



SOLAR ECLIPSES – DANGER TO EYESIGHT

On 11 August 1999, most people living in Europe and populations in a number of Asian countries will witness the last total solar eclipse of the millennium. This eclipse will also be the first in nearly 40 years that will be visible from Europe. The late morning skies in these countries will suddenly darken, as if to remind us of Armageddon, when the moon eclipses the sun.

This celestial phenomenon will most certainly attract the attention of astronomers and millions of sun-gazers, as it has done for centuries. Unfortunately, unless precautionary measures are taken, it will also lead to many cases of retinal injuries and even the loss of eyesight, referred to as "eclipse blindness".

Statistical evidence, accumulated mostly in developed countries, is scarce. Eclipse blindness is often underreported because patients consult eye specialists long after viewing an eclipse. In many cases, they do not associate their condition with looking directly at the sun for only a few seconds. In the majority of developing countries, such statistics do not exist at all.

That is why the official global figures of eclipse blindness and visual impairment do not look impressive. After the partial solar eclipse of 1952, for example, 52 cases of blindness or severe visual impairment were registered worldwide. After the 1970 and 1980 total solar eclipses, 145 and 112 cases of serious visual impairment were reported respectively.

Why Can Direct Viewing of the Sun Damage One's Vision? The sun is an extremely intense source of light - both visible and invisible (infrared and ultraviolet). It is so intense that when sunlight shines on our skin we feel warmth although the sun is 150 million km away from us! The lens of the eye acts as a magnifying glass. It produces tiny images on the *retina* of what we are viewing, with a concentration factor of about 10 000. During direct viewing of the sun, for even a few seconds, the light entering the eye is concentrated to the point that it can burn the cells of the retina. The cells are destroyed beyond any hope of healing and that part of the retina becomes blind.

Direct viewing of the sun and other extremely bright objects can also seriously damage the very sensitive part of the retina called the *yellow spot*, *fovea* or *macula leutea*. When the cells of the fovea are destroyed, people can no longer view fine details, particularly when light levels are low. While such blindness is not total, it represents a serious visual

impairment making it impossible to read, sew, watch TV, recognise faces, drive a vehicle or do any task which requires recognition of fine details.

The structure of our brows, eyebrows and eyelashes, as well as the natural reflex to look away from the sun—all these help protect our retinas from damaging exposures to sunlight. However, during solar eclipses people tend to forget that looking directly at the sun is *always extremely dangerous*. They suppress their aversion reflex and look at the sun directly, repeatedly and for extended periods (more than a few seconds).

How Can One Enjoy a Solar Eclipse Safely? There are two ways to enjoy the partial phases of a solar eclipse safely. One is to use an appropriate filter to safely view the eclipse directly. The other is to view the eclipse indirectly.

Filters: An appropriate filter interposed between the eyes and the sun must reduce the amount of sunlight reaching the eye by a factor of much more than 1000. It must also be effective in reducing the components of sunlight not visible to humans (infrared and ultraviolet). Such a filter looks totally black or, if made of reflective material, like a mirror. Viewing a normal scene through such a filter is not possible. When you look at an ordinary lamp you will only barely discern the brightest, hottest parts of the lamp (for example, the filament if it is an incandescent lamp). However, viewing the sun, you will be able to easily discern the details of an eclipse as it progresses.

Many countries have standards for such protective filters that usually require accompanying informative markings. Always make sure such markings are present before using any filter. *Do not rely on any unmarked filter*. One's vision is too precious to risk.

The darker filters used by welders are suitable and probably the best. They are robust and of good optical quality. Welder's filters are marked with numbers indicating their darkness. The number should be greater than 10 to be sufficiently protective and above 12 to be comfortable. Filters with numbers greater than 14 will probably be too dark to be useful.

A plastic film called Mylar® can be coated with a sufficient amount of aluminium to make it almost totally reflective. Such films are relatively fragile but can be adequately protective, if suitably laminated (covered with plastic on both sides) and maintained wrinkle free by a protective holder (e.g. a pair of eyeglasses). Some countries have standards for such films and holders. Look for such markings for reassurance that the film is suitable for viewing a solar eclipse.

Exposed films and smoked glass are unreliable and unsafe devices to view a solar eclipse. Smoked glass produced by holding a piece of glass over a candle flame and darkening it thoroughly with soot has been used as a filter in the past. However, such films of soot are extremely fragile and adequate uniformity is difficult to achieve. Such primitive filters are to be avoided. Black and white photographic film, totally exposed to light and fully developed has also been used in the past but should also be avoided.

Viewing a Solar Eclipse Indirectly: The safest way to view a solar eclipse is indirectly by using a pinhole camera. A pinhole camera can be made from a long box or tube. At

the end that will face the sun, a pinhole is made. The pinhole must be very small and as perfectly circular as possible in order to create the sharpest possible image.

The pinhole can be made using a piece of aluminium foil (heavy duty, if available) pierced with a needle and carefully taped over the end of the tube or an opening cut at the end of the box. At the opposite end, where the image will be formed, a piece of fine white paper should be attached to act as a viewing screen. Cut an opening in the side of the box or tube near the end with the white paper screen so that the image can be viewed. If the distance between the pinhole and the screen is 1 m, you will get an image with a diameter of about 9 mm. The greater the length, the greater will be the image diameter.

However, longer boxes or tubes will be more difficult to aim and hold steady. Nevertheless, a good image of the sun can be obtained this way. The image will be easier to see if you can create some extra shade by draping a cloth over your head and the screen end of your pinhole camera. You can test the quality of the pinhole and experiment by enlarging it to let in more light while aiming the camera at a window from the opposite side of a room. You will be able to see an image of the window on the screen. It will be inverted and much larger than the image of the sun.

If you place a lighted lamp in front of the window you will get a better idea of what the image of the sun will look like. You can also take your camera out into the street at night and try imaging a street lamp or the headlights of a car several tens of metres away. A little bit of experimenting in this way will give you experience with aiming the camera so that it will be easier to use during an eclipse.

Under no circumstances, should one try to view the solar eclipse directly through the pinhole, i.e. without the white paper screen between the eyes and the pinhole.

- ***Without adequate protection, direct viewing of the solar eclipse, whether partial or total, is extremely dangerous for your eyesight. It may lead to irreversible central blindness or serious visual impairment.***
- ***The safest way to enjoy a solar eclipse is through indirect viewing by using a pinhole camera. Your good vision is worth all the trouble making such a camera.***
- ***Be careful when choosing filters to view an eclipse. Do not rely on any unmarked filter.***
- ***Do not use sunglasses, exposed film or smoked glass to look directly at the sun.***
- ***If you have no protective devices, do not yield to the temptation to view the 1999 solar eclipse. Your eyesight is much more important.***

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