The Sun and the Eclipse Across America

August 21, 2017

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ST13, NASA/MSFC
March 7, 2017

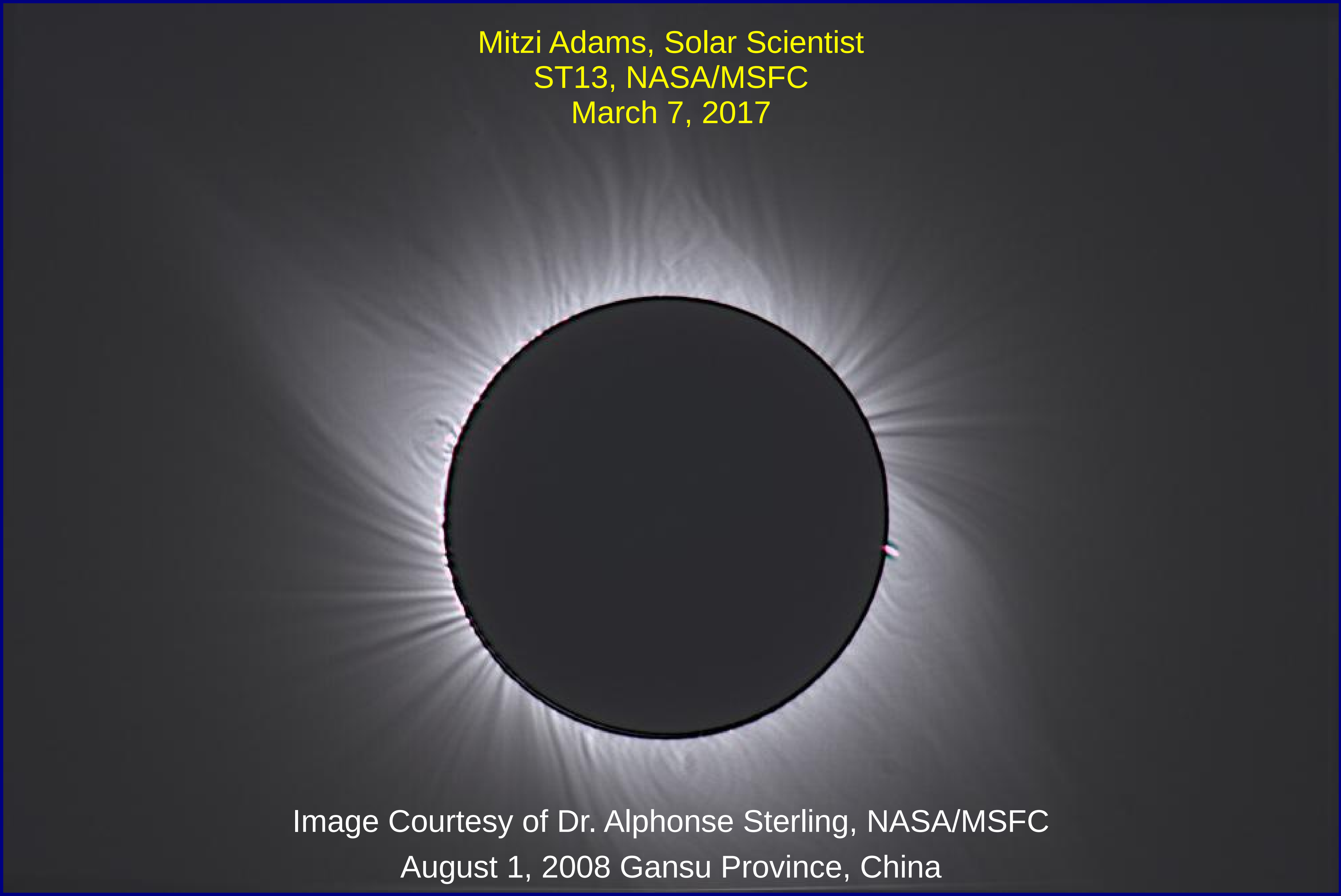
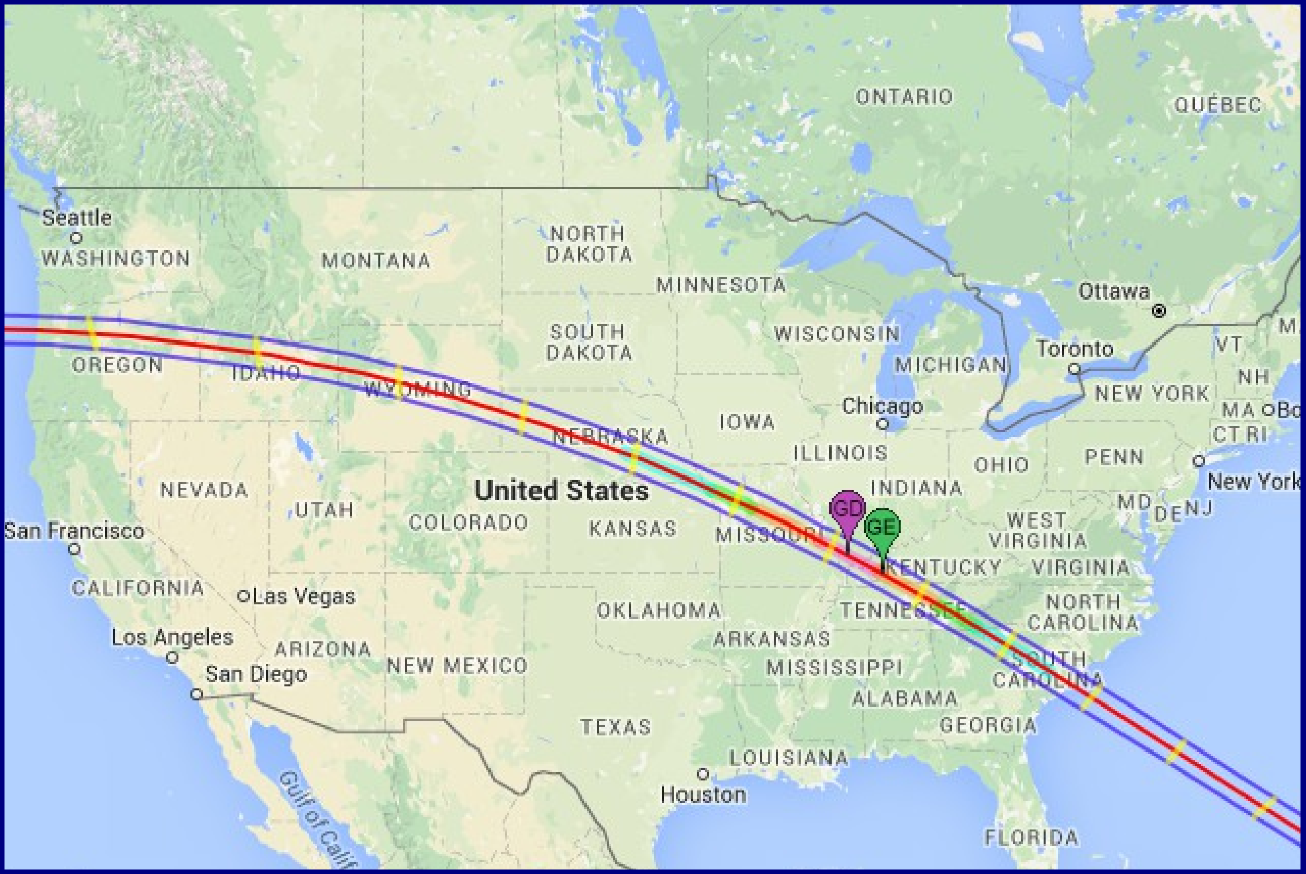


Image Courtesy of Dr. Alphonse Sterling, NASA/MSFC

August 1, 2008 Gansu Province, China

Eclipse Across America

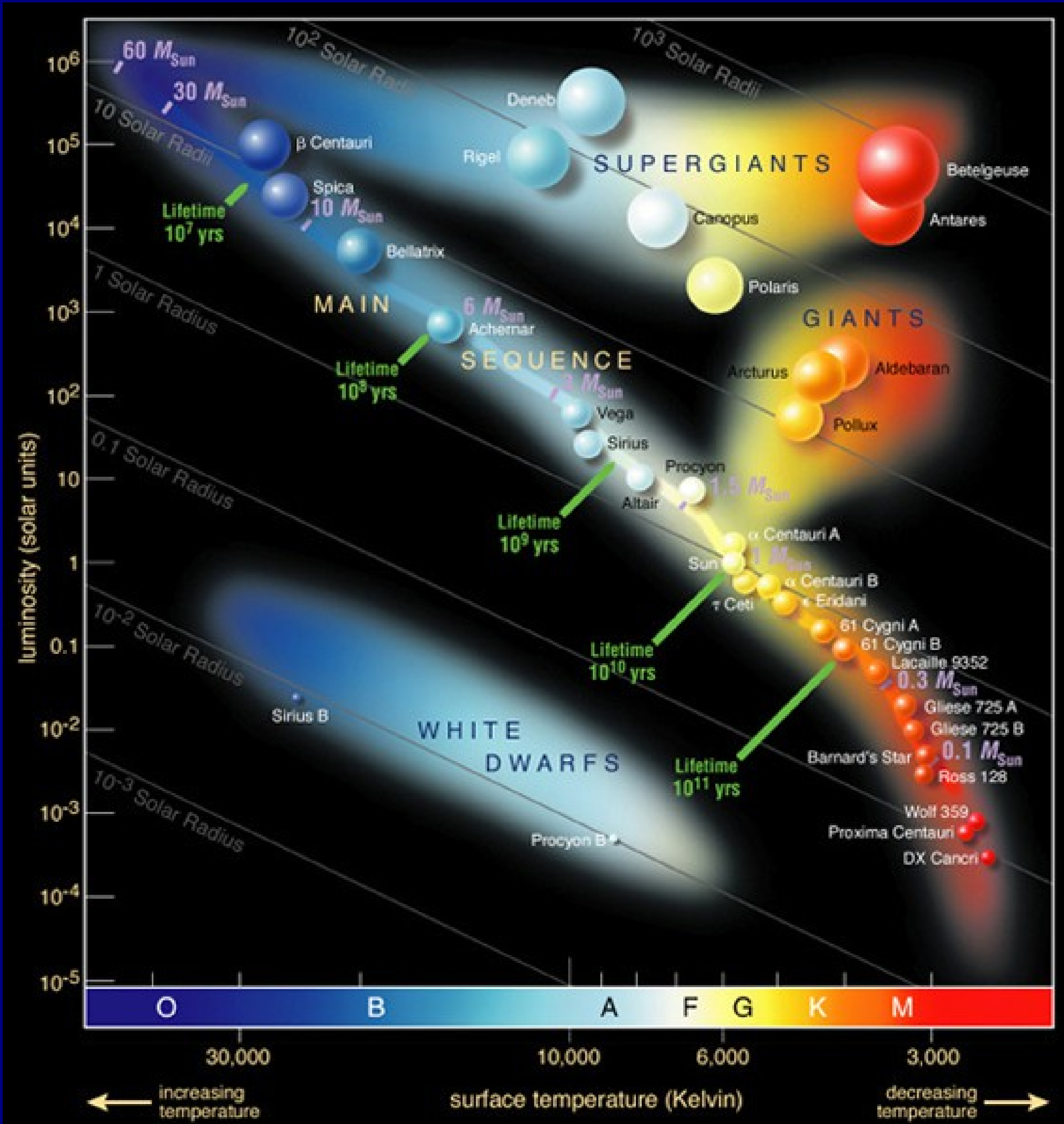
August 21, 2017



Close to Hopkinsville, Kentucky (GE):

Start of partial eclipse	16:56 UT	11:56 a.m. CDT
Start of totality	18:24 UT	1:24 p.m. CDT
Maximum eclipse	18:25 UT	1:25 p.m. CDT
End of totality	18:26 UT	1:26 p.m. CDT
End of partial eclipse	19:51 UT	2:51 p.m. CDT

What IS the Sun?



The Sun is a Star
Stars are Mostly Hydrogen Gas

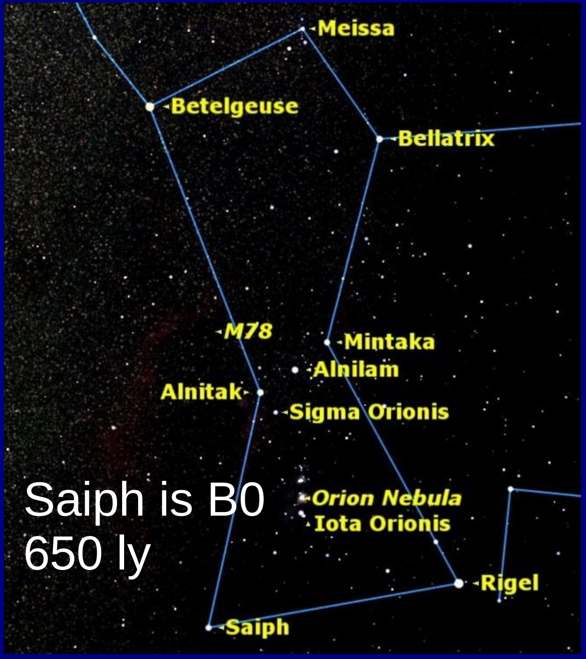
α-Cen-A is G2,
α-Cen-B is K1,
Proxima (α-Cen-C) is M6,

the Sun is G2
8.5 light minutes away

Betelgeuse is M2
643 ly

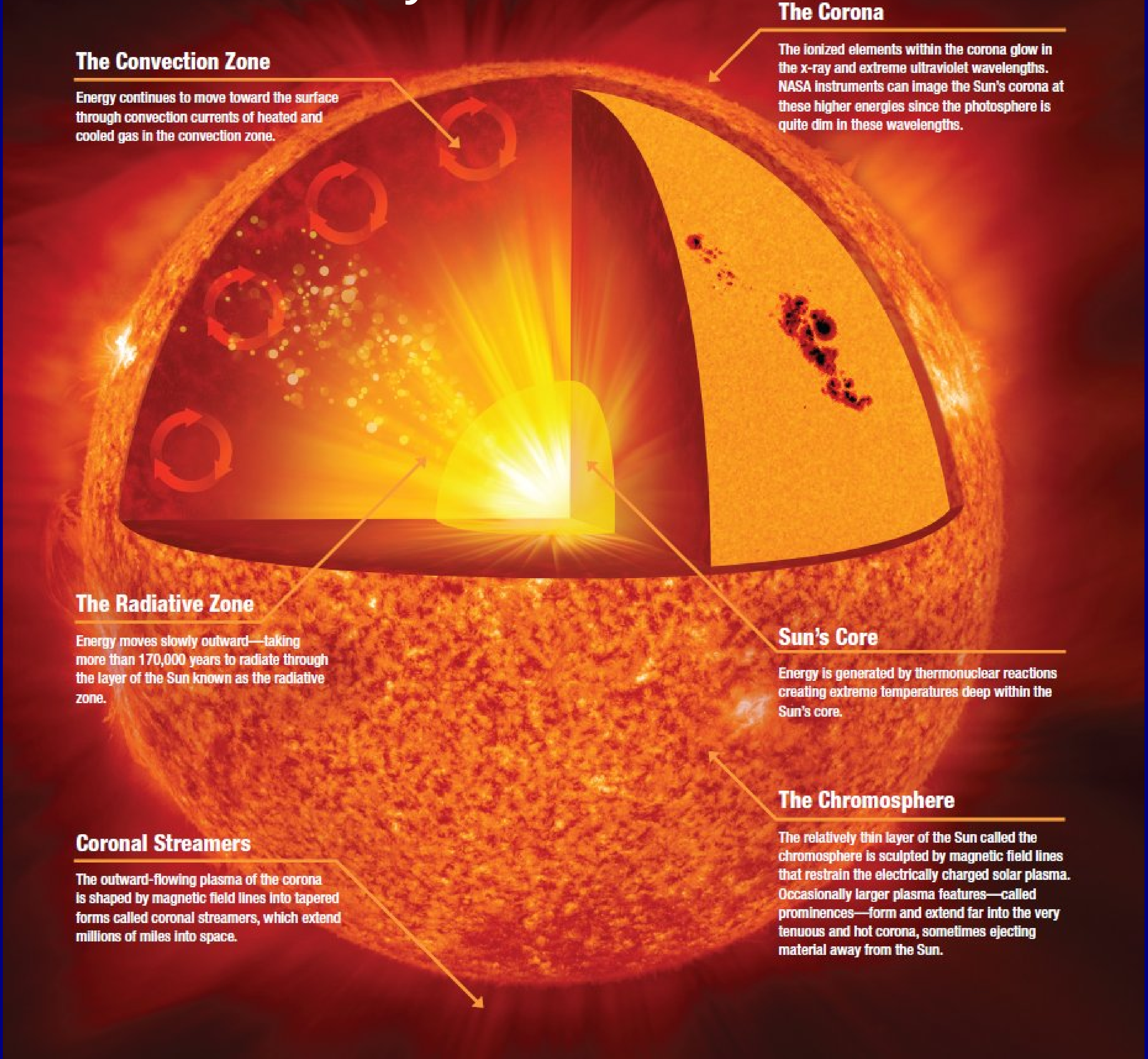
Bellatrix is B2
250 ly

Rigel is B8
860 ly



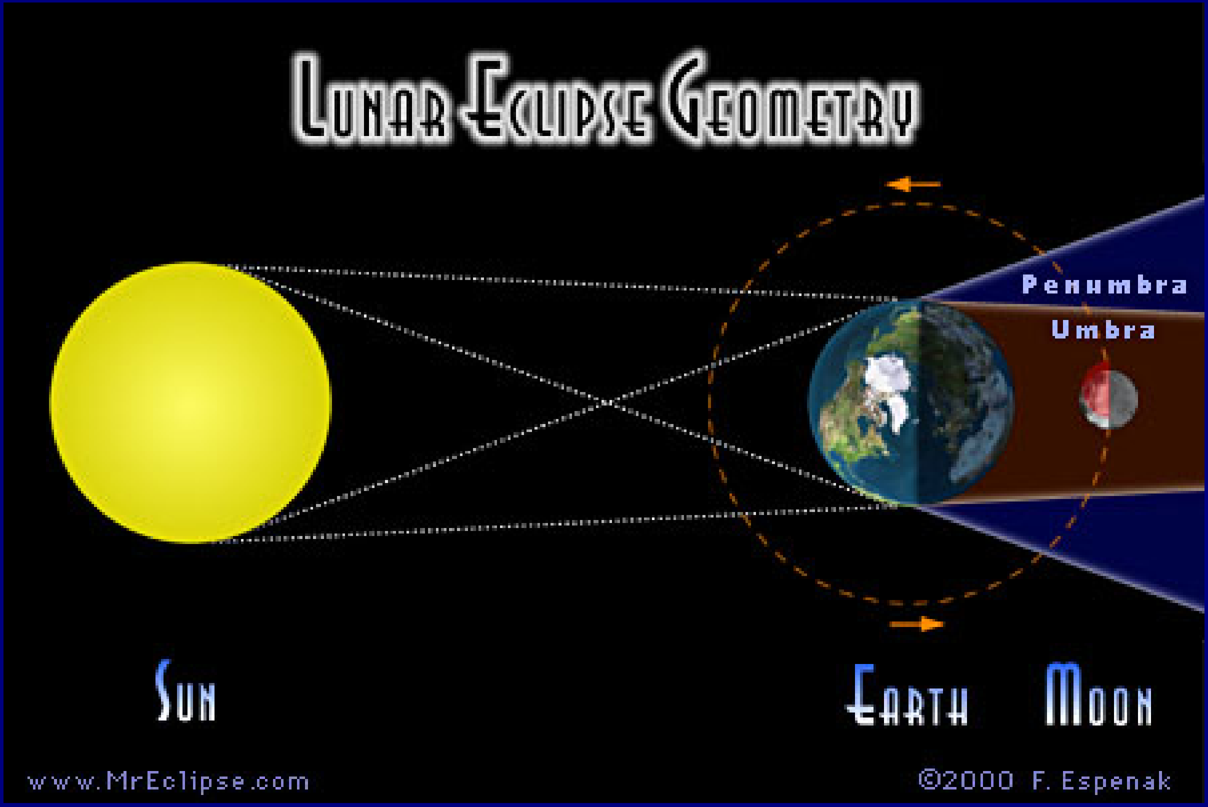
Saiph is B0
650 ly

Layers of the Sun



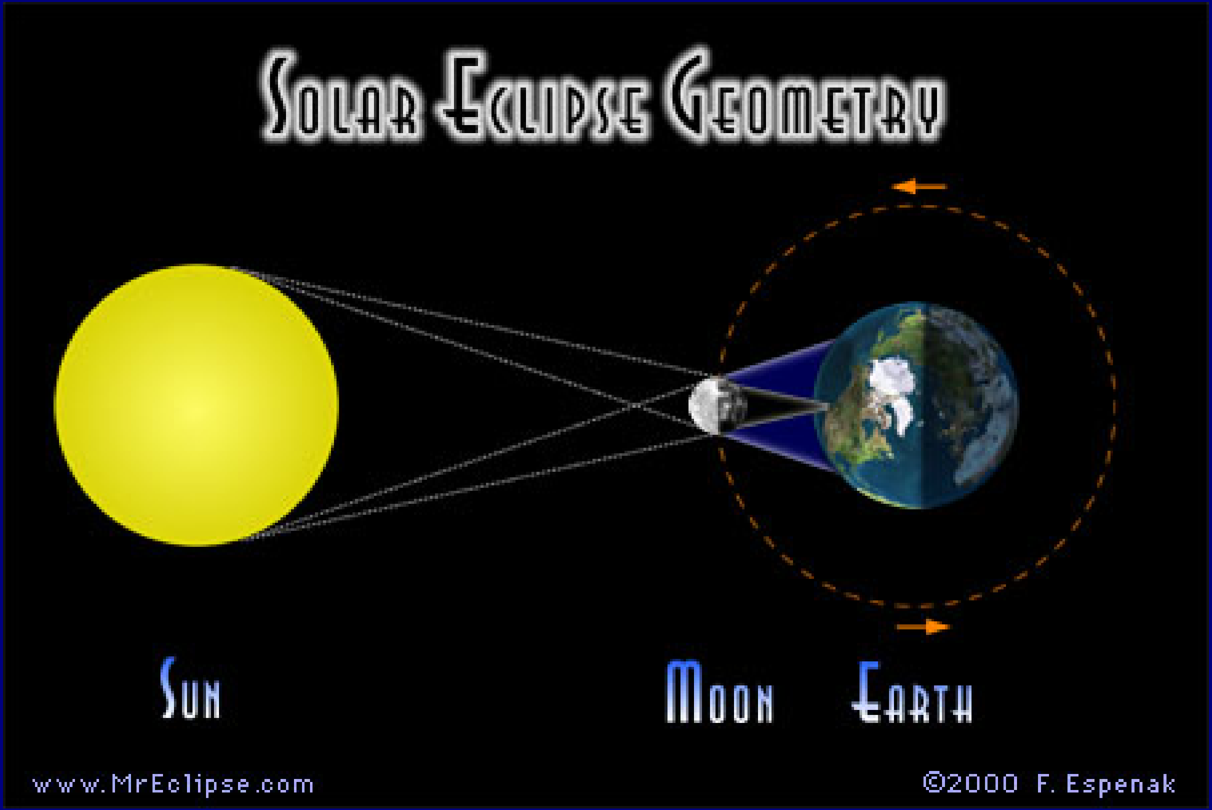
What Is an Eclipse?

An eclipse happens when one object blocks light from falling onto another object.
The shadow of the eclipsed object falls onto the other object.



Images Used With Permission

Solar Eclipses



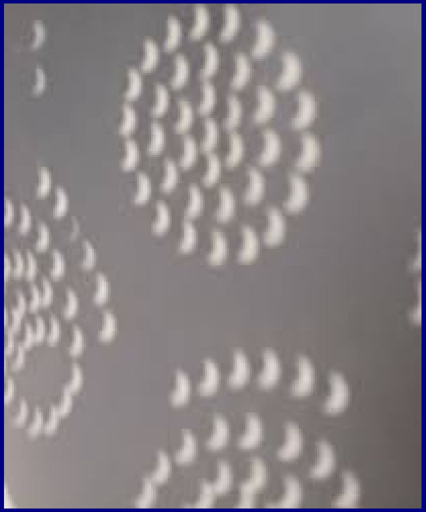
Images Used With Permission

What You Can See: Partial Eclipse

The entire United States will see a partial eclipse.

Use a Kitchen Colander or Trees For Partial Phases






What You Can See: Total Eclipse

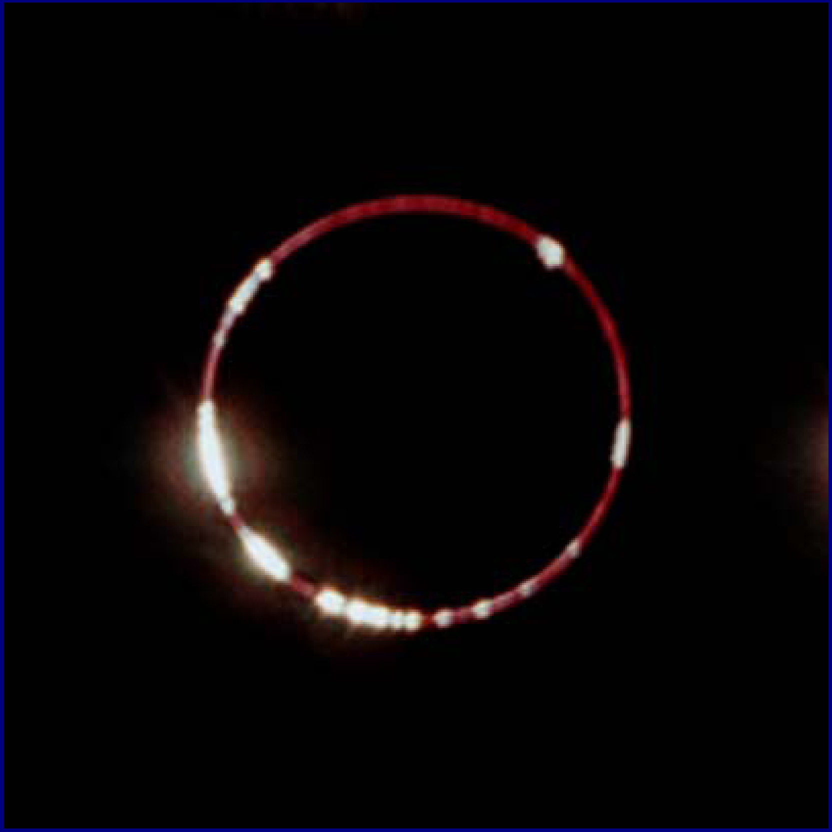
Image Used With Permission

Zophia Edwards wide-angle view, from Jay Pasachoff's Eclipse 2013 page

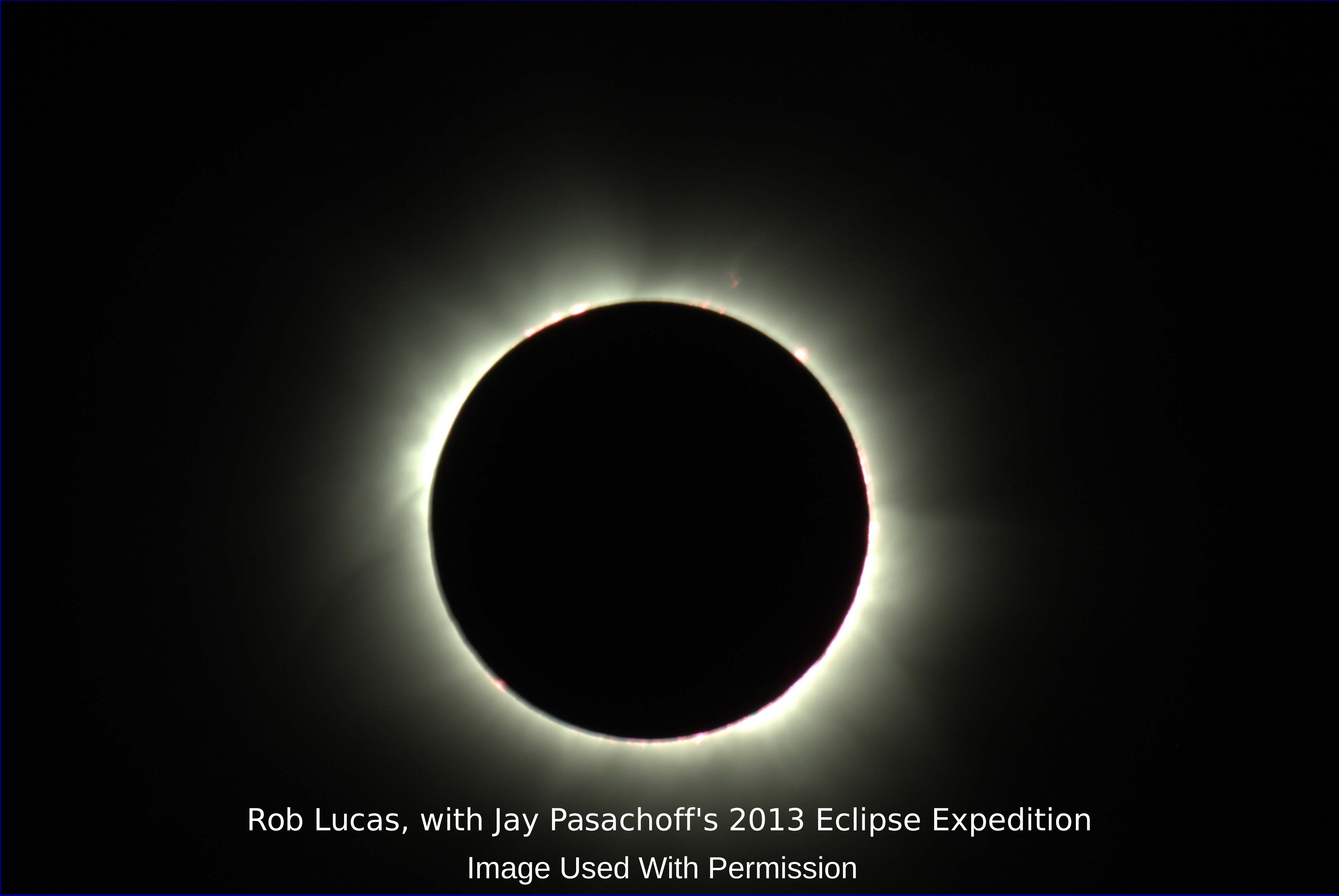
Shadow Bands

Light shines through air, creating a wavy pattern similar to light through water in a pool

Total Eclipse: Diamond Ring and Bailey's Beads



The Corona and Prominences

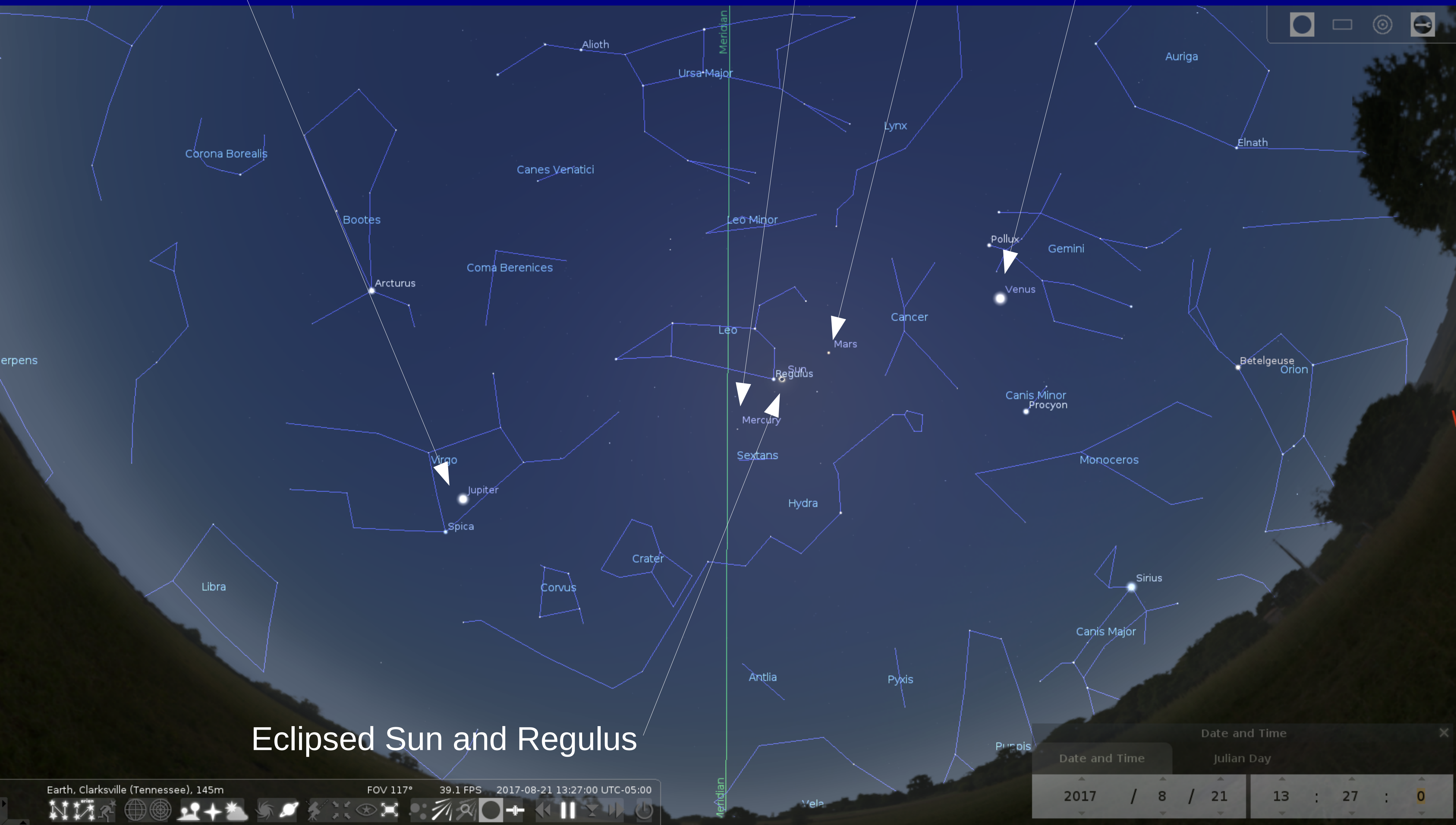


Rob Lucas, with Jay Pasachoff's 2013 Eclipse Expedition

Image Used With Permission

The Sky During Totality

Jupiter is to the east of the Meridian (left), Mercury, Mars, and Venus to the west.



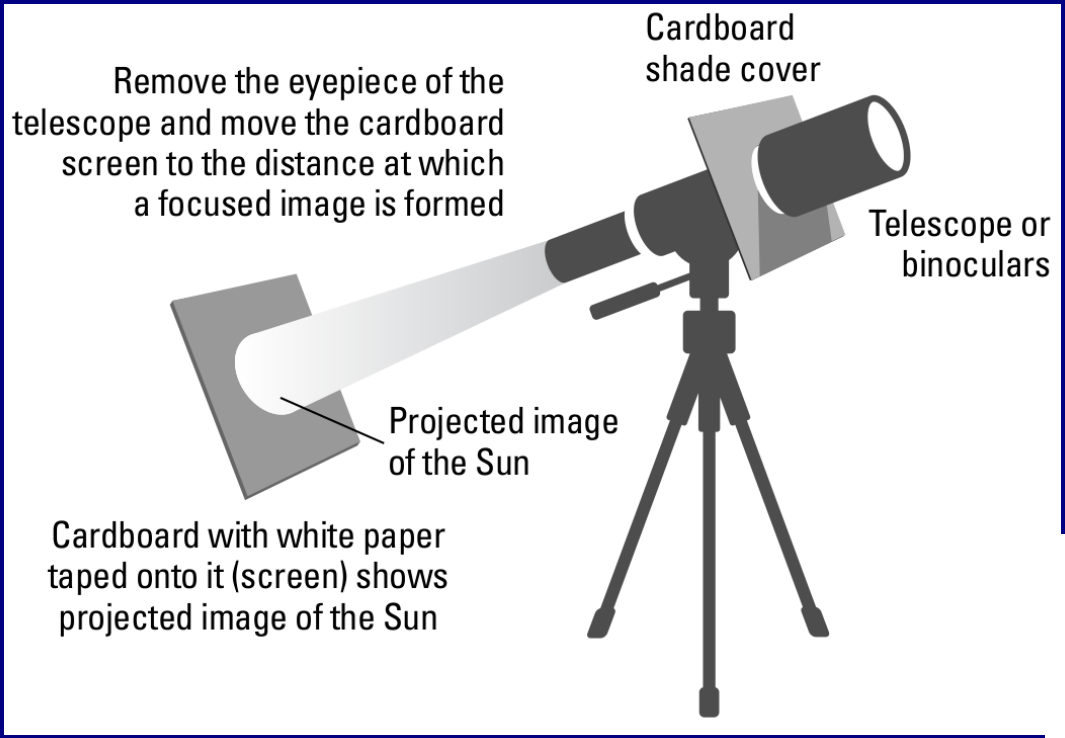
Safely Viewing an Eclipse

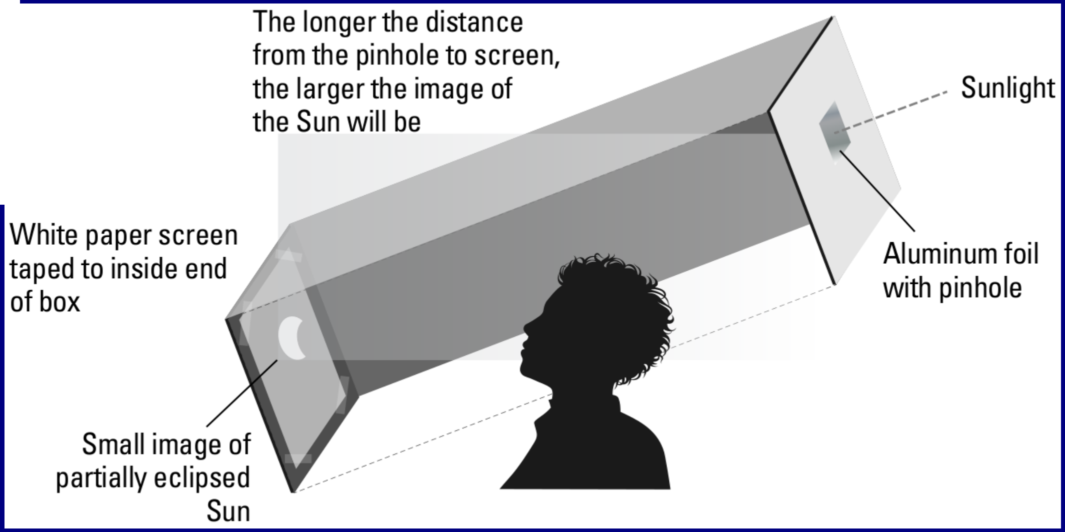
How to Safely Observe An Eclipse

No Special Rules for Lunar Eclipses

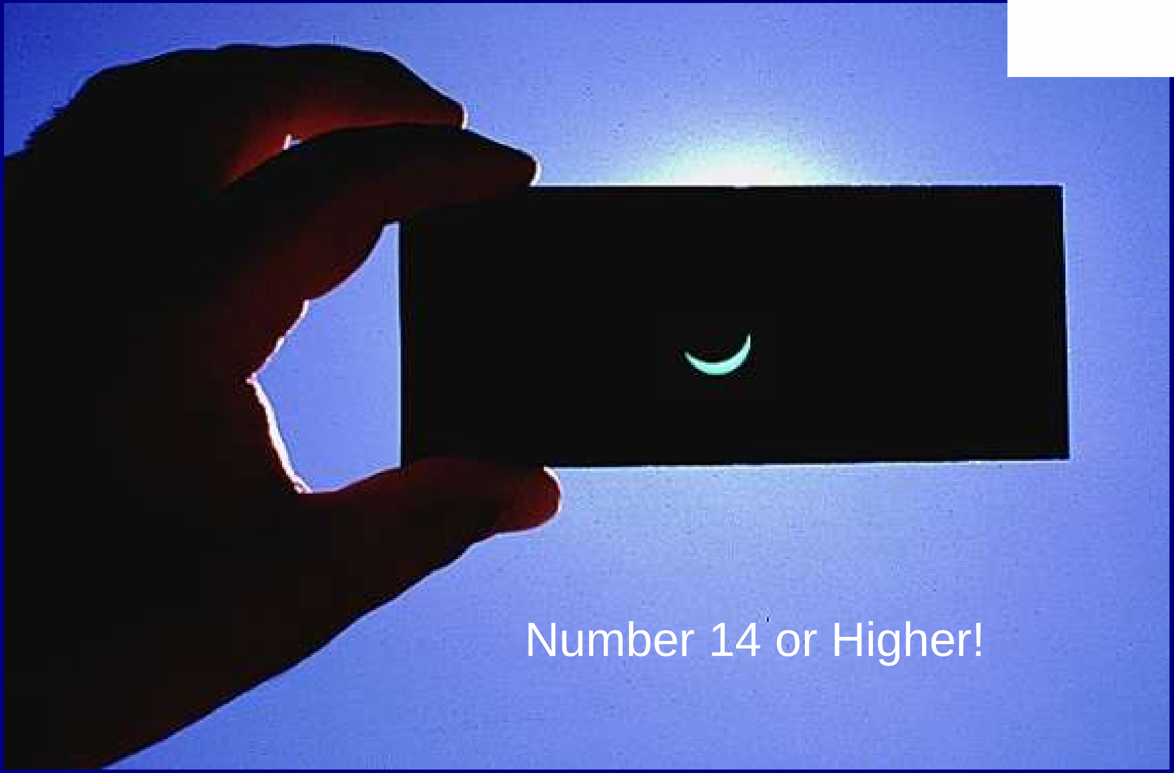
For Solar Eclipses:

- Projection
- Special Telescope Filters
- Eclipse Glasses
- Number 14 Welder's Glass





Eclipse Glasses
and Welder's Glass



Solar Filters for Telescopes

More Information

http://www.astrosociety.org/tov/Build_a_Sun_Funnel2.pdf

http://www.nasa.gov/offices/education/about/index.html

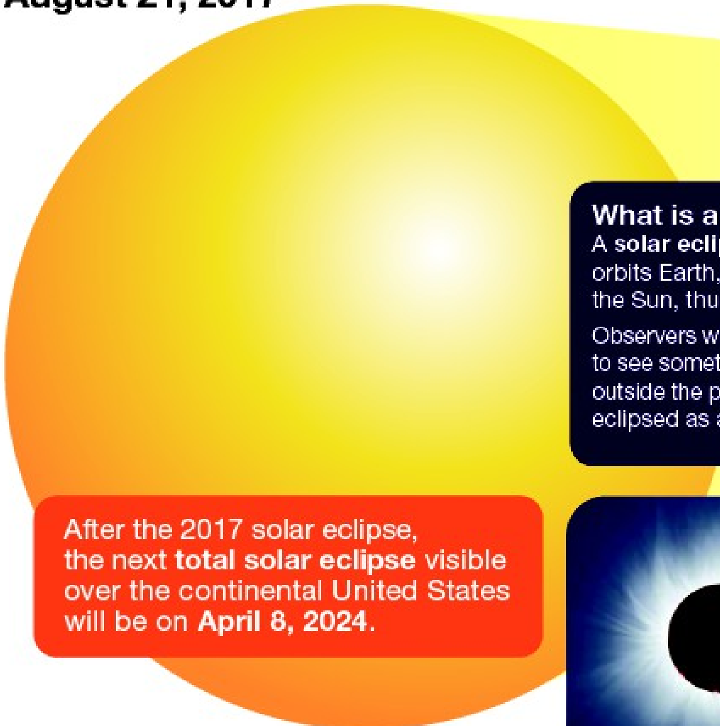
http://www.greatamericaneclipse.com/

http://eclipse.gsfc.nasa.gov/SEgoogle/SEgoogle2001/SE2017Aug21Tgoogle.html

Eclipse Across America

August 21, 2017

National Aeronautics and
Space Administration



What is a Solar Eclipse?

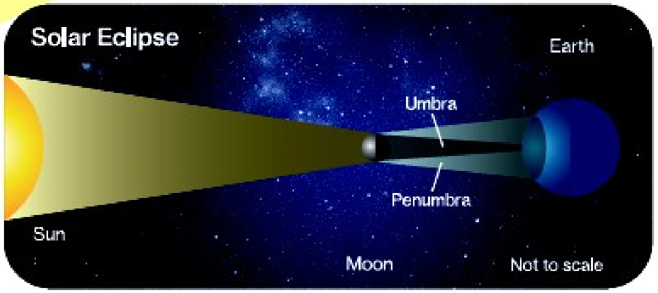
A **solar eclipse** happens when the Moon, as it orbits Earth, fully or partially blocks the light of the Sun, thus casting its shadow on Earth.

Observers within the path of totality can expect to see something like the image below. bservers outside the path of totality will see the Sun partially eclipsed as a crescent Sun (with safe filters).

Greatest Eclipse

Time	Location
10:17 a.m. PDT	Lincoln Beach, OR Depoe Bay, OR
11:26 a.m. MDT	Lime, ID
1:19 p.m. CDT	Valley View, MO Bloomsdale, MO
1:28 p.m. CDT	Calistia, TN
2:47 p.m. EDT	Bethera, SC

After the 2017 solar eclipse, the next **total solar eclipse** visible over the continental United States will be on **April 8, 2024**.



If the Sun is scaled to about 10 cm (3.9 in), Earth would be about 10 meters away (33 feet).

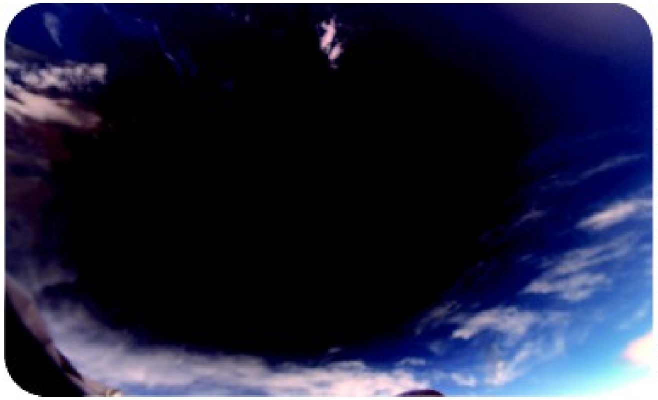
The predicted path of the August 21, 2017 solar eclipse

Duration of Greatest Eclipse:
2 min 40 sec
(18:25 UT=13:25 CDT or 1:25 p.m. CDT)

Location Greatest Eclipse:
36 deg 58 min N; 87 deg 40 min W
(between Princeton and Hopkinsville, KY)

Path Width: **approximately 115 km**

Eclipse Predictions by Fred Espenak, GSFC, NASA-emeritus



The NASA image above shows the Moon's umbral shadow as seen from the International Space Station during the total solar eclipse on 29 March 2006.

Never look directly at the Sun unless you have filters that you know are safe.

For more information: http://eclipse/gsfc.nasa.gov/SEhelp/safety.html

For more information about solar eclipses: http://eclipse.gsfc.nasa.gov/solar.html
http://eclipsewise.com/solar
http://eclipsewise.com/solar/SEnews/TSE2017/TSE2017.html
http://eclipse2017.nasa.gov/

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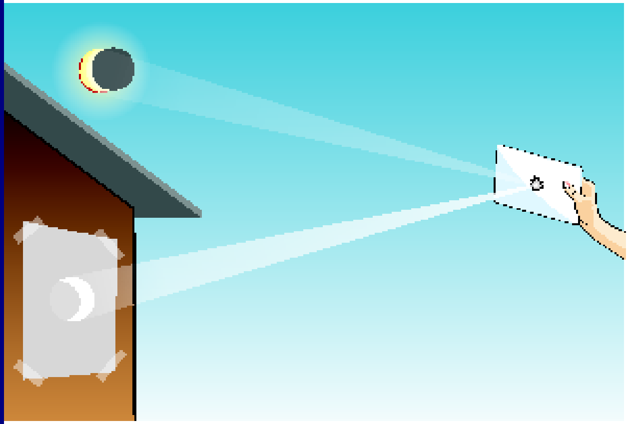
FL-2016-10-122-MSFC G–248081

Safely Observing the Sun

WARNING: Never look directly at the Sun without proper eye protection. You can *seriously* injure your eyes.



Mirror in an Envelope

Slide a mirror into an envelope with a ragged hole cut into the front. Point the mirror toward the Sun so that an image is reflected onto a screen at least 5 meters (about 15 feet) away. The longer the distance, the larger the image.

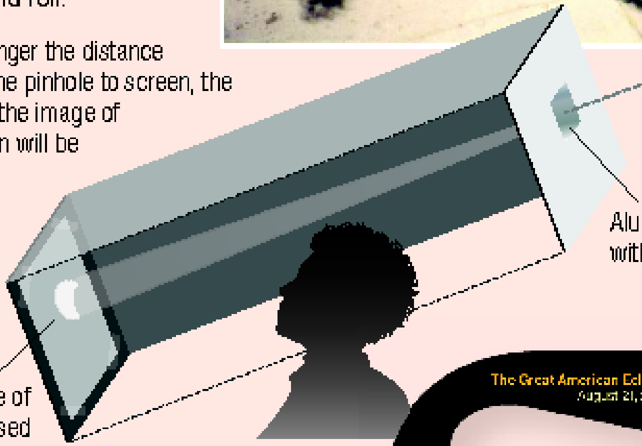
Do not look at the mirror, only at the screen.

Strange Shadows!

Sunlight through trees produces projected crescents during partial phases.

Go Stick Your Head in a Box

You can make this simple "eclipse telescope" with some cardboard, paper, tape, and foil.



Local Area Eclipse Details

Location	% Covered	Start (CDT)	Max (CDT)	End (CDT)
Nashville, TN	100.0%	11:58AM	1:28PM	2:54PM
Totality begins 1:27PM • Totality ends 1:29PM				
Brentwood, TN	100.0%	11:58AM	1:28PM	2:54PM
Totality begins 1:28PM • Totality ends 1:29PM				
Franklin, TN	99.9	11:58AM	1:28PM	2:54PM
Fayetteville, TN	98.2	11:59	1:30	2:56
Ardmore, AL/TN	97.3	11:59	1:29	2:55
Florence, AL	95.9	11:57	1:28	2:54
Athens, AL	96.7	11:59	1:29	2:56
Decatur, AL	96.1	11:59	1:30	2:56
Hartselle, AL	95.8	11:59	1:30	2:56
Madison, AL	96.7	11:59	1:30	2:56
USSRC	96.8	11:59	1:30	2:56
Huntsville, AL	97.0	11:59	1:30	2:56
VBAS	97.1	12:00NOON	1:30	2:56
Arab, AL	96.0	12:00	1:31	2:57
Gurley, AL	97.1	12:00	1:31	2:57
Guntersville, AL	96.4	12:01	1:31	2:57
Scottsboro, AL	97.4	12:01	1:31	2:57
Bridgeport, AL	98.6	12:01	1:32	2:57

JAVA Script Solar Eclipse Explorer
http://eclipse.gsfc.nasa.gov/JSEX/JSEX-NA.html

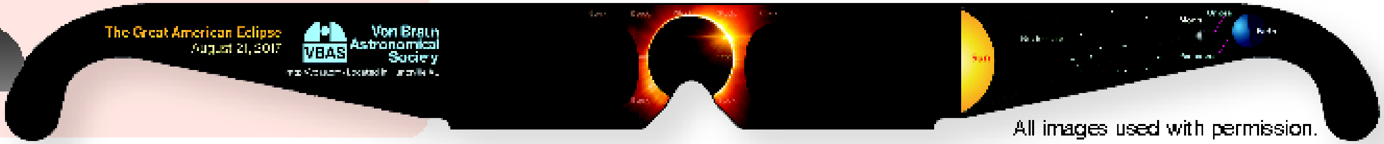
Sun Funnel

Make this device for your telescope with simple instructions at: www.astrosociety.org/tov/Build_a_Sun_Funnel.pdf

Cool in the Shades

Visit the Von Braun Astronomical Society (or your local astronomical society) and pick up a pair of these special Eclipse Sunglasses!

www.vbas.org



Eclipse Science

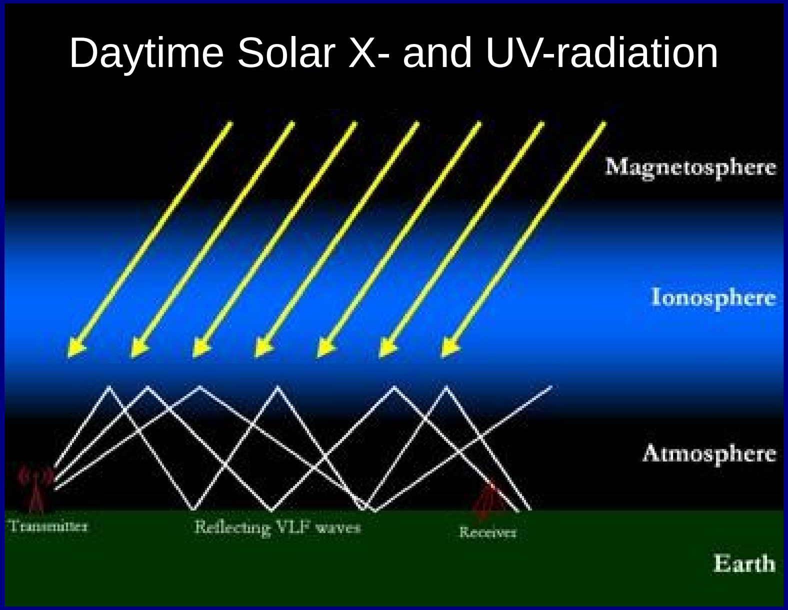
Proposed Activities for Total Solar Eclipse 2017
Involving Advanced Space Academy Kids
Select Local (Huntsville, AL) High School Students
Austin Peay State University Students
University of Alabama in Huntsville Students

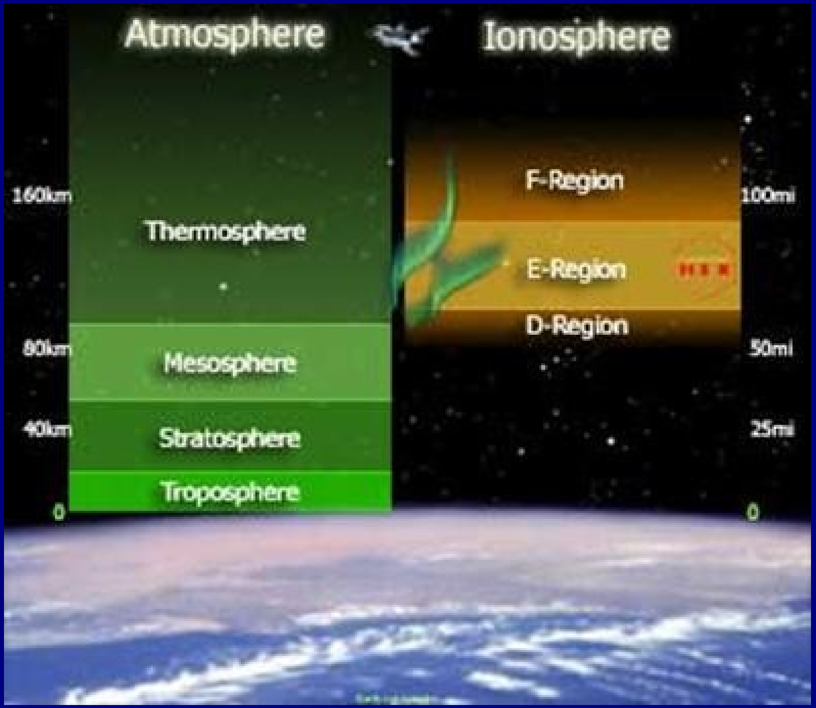
1. RadioJove/INSPIRE/Reverse Beacon
2. Balloon Experiments -- meteorological and other
3. Weather Observations
4. Animal/Plant Observations
5. Solar Corona/Chromosphere Observations

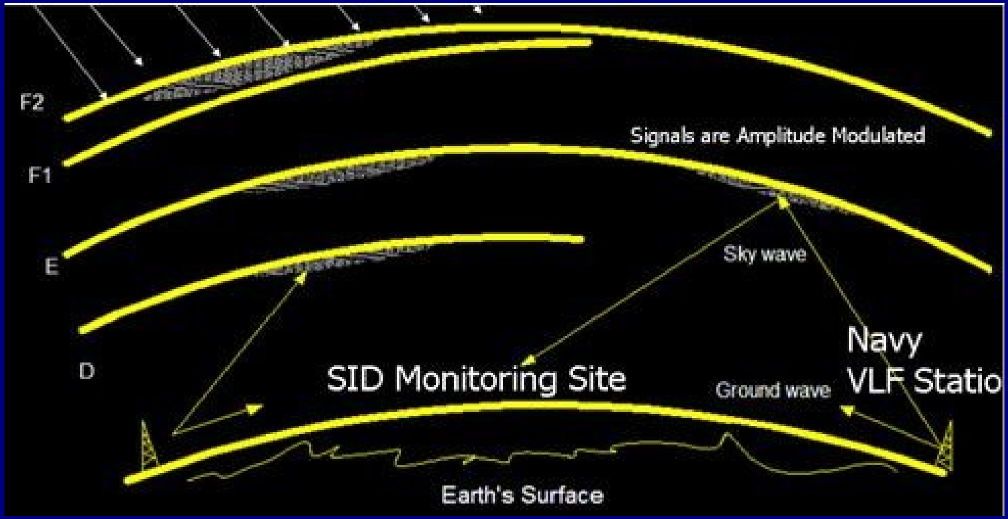
Austin Peay State University
Clarksville, Tennessee

- 45 minutes from downtown Nashville
- Bachelor and Master degree programs
- Departments include Agriculture, Health Sciences, Biology, Geosciences, and Physics and Astronomy

Ionospheric Changes



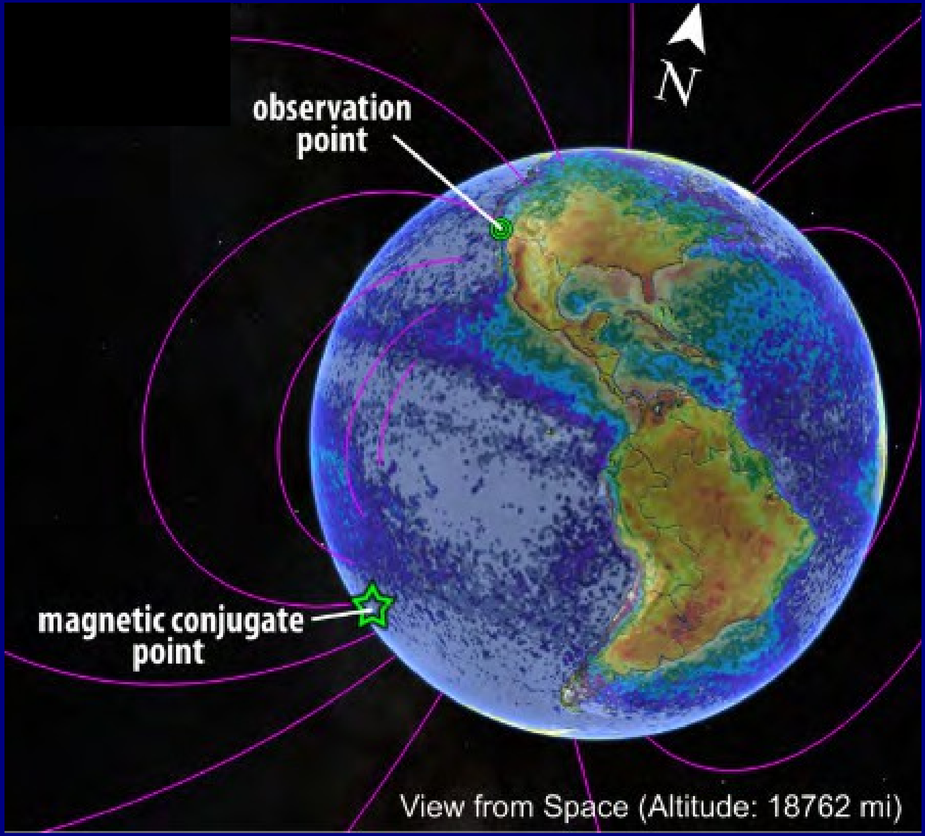




At night (on right), ions recombine, ionosphere has only F and E layers, transmitted radio signals travel higher before bouncing, so can be received at larger distances.

The INSPIRE Project provides creative hands-on opportunities for students of all ages to observe Very Low Frequency waves (i.e. lightning and other atmospheric sounds) by using the INSPIRE VLF-3 Natural Radio Sound Receiver.

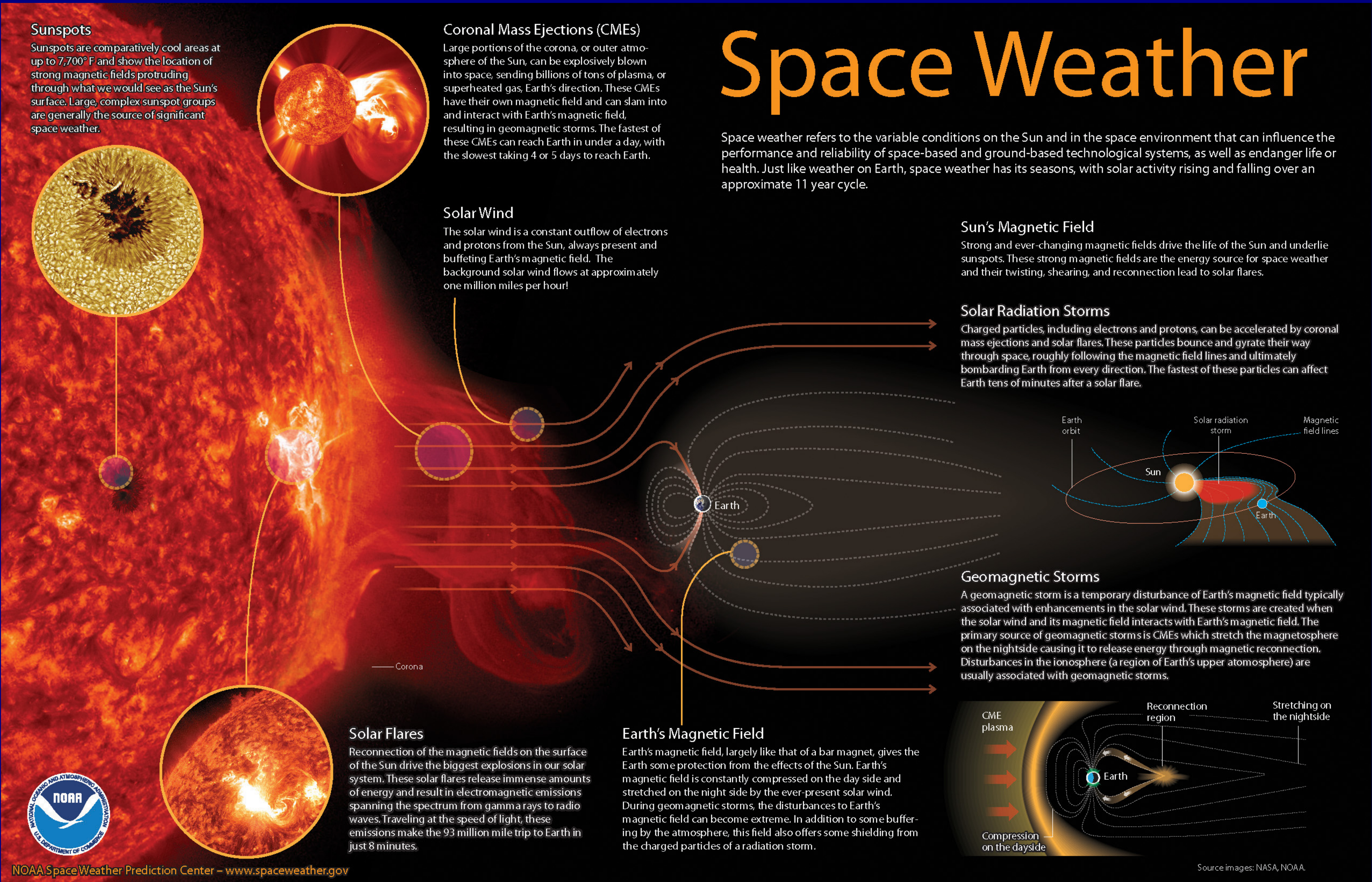
INSPIRE
INTERACTIVE NASA SPACE PHYSICS IONOSPHERE RADIO EXPERIMENTS

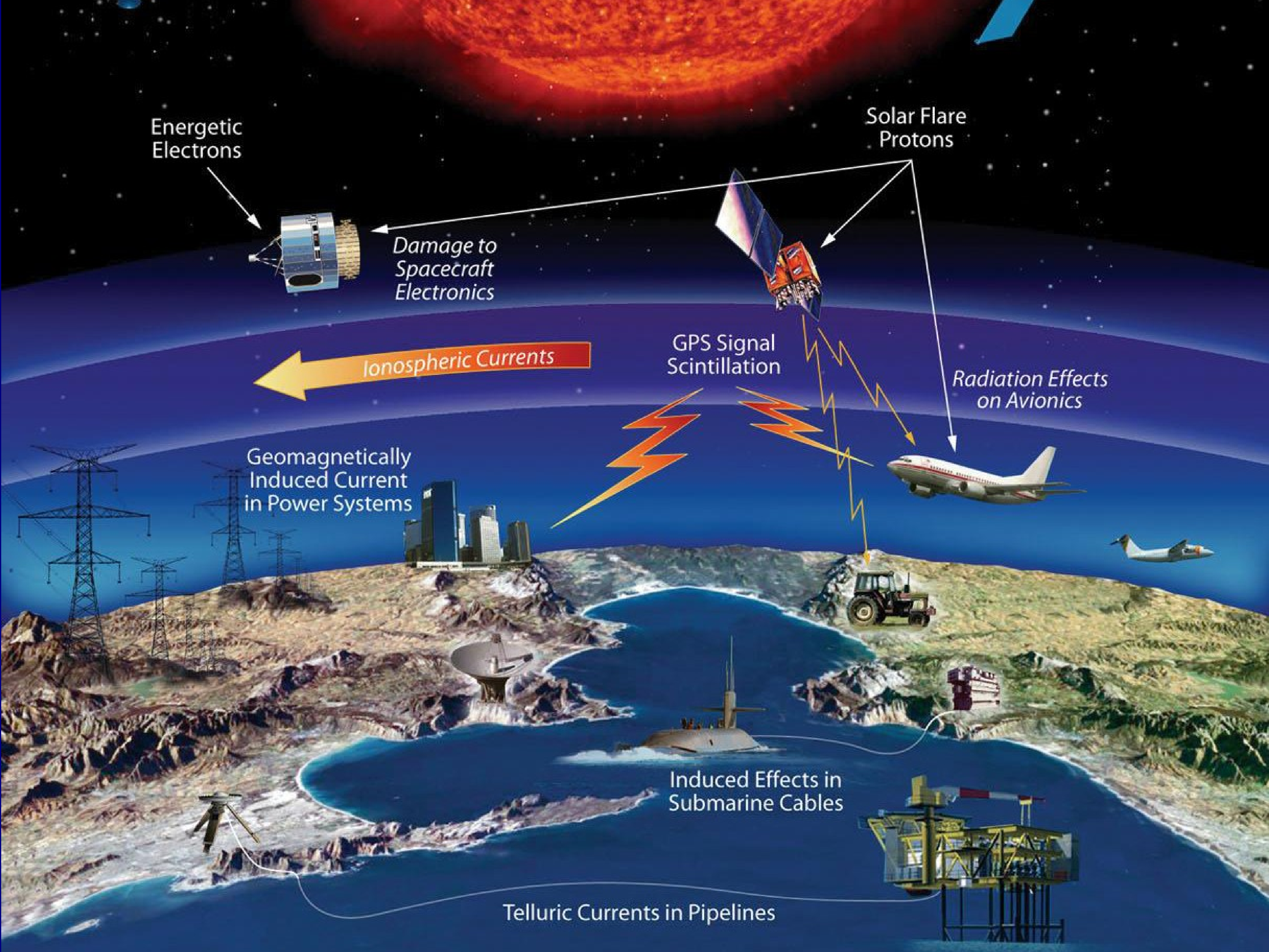


WAV File!

Weather Observations

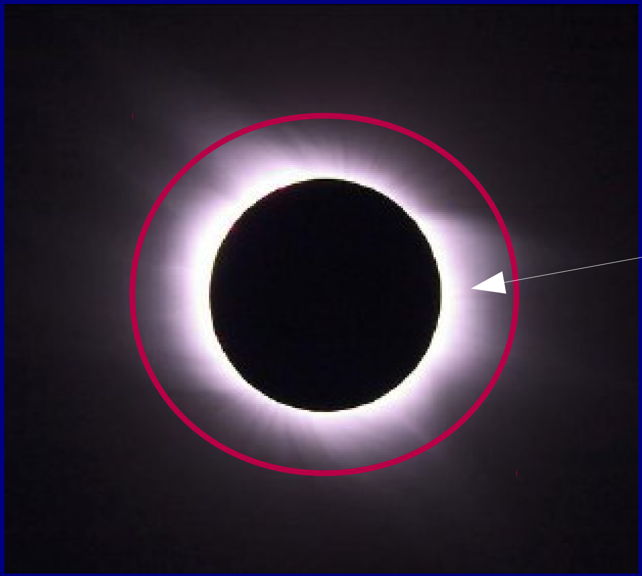
Sounding Equipment


Space Weather
Space weather refers to the variable conditions on the Sun and in the space environment that can influence the performance and reliability of space-based and ground-based technological systems, as well as endanger life or health. Just like weather on Earth, space weather has its seasons, with solar activity rising and falling over an approximate 11 year cycle.
Sunspots
Sunspots are comparatively cool areas at up to 7,700° F and show the location of strong magnetic fields protruding through what we would see as the Sun's surface. Large, complex sunspot groups are generally the source of significant space weather.
Coronal Mass Ejections (CMEs)
Large portions of the corona, or outer atmosphere of the Sun, can be explosively blown into space, sending billions of tons of plasma, or superheated gas, Earth's direction. These CMEs have their own magnetic field and can slam into and interact with Earth's magnetic field, resulting in geomagnetic storms. The fastest of these CMEs can reach Earth in under a day, with the slowest taking 4 or 5 days to reach Earth.
Solar Wind
The solar wind is a constant outflow of electrons and protons from the Sun, always present and buffeting Earth's magnetic field. The background solar wind flows at approximately one million miles per hour!
Sun's Magnetic Field
Strong and ever-changing magnetic fields drive the life of the Sun and underlie sunspots. These strong magnetic fields are the energy source for space weather and their twisting, shearing, and reconnection lead to solar flares.
Solar Radiation Storms
Charged particles, including electrons and protons, can be accelerated by coronal mass ejections and solar flares. These particles bounce and gyrate their way through space, roughly following the magnetic field lines and ultimately bombarding Earth from every direction. The fastest of these particles can affect Earth tens of minutes after a solar flare.
Earth orbit
Solar radiation storm
Magnetic field lines
Sun
Earth
Earth
Corona
Geomagnetic Storms
A geomagnetic storm is a temporary disturbance of Earth's magnetic field typically associated with enhancements in the solar wind. These storms are created when the solar wind and its magnetic field interacts with Earth's magnetic field. The primary source of geomagnetic storms is CMEs which stretch the magnetosphere on the nightside causing it to release energy through magnetic reconnection. Disturbances in the ionosphere (a region of Earth's upper atomosphere) are usually associated with geomagnetic storms.
CME plasma
Reconnection region
Stretching on the nightside
Earth
Compression on the dayside
Solar Flares
Reconnection of the magnetic fields on the surface of the Sun drive the biggest explosions in our solar system. These solar flares release immense amounts of energy and result in electromagnetic emissions spanning the spectrum from gamma rays to radio waves. Traveling at the speed of light, these emissions make the 93 million mile trip to Earth in just 8 minutes.
Earth's Magnetic Field
Earth's magnetic field, largely like that of a bar magnet, gives the Earth some protection from the effects of the Sun. Earth's magnetic field is constantly compressed on the day side and stretched on the night side by the ever-present solar wind. During geomagnetic storms, the disturbances to Earth's magnetic field can become extreme. In addition to some buffering by the atmosphere, this field also offers some shielding from the charged particles of a radiation storm.
NOAA
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE
NOAA Space Weather Prediction Center – www.spaceweather.gov
Source images: NASA, NOAA.

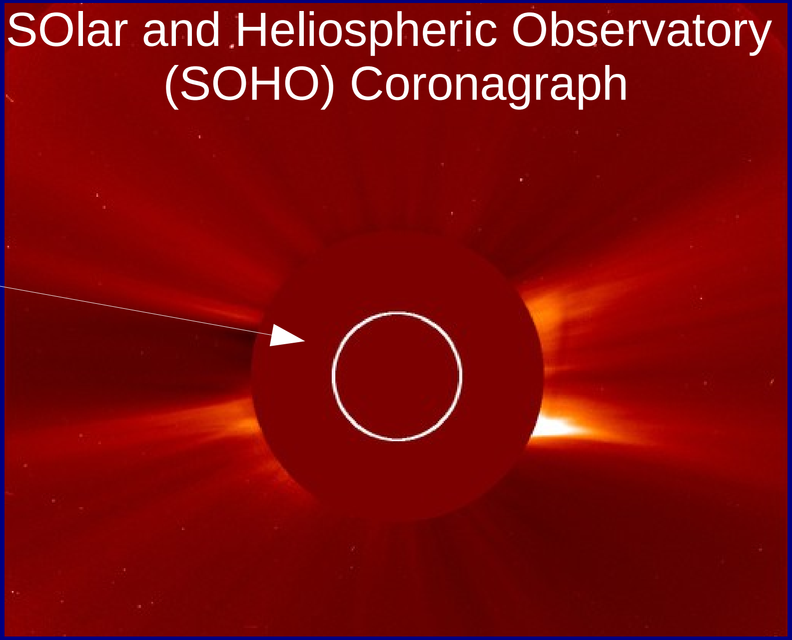


Energetic Electrons
Solar Flare Protons
Damage to Spacecraft Electronics
GPS Signal Scintillation
Ionospheric Currents
Radiation Effects on Avionics
Geomagnetically Induced Current in Power Systems
Induced Effects in Submarine Cables
Telluric Currents in Pipelines

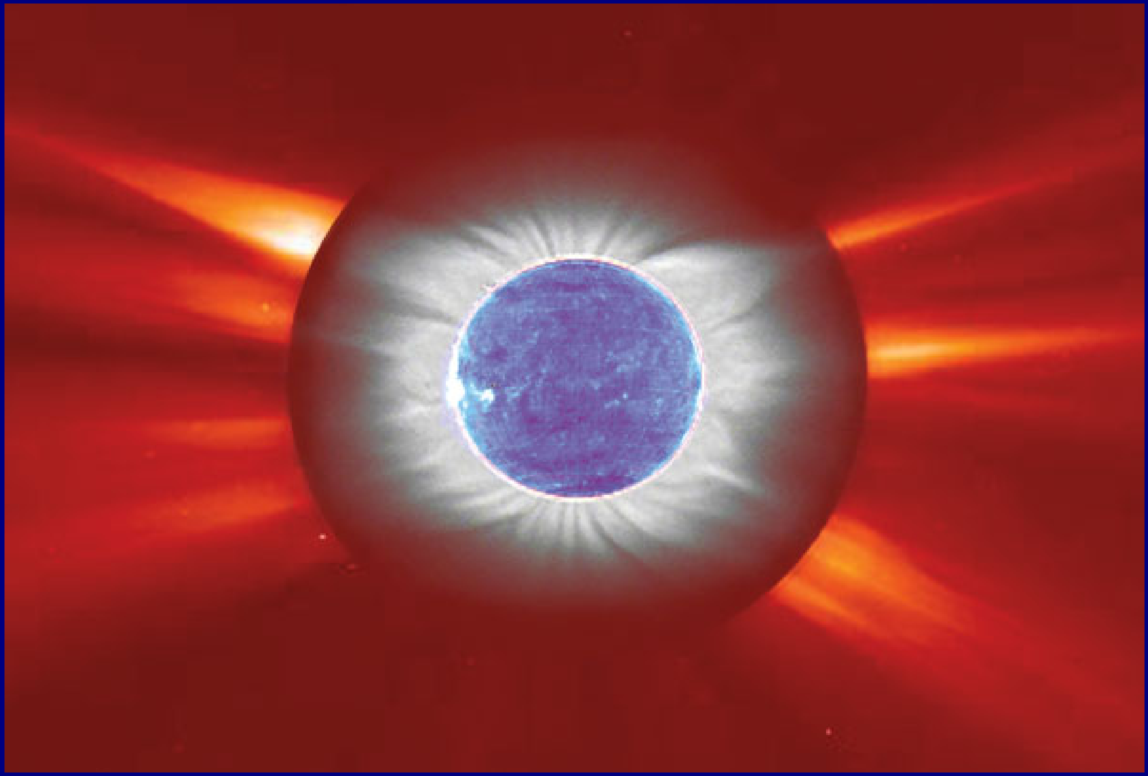
Coronal/Chromospheric Observations



Inner Corona



Ground-based observatories see up to about 1.3 times the radius of the Sun.



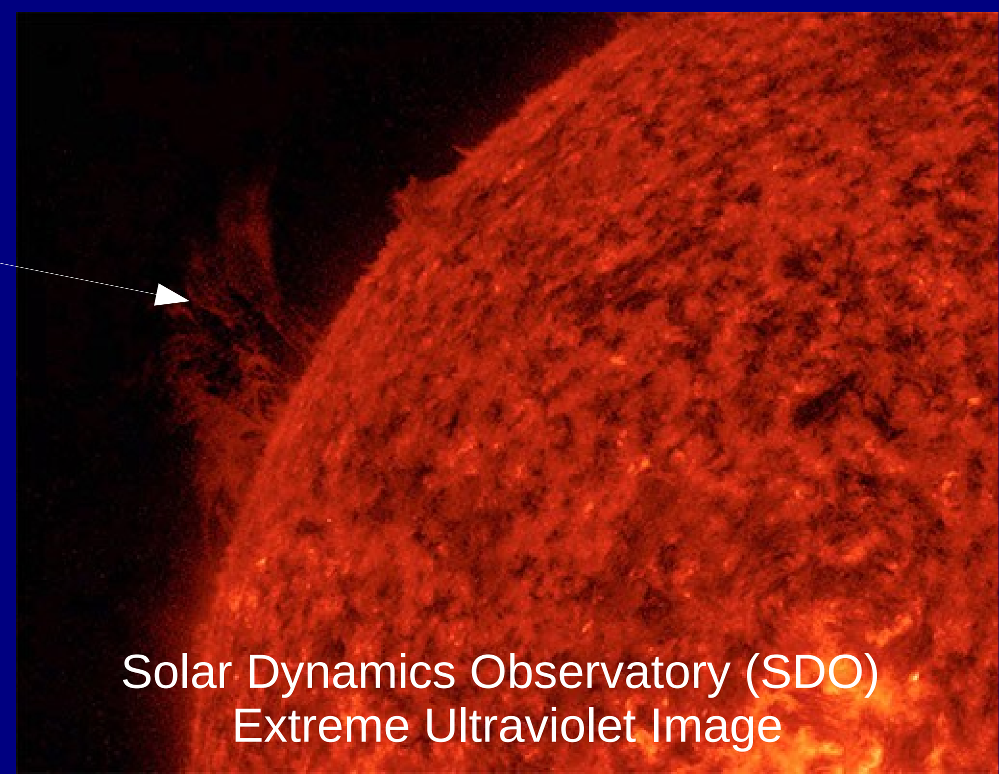
Space-based telescopes see from about 2.2. to 30 times the solar radius.

March 2006

Standardized Eclipse Observations

Citizen Continental-America Telescopic Eclipse Experiment (CATE):
https://sites.google.com/site/citizencateexperiment/home/

Prominences



Solar Dynamics Observatory (SDO)
Extreme Ultraviolet Image