HOW TO PROTECT YOUR EYES FROM SOLAR RETINOPATHY

STALMANS P.[1], WECKHUYSEN B.[2], SCHOONHEYDT R.[2], LEYS A.[1], MISSOTTEN L.[1], SPILEERS W.[1], DRALANDS L.[1]

ABSTRACT

On August 11, in Belgium a solar eclipse will occur which will be total in the Southern area of the country. Although the observation of a solar eclipse is an intriguing phenomenon, inappropriate shielding from the sunlight can cause irreversible ocular lesions. Besides good absolute absorption of visible light, a blocking of ultraviolet and infrared light is equally important. In this study, four homemade sun filters were tested: a soot-blackened piece of glass, a black unexposed developed slide film, an audio-CD and a recordable CD-ROM. Also two commercially available filters were investigated: eclipse-shades and mylar foil. The soot-blackened glass and black slide film slip were highly transparent for infrared light, making them dangerous for solar observation. The recordable CD-ROM was too transparent for visible light to serve as solar filter, while the audio-CD tested absorbed enough visible, ultraviolet and infrared light to make it suitable for eclipse viewing. However, many types of audio-CD's are available making it impossible for the observer to know if a given CD is safe to use for solar viewing. Both commercially available solar filters tested had a good absolute visible light absorption, as well as an equally good absorption of ultraviolet and infrared light, making them safe for eclipse observation.

SAMENVATTING

Op 11/8/99 treedt er in België een zonne-eclips op die in het zuiden van het land zelfs volledig zal zijn. Het waarnemen van een zonne-eclips is boeiend, doch kan blijvende oogletsels veroorzaken indien geen adequate zonnefilter gebruikt wordt. Naast het absolute absorberende vermogen van het zichtbare zonnelicht, is het evenzeer belangrijk dat het ultraviolette en vooral het infrarode licht voldoende geabsorbeerd wordt. In deze studie worden 4 "huis- en tuin" zonnefilters nagekeken: een stuk beroet glas, een zwart stukje diafilm, een audio-CD en een recordable-CD. Daarnaast werden ook 2 commercieel beschikbare zonnefilters uitgetest: de "eclipsbril" en mylar folie die door de Urania sterrenwacht verdeeld worden. Het beroete glas en zwart stukje diafilm bleken een grote hoeveelheid infrarood licht door te laten, en zijn daarom ronduit gevaarlijk bij het gebruik als zonne-filter. Een recordable-CD heeft een te laag absoluut absorberend vermogen, terwijl sommige audio-CD's wel voldoende licht kunnen absorberen. Er zijn echter grote verschillen tussen de verschillende audio-CD's in de handel, zodat de gebruiker niet kan weten of hij wel over een veilige zonnefilter beschikt. De eclips-bril en mylar folie bleken echter een zeer hoog absoluut absorberend vermogen te hebben, en laten ook slechts zeer weinig ultraviolet en infrarood licht door, zodat deze als zeer veilig mogen beschouwd worden.

RESUME

Le 11 août 99, une éclipse solaire sera visible en Belgique. Elle sera même totale dans le sud du pays. L'observation d'une éclipse est fascinante, mais peut créer des lésions maculaires permanentes si l'observateur n'utilise pas un bon filtre solaire. Un bon filtre absorbe non seulement la lumière solaire visible, mais aussi la lumière ultraviolette et infrarouge. Dans cette étude, 4 filtres populaires ont été évalués: un morceau de verre charbonné, une

.....

The results of this study were published as a short communication in issue nr. 43 of the "Info" of the BOG/SBO.

[1] *Dienst Oogziekten UZ Leuven.*
[2] *Centrum voor Oppervlaktechemie en Katalyse van de Faculteit Landbouwkundige en Toegepaste Biologische Wetenschappen van de K.U.-Leuven.*

received 24.03.99
accepted 12.04.99

diapositive noire, un compact disk audio, et un CD-ROM enregistrable. Deux filtres commercialisés par l'astroshop de l'observatoire Urania ont aussi été testés: des lunettes-éclipses et un film en mylar. Le morceau de verre noir et la diapositive sont trop transparents à la lumière infrarouge et sont donc dangereux pour observer une éclipse solaire. Un CD-ROM enregistrable n'absorde pas suffisamment la lumière visible. Par contre, le CD-audio testé convient comme filtre solaire.
Malheureusement, les CDs vendus sont de qualité différente. Il est donc impossible pour l'observateur de savoir si un CD particulier convient pour observer une éclipse. Les lunettes-éclipses et le film en mylar absorbent aussi bien la lumière visible que la lumière ultraviolette et infrarouge et sont des bons filtres pour observer une éclipse solaire.

KEY WORDS

Solar eclipse, sun gazing, solar retinopathy, solar filters.

MOTS CLES

Eclipse solaire, observation solaire, rétinopathie solaire, filtres solaires.

INTRODUCTION

Solar eclipses occur when the earth, the moon and the sun align in such a way that the moon blocks the sun's light path to the earth. A complete shading of the sun's light, a total eclipse, is a rare phenomenon. In the Middle Ages, a solar eclipse was interpreted as the announcement of calamities.
On August 11, 1999, a solar eclipse will occur in a large part of Europe, and will be total in the southern part of Belgium (south from an imaginary line between Bouillon and Arlon). More details on the eclipse can be found on the Web-site of the "Urania Volkssterrenwacht" on http://www.eclips99.be.
It is intriguing to observe the formation of a solar eclipse, whereby the round shape of the sun is progressively shaded by the moon's opacity. To observe this eclipse formation, adequate eye protection is mandatory to prevent permanent damage of the retina. Only when a total eclipse has been established, the sun's core light is blocked, and the sun's corona can be observed safely without eye protection.
The sunlight covers a broad range of wavelengths, of which only a small part penetrates the ozone layer and reaches the earth's surface. Ultraviolet light of less than 300 nm wavelength is absorbed by the corneal tissue, and can induce UV-keratitis (such as occurs when welding without adequate safety goggles). Both visible light (approx. 400-800 nm wavelength) and infrared light of up to 1600 nm are passed through the cornea and lens and will reach the retinal surface. Prolonged exposure to high light intensity induces phototoxic, photochemical and photocoagulation changes (1) (the latter is intentionally induced in retinal laser photocoagulation). This can result in permanent ocular damage with permanent central scotoma formation. During the last solar eclipse in Belgium in 1977, several cases of solar retinitis were observed, some with permanent retinal damage, due to observation of the eclipse without safety glasses (2) (figure 1).
A good filtering device that allows solar observation must have two properties: first, it must absorb or reflect enough light to allow a good visualization of the sun 's globe without evoking a blinking reflex. Secondly, the filtering effect must cover light of all wavelengths

capable of inducing ocular damage, being 300-1600 nm wavelength.

Several filtering devices have been advocated for eye protection allowing safe solar observation (3). Most popular is a piece of glass that has been soot-blackened by holding it over a wax candle. Another easy-to-obtain filter is a piece of unexposed developed slide film, or overexposed and developed photo negative. Furthermore, it is suggested that the silvery coating of compact disks can be used as a solar filter.

Besides these popular devices, solar filters are commercialized for this purpose. For plain solar viewing, "solar eclipse viewer" glasses are available, which are worn as spectacles, and can even be used on top over own glasses.

For use with binoculars, telescopes and other viewing the instruments, an aluminum-coated mylar filter is available as a foil that can be applied on the objective side of the viewing device.

The aim of this study was to spectroscopically analyze several of the popular and commercially available solar filters in order to determine which are suitable for safe observation of a solar eclipse.

MATERIALS AND METHODS

MATERIALS

Six different devices that can be used as solar filter were spectroscopically evaluated:

1) An unexposed Kodak Elite II ISO 100 slide film that was processed in a standard E6 developing procedure.
2) An standard microscopy glass plate of 7.5 × 2.5 cm that was soot-blackened by holding it in the flame of a burning wax candle for approximately 30 seconds.
3) An audio-CD from a record shop ("Potverdekke! (it's great to be a Belgian)", Mister John, Pink Records, Inc.).
4) A recordable CD-ROM from 3M: CDR 650/74. This is the widely used goldcolored recordable CD-ROM that can be used in personal computers to digitally store data.
5) "Eclipse shades" obtained from the "Urania Volkssterrenwacht" (Mattheessenstraat 60 te 2540 Hove, Belgium), which are manufactured by "Rainbow Symphony, Inc", Reseda, CA91335, USA.
6) A piece of aluminum-coated mylar film that is also distributed by the "Urania Volkssterrenwacht".

METHODS

UV-Vis-NIR measurements were done on a Varian Cary 5 spectrophotometer at room temperature using a diffuse reflectance attachment. The spectra were recorded in absorption and transmission mode against a halon white reflectance standard in the range 2500-200 nm. The materials were measured in both absorption (in the presence of a white reflectance standard behind the sample) and transmission mode (in the absence of a white reflectance standard behind the sample).

RESULTS

1) UNEXPOSED SLIDE FILM (FIGURE 2)

When the slip of slide film was examined, a fair and linear blockage of visible light was observed in the 400-800 nm range, which will prevent the occurrence of a blinking reflex when observing a solar eclipse. However, infrared light of longer wavelengths readily passed through the film's emulsion.

2) SOOT-BLACKENED GLASS (FIG. 3)

In the visible light range, a non-linear absorption was found. The amount of visible light absorption will reduce the sunlight to levels that suppress a blinking reflex. However, similar to the unexposed slide film, infrared light of $>$ 800 nm is virtually not absorbed by this filtering device.

3) AUDIO-CD (FIGURE 4)

The audio-CD absorbed virtually all non-visible light in the ultraviolet ($<$ 400 nm) and the infrared ($>$ 800 nm) range. In the visible spectrum (400-800 nm), a fair amount of light absorption was found that prevents the reflective blinking when observing the sun.

Fig 1. Fundus photograph of solar burn retinopathy.
Note the small foveal defect.

4) RECORDABLE CD (FIGURE 5)

A bizarre filtering effect was found: in the visible light range, a relatively high transmission peak was found between 400 and 500 nm, while a high light absorption between 500 and 750 nm was found. Light of wavelengths exceeding 750 nm was transmitted through the disk material till wavelengths of approximately 1200 nm, whereafter a high light absorption

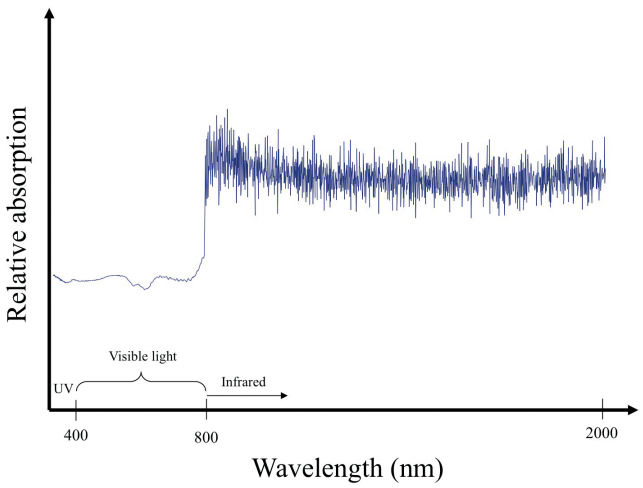

Fig 2. Slide film

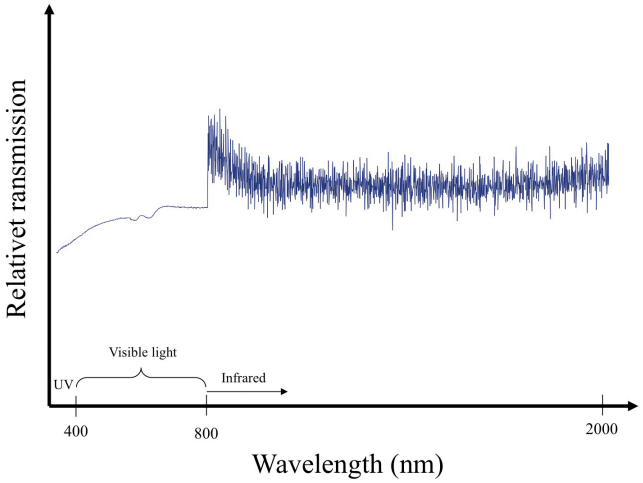

Fig 3. Soot-blackened glass

was found. The visible light absorption is not sufficient to prevent a blinking reflex when observing the sun globe.

5) ECLIPSE SHADES (FIGURE 6)

The eclipse shades were found to have a virtually linear absorption in the whole light spec-

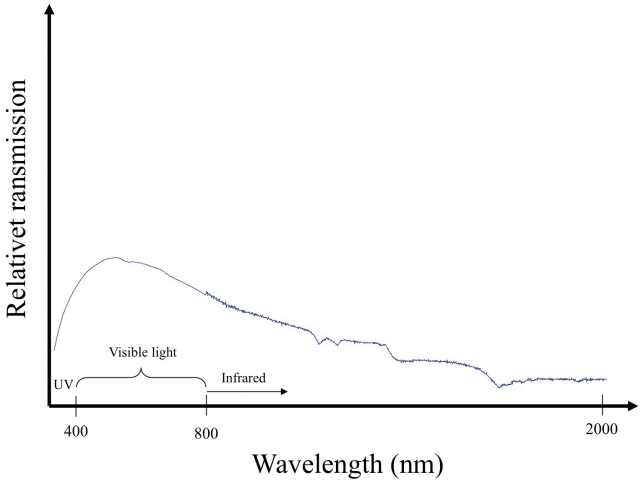

Fig 4. Audio-CD

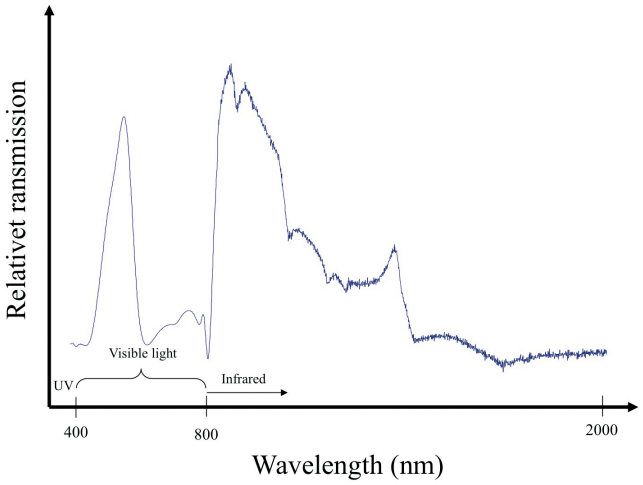

Fig 5. Recordable CD

trum ranging from 300 nm to more than 1600 nm. Furthermore, a high absolute light absorption was found, which allows a comfortable viewing of the sun without any blinking reflex.

6) MYLAR FOIL (FIGURE 7)

The aluminum-coated mylar foil presented similar characteristics as the eclipse shades: a

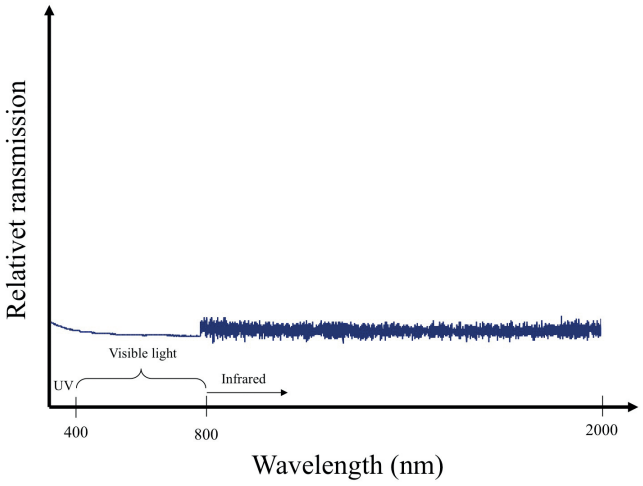

Fig 6. Eclips shades

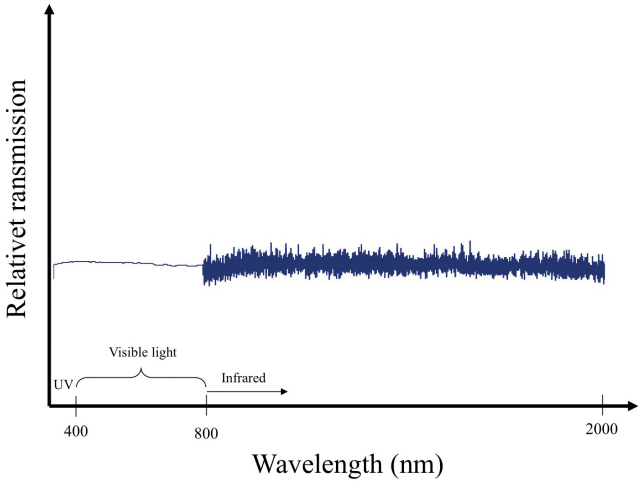

Fig 7. Mylar filter

virtually linear absorption of light of all wavelengths, and a high absolute light absorption. The absorption was slightly less than that of the eclipse shades.

CONCLUSIONS

Of all tested filters, the use of slide film or soot-blackened glass is dangerous and must be discouraged: although a comfortable viewing of the solar eclipse can be achieved due to the fair absorption of visible light by these filtering systems, the infrared light readily penetrates the eye and can cause retinal damage, which is not noticed by the viewer until severe (and possibly permanent) damage has resulted.

Also the use of a gold-colored recordable CD-disk is not advisable: both light in the visible and infrared range is inadequately blocked and can cause retinal damage. Moreover, comfortable viewing cannot be achieved with this filtering device.

The audio-CD we tested seemed an appropriate filter of blocking the sun light. However, a wide variety of audio-CD's exists and all types have different transmittance characteristics: some look even transparent for ambient light levels! Therefore, the use of audio-CD's for solar eclipse observation cannot be recommended: some types are suitable, but other disks are inappropriate for this purpose. Since it is impossible to know without spectroscopic evaluation, if a given audio-CD is suitable for solar viewing, the general use of audio-CD's cannot be recommended.

The commercially available solar shades however are highly suitable for solar viewing. First, a high light absorption and reflection is obtained, which allows a comfortable observation of the sun globe. Furthermore, a virtually linear absorption of all ultraviolet, visible and infrared wavelengths was found, which indicates that gazing at the sunlight is safe. These spectacles are available from the Urania Astroshop for 100,- BEF (Mattheessenstraat 60 te 2540 Hove, tel.: 03/455.24.93, Web: http://www.eclips99.be), and are also distributed by many opticians in Belgium.

Covering the objective of viewing instruments such as telescopes and binoculars with the aluminum mylar foil seems also a safe method for solar observation. It must be noted however that this foil must only be used at the objective

side (where the light enters the instrument), and not at the ocular side (where the image is viewed).
In conclusion: observing a solar eclipse can cause permanent eye damage. The only recommendable filtering devices for this purpose are the commercially available solar shades or the aluminum-coated mylar foil.

REFERENCES

(1) KRAUSS, J.M., PULIAFITO, C.A. – Lasers in ophthalmology. Lasers Surg Med 1995; 17: 102-159.

(2) LEYS, A., SWINNEN, T., HANNON, L., VAN WING, F. – Solar retinopathy and foveal cysts. Bull Soc belge Ophtalmol 1978; 182: 74-81.

(3) MAINSTER, M.A. – Solar eclips safety (editorial). Ophthalmology 1998; 105: 9-10.

.....

Reprints request:
PETER STALMANS, M.D., Ph.D.
Dienst Oogziekten UZ Leuven
Capucijnenvoer, 33
3000 Leuven
E-mail: Peter.Stalmans@med.kuleuven.ac.be.