

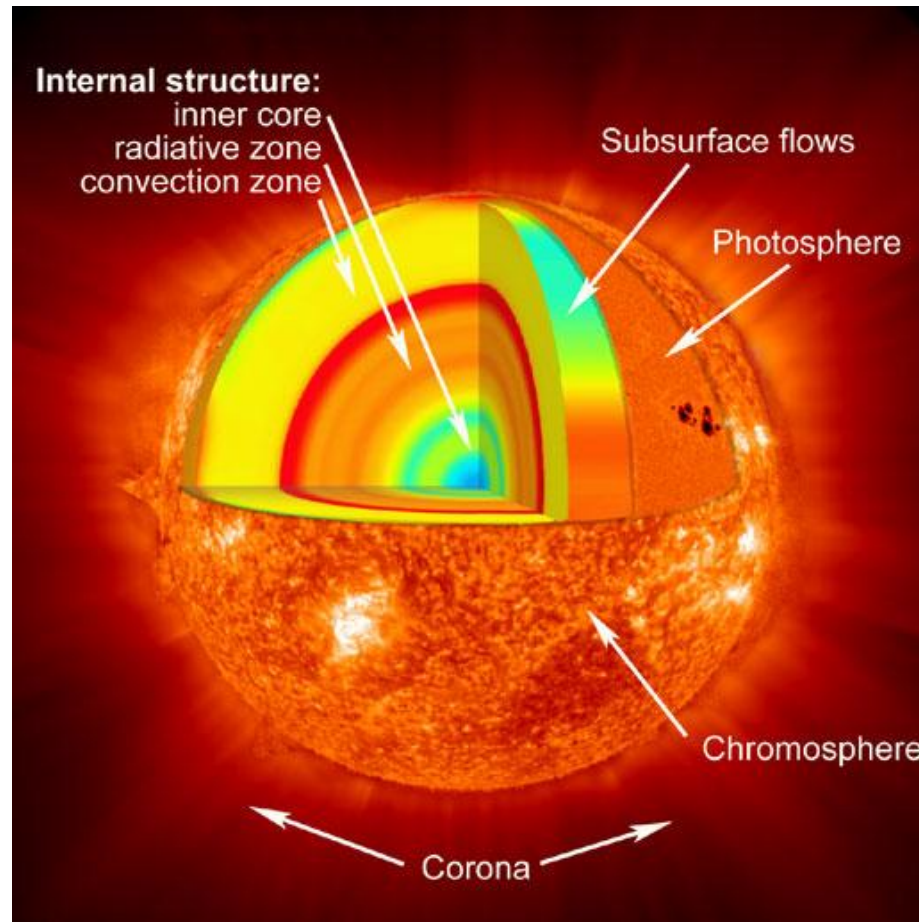
The Sun

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General Characteristics

- Our closest star
- Source of almost all our energy
- One of 100 billion in the Milky Way Galaxy
- “average’ star, but gigantic compared with Earth in most ways
 - > 109 Earth’s diameter
 - > 1.25 millions times Earth’s volume
 - > 332,000 times Earth’s mass
 - > $\frac{1}{4}$ Earth’s mass

Sun's layers: Photosphere, chromosphere, corona, and interior



http://www.nasa.gov/images/content/171925main_heliolayers_label_516.jpg

Sun layers: Photosphere

- Visible surface
- Less than 500 km thick
- Grainy hot gases rising from below, cooling, and sinking (in about 10 – 20 minutes)
- About 90% H, almost 10% He, minor amounts of other elements

Sun layers: Chromosphere

- Thin layer of hot gases a few thousand km thick
- Seen as thin red rim only visible during total eclipse
- Reddish color (from H) in emission spectrum

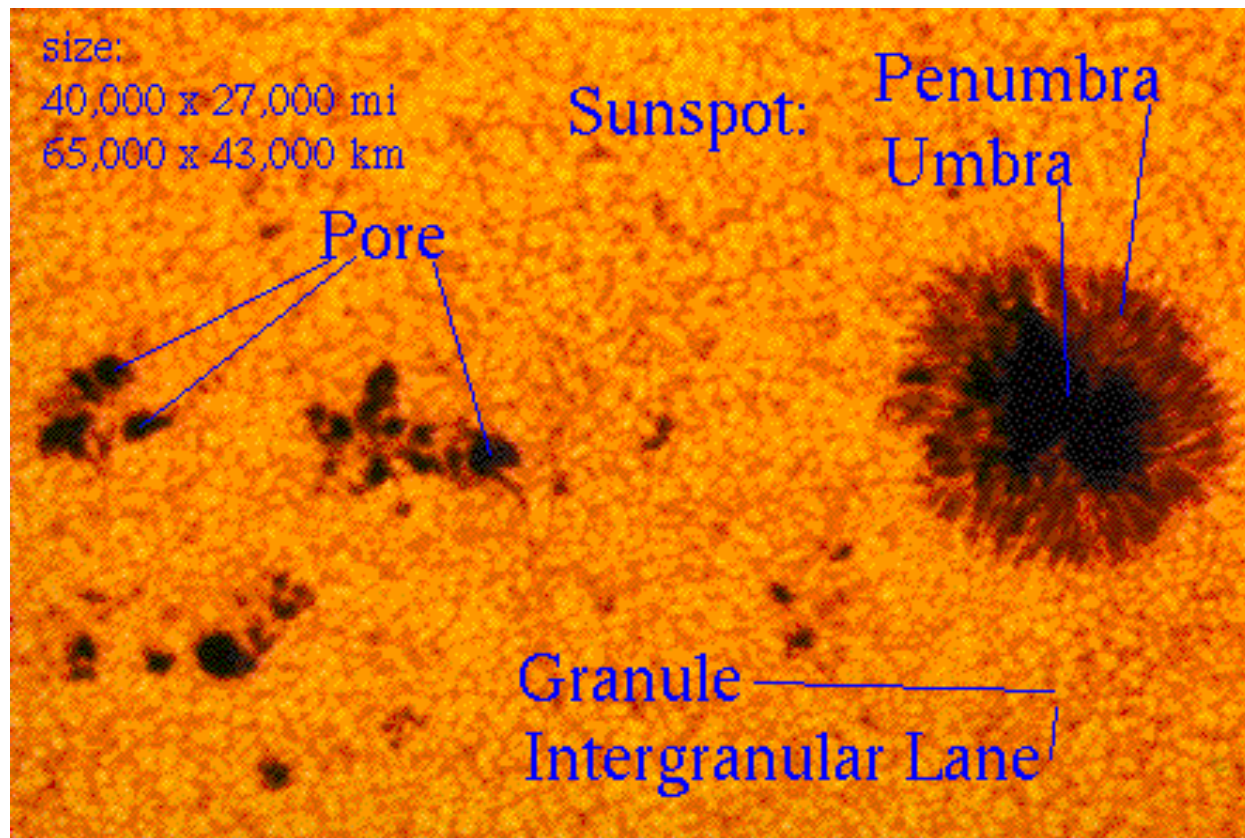
Sun layers: Corona

- Outermost portion of solar atmosphere
- “crown” extending more than a million km into space
- About half as bright as the Full Moon
- Ionized gases streaming out as “solar winds”
- Earth’s magnetic field mostly protects us from these potentially harmful radiations

Sunspots

- Dark areas on Sun where gases are up to 1500 K cooler
- First observed by Galileo
- Go through 11-year cycles from “maximum” to “minimum” numbers

What do sunspots look like?



http://starchild.gsfc.nasa.gov/Images/StarChild/questions/sunspot_dia.gif

Other Features: Prominences and Solar Flares

- Prominences
 - > huge cloud-like features extending upward from regions of intense solar activity
- Solar Flares
 - > brief outbursts lasting about an hour
 - > release enormous bursts of ultraviolet, X-ray, and radio waves
 - > can affect radio communication on Earth
 - > produce “auroras”
 - Northern Lights (aurora borealis)
 - Southern Lights (aurora australis)

Solar Interior: Where Energy Is Created

- Nuclear Fusion
 - > Hydrogen atoms and neutrons fuse (join together) to form more massive atoms
 - > Some of the original mass (m) is converted into pure energy (E)

Einstein's Equation: $E = mc^2$
(c = constant number)

More about nuclear fusion

- $^1\text{H} + \text{n} \rightarrow ^2\text{H} + \text{energy}$
- $^2\text{H} + \text{n} \rightarrow ^3\text{H} + \text{energy}$
- $^3\text{H} + \text{n} \rightarrow \text{nothing happens}$

But with about 1 out of 2000 atoms in Sun

- $^3\text{H} + \text{n} \rightarrow ^3\text{He} + \text{energy}$
- $^3\text{He} + \text{n} \rightarrow ^4\text{He} + \text{energy}$

****Basic story: atoms of H become atoms of He****
and emit energy at many wavelengths,
especially visible light (at this temperature)

How Long Can This Go On?

- Has happened every moment since our solar system formed about 4.5 billion years ago (4,500,000,000 years)
- May continue for another 4.5 + billion years
- Jupiter is about 10 x not massive enough to have become a “binary star” (2 suns)
- Many solar systems have binary, and even tertiary, stars

For additional information

- NASA Star Child
<http://starchild.gsfc.nasa.gov/docs/StarChild/StarChild.html>
- NASA Marshall Space Flight Center Solar Physics
<http://solarscience.msfc.nasa.gov/SunspotCycle.shtml>
- NASA SOHO (Solar and Heliospheric Observatory)
http://www.nasa.gov/mission_pages/soho/index.html
- NASA SDO (Solar Dynamics Observatory)
http://www.nasa.gov/mission_pages/sdo/main/index.html