AN ECLIPSE MANUAL

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(Kannada translation: Sahana and Anantha Padmanabha)

Contents

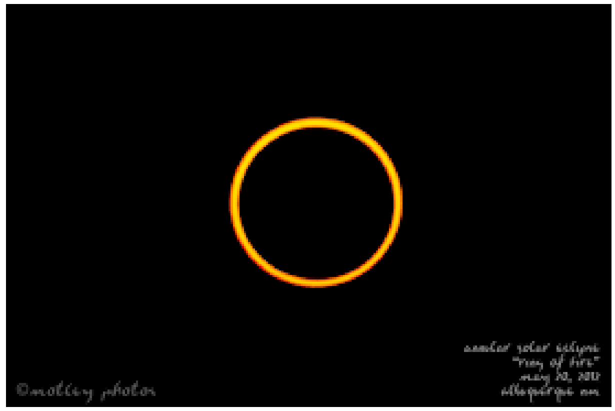

FIGURE 1. The annular solar eclipse of May 2012

ACKNOWLEDGEMENT

In preparing this manual NDH has relied on his experiences of the 1980 Solar Eclipse which he viewed and photographed from the scenic Magod Falls area of Karnataka, as well as the excellent material contained in the following pamphlets:

(1) *Total Solar Eclipse of 16 February 1980 – Circumstances Relating to India* issued by The India Meteorological Department.
(2) *Solar Eclipse – Photography for the Amateur*, Kodak Publication No.AM-10, produced by the Consumer Markets Division of the Eastman Kodak Company, Rochester, NY 14650, USA.

The solar eclipse photography as well as viewing were a success largely due to these two pamphlets.

N.D. Hari Dass, Institute of Mathematical Sciences, Madras

Credits. This text is adapted from the solar eclipse manual prepared by N.D. Hari Dass for the total solar eclipse of 24 October 1995. Section 8 is adapted from Calla Cofield in *Skywatching*. We thank Balachandra Rao for his comments.

Wikipedia provided many of the pictures. Figure 3 is by Deepak Khemani from his book *Signs of the Zodiac*, pubished by Bharat Gyan Vigyan Samiti.

NDH, Mysuru, and KL, Bengaluru

1. A Primer on Eclipses

This section is mainly for readers who are not clear about how an eclipse happens. If you have no problem with the mechanics, skip ahead to Section 2.

1.1. **What is an eclipse?** An eclipse stands for blocking of light. In a cinema, when a person blocks light from the projector, he "eclipses" the screen and the film being shown on it. The Earth eclipses the Moon in the same way in a *lunar eclipse.*

With a coin, you can block the Sun's light from falling on your eye. For your eyes, the Sun is "eclipsed." The Moon eclipses the Sun like this to show us a *solar eclipse.*

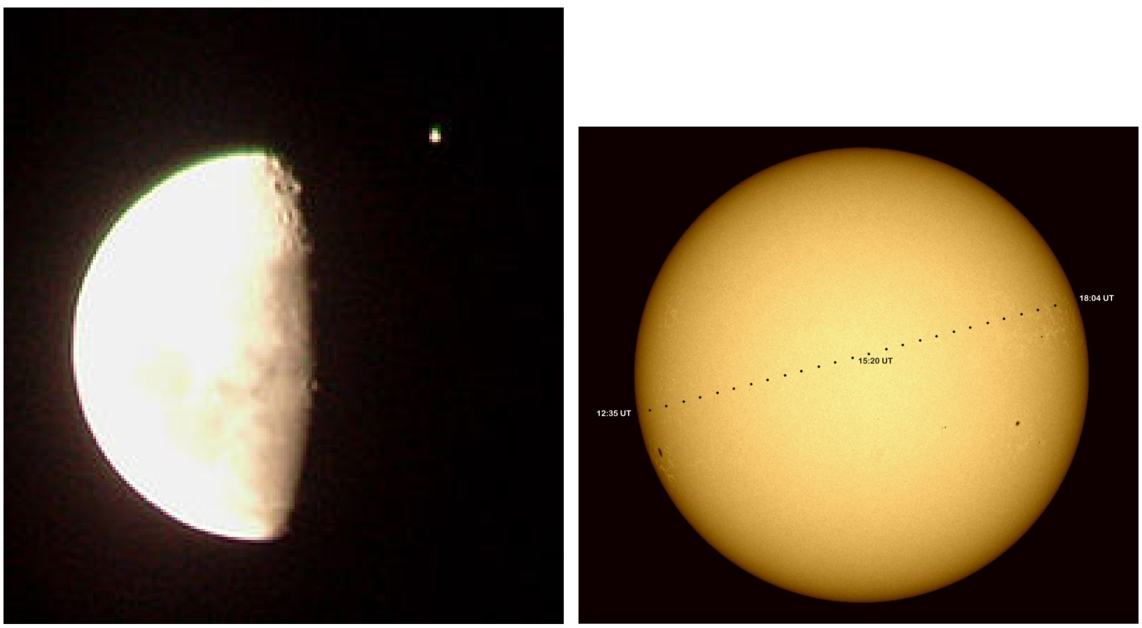

Figure 2. Occultation of Jupiter about to take place on 16 June 2005, and transit of Mercury across the Sun on 11 November 2019

1.2. **Are there other eclipses?** Sure. The planets Mercury (Budha) and Venus (Shukra, Velli) come between the Earth and the Sun. But they are so far away from us that they appear just as tiny dots on the Sun, not even visible to the unaided eye. So these "eclipses" (called *transits*) are of interest only to people having telescopes. The next transit of Mercury is on 13 November 2032. Careful observation of transits on other stars than the Sun have provided evidence of their planets, these are called *exoplanets.*

The moon also (occasionally) passes in front of stars, "eclipsing" them. (This is called an *occultation.*) Again, these are not easy to see with the naked eye. In fact, in 1977, a team of astronomers (including Indians) discovered that the planet Uranus had rings around it by observing it when it occulted a star.

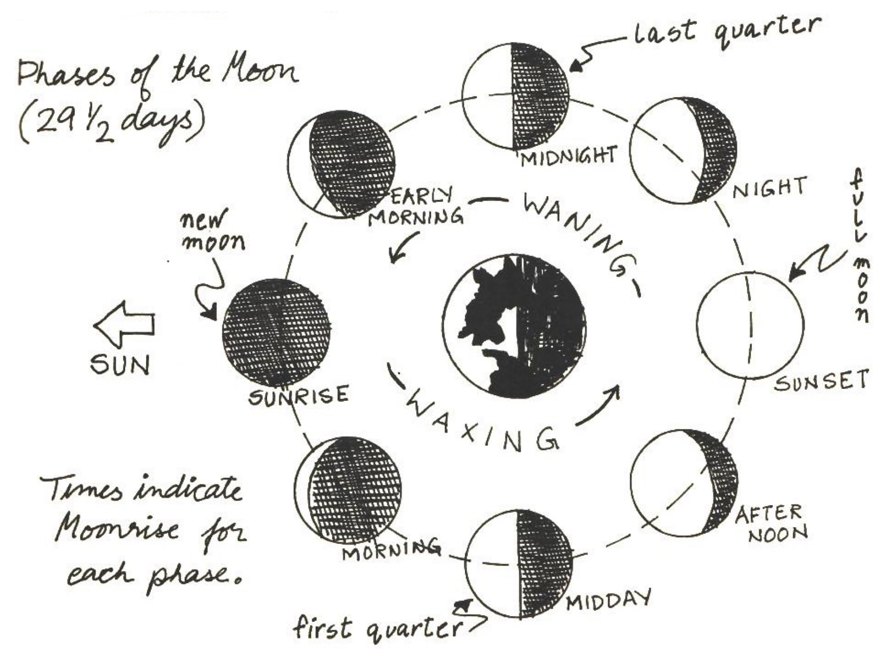

FIGURE 3. Phases

1.3. **Are eclipses related to phases of the Moon?** No. Phases of the Moon are a view of the sunlit portion of the Moon, seen from different angles as the Moon goes around the Earth. Deepak Khemani's picture from *Signs of the Zodiac* shows how.

From the picture, it should be clear that, seen from the Moon, the Earth will also go through phases. When we have New Moon, seen from the Moon it will be Full Earth. When we have Full Moon, seen from the Moon it will be New Earth.

But eclipses require that the Sun, Moon and Earth be in a straight line (so that the shadow of one can fall on the other). Hence they can only happen on New Moon (*amavasya*) or Full Moon (*poornima*). On an *amavasya*, the Moon can come between the Sun and the Earth on that day. Its shadow falls on the Earth, giving us a solar eclipse. On a *poornima*, the Earth can come between the Sun and the Moon. Its shadow falls on the Moon, giving us a lunar eclipse.

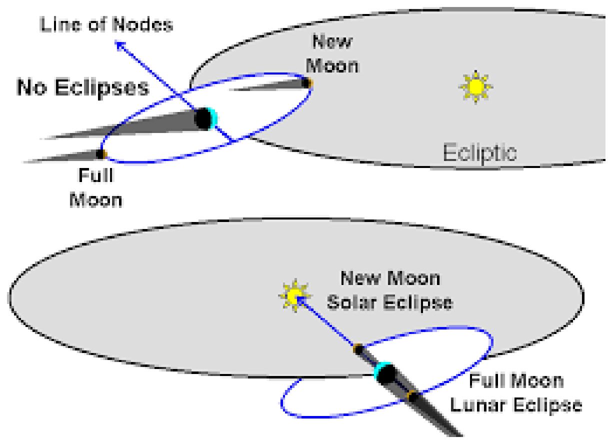

FIGURE 4. Eclipses do not happen every New and Full Moon

1.4. **Why don't eclipses happen every New and Full Moon?** The plane of the Moon's path around the Earth is tilted at an angle of 5° to that of the Earth's path around the Sun, as shown in Figure 4. So on most New and Full Moons, the Sun, Earth and Moon do not stand in a straight line. This seems to have been first understood about 1500 years ago by Aryabhata.

1.5. **What are Rahu and Ketu?** Until about 1500 years ago, the explanation given above was not understood. In India, solar eclipses were thought to be because a demon called Rahu seized the Sun (the word used is *grahana*), and lunar eclipses were thought to be because a demon called Ketu seized the Moon. The beauty of the event was replaced by fear. Superstitions came up based on the fear of demons fighting in the sky.

Aryabhata came up with the correct explanation where no demons figured. To rescue the old theory of demons, people opposed to him said that Rahu and Ketu were planets (the Indian word is *graha*). Rahu was said to be a black planet which went around the Earth in the opposite direction to the Moon, and covered the Sun at the time of a solar eclipse. That is, the Sun, Rahu and Earth were in a straight line at that time because of this oppositely moving planet. Ketu was said to be a red planet which went around the Earth in the opposite direction to the Moon, and covered the Moon at the time of a lunar eclipse. That is, the Moon, Ketu and Earth were in a straight line at that time because of this oppositely moving planet.

This explanation is false. Aryabhata was right, there are no planets going around the Earth in opposite direction to the Moon.

FIGURE 5. Moon's shadow on Earth during the solar eclipse of 2 July 2019, seen from Chinese satellite Longjiang2 at the Moon

1.6. **What are partial and total eclipses?** Because the Moon's path is at an angle, only part of it may fall in the Earth's shadow. This gives rise to a *partial* lunar eclipse.

For a *solar* eclipse to be partial, there is an additional reason. The Moon's shadow on Earth is very small. So a central solar eclipse will be partial when seen from most places, and central on a narrow path.

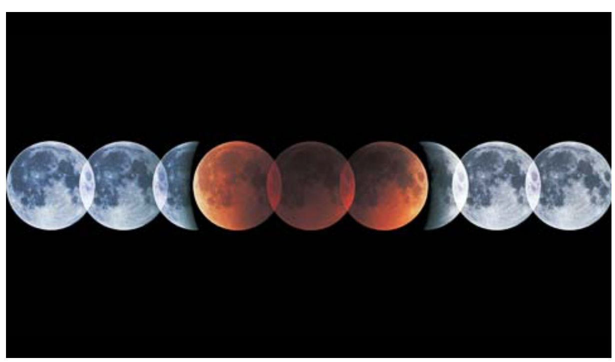

FIGURE 6. Progress of a lunar eclipse

2. Lunar eclipses

Eclipses of the Moon are easy to see, because any one can see them with their eyes. There is no risk to any one, because it is the Moon on which the light changes. Nothing happens on Earth. Total lunar eclipses happen closer to midnight.

As the eclipse starts, parts of it come into the Earth's shadow and become dark. It can be clearly seen that the Earth's shadow is *curved*. Then the Moon is entirely in shadow, or *totally* eclipsed, this may last as long as an hour. See Figure 6. Then the Moon comes out, and the curvature of the Earth's shadow can be seen facing the opposite direction. Thus one infers that the Earth's shadow at the Moon forms a circle larger than the Moon. The Earth is round and much larger than the Moon.

Even though the Moon is totally in the Earth's shadow, it can still be seen. This is because of sunlight which gets bent by the Earth's atmosphere. Our sky is blue because the atmosphere scatters the blue part of sunlight in all directions. The orange-red part of sunlight gets bent and some of it falls on the Moon. Since only this part reaches the Moon, it is seen to be reddish.

Here are Fred Espenak's webpages giving details of lunar eclipses over the next few years. The eclipse of 20 December 2029 is total from West India, but partial elsewhere.

26 May 2021, partial: eclipse.gsfc.nasa.gov/LEplot/LEplot2001/LE2021May26T.pdf
7 September 2025, total: eclipse.gsfc.nasa.gov/LEplot/LEplot2001/LE2025Sep07T.pdf
3 March 2026, partial: eclipse.gsfc.nasa.gov/LEplot/LEplot2001/LE2026Mar03T.pdf
6 July 2028, partial: eclipse.gsfc.nasa.gov/LEplot/LEplot2001/LE2028Jul06P.pdf
31 December 2028, total: eclipse.gsfc.nasa.gov/LEplot/LEplot2001/LE2028Dec31T.pdf
20 December 2029: eclipse.gsfc.nasa.gov/LEplot/LEplot2001/LE2029Dec20T.pdf
15 June 2030, partial: eclipse.gsfc.nasa.gov/LEplot/LEplot2001/LE2030Jun15P.pdf

3. Solar Eclipses

A total solar eclipse is one of the most spectacular of celestial phenomena. A solar eclipse is caused when the Moon obstructs our line of sight to the Sun. The eclipses are classified as:

Partial: when the Moon only partially obstructs the Sun, and
Central: when the Moon maximally obstructs the Sun,
  Total: when the Moon completely obstructs the Sun, and

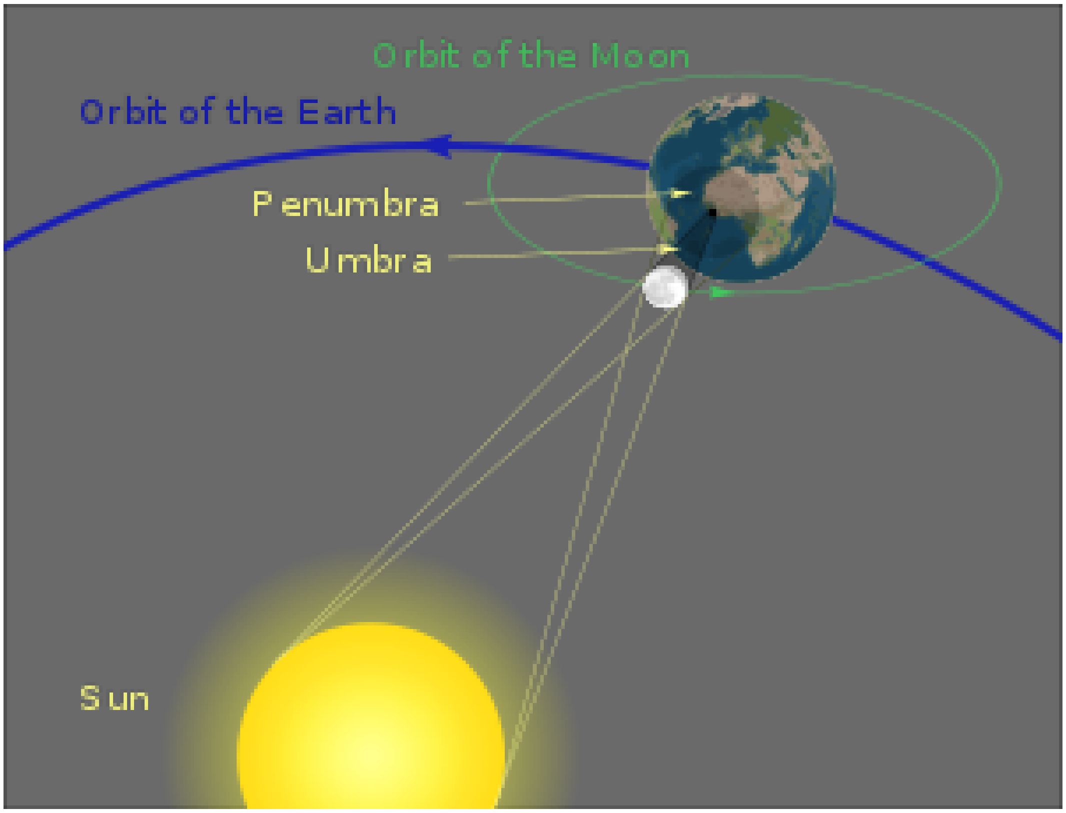

FIGURE 7. Geometry of a solar eclipse

Annular: when a thin ring of the Sun's disc is not covered by the Moon.

Due to the variation in the Earth–Moon distance, the angular diameter of the Moon and the Sun need not match exactly during a central solar eclipse. Because of this, when the Moon is farther enough from the Earth we get an **annular** eclipse. When the Moon is close enough to the Earth we get a **total** eclipse. The fraction of the solar *diameter* covered by the Moon is called the **magnitude** of the eclipse, and the fraction of the solar *area* covered the **obscuration**. Sometimes these fractions are indicated to be greater than one! This simply means that at the greatest phase the angular diameter or area of the Moon is greater than that of the Sun. Obviously, that happens only during a total eclipse.

At any given place on the Earth, the average frequency of a central solar eclipse is about once every 3 centuries though partial eclipses are more frequent. The next partial solar eclipse visible almost all over India is on 25 October 2022, a little before sunset. The next central solar eclipse visible in India will only be seen as a partial eclipse, on 2 August 2027. The next central solar eclipse visible in India as a central eclipse is annular, on 21 May 2031, the path of annularity passes through South India, Kochi in Kerala and Madurai in Tamil Nadu are close to the centre line.After that we have a total eclipse on 20 March 2034, the path of totality passes through Srinagar in Kashmir and Leh in Ladakh.

A partial eclipse where even as much as 95% of the Sun is obscured, or an annular eclipse, is still no match to the total eclipse as the brightness of daylight during partiality can still be some 10,000 to 100,000 times the brightness during totality! This is why total eclipses are so special. The same is true of annular eclipses also where the obscuration of the sun is of similar amount. That is why it is very important to pay attention to safety aspects even during annular eclipses though a 95% obscuration may give a false sense of safety.

Central solar eclipses begin with partial eclipsing of increasing magnitude, and are followed by partial eclipsing of decreasing magnitude. The total duration of the eclipse, beginning with the first contact of the projected lunar disc with that of the Sun and ending with the last contact can be nearly 3 hours. But the duration of the totality or annularity itself is only a few minutes at best.

The duration of centrality is determined by the speed with which the shadow of the moon sweeps the earth on the one hand, and by the excess of the angular diameter of the Moon over that of the Sun on the other. In the absence of Earth's rotation, this speed would have been approximately 3380 kilometres per hour. But due to the fact that the Earth is rotating in the same general direction in which the lunar shadow is sweeping the Earth, the velocity of the shadow is reduced to about 1670 km/hr at the equator. At higher latitudes, the shadow moves much faster. Also, when the shadow falls very obliquely (as happens close to sunrise and sunset) the velocities can be very high - as great as 6000 to 8000 km/hr. Under the most favourable conditions, the duration of totality can reach its maximum value of $7\frac{1}{2}$ minutes! Such a spectacular total eclipse will be visible in India on 5 July 2168.

4. Where to View The Eclipse

The choice of an ideal site to view the eclipse is determined by several factors which could sometimes be mutually exclusive! The most important among such factors are :

4.1. **Duration of Centrality.**

Naturally it would be best if one could view centrality for as long a duration as possible. First choose a site where the eclipse will be total. This can be done by choosing sites well within the band of centrality. Sites close to the edges of the band will have lesser durations than those within. Then try to choose a site with the lowest latitude possible. This last point is useful only if substantial reduction in latitude could be achieved; otherwise one can ignore this consideration.

If one is only interested in experiencing the great spectacle of the solar eclipse without any plans for photography or experiments, a duration of 20 to 30 seconds of centrality will suffice. This will allow a greater flexibility in choosing the site.

4.2. **Weather Conditions.** It is better to avoid regions where it is likely to be cloudy around the time of centrality. So study the weather pattern around the region of your site for the days around the eclipse.

4.3. **Aesthetics.** In addition to the above factors which are crucial for a successful viewing of the event, the psychological impact of the event can be heightened by choosing a site with beautiful natural surroundings. Lots of trees and vegetation around affords the unique opportunity of seeing them under very peculiar lighting.

For example, you could pick a vantage point from a hill top from which one has a clear view of the distant horizon. These places do exist though one has to do some homework to find them! Such a vantage point will offer one the brilliant spectacles of the Moon's shadow racing with terrifying speed, as well as the unique spectacle of darkness surrounded by light all around (from places where either the totality phase is either yet to come or already over)!

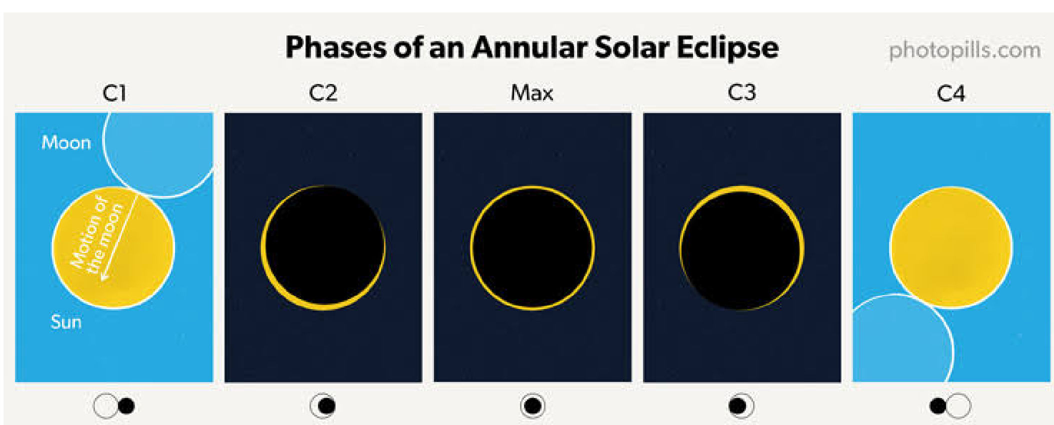

Figure 8. Contacts

5. What to See

The solar eclipse is characterised by the four so-called **contacts**; the **first contact** is when the edge of the Moon first touches the edge of the Sun. This is the beginning of the phase of partial eclipse. The solar disc from then on is eclipsed to a greater and greater degree till the **second contact**. At the time of the second contact the eclipse is total or annular depending on the circumstances. The **third contact** is characterised by the cessation of total or annular eclipse when a thin crescent of the solar disc begins to be observable, and finally the **fourth contact** is when the Moon leaves the Sun's disc. The duration between the first and second contacts, as well as between the third and fourth contacts is the **partial phase**. The duration between the second and third contacts is the **centrality phase**.

5.1. **During the Partial phase....** Though this phase is no match to the totality phase in grandeur, Several interesting phenomena may also be seen during this phase. One such is the monitoring of progress of the eclipse itself. This will require seeing the partially eclipsed sun.

Great care must be exercised to protect your eyes from getting damaged. The surface brightness of the solar disc is unaltered during the partial phase. Please read Section 6 of this book, on Precautions, carefully before attempting to observe the partially eclipsed sun.

5.1.1. *Pin-hole camera effect.* Another interesting phenomenon to observe during partial phase is the "Pin-hole" camera effect created by the leaves of trees as sunlight filters through them (more precisely, through gaps in them). Before the eclipse begins, the ground is covered by overlapping discs which are actually the images of the sun. As the eclipse progresses, these discs take the shape of the eclipsed sun. When the eclipse is quite advanced, one sees a myriad collection of crescents! The effect may be enhanced by spreading a white sheet on the ground.

A few minutes before totality one can begin to feel the appreciable drop in the brightness of daylight. The quality of light itself is quite unique and the landscape appears quite magical. If the observation site is so situated that the distant horizon is clearly visible, a spectacular sight to see is the advancing of the Moon's shadow across the landscape. The swiftness of this motion (several thousands of kilometres an hour) is truly startling.

Around this time, the temperature falls significantly. It is interesting to watch the confused behaviour of animals as they think the day is ending (or beginning)!

FIGURE 9. Pin-hole camera effect

5.1.2. *Shadow Bands.* Just before the shadow of the Moon reaches the observation site (as totality is about to begin), one can see quivering, ripple-like bands of shadows on the ground. Their visibility can be enhanced by spreading a bright white sheet on the ground. These bands are a very beautiful phenomenon to watch. They give the impression of a multitude of snakes crawling on the ground!

These bands are caused by the irregularities in the refraction of the earth's atmosphere observed under the lighting conditions prevalent just before the onset of the totality.

Shadow bands can be visible during annular eclipses too. But the obscuration has to be around 98% at least.

5.2. **During the Central phase....**

5.2.1. *Bailey's Beads.* For a second or two, just before centrality and again as the Sun emerges at the end of centrality, light breaks through the valleys on the rim of the Moon, forming what looks like a beaded necklace along the edge of the Moon. This is a very spectacular effect and is rather short-lived. But to observers situated near

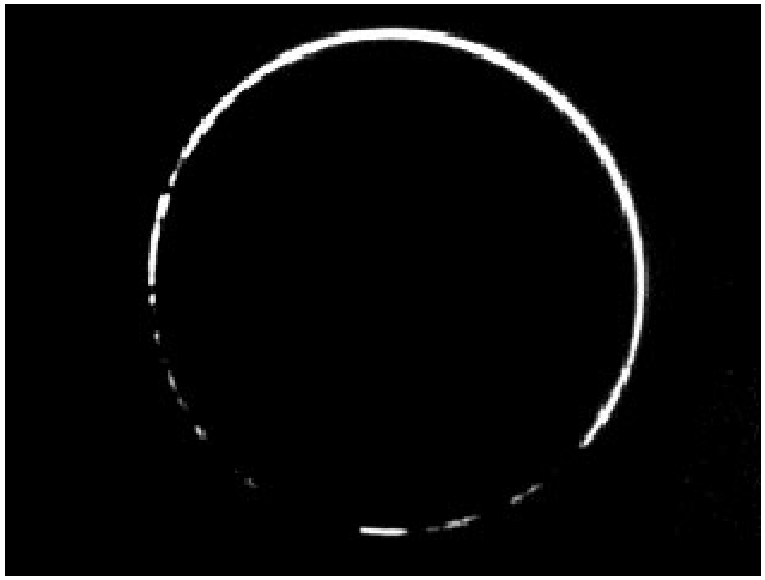

FIGURE 10. Bailey's Beads during annularity

the edge of the band of centrality the Beads can be visible for several seconds.With the disappearance of the last bead on one rim of the moon, centrality begins; this occurs just around the time of the second contact. likewise, with the disappearance of the last bead on the other rim, centrality ends, just around the time of the third contact.

5.2.2. *Flash Spectrum.* Just as the last of the Bailey's beads disappears and totality begins comes the moment for observing the flash spectrum.

5.2.3. *Corona.* Moments after totality has begun, the chief feature of the eclipse flashes into view – the **corona**. This is a pearly white unearthly light surrounding the Sun. The visual impact of the corona is something that can be seldom reproduced with the same grandeur by even the most sophisticated photo, film or video techniques. So get as much of this spectacular vision imprinted in your mind as possible! At this moment the sky overhead darkens to a midnight hue and bright stars and planets can be seen shining through.

At totality, the corona appears around the solar disc as a beautiful halo, decreasing in brightness as one moves outwards from the rim. Points of interest to observe in the "outer" corona are the equatorial streamers, which may extend several diameters from the sun. In the "inner" corona, one should look out for the

FIGURE 11. The Sun's corona (outer atmosphere) and prominences (pink) during a total solar eclipse on 11 August 1999

so called **prominences** which appear as scarlet, tongue-like jets shooting outward from behind the Moon's rim.

5.2.4. *Diamond Ring.* This is a much sought after effect which happens at the third contact. Just as totality is ending, a bright flash from the first beam of light emerges at the point of the rim where the third contact takes place. This is a very beautiful effect and lasts only a split-second. Immediately after this, the corona vanishes, totality ends and the partial phase follows.

This is a particularly important moment from the safety point of view as the Sun very quickly moves from the total phase, where no protective devices are necessary, to the partial phase where the eyes have to be protected against the sudden increase in heat and light radiation from the sun.

6. Precautions to be Taken ...

Looking at the Sun, either directly or through the view-finder on your camera, can burn your eyes and cause blindness. Never look at the sun without adequate protection. Protecting your eyes adequately means reducing exposure to ultra-violet and infra-red radiation, which can damage your eyes instantaneously without your

FIGURE 12. Diamond ring during a total solar eclipse on 21 August 2017

immediately being aware of it. Also, adequate protection will increase eye comfort by reducing the intensity of sun's visible rays.

The intensity of sunlight for direct safe viewing should be reduced by at least 100,000 times and ultra-violet and infra-red part of the solar radiation should be effectively cut off. Therefore always use a filter that will absorb equally and sufficiently the ultra-violet, infra-red and visible energy of the Sun.

There have been erroneous recommendations suggesting the use of materials that absorb the visible energy but do not absorb the dangerous, invisible infra-red rays.

Filters that are NOT safe

- ***Smoked Glass***
- ***Crossed-Polarising elements***
- ***Colour film***
- ***Sunglasses***

Filters that ARE safe

- ***Dark arc-welders glass***
- ***Two or three thicknesses of BLACK and WHITE (NOT colour) photographic film completely exposed and developed***

Place the filter in FRONT of your eyes before facing the sun.

Such a filter can be made by exposing the black and white film completely and developing to maximum density. The film can be completely exposed by unrolling it in broad daylight. The film should then be fully developed according to the manufacturer's recommendations. *Such Films Are Not Good for Photographic Use.*

These days filters and goggles are sold by many commercial platforms. But ensure their safety by reading reviews about the products. This is extremely important. Don't always go for cheaper alternatives, safety comes before savings!

6.1. **Projected Images.** Partial phases can also be observed by projecting the image of the Sun. The following simple arrangement should work quite well: cover a plane mirror with a piece of paper having a circular hole of diameter 1 to 2 cms. The sunlight reflected from this arrangement may be thrown on to a shaded wall indoors. Reduction in the diameter of the hole in the paper will increase the sharpness of the image at the loss of its brightness. Alternately, one can just build

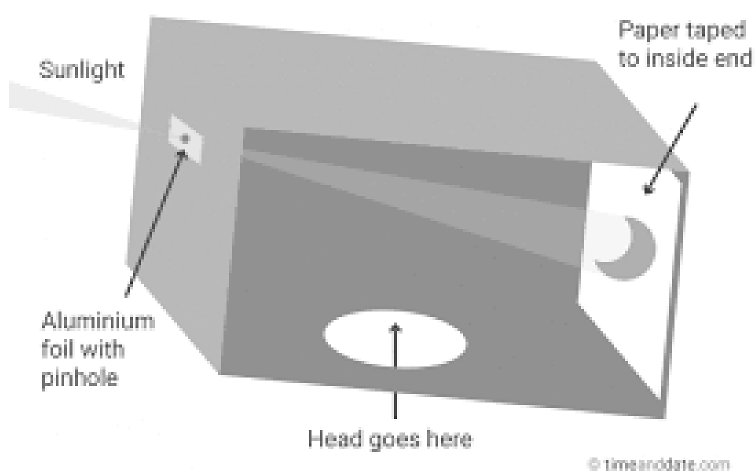

Figure 13. Projecting the image

a *pinhole camera* with two plane cardboard sheets. In one, make a hole that is not too small (smaller the hole, less bright will be the image), nor too big (bigger the hole less sharp will be the image). A separation of 1 metre can produce an image of about half a cm.

7. What to Photograph and How to Do it

7.1. **The Three Unforgettables...**

7.1.1. *Camera Protection.* The Sun can burn holes in focal-plane shutters, warp the leaves of the between-the-lens shutters, and melt composition shutter blades. Use small lens openings and *Neutral Density Filters (ND-Filters)* that are made for *photographic* use. If the camera must be pointed toward the Sun throughout the eclipse, shade it between exposures.

7.1.2. *Aiming The Camera. NEVER* look at the Sun through a camera finder without suitable filters. This is especially important with single-lens reflex cameras, both still and movie. It is best to aim the camera without using its finder. (A way to do this will be explained shortly.)

If you must use the finder, use filters (as described in the section on safety precautions) held in front of the view-finder if the camera is *NOT* of the single-lens reflex type, and in front of the lens if it *IS* a single-lens reflex camera. While using the filters for viewing, remove the Neutral Density filters and put them back while photographing. After the ND-filters have been put back, do not look through the finder.

7.1.3. *Aiming Without Using The Finder.* A simple device that allows one to aim the camera at the sun without using the view-finder is the following: mount a thin straight wire of about 6 inches on a flat platform of roughly 1 square inch area such that the wire is at right angles to the flat area. Now to aim the camera, place the flat area on the front part of the camera body and move the camera till the shadow of the wire on the body disappears. Now the camera is exactly facing the Sun.

Typical Exposures	
Film Speed	64-80 ASA
ND Filter	5
Lens Opening	f/8
Exposure Time	1/125 second
Exposure Time for Bailey's Beads	1/15 second

7.2. **Exposure and filters.** The light from the Sun's surface is so intense that even to photograph a well eclipsed Sun, the intensity must be reduced by factors of 10,000 to 100,000. Neutral density filters are the best way of cutting down the light to allow normal exposures. During the partial phase, the intensity of the surface of the Sun is the *SAME* as in normal sunlight. Therefore the best exposures for the partial phases can be determined well ahead of the eclipse by making test exposures of the Sun with a *Neutral Density 5* filter. It cuts down the intensity by a factor of 100,000.

In addition to neutral density (ND) filters, so called *Solar Filters* are also available. Solar filters cut out more infrared than ND. Optical density filters (OD) work similar to ND filters.

It is advisable to use *Full Aperture* filters. With filters, the film speed is not critical. This is because there is enough brightness even after filtering. Interested readers can further consult: nikonusa.com/learn-and-explore/a/tips-and-techniques/how-to-photograph-a-solar-eclipse.html.

Techniques for using mobile phone cameras will be discussed a little later. The safety hazards with the use of mobiles can be greater so readers are urged to carefully read that section.

Remarks. Always try, where possible, to also take exposures that are equivalent to one f-stop more and one f-stop less than the exposures recommended in this manual.

7.3. **Photography During the Partial phase....** An interesting thing to photograph during partial phase is the record of the eclipse that includes the partial phase before centrality, centrality phase and the partial phase after centrality. One could start roughly one hour before centrality and go on for one hour after centrality. The camera should be mounted on a firm support and a series of exposures at 5-minute intervals should be made on the *same* film frame. The position of the Sun will change about 15° per hour. A normal focal length camera lens will cover a sufficient angle for a 2-hour exposure. It should be so planned that at the time of totality the sun is at the center of the frame. The timing of the progress of the eclipse is necessary to plan the camera position as well as the exposure schedule.

Remarks. The fraction of the film occupied by the image of the Sun depends on the effective angle of view of the lens. For example, on a 200 mm telephoto lens the image of the sun is much bigger than with a 55 mm normal lens. The actual image size (diameter) on the film can be estimated by dividing the focal length by 100. You should carefully calculate the number of exposures and the interval between exposures so that images do not overlap. Because of the multiple exposures you may be afraid that the background may be over exposed. But since the eclipsed sun is being photographed with a neutral density 5 filter which cuts down the intensity by a factor of 100,000 even 100 exposures of the background on the same frame will only let one thousandth the brightness of the background to be recorded on the film.

If photography on the same frame of film proves difficult, try recording the progress of the eclipse as follows: make sure that during the entire period of the record, the sun is visible in the field of view of the camera which should be so oriented that at centrality, the fully eclipsed sun is at the centre of the frame. Keep this orientation of the camera *fixed* during all the exposures which will be on *different* frames on film. For best results, use film for slides. Projection of these slides in rapid sequence can recreate the entire history of the eclipse in a short span of time!

7.3.1. *Bailey's Beads and Diamond Ring.* For still cameras the recommended exposure is at a shutter speed of 1/15 second and the *same* lens opening *with* ND Filter as used during the partial phase. Remember that these effects are very short-lived! For the diamond ring, you have to be on your guard as it just sneaks in on you! Even if you are a second too late, the quality of the photograph deteriorates appreciably.

7.4. **Photography During the Centrality phase....** *Centrality during the coming Eclipse will last at most for about* 3 *minutes.* Therefore, plan well in advance and be prepared so that you can take many exposures during this brief period. It will be quite dark making it hard to read the settings on the camera. So carry a small torchlight to assist you. But make sure not to disturb others while using the torchlight. *Rehearsing the action a few times before hand is a very good idea!*

7.4.1. *Corona.* As the intensity of the corona fades rapidly away from the solar limb, the distance to which the photograph will show the corona depends on exposure. The longer the exposure the greater will be the extension. But too large exposures will result in artificial colours as well as overexposure of the inner corona. Shorter exposures yield more spectacular results.

Typical Exposures	
Film Speed	64-80 ASA
ND Filter	No ND Filter during totality !
Lens Opening	f/6.3
Exposure Time for Inner Corona	1/15 second
Exposure Time for Outer Corona	1/2 second

Caution. As the time available during centrality is limited and the exposure times are relatively long, *it is very important to reduce camera shake as much as possible.*

If you are planning serious photography, prior planning based on use of tripods is important. It is advisable to use data on the height of the sun during various phases. Such information for the place you are observing from can be found for example at www.timeanddate.com.

8. Photographing solar eclipses with mobiles

A large number of people will be using their mobile phones for photographing the eclipse. There are several safety aspects that need to be stringently adhered to.

Filters cannot be easily mounted on to mobile cameras. One way is to stick suitable filters to cover the camera openings with the help of scotch tapes. It is not advisable to simply hold goggles over the camera openings. Even after fixing filters over camera openings, the danger is that one may inadvertently look up at the sun directly, which should be avoided at all costs.

Calla Cofield in *Skywatching* has suggested an ingenious way of avoiding this danger. The picture on the next page should be helpful in understanding her suggestion.

The idea is to have the Sun *behind* you so the danger of accidentally looking at the Sun directly does not arise. Most mobile phones come with front facing and back facing cameras. Choose the camera that faces your face and scenes behind your back. Now cover that camera opening with a layer of suitable filter. Now you can look at the screen of the camera without looking directly at the Sun. A tripod on which the mobile can be mounted will make it even more hassle-free.

Do not spend all your time staring at your camera !

Get as much visual impression of the eclipse as possible !!