Australian Astronomy

ASA Factsheet No.23

Eclipse of the Sun
14 November 2012

Warning: It is very dangerous to look directly at the Sun, especially through binoculars or telescopes. SERIOUS EYE DAMAGE MAY RESULT. A safe method of indirectly observing the Sun's disc is described below.

It *is* safe – and spectacular – to watch the eclipse during the brief period called **totality**, while the Moon is *completely* covering the Sun – that is the excitement of this event! However, you *must be sure* that you are watching at the correct time and are in totality.

General Information

A total eclipse of the Sun will take place on the morning of Wednesday 14 November 2012. (Important note – overseas publications and websites give the date as a day earlier because that is the case in Universal (Greenwich) Time or in United States time zones.)

Total eclipses of the Sun in a particular area are rare. There has not been a total eclipse seen from mainland Australia since the South Australian eclipse of 4 December 2002. The next total solar eclipse of the Sun to be seen from mainland Australia will just touch the coast of Western Australia on 20 April 2023. Much more impressive, the following total eclipse on 22 July 2028 will cross from the north-west Australia to Sydney and then over Dunedin in New Zealand.

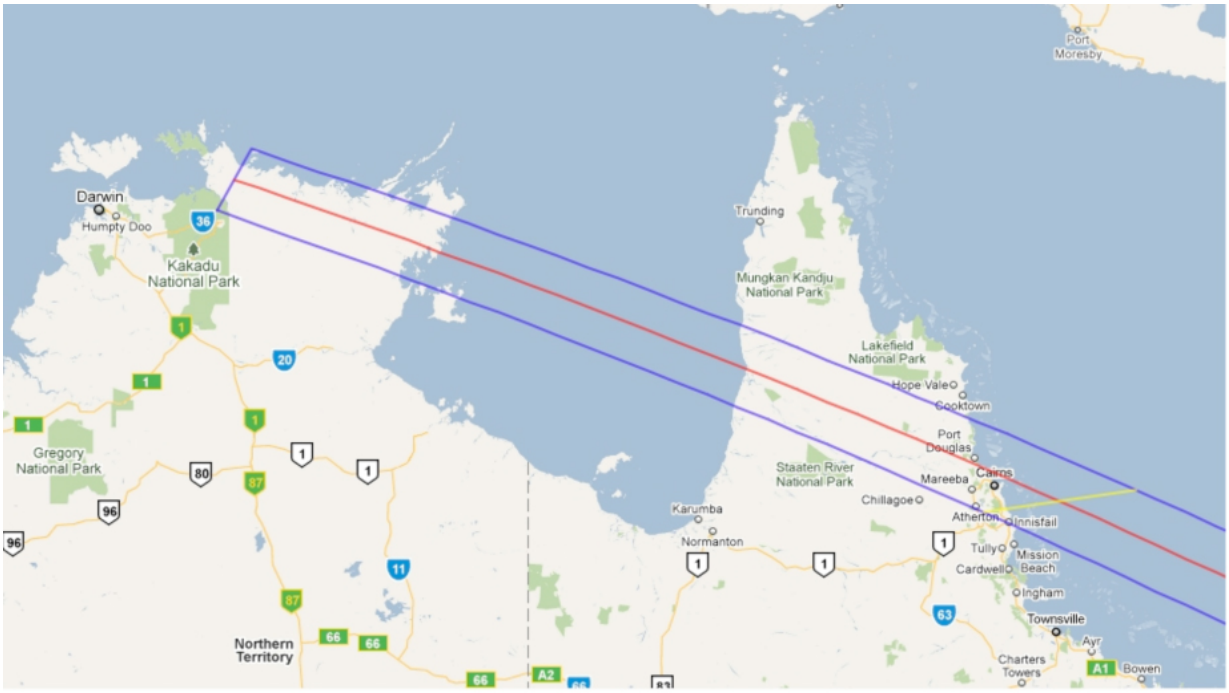

Figure 1 – The path of totality over northern Australia. The red line is the centre line of the eclipse and the blue lines indicate the limits of where the eclipse is seen as total. The map is taken from the zoomable, interactive map of the eclipse track provided by NASA at http://eclipse.gsfc.nasa.gov/SEgoogle/SEgoogle2001/SE2012Nov13Tgoogle.html.

The path of totality of this eclipse will begin at sunrise in the north of Australia in Arnhem Land and cross Cape York before moving out into the Pacific. The most likely viewing spots for most eclipse watchers are likely to be in the city of Cairns on the east coast of Cape York and in its environs.

The centre of the narrow path of totality crosses the east coast of Cape York on the Captain Cook Highway, south of Oak Beach. At that location totality begins at 6:38:10 am (10 seconds past 6:38 am) AEST and lasts two minutes and five seconds with the eclipsed Sun just 13.5 degrees above the horizon. Cairns is just below the centre line. From there totality begins at 6:38:34 am and lasts two minutes. It needs to be noted that November is the start of the wet season in the Cairns area so that clouds could easily block the views of the eclipse, especially with the event taking place so close to the horizon.

For the rest of Australia outside the path of totality the eclipse will be seen as a partial eclipse of the Sun in the early morning or at sunrise. The Table below gives the details for each location. Note that to avoid the possibility of serious eye damage precautions must be taken as mentioned in the warning above.

Table of partial eclipse times
Following are the circumstances in LOCAL TIME for Australian and New Zealand capital cities. Summer time has been added where applicable (ACT, New South Wales, Victoria, South Australia and Tasmania).

Place	Start partial eclipse	Maximum eclipse	End partial eclipse	Sun elevation maximum	Fraction of Sun's width covered
Adelaide	6:43 am	7:31 am	8:22 am	17°	0.52
Auckland	9:18 am	10:27 am	11:44 am	51°	0.87
Brisbane	5:56 am	6:54 am	7:59 am	26°	0.84
Canberra	7:10 am	8:04 am	9:03 am	26°	0.62
Darwin	Sunrise		7:01 am	-2°	0.98
Hobart	7:26 am	8:15 am	9:07 am	27°	0.45
Melbourne	7:16 am	8:06 am	9:00 am	23°	0.52
Perth	Sunrise		5:42 am	-3°	0.41
Sydney	7:07 am	8:03 am	9:04 am	27°	0.67
Wellington	9:27 am	10:34 am	11:48 am	50°	0.76
All times in local time, including summer time where applicable					

How solar eclipses occur

A solar eclipse occurs when the Moon, in its circuit around the Earth, blocks all or part of the Sun's disc as seen from the surface of the Earth (see Figure 2). Only by observing from within the cone-shaped **umbra** of the Moon's shadow can we see the Sun's disc completely obscured; from within the lighter **penumbra** at least part of the Sun remains visible and we witness only a partial eclipse.

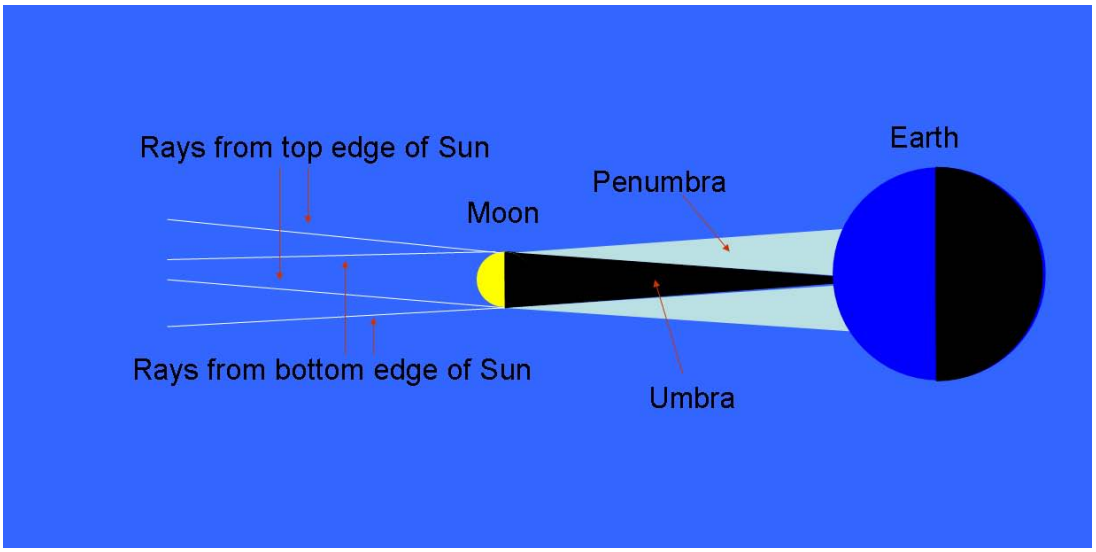

Figure 2 – How a solar eclipse occurs

Although a solar eclipse of some kind occurs somewhere on Earth at least twice each year, in only some of these events does the Moon completely cover the Sun; sometimes the umbra misses the Earth altogether, passing 'above' or 'below' our planet. Even when the umbra does intersect the Earth, we are very close to its end where the width of the shadow is very small. So as the Moon's shadow moves from west to east across the Earth's surface due to the orbital motion of the Moon, it traces out a quite narrow path – at most about 270 km wide.

Only those people lucky enough to be within the path of totality will see the brief spectacle of the Moon completely covering the Sun. People on a large surrounding area of the Earth's surface will witness a **partial** eclipse. Sometimes the Earth's surface is actually beyond the cone of the umbra and we see an **annular** eclipse. In these eclipses a ring of sunlight appears to surround the Moon at mid-eclipse and the Sun is not completely covered from any location. Such an annular eclipse was seen from Australia in February 1999.

How to watch the eclipse safely

The best way is to contact your local observatory or local amateur astronomical society (see http://www.astronomy.org.au/ngn/engine.php?SID=1000005). However, it is possible to safely watch the eclipse yourself using a small telescope to project the image, as shown in Figure 3. The diameter of the telescope's lens or mirror should be less than 80-mm (or 'stopped down' to this size) to prevent damage to your telescope and eyepieces. With your back to the Sun aim a telescope towards it (this is not as difficult as it sounds – use the shadow of the telescope) and focus its image onto a white card held about 20 cm behind the eyepiece. DO NOT LOOK THROUGH THE TELESCOPE! Viewing the projected image is quite safe, but looking through the telescope will cause almost instant blindness. The little finderscope on the side of many telescopes is dangerous too, so remove it. Never leave the telescope unattended and ensure that children are supervised at all times.

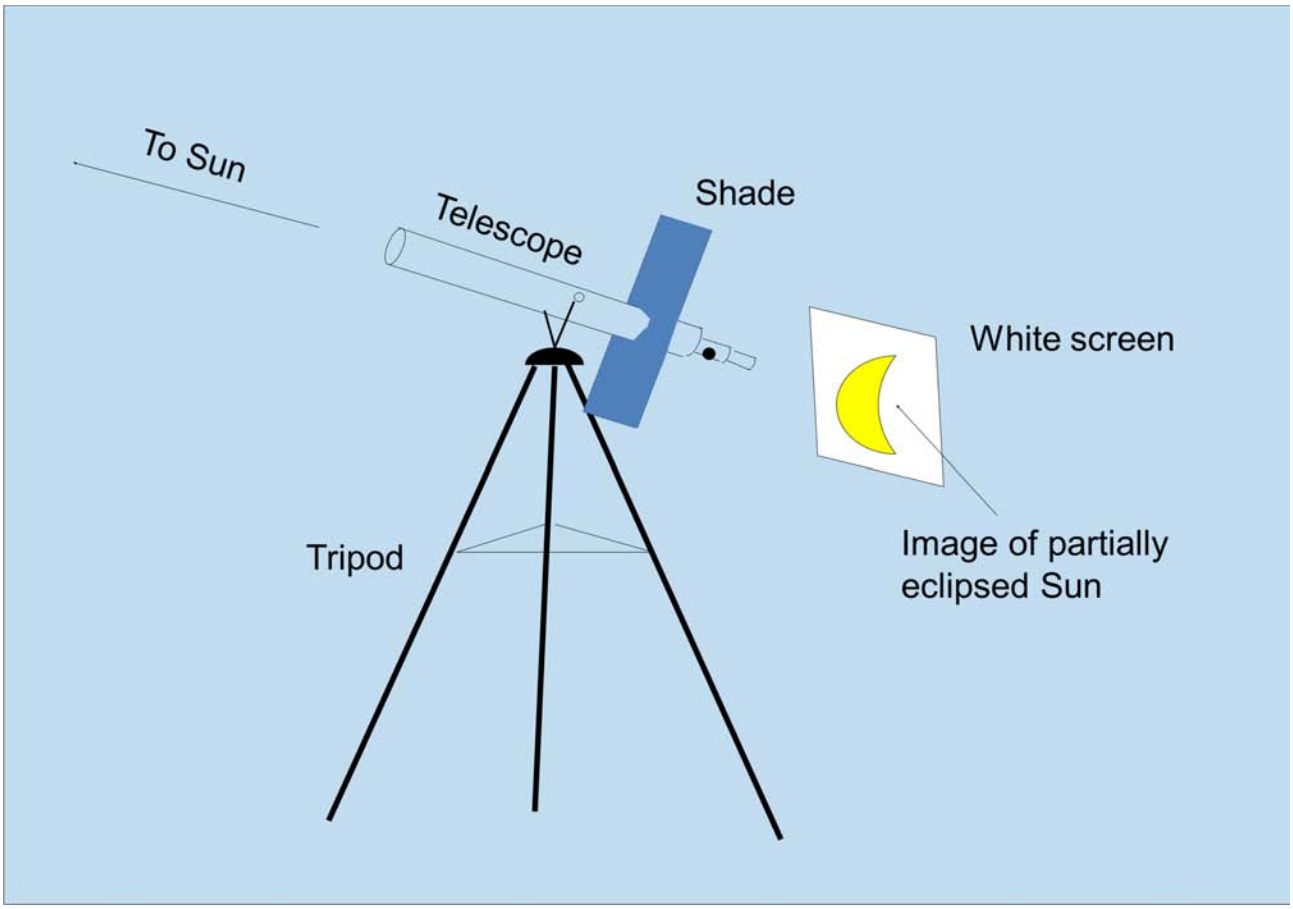

Figure 3 – How to project an image of the Sun through a telescope.
Never look through the telescope at the Sun! Remove its little finderscope if it has one.

If you do not have access to a telescope you can also use a large piece of card with a hole or holes of about 2 mm across. With your back to the Sun, hold the card so that the sunlight passes through the hole and onto another card held about a metre away. This 'pinhole method' will give you an image of the Sun that is small, but good enough to make out the missing 'bite' on the disc. You may also notice during the eclipse that there are images of the eclipsed Sun under leafy trees where the gaps between the leaves form little 'pinholes' of their own!

Another way to view the eclipse is to use eclipse viewing devices that conform to the European Community standard EN 1836:2005 and carry the 'CE' mark. These devices include cardboard framed 'eclipse glasses' and they are safe to use if their instructions are followed. Do not use these devices with binoculars, telescopes, cameras or other optical instruments. Children using the 'eclipse glasses' must be carefully supervised to ensure that they do not peek at the Sun directly. Suitable 'eclipse glasses' with the CE mark are normally available from reputable astronomy shops and public observatories and planetariums.

What can we expect to see?

If clouds allow a view, the eclipse will be a spectacular event for those on the path of totality. During the two minutes and five seconds of totality as seen from Cairns it will be safe to look directly at the eclipsed Sun, but precautions as outlined above will need to be taken before and after totality.

Just before and just after totality the disc of the Sun is glimpsed as a pinpoint of light through mountains and craters at the edge of the Moon. This 'diamond ring effect' is one of the highlights of a total eclipse.

During totality the Sun's faint outer atmosphere, the corona, becomes, visible. This is one of Nature's greatest spectacles and the reason why many amateur astronomers try to travel to as many total eclipses of the Sun as they can. The appearance of the corona varies between eclipses and depends largely on the state of the 11-year cycle of solar activity. On some occasions tiny faint pink regions can be seen at the edge of the eclipsed Sun. These are prominences that can normally only be seen through telescopes equipped special filters.

During totality the sky becomes dark, confusing birds and other animals. Street lights may come on as their sensors register the lack of light. Bright stars and planets become visible. At this 2012 eclipse the planet Mercury will be below the Sun and the planets Saturn and Venus above.

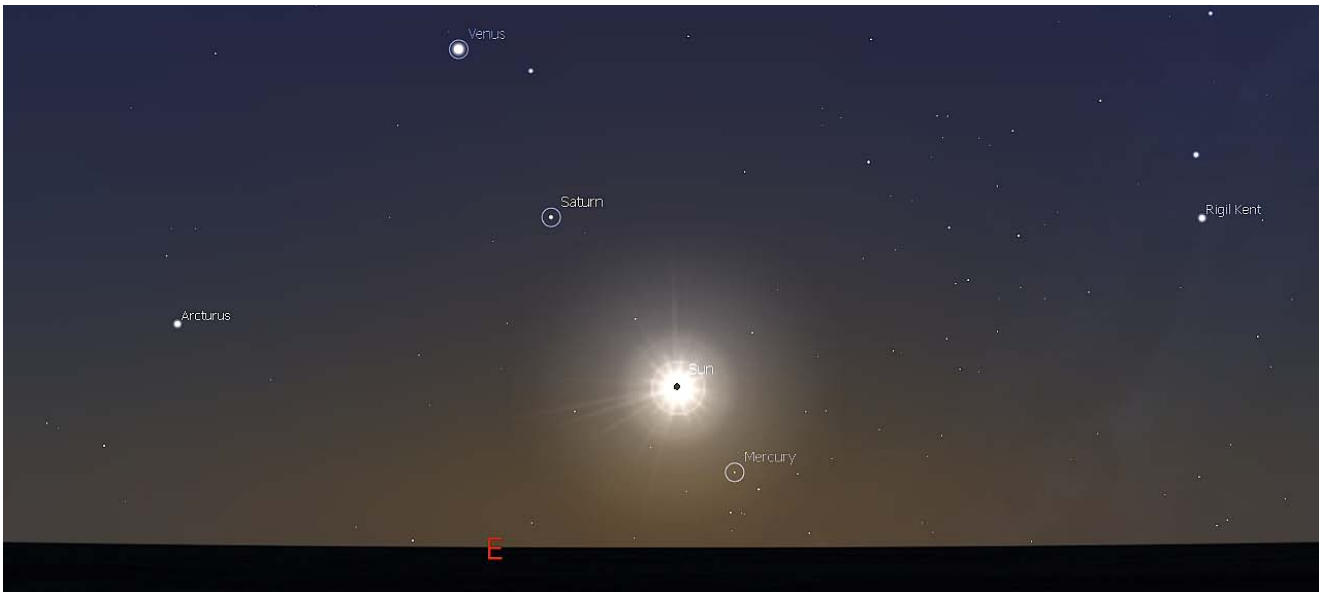

Figure 4 – The sky during totality as seen from Cairns, Queensland at 6:39 am AEST on 14 November 2012. Image: Nick Lomb using Stellarium (http://www.stellarium.org/) software.

Photographing the eclipse

A simple and safe way to photograph the partial phases is to take pictures of the projected image (see section on 'How to watch the eclipse safely'). Do NOT attempt to photograph the Sun directly unless you have prior experience in solar photography. Permanent damage both to eyes and to photographic equipment may result.

For advice on techniques and equipment needed to directly image the Sun contact your local amateur astronomy group, public observatory or planetarium.

Photography is much safer during totality and with modern digital cameras some excellent results are possible. However, as totality lasts for only two minutes as seen from Cairns, preplanning is essential.

A tripod is highly recommended. Try to take images at different zoom factors from wide-angle views of the eclipsed scene to close-ups of the eclipsed Sun. If possible, try to bracket exposures as there is no correct exposure for the corona and different parts of it

appear as the exposure changes. Some cameras can be programmed to take bracketed exposures, but otherwise experiment before the eclipse to see if your camera can be put into manual mode and how to vary exposure. Alternatively, it may be possible to change exposure even on a fully automatic camera by moving the eclipsed Sun off-centre while fixing the exposure by pressing the shutter button halfway.

Important: Stop direct photography and point your camera away from the Sun as soon as totality is over.

Figure 5 – The sky during totality during the 1 August 2008 eclipse as seen from Novisibirsk, Siberia. The planets Venus and Mercury are visible above the Sun. Photo: Nick Lomb

Weather prospects and places to view

November is the start of the wet season in far North Queensland. Weather conditions during the eclipse cannot be predicted this far in advance, but climate statistics can provide an indication.

The Bureau of Meteorology's Cairns Aero Station, site no 031011, has been operating since 1941. Observations from there indicate the mean number of days with rain in November is 10.2 while the number of clear days is 7.9. The mean cloud cover at 9 am AEST is 4.2 oktas – each okta denotes that an eighth of the sky covered by cloud – so that 4.2 oktas suggest that on average just over one half of the sky is covered.

Totality takes place with the Sun only 13.5° above the horizon – for comparison the width of a handspan at arm's length is about 20°. Cloud banks over the ocean are even more likely than the above data would suggest.

The vicinity of Cairns offers the best locality for viewing the eclipse, which is total anywhere between the blue lines on the NASA map referred to in the introduction. From Cairns any viewing spot selected should have an unobstructed view over the ocean so that a clear view of totality can be obtained with the Sun low in the eastern sky.

Some people may want to try to travel inland to move away from the possibility of coastal cloud and increase their chances of seeing the eclipse. The obvious way to do this is to drive along the Mulligan Highway (formerly the Peninsula Development Road) as a section of the road crosses the centre line of the eclipse. However, caution is urged and people are strongly advised only to venture on the road under local guidance and by prior arrangement. Some of the problems include:

1. In many places there are hills to the east of the road that would block the view of the eclipse.
2. There are also power lines to the east of the road that would disturb the view.
3. There are few places to stop with parking available.
4. The Queensland Department of Roads has very strict rules about pedestrians being within 10 m of the road, while the land is private property beyond that distance.
5. The road is likely to be exceptionally busy on the morning of the eclipse, including B-double road-trains travelling at 110 km/h!

Almost certainly there will be a number of organised tours to view the eclipse led by experienced observers. One such tour is being organised by Sydney Observatory.

Summary

The total solar eclipse of 14 November 2012 will be seen as a partial eclipse throughout Australia. For those who would like to see totality the best places to view are likely to be in the vicinity of Cairns in North Queensland. A spot with an unobstructed view towards the ocean is likely to be best. However, there is a high probability of clouds blocking the view.

Acknowledgments

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This information was prepared for the ASA by Dr Nick Lomb (nrl@bigpond.com) of Sydney Observatory (http://www.sydneyobservatory.com.au)
ASA Factsheets are an initiative of the Astronomical Society of Australia's Education and Public Outreach Chapter. Other sheets are available from the ASA's Australian Astronomy web site (http://www.astronomy.org.au/).

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