Instruments and Imaging Section
Technical Tips No. 9
30 May 2013

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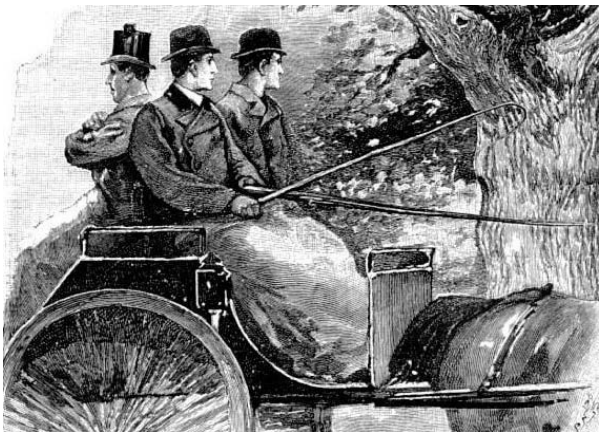
In his early years, J. Hedley Robinson (1905–1991) was chiefly interested in variable stars and made thousands of observations. Later, however, he turned to lunar work and then planetary work, and from 1965 to 1980 was Director of the Mercury and Venus Section. He was a pioneer in the use of filters in lunar and planetary observation, and the paper reproduced here appeared in the *Journal*, 90 (1980), 434–7. Although published more than three decades ago, the types of filter used for visual planetary work remain essentially the same.

The mystery object in the previous *Technical Tips* is a steam road carriage by Cooke of York, *c.*1865, banned due to its high speed of 8 mph. What is the mystery object at top right?

The use of colour filters in visual planetary observation

J. Hedley Robinson



Alright, don't sulk... you can *both* borrow my set of filters

First, it must be made clear that filters cannot improve the telescope's prime focus image, but they can be used to clean it up and to render visible detail easier to see. This can relieve eye strain and enable better work to be accomplished. There are four main uses of filters:

1 To reduce glare from bright objects, for which purpose a neutral filter is often employed.
2 To cancel chromatic aberration by supressing unwanted colour, and so clean up the image.
3 To enhance an image by transmitting light of the colour of that image. Typical uses of this kind are red for the Great Red Spot on Jupiter, green for the cusp caps and bright areas of Venus, and orange or yellow for detail in Mercury and Mars.
4 To suppress colour; for example, to render red objects black through a blue filter, as is often done with Jupiter and Saturn.

Choice of filter

Apart from neutral filters, for which density seems to be the main criterion and which are used to diminish the glare of an image, colour filters should be of as narrow a cut as may be feasible. That is to say, light of a limited range of wavelengths should be passed by the filter and other wavelengths should be cut off completely. The passband should be as narrow as conditions permit to avoid any possible overlap, because unwanted wavelengths, if transmitted, destroy the advantages gained by the use of the filter.

The density of a filter is related to the area of the telescope's light-gathering power. For small instruments a light filter, passing as much light as admissable, is desired. Larger instruments with their extra light-gathering power may accommodate denser filters with narrower cut-offs.

Eye response is also a limiting factor. Light between the limits of about 3500Å and 7000Å – that is, from blue to red – is the limit of wavelengths available for visual observation. It must also be remarked that the eye's response to colour (wavelength) is not the same as that for a photographic emulsion, but with the latter we are not at present concerned.

These conditions for red and blue light were well met by the Dufay Tricolour series of filters, which are not now available. However, similar suitable filters have been selected from the Kodak Wratten series and are given below. They may be obtained through any good photographic dealer or direct from Kodak if difficulty is encountered.

They are recommended in gelatine form for cheapness, and may be cut into about 25-mm squares for use. These offcuts should be mounted between glass slips, such as microscope slide glasses, and the edges taped to prevent damage and the entry of damp. They should be stored in a dry dark place. (A wooden box is ideal if kept indoors and not in the observatory building.)

The filters must not be touched with the fingers during mounting, because fingerprints render the transmission faulty and will destroy the image. A pair of tweezers used at the corners of the offcuts will be found useful when mounting them.

Method of use

Placed in front of the eyepiece, out of the focal plane, the filters can be arranged easily on a reflector. In the case of a refractor their use would entail cutting slots in the draw tube, which is not recommended because it weakens the tube and can lead to trouble. The alternative is to mount the filters in a slide fixed between the eyepiece and the eye. An old sun-cap with the glass filter removed makes a good base on which to fix the slides, because the glass slip can be pushed across the exit pupil to enable various filters to be used in succession. If used in this position there may be some restriction of eye clearance behind the eyepiece, especially if the observer uses spectacles, but experimenting with various eyepieces should resolve the difficulty. Use the eyepiece that gives the best definition and clearance.

The suggestions that follow are the result of many years of use of filters, and may help those embarking on this most interesting method of observation.

Mercury

An orange or yellow filter has been used to advantage for seeing detail on the disk, but the author has done very little in this area of observation because of poor seeing conditions. There is room for further experiment.

Venus

Here the situation is much different. As found by the author in 1956 and by other observers in 1959, the phase of Venus is smaller in blue light than in red. The terminator shading is broad in blue, and narrower in red, as it is

also in yellow light. This narrower terminator shading makes phase estimates much easier to evaluate.

Blue light seems to be scattered by the high atmosphere of Venus, so producing different cloud patterns from those seen in yellow or red light.

Choice of a suitable filter for general observation would seem at first sight to fall in the green area of the spectrum. However, green enhances the light areas and cusp caps, so rendering a false picture of the disk as a whole. Therefore, the yellow area was selected as being nearer the true image. Yellow light detail does not differ greatly from that in white integrated light, but the use of the yellow filter does cut down to a large extent errors in phase estimates made from measured drawings. Therefore, yellow light has been used for phase values, green for light areas when necessary, and when these are not clear in yellow.

Phase anomalies as between blue and red light – that is, as between 4400Å and 6500Å, have been shown to average about 3% throughout an average elongation. This difference will vary between observers with a colour appreciation difficulty. Therefore, the yellow filter should provide a more accurate rendering of phase, and cancel out the root errors produced by various observers with differing colour appreciation, by bringing all observers into line with light of a fixed wavelength. Plotting of observations of phase has vindicated this course over the years.

Mars

The use of orange or yellow filters for detail has been established for some long time, but the blue Wratten 80B has recently come into use with some success for observing cloud formations on Mars.

Jupiter and Saturn

The suppression technique has been used to advantage by viewing these planets through a blue filter, which denies the passage of red light, and so renders the ruddy belts and red spot black against a light blue background. Titan has been shown to vary in brightness as between red and blue.

Suitable filters

The following suggestions are made as a result of some years of experiment and experience in the use of filters.

Yellow Kodak Wratten 15 (very deep yellow) transmits from 5100Å into the red, and cuts off all blue excepting a very small transmission at 3200Å, which is negligible. The strongest effect is from 5600Å into, and including, the red.

Red For larger instruments the Wratten 29 deep red filter absorbing ultraviolet, blue, and green, and transmitting from about 6000Å downwards, will be found suitable. For smaller instruments with less light grasp, the Wratten 25 type standard filter will be found best. It passes light from 5800Å downwards, and so gives the eye a little more latitude than the 29 filter. This may be found to give the visual impression that the 25 is not so dense as the 29.

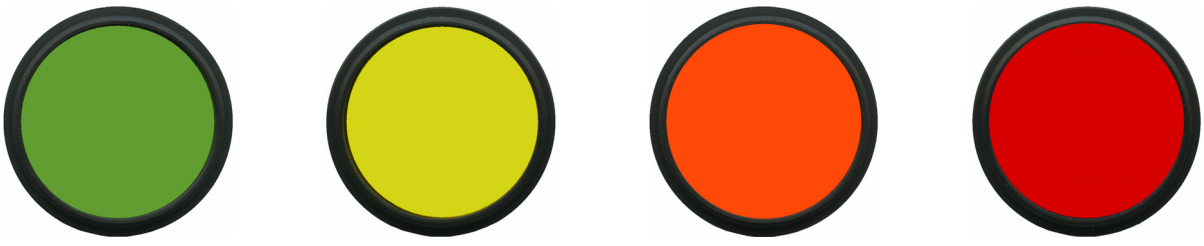
Blue For larger instruments with good light grasp the Wratten 47 or 80B with passbands at 4200Å are recommended, as they absorb both red and green light. For smaller instruments the Wratten 44A will be found less dense, but transmitting some green, while absorbing from 5800Å to 6800Å in the red region.

Green This does not seem to be quite so demanding as regards cut-off in comparison with red and blue types. There is a Wratten 45A (blue–green) used for high resolution in visual microscopy, which might well repay experiment at the telescope.

Purple (or magenta) Wratten 35 is difficult and tiring to the eye, but can be used to advantage for patrolling for the ashen light on Venus. This has a visual passband at 4430Å, but the eye does not respond to it easily. It must be used in conjunction with an occulting bar, or other device, to hide the bright disk of Venus and prevent the appearance of the subjective completion of the disk as seen in the telescope.

Conclusion

The use of filters is an art that can be acquired by practice and experiment, to determine which type is best for the kind of observation undertaken. There will also be found a personal preference, not only in connection with telescope size, but also with due regard to the colour sensitivity of each individual observer. However, the foregoing should provide a general guide, and is suggested as a standard to be adopted by observers.



11
Light yellow–green

15
Yellow

21
Orange

25
Red

47
Violet

58
Green

80A
Pale blue

82A
Very pale blue

A selection of filters