Thoughts about eyepieces

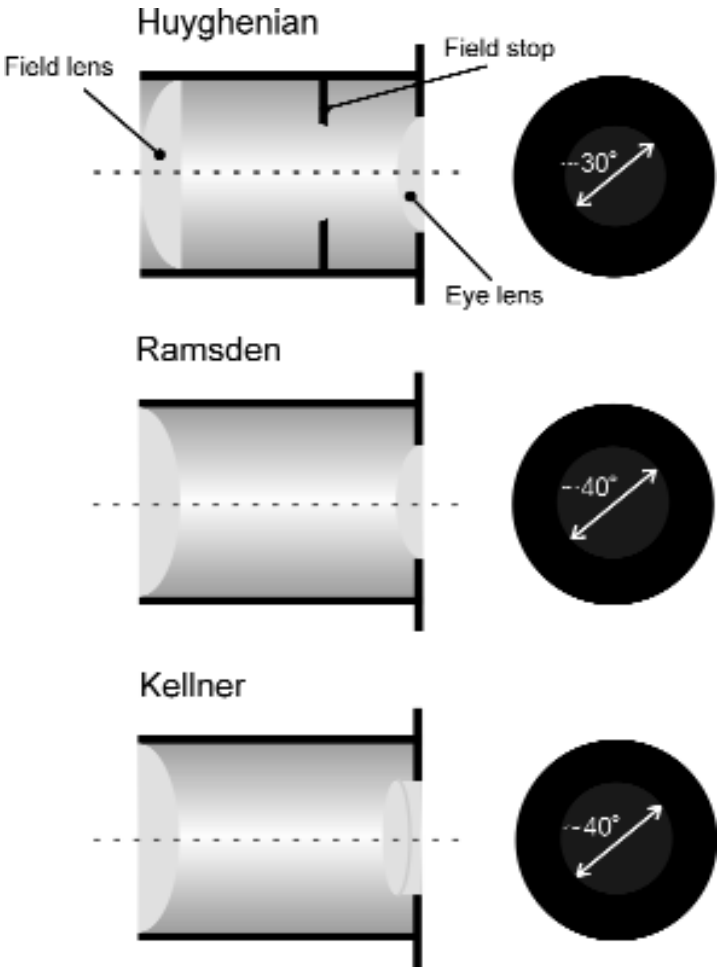
A selection of eyepieces and Barlow lenses (all images by Peter Grego).

Some basics

A telescope produces an image of the sky or an object like the Moon in what is called its focal plane. This lies at a distance from the objective lens or mirror given by its **focal length**, F. The purpose of the eyepiece is simply to allow one to observe this image in detail, rather like using a magnifying glass to see fine detail in an object — in fact, a magnifying glass could be used to as an eyepiece though it would not be a good one! An eyepiece too has a focal length, say f, which can vary from ~2.5 mm up to 55 mm. Eyepieces with shorter focal lengths allow one to observe the image in greater detail but also reduce the area of the image that can be observed at one time. The ratio F/f gives what is called the magnification. For example, a 10 mm eyepiece used with a 1200 mm focal length telescope gives a magnification of 120.

Apart from the focal length, there are two further key parameters of any given eyepiece. The first is the **apparent field of view**. This can range from about 30° up to about 82°. Those with wider apparent fields of view will enable the observer to see more sky at one time, which is very useful. The actual field of view on the sky is given approximately by the apparent field of view divided by the magnification, so if the 10 mm eyepiece above had an apparent field of view of 52° then the actual field when used with the 1200 mm focal length telescope would be ~52/120 = 0.43°.

The second key parameter is what is called the **eye relief** and is basically how close your eye must be to the eye lens of the eyepiece to see all of the image. With simple eyepieces the eye relief gets less the shorter the focal length of the eyepiece and will often not allow the observer to wear of glasses when observing through them. This is not a real problem unless one's eye is badly astigmatic. Long eye relief eyepieces (~20 mm of eye relief) also tend to be easier for those unused to using telescopes to look through so are very useful for star parties.



Simple eyepieces

For many years the standard eyepieces were either Ramsden or Huyghenian which used just two glass elements to form an image. Their apparent fields of view were very small and so have fallen out of favour. They are, however, useful for projecting images of the Sun as the there are no cemented glass elements which could be damaged by the Sun's heat.

Low cost telescopes will tend to come equipped with three element eyepieces such as the Kellner or Modified Achromat. At the centre of their somewhat modest field of view, they can give excellent images, but tend to suffer what is called 'lateral colour' towards the edge of the field of view.

Standard eyepieces

Higher priced telescopes may well come with Plossl eyepieces made from two achromatic doublets. These can be excellent performers usually having an apparent field of view of ~ 52°. Variations of Plossl eyepieces which use a 5th element can improve the performance even more; the Celestron Ultimas were an excellent example. There are also long eye relief eyepieces (~20 mm) with similar apparent fields of view such as the Vixen Lanthanum range and Celestron X-Cel range.

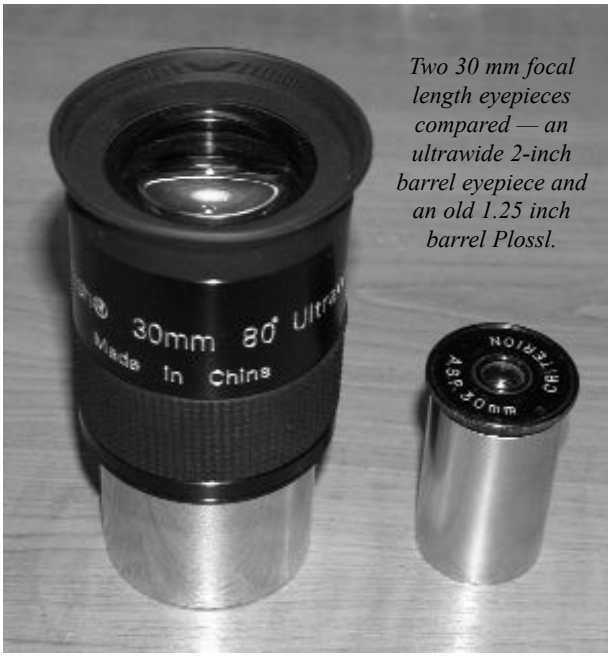
Barlow lenses

Though not specifically an eyepiece, many astronomers will have a Barlow lens in their eyepiece case. This is usually an achromatic doublet which diverges the cone of light from the objective, be it lens or mirror, and so increases its effective focal length — usually by a factor of two. This doubles the magnification when used with a given eyepiece so the use of a Barlow is equivalent to having extra eyepieces. If your telescope came with 26 mm and 10 mm eyepieces, the use of a ×2 Barlow will give you the effect of having additional 13 and 5 mm eyepieces. One advantage is that the eye relief of the effective 5 mm eyepiece is that of the 10 mm eyepiece and would thus be easier to use than if one bought a 5 mm eyepiece of the same type. Televue make an improved form of Barlow using four elements called the Powermate. These are superb, if a little costly.

Wide field eyepieces

There is now a lot of interest in what are called 'wide field' eyepieces. These have wider than normal apparent fields of view ranging from ~60° up to ~82° so enabling one to observe a wider field of view for a given magnification. One can thus use a shorter focal length to encompass a given object in the sky. This increases the magnification which, in turn, darkens the sky background so enabling fainter stars to be seen. Eyepieces with ~80 mm apparent field of view give a rather nice 'space walk' feel which can be very satisfying. To achieve such wide apparent fields of view up to eight glass elements are required, so such eyepieces are not cheap!

The cheaper of such eyepieces tend to have apparent fields of view in the range 60 to 68° (compared to ~52° for Plossls). Vixen provide a set of Lanthanum LVW eyepieces which have apparent fields of 65°. Celestron have an Axiom range which have apparent fields of 70° as do the Meade Series 4000 QX and 5000 SWA eyepieces. Televue Radian eyepieces have a field of view of 60° and their Panoptic eyepieces, 68°. Beyond 70° fields of view, eyepieces get very expensive. Some of the best wide field eyepieces are the Televue Naglers and Meade series 5000 UWA with their 82° apparent fields of view.

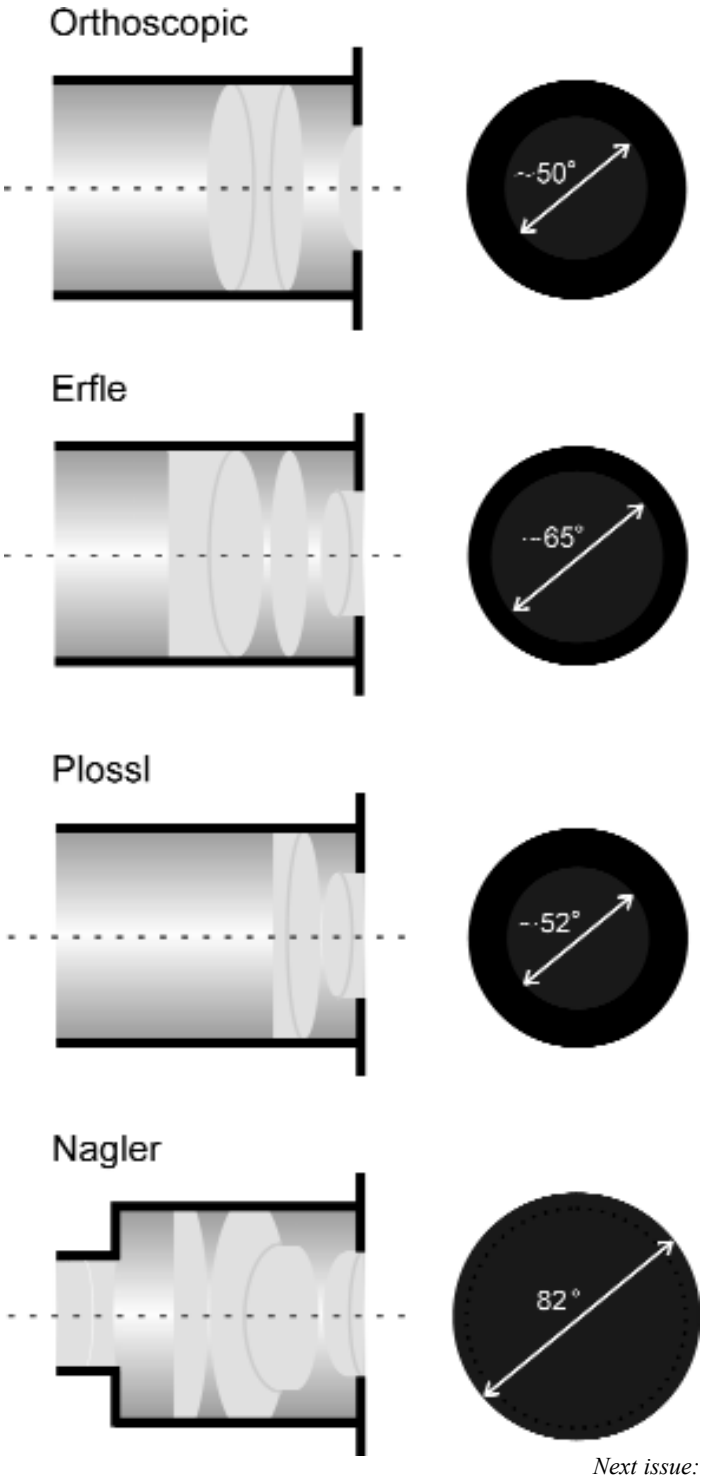


Two 30 mm focal length eyepieces compared — an ultrawide 2-inch barrel eyepiece and an old 1.25 inch barrel Plossl.

2-inch eyepieces

The maximum field of view that can be observed with a given telescope obviously depends on its focal length — the shorter the focal length the wider the field — but it also depends on whether the focuser has a barrel size of 1.25 or 2 inches. If your telescope focuser has a 1.25 inch barrel size, then a 32 mm Plossl or a 24 mm Televue Panoptic will give the widest possible field of view as their field stops are 27 mm across — about the maximum you can fit into a 1.25 inch barrel. A 2 inch barrel can accommodate a field stop of ~46 mm so you can see significantly more. The Televue 31 mm Nagler is perhaps the ultimate 2 inch wide field eyepiece, but the TMB Paragon 40 mm eyepiece is almost as good and significantly cheaper.

It was fun building up my eyepiece collection — I hope you will enjoy adding to yours!



Next issue: Schmidt-Newtonian and Maksutov-Newtonian telescopes.