 by Alan MacRobert

Filters for Sun-Watching

If you enjoy observing the stars, don't forget that there's a star a quarter million times closer than any other and 13 billion times brighter. And it appears enormous, as big in your telescope's eyepiece as the Moon. Of course, it's the Sun. If you've got a telescope, you're missing out if you don't equip it for observing our great, big daystar.

HAVE YOU EQUIPPED YOUR SCOPE FOR OBSERVING THE NEAREST STAR? WE TESTED SOLAR FILTERS — AND FOUND THAT THE BEST ONE COSTS THE LEAST!

Warning: the Sun can blind you, especially when its light is concentrated by a telescope. But if you use a proper Sun-observing filter and don't do something careless (such as letting the filter blow off in the wind), you can watch the Sun safely for a lifetime.

By a "proper" filter, I mean one that *goes over the telescope's front*, and that is *specially designed for safe Sun viewing*.

Years ago, small telescopes were often sold with "Sun cap" filters that went over the eyepiece in back. These were a terrible idea. They could crack or catch fire in the superhot concentrated sunlight behind the eyepiece, letting a blast of light into your eye. If you have one of these old relics lying around, go find it and throw it out. A filter over the front keeps virtually all of the Sun's light and heat from ever getting into the scope.

People sometimes get the notion to make their own solar filter out of any material that seems to dim the Sun enough. Another bad idea! Maybe the Sun *looks* comfortably dim through it, but you don't know how much invisible infrared or ultraviolet light may be getting through to burn a blind spot (painlessly) in your retina. You want a filter designed to block visible *and* invisible wavelengths.

Fortunately, many such filters for your telescope are on the market. Even more fortunately, the best (judging by our testing and others') also happens to be the cheapest!

In late 2006, the Sun is near the predicted minimum of its 11-year sunspot activity cycle. Even so, there's often a nice, detailed spot or two on the Sun's surface to check out, and activity on the Sun's surface is guaranteed to pick up in the next few years. Also, don't miss the transit of Mercury on November 8th (see page 38).

Filters to Choose From

Several types and brands of solar filters are sold today. Most fall into two categories. "White light" filters dim the Sun enough to view it safely and comfortably. "Hydrogen-alpha" (or "H-alpha") filters block all light except the narrow, deep-red wavelength emitted by hot hydrogen atoms.

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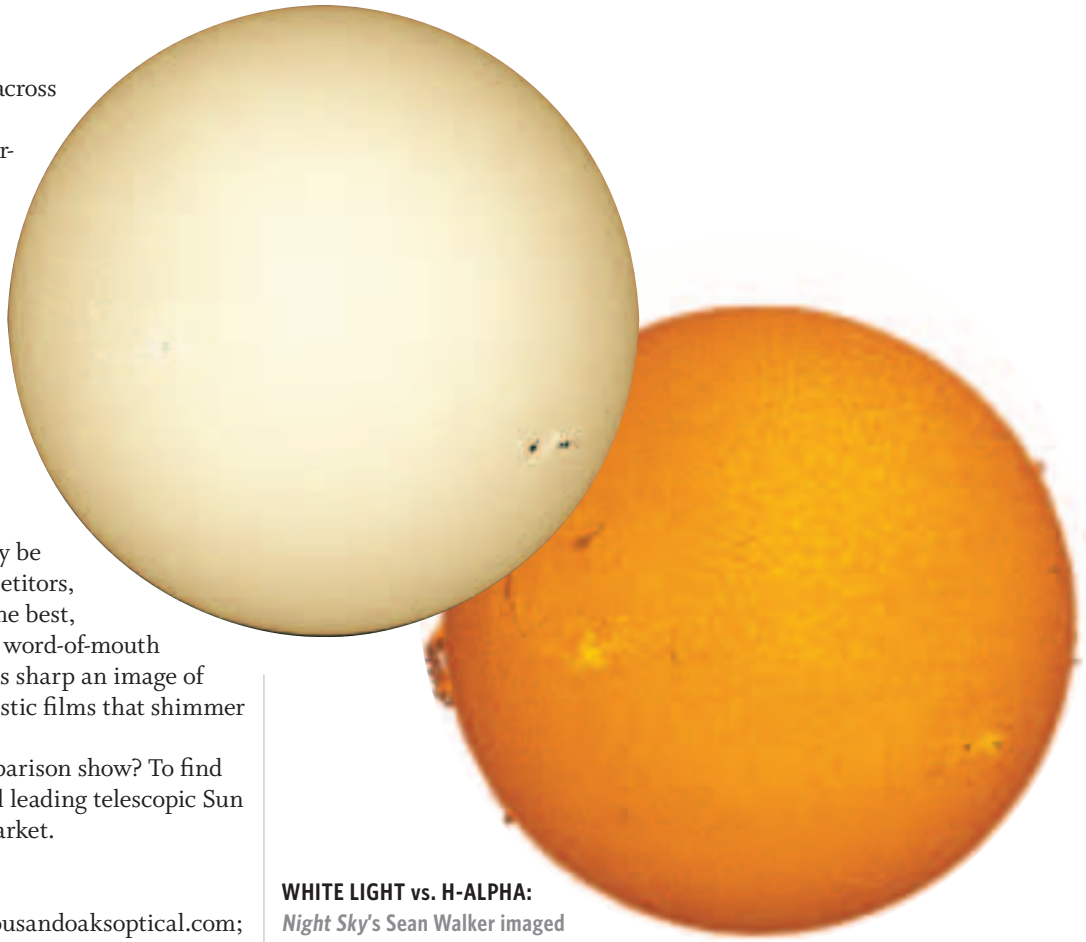
H-alpha filters reveal lots of detail across the Sun's surface that's invisible in white light, as shown in the comparison pictures at right. But they are much more complex and expensive, often come built into their own single-purpose telescope, and won't be covered here.

A white-light solar filter, on the other hand, is something every telescope owner should have. Some of these are made of metal-coated glass, and some are made of thin, wrinkly, mirrorized plastic. You might think a good-looking glass filter would obviously be better than its flimsy plastic competitors, but you would be wrong. All but the best, most expensive glass filters have a word-of-mouth reputation for showing not quite as sharp an image of the Sun as thin, cheap-looking plastic films that shimmer and flutter in the breeze.

What would a side-by-side comparison show? To find out, a while back we tested several leading telescopic Sun filters that are currently on the market.



WHITE LIGHT vs. H-ALPHA: *Night Sky*'s Sean Walker imaged the Sun on June 20, 2005, through a white-light filter *(upper left)* and a hydrogen-alpha filter *(upper right)* using similar telescopes. The latter reveals hidden detail, including *prominences* glowing brightly around the Sun's limb and seen as dark *filaments* silhouetted against the Sun's surface. But H-alpha setups are much more complex and expensive (starting at around $500) than ordinary ones.

The Products

Thousand Oaks Optical (www.thousandoaksoptical.com; 805-491-3642) sells glass filters with a metal coating on one side, called Type 2+, sized for various telescopes.

Metal-on-glass filters are also manufactured by J.M.B. (www.identi-view.com). These are sold in various sizes as Identi-View Class A Solar Filters, and you can buy them through several retailers: Adorama (www.adorama.com; 212-741-0052), Orion Telescopes & Binoculars (www.oriontelescopes.com; 800-676-1343), and others.

IGNORE THE WRINKLES: This homemade solar filter *(left)* uses Baader AstroSolar Safety Film on the front of a 5-inch refractor. If you buy the film in sheet form, you need to make a cell for it to fit your scope. Be sure to leave the film a little loose and billowy. Gordon Garcia observes the Sun through this setup from Hoffman Estates, Illinois. Garcia videotaped a nice sunspot group *(above)* through this telescope and filter.

NIGHT SKY: CRAIG MICHAEL UTTER

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Today's most popular solar-filter material is Baader AstroSolar Safety Film. It's sold by Astro-Physics (www.astro-physics.com; 815-282-1513), Kendrick Astro Instruments (www.kendrickastro.com; 800-393-5456), Adirondack Astronomy (www.astrovid.com; 518-747-4141), and perhaps others. You can buy it relatively inexpensively as a plain sheet of film and make a do-it-yourself cell to hold it on the front of your telescope, as shown at right in Donald Lane's step-by-step instructions. Various dealers and telescope manufacturers also sell the Baader film in preassembled, ready-to-use holders designed to fit particular scopes.

Finally, the late Roger W. Tuthill long sold filters made of thin, aluminized Mylar under the name Solar Skreen. Some of these may still be available, especially on the used-equipment market.

Of the filters I bought (anonymously) for testing, none showed any visible flaws. I sized them all alike, using cardboard rings, to a circular opening 3.7 inches wide. My test telescope was a 12.5-inch f/6 reflector with excellent optics. I mounted four filters at a time in a cardboard mask over the telescope's front (positioning them between the four spider vanes supporting the scope's secondary mirror). In front of the mask I put a rotating cardboard sector to cover all but one filter at a time. This way I could turn the sector to switch back and forth from one filter to another while watching the Sun in the eyepiece, making comparisons easy. In effect, I had four identical 3.7-inch telescopes feeding the same eyepiece with the turn of a dial!

At first look, all the filters offered sharp, contrasty views during brief spells of good atmospheric stability. But with repeated tests, subtle differences emerged. The consistently sharpest view was through the Baader AstroSolar Safety Film.

In working with the plastic films, I was careful not to stretch the material. A thin-film solar filter should never be pulled tight to make it nice and smooth. Stretching will spoil its optical quality and may also open swarms of microscopic cracks in the metal coatings, letting in stray light that will degrade contrast. The plastic should remain relaxed and a little billowy.

The Views

The most obvious difference among the filters is the color they show the Sun. The Thousand Oaks Type 2+ gives a deep orange image. Solar Skreen turns the Sun blue. The J.M.B. (Identi-View Class A) and Baader AstroSolar filters show the Sun in more natural shades of yellowish white and white with a slight purple tinge, respectively.

At first look using a magnification of 75×, all of the filters offered sharp, contrasty views during brief spells of good atmospheric stability. All revealed tiny details in sunspot groups, glimpses of streaky structure in the *penumbras* (gray fringes) of the largest spots, bright *faculae* (white patches) in active regions near the Sun's edge, and hints of mottling (*granulation*) all across the Sun's surface.

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MAKE YOUR OWN SOLAR FILTER

by Donald Lane

Recently the San Antonio Astronomical Association in Texas hosted a very successful workshop to show its members how to make solar filters for their telescopes using Baader AstroSolar Safety Film. The workshop went so well that I wanted to share our method with *Night Sky* readers.

We obtained our Baader AstroSolar film from Astro-Physics, Inc., though you can also get it from one of the online retailers listed at upper left. Typically you'll want to purchase a single small sheet (about $36) of the *visual* (not photographic) kind. The other items you'll need can be purchased at a craft store, or you may already have substitutes around the house.

You need to make a filter cell with a collar that will fit firmly over the front of your telescope. The collar must fit snugly enough that it won't blow off or get knocked off, but not so tightly that it stretches and damages the solar-filter film. If the fit is too loose, try lining the collar's inner wall with felt.

For telescopes with apertures of 6 inches or less, make a filter large enough to span the entire aperture of the main lens or mirror. For a larger telescope that has a central obstruction, consider making a smaller filter positioned off-axis to avoid the obstruction (and any supports it may have), as shown in the example below.

This finished off-axis solar filter is cheap, easy to make, and uses household materials.

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Making the Front Piece

1. Cut two rings from poster board or other thin cardboard. The outer diameter should match the outer rim of your telescope's front end. The inside diameter should be the size you want the filter to be, but far enough in from the outer edge to provide some stiffness.

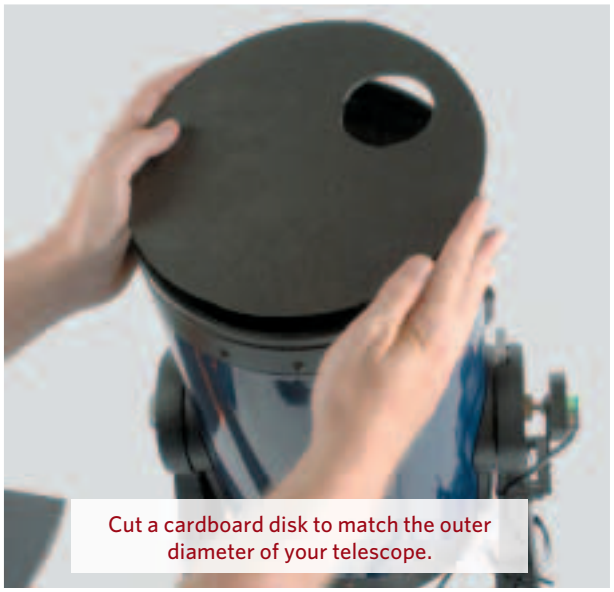
If you want an off-axis filter, as pictured below, you can make just one cardboard disk. In it, cut the largest round hole that will fit between the edge of the telescope's main mirror (as you look straight down the tube) and the central obstruction. Position the hole so it will line up between these correctly.

2. Cut a square of AstroSolar film a little larger than the rings. To avoid scratching the film, cover your work surface with tissue or paper towel. Hold the film only by the edges, or wear thin gloves, so you don't leave fingerprints on it.

3. Place pieces of double-sided tape, or dots of water-based glue, on one ring. Press the ring, sticky side down, onto the film. Minor wrinkles in the film don't matter; ignore them.

4. Once the glue dries, turn the ring and film over so it's film-side up. Apply adhesive to the second ring, and place it on top. Once everything is dry, trim the excess film from around the outer edge.

For an off-axis filter, you can simply tape a piece of the film over the hole. (Be sure to tape down all of its edges completely.)



Cut a cardboard disk to match the outer diameter of your telescope.

Avoid scratching the AstroSolar film by covering your work surface.

PHIL CASSELL (5)

Making the Collar

For a small refractor, a mailing tube or the cardboard core from a large roll of tape may be a perfect fit to the outer rim of your scope's tube. Otherwise, follow these steps to make a collar to hold your filter onto the telescope.

1. From flexible poster board, cut several 2-inch-wide strips lengthwise. If you have a large-diameter scope, glue two of these together by overlapping the ends a couple of inches. Allow the glue to dry.

2. Wrap a strip (or this long strip if needed) around the telescope's front end, and glue the overlapping parts together. Wrap additional strips around this form until you have a firm collar with several layers. Glue them all (be careful not to get glue on your telescope).

3. When all glue is dry, the collar may need to be adapted to fit past any mounting brackets or bolt heads on the sides of the telescope's front. Just cut notches in the collar to accommodate any such protrusions.

4. The collar should fit smoothly around the outside of the front piece that you made holding the solar filter. (If it doesn't, trim the front piece as necessary.) Press the collar around the front piece, and apply a bead of glue all along the inner joint.

Once the whole assembly is dry, apply duct tape or electrician's tape around the seam to block light leaks.

Test the whole thing again for a good fit on your telescope. If you have any concern about it coming off (especially amid a group of grabby kids!), you can tape it to the telescope while in use for added security.

Keep the filter clean and safe in its own storage box (a shallow plastic food-storage container works well), and it should last for many years.

This do-it-yourself project is sure to bring hours of daytime astronomical enjoyment. Best of all: light pollution is never a problem when you're viewing our closest star!

Donald Lane plans to watch the transit of Mercury with his friends in the San Antonio Astronomical Association.

Make the collar by wrapping thin cardboard strips around the telescope's front end. Glue them together, then glue the finished collar to the disk.

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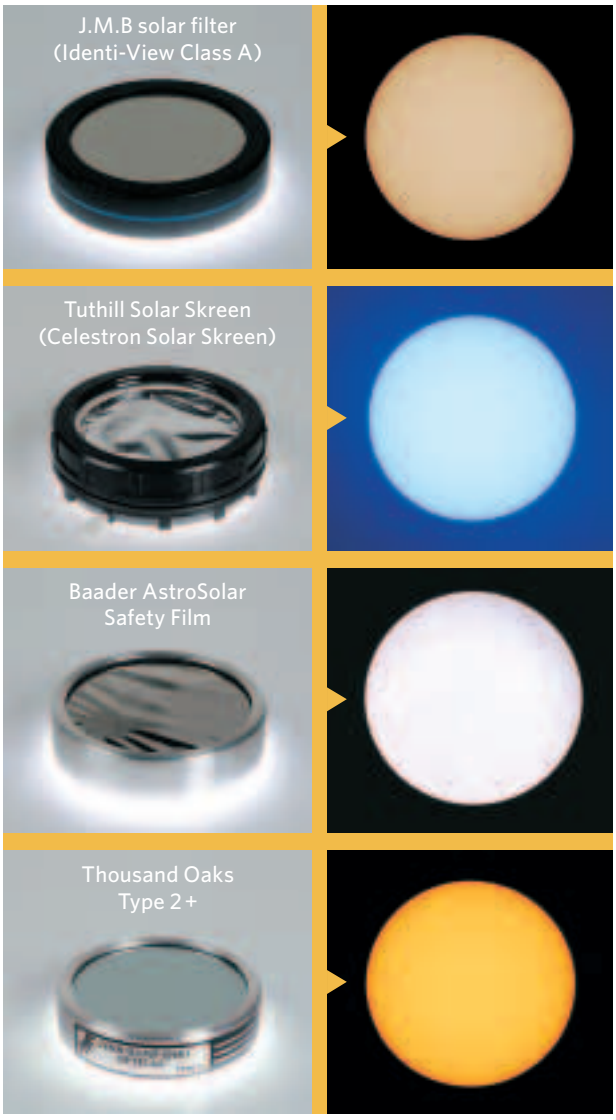

COLOR COMPARISON: A "white-light" filter doesn't necessarily show the Sun as white. Different materials give the Sun different tints. The most natural-looking in practice are the J.M.B. (Identi-View) glass filter and the Baader Astro-Solar plastic film.

However, the blue view through Tuthill Solar Skreen does emphasize solar *faculae* (bright patches around active regions) slightly better than the other filters, because faculae are slightly bluer than the surrounding yellow-white solar surface.

The filters also differ in how much light they scatter across the field of view. The blue glow around the Sun in a Solar-Skreen-filtered telescope is not the blue sky, but scattered light from within the filter that will slightly diminish contrast on the Sun's disk itself.

Baader AstroSolar Safety Film, especially at higher magnification (110×). In addition, the Baader filter let more light through, providing a brighter image for easier viewing while peering into a telescope amid full sunlight. With the others, I needed to put a towel over my head and the eyepiece to block out daylight while viewing at the higher magnification.

The glass filters, however, did scatter the least light; they showed a sharp-edged Sun on a black sky. The Baader film came next, with the sky around the Sun looking dark gray. Solar Skreen puts a wash of blue light across the field of view (which many users mistake for the blue sky). Too much scattered light will reduce contrast.

Associate editor Gary Seronik and I later tested the filters on his 3.5-inch Questar Maksutov telescope. We both reached the same judgments as I had using the 12.5-inch reflector. Although the differences in optical quality were very slight, they were detectable.

The good news is that any of these filters will reveal lots of solar detail when the Sun is displaying detail at all, and they'll easily reveal the tiny black disk of Mercury when it crosses the Sun on November 8th. Most of the time, the limiting factor is not going to be the optical quality of the filter but the notoriously poor atmospheric *seeing* (tiny rippling heat waves) during daytime.

So it's easy. Why not expand your astronomical observing from night into day?◂

Alan MacRobert, a senior editor for Night Sky *and* Sky & Telescope, *goes whole hog and uses a full-aperture solar filter on his 12.5-inch reflector.*

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