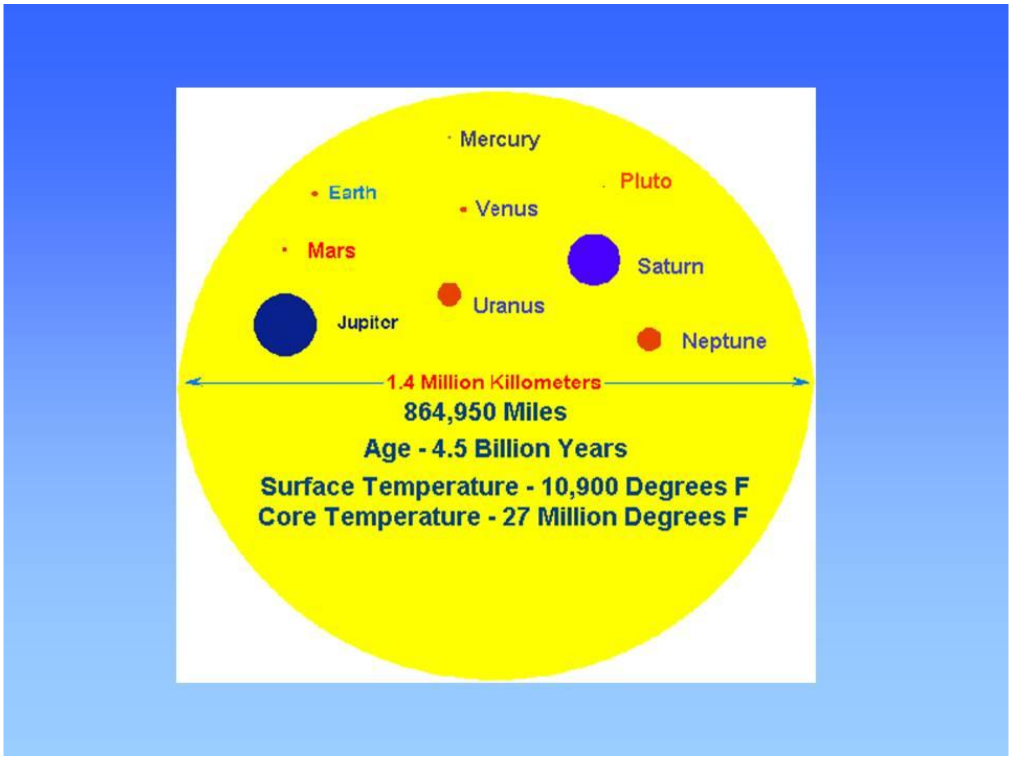
An Introduction to Solar Observing:

Good Afternoon. Today we are going to review an introduction to observing our nearest star, the Sun.
For thousands of years, man has been interested in and inspired by the Sun, and it held a special place in all of the early civilizations. There was the sun god "Re" of the ancient Egyptians. The rulers of the Aztecs considered themselves divine descendants of the sun. And the ancient Greeks who worshipped the Sun as 'Apollo', the Sun God.

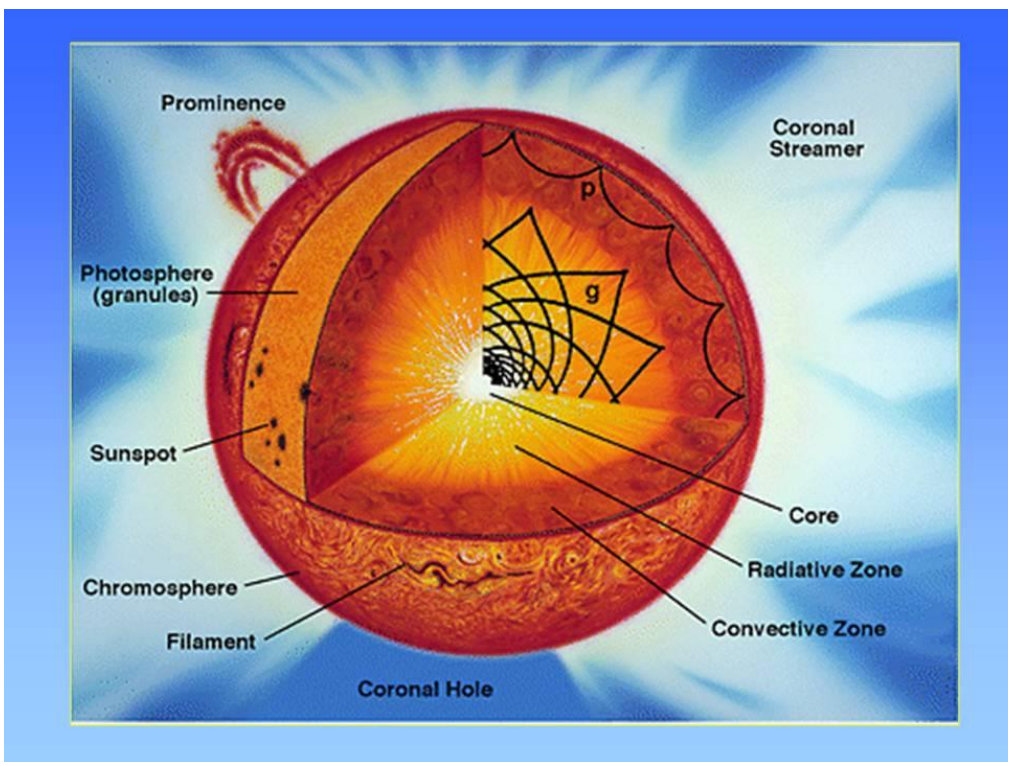
But as people became more knowledgeable of the sky, the Sun lost its religious importance.
Chinese astronomers began making recorded observations of the Sun. They noticed that during sunrise or sunset, they occasionally would see dark markings or spots on the sun. This was the first recorded observation of sunspots. This was pretty much the extent of our observational knowledge about the Sun until after the invention of the telescope. Modern Solar astronomy began in 1610 when Galileo used his telescope to observe the Sun and 'discovered' sunspots. As the telescope was improved over the centuries, many important discoveries and theories were made, leading up to our present day knowledge of the Sun and how it works. Some of the more significant 'solar astronomers', who helped advance our knowledge of the Sun include: *William Herschel (1780s) - discovered the Sun's motion in space,* Heinrich Schwabe (1843) - determined the appearance of sunspot cycles, Robert Bunsen (1860s) - invented the spectroscope and discovered the elements found in the Sun, George Hale (1908) - discovered the magnetic fields of sunspots, and Albert Einstein (1920s) - proposed the theory that sunlight was made of particles. No one believed him until it was proven 10 years later.

This is a good slide showing basic solar data and planetary size comparisons.

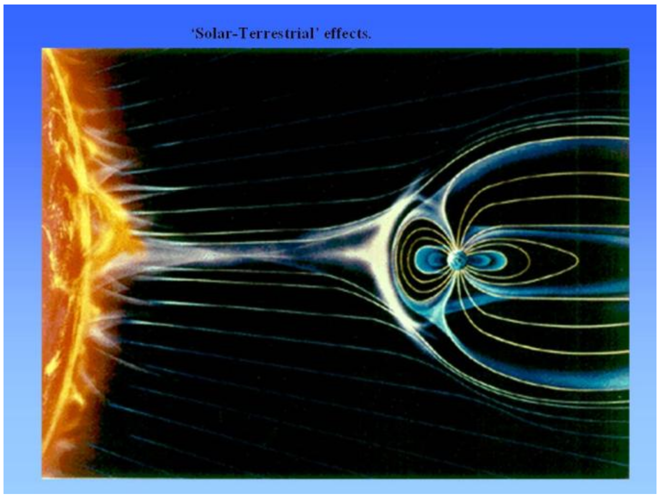
You can find information on the Sun in almost any basic astronomy book. It's about 864,000 miles in diameter, takes about 25 - 35 days to make one rotation, and the Sun is made up of mostly hydrogen and helium gas, with traces of other elements.

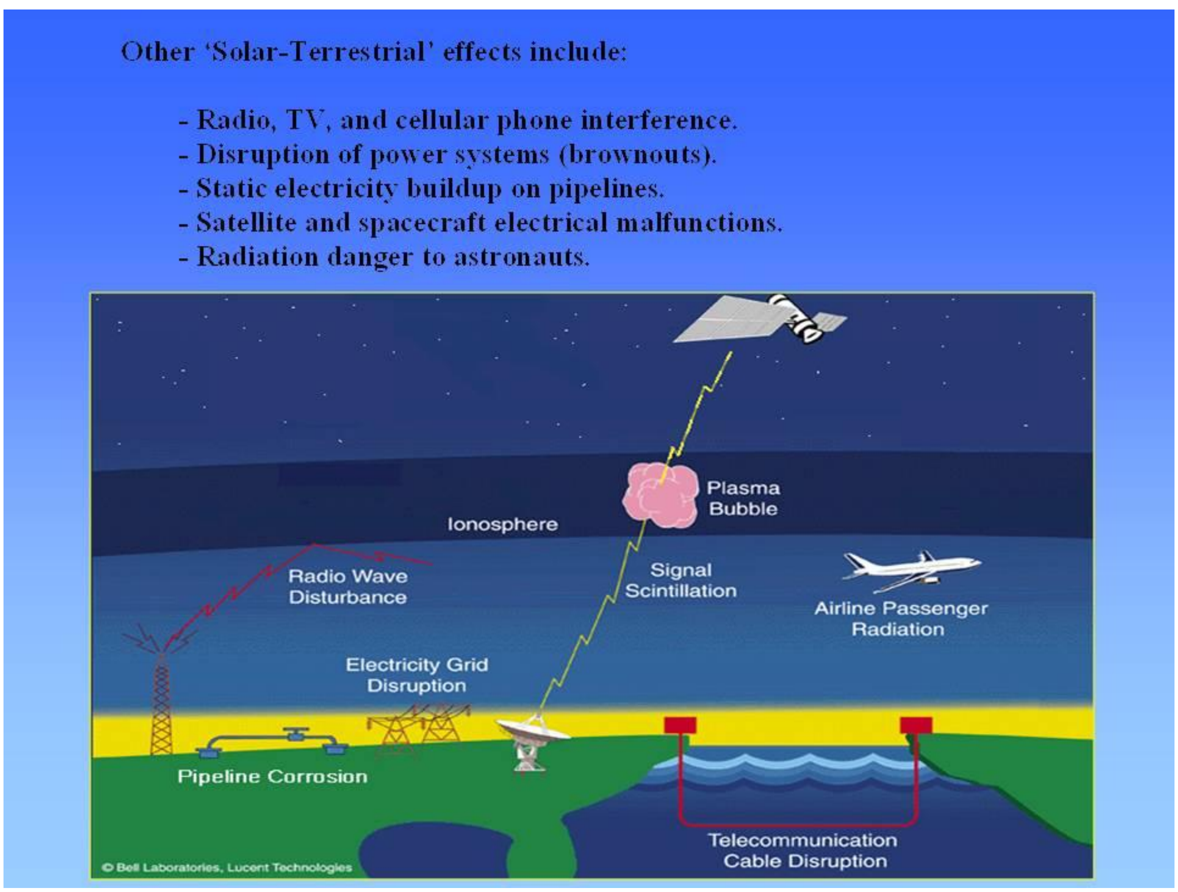


Using telescopes, we can observe various features of the Sun's outer layers, what we would consider to be its atmosphere, (Chromosphere), and its surface (Photosphere). And using space based instruments, we've been able to deduce what is going on inside the Sun.



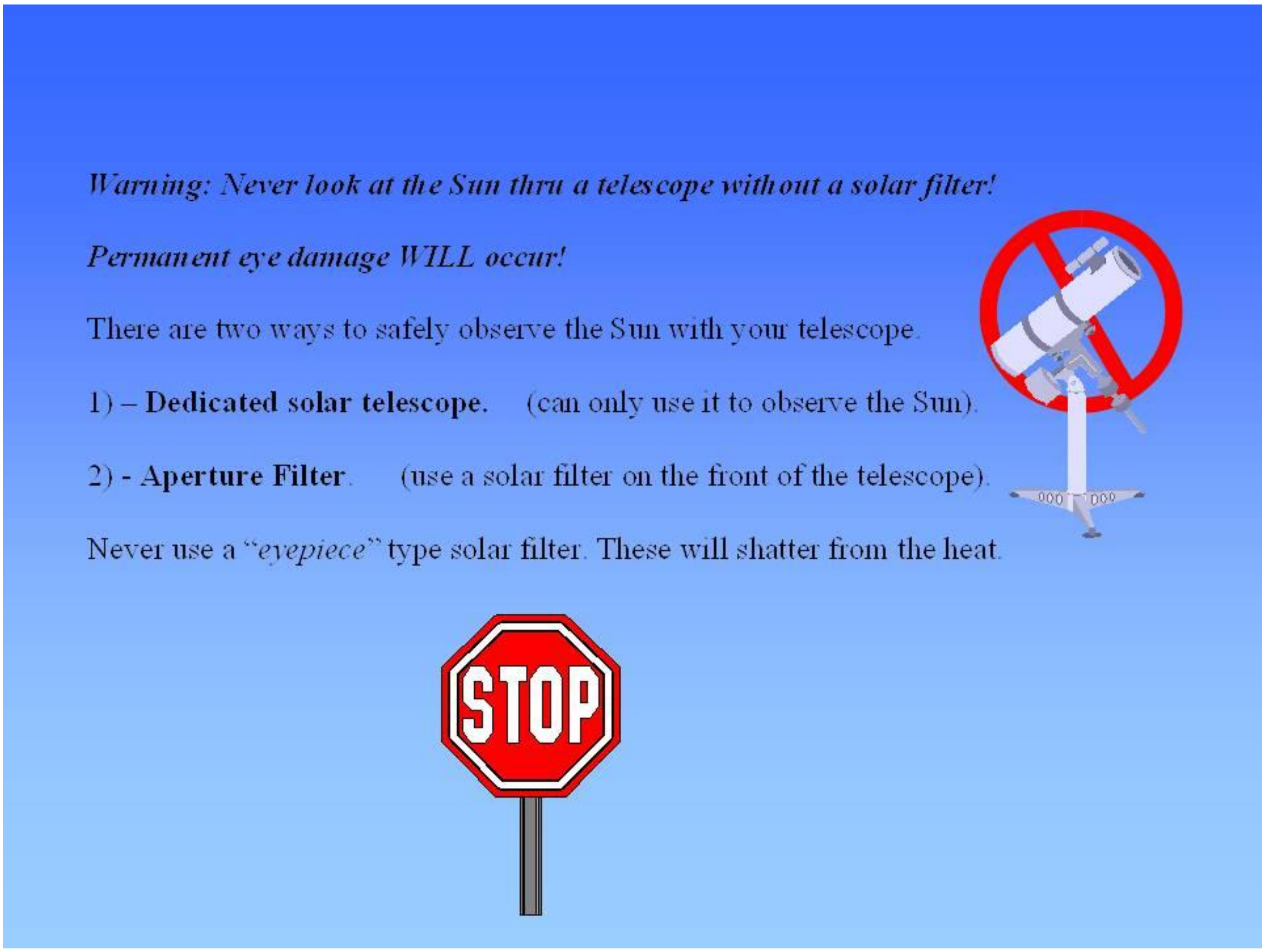
One of the main reasons that I like to observe the Sun, is that it's one of the few astronomical objects that can have a real physical affect on us. Beyond the obvious, in which the Sun supplies us with heat, light, energy, & life, there are some lesser known affects caused by radiation from the Sun and solar flares hitting the Earth's atmosphere and magnetic field. These are called 'Solar-Terrestrial' effects, or 'Space Weather', and are caused by charged particles from the Sun striking the Earth's Magnetosphere and flowing around it.
The most common and beautiful effect is the Aurora or 'Northern Lights'. Aurora are shimmering, colorful curtains of light that sometimes glow in the night sky. It was only about a hundred years ago that scientists discovered that they were caused by interactions with the Sun. The solar wind carries charged particles from the Sun that excite gases in our upper atmosphere. These gases glow in different colors (like neon lights).



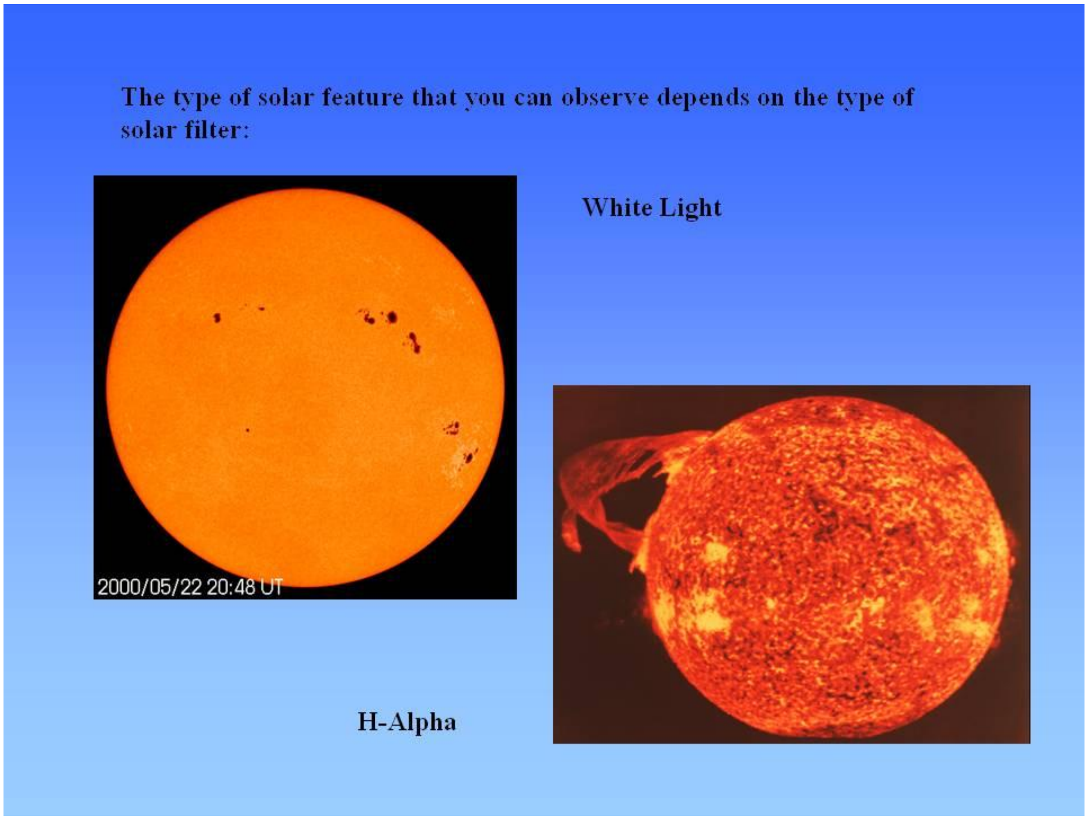


Observing the Sun can be an interesting activity for amateur astronomers. It is also one of the few areas where amateur's can still contribute scientific data to professional astronomers. (thru counting and tracking sunspots). Because of the Sun's brightness and size, even a small telescope will show plenty of detail.
The solar features change from day to day, and it's exciting to observe the appearance of a giant sunspot group, or see a large loop prominence arching over the solar limb.

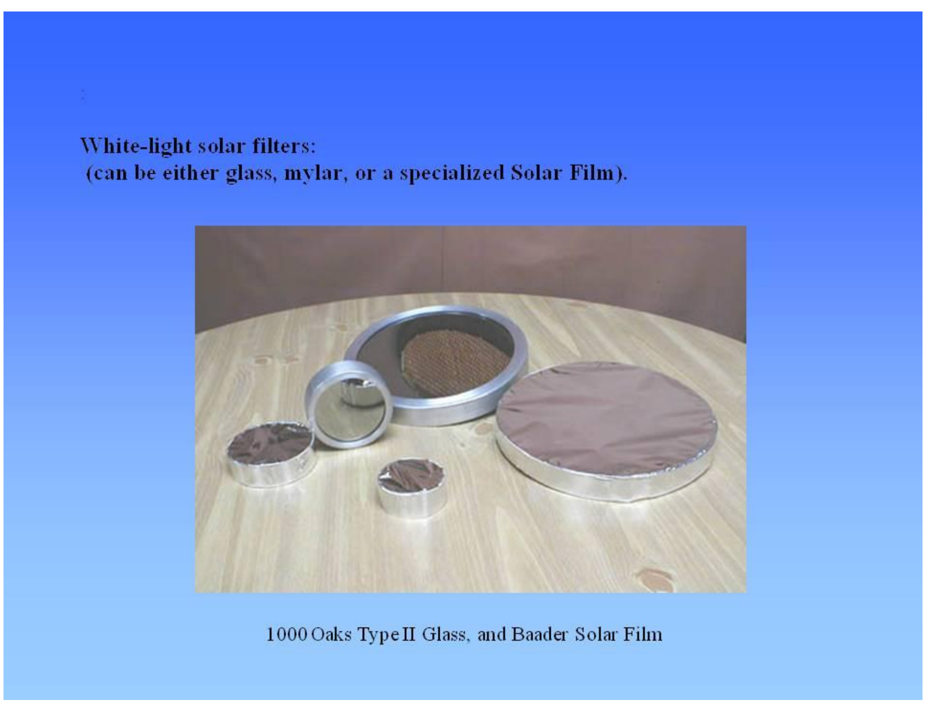
If you learn one thing today, that is: ***<u>Never</u>*** *<u>look at the Sun</u>* ***<u>without</u>*** *<u>a solar filter!</u>*
Your body will not be able to react quick enough to turn your head. In a split second, your retina will burn, and you will go blind in that eye. In addition to the below methods to safely observe the Sun, there's also dedicated solar telescopes that can only be used to observe the Sun.



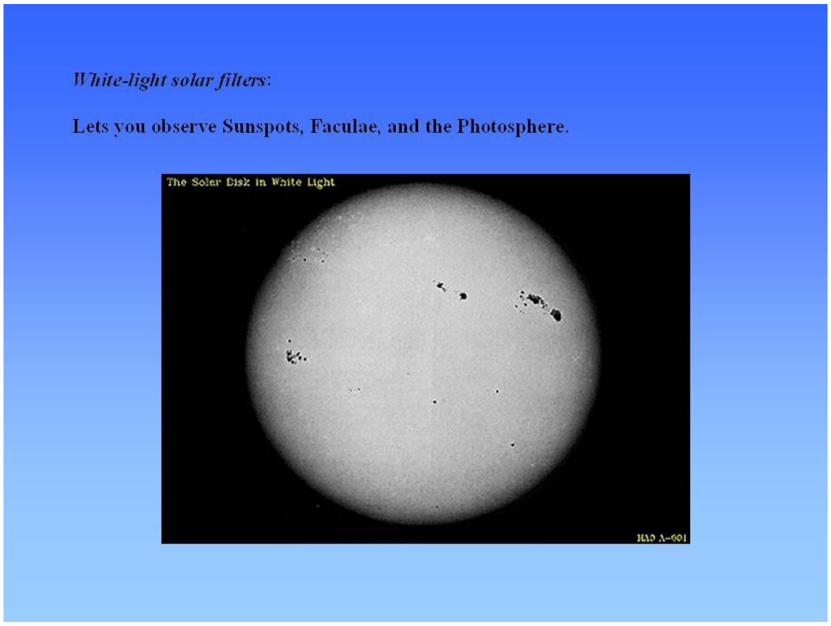
The type of solar feature that you can observe depends on the type of solar filter:
White-Light or Hydrogen-Alpha filters.



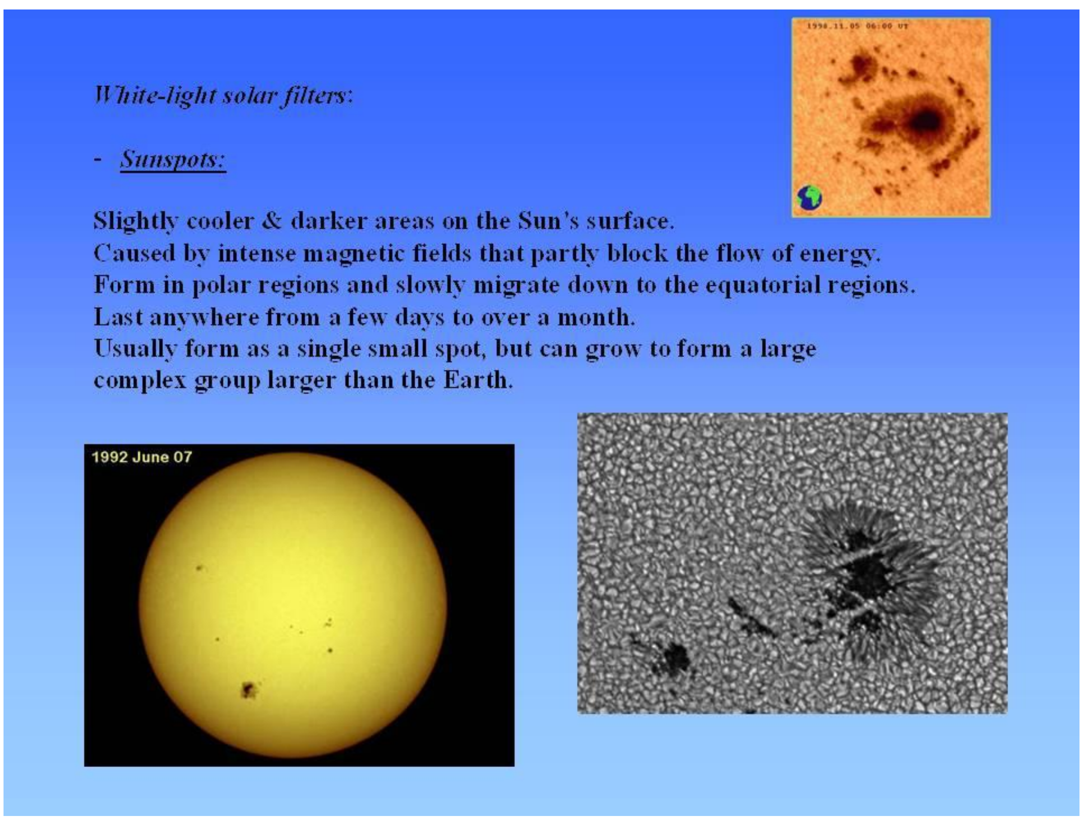
Let’s talk about White-light solar filters first.
You have many options today. The filters can be made of either glass, Mylar, or Baader Solar Film. You can buy them premade or you can get a sheet of the Baader filter material and make your own.



White-light solar filters: Lets you observe Sunspots, Faculae, and the Photosphere.



Sunspots are Slightly cooler & darker areas on the Sun's surface, caused by intense magnetic fields that partly block the flow of energy. Last anywhere from a few days to over a month. Usually form as a single small spot, but can grow to form a groups larger than the Earth. The dark center is called the Umbra, lighter outer region is the Penumbra. One way to think of Sunspots is that they are like giant bar magnets, with one spot being the north and the other being the south pole of the magnet. The Sun goes thru a 11 year cycle of high & low magnetic activity.



Sunspots are classified into different 'types' of groups, based on size and shape:
They run from 'Type A' small groups, to 'Type J', which is a decayed remnant. The largest group is 'Type F'.
These groups span many times the size of the Earth, and can be seen with the naked-eye.

Let's run thru the Sunspot classifications:

Type A:
One or more tiny spots that do not demonstrate bi-polarity or exhibit penumbra.

Type B:
Two or more tiny spots that demonstrate bi-polarity but do not exhibit penumbra. (bi-polarity = spots are in a E-W row, like a bar magnetic)

Type C:
Two or more spots that demonstrate bi-polarity and on spot has a penumbra.

Type D:
Two or more spots that demonstrate bi-polarity and both spots display a penumbra.
The size of the group is increasing!

Type E:
This group type is similar to the "D" type but spreads between 10 and 15 degrees of Solar longitude.
Bigger, more complex shapes, especially the penumbra.

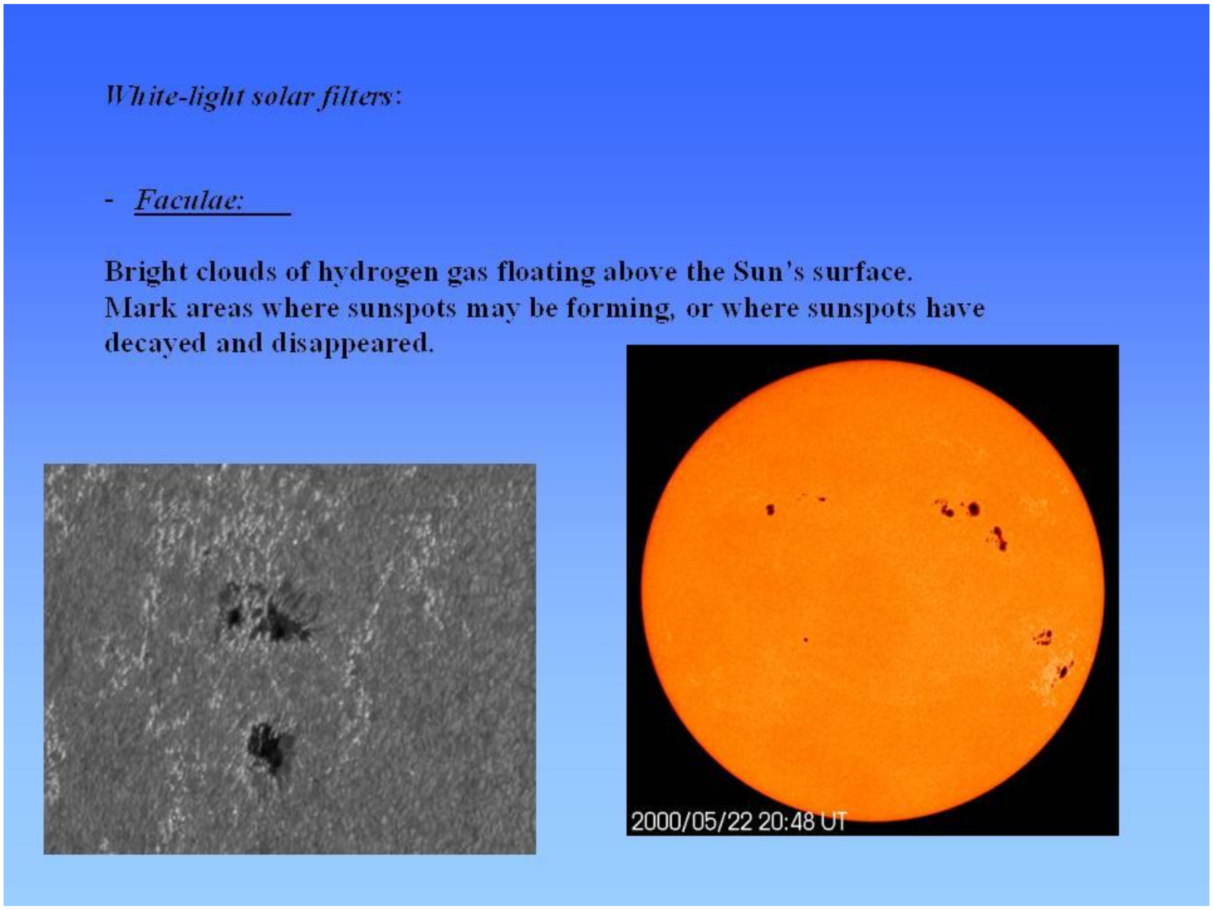
Type F:
Largest and most extensive of groups, cover over 15 degrees of Solar longitude. (naked eye groups)

Type G:
The decayed remnant, a bi-polar group with penumbras.

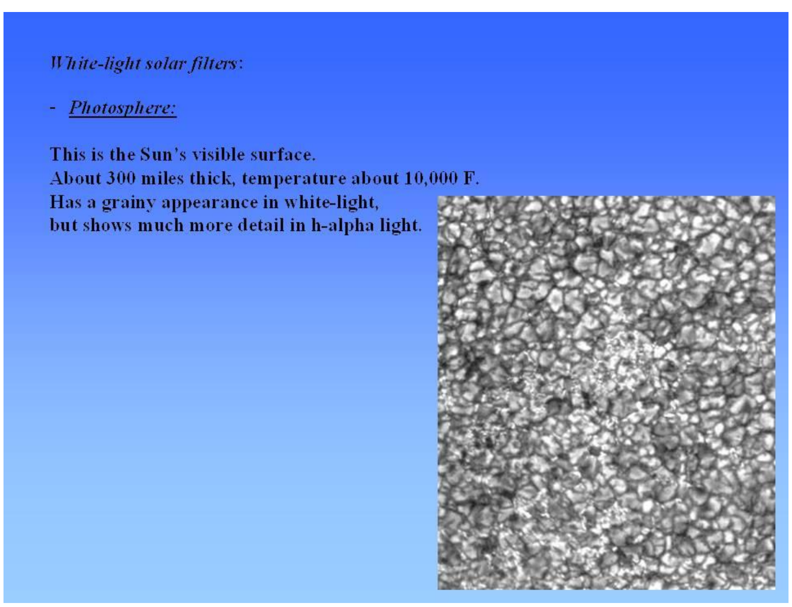
Type H:
The decayed remnant, a single spot group with penumbra. > 2½ degrees.
Type J:
The same as the "H" type but has a diameter less than 2½ degrees

Finally, the Wilson Effect is an interesting visual effect seen in sunspots near the eastern or western solar limb.
It's like you are looking down into a cup or hole in the Sun's surface. For years, it was thought of as an optical illusion, but spacecraft have actually proved it to be real. Sunspots are cone shaped and do 'dip' into the solar surface.

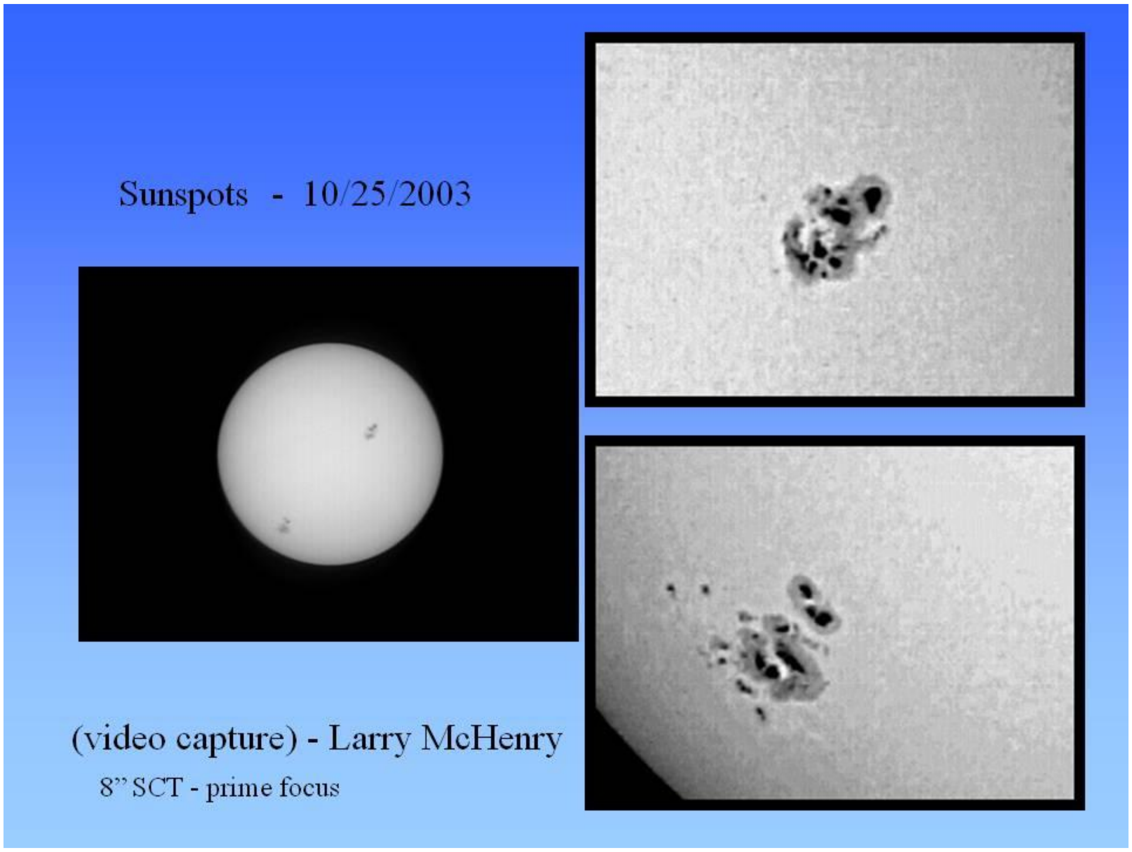
Another common feature visible in white-light are **Faculae**:
These are Bright clouds of hydrogen gas floating above the Sun's surface. They mark areas where sunspots may be forming, or where sunspots have decayed and disappeared. Faculae are best visible near the edge of the disk.

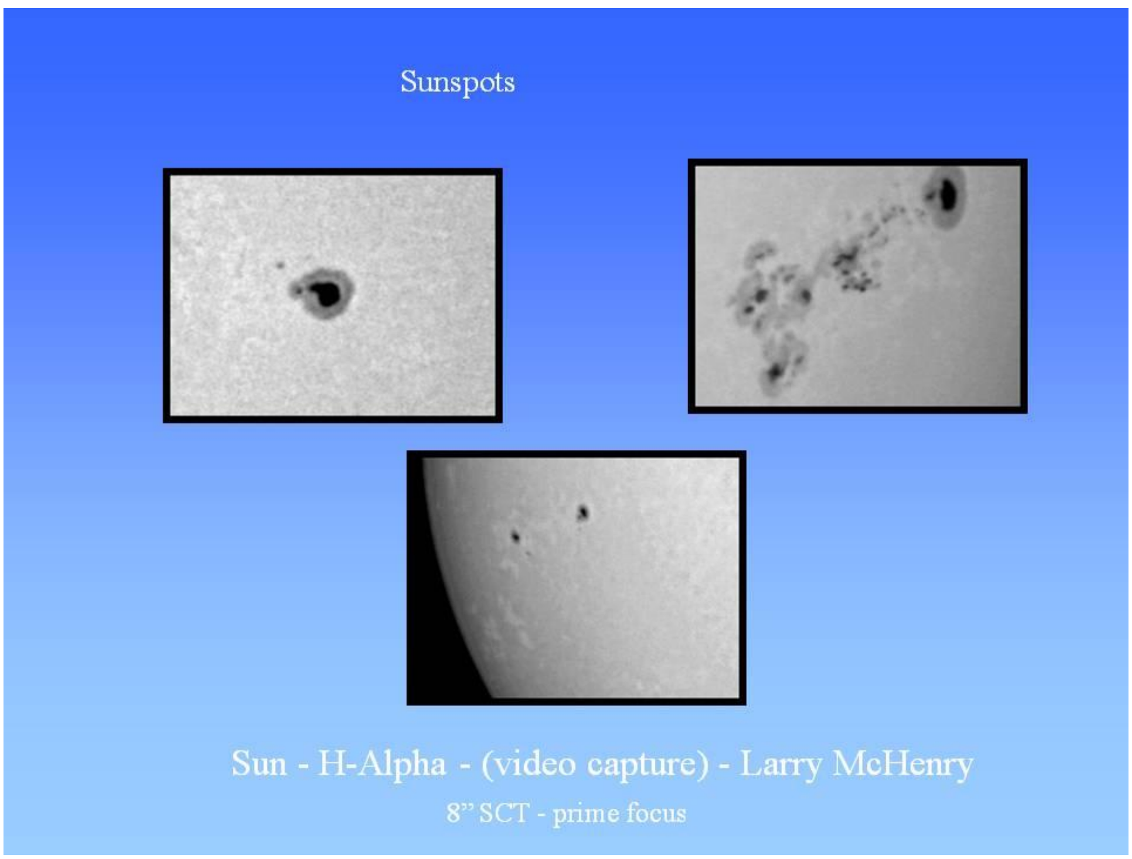


The last common feature visible in white-light is the **Photosphere***:*
This is the Sun's visible surface. Has a grainy appearance in white-light,
You can think of the Photosphere as giant convection gas bubbles, kind of like what you get when you boil water.

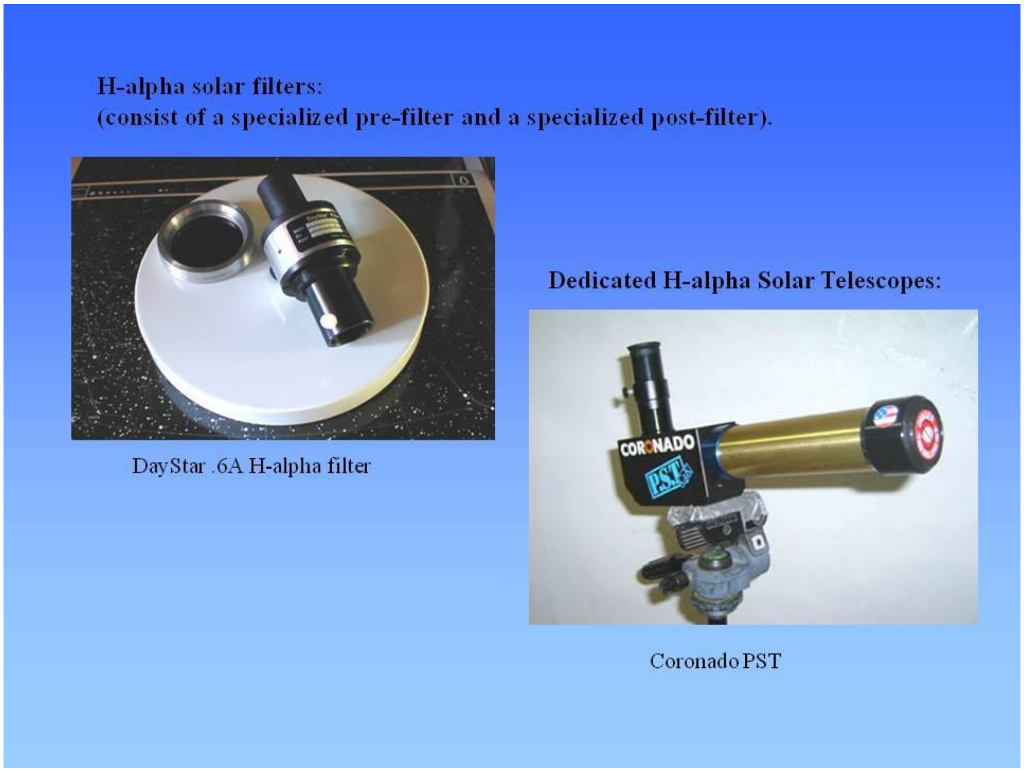


***Observing Projects*:** White-Light: Sunspots, Faculae, and Photosphere.

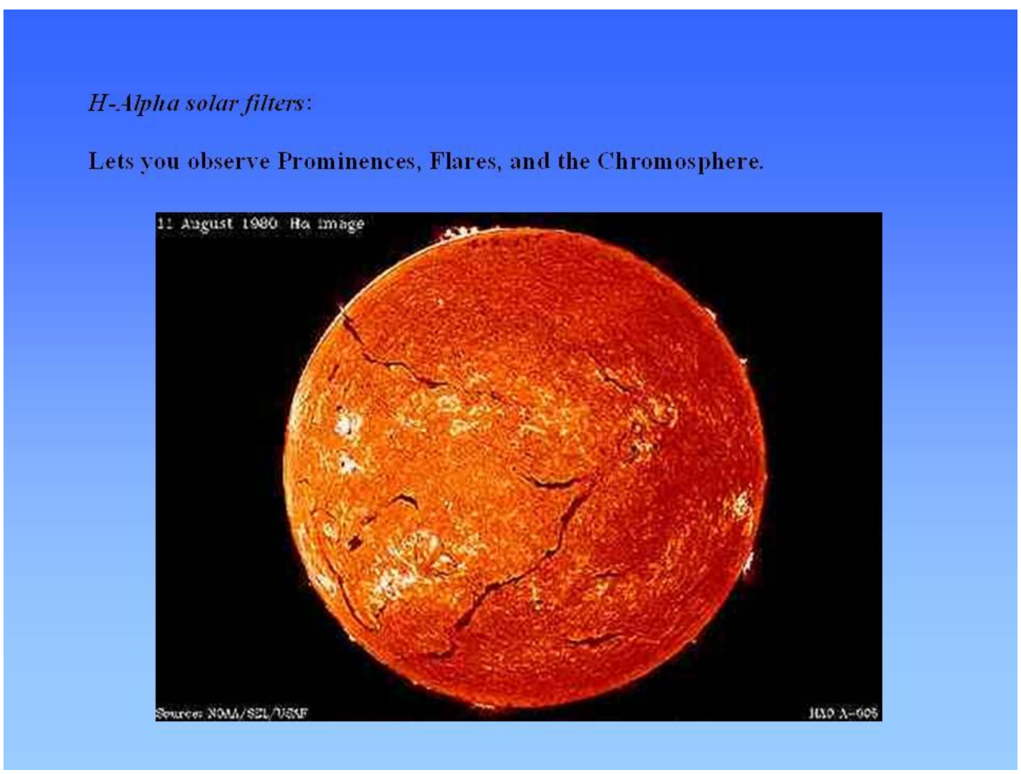




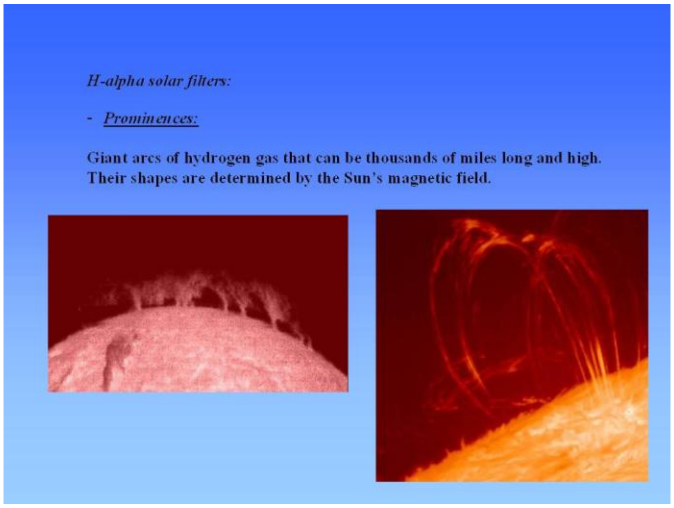
__H-alpha solar filters__ consist of a specialized pre-filter that fits on the front of the telescope, and a specialized post-filter that goes with the eyepiece. There's also dedicated solar telescopes sold by Coronado, Lunt, and others.

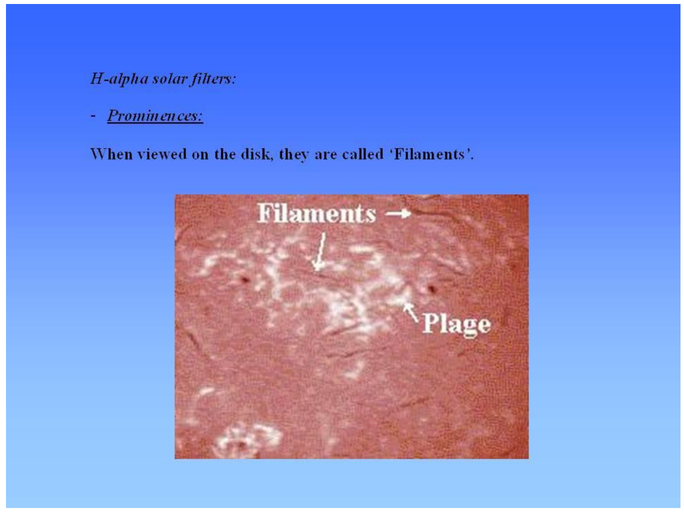


H-Alpha solar filters: Lets you observe Prominences, Flares, and the Chromosphere, or atmosphere of the Sun.

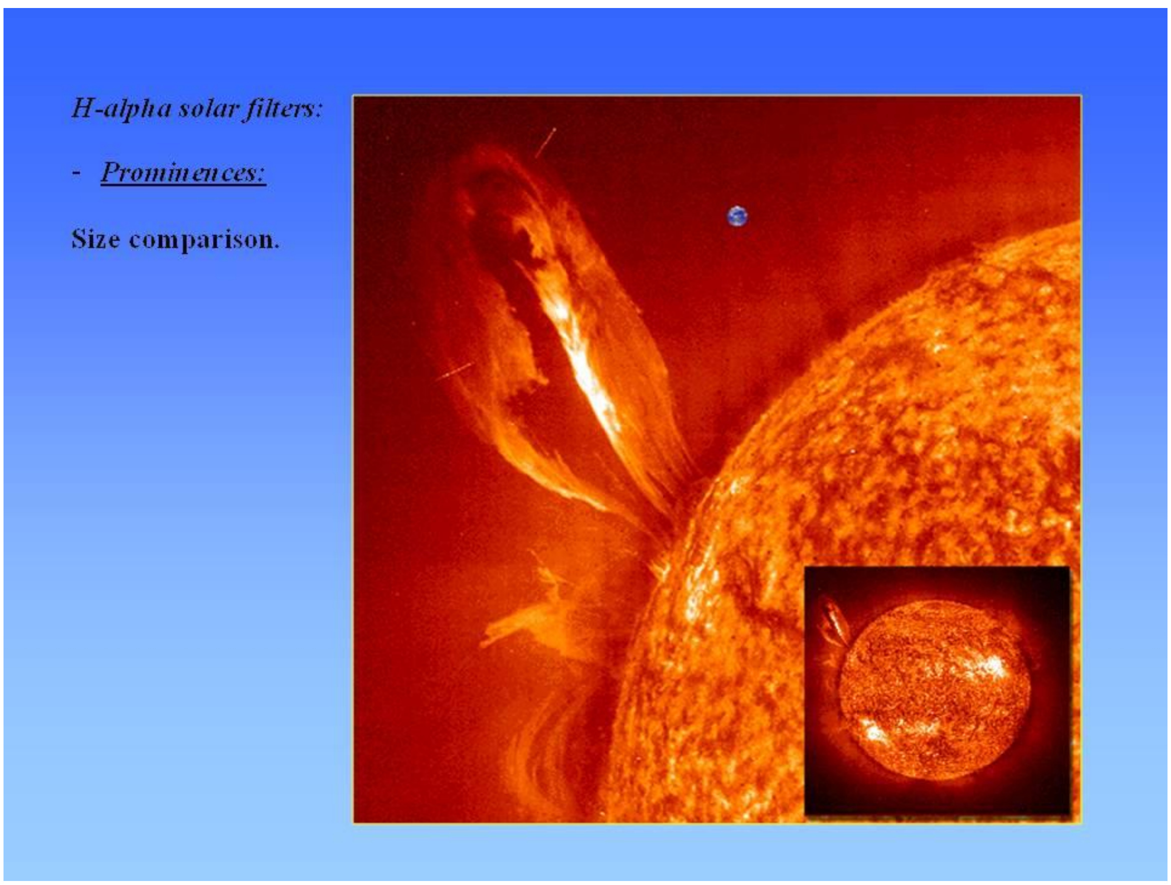


Prominences: Are giant arcs of hydrogen gas thousands of miles long, whose shapes are determined by the Sun's magnetic field in that area. When viewed on the face of the disk, are called **'Filaments'**. *(look like squiggly lines)* Back in the early days of solar astronomy, it was thought that Prominence and filaments were two different features. But, now we know that they are really the same feature, just viewed at a different angle.





Size comparison. It's a good thing that the Earth is not really that close. We'd be a burned marshmallow!!!!



There are two main categories or types of Prominences:
Quiescen*t:*
These are long lasting prominences and can last many rotations.

Active *Prominences:*
Shows great movement in a short space of time. These type of eruptions are the most violent and short lived.

Let's run thru the first category - ***Quiescent****:*

Hedgerow*:*
The most common type is the hedgerow prominence. It looks like a row of shrubbery along the solar limb and is in contact with the surface of the Sun at only a few points, like the trunks of bushes.

Curtain, Flame, Fan:
Another common type. The curtains and flames have broad bases, while the fans have a small point of contact with the surface of the Sun.

Arch, Platform:
Arched or table shaped, may have multiple 'legs' connecting to the sun.

Cap, fragment:
Caps are low surface hugging displays. Fragments are small detached clouds.

Disparition Brusque*:*
These are decayed versions of Hedgerows, Arches, and platforms that have elongated points of surface contact.
These are worth watching, as they may at any moment breakaway and explode from the surface.

Active Prominences*:*
Now, let's go thru the second category - ***Active Prominences****:*

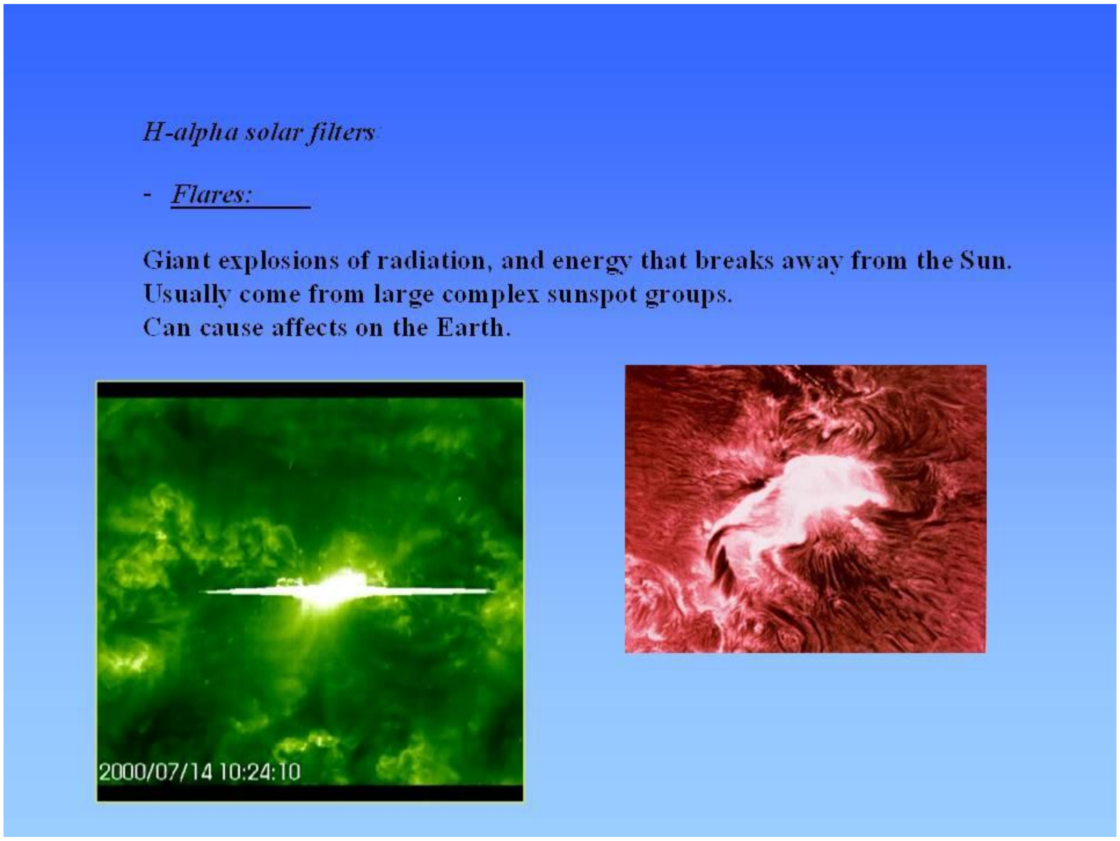
Eruptive:
The most common are the Eruptive prominences. Usually due to a flare, and are associated with active areas (sunspot groups).

Surges*:*
Surges shoot out of the Sun, ascending in a straight or curved column with speeds of 50 and 200 km's/s with heights of up to100,000 km's, then descending back to the sun usually using the same path, Surges can occur in the same place many times.

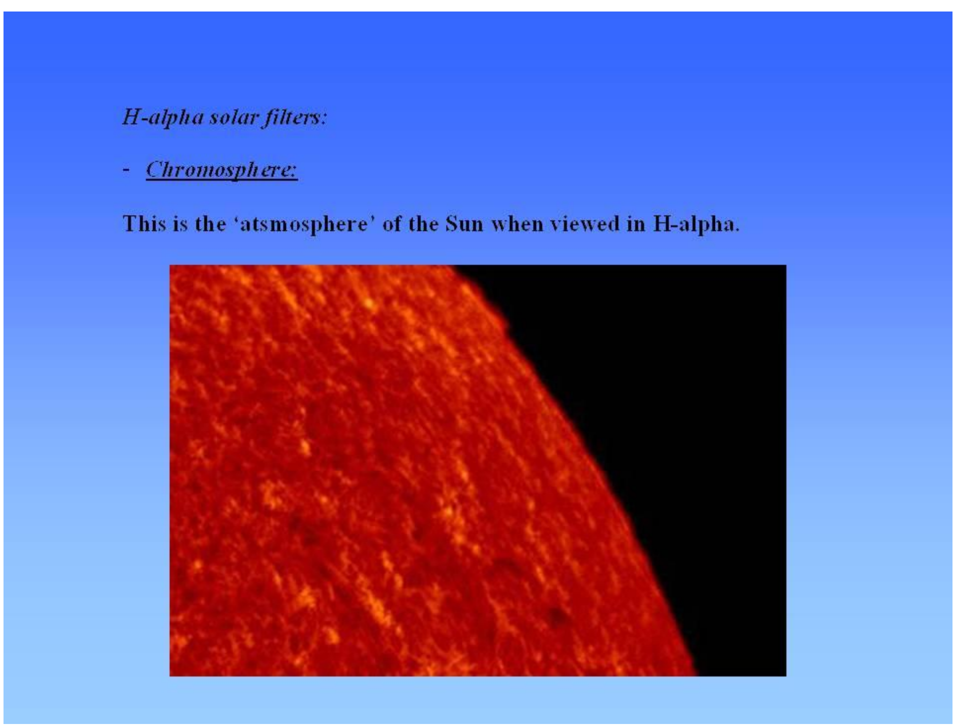
Sprays:
Sprays are explosive events which eject material at speeds of 2,000 km's/s higher than the escape velocity of 20 km's/s. This event is so energetic that the matter is not contained but comes out in fragments when ejected.

Loop prominences:
One of the most beautiful of solar features is the Loop prominence.
Loop prominences, also known as Ribbon prominences, are loops of plasma which fade after a few hours.
They can reach towering heights of 100,000 km's above the surface.

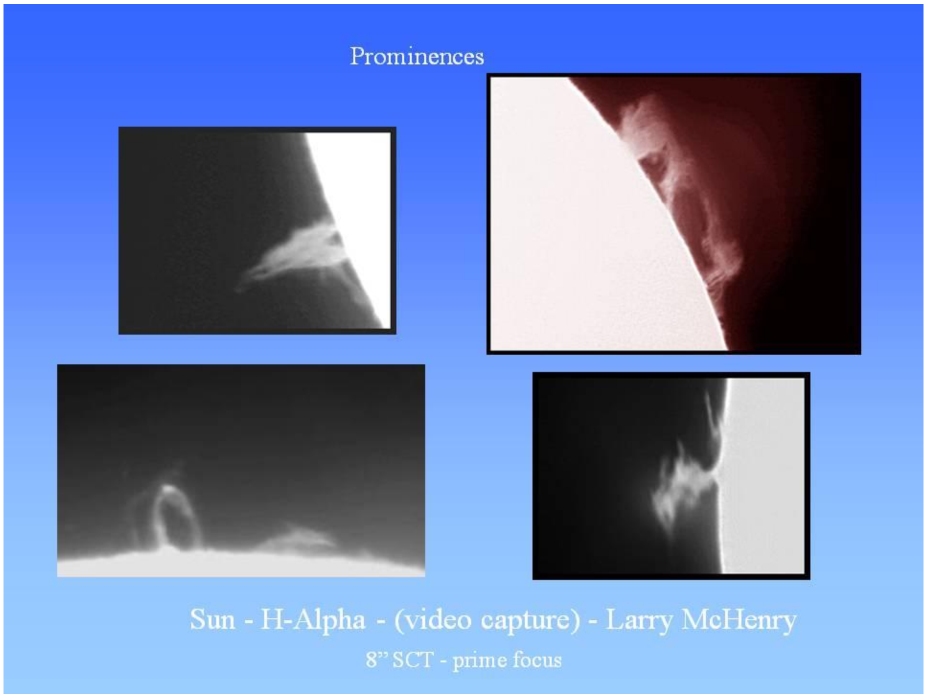
A less common feature that you might be lucky to see are ***Flares:***
Giant nuclear explosions of radiation, and energy caused by the magnetic field lines becoming twisted together and finally snapping, like giant rubberbands! Depending on the location of the flare on the solar disk and the geometry of the Earth's orbit around the Sun, these can cause affects on the Earth.

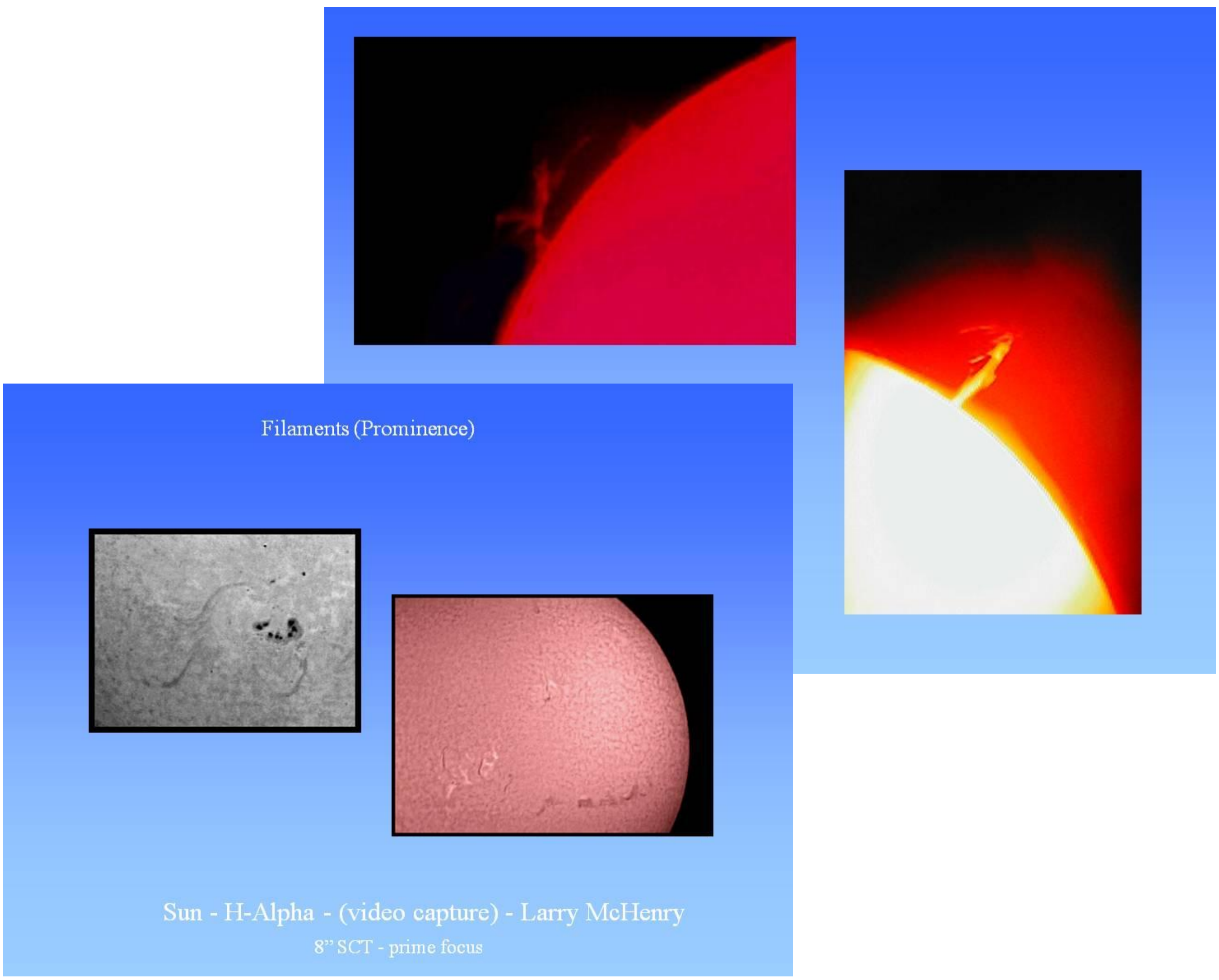


Finally there is the **Chromosphere**.
This is the 'atmosphere' of the Sun when viewed in H-alpha. It has a mottled, freckly look.

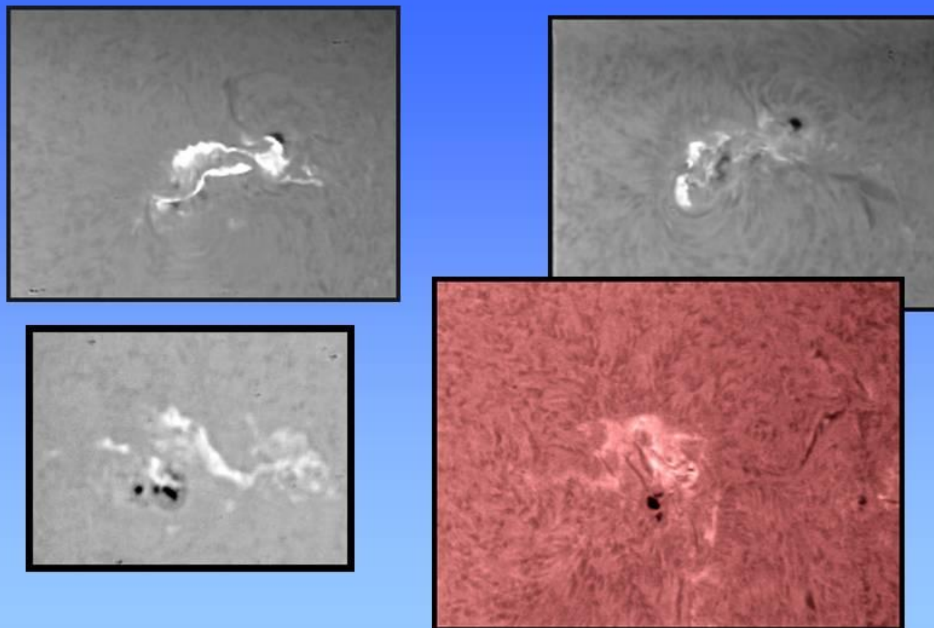


***Observing Projects*:** H-Alpha: prominences, flares, chromosphere)





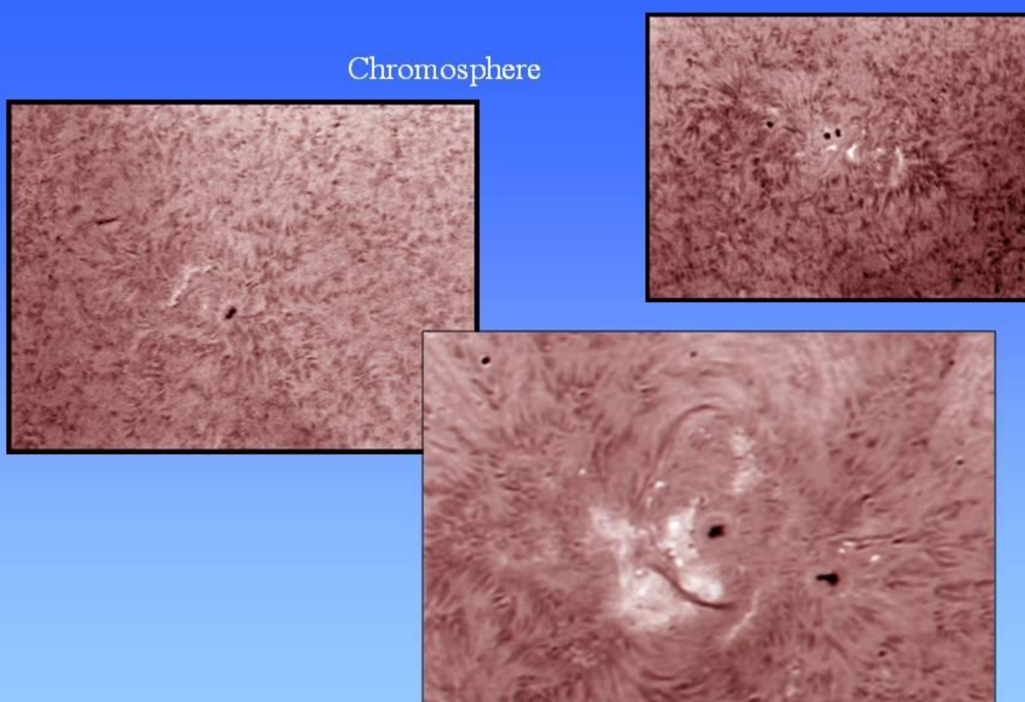
Flares



Sun - H-Alpha - (video capture) - Larry McHenry

8" SCT - prime focus

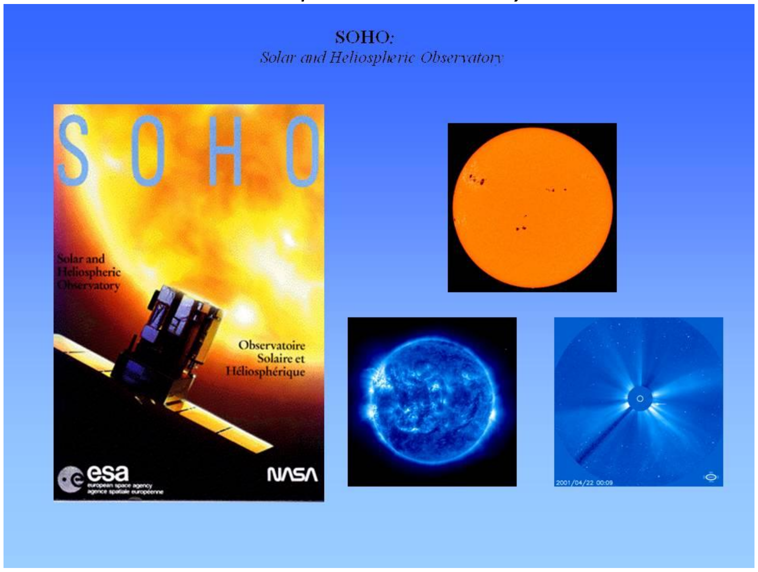
Chromosphere



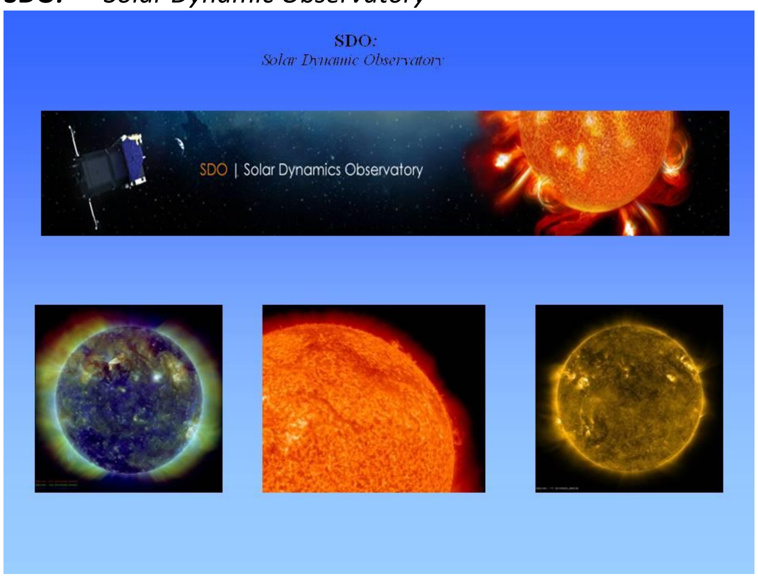
Sun - H-Alpha - (video capture) - Larry McHenry

8" SCT - prime focus

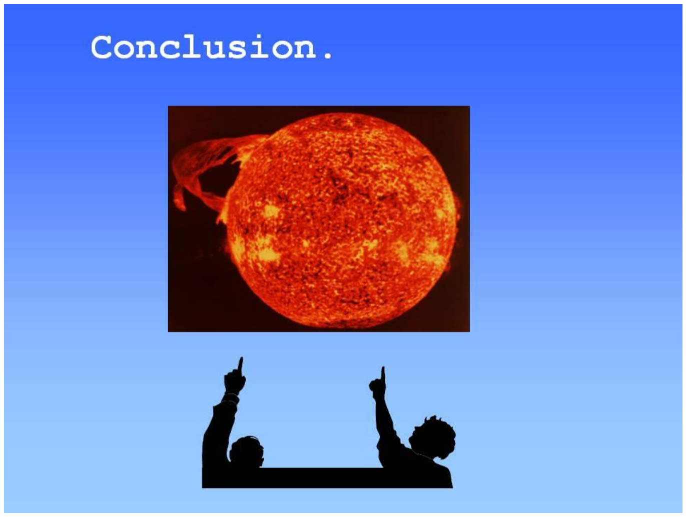
SOHO: *Solar and Heliospheric Observatory*



SDO: *Solar Dynamic Observatory*



BBSO: *Big Bear Solar Observatory*



Conclusion: This concludes my introduction to Solar Observing.
Hopefully, you've learned a little about our closest star – the Sun!
Thank You

Recommended Readings:

"How to Observe the Sun"	Astronomical League
"Observing the Sun"	Peter Taylor
"Solar Astronomy Handbook"	Rainer Beck
"AstroPhysics of the Sun"	Harold Zirin

Favorite websites:

Marshall Space Flight Center
Stanford Solar Center
Space Weather