Planetary Filters for Small Telescopes

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During our observing career of several decades the universe was very generous to us: We witnessed a comet impact on Jupiter, we saw frosty ice clouds on Mars' limb, we studied lunar rilles and the tiny craterlets inside of Plato, we observed passages of the Jovian moons in front of their planet, we were fascinated by the lighting up of Saturn's rings on opposition date, we studied hazy structure in Venus' upper atmosphere and followed a mighty storm on Saturn.

For all this, we never used a telescope of more than 11cm aperture. The bottom line is, a small telescope can show you a lot, even on planets. Although widely underestimated, a telescope in the 4 inch class is a powerful instrument that can provide you with fascinating views of our solar system's planets. Besides high optical quality, proper collimation, a night of good seeing and a lot of patience there is one tool that can improve your views significantly: a set of the right filters.

What is the right filter set?

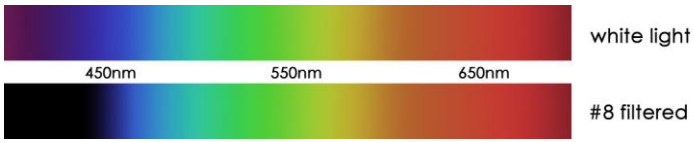
There are so many filters available that one can easily get lost. Even the manufacturer's recommendations are of no great help, since they are mostly for larger apertures of eight inch and over. That is why this article gives a recommendation for a filter set that matches perfectly with a small telescope of an aperture between 70 and 110mm. The filters #8 light yellow, #21 orange, #80A blue and Baader Neodymium are an ideal combination for planetary observing with a small refractor, Maksutov or Newtonian telescope.

What to expect from filters?

When observing detail on the Moon and the planets you have to remind yourself, this game is all about contrast. Contrast in general is defined as the ratio of two brightness values. If the brightness-ratio (or contrast) between two planetary features is high enough, you might separate them. If the contrast is too low, you won't. This is where planetary filters come in: In some cases they are enhancing the contrast and therefore the visibility of planetary and lunar features. How and when they are doing this is described on the following pages. But before you dive into the colors, one last warning: The contrast enhancements filters provide never are stunning. So don't expect too much, keep your eyes and your mind open and enjoy the subtle but fascinating improvements your planetary views will gain.

#8 light yellow

The #8 light yellow filter cuts off the violet and deep blue part of the spectrum. At a wavelength of about 450nm the filter gets transparent and all higher wavelengths from medium blue to deep red pass unchanged.



What to expect in the eyepiece

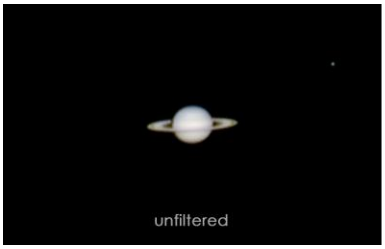
All celestial objects get a slight yellowish hue. The #8 light yellow filter has an overall transmission of about 85% and dims the telescopic image only slightly.

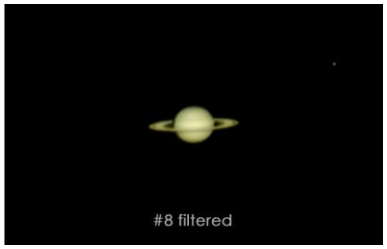
Moon: On the Moon, the #8 light yellow filter is useful to enhance details. Lunar craters, mountains and rilles look a little crisper.

Mars: The dark albedo features on Mars stand out a bit more prominent.

Jupiter: Jupiter's cloud belts are somewhat enhanced.

Saturn: With a small telescope, the #8 works especially well for Saturn's cloud belts and polar regions. These low contrast features may be hard to discern in a small telescope - the light yellow filter can make the difference.





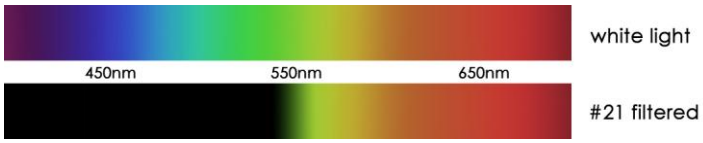
Great Saturn Filter
Simulated small telescope view of Saturn unfiltered and #8 filtered

Comets: The #8 may also be used on bright comets to enhance the contrast of the dust tail.

All objects: When used with an achromatic refractor, the #8 filter eliminates part of the chromatic aberrations, which introduce violet and blue stray light into an image. Since the #8 yellow filter cuts off violet and deep blue, it reduces this unwanted blurring and the contrast of the telescopic image improves.

#21 orange

The #21 orange filter cuts off the violet, blue and green part of the spectrum. At a wavelength of about 550nm the filter gets transparent and all higher wavelengths from yellow-green to deep red pass unchanged.



What to expect in the eyepiece

All celestial objects get a distinct orange hue. The #21 orange filter has an overall transmission of about 50% and dims the telescopic image noticeably, but not as much as the red filters #23A or #25A would do. For a small telescope it is the ideal filter on the red side of the spectrum.

Moon: For observing small detail along the terminator, the #21 is a very good choice. Contrast is strongly improved.

Mars: The #21 orange filter is very useful to enhance the dark albedo features on Mars. These have a bluish/greenish hue, with the #21 in place they stand out better against the bright orange background of the planet's disk.

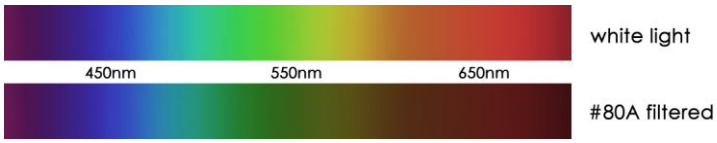
Great Mars Filter
Simulated small telescope view of Mars unfiltered and #21 filtered

Jupiter: On nights of very good seeing, the filter may be used to enhance the bluish features that can be found in Jupiter's atmosphere, like festoons or the polar regions.

All objects: Filter #21 orange is especially useful for telescopic twilight observations, for example of Mercury, Venus or the Moon. Since the filter cuts off blue colors, it considerably darkens the twilight sky and celestial objects stand out better.

#80A blue

The #80A blue filter lets violet and blue light pass nearly unchanged. Around a wavelength of 500nm transmittance drops and green, yellow, orange and red light still passes but only strongly dimmed to about 20%.



What to expect in the eyepiece

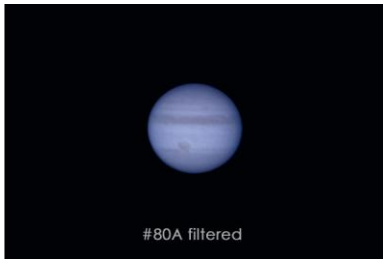
All celestial objects get a distinct blue hue. The #80A blue filter has an overall transmission of about 30% and dims the telescopic image considerably, but not as much as the blue filter #38A would do. For a small telescope it is the ideal filter on the blue side of the spectrum.

Moon: Viewing the bright part of the Moon off the terminator, it greatly improves the contrast of maria and crater rays.

Venus: When Venus is high in the sky and seeing is stable, the #80A may be used to look for shadings in Venus' upper atmosphere.

Mars: Since the blue filter darkens Mars' orange disk, it works great to bring out the polar ice caps and the white or bluish limb haze.

Jupiter: On Jupiter, the #80A blue filter darkens the orange colored cloud belts and the Great Red Spot and makes them stand out better.

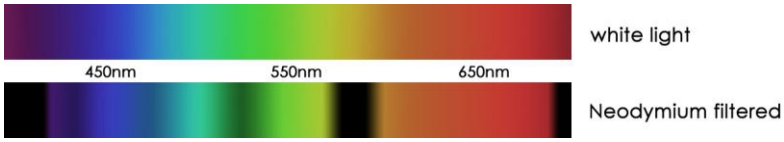


Great Jupiter Filter
Simulated small telescope view of Jupiter unfiltered and #80A filtered

Comets: The #80A may also be used on bright comets to enhance the contrast of the gas tail and the coma.

Baader Neodymium

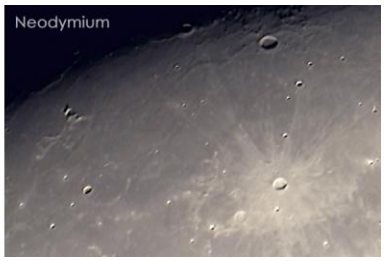
The Baader Neodymium has a complex transmission curve with several sections of reduced transmittance. The most prominent gap is around 580nm, filtering yellow light almost completely out.



What to expect in the eyepiece

All celestial objects get a weak blue hue that is practically unnoticeable. The Neodymium filter has an overall transmission of about 75% and dims the telescopic image only a little. The filter performs a color separation and therefore enhances colors and contrast while at the same time leaving natural colors almost intact.

Moon: The Neodymium filter gives a nice overall contrast enhancement. Contrast improvement of details is nearly as strong as with filter #21 and the Moon's color is hardly altered at all.



Great Allround Filter
Simulated small telescope view of lunar detail unfiltered and Neodymium filtered

Venus: The Neodymium filter helps to detect the large-scale C- or Y-shaped features in the upper layers of Venus' atmosphere.

Mars & Jupiter: With the Neodymium filter in place, detail on both planets is enhanced. The enhancements are not as strong as with #21 orange and #80A blue, but with the benefit of a neutral look.

Saturn: The Neodymium filter mildly enhances the cloud belts, comparable to the filter #8 light yellow.

Other objects: Since the Neodymium filter blocks yellow light, it reduces artificial skyglow. This effect is quite weak and not comparable to what a true deep sky filter does. But the filter may be of some use when observing star clusters or galaxies.

Filter Guide for Objects

As mentioned above, the four filters #8 light yellow, #21 orange, #80A blue and Baader Neodymium make an ideal set for any small telescope. If you want to buy only one planetary filter, go either for the #8 light yellow or the Baader Neodymium. Both are nice allrounders. When your telescope is a small achromatic refractor, you might want to consider the Baader Semi Apo filter instead. This filter basically is the same as the Baader Neodymium, but with a slight cut-off at the blue end to reduce chromatic aberrations.

The table below gives a summary of the effects the filters have on different targets:

	#8	#21	#80A	Neodymium
Moon	Light overall contrast enhancement	Enhanced contrast of detail on the terminator	Enhanced contrast of maria and crater rays on the bright side	Overall contrast enhancement
Mercury		Darkened twilight sky		
Venus		Darkened twilight sky	Enhanced contrast of shadings in upper atmosphere	Enhanced contrast of shadings in upper atmosphere
Mars	Light overall contrast enhancement	Enhanced contrast of dark albedo features	Enhanced contrast of polar caps and limb haze	Overall contrast enhancement
Jupiter	Light overall contrast enhancement	Enhanced contrast of festoons and polar regions	Enhanced belts and Great Red Spot	Overall contrast enhancement
Saturn	Light overall contrast enhancement			Light overall contrast enhancement
Comets	Enhanced dust tail		Enhanced gas tail	

Trust Your Own Eyes

All descriptions in this article on what the filters may improve are from first-hand experience, using small telescopes with apertures between 70mm and 110mm. But the best advice we can give you for using planetary filters is to experiment and find out for yourself what each filter does and for which applications it works.

On the Internet a lot of color filter descriptions can be found, specifying exactly which filter is helpful for what. These descriptions are mostly provided by manufacturers and telescope dealers. Since they often have the exact same wording, copy & paste seems to be a common practice in the eyepiece filter selling business. Needless to say, repeating the same information over and over again doesn't make it more reliable. For example, there is the persistent green filter myth. The legend says that a green filter is the most important contrast filter for a small telescope. Sure it is true that a green filter like #56 gives a nice contrast enhancement on several occasions. But in our experience there is absolutely no application for a green filter on a small telescope that can't be realized with either the #21 orange or the #80A blue. A green filter would be a redundant piece of equipment and for this simple reason it is not part of our recommendation for a basic planetary filter set.

Also keep in mind that when you observe a planet a huge number of varying factors are involved. To name only a few: Scattering in the planet's atmosphere, scattering in the Earth's atmosphere, stray light in your instrument, color correction of your instrument, color correction of your eyepiece, irritation by glare, color contrast of the features observed, the highly individual color and contrast sensitivity of your eyes etc. So there really can be no fixed rules which filter works best for which object.

All images and illustrations by the authors.

*The authors **Karoline Mrazek** and **Erwin Matys** are founding members of the astrophotography group project nightflight. Check out their images, tests and tools at www.project-nightflight.net.*