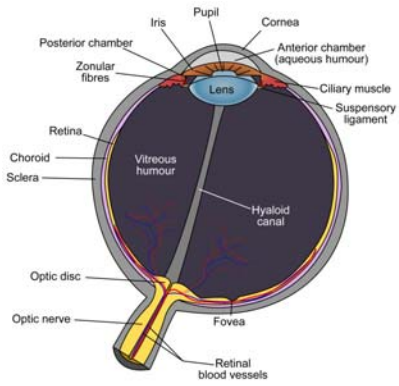
How to safely observe the Sun

The dangers of Sun gazing

We all know about the hazard solar UV rays represent to our skin... but can the Sun also damage our eyes?

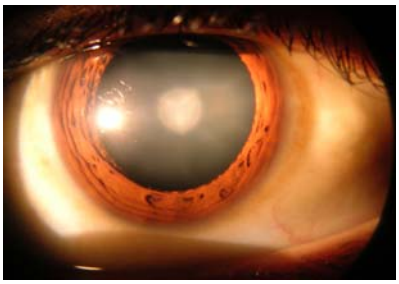


The human eye is less than 3 cm (1.2 inches) in diameter, and the pupil is less than 1 cm (around 0.3 inches), so it collects very little energy. On the other hand, the Sun emits an astronomical amount of energy. Which is more relevant?

The Sun emits around 64 million W/m^2 (Watt per square meter), but since that emission is in every direction, the amount that reaches the Earth is just below 1400 W/m^2, which is known as the solar constant. When you are looking directly at the Sun, the eye collects around 4 mW (milliwatts). This energy is distributed throughout all solar spectrum, and some wavelengths are more dangerous than others.

Infrared wavelengths slightly heat the retina (the area of the eye were light is focused), which may cause visual artefacts or even eye damage, from temporary to permanent blindness, depending on how much time you spend looking directly at the Sun. These damages are caused by sunburn-like damage to the retina. This can be amplified in the case of the young eyes of children, new lens implants, Sun angles near the zenith, and in locations at high altitudes.

Ultraviolet is rather harmless to the retina. However, prolonged exposure to UV light slightly yellow the eye lenses, making it more opaque with time, which eventually leads to cataracts (see image on the right).



All these problems are greatly amplified when you are using light focusing devices, such as binoculars and telescopes, which concentrate the light from the Sun.

Everyone has seen how to start a fire with a magnifying glass, but a telescope can focus much more light than a magnifying glass. Sunlight focused by a 10 inch reflector telescope can burn through six layers of 1 millimetre thick cardboard in a matter of seconds, so imagine what that would do to your eye!

How to observe the Sun

The safest way to observe the Sun is by using some kind of solar filter.

There are several types of filters from “cheap” (meaning less expensive) and easier to buy, to the more expensive ones.

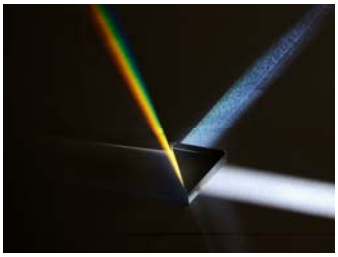
In the “cheap” category you have sheets of high density polymers (see image on the right). At first glance you might mistake these for aluminium foil, but they are very different, because they block not only visible light, but also infrared. The problem with these is that they degrade relatively fast and are very fragile, so you should take care not use them for a very long time.

A similar effect can be achieved with some types of welding glasses. However, to safely watch the Sun, they must be at least #14, and they should not be used in light focusing devices such as telescopes.

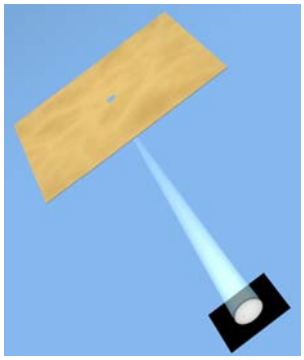
Although the “cheap” version can also be used in telescopes, usually telescope filters are very similar to mirrors (see image on the left). Like any other mirror, they reflect almost all the light that shines in them. But there is always a very small amount of light that goes through a mirror. When you're observing the Sun, it's exactly that small amount that is safe to watch. *(Be advised that a regular mirror is not specially designed for solar observation, so do not try to use your bathroom mirror to watch the Sun.)*

With these types of filters, the only solar activity you will be able to observe are Sunspots.

There is a third type of filters, which are used to observe specific wavelengths of sunlight. Unlike “regular” filters (like the ones described in the last paragraphs), that block a certain amount of sunlight, these filters (for example, H-alpha filters, like the one on the right) block sunlight by wavelength.



To understand how these work, think of a rainbow. A rainbow occurs when rain water refracts sunlight in such a way that it decomposes the Sun's white light in all the colours (of the rainbow, of course). The same happens when you shine the light from the Sun in a prism (see image on the left).



Now imagine that you block every colour of that rainbow, except a small slit in a specific colour of the spectrum. For example, if it's an H-alpha filter, your slit will be in the red area of the spectrum. H-alpha filters allow you to see three types of solar activity – Granulation, Filaments and Prominences.

Finally, if you don't want to spend any money, there is a safe, indirect viewing technique to observe an image of the sun – a pinhole projector (image on the right), where a pinhole or small opening is used to form an image of the Sun on a screen placed about a meter behind the opening.

What NOT to use

The are some urban myths that talk about other tricks that (supposedly) allow you safely observe the Sun. Here is a short list with some of those that ***DO NOT*** work.

- Exposed photographic film

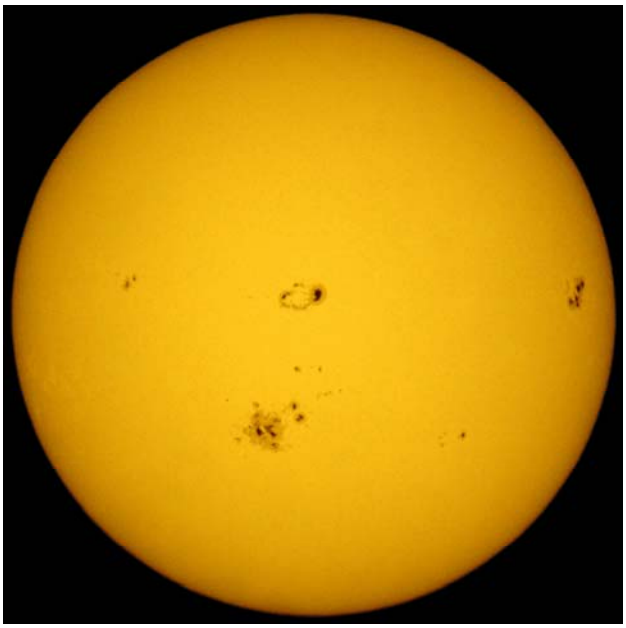
- Smoked glass

- Medical x-rays

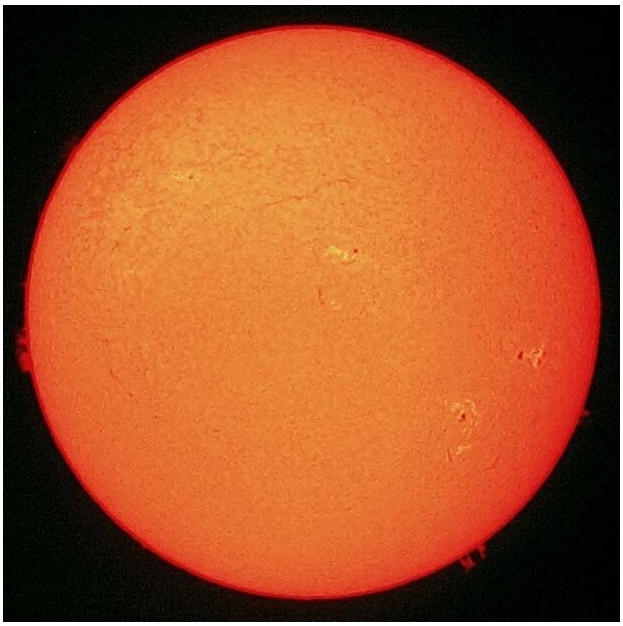
- Floppy disks

Please do not use any of these to look at the Sun. Even if they seem to block enough of the Sun's brightness, they either don't protect your eyes against UV or infrared light, and you can still damage your eyes.

What you will see



Sun, visible light (© Filipe Pires – CAUP)



Sun, H-Alpha (© Luís Carreira - Pátio da Astronomia)