Telescope Eyepieces

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Eyepiece Basics

- The main purpose of the eyepiece is to magnify the image produced by the objective of the telescope.
- Eyepieces come in various focal lengths measured in millimeters (mm).
- The magnification provided by an eyepiece is determined by dividing the focal length of the telescope (also measured in mm) by the focal length of the eyepiece.

Scope Calculator

- For example, a scope with 1000mm focal length is used with a 10mm eyepiece, resulting in a magnification of 100x (1000/10).
- Prices range from about $20 to several hundred dollars.
- Good quality eyepieces are “multicoated”, better quality eyepieces are “fully multicoated”.
- Some eyepiece sets are parfocal - very little refocusing required when switching from one eyepiece to another.

Eyepiece Basics

- Eyepieces come in three sizes: .965”, 1.25” and 2”, which indicates the size of the barrel that fits into the focuser tube (part of the scope itself).
- The .965 variety is only available in low quality eyepieces and must be avoided.
- The majority of eyepieces are 1.25”.
- The 2” models are to allow for a wider field of view on low power eyepieces.
- Some eyepieces are heavy and unbalance small scopes.
- The eye relief of an eyepiece indicates the farthest distance your eye can be from the first lens and still take in the entire field of view (FOV).
- With most eyepiece designs, the shorter the focal length, the shorter the eye relief.
- If you must wear glasses when using a scope (necessary if you have astigmatism), a long eye relief will be required.

Field of View (FOV)

- The amount of sky we can see through a telescope (or binoculars) is measured in degrees and is called the FOV or more correctly the True FOV (TFOV)
- The maximum possible TFOV is determined by the focal length of the scope and size of the “field stop”.
- Field stop is basically the inside diameter of the eyepiece used, so, 2” eyepieces give a wider possible TFOV than 1.25” eyepieces.
- Eyepieces have a characteristic known as Apparent FOV (AFOV).
- The TFOV given by a specific eyepiece and telescope is calculated as:

$$\frac{\text{AFOV}}{\text{Magnification}}$$

- So if we are using a 1000mm scope and a 10mm eyepiece with a 50 degree AFOV:

$$\frac{50}{1000/10} = .5 \text{ deg}$$

True Field of View Scope Calculator

Common Eyepiece Types

Kellner	Usually included with intro scopes. Ok in longer focal lengths. Exhibits chromatic aberration and poor performance at the edge of the FOV.	• AFOV: 45-50 • 3 lenses
Orthoscopic	Good eye relief at short focal lengths. Narrow field of view. Poor performance at the edge of the FOV. Excels at planetary views.	• AFOV: 40-45 • 4 lenses
Plossl	Very good performance to the edge with few optical flaws. Best all-around performer. Moderate FOV. Poor eye relief at short focal lengths.	• AFOV: 50 • 4 lenses
Wide Angle	Various trade names and designs. The most expensive class of eyepiece, prized for wide field of view at higher magnifications. Try before you buy. Watch for poor sharpness at the edge, difficulty positioning eye and black-outs when moving head. Some are very heavy.	• AFOV: 60-100 • 5 or more lenses
Long Eye Relief designs	Various trade names and designs. Try before you buy - but very nice for eyeglass wearers. Some users complain of poor optical performance and difficulty positioning eye. Eye relief typically 20mm.	• AFOV varies by type • 5 or more lenses

Zoom Eyepieces

Pros

- Zoom eyepieces allow you to twist the barrel of the eyepiece to adjust its focal length, thereby adjusting the magnification.
- Very convenient for tuning in to just the right magnification for a given object.
- Can save you money – like having multiple eyepieces, all in one.

Cons

- Most have very narrow field of view at lower magnification – 40 degrees or possibly less – just when you want a wider field of view.
- Often, optical quality is lower than even a budget Plossl eyepiece.
- Some are mechanically a nightmare - sloppy design, hard to twist, etc.

Be sure to try before you buy!

Warning, Warning!!!

There are some designs not previously mentioned, and they are to be avoided. These are some of the earliest eyepiece designs and exhibit many serious optical flaws. They are often shipped with department store scopes:

- Huygenian - usually marked as H4 (Huygenian 4mm)
- Ramsden - usually marked as R20 (Ramsden 20mm)

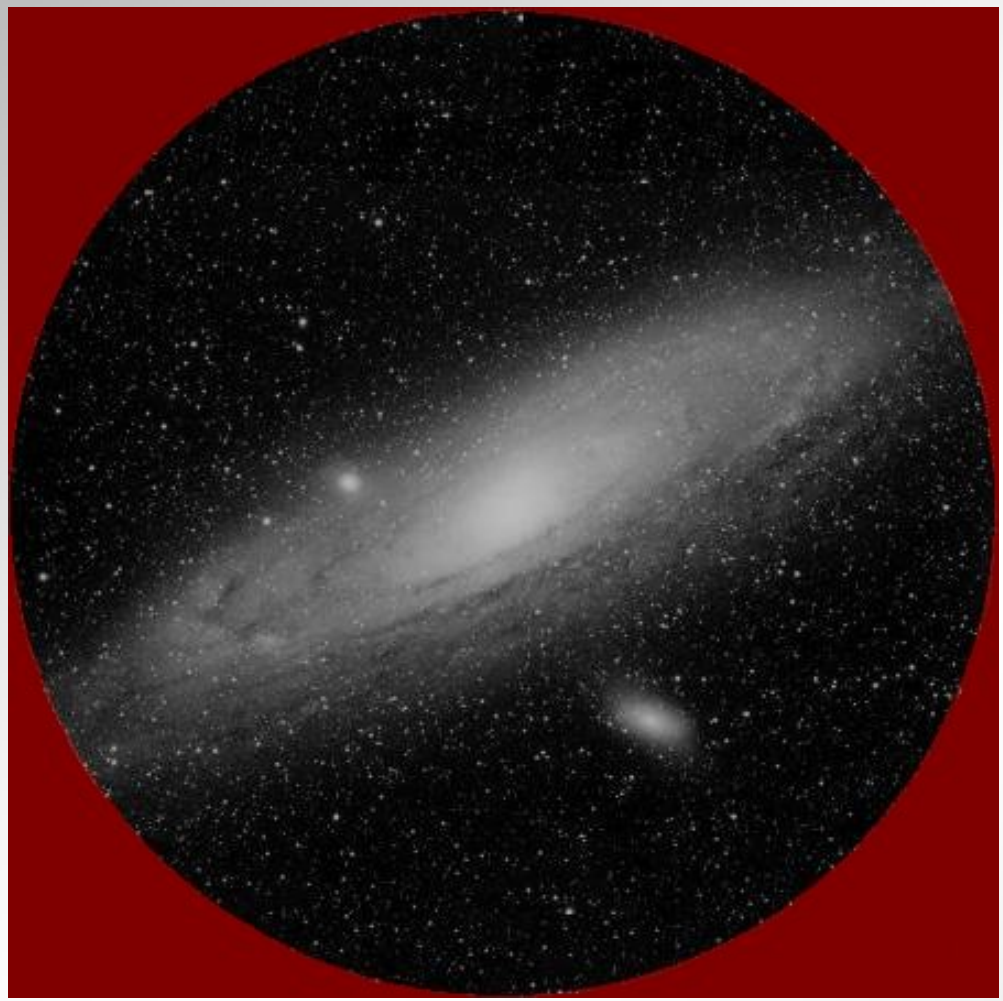
Barlows and Magnifiers

- A Barlow lens effectively stretches the focal length of any scope resulting in higher magnification from any given eyepiece.
- The Barlow is inserted into the eyepiece holder and the eyepiece is then inserted into the Barlow.
- Barlow lenses are designated by their magnification factor – 2x, 3x, etc.
- Better Barlow lenses sport multicoated optics, precise mechanical tolerances, and effective internal blackening.
- Typical Barlows have 2 lenses, but better models include a third lens for edge correction and reduced chromatic aberrations.
- TeleVue Powermates (4 lens elements) – available in 2x, 2.5x, 4x and 5x – are similar in concept, but provide the best in image fidelity and do not extend the eye relief of the eyepiece.

Binoviewers

- You have two eyes...use them!
- Binoviewers fit into the telescope's eyepiece holder and has holders for two eyepieces.
- Prisms inside the binoviewer split the light so that half goes to each eyepiece.
- The added distance between the eyepieces and the focal plane of the telescope may make focusing impossible without an adapter.
- Pairs of identical eyepieces are needed.
- The greatly added weight may cause balance problems for some telescopes/mounts.
- Problems merging images can be caused by mismatched or poor quality eyepieces, uncollimated binoviewer or inability to position the eyepieces close enough for your interpupillary distance.
- Less expensive models may result in vignetting of wide field images
- Need room for your nose!

Clear Skies!



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