The Use of Filters

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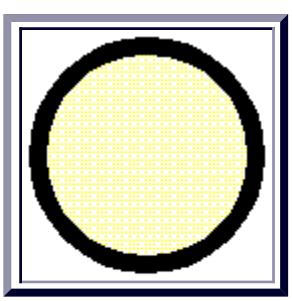
One of the puzzles of visual astronomy that many beginning amateur astronomers get caught up in is the use of filters. Which ones to purchase, and which ones are useful for what types of observing are the most frequently asked questions. Here, then, is a summary of most of the filters in current production and their uses, with a few hints thrown in from my own personal observations.

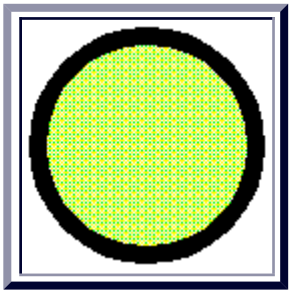
First of all, let's start with the question of why one uses a filter at all. Simply put, a filter can greatly enhance the human eye's perception of small details on solar system and deep sky objects. There are those amateur observers who maintain that they never use filters and that one doesn't need them. To this argument, I have only this to say; no pair of human eyes is perfect. If a filter helps you get better use out of yours, then use them. Judicious use of photo-visual filters can greatly enhance an observing session.

Filters work by blocking a specific part of the color spectrum, thus significantly enhancing the remaining wavelengths. Colored filters work by absorption/transmission, and instantly tell you which part of the spectrum they are reflecting, and therefore transmitting. The so-called light-pollution reduction and nebulae filters are very selective in the wavelengths they transmit. For these it is best to refer to the manufacturer's specifications on a given filter.

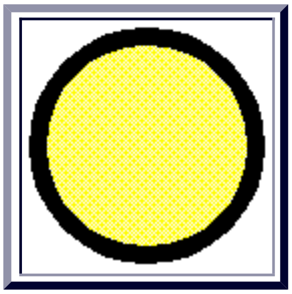
Colored filters are referred to by their Wratten numbers. The Wratten system was developed by Kodak in 1909 and has been the standard ever since. Filters used for photography, astronomy, and other applications all use this same standard. So here, then, is a summary of the filters most commonly used in astronomy.



#8 Light Yellow (*83% transmission*) This is used for enhancing the detail in red and orange features in the belts of Jupiter. It is also useful in increasing the contrast in the maria on Mars, and increasing the resolution of detail on Uranus and Neptune in telescopes with 10" or more of aperture. This is a great filter for enhancing lunar detail, too, particularly on telescopes with 8" of aperture or less.

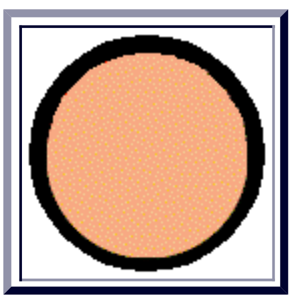


#11 Yellow-Green (*78% transmission*) This filter is great for bringing out surface details on Jupiter, and to some degree, Saturn. It darkens the maria on Mars and does slightly improve visual detail on Uranus and Neptune, again in telescopes with 10" of aperture or more. This filter is what I used primarily for observations of Jupiter after it was pummeled by Comet Shoemaker-Levy in 1994. It brought out the impact areas in excruciating detail.



#12 Yellow (*74% transmission*) Enhances red and orange features on Jupiter and Saturn, while blocking blue and green wavelengths. It also lightens the red and orange features on Mars, while reducing, or blocking, the transmission of blue and green areas; this increases the contrast between the two. It also enhances the blue clouds in the Martian atmosphere. This is one of my favorite Mars filters for that reason. Very nice for increasing contrast in lunar features also, in telescopes of 6" of aperture and above.

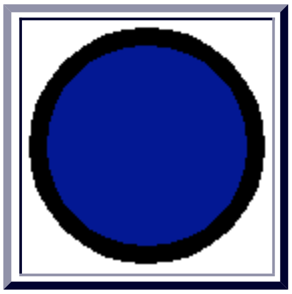
#15 Deep Yellow (*67% transmission*) This filter is used to bring out Martian surface features, and the polar ice caps. It can also be used to enhance the orange and red features, bands and festoons, on Jupiter and Saturn, and for low-contrast cloud detail on Venus. Try it also on lunar surfaces; it works nicely to improve the contrast. **Grins and Giggles:** Try this one for daylight observation of Venus and Mercury.



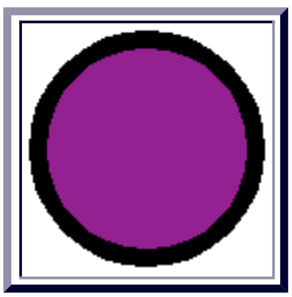
#21 Orange (*46% transmission*) The #21 orange reduces transmission of blue and green wavelengths, thus increasing the contrast between these areas and red or yellow or orange areas. It is great on Mars because of this. It sharpens the boundaries between these areas on the planet's surface. I also use it on Jupiter to sharpen the contrast in the belts and to bring out the Great Red Spot. It will also slightly increase surface details on Saturn. This one behaves very similarly to the #15 but gives slightly more contrast.

#23A Light Red (*25% transmission*) This is another great filter for use on Mars, Jupiter, and Saturn, but because of lowered light transmission, probably shouldn't be used on a scope of 6" of aperture or smaller. It performs many of the same functions as the #21 and the #15, but again, with more contrast than do either of these. It is also a great one to try for daylight observations of Mercury and Venus because it increases the contrast between these planets and the bright blue sky.

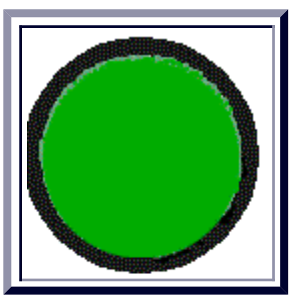
#25A Red (*14% transmission*) The #25A filter strongly blocks the transmission of blue and green wavelengths, which result in very sharply defined contrast between the cloud formations and the lighter-toned surface features on Jupiter. This filter is also quite useful for definition of the Martian polar ice caps and maria. However, because of the reduced light transmission, the #25A should probably only be used on telescopes with 8" of aperture, or more. Grins and Giggles: Try this one on Venus. Not only does it reduce the light glare, it really does some interesting things to the clouded Venusian atmosphere.



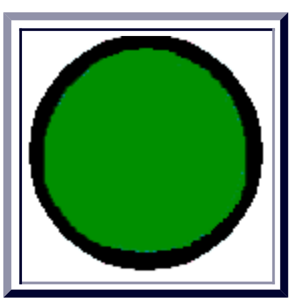
#38A Dark Blue (*17% transmission*) The #38A is very good for use on Jupiter because it strongly rejects red and orange wavelengths in the belts and in the Great Red Spot, thus increasing the contrast. It works well on Martian surface phenomena, like dust storms, and increases the contrast in the rings of Saturn. This is a good one to use on Venus, too, because of its low light transmission; it really increases the contrast of subtle cloud markings. The #38A should only be used on telescopes of 8" of aperture or more, because of the reduced light transmission.



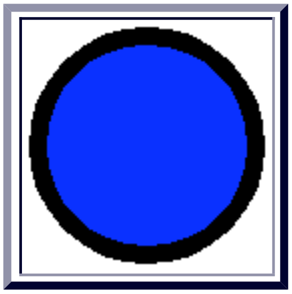
#47 Violet (*3% transmission*) This filter strongly rejects red, yellow, and green wavelengths, making it a good one to use on the Martian polar ice caps. It is THE filter of choice for observations of Venus because of its low light transmission and its ability to enhance upper atmosphere phenomena. It is also touted as being useful for providing contrast in the ring system of Saturn, but I have not found it to be particularly useful for this purpose. Great for enhancing lunar detail, also. Grins and Giggles: Try this one on Jupiter and the Galilean moons. The planet is electric purple, the moons hot pink. A psychedelic trip that's LEGAL!!



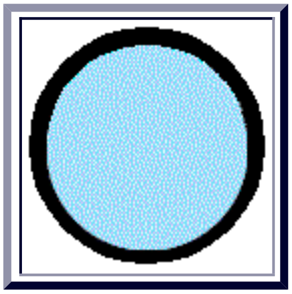
#56 Light Green (*53% transmission*) This filter is excellent for the observation of Martian polar ice caps and for the yellow tinted dust storms on the planet's surface. It also increases the contrast of the red and blue regions in Jupiter's atmosphere and cloud belts. Another one that is great for lunar observing also.



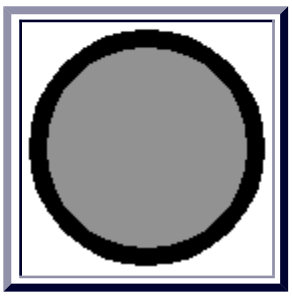
#58 Green (*24% transmission*) This filter strongly rejects red and blue wavelengths and increases their contrast on the lighter parts of the surface of Jupiter. It is also useful for enhancing the cloud belts and polar regions on Saturn. It does a fantastic job on increasing the contrast in Mars polar ice caps and also does a reasonable job of increasing the contrast of atmospheric features on Venus. Again, because of lower levels of light transmission, this filter probably shouldn't be used on telescopes of less than 8" of aperture.



#80A Blue (*30% transmission*) Many people say that if you can only buy one filter, this should be it. This is the one of two that come out of my filter case the most often. This filter is the best and most popular for the study of detail on Jupiter and Saturn. It enhances the contrast of rills and festoons in Jupiter's cloud belts, as well as details of the Great Red Spot. It also brings out detail in Saturn's belts and polar features. This filter is also very useful for lunar observing. **Grins and Giggles:** Try this filter to split Antares. It works very well for this purpose, especially when the two stars are at their maximum separation.



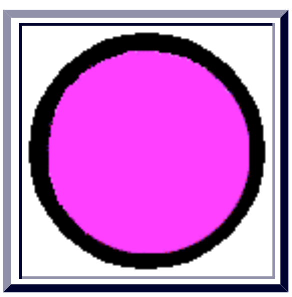
#82A Light Blue (*73% transmission*) This is the second filter that, along with the #80A, comes out of my filter case the most often. It works well on Jupiter, Mars, Saturn and the moon. Its pale blue color enhances areas of low contrast and avoids significant reduction of overall light level at the same time. I find this filter extremely useful. **Grins and Giggles:** Try this one on bright galaxies, particularly face-on spirals. I accidentally left it in an eyepiece when I swung over to take a look at M51. The detail in the spiral arms was quite pronounced over what I was used to seeing. It took me some time to figure out why. I've tried it on a number of bright galaxies since then and it really does a great job in increasing the detail in galactic structure. Also, try this one to split Antares. Either the 80A or the 82A works quite well for this.



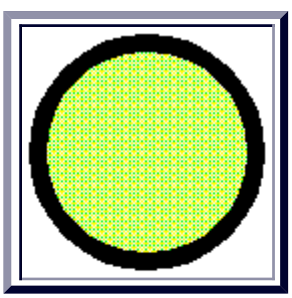
ND96 Neutral Density (*0.9 density, 13% transmission*) The neutral density filter transmits light uniformly across the entire visible spectrum. Because of this, it is an excellent filter to use for glare reduction, particularly while observing the moon with any telescope 4" of aperture and larger. Some people also use it to split difficult double stars, particularly those in which one member of the pair is significantly brighter than the other. I have tried this myself, but so far with limited success.

SPECIALTY FILTERS

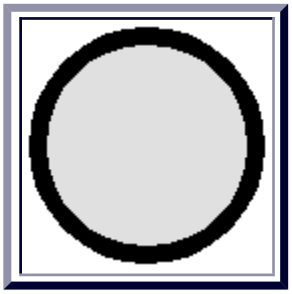
BROADBAND, OR LIGHT POLLUTION REDUCTION FILTERS



Orion SkyGlow This is one of a relatively new class of filters known as light pollution reduction, or LPR, filters. It is designed to darken the background sky by blocking mercury vapor light transmission and enhancing transmission in the hydrogen beta, doubly ionized oxygen (OIII) and hydrogen alpha regions of the spectrum. What this means to the layman is that the filter increases the contrast of deep-sky objects, emission nebulae in particular, with the background light-polluted sky. This filter doesn't work particularly well on other types of objects, but does a fine job with emission and planetary nebulae, because they emit light in the hydrogen alpha, hydrogen beta, and doubly ionized oxygen wavelengths.

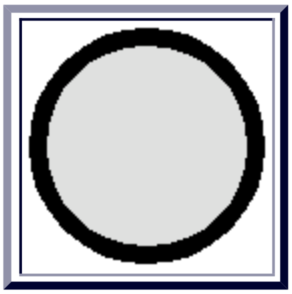


Meade Broadband This is another type of LPR filter; the spectrum of wavelengths passed by the Meade Broadband is nearly identical to that of the SkyGlow. Since I very seldom observe from light polluted skies, I am probably not getting the maximum benefit from my Broadband, but even under dark skies it is quite effective in improving the contrast of emission and planetary nebula. One thing I have found out in observing planetary nebulae, though – use of these filters on M1 under even a fairly light-polluted backyard sky can help bring out such diffuse nebula as M1. Under a VERY dark site. M1 will reveal detail that is not quite as clear without the filter.

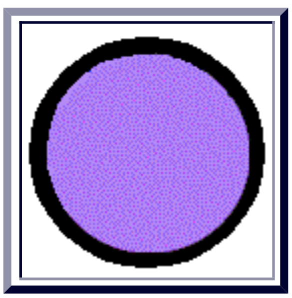


Celestron LPR Celestron recently came out with this filter. It also enhances the transmission of light in the hydrogen alpha, hydrogen beta, and doubly ionized oxygen wavelengths. I have never used it, so have little to say on its performance, but I would expect it to react very similarly to both the SkyGlow and the Broadband.

NARROWBAND FILTERS



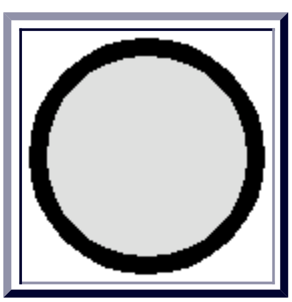
Lumicon Ultra High Contrast (UHC) This is probably the most focused of narrowband filters. This filter performs equally well under skies with some light pollution, or a dark sky site. It provides great contrast on emission and planetary nebulae. Of the three in this category, this is my favorite. It does a great job in bringing out detail on diffuse nebulae such as M1.



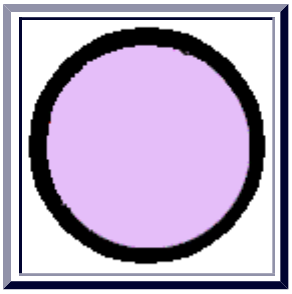
Orion UltraBlock This filter optimizes transmission of light in the hydrogen beta and doubly ionized oxygen wavelengths, as well as strongly blocking (99.9%) mercury and sodium emission bands. Put simply, it blocks all types of light pollution, from incandescent to fluorescent lighting, which broadband filters do not stop. It provides great contrast on planetary and emission nebulae, even from heavily light polluted areas. The Ultrablock also has very similar bandpass and performance as the Lumicon UHC, and the Thousand Oaks Type II. It does, however, have a more rounded and very slightly narrower bandpass than the UHC. It also doesn't have the deep-red bandpass for hydrogen-alpha that the UHC has. Sirius also makes a narrowband filter that is "tunable" in bandpass.

Meade Narrowband This filter also optimizes transmission of light in the hydrogen beta and double ionized oxygen wavelengths, but unlike the UltraBlock, it also transmits hydrogen alpha emissions as well. The difference between the BroadBand and the NarrowBand is that the NarrowBand is more focused. This is THE best filter for use on M27, the Dumbbell. Nothing else comes close. This filter's characteristics, in terms of bandpass width, are almost identical to the Lumicon UHC.

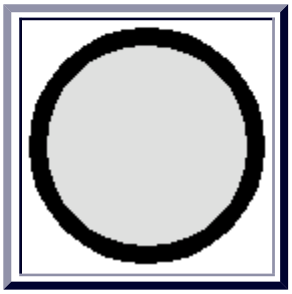
OTHER SPECIALTY FILTERS



Lumicon OxyIII This filter is quite specialized in that it allows light transmission only in the doubly ionized oxygen wavelengths. This is the filter of choice for the Veil and does amazing things with other emission nebulae whose predominant emissions are in the doubly ionized oxygen range. **Grins and Giggles:** Having difficulty splitting Antares? Try the OIII on it. It turns the primary star into what looks like a red LED, and the companion into a green one. Pretty cool! You can try it on other doubles too, where the primary star is much brighter than the companion.



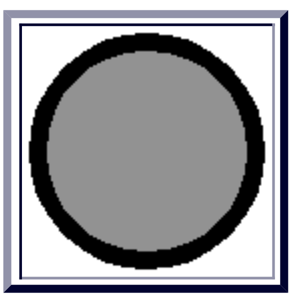
Lumicon H Beta This filter is so specialized, it is really only good for two objects; IC 434, the emission nebula surrounding the Horsehead Nebula in Orion, and the California Nebula. Both of these objects emit strongly in the hydrogen beta portion of the spectrum. While it is possible, just barely, to catch a glimpse of the Horsehead without the H Beta, the view with it is far more stunning. The filter emphasizes the glow of both of these nebulae, turning them red. In the case of IC 434, the red outline around the actual Horsehead itself (B33) is what makes it visible. The California Nebula is similar in that it is just barely visible without the H Beta. With it, the California "shape" becomes clearly visible. This filter can also be used for viewing some nebulae; unfortunately most of them are quite faint.



Solar Filters These fall into two basic types: optical mylar and coated glass, often referred to as a Type II. Both Thousand Oaks and Orion make these filters, which are an absolute must for solar observing. The solar image through mylar is a pale blue; through the glass filters it is orange. Sunspots and faculae are readily visible. They can either be purchased for the full aperture of the scope, or smaller and used off-axis. The glass filters are more expensive, but more durable. If scratches or pinholes appear on these filters, you can simply cover them over with a black waterproof felt-tip pen. This will in no way diminish light transmission.

Hydrogen Alpha These filters are also used strictly for solar observing. They transmit strongly in the hydrogen alpha portion of the spectrum, thus revealing solar prominences and flares. They come in three basic types; as heated interference filters – the DayStar type, or as "T=Scanners", which are small filters that can be tilted in front of the eyepiece to tune the wavelength and are low transmission sub-angstrom bandwidth solar filters. The third type is a low transmission 1.5 angstrom bandwidth solar prominence filter. DayStar filters (multi-element sandwich construction monochromators) are expensive, from $1500-$3500 for the amateur on up to $8000 for university grade. They employ an 80 layer interference filter in an "oven" which maintains a constant temperature. They are graded by how sensitive they are in their resolution, in angstroms; .9, .8, .7, .6, and .5, with the .5 being the most sensitive. Unheated versions can be purchased for as little as $800. The Coronado line falls into the category of a T-scanner.

The T-scanners are relatively inexpensive. They look like a nebula filter in a large holder that goes in front of the eyepiece and can manually tilted to tune the frequency of the light. Both types, the DayStar an the T-scanner, require a red "energy rejection filter" over the objective and an f/30 optical system – usually achieved by using an off-axis sub-aperture mask and filter. The f/30 focal ratio also gives very high magnification.



Polarizing Filters These filters adjust the brightness of images to a more optimal level for observing. They consist of two polarizing layers mounted in a rotating cell. They vary the light transmission from 3% to 40% and are most frequently used for lunar observing. The light transmission can be varied depending on the phase of the moon.

There are probably other types of filters out there that are in use by some astronomers, but this list covers those that are most commonly used. You can obtain a set of 100 colored filters from companies like Edmund Scientific; these filters are acrylic, and very inexpensive. They come in two sizes and can be held in front of the eyepiece to see the effects. The smaller size, 1.5" by 3.25" is extremely convenient for eyepiece cases. The larger size, 3" x 5", can be cut into four pieces and mounted in cardboard slide mounts, thus making four sets of very inexpensive filters. The slides can then be held over the eyepiece for observing. Each of these sets comes with the transmission wavelength graph for each filter.

Filters can also be stacked on top of each other to obtain the characteristics of each at the same time. Keep in mind that the more filters you stack, the more you reduce light transmission. Most people, when stacking filters, will stick to the lighter colors. Also, keep in mind that if you stack a red, green, and blue filter together, you have essentially created a neutral density filter which will block all wavelengths. For some objects this would be a total disaster.

So, which ones should you buy? You may wish to order an inexpensive acrylic set and try them out before you purchase the more expensive glass filters, at least for the colored filter categories. As for other LPR and nebulae filters, it is best to try them out with your own telescope, your viewing conditions, and your own eyes, if possible, before making a decision. It is also a good idea to educate yourself on the use of filters in general. Filters improperly used can make for less than optimal observing; but they can greatly enhance an observing session if the observer knows in advance what they can, and cannot, do.

As of April, 2003, Parks Optical purchased what was left of Lumicon. They have promised to produce the same filters with the same quality as Lumicon did when it was in business. Parks has also announced that they will produce a line of colored planetary filters that will be of far better quality than those that are already on the market.

With much thanks to Robert Haler, David Knisely, and Chuck Hards for pointing out errors contained in my assessments.

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