



Understanding and Observing



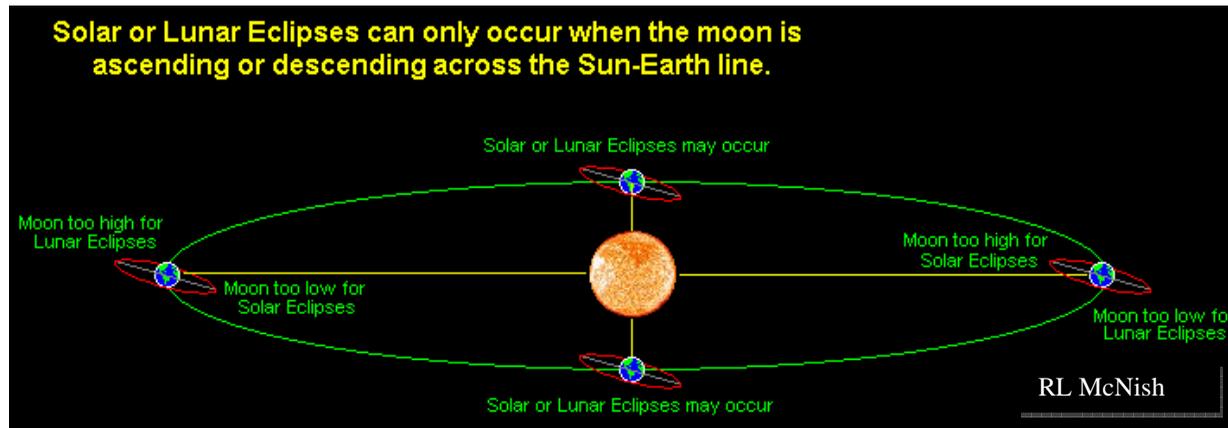
Solar Eclipses

www.rasc.ca

A solar eclipse is a tightly-scripted alignment between the motions of the Earth and Moon as the pair orbit around the Sun. Total solar eclipses are beautiful events, and can be simply enjoyed for their own sake, or, whether with the unaided eye, binoculars, or a telescope, are opportunities to do some basic science.

Partial solar eclipses are more common and partial eclipses also accompany total eclipses in a wide swath outside the path of totality.

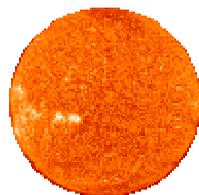
However, as with all observations of the Sun, precautions for eye safety **MUST** be followed; these are described later in this document.



Earthly and Lunar Motions

Since the Moon's orbital plane is at an angle to the Earth's orbit, most of the time the three bodies do not lie in one line, even when the Moon is New or Full. Typically, a Full Moon will pass above or below the Earth's shadow as it extends into space and a normal New Moon will pass, sight unseen, just above or below the solar disk. When these lunar phases take place while the Moon is near or at the points in its orbit where its orbital plane intersects the plane of the Earth's orbit around the Sun, then things can get quite interesting. These orbital paths intersect twice a year, and thus there is a chance for eclipses, both lunar and solar, provided the Moon is in the correct phase at the time (full for lunar and New for solar). The key factor for eclipses is that the three bodies, Sun, Moon and Earth (and you!) are in a straight line.

At Full Moon, the Moon will pass into the Earth's



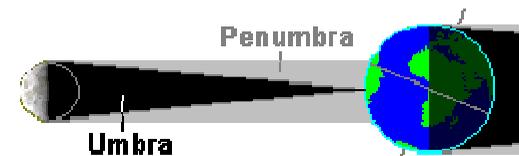
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shadow and a partial or total penumbral or umbral eclipse will occur (see the Royal Astronomical Society of Canada's companion brochure, *Understanding and Observing Lunar Eclipses* for more info).

Solar Eclipses

Unlike lunar eclipses, which are visible at exactly the same moment all across the night time side of Earth, solar eclipses sweep across the Earth, meaning each locality will see a different view occurring at disparate times and some regions will not see the Sun get eclipsed at all.

Because the Sun is not a point source, shadows cast in sunlight do not have sharp edges. The Moon's shadow thus consists of two parts: the dark central part, where the Sun's light is completely blocked, called the umbra (about 0 to about 800 km across); and the outer lighter part where only part of the Sun's light is obscured,



called the penumbra (which can span as much as one third of the globe). These correspond on the Earth to regions of partial eclipses (Moon's penumbra) and total eclipses (Moon's umbra).

Partial Eclipses

Although not every partial eclipse lead to a total eclipse, every total eclipse has partial phases.

First contact is when the limb of the Moon and that of the Sun first touch – it is the start of the eclipse. *Fourth contact* occurs when the Moon's disk leaves the solar disk.



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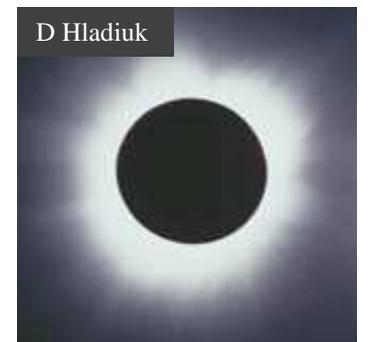
Total Eclipses

Only during the few seconds or minutes of totality is it safe to view the Sun without filters.

At *second contact*, the moon completes its journey onto the solar disk – this is the start of a total solar eclipse.

It is at this time that the tenuous outer corona reveals its gossamer appearance.

Third contact represents the end of totality. Since the bright photosphere of the Sun reemerges from behind the Moon at this time, **IT IS CRITICAL TO KNOW IN ADVANCE WHEN THIS OCCURS**, so as to replace filters.



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Safely Observing the Sun and Solar Eclipses

The Sun is an energetic incandescent ball of plasma powered by the fusion of hydrogen to helium in its core. Even at the Earth's great distance from the Sun (150,000,000 km), the energy emitted from the Sun has the potential to do great harm if proper precautions are not followed.

Damage to the retina of the eye occurs because of

the intensity, in visible, infrared and ultraviolet wavelengths of each part of the solar surface. Normally, the body's natural glare response to bright light causes us to look away. The eye's glare response is to the total intensity of light from the Sun. However, as the Sun gets progressively covered by the Moon during the onset of eclipse, the total light intensity may drop enough to subdue the eye's natural glare response; but the brightness intensity of the visible part of the solar disk is unchanged, meaning eye damage is still possible and perhaps even more likely, given the reduced chance of the natural glare response being triggered.

The following safety guidelines are courtesy of B. Ralph Chou:

*****WARNING! Never look at the Sun with unprotected eyes! Permanent damage, and even blindness, will result. If in doubt, do not use the equipment.*****

Home-made or improvised solar filters, such as smoked glass, exposed film, sunglasses (single or multiple pairs), photographic neutral density filters and polarizing filters or CDs are **NOT SAFE** as these provide no protection against harmful ultraviolet and infrared rays.

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.

Partial Solar Eclipse of 2014 Oct 23

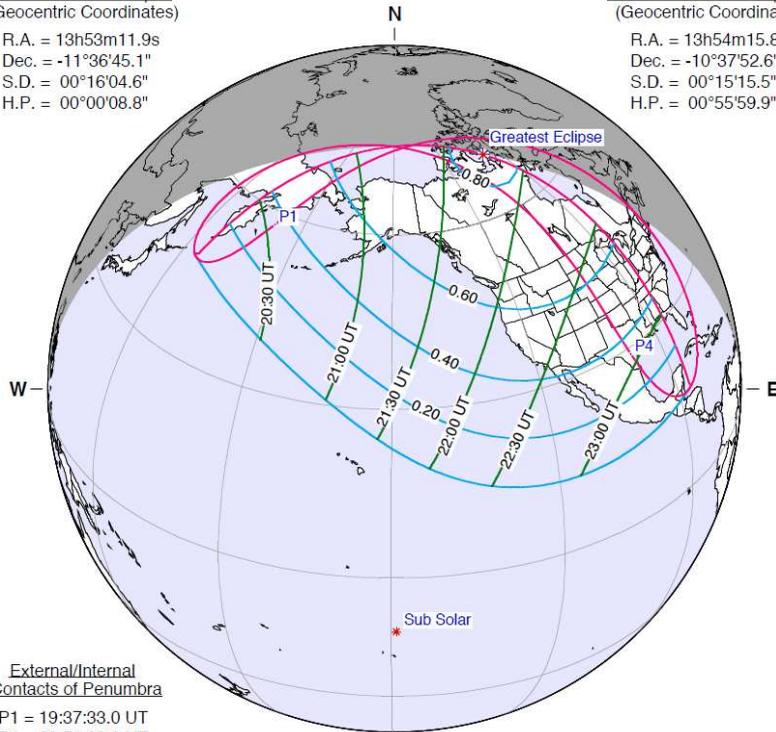
Ecliptic Conjunction = 21:57:46.8 TD (= 21:56:39.5 UT)
 Greatest Eclipse = 21:45:38.7 TD (= 21:44:31.4 UT)
 Eclipse Magnitude = 0.8114 Gamma = 1.0908
 Saros Series = 153 Member = 9 of 70

Sun at Greatest Eclipse
 (Geocentric Coordinates)

R.A. = 13h53m11.9s
 Dec. = -11°36'45.1"
 S.D. = 00°16'04.6"
 H.P. = 00°00'08.8"

Moon at Greatest Eclipse
 (Geocentric Coordinates)

R.A. = 13h54m15.8s
 Dec. = -10°37'52.6"
 S.D. = 00°15'15.5"
 H.P. = 00°55'59.9"



External/Internal
 Contacts of Penumbra

P1 = 19:37:33.0 UT
 P4 = 23:51:39.8 UT

After F Espenak, Royal Astronomical Society of Canada – Observer's Handbook 2014

	Eclipse Begins hh:mm	Maximum Eclipse hh:mm	Eclipse Ends hh:mm
Canada			
Abbotsford, BC	13:33	14:58	16:18
Barrie, ON	17:37	18:20s	— s
Brantford, ON	17:40	18:24s	— s
Calgary, AB	14:43	16:06	17:22
Chicoutimi, QC	17:33	17:38s	— s
Chilliwack, BC	13:34	14:59	16:18
Cornwall, ON	17:39	17:59s	— s
Drummondville, QC	17:38	17:49s	— s
Edmonton, AB	14:41	16:02	17:18
Fort McMurray, AB	14:39	15:59	17:14
Grande Prairie, AB	14:31	15:54	17:11
Guelph, ON	17:39	18:23s	— s
Hamilton, ON	17:40	18:22s	— s
Kamloops, BC	13:34	14:58	16:17
Kelowna, BC	13:37	15:01	16:19
Kingston, ON	17:40	18:07s	— s
Kitchener, ON	17:39	18:24s	— s
Lethbridge, AB	14:47	16:09	17:25
London, ON	17:39	18:28s	— s
Medicine Hat, AB	14:50	16:11	17:26
Montréal, QC	17:38	17:53s	— s
Nanaimo, BC	13:31	14:56	16:16
North Bay, ON	17:33	18:16s	— s
Oshawa, ON	17:39	18:17s	— s
Ottawa, ON	17:37	18:02s	— s
Peterborough, ON	17:38	18:14s	— s
Prince George, BC	13:27	14:51	16:10
Québec, QC	17:37	17:42s	— s
Red Deer, AB	14:42	16:04	17:20
Regina, SK	15:58	17:17	18:29
Saint Catharines, ON	17:40	18:20s	— s
Saint-Jean-sur-Richelieu, QC	17:39	17:53s	— s
Saint-Jérôme, QC	17:38	17:55s	— s
Sarnia, ON	17:38	18:33s	— s
Saskatoon, SK	15:52	17:12	18:25
Sault Sainte Marie, ON	17:29	18:35s	— s
Shawinigan, QC	17:36	17:48s	— s
Sherbrooke, QC	17:39	17:47s	— s
Sudbury, ON	17:31	18:22s	— s
Thunder Bay, ON	17:20	18:31	— s
Toronto, ON	17:39	18:20s	— s
Trois Rivières, QC	17:37	17:48s	— s
Vancouver, BC	13:32	14:57	16:16
Victoria, BC	13:32	14:58	16:17
Whitehorse, YT	13:08	14:28	15:47
Windsor, ON	17:39	18:36s	— s
Winnipeg, MB	16:08	17:24	— s
Yellowknife, NT	14:29	15:48	17:02

of Venus or designated solar eclipse viewers. They are equipped with scratch resistant, double-aluminized mylar that filters out 99.999% of solar radiation, including harmful ultra-violet and infrared rays of the sun.

Before viewing the Sun, always check the condition of your solar viewers. Hold them up to a bright artificial light and look for holes, scratches and other abrasions. If the surfaces are damaged, do not use the glasses to view the Sun. Protect the optical parts of your solar glasses, and store them away from humidity, dust, and sharp objects.

As well, no filter (including solar eclipse viewers) 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).

Find out more

To learn more about the Royal Astronomical Society of Canada, or membership in the Society, contact your local Centre or the Society's National Office:

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 203 - 4920 Dundas St W



A person with eye damage from improper viewing may not notice the damage until hours later.

It is safe to view the October 2014 Solar Eclipse and similar events through Transit