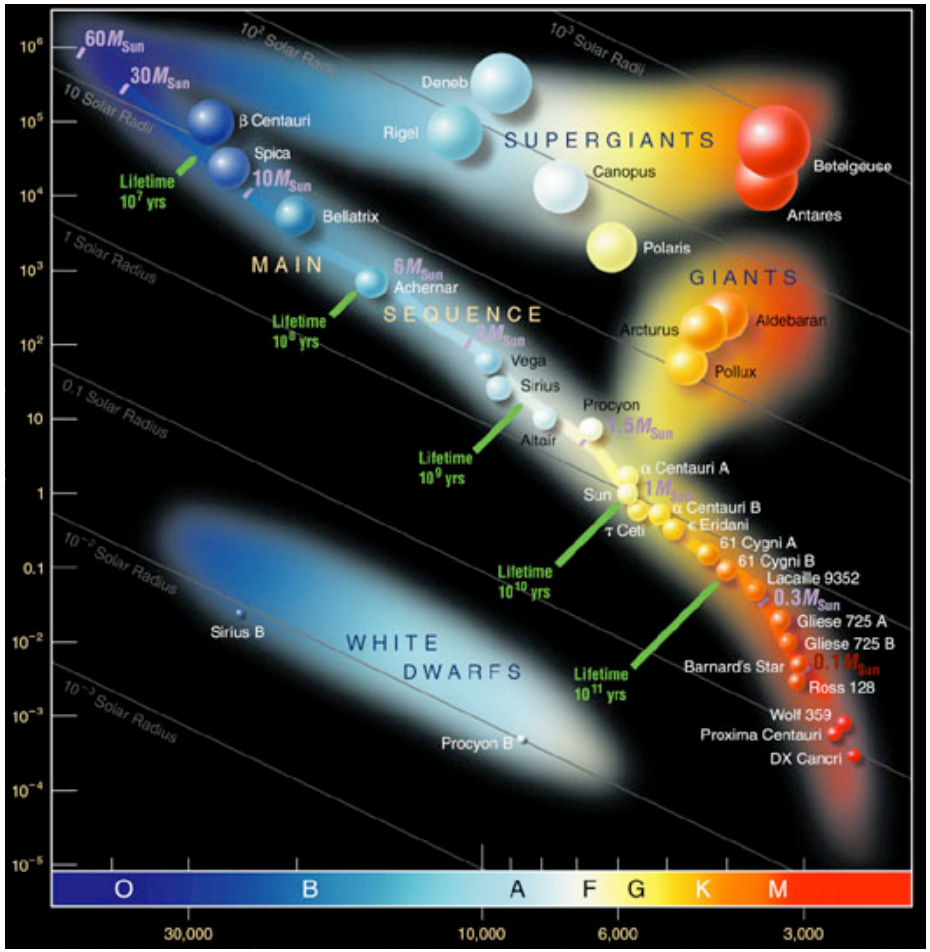


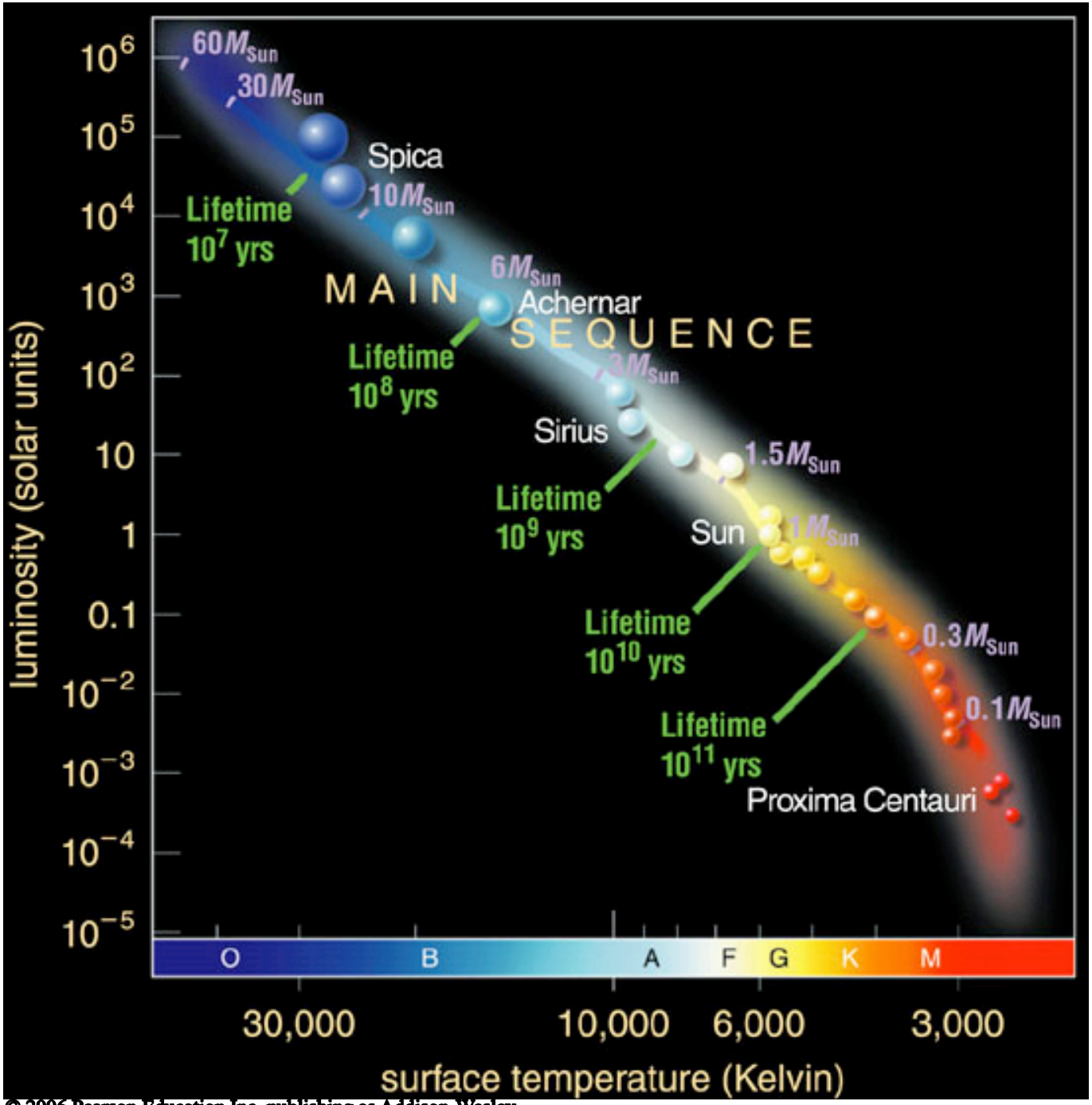
Sunspot cycle has something to do with winding and twisting of Sun's magnetic field

Pioneers of Stellar Classification

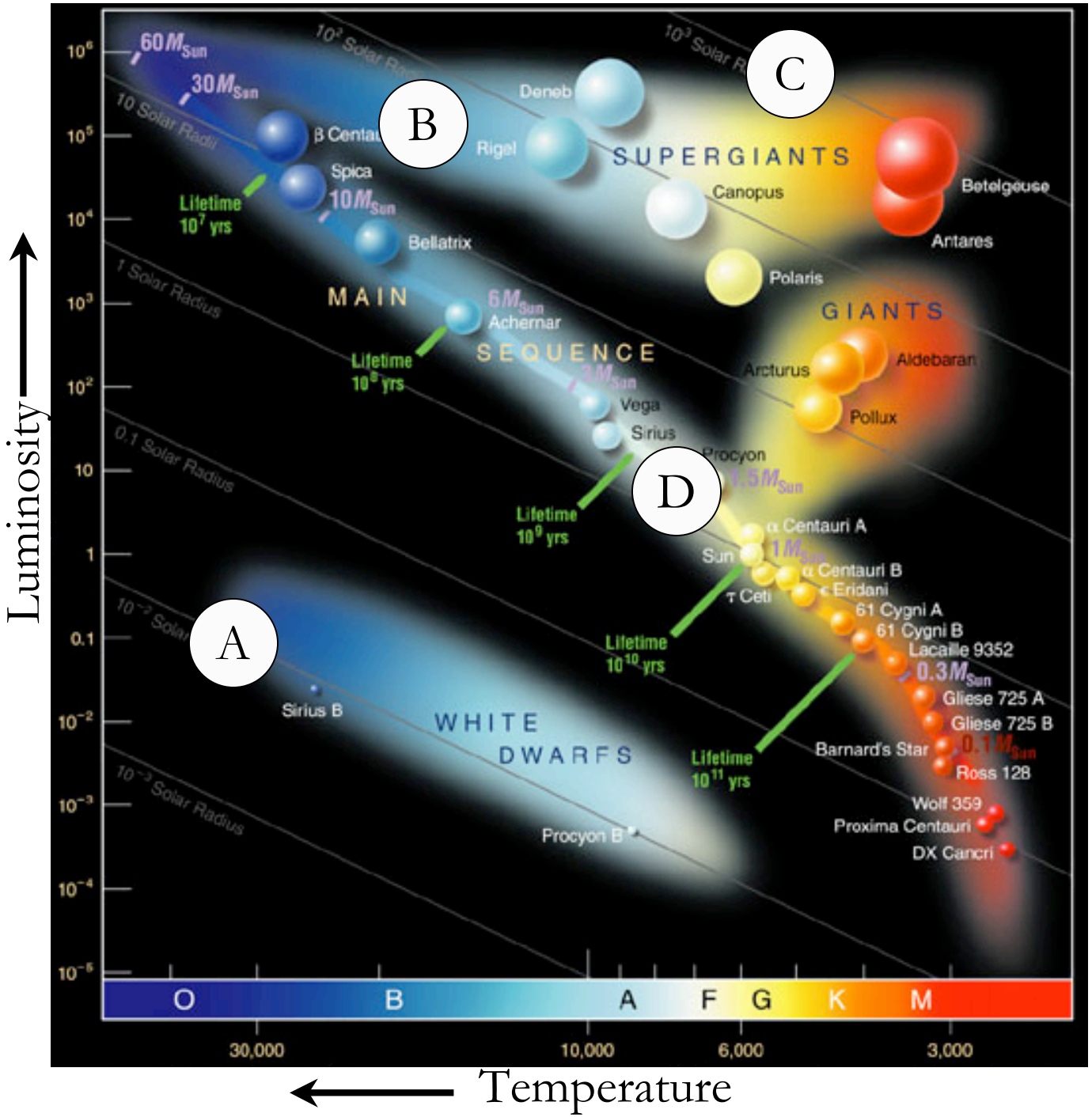
- Annie Jump Cannon and the "calculators" at Harvard laid the foundation of modern stellar classification

What is a Hertzsprung-Russell diagram?

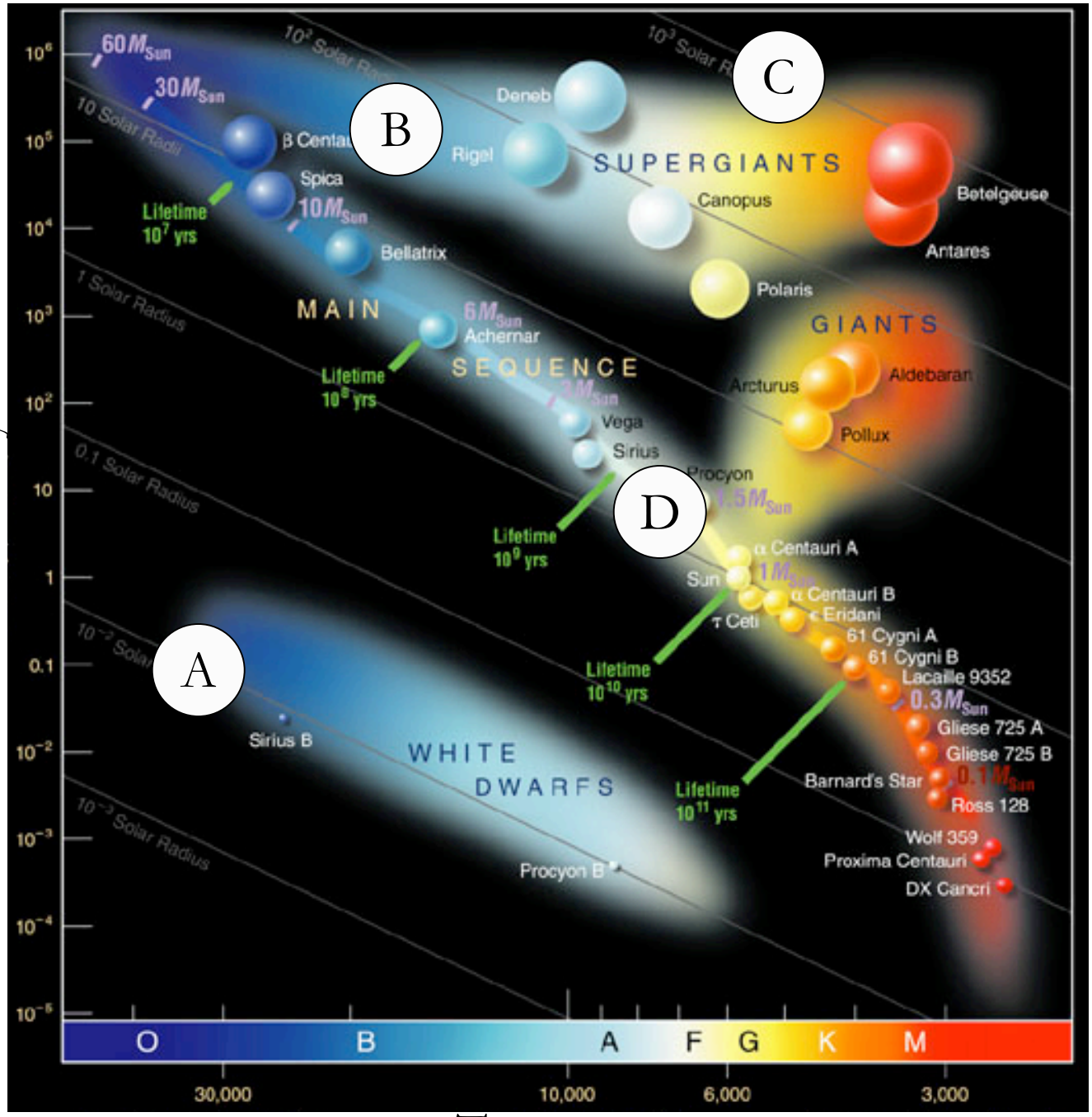




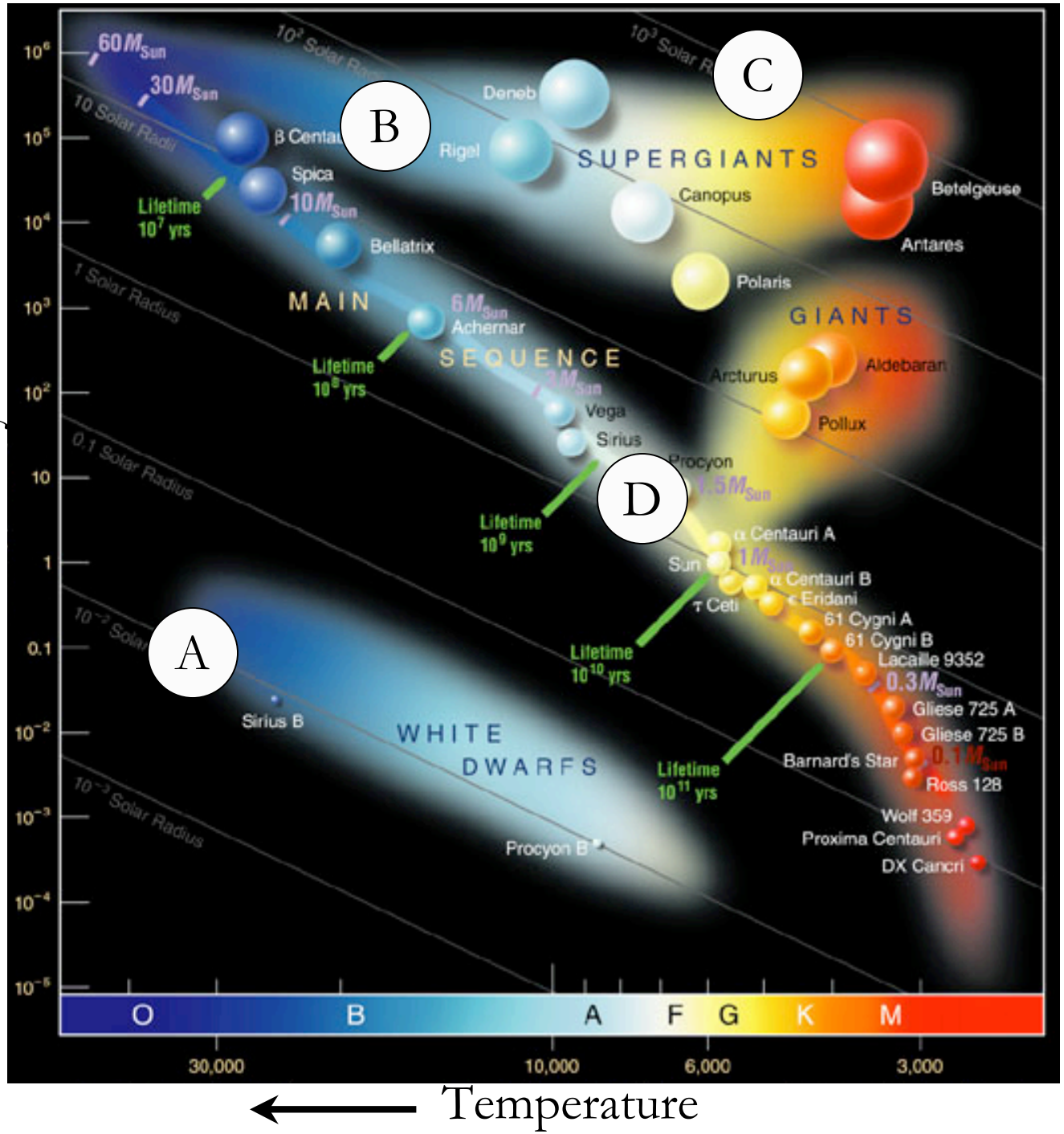
Most stars fall somewhere on the ***main sequence*** of the H-R diagram



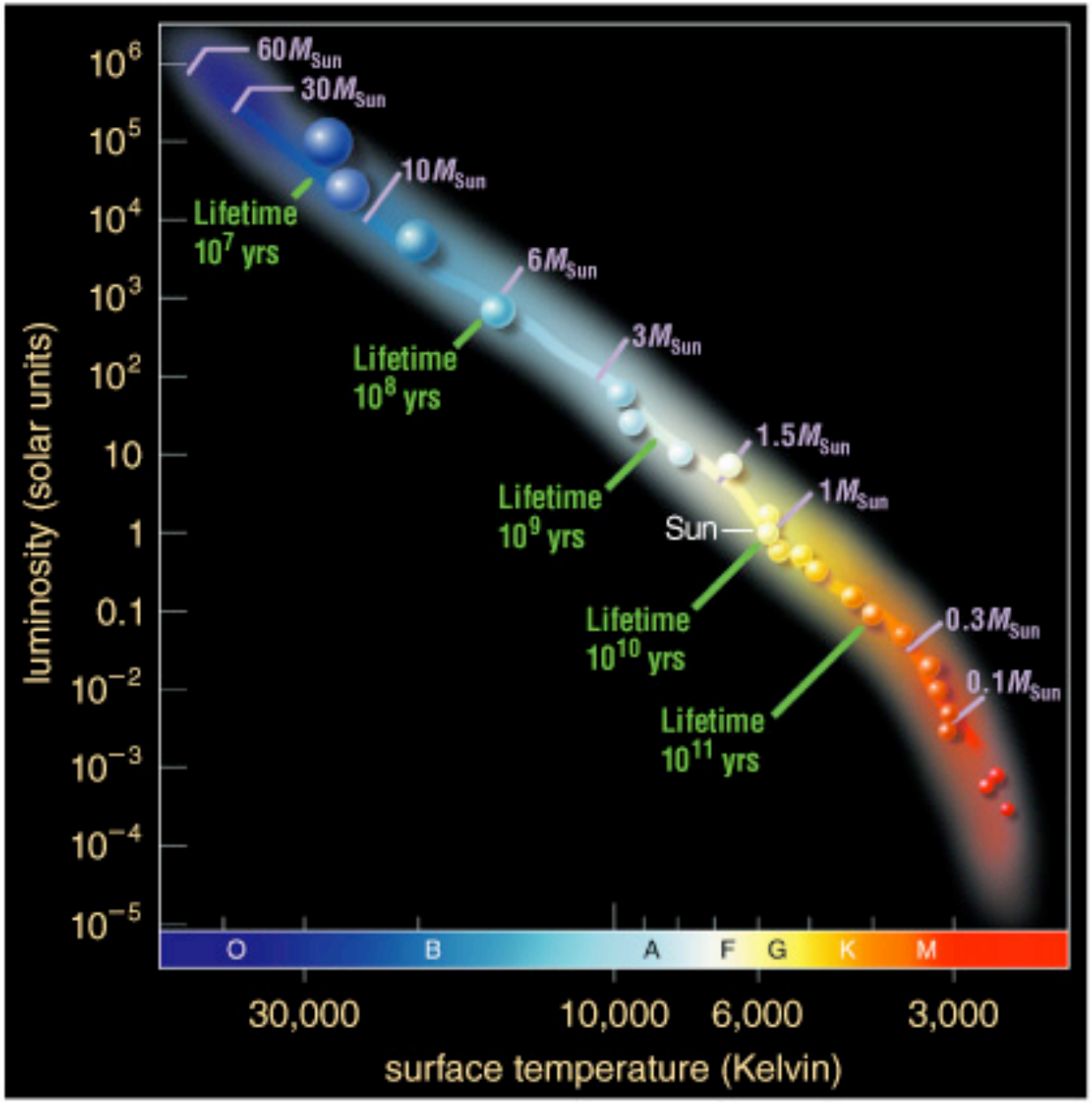
Which star is the hottest?



Which star is the most luminous?



Which star has the largest radius?



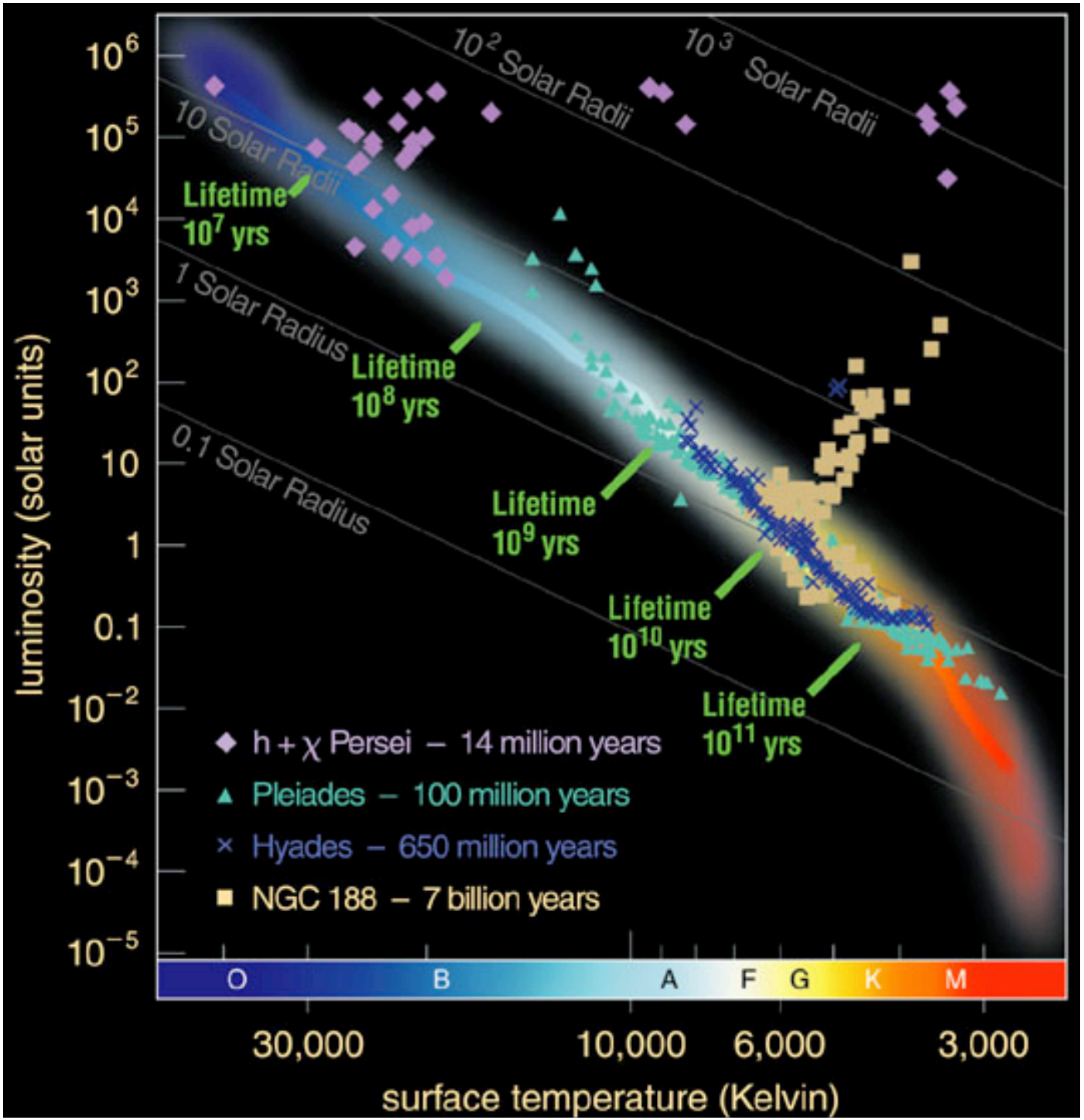
Main-sequence stars are fusing hydrogen into helium in their cores like the Sun

Luminous main-sequence stars are hot (blue)

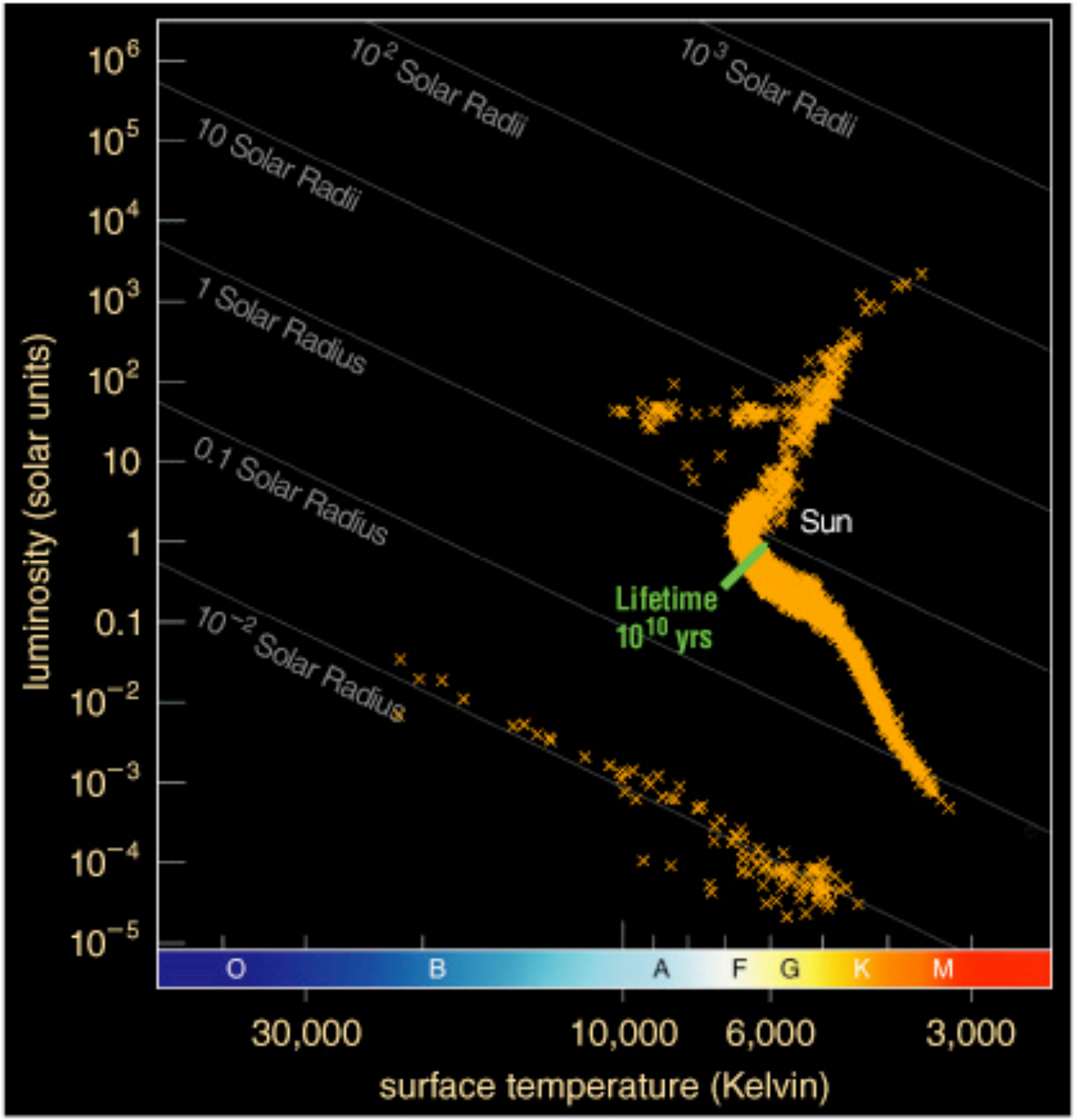
Less luminous ones are cooler (yellow or red)

Open cluster: A few thousand loosely packed stars

Globular cluster: Up to a million or more stars in a dense ball bound together by gravity



Main-sequence turnoff point of a cluster tells us its age



Detailed modeling of the oldest globular clusters reveals that they are about 13 billion years old