Name: _____ **School:** _____

Grade or Level: _____ **Lesson Plan #:** _____ **Date:** _____

Solar Observation Class Project

Object

The object of this classroom exercise to involve as individuals or as teams, students in the actual astronomical research for significant events occurring on and around the sun. They will learn the use of data being generated real-time every 12 minutes by the **SOHO** (**Solar and Heliospheric Observatory)** satellite. They will also learn to make careful observations and record their findings in typical scientific log of observations.

Related URL's:

- http://www.space-exploratorium.com/sunspot-flares.htm
- http://sohodata.nascom.nasa.gov/cgi-bin/data_query
- http://sungrazer.nrl.navy.mil/index.php?p=transits/transits

Curricular Connections: (QCC/IEP/Local or National Standards):

_____

Pre-teaching for Background Knowledge

To do this student activity students should know what the following terms mean. Students should have an adult help you search the internet, or take them to a local library to find out more!

- Comets
- Coronal Mass Ejections ("CME")
- First Lagrangian Point (L1)
- Large Angle and Spectrometric Coronagraph (LASCO C2)
- Solar and Heliospheric Observatory (SOHO)
- Cosmic Rays
- Occulting disk
- Solar Flares

Questions

1. What Coronal Mass Ejections ("CME")?
2. What happens when a comet wanders to close to the sun?
3. What is the Solar and Heliospheric Observatory (SOHO)?
4. What is LASCO?
5. What are Cosmic Rays?

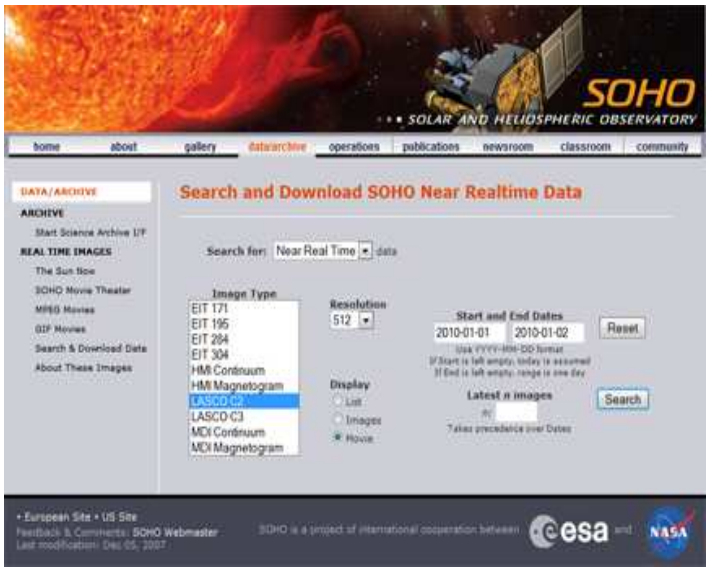
Materials and Equipment Needed by the Students

Access to computer connected to the internet. Photo manipulating software that will allow students to make videos from a series of .jpg or .gif images. Microsoft Movie Maker (for XP Operating Systems) or Windows Live Move Maker (for Vista or Windows & Operating Systems) will work well.

Experimental Procedure

Students will be divided up into 12 observation teams. Each team will be assigned a month of data to analysis. The teams will be asked to record all significant observations such as: Solar Eruptions or Coronal Mass Ejections ("CMEs"); Comets, Planets and any other unusual activity in the field of view of the observation instrument onboard the SOHO satellite. For this purpose the **Large Angle and Spectrometric Coronagraph (LASCO C2)** onboard the satellite will be utilized.

How best to use the SOHO tools: There will be a large amount of data to observe. The best way to do this is by recording 2-days of data and using the movie feature Search Tool. The students can quicly review 2-dyays of data looking for interesting events. After seeing the entire movie, they can rerun the movie and stop and step forward or backward to find the start time and finish time of the even. This date range and time should be entered into the Observer's log as well as the type of event. Any unusual observations, questions or other comments should also be entered.



Team project results: At the end of the observation period, each team should create and show the entire class a movie that they made of their significant observations.

As an extra credit students should identify each planet they see. This can be done by going to this website: http://sungrazer.nrl.navy.mil/index.php?p=transits/transits and identifying which planets has transited the LASCO field of view

Classroom results: After all of the teams have presented their observations the teacher should make composite video of the entire year of significant solar events a give each student a copy so that he or she can show their parents and friends their part of a significant astronomy observation project!

SOHO, the **Solar and Heliospheric Observatory**, is a project of international cooperation between ESA and NASA to study the Sun, from its deep core to the outer corona, and the solar wind.

SOHO moves around the Sun in step with the Earth, by slowly orbiting around the First Lagrangian Point (L1), where the combined gravity of the Earth and Sun keep SOHO in an orbit locked to the Earth-Sun line. The L1 point is approximately 1.5 million kilometers away from Earth (about four times the distance of the Moon), in the direction of the Sun. There, SOHO enjoys an uninterrupted view of our daylight star we call the Sun. Onboard SOHO is a payload of 12 complementary instruments of which we will be using the ***Large Angle and Spectrometric Coronograph (LASCO).***

LASCO observes the outer solar atmosphere (corona) from near the solar limb to a distance of 21 million kilometers, that is, about one seventh of the distance between the Sun and the Earth. LASCO blocks direct light from the surface of the Sun with an occulter, creating an artificial eclipse, 24 hours a day, 7 days a week.

What the images are showing

The dominant feature of the LASCO C2 images is the disk in the center of the images. This is the "occulting disk" that blocks out the direct light from the Sun and allows us to see the fainter features in the images.

Radiating out from the occulting disk, you can see the bright "coronal streamers" which are structures formed by the Sun's magnetic field. Sometimes they do not last very long, but some can last for months.

What You May See:

Visible all over the LASCO C2 images are hundreds of tiny white dots and streaks. **Most** of the dots are stars; **most** of the streaks are cosmic rays (noise). Here's how to tell what you are seeing apart:

- **Stars:** In the LASCO images, stars **always** move from left-to-right, **always** horizontally and **always** at the same speed as one another. There are usually between 15 and 40 stars visible at any one time in LASCO-C2. They are very easy to spot if you look at a sequence of three or more images.
- **Cosmic Rays:** Cosmic rays are noise (white dots, blobs and streaks) created in the images by ***energetic particles*** striking the cameras in the telescopes. Cosmic rays get reported as comets more often than real comets do! So it essential to learn how to distinguish them from something that is real. Cosmic rays are completely random -- they can, and do, appear absolutely anywhere in the images and they only appear once. They are most commonly just dots, but they are also occasionally blobs or streaks. Some are very faint, but most are quite bright. Some even saturate the camera and cause the large horizontal spikes we often see on planets and bright stars.

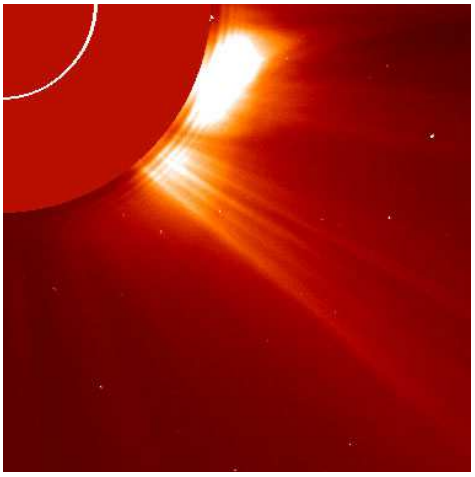
- **Planets:** Planets are easy to tell apart. They always move horizontally, but can go either **left-to-right OR right-to-left**, they are usually much larger and brighter than stars, they move at a different speed to the stars and they nearly always have big, bright "diffraction spikes" cause by saturation of the image in the camera.
- **Coronal Mass Ejections ("CMEs"):** CMEs are enormous bubbles of plasma that blow out from the surface of the Sun. (These CMEs can be very dangerous to both astronauts and satellites, which is one reason why studies of them are so important.)
- **Comets:** Comets are typically small, faint dots moving slowly between images. Most often (over 84% of the time) it will be moving towards the Sun from the lower-half of the images. You need to find something that is **visible in at least five consecutive LASCO images**. It's OK if there is a data gap, as long as the object is still visible after the gap. So what do the comets look like? Well, unfortunately they look a lot like most stars (they maybe faint and barely visible) and may have a tail, and also they may look like some cosmic rays, but there are two major differences:

    1) SOHO comets almost **never** move horizontally like stars

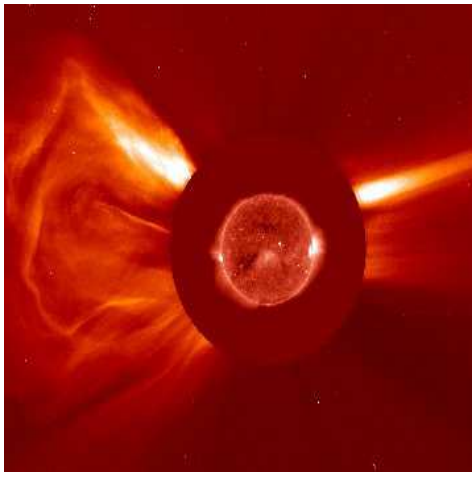
    2) SOHO comets **always** move in a near-perfect straight line with a near-constant speed, size, shape and brightness.

Some past observations:

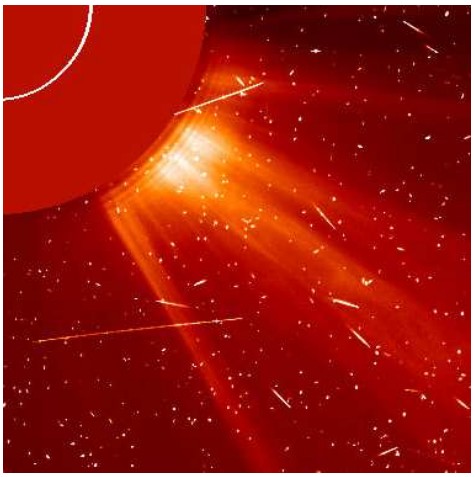
Stars:



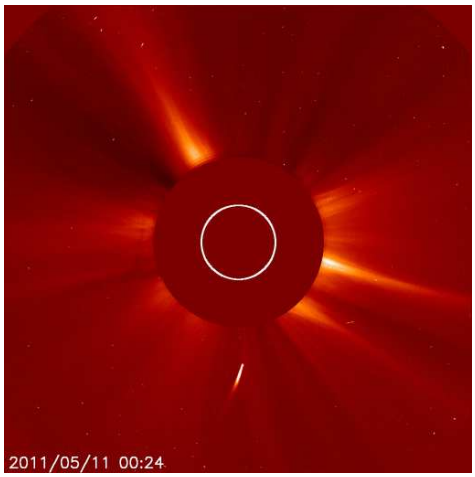
CMEs:



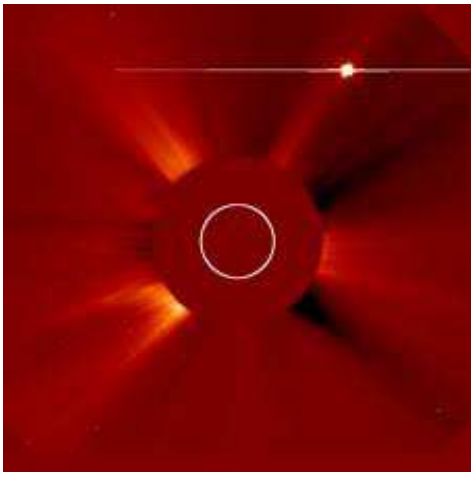
Cosmic Rays and Stars:



Comet:



Planet:



Astronomical Observers Log

Observers Name: _____ Observation Date: _____

Observation Instrument: _____ Target of Observation: _____

Significant Observations:

Type of Event:	Date and Time Range:	Observer's Comments:

Project Lesson Assessment

When this project is completed the students should be able to answer these questions:

1. What Coronal Mass Ejections ("CME")?
2. What happens when a comet wanders to close to the sun?
3. What is the Solar and Heliospheric Observatory (SOHO)?
4. What is LASCO?
5. What are Cosmic Rays?

Assessment Data:

	# at 30%	# at 30 to 70%	# at 70%+
What Coronal Mass Ejections ("CME")?			
What happens when a comet wanders to close to the sun?			
What is the Solar and Heliospheric Observatory (SOHO)?			
What is LASCO?			
What are Cosmic Rays?			

Teacher Assessment Results Summary:

Does this lesson need to be re-taught? _____YES _____NO

What portion of the lesson was most effective and why?

_____

_____

What portion of the lesson was least effective?

_____

_____

What would most improve the learning of that portion of the lesson?

_____

_____

_____

_____

_____

What I will do to re-teach this portion:

_____

_____

_____

When I teach this full lesson next time, I will:

_____

_____

_____

_____