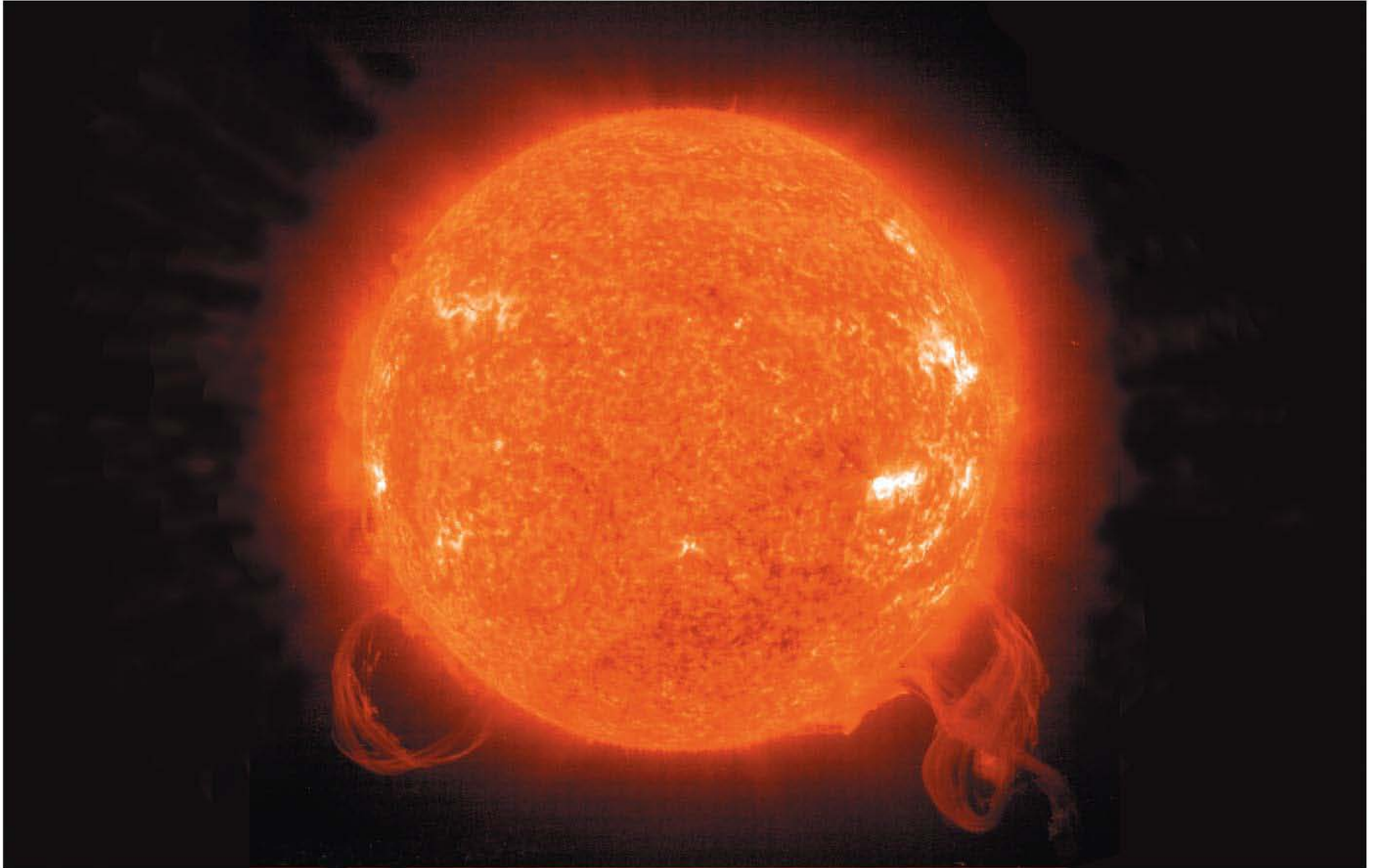


Chapter 14

Our Star



14.1 A Closer Look at the Sun

Our goals for learning:

- Why was the Sun's energy source a major mystery?
- Why does the Sun shine?
- What is the Sun's structure?



Is it on FIRE? ... NO!

Chemical Energy Content

Luminosity

~ 10,000 years



Is it CONTRACTING? ... NO!

Gravitational Potential Energy

Luminosity

~ 25 million years

Why does the Sun shine?

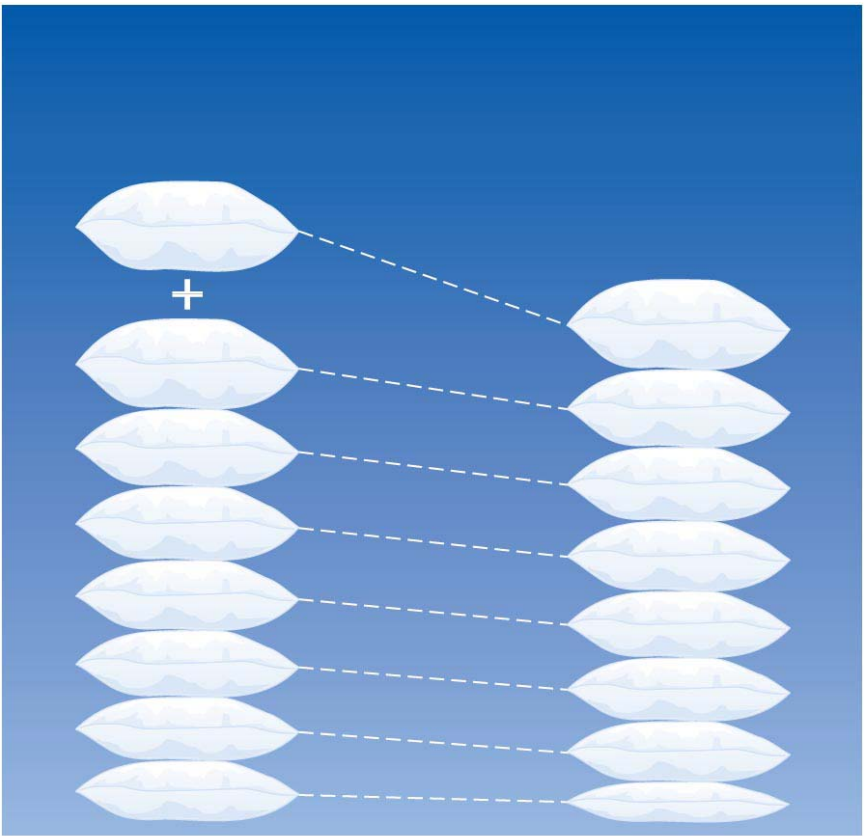



$$E = mc^2$$

- Einstein, 1905

It can be powered by NUCLEAR ENERGY!

$$\frac{\text{Nuclear Potential Energy (core)}}{\text{Luminosity}} \sim 10 \text{ billion years}$$

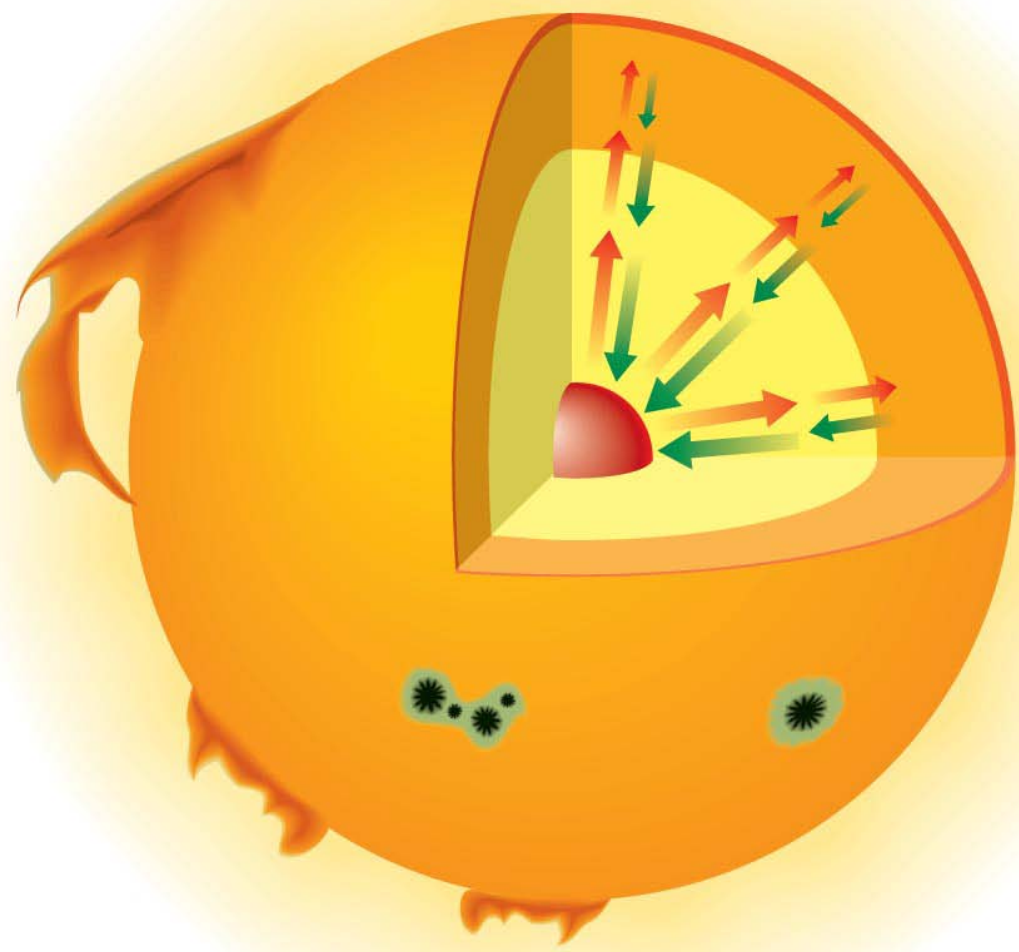


Weight of upper layers
compresses lower layers

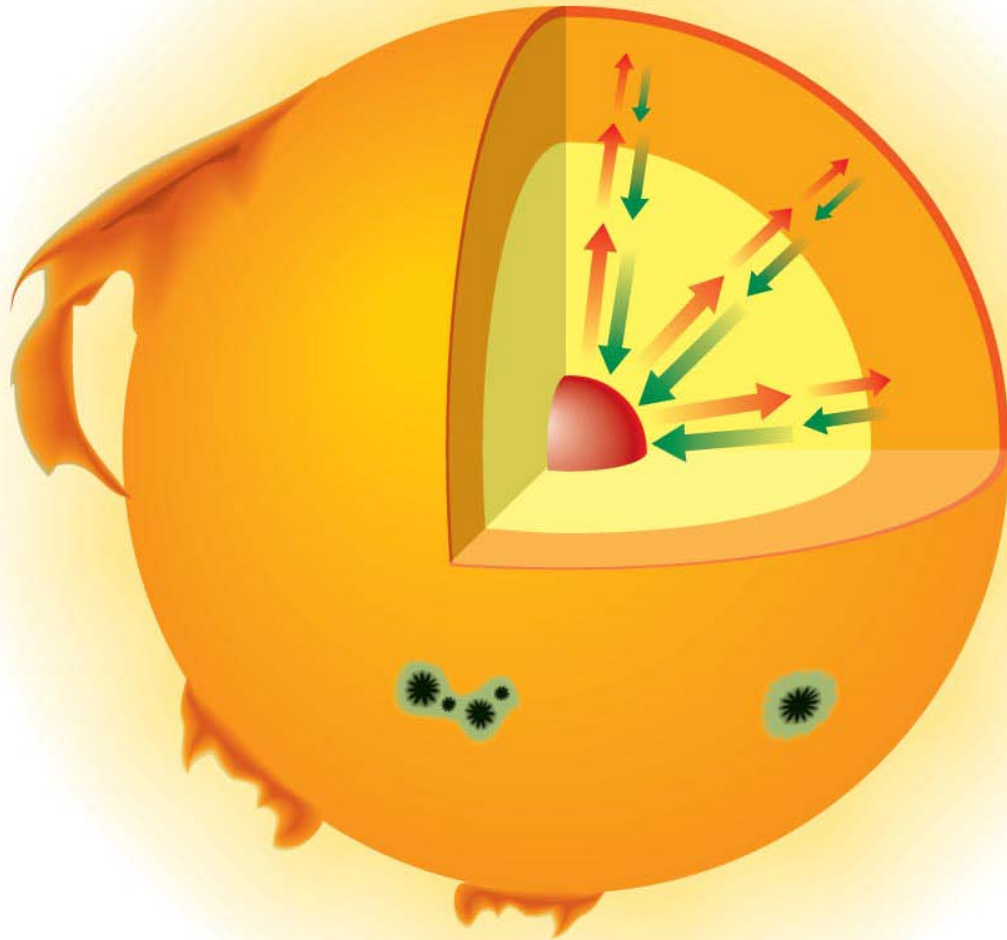
pressure 
gravity 

*Gravitational
equilibrium:*

Energy provided
by fusion
maintains the
pressure



pressure →
gravity ←

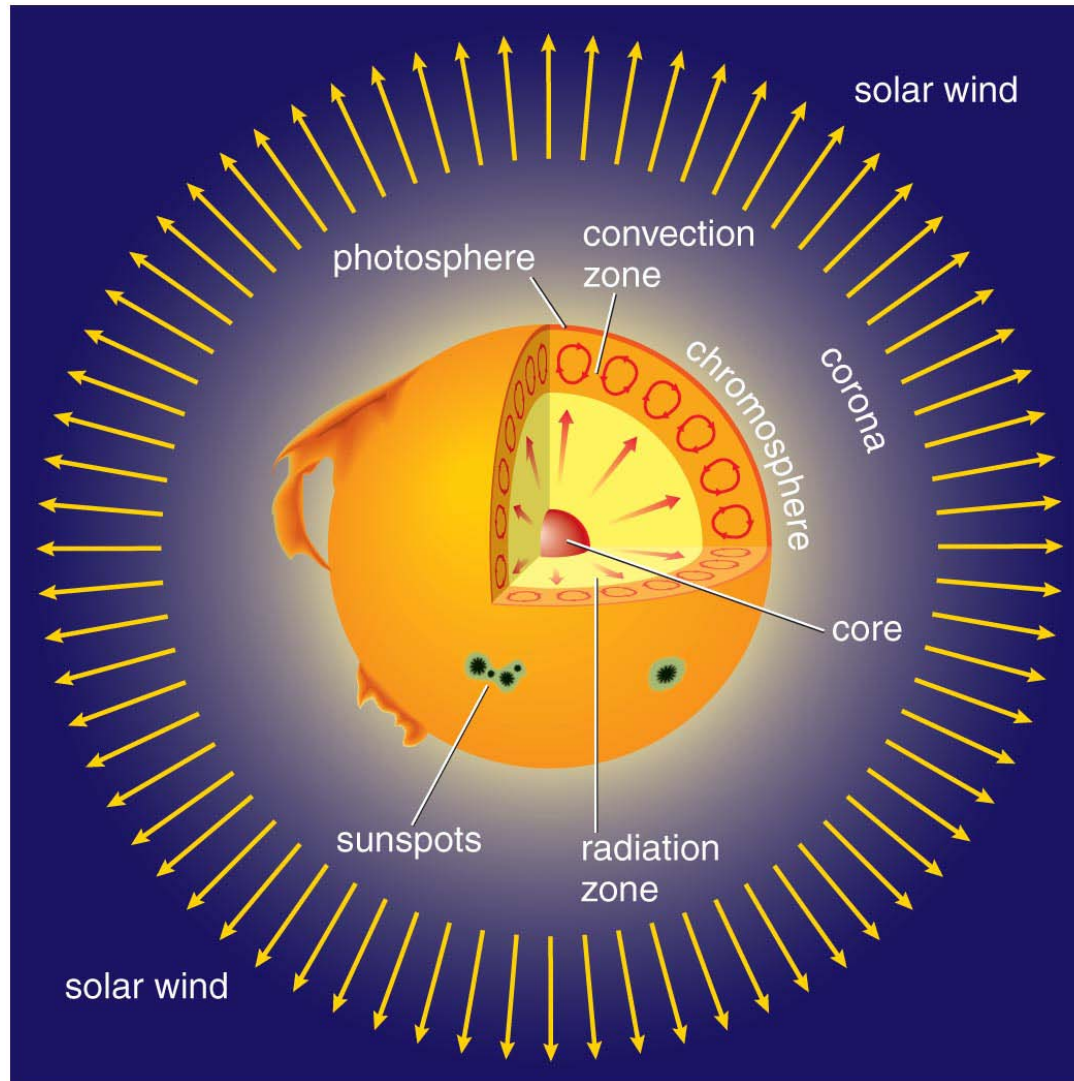


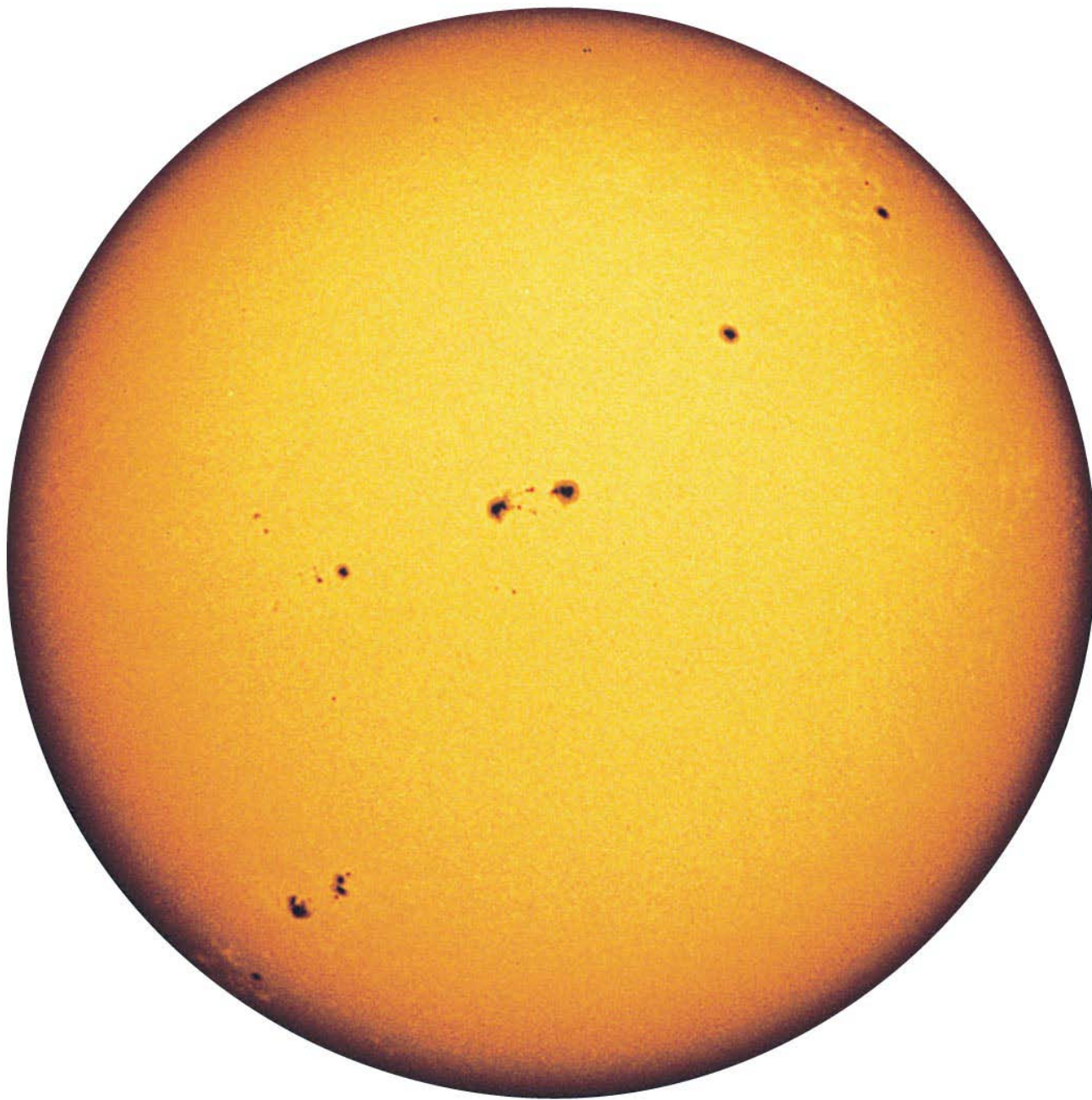
Gravitational contraction:

Provided the energy that heated the core as Sun was forming

Contraction stopped when fusion began

What is the Sun's structure?





Radius:

$6.9 \times 10^8 \text{ m}$

(109 times Earth)

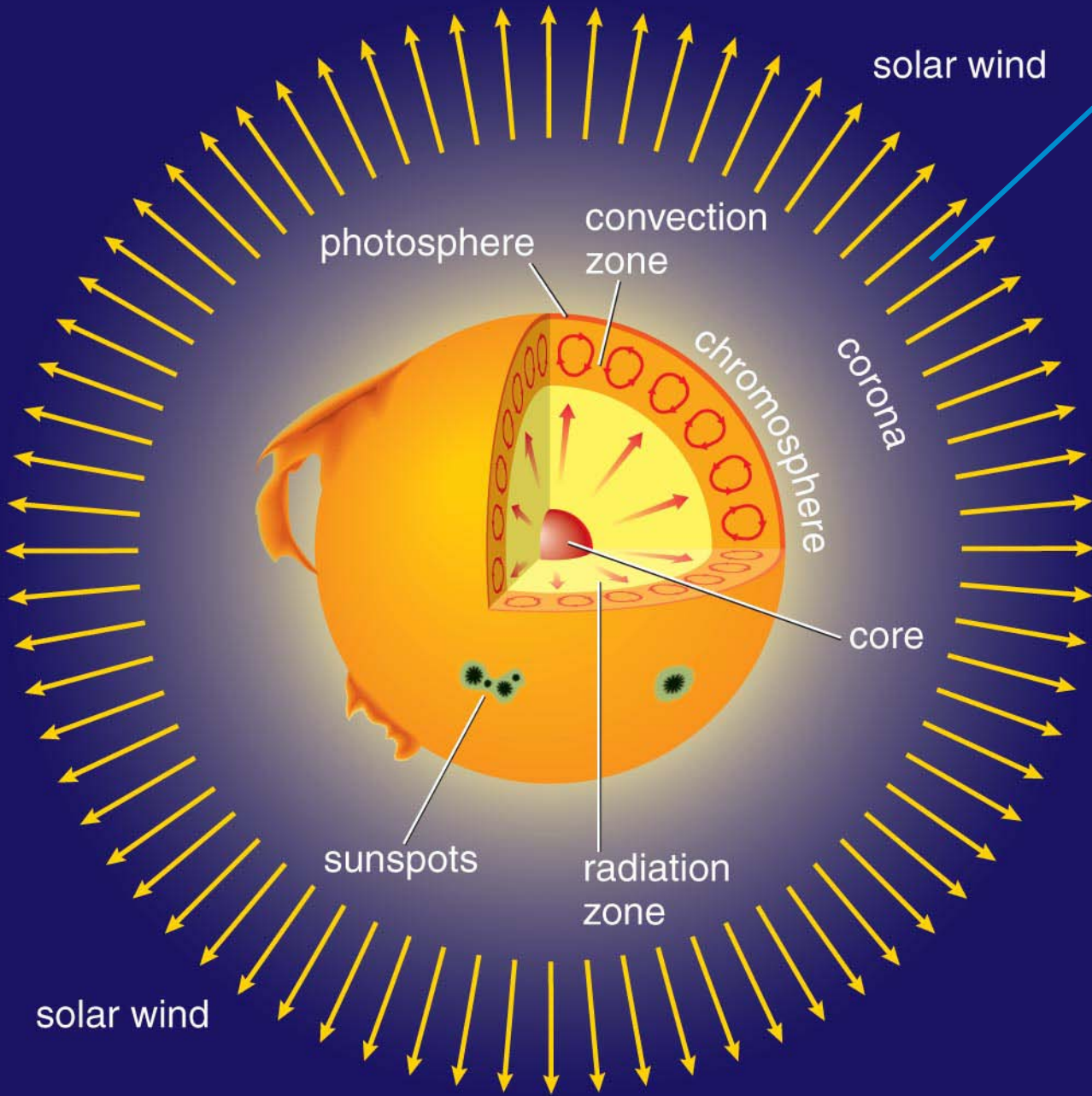
Mass:

$2 \times 10^{30} \text{ kg}$

(300,000 Earths)

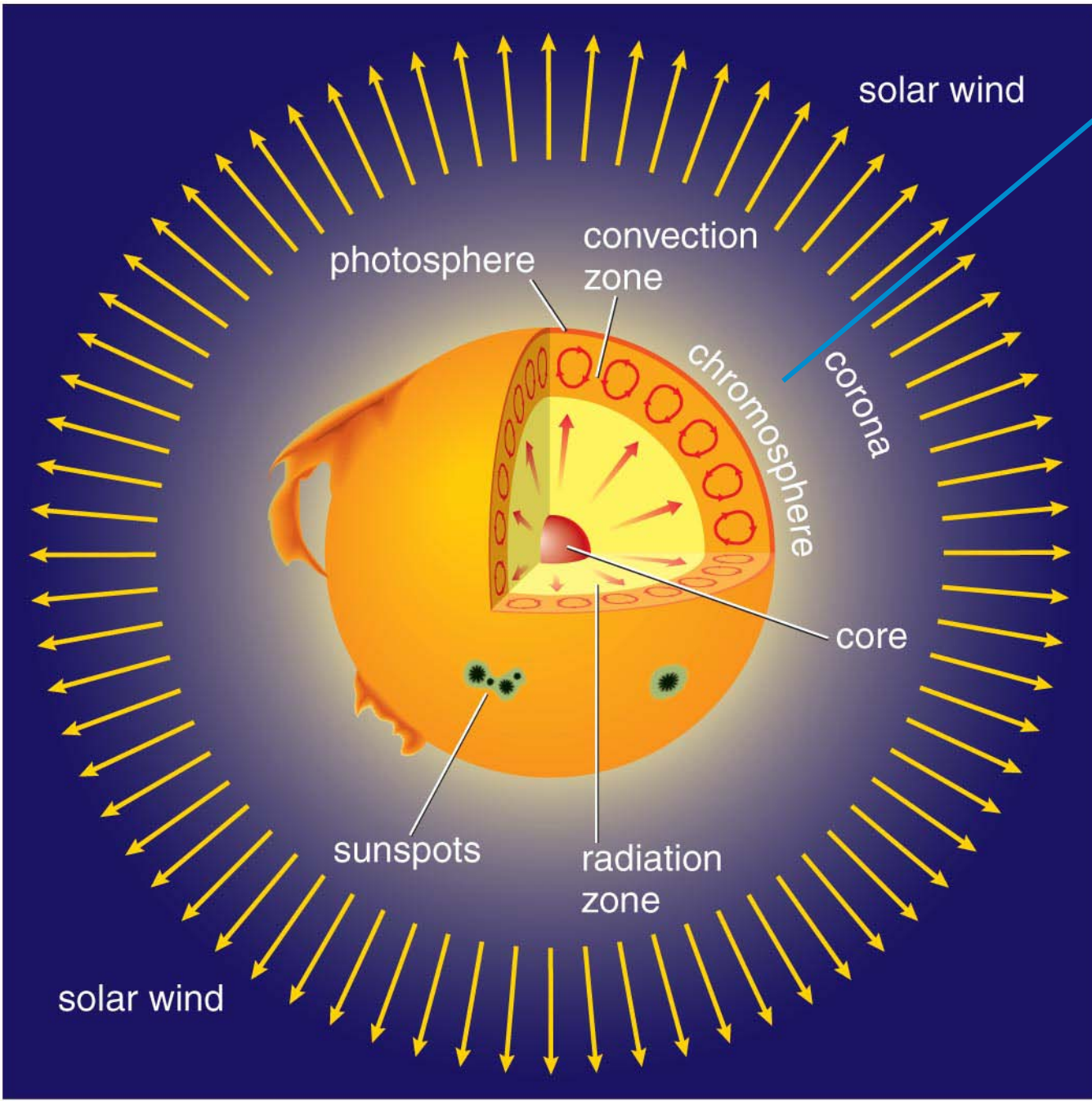
Luminosity:

$3.8 \times 10^{26} \text{ watts}$



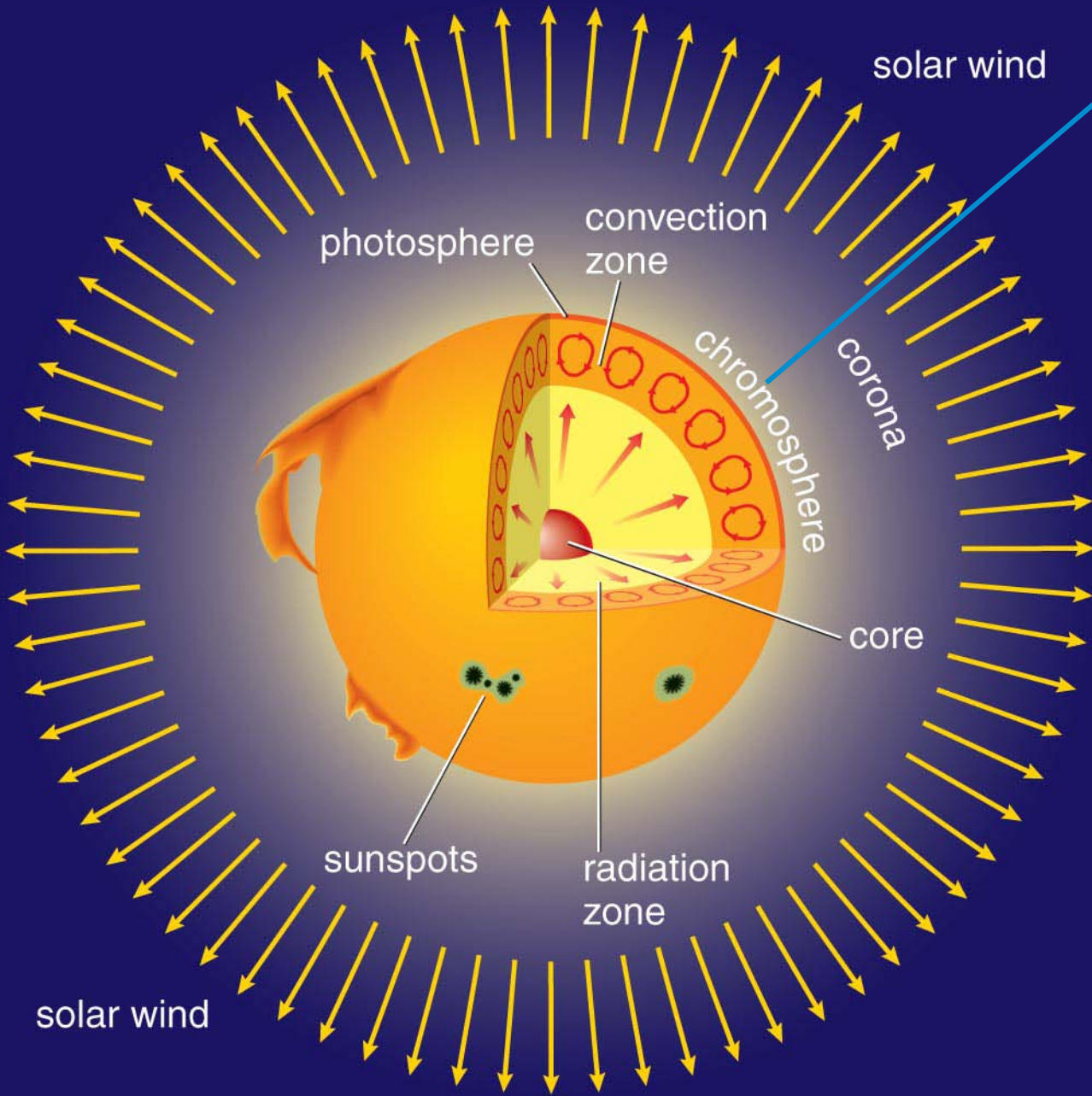
Solar wind:

A flow of charged particles from the surface of the Sun



Corona:
Outermost layer
of solar
atmosphere
~1 million K

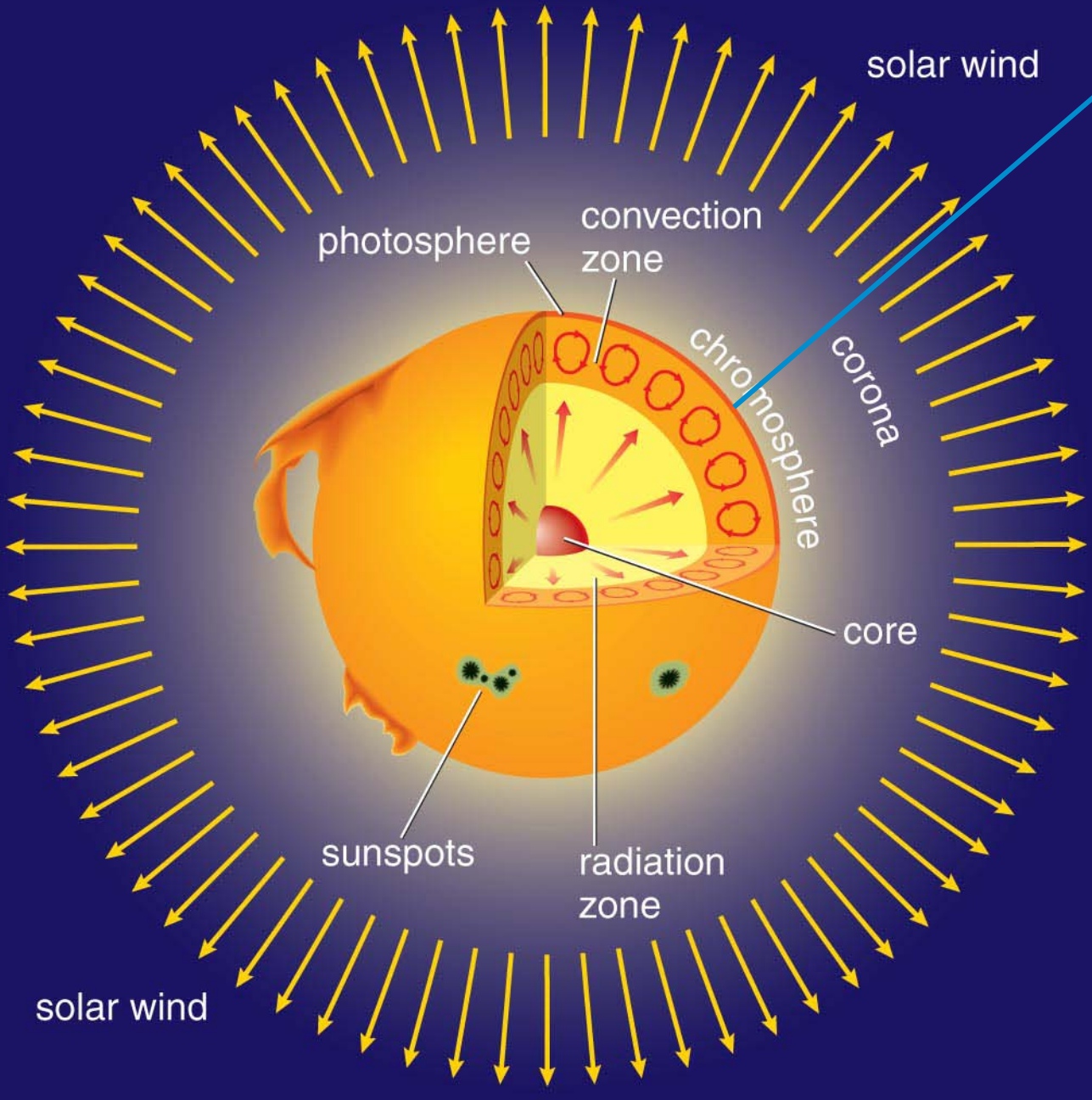
Interactive Figure



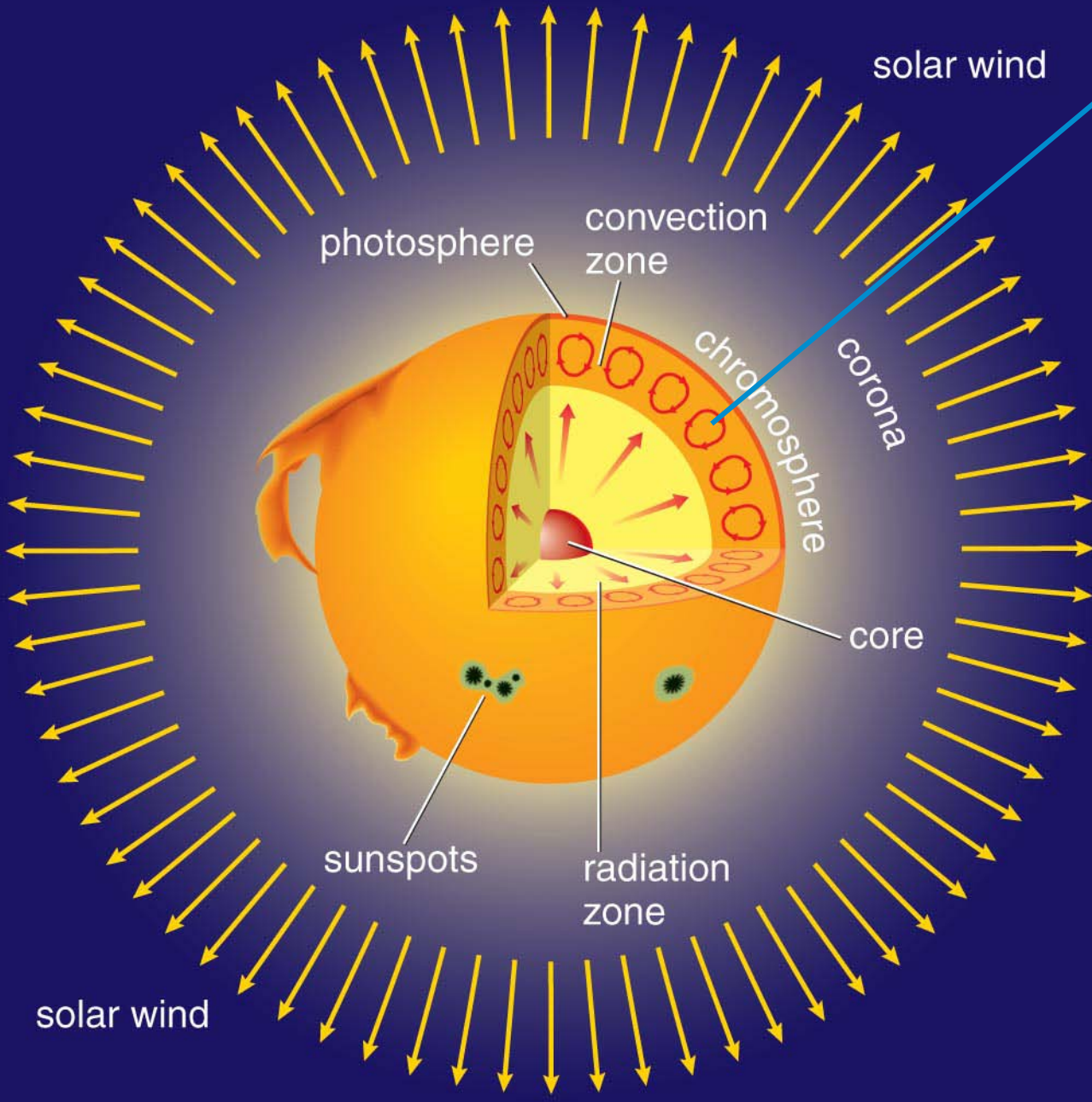
Chromosphere:

Middle layer of solar atmosphere

$\sim 10^4 - 10^5$ K

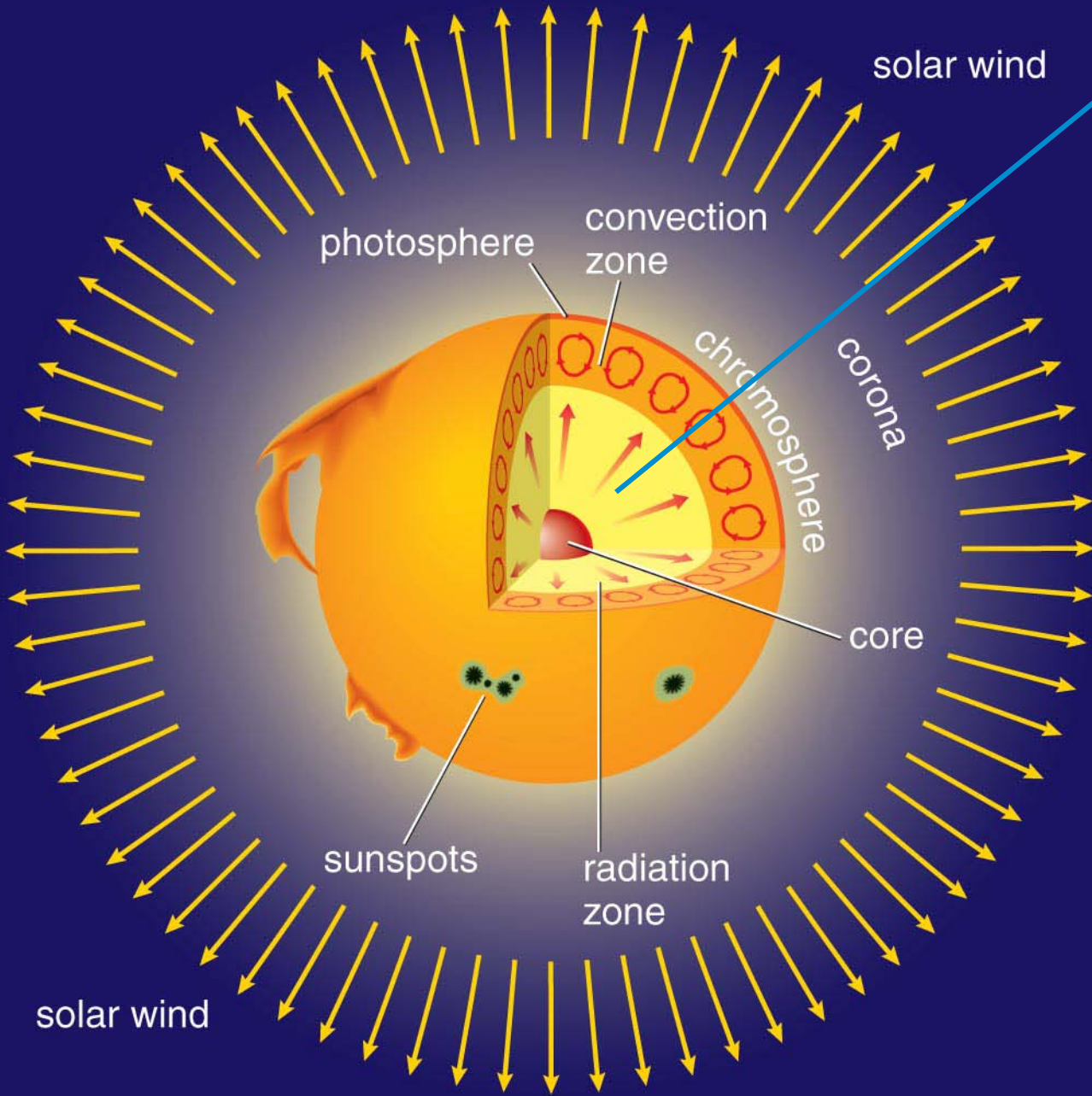


Photosphere:
Visible surface of Sun
~ 6,000 K



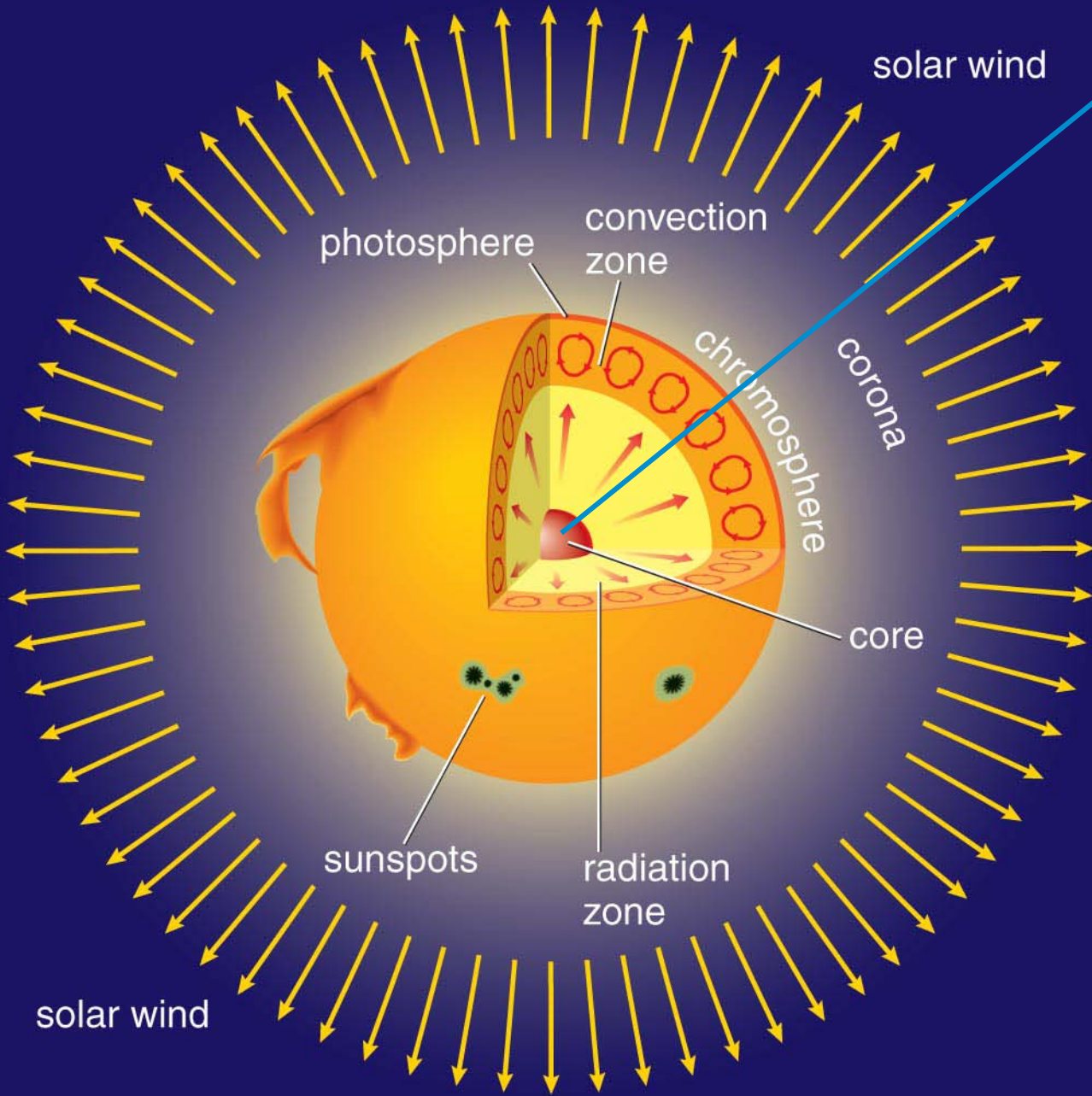
Convection Zone:

Energy transported upward by rising hot gas



Radiation Zone:

Energy transported upward by photons



Core:

Energy generated by nuclear fusion

~ 15 million K

What have we learned?

- Why was the Sun's energy source a major mystery?
 - Chemical and gravitational energy sources could not explain how the Sun could sustain its luminosity for more than about 25 million years
- Why does the Sun shine?
 - The Sun shines because **gravitational equilibrium** keeps its core hot and dense enough to release energy through nuclear fusion.

What have we learned?

- What is the Sun's structure?
 - From inside out, the layers are:
 - Core
 - Radiation Zone
 - Convection Zone
 - Photosphere
 - Chromosphere
 - Corona