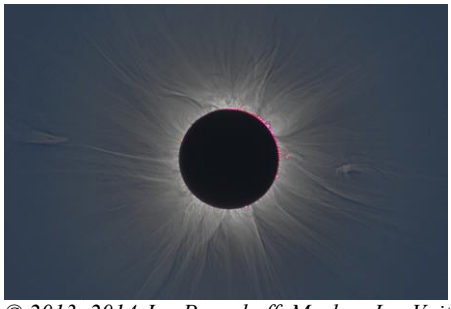
Design your own Solar Cupcakes!

An activity developed by students of Jay Pasachoff at Williams College in Massachusetts: Tina Seeger '16, Muzhou Lu '13, and Adam Schiff '15, produced by Nina Amezcua and Deborah Scherrer, Stanford Solar Center.

This activity could be useful in preparing students to observe the Great American Solar Eclipse of 21 August 2017, whose path of totality crosses the continental United States. All 50 states as well as Canada and Mexico will enjoy at least a partial eclipse. http://GreatAmericanEclipse.com

Also good preparation for the Mercury transit on 9 May 2016.



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Age Range:
5-14

Duration:
45 minutes

Notes
Good activity for informal science events, Scouts/4H groups, afterschool programs, community events.

This activity can also be done with cookies.

Overview:

Participants will explore aspects of the Sun and solar activity by modeling them as solar cupcakes.

Activity Goals:

Participants will:

- Research aspects of the Sun, including solar activity, eclipses, transits, and the like.
- Creatively model what they have learned about the Sun by decorating cupcakes.
- Develop an interest in the Sun and enthusiasm for learning more about it.

Materials:

- Home-made or ready-made cupcakes, at least one for each participant
- Icing for cupcakes. Note that most people believe the Sun is yellow, but it is actually white: http://solar-center.stanford.edu/activities/SunColor/). Choose your colors accordingly.
- Knives for spreading icing.
- An assortment of decorations such as candy corn, sugar sprinkles, chocolate chips (sunspots), strips of licorice (prominences), etc.

Preparation:

1. Provide imagery and resources on the Sun for your participants to explore before they begin decorating their cupcakes. Attached are suggestions.
2. Purchase and/or make enough cupcakes for your participants.
3. Gather your assortment of decoration items and make them readily available to participants
4. Suggest your participants work in teams, collaborating about what they want to represent in their models

Lesson Plan:

1. Prompt a discussion on the Sun's appearance from Earth and its "movement" across the sky.
2. Explain the Sun's placement in the Solar System relative to its planets and provide images of the Sun's appearance from space. Talk about how certain objects including the Moon, Venus, and Mercury can pass between the Earth and the Sun.
3. Discuss the different aspects of the Sun that the students will model in the activity and give examples of each type (samples listed below).
4. Distribute the materials to students and allow them to decorate the cupcakes based on the aspects of the Sun, using the examples on this plan.
5. After the cupcakes are decorated, but before they are eaten, have each participant explain the features of their Sun.

Going Farther:

Sun Cookies:

http://lawrencehallofscience.org/static/diy_sun_science/downloads/diy_ss_sun_cookies.pdf

How to Bake Scientifically Accurate Cake Planets:

http://solar-center.stanford.edu/activities/cakeplanets.pdf

Resources:

Stanford Solar Center: http://solar-center.stanford.edu/
For educators: http://solar-center.stanford.edu/teachers/
For students: http://solar-center.stanford.edu/activities/

Colors and Motions of the Sun: https://www.youtube.com/watch?v=ym3WOA2GzFI

Great American Eclipse: http://GreatAmericanEclipse.com
http://eclipse.gsfc.nasa.gov/SEgoogle/SEgoogle2001/SE2017Aug21Tgoogle.html

Mercury Transit: http://eclipse.gsfc.nasa.gov/transit/catalog/MercuryCatalog.html

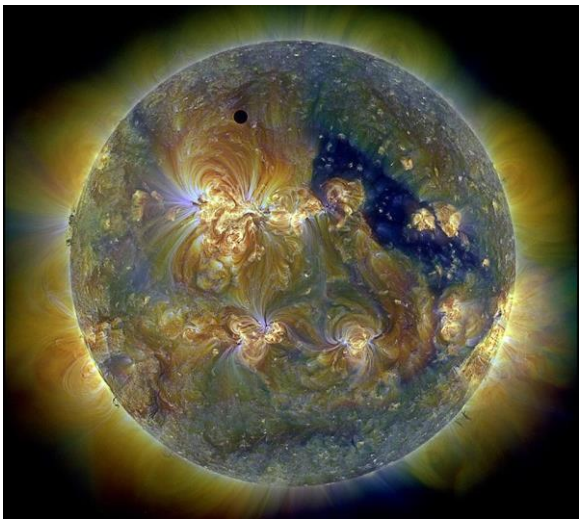
NASA Wavelength: http://nasawavelength.org

NASA's Solar Dynamics Observatory Mission: http://sdo.gsfc.nasa.gov/

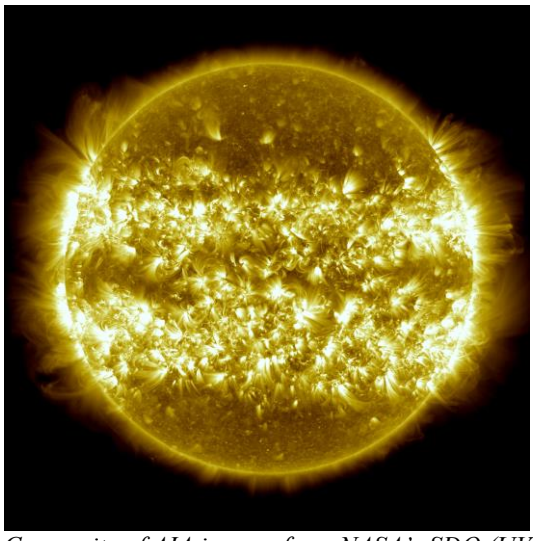
ESA/NASA's Solar & Heliospheric Observatory: http://sohowww.nascom.nasa.gov

NASA's STEREO Mission: http://stereo.gsfc.nasa.gov/

Sun Overviews: http://solarsystem.nasa.gov/planets/profile.cfm?Object=Sun
http://science.nationalgeographic.com/science/space/solar-system/sun-article/
http://www.bbc.co.uk/science/space/solarsystem/sun_and_planets/sun



Venus Transit of the Sun
Image from NASA's SDO – shown in ultraviolet light & artificially colored



Composite of AIA images from NASA's SDO (UV light with artificial colors)

Modeling the Sun as Cupcakes

Sun at Noon and Sun at Sunset

What color do you think the Sun is? In the top photo is the Sun at noon, in the lower the Sun at sunset. Turns out, the Sun is white. But it looks yellow or orange at sunset because the Earth's atmosphere bounces away all the colors but red-yellow-orange.

http://solar-center.stanford.edu/activities/SunColor/

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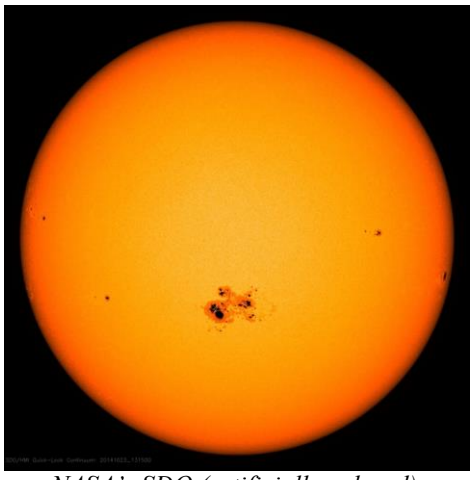
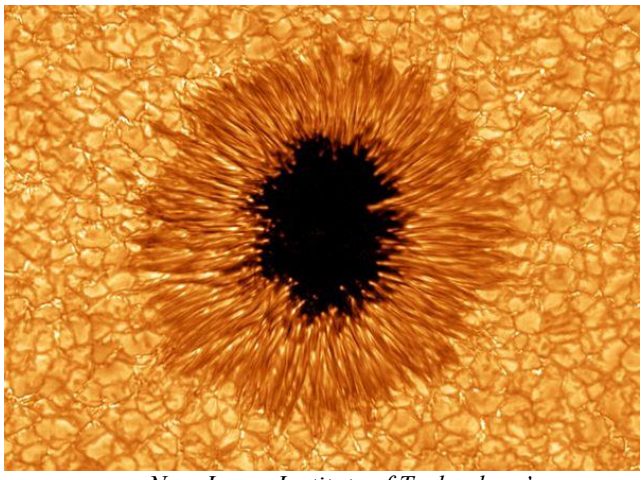
Sunspots

Sunspots are areas of the Sun that appear as "spots" on its surface that are darker than the surrounding area. They are dark because they are cooler than the average surface temperature (though still very hot!). Sunspots are caused by immense magnetic storms at the Sun's surface. Their size ranges from 16 km to 160000 km, and they travel at

hundreds of meters per second. The number of sunspots varies on an 11-year cycle, going from few sunspots to lots of sunspots then back again.

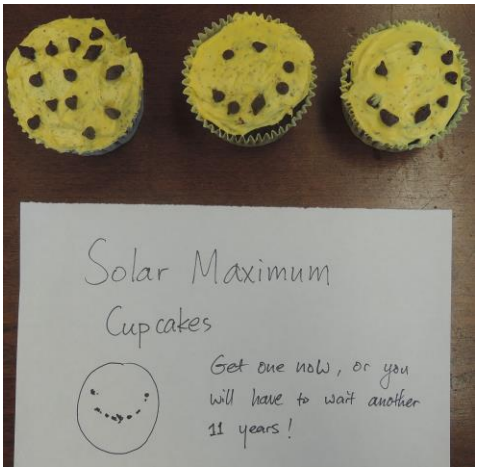


NASA's SDO (artificially colored)



New Jersey Institute of Technology's New Solar Telescope (artificially colored)

Solar Minimum

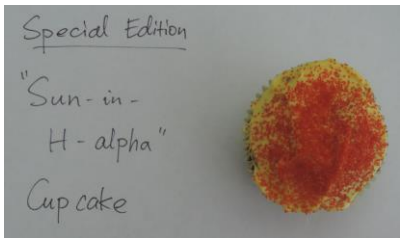


Solar Maximum

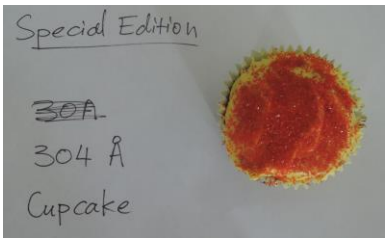
Sun through filters

Looking at the Sun through a telescope without proper filters can DESTROY your eyes! So astronomers use special solar filters to darken the Sun by a factor of 100,000 to a million times, to make it safe to observe. These filters often pass slightly more red or orange light than other colors, while still observing almost all the light, so you see a lot of pictures of the Sun that look red and orange. During the seconds or minutes of totality at a total solar eclipse, when only the corona is visible, the corona's brightness is the same as that of the full moon and is equally safe to look at. But before or after that totality, or off to the side, special solar filters are needed.

Sun in H-alpha (red) filter



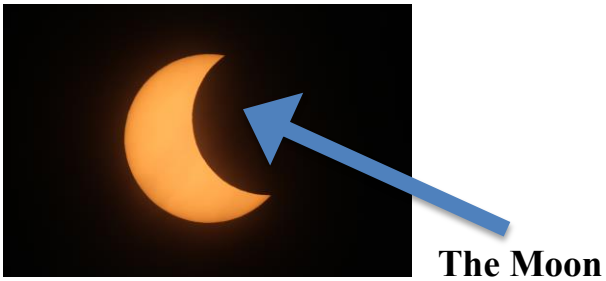
Sun in H-alpha (red) filter



Sun in 304 angstroms (red)
Artificially colored

Solar Eclipses

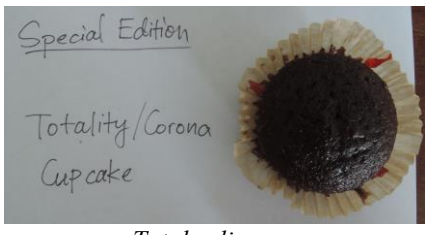
A solar eclipse occurs when the Moon passes between the Earth and the Sun, blocking out part of or the entire Sun for a short amount of time. Since the Moon's orbit is at an angle to the Earth, these events are rare and separated into categories: **Total Eclipse:** The Moon completely obscures the Sun, showing its glorious corona (atmosphere) and part of the Earth becomes dark from the Moon's shadow. **Partial Eclipse:** The Moon partially obscures the Sun, and the Sun appears as a crescent. **Annular Eclipse:** The Moon is at a distance at which it cannot cover the Sun completely (i.e. it appears smaller in the sky) and covers the center of the Sun, creating an "annulus" or ring.



Partial solar eclipse (filtered)

Total solar eclipse, NASA

These photos show the Sun as yellow because a special colored filter was used.



Total eclipse

Annular eclipse

Partial eclipse

Eclipse sequence

Annular eclipse

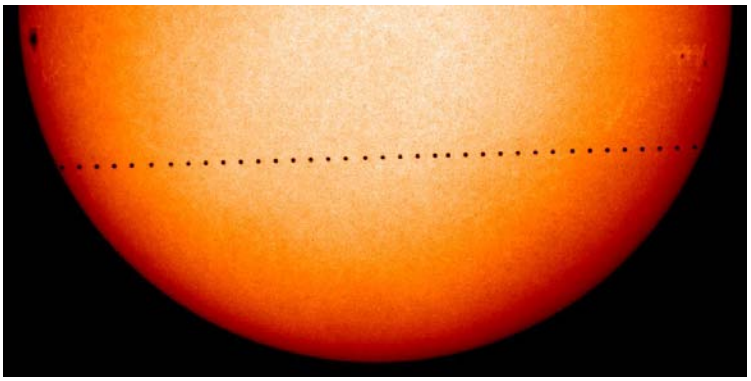
Solar Transits

A transit occurs when another planet (Mercury or Venus) passes between the Sun and the Earth, allowing us to see the silhouette of the planet against our view of the Sun.

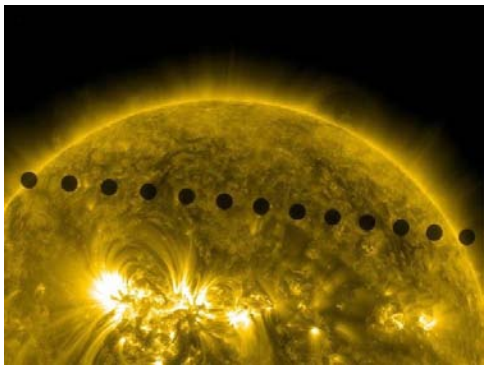
Mercury Transit: Mercury transits are more common than Venus Transits, and they occur around 13 to 14 times a century. The next transit of Mercury will be on 9 May 2016.

Venus Transit： The Venus transits occur in pairs, every 105.5 and 121.5 years, because the angle of its orbit compared to Earth's means that it rarely passes directly between the Sun and the Earth. The next Venus transit will be in December 2117.

Transits will appear to cross the Sun at slightly different places when you view them from different parts of the Earth! And the path of Venus across the Sun is different at each transit.

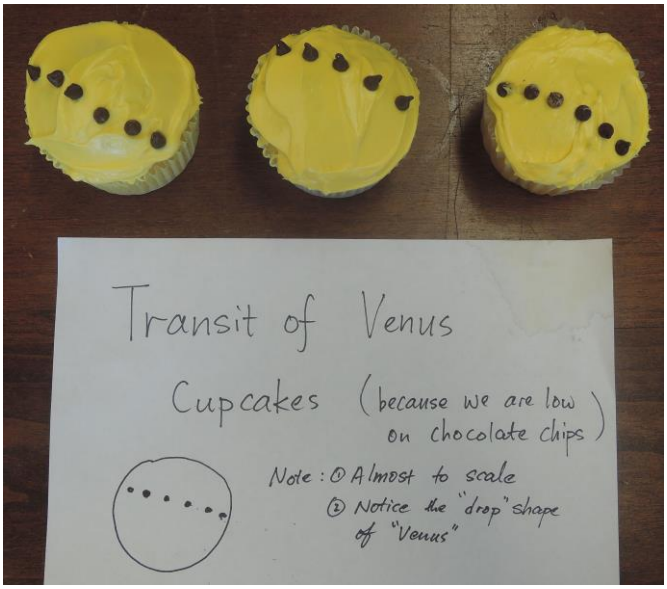


Mercury Transit, 8 Nov 2006



Venus Transit, 5-6 June 2012

Transit of Mercury, 9 May 2016 as viewed from from Berlin (top), San Francisco (middle), and New Delhi (bottom)



Transit of Venus

Solar Flares

A solar flare is a sudden huge explosion of energy on the Sun, caused by magnetic fields tangling, twisting, breaking, then quickly reconnecting. The flares send out dangerous X-rays into space. The image below shows the Sun in ultraviolet light, which our eyes cannot see. So scientists colored the image yellow to highlight details.

Solar Flare

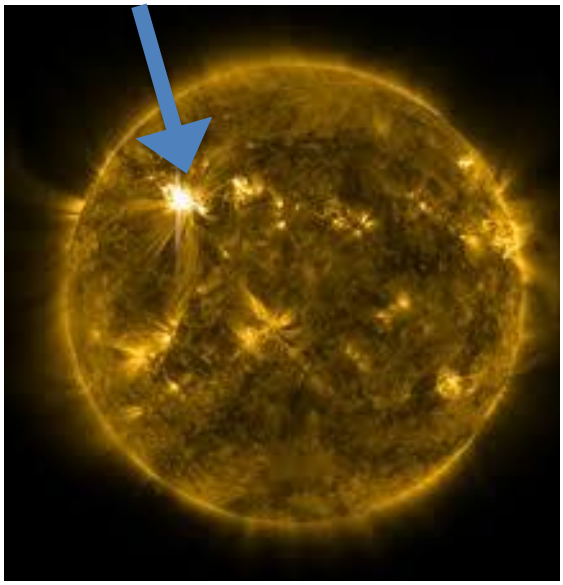


Image from NASA's SDO

Solar Prominences

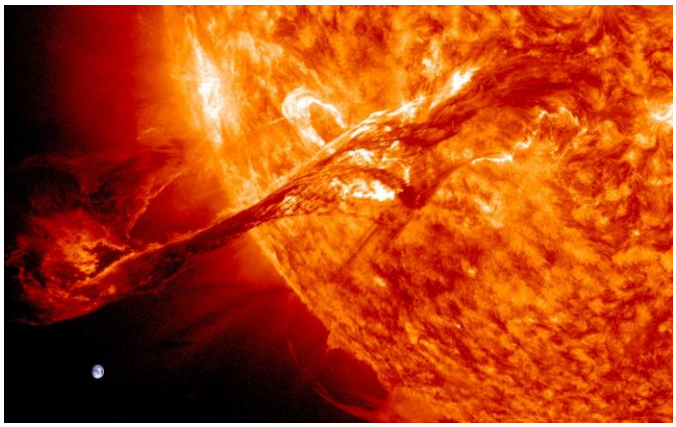


Image from NASA's SDO (Earth added to show scale)

A prominence is a huge loop of gas extending outward from the Sun's surface. Prominences are plasma (gas with electrons stripped from their atoms) trapped in magnetic fields on the Sun. They can last between several weeks and months. A typical solar prominence is thousands of kilometers long, and the largest ever recorded was over 800,000 kilometers. Sometimes prominences erupt and send plasma into space. (Again, the images are in ultraviolet light artificially colored.)

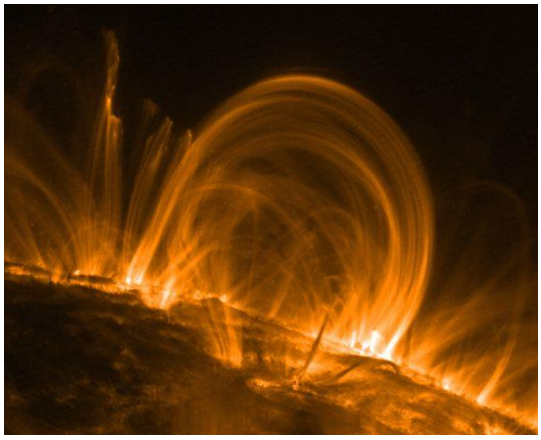


Image from NASA's TRACE Mission

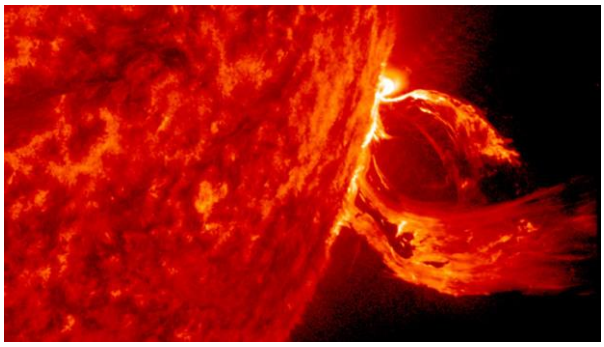
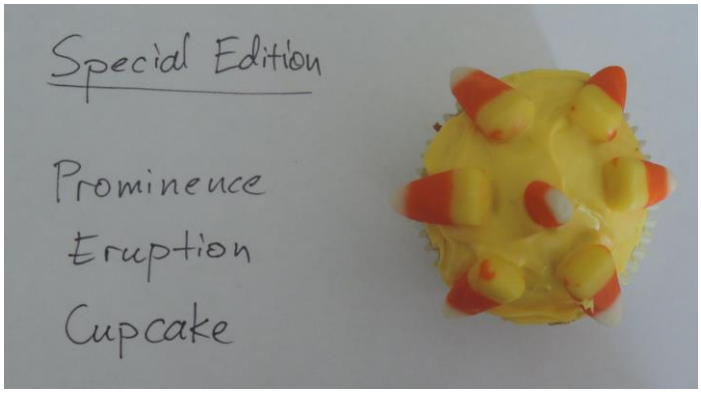


Image from NASA's SDO Mission

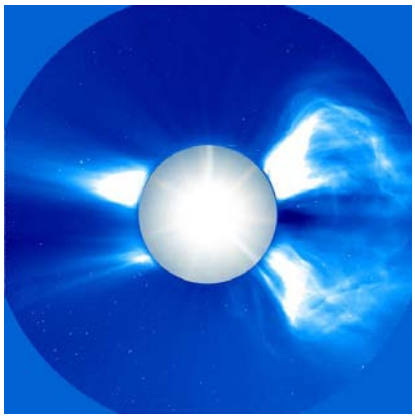
Solar Prominence Cupcake



Prominence Eruption Cupcake

Coronal Mass Ejections (CMEs)

A Coronal Mass Ejection (CME) is a massive burst of gas and magnetic fields arising from the Sun's corona (atmosphere) and going off into space. Sometimes they can impact the Earth and cause problems with its magnetic fields.



< Coronal Mass Ejection (from SOHO)

Coronal "Messy" Ejection >

Now, design your own solar cupcake!

Exhibiting safe solar flare viewing