

## The Sun Astronomy Lesson 10

Great online resources:

This is a really cool, interactive Solar Media Viewer available through NASA:  
<http://ds9.ssl.berkeley.edu/viewer/flash/flash.html>

This is a collection of high-quality images of the Sun (most of them are under copyright) but they're available for educational purposes:  
[http://ds9.ssl.berkeley.edu/LWS\\_GEMS/6/secef.htm](http://ds9.ssl.berkeley.edu/LWS_GEMS/6/secef.htm)

This is a collection of the best images from the Solar and Heliospheric Observatory (SOHO):  
[http://soho.nascom.nasa.gov/gallery/top10/top10\\_results.html](http://soho.nascom.nasa.gov/gallery/top10/top10_results.html)

This is a collection of videos of the Sun:  
<http://soho.nascom.nasa.gov/gallery/movies.html>

I really like this one to show solar flares:  
[http://soho.nascom.nasa.gov/gallery/Movies/Action20030605\\_EIT304/304active1.mov](http://soho.nascom.nasa.gov/gallery/Movies/Action20030605_EIT304/304active1.mov)

I really like this one to show how the Sun changes over time:  
[http://soho.nascom.nasa.gov/gallery/Movies/10th/SOHO\\_EIT\\_sm.mov](http://soho.nascom.nasa.gov/gallery/Movies/10th/SOHO_EIT_sm.mov)

This page includes information about the total solar eclipse on July 22, 2009:  
<http://eclipse.gsfc.nasa.gov/SEmono/TSE2009/TSE2009.html>

### *The Lesson:*

In broad terms, the charted regions of the Solar System consist of the Sun, four terrestrial inner planets, an asteroid belt composed of small rocky bodies, four gas giant outer planets, and a second asteroid belt, called the Kuiper belt, composed of icy objects.

In order of their distances from the Sun, the planets are Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, and Neptune. Moons, or natural satellites orbit six of the eight planets, and planetary rings of dust and other particles encircle each of the outer planets. All the planets except Earth are named after gods and goddesses from Greek and Roman mythology.

Now, think about the mass of all of those objects combined—the Earth, Jupiter, Saturn, the moons, meteorites, everything but the Sun. Added all

together, they account for only 0.2% of the total mass of our solar system! The Sun makes up the remaining 99.8% of all of the mass in our solar system.

### *The Structure Zones of the Sun*

Unlike the Earth, the Sun does not have a solid surface. Rather, the sun is a ball of glowing gas. About  $\frac{3}{4}$  of the Sun's mass is hydrogen and  $\frac{1}{4}$  is helium. The sun's interior consists of the core, the radiation zone, and the convection zone.

**The Core:** The sun produces an enormous amount of energy in its core or center region. Burning fuel does not produce this energy. Rather, the sun's energy comes from nuclear fusion. In the process of nuclear fusion, hydrogen atoms join together to form helium atoms. Nuclear fusion occurs only under conditions of extremely high temperature and pressure. The temperature inside the core reaches temperatures as high as 27 million degrees Celsius. The mass of the helium produced through nuclear fusion is less than the mass of the hydrogen that goes into forming it. What happens to that extra mass? It is converted to energy and slowly moves out from the core.

**Radiation Zone:** The energy produced in the sun's core moves outward through the middle layer of the sun's interior – the radiation zone. The radiation zone is a region of very tightly packed gas, where energy is transferred in the form of electromagnetic radiation (a self-propagating wave with electric and magnetic components like light waves or radio waves). Because the radiation zone is so thick, energy can take more than 100,000 years to move through it.

**Convection Zone:** The outermost layer of the Sun is known as the convection zone. Hot gasses rise from the bottom of the convection zone and gradually cool as they approach the top. Cooler gases sink, forming loops of gas that move energy towards the sun's surface.

### *The Sun's Atmosphere*

The photosphere is the visible surface of the Sun. This is the region of the Sun that emits sunlight. It's also one of the coolest layers of the Sun—only about 6,700 °C. Looking at a photograph of the Sun's surface, you can see that it has several different colors; oranges, yellows, and reds, giving it a grainy appearance. We cannot see this when we look quickly at the Sun because our eyes cannot focus that quickly and the Sun is too bright for us to look at for more than a brief moment.

The chromosphere is a layer about 2000 kilometers thick that lies directly about the photosphere. The chromosphere is a thin region of the Sun's atmosphere that glows red as it is heated by energy from the photosphere.

The corona is the outermost layer of the Sun and is the outermost part of its atmosphere. It is the Sun's halo or crown. It has a temperature of 2 to 5 million degrees Celsius and is much hotter than the visible surface of the Sun or the photosphere. The corona extends millions of kilometers into space. During a total solar eclipse, you can see the Sun's corona shining out into space.

### *The Sun's Surface Features*

For hundreds of years, scientists have used telescopes to study the Sun and they have spotted many features on the surface of the sun including sunspots and solar flares.

**Sunspots:** Dark spots on the sun's surface are known as sunspots. They may look small from Earth, but they can be as large as the Earth itself! Sunspots are areas of gas on the sun's surface that are cooler than the gas around them. Cooler gases don't give off as much light as hotter gases, which is why sunspots look darker. The number of sunspots can vary at a given time.

**Solar Flares:** A solar flare is an explosion in the sun's atmosphere. Flares are powered by the sudden release of energy from the corona.

Solar flares can greatly increase the solar winds, a thin stream of electrically charged particles, from the corona. This increases the number of particles reaching the Earth's upper atmosphere. As these particles interact and collide with the gases in our upper atmosphere, they start to glow and this glowing is known as an Aurora.

### *Brainstorm*

So, the Sun is a complex and intricate structure that affects our entire solar system. But, we rarely think about the impact of the Sun on a daily basis. In what ways can you think of that the Sun impacts life on Earth?

[I give students 5-10 minutes to discuss this question. It makes a good lead-in for the discussion of the planets over the next three lessons and establishing why life doesn't exist on other bodies in our solar system.]

Images used in this lesson:

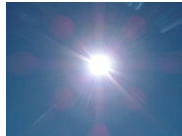


The Sun

Source:

<http://solarsystem.nasa.gov/multimedia/gallery/PIA03149.jpg>

License: Public Domain



The Sun from Earth

Source: [http://en.wikipedia.org/wiki/File:The\\_sun1.jpg](http://en.wikipedia.org/wiki/File:The_sun1.jpg)

License: GFDL

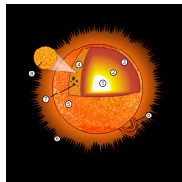


Solar Corona visible during a total Solar Eclipse

Source:

[http://en.wikipedia.org/wiki/File:Solar\\_eclips\\_1999\\_4\\_NR.jpg](http://en.wikipedia.org/wiki/File:Solar_eclips_1999_4_NR.jpg)

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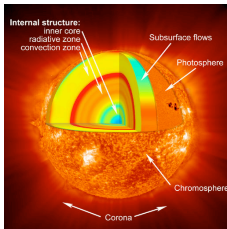


Sun Diagram

Source: [http://en.wikipedia.org/wiki/File:Sun\\_diagram.svg](http://en.wikipedia.org/wiki/File:Sun_diagram.svg)

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(1-Core 2-Radiative Zone 3-Convective Zone 4-Photosphere 5-Chromosphere 6-Corona 7-Sunspot 8-Granulated Surface 9-Solar Flare)



Layers of the Sun

Source: [http://www.nasa.gov/mission\\_pages/solar-b/solar\\_020.html](http://www.nasa.gov/mission_pages/solar-b/solar_020.html)

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