Live from McDonald Observatory: Observing the Sun and its features
Videoconference
Teacher Edition for grades 6-8

Introduction

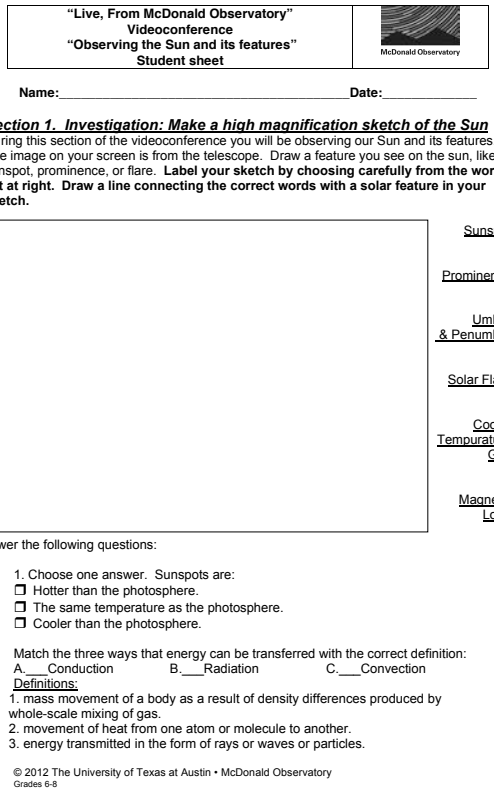
The videoconference will introduce students to McDonald Observatory, telescopes, and a few astronomical objects near and far that astronomers explore. The student sheets are designed to help the student discuss important concepts. Students should be directed to not fill in their sheets until prompted.

Investigation: Make a high magnification sketch of the sun!

Prior to the videoconference, students should have filled in the pre-assessment sheet. The drawings and words that they use will help you gauge their pre-conceptions as well as prepare them for encountering new information about the sun.

If the weather conditions are favorable at McDonald Observatory, the image of the sun your students will see is live, real-time and captured by digital video-camera's attached to the telescope. During the videoconference the facilitator controls the telescope using a computer in the videoconference studio. What students see depends greatly on current weather conditions. Clouds may partially or completely block the image of the sun.

Before actually observing the sun, the facilitator will familiarize students with the dome, telescope, solar filter, video-camera and control system. The facilitator will provide commentary while showing images of the sun in white light and light that has passed through an H-alpha filter. The facilitator will perform demonstrations to make important links between the physical concepts and the sun.



"Live, From McDonald Observatory"
Videoconference
"Observing the Sun and its features"
Student sheet

McDonald Observatory

Name:_____**Date:**_____

Section 1. Investigation: Make a high magnification sketch of the Sun

During this section of the videoconference you will be observing our Sun and its features. The image on your screen is from the telescope. Draw a feature you see on the sun, like a sunspot, prominence, or flare. **Label your sketch by choosing carefully from the word list at right. Draw a line connecting the correct words with a solar feature in your sketch.**

Sunspot
Prominence
Umbra & Penumbra
Solar Flare
Cooler Tempurature Gas
Magnetic Loop

Answer the following questions:

1. Choose one answer. Sunspots are:
❒ Hotter than the photosphere.
❒ The same temperature as the photosphere.
❒ Cooler than the photosphere.

Match the three ways that energy can be transferred with the correct definition:
A.___Conduction B.___Radiation C.___Convection
Definitions:
1. mass movement of a body as a result of density differences produced by whole-scale mixing of gas.
2. movement of heat from one atom or molecule to another.
3. energy transmitted in the form of rays or waves or particles.

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The facilitator will also provide commentary while exploring the sun in high-magnification. What students see depends upon what features are most visible during your videoconference. Students may make high-magnification observations of sunspots, prominences, or solar flares. The facilitator will decide what area to point the telescope and instruct the students to draw a feature in the box. Their drawing should be like a zoom-in of a part of the sun, i.e. there should not be a full disk. (In the pre-assessment, it is likely that they drew a full disk image.)

In the zoom-in view that students draw, they should include a feature of the sun such as a prominence or a magnetic loop and should label it accordingly. If the telescope has been pointed to a sunspot, the "Umbra" label should be for the inner-most, darkest region of the sunspot. Surrounding the Umbra is the "Penumbra", appearing not as dark as the Umbra. The "Cooler Gas" label should be used for any region of the sun that appears much darker than the rest of the sun, particularly a sunspot. If the telescope has been pointed at a prominence, the students might see a looping cloud of gas along the limb of the sun, called a "Magnetic Loop". The "Solar Flare" label should be used for areas of the sun that appear much brighter that the rest of the sun.

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Choose one answer: Sunspots are:

Correct answer: Sunspots are cooler that the photosphere. The facilitator will have done a demonstration of sunspots' relative coolness using an overhead projector and a light bulb on a rheostat. Remind students of how the filament appeared dark against a hotter surface, if they answered incorrectly. The filament was cooler, thus darker, than the surrounding area in the same way that sunspots are cooler than the surrounding photosphere. The temperature of the photosphere is about 6000K (10,000 F) while sunspots are about 4600K (7000 F).

Match the three ways that energy can be transferred with the correct definition.

Answers: A-2, B-3, C-1

Students should easily identify radiation with electromagnetic waves, and after the videoconference discussion of convection in the sun and the demonstration with the lava lamp, they should identify convection with the mixing of gas. Conduction is not an active mode of heat transfer in the sun, but students should recognize that it requires contact of atoms/molecules.

References and Extensions:

Many websites discuss convection, conduction and radiation. Here are some samples:
http://sol.sci.uop.edu/~jfalward/heattransfer/heattransfer.html
http://www.mansfieldct.org/schools/MMS/staff/hand/convcondrad.htm

A NASA tutorial on magnetic fields:
http://www-spof.gsfc.nasa.gov/Education/wmfield.html

Instructions for making magnetic field demonstrator:
http://www.exploratorium.edu/snacks/magnetic_lines.html

To check out daily photos of the sun and track sunspots through the Solar Dynamics Observatory <http://sdo.gsfc.nasa.gov>

The general pictures and information about observing the Sun, visit the Solar & Heliospheric Observatory (SOHO) website at: http://sohowww.nascom.nasa.gov/

An H-alpha filter allows only radiation near the Balmer line, H-alpha, to pass to the detector. It is the transition in the standard Bohr model of the hydrogen atom from n=3 to n=2. This transition occurs at 656.3 nanometers wavelength. Using this filter allows the astronomer to observe the chromospheric layer of the sun.

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Sunspot Challenge

In this activity, students consider the data as plotted, plot additional points, analyze the data, and predict future trends.

The students should be able to plot the data fairly accurately. When analyzing the trend, there may be variable responses such as:

- noting the changing trend, i.e. "It goes up and down."
- noticing specific details, such as:
  - the increase in number after the first dip.
  - the points for 2008 and 2009 are lowest.
  - The point for 1991 is the highest.
  - The second dip is deeper than the first.
- noticing the periodicity of the curve.

It is important that students note this periodicity in order to predict the future trend. When they predict data for 2012-2016, their points should be in an upward trend. Students who do not notice the periodicity before plotting their predictions may have plots with data steadily declining, or staying at a constant value.

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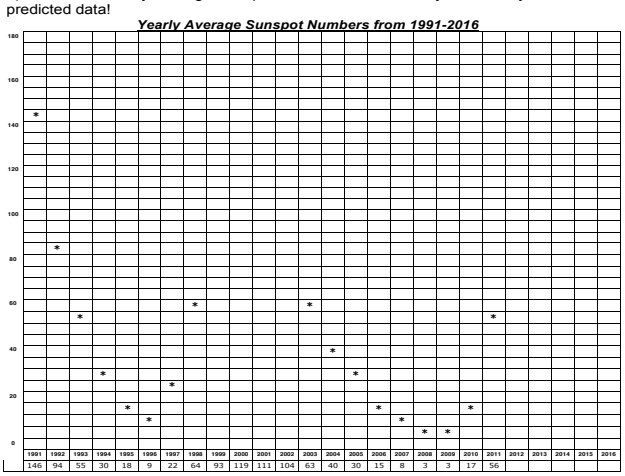
McDonald Observatory

Name:_____**Date:**_____

Section 2: Sunspot Challenge: small group discussion

Below is an incomplete graph of Yearly Average Sunspot Numbers.
Your small group must:
1) Use the data table below the chart to plot the missing data points for 1992-1998.
2) Analyze all the data for a trend, or pattern.
3) Predict the Yearly Average Sunspot Number for the next 5 years. Plot your predicted data!

Yearly Average Sunspot Numbers from 1991-2016



1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
146	94	55	30	18	9	22	64	93	119	111	104	63	40	30	15	8	3	3	17	56					

This scientific data was collected by the Solar Influences Data Analysis Center, World Data Center for the sunspot index, Royal Observatory of Belgium.

Galileo was one of the first astronomers to observe sunspots (although records of Chinese astronomers observing sunspots with the unaided eye go back to about 1000 BC, they were not done systematically.) The records from Galileo's time onward illustrate the 11-year cycle that is due to regular changes in the magnetic field of the sun. Sunspots can be used to calculate the sun's rotation rate (which is different for the equator and poles, since the equator rotates faster). An active sun (many sunspots, flares, prominences) means more violent space weather on Earth (e.g., more disruptions of communication and more aurora as charged particles stream from the sun and are trapped in Earth's magnetic field.)

References and Extensions:

For a diagram of sunspot numbers versus time
http://history.nasa.gov/SP-402/p12.htm

There are many references to sunspots and solar phenomena
http://helios.gsfc.nasa.gov/scycle.html

Sun as viewed with different filters
http://eo.nso.edu/MrSunspot/solarzoo/

Sun Earth Day 2012
http:/sunearthday.nasa.gov/2012/index.php

Equipment and Hardware used in solar observations

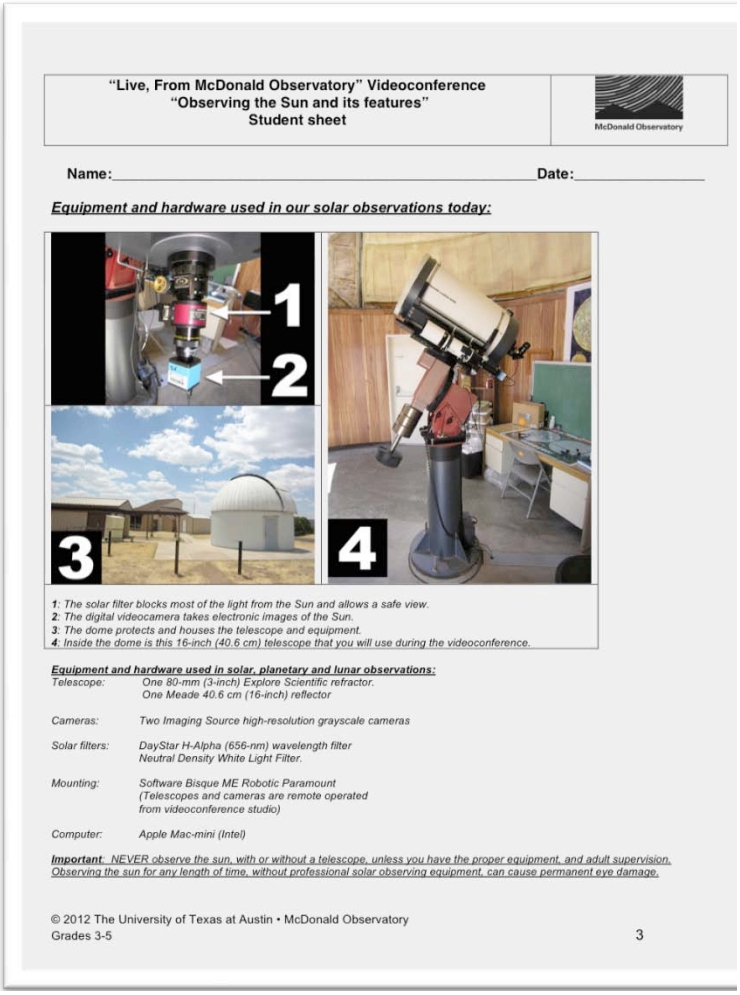
This page gives students a better understanding of the equipment involved in acquiring the images they are seeing of the sun during the videoconference. The purpose of this page is to allow students to make the connection between science and technology. Technology provides improved means for scientists to acquire a better understanding of the universe.

There are two telescopes here:

• The large, white Meade 16-inch (40.6 cm) telescope is used for high-magnification views of the sun. It has an H-alpha filter. The entire aperture of this telescope is not used for solar viewing. Although it is difficult to see in image #4, there is a cap on the end of the telescope that has a small hole cut so as to limit the total amount of light that is collected by the telescope and camera.

•The 3-inch (80-mm) telescope provides a white-light full-disk image. Because the sun is so bright, a neutral density filter is used to reduce the amount of sunlight reaching the camera.

Students may be surprised to learn that the computer is similar to those that they may use at home or school. Although astronomers use special software on their computers, often a standard home-quality computer is sufficient for the data management of many projects. (Note: astronomers who work on making mathematic models of astronomical phenomena or who have extremely large data bases do require special computers.)



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Name:_____ Date:_____

Equipment and hardware used in our solar observations today:

1: The solar filter blocks most of the light from the Sun and allows a safe view.
2: The digital videocamera takes electronic images of the Sun.
3: The dome protects and houses the telescope and equipment.
4: Inside the dome is this 16-inch (40.6 cm) telescope that you will use during the videoconference.

Equipment and hardware used in solar, planetary and lunar observations:

Telescope:	*One 80-mm (3-inch) Explore Scientific refractor.* *One Meade 40.6 cm (16-inch) reflector*
Cameras:	*Two Imaging Source high-resolution grayscale cameras*
Solar filters:	*DayStar H-Alpha (656-nm) wavelength filter* *Neutral Density White Light Filter.*
Mounting:	*Software Bisque ME Robotic Paramount* *(Telescopes and cameras are remote operated from videoconference studio)*
Computer:	*Apple Mac-mini (Intel)*

***Important**: NEVER observe the sun, with or without a telescope, unless you have the proper equipment, and adult supervision. Observing the sun for any length of time, without professional solar observing equipment, can cause permanent eye damage.*

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References and Extensions:

H-alpha filters – descriptions from the Northern Virginia Astronomy Club
http://www.novac.com/resources/solar/

TeleVue telescopes
http://www.televue.com/

Adirondack Video Stellacam
http://www.astrovid.com/

DayStar H-alpha filter
http://www.daystarfilters.com/hydrogen.htm

The videoconference telescope mount that is remotely controlled
http://wwwbisque.com/Products/Paramount/