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Blind Love



Love is blind! Engraving from Harper's Weekly magazine (April 28, 1883) shows a woman viewing the transit of Venus through a telescope. Doing so with no solar filter would result in instant eye damage and likely blindness. Do not let June 5, 2012, be your blind date--use proper observing equipment and common sense.

Color image at <http://www.nmm.ac.uk/rog/Transit%20of%20>

2012 June 5-6 Eye Safety

Safe Viewing Techniques

To observe the transit of Venus directly you must protect your eyes at all times with proper solar filters. However, do not let the requisite warnings scare you away from witnessing this rare spectacle. You *can* experience the transit of Venus safely, *provided you use proper eye protection*. A variety of solar viewing devices available for purchase are listed at the [Store](#) page, or you can [build a Sun Funnel](#) for your telescope.

See <http://youtu.be/4RGr9FcBrSM> video or read [Viewing the Transit & Eye Safety at june2012/eye-safety/280-viewing-the-transit-eye-safety](#) for definitive advice on viewing the sun safely; by B. Ralph Chou, MSc, OD.

Six Ways to See the Transit of Venus

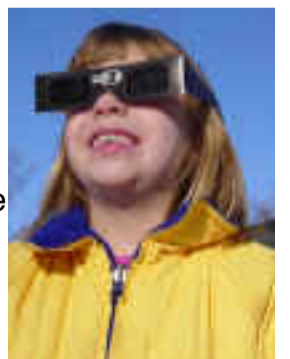


See [Viewing the Transit & Eye Safety](#) by B. Ralph Chou, MSc, OD, for definitive advice on viewing the sun safely. Below are six suggestions for observing the sun and the transit of Venus. Or watch the best video on the subject: <http://youtu.be/4RGr9FcBrSM>.

1 As suggested in the [safety guidelines](#) above, the use of **eclipse shades** or of **#14 shade welding glass** will permit a large number of people who do not have specialized equipment to observe this event. However, as the planet approaches the limb of the sun, subtleties like the "black drop" effect will not be discernible. At one minute of arc in size, Venus is near the visual limit of most people's eyes. It's tiny compared to the sun, which is about 32 arcminutes in diameter.
YES!



Eclipse Shades or Solar Shades appear similar to sunglasses, but they have a special filter that permits safe viewing if the filter is in new condition. Eclipse/solar shades are available through Rainbow Symphony and other retailers listed at <http://www.mreclipse.com/Totality/TotalityApC.html> under "Solar Filters." Before looking at the sun, inspect the material to make sure the lenses are not scratched or compromised in any way. If so, discard the shades.



NO!



Do not be lulled into thinking that you can look safely at the sun while wearing sunglasses, for sunglasses do not protect your eyes sufficiently. So don't try it!
Image courtesy of Sarah.



Do not try to view the sun directly with the naked eye or through any questionable medium. These children, depicted on the April 28, 1883, cover of Harper's Weekly, are at risk of serious eye injury. They are using smoked glass, which is not sufficient.

2 Pinhole projectors are a safe, indirect viewing technique for observing an image of the sun. While popular for viewing solar eclipses, pinhole projectors suffer from the same shortcomings as unmagnified views when Venus approaches the edges of the sun. Small features like the 'black drop' effect will not be discernible.

Unattended Equipment Hazards

Always be aware of the power of the sun. Yes, it obviously can fry your eyes without your knowing it, for your eyeball has no pain receptors within. But there are other burn hazards. Keith Johnson of the Fleischmann Planetarium shares this story:

"Just to underscore the necessity of keeping constant watch on your telescope while it's pointed at the Sun... I was running a basic astronomy class lab in Tucson while I was in grad school one day, and we were observing the Sun with a white-light filter. I had placed a film container over the finder as usual. But apparently not firmly enough: it fell off at one point, and I didn't notice it.

One undergrad had come in her pajamas and bathrobe, believe it or not (it was an early-morning class). While she was peering intently through the main eyepiece, I noticed some smoke starting to come from the shoulder of her bathrobe. Sure enough, the finder had set her robe on fire! or at least smoldering..."

Safety Notice

Viewing the sun without proper equipment and/or techniques can result in serious eye injury and blindness. The solar observing descriptions and comments listed in this website are not an endorsement of any particular technique or product. Observers are responsible for their own eye safety. This website accepts no responsibility for the conduct of others in viewing the sun. For definitive advise on observing the sun, see *Viewing the Transit & Eye Safety*, by Dr. B. Ralph Chou, at <http://www.transitofvenus.org/june2012/eye-safety/280-viewing-the-transit-eye-safety>.

"It is never safe to look at the sun without proper eye protection. No filter should be used with an optical device (e.g. binoculars, telescope, camera) unless that filter has been specifically designed for that purpose and is mounted at the front end (i.e., end towards the Sun). Unsafe filters include all color film, black-and-white film that contains no silver, photographic negatives with images on them (x-rays and snapshots), smoked glass, sunglasses (single or multiple pairs), photographic neutral density filters and polarizing filters, computer disk media. Most of these transmit high levels of invisible infrared radiation which can cause a thermal retinal burn. The fact that the Sun appears dim, or that you feel no discomfort when looking at the Sun through the filter, is no guarantee that your eyes are safe. A person with eye damage from improper viewing may not notice the damage until hours later."

<http://www.leaderdog.org/>

For observers who refuse to view the sun safely--Leader Dogs for the Blind in Rochester, Michigan.

Dr. Hugh Hunt demonstrates a successful pinhole projection (right) of the 2004 transit of Venus at <http://www2.eng.cam.ac.uk/~hemh/transit.htm>. Additional instructions for pinhole projectors are at <http://www.exploratorium.edu/eclipse/how.html>; from the Exploratorium.



3 You may **project a magnified view** of the sun through a reflector telescope or binoculars onto a white surface, which conveniently allows a larger number of people to watch concurrently. See http://casa.colorado.edu/~dduncan/wp/?page_id=261 for video instructions for projecting the sun, by Dr. Doug Duncan.



The projection technique sometimes has its own limitations. Because magnified projections usually have an exposed focal point beyond the eyepiece, a bystander can inadvertently put her eye or body in the sight line of the sun. Hence, a projecting telescope must not be left unattended. (See Unattended Equipment Hazards, left column.) Large reflector telescopes can generate too much heat by concentrating a lot of the sun's energy on the secondary mirror and eyepiece, so the incoming light must be attenuated first. "Stop down" the aperture. Likewise, SCT or Schmidt-Cassegrain telescopes can experience too much heat build-up as the light bounces internally.



Hubert van Hecke provides the [design and instructions for making his sunspotter](#). Additional pages at his Ask Mr. Science web page indicate [how to take sunspot data and analyze them](#).



The Exploratorium demonstrates how to view a planet in transit safely by [projecting the image of the sun with binoculars](#). Important: Do not look at the sun through binoculars without solar filters on the large ends of both the barrels. Do not leave this rig unattended.

4 A method for allowing a large crowd to witness the transit of Venus concurrently is to project a magnified image through a closed-loop device.

A popular projection device used during the 2004 transit of Venus was the now-improved Sun Funnel. Made from simple materials (a plastic funnel, a clamp, an eyepiece, and some projection fabric), the device fits in your telescope like an eyepiece with an appendage. A clear image of Venus transiting the sun appears on the screen. Because the entire light path is enclosed, observers are not at risk. A larger version of the screen uses a bucket to yield a larger image. Download [simple instructions and supplies list](#) written by AAS Press Officer Richard Tresch Fienberg.



Bruce Hegerberg's design for a Sun Gun is online at www.sunguntelescope.com.

Another viewing tool is Gene Zajac's modified version of a Sun Gun (see 1999 GLPA Proceedings). The device safely allows a crowd of spectators to view a large projection of the sun, the transiting planet, and sunspots.



TIP: To avoid excessive heat build-up on your eyepiece, do not aim the telescope continuously at the sun for an extended time. For large scopes, stop down or attenuate the incoming light, for the telescope's purpose is to magnify the image of the sun, not to gather a lot of sunlight.



The **Sunspotter** is commercially available from Science First. It provides a surface on which you can safely trace the sun's outline and sunspots onto a piece of paper.

The Venuscope and solar shades are commercially available from SODAP-SOBOMEX- Department Sky & Space.

<http://www.solarscope.com/>

A Solarscope is commercially available from [Light Tec Optical Instruments]

The transit of Venus is perhaps best when **viewed directly when magnified**, which demands an *appropriate solar filter* over the large end of the telescope. Often made of glass or Mylar, these "white light" filters block about 99.99% of the incoming sunlight, which allows the eyepiece then to magnify the image. A filtered, magnified view will show the sun (either blue or orange), the planet Venus, the "black drop" effect, and sunspots. See [Solar Filters](#) or http://skyandtelescope.com/observing/objects/sun/article_101_1.asp for a list of retailers.



Note #1: The sun's immense energy must be drastically reduced *before* it enters the telescope. Do not use small filters that fit over the eyepiece (as found in some older, cheaper telescopes), for the concentrated sunlight can shatter them.

Note #2: Remove unfiltered finder scopes so they are not inadvertently accessed. Do not rely on a lens cap--even if it is taped on--to keep the eyes of a prying person at bay. (See Unattended Equipment Hazards in left column.)



Special telescopes with built-in hydrogen-alpha filters show additional solar features, such as the sun's surface granulation and prominences extending outward into space. Though more expensive than traditional telescopes, they offer wonderful views of the magnified sun not seen by astronomers in previous centuries.

6 Transit not visible from your location, or clouds interfering? Watch the [live webcast](#) from atop Mauna Kea in Hawaii, with expert commentary brought to you by the fun team at NASA EDGE. Don't miss the 2012 transit of Venus!

Viewing the Transit & Eye Safety



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B. Ralph Chou, MSc, OD

Associate Professor, School of Optometry, University of Waterloo

[See also <http://youtu.be/4RGr9FcBrSM> for talk at 2012 Symposium at University of Toronto.]

Watching the profile of Venus as it passes across the Sun during a transit is a wonderful demonstration of the way the solar system works. Over the course of several hours, Venus traces a path across the disk of the Sun, then leaves, in what can be thought of as an extreme example of an annular eclipse of the Sun.



Observing the Sun, however, can be dangerous if the proper precautions are not taken. The solar radiation that reaches the surface of Earth ranges from ultraviolet (UV) radiation at wavelengths longer than 290 nm, to radio waves in the metre range. The tissues in the eye transmit a substantial part of the radiation between 380–400 nm to the light-sensitive retina at the back of the eye. While environmental exposure to UV radiation is known to contribute to the accelerated aging of the outer layers of the eye and the development of cataracts, the primary concern over improper viewing of the Sun during the transit is the development of "solar retinopathy" or retinal burns.



Exposure of the retina to intense visible light causes damage to its light-sensitive rod and cone cells. The light triggers a series of complex chemical reactions within the cells which damages their ability to respond to a visual stimulus, and in extreme cases, can destroy them. The result is a loss of visual function, which may be either temporary or permanent depending on the severity of the damage.

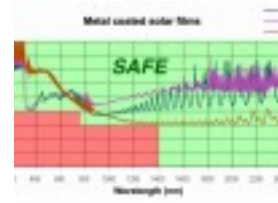
When a person looks repeatedly, or for a long time, at the Sun without proper eye protection, this photochemical retinal damage may be accompanied by a thermal injury—the high level of visible and near-infrared radiation causes heating that literally cooks the exposed tissue. This thermal injury or photocoagulation destroys the rods and cones, creating a small blind area. The danger to vision is significant because photic retinal injuries occur without any feeling of pain (the retina has no pain receptors), and the visual effects do not become apparent for at least several hours after the damage is done (Pitts 1993). Viewing the Sun through binoculars, a telescope, or other optical devices without proper protective filters can result in immediate thermal retinal injury because of the high irradiance level in the magnified image.

Because the apparent diameter of Venus is only 1/30 that of the Sun, there is never a time during the transit when it is safe to look at it without proper eye protection. Failure to use proper observing methods may result in permanent eye damage and severe visual loss. This can have important adverse effects on career choices and earning potential, because it has been shown that most individuals who sustain solar retinopathy eye injuries are children and young adults (Penner and McNair 1966, Chou and Krailo 1981, and Michaelides et al. 2001).

The same techniques for observing the Sun outside of eclipses are used to view and photograph the transit (Sherrod 1981, Pasachoff 2000, Pasachoff and Covington 1993, and Reynolds and Sweetsir 1995). The safest and most inexpensive method is by projection. A pinhole or small opening is used to form an image of the Sun on a screen placed about a metre behind the opening. Binoculars or a small telescope mounted on a tripod can also be used to project a magnified image of the Sun onto a white card. All of these methods can be used to provide a safe view of the transit to a group of observers, but care must be taken to ensure that no one looks through the device. The main advantage of the projection methods is that nobody is



looking directly at the Sun. The disadvantage of the pinhole method is that the screen must be placed at least a metre behind the opening to get a solar image with a silhouetted disk of Venus that is large enough to be easily seen.



The Sun can only be viewed directly when filters specially designed to protect the eyes are used. Most of these filters have a thin layer of chromium alloy or aluminum deposited on their surfaces that attenuates both visible and near-infrared radiation. A safe solar filter should transmit less than 0.003% (density ~ 4.5) of visible light and no more than 0.5% (density ~ 2.3) of the near-infrared radiation from 780–1400 nm. (In addition to the term transmittance [in percent], the energy transmission of a filter can also be described by the term density [unitless] where density, d , is the common logarithm of the reciprocal of transmittance, t , or $d = \log_{10}[1/t]$. A density of '0' corresponds to a transmittance of 100%; a density of '1' corresponds to a transmittance of 10%; a density of '2' corresponds to a transmittance of 1%, etc.). **Figure 1** shows transmittance curves for a selection of safe solar filters (Chou 1981, 1998). The "safe" zones of the plot are transmittance levels less than 0.0001 between 200 and 780 nm (above the 1E-04 line in the graph) and transmittance levels less than 0.001 between 780 and 1400 nm (above the 1E-03 line in the graph). The longer infrared between 1400 and 2500 nm does not get past the tears and front of the eyeball, so is not a problem.

[Read more: Viewing the Transit & Eye Safety](#)

Eye Safety Warning



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Chuck

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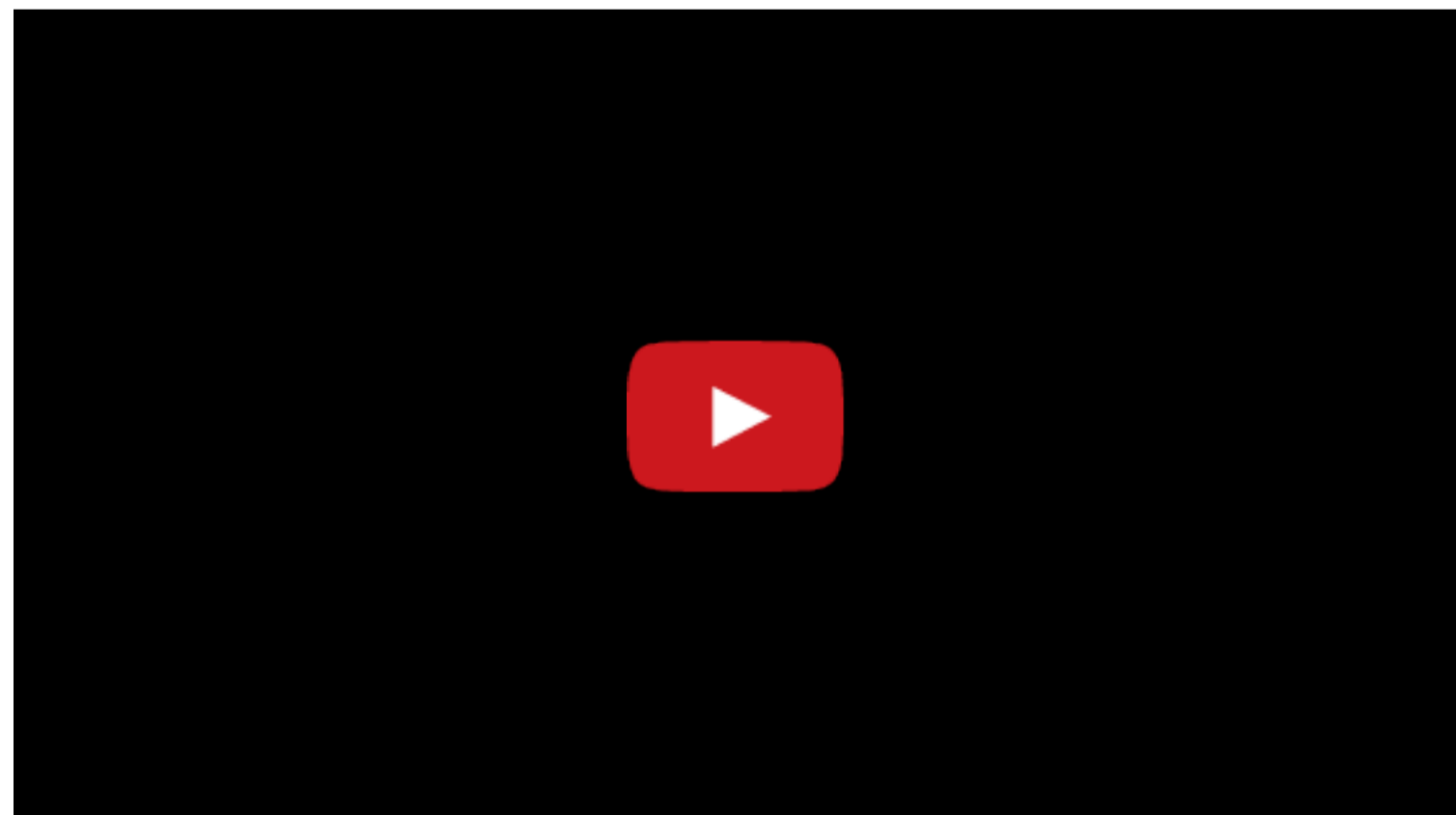
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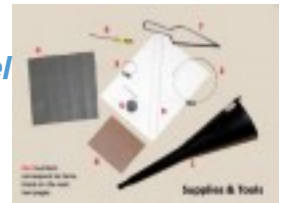
Build a Sun Funnel for Group Viewing with a Telescope





One of the best ways for a group of people to view the magnified sun safely is to use a rear screen projection that is enclosed. Because no one is exposed to the intense light path, a Sun Funnel allows a crowd of people to see concurrently the transit of Venus, sunspots, or eclipses.

After leading a hands-on workshop to make the inexpensive devices, AAS Education & Outreach Coordinator Richard Tresch Fienberg wrote and illustrated [Build a Sun Funnel for Group Viewing of Sunspots and the Transit of Venus](#) (updated April 2013). The how-to manual gives clear, step-by-step assembly instructions and sources for inexpensive materials.



See [Eye Safety](#) for more techniques and advice for viewing the sun safely.

[SPANISH VERSION](#); courtesy of Manuel Alvarez, Instituto de Astronomia Sede Ensenada B.C.

Note: Da-Lite screen can be purchased from <http://www.bigscreencenter.com/Venus-Transit-Sun-Funnels/4476.htm>.

Spanish Version of Sun Funnel: El Embudo Solar



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Chuck

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A Spanish version of the instructions for building a Sun Funnel now accompanies the [English version](#) (April 2013). Thanks go to Manuel Alvarez of [Instituto de Astronomia Sede Ensenada B.C.](#) for translating the original text and dividing it into two parts:

- [Construcción de un Embudo Solar para observar manchas solares y el Tránsito de Venus](#)
- [Embudo Solar para observar manchas solares y el Tránsito de Venus](#)

Alvarez writes, "We are planning to observe the Transit of Venus at the same place that Joaquín Velásquez de León and Abad Chappe d'Aueroche observed the transit on June 3rd. 1769; (243 years ago); (i.e. "Visita de Santa Ana", near La Paz in Baja California Sur (Velasquez) and "Misión de San José del Cabo", Baja California Sur), (Chappe). At the same time, we are considering building some Sun-Funnels for people to observe the Sun and the Transit."

Galileoscope Solar Filter



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Chuck



Are you one of the 200,000+ people who has a Galileoscope that was developed for the 2009 International Year of Astronomy? If so, you can put your Galileoscope into service during the 2012 transit of Venus if you use one of two techniques for viewing the sun safely. Nothing in the sky is easier to find with a telescope than the sun.

First, you may purchase an inexpensive solar filter that fits over the large end of the tube. The large end of the Galileoscope is just under 70mm in diameter, so you want a filter with an outer cell I.D. of 70mm\2.75". A suitable choice is the Solar Filter 70mm Black Polymer from Rainbow Symphony, which can be ordered from <http://www.rainbowsymphonystore.com/solar-filter-70mmblack.html>. As of this writing in mid-March, the \$15.00 filter is on sale for \$10.00. It comes with felt tape to give a snug, custom fit.



[Read more: Galileoscope Solar Filter](#)



One of the most common questions I get about the transit of Venus after a public talk is, "Where can I get some of those solar shades?" For simplicity I have referred people to [Rainbow Symphony](#), which for years has been a reliable purveyor of "eclipse shades" suitable for viewing the sun. Fred Espenak of NASA GSFC provides a more thorough list of [solar filter manufacturers](#).

You may also purchase bulk quantities of [solar shades through Astronomers Without Borders \(AWB\)](#), which has been a strong supporter of 2012 Transit of Venus education outreach. Proceeds from sales of solar shades with AWB branding will benefit the non-profit organization, with the following volume pricing available:

1 - 25 for \$0.95 each
25 - 99 for \$0.85 each
100 - 250 for \$0.75 each
251 - 499 for \$0.60 each
500 - 999 for \$0.50 each
1000+ for \$0.45 each

More Articles...

 [Must-See TV \(Transit Venus\) Screen](#)

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