
BINOCULAR verses TELESCOPE
Newbury Astronomical Society Beginners
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What can we see using binoculars?

1. The different areas on the Moon look clearer
2. The four brightest moons of Jupiter
3. Bright comets (when they are around)
4. Some of the brightest deep space objects
5. Only one galaxy can be seen
6. A few of the brightest star clusters can be seen
7. They are good for a wide view of the sky
8. The star fields of the Milky Way are breathtaking
9. Asterisms (star patterns) can be seen
10. They are good for searching for satellites

Binoculars generally have a low magnification and therefore have a wide field of view.

Consequently they give a wide view of a large area of sky but the objects within this field of view appear small.

This means binoculars are useful for locating objects but the low magnification (7 to 10 times) do not allow detailed study.

They are best for sweeping across large areas of the sky or looking at large objects of interest.

Binoculars can help us explore the night sky.

They can be used to sweep the sky for fainter satellites.

Binoculars are often the first visual aid to be used to improve the view of the night sky.

There are many variations of binoculars with different specifications and price.

Try to borrow binoculars if possible to get started and to become familiar with the observing concept.

Binoculars can be expensive so have a good think and trial before spending your money.

Binoculars are defined by their inherent magnification and the aperture (diameter) in millimetres (mm).

The usual magnification used is between 7x and 10x so 8x or 9x is most common.

General purpose binoculars usually have an aperture of 50mm, but larger apertures are available but larger instruments can be a bit heavy.

What are the limits of binoculars?

1. They cannot reveal details on the Moon
2. The planets look very small
3. Binoculars cannot reveal detail on the Planets
4. Most deep space objects are beyond reach
5. Only one galaxy can be seen as a shape M31
6. A few of the closer star clusters can be seen
7. The brighter comets can be seen
8. Magnification beyond 10x needs to be supported
9. Binoculars over 70mm are heavy and need support

Binoculars have a low magnification and a wide field of view.

As a result they provide a wide view of a large area of sky but the objects within this field of view appear small.

This means binoculars are useful for locating objects but the low magnification (7 to 10 times) does not allow detailed study.

A telescope with a larger (>100mm) aperture and a magnification of between 25x and 250x can be used.

We will consider telescopes later.

Binoculars are good for sweeping across the sky to see many more stars.

Especially impressive is the view of the Milky Way star fields.

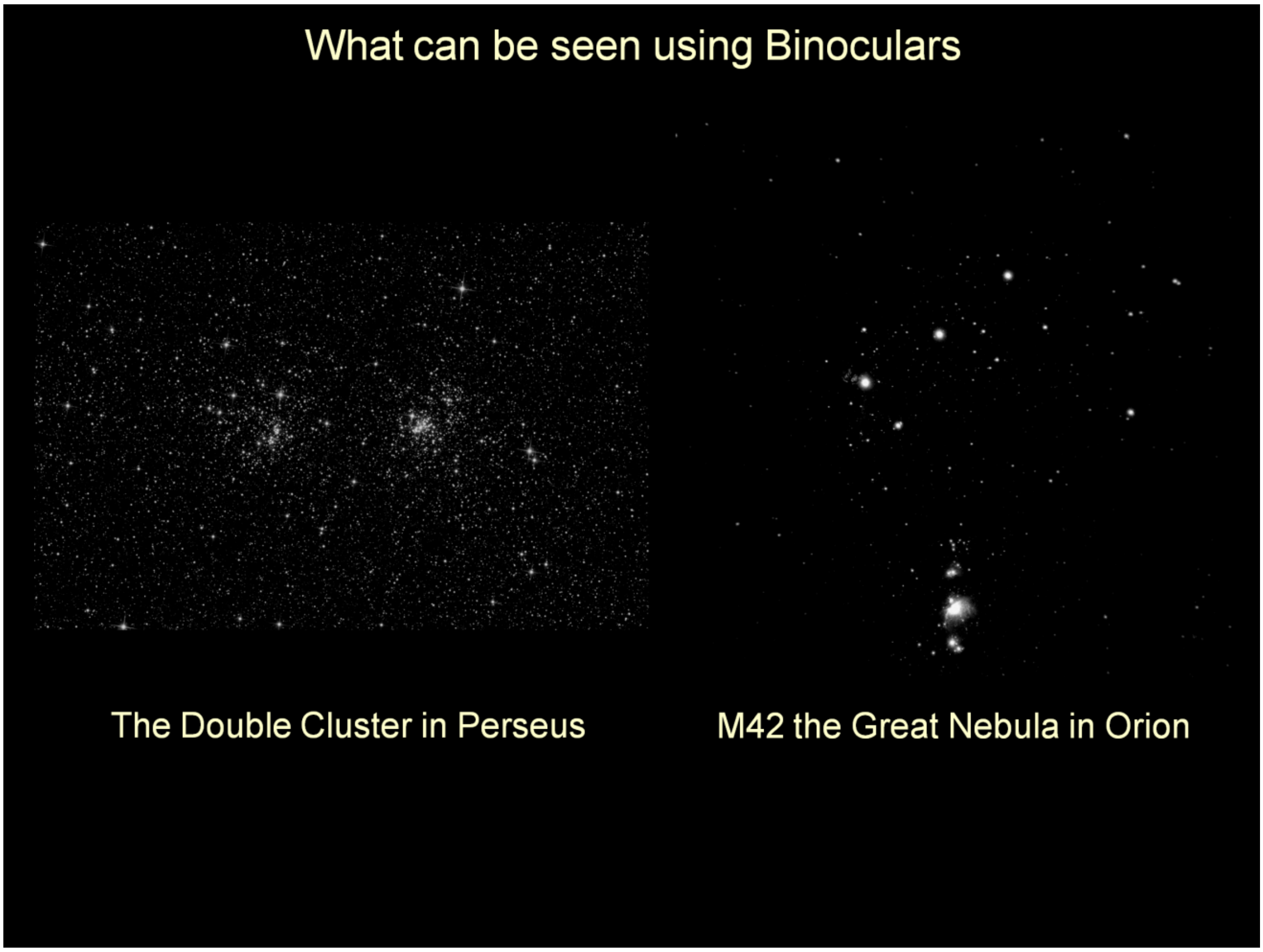
An overall and more detailed view of the Moon can be obtained showing the rugged surface.

The larger craters can be seen and the difference in terrain can be made out.

The darker areas called Maria (seas) can be made out as shown above.

Some of the larger star clusters and Asterisms (patterns of stars) can be seen.

The Great Galaxy in Andromeda Messier 31 (M31) is the only galaxy that can be seen easily, from the UK, using binoculars.



Open Clusters are nurseries of young recently created stars (a few 10s of millions of years).

A beautiful pair of Open Clusters can be seen in the constellation of Perseus.

In the winter sky we can see the constellation of Orion the Hunter.

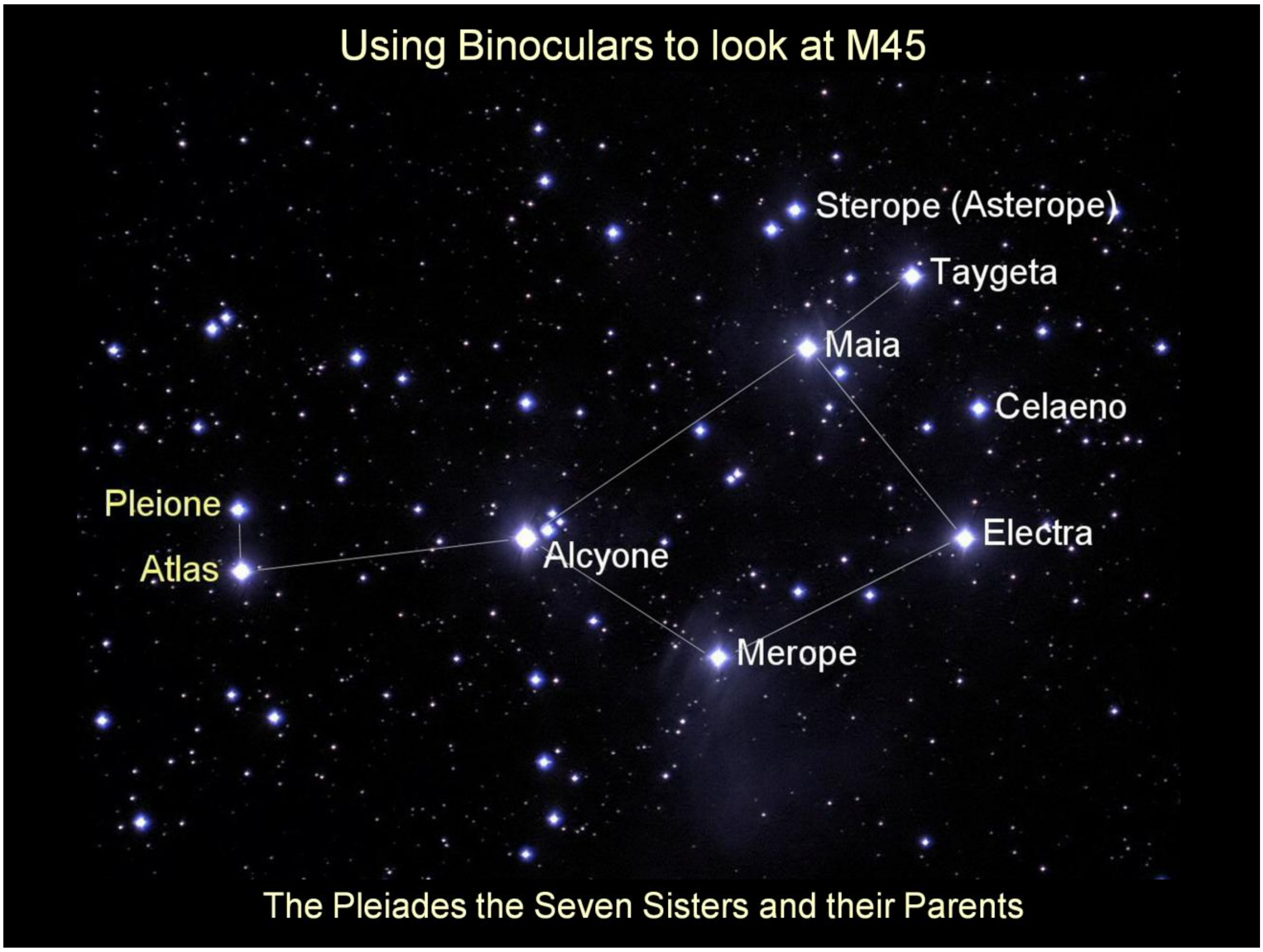
One of the most sought after deep sky objects can be found in Orion, this is Messier 42 (M42).

M42 is a Nebula that is part of a vast cloud of mainly Hydrogen Gas where stars are forming.

Below the three stars that represent Orion’s Belt is the line of stars that form his sword.

Binoculars will show a misty patch in the sword can be seen using binoculars, see the image above.

A telescope is needed to see the nebula and the young stars in detail.



Messier 45 (M45) is called the Pleiades Open Cluster or the Seven Sisters indicated by the lines above is best seen using binoculars.

This is a cluster of seven 'naked eye' stars that can be counted on a clear night. The seven naked eye stars are linked with lines in the image above.

The cluster is beautiful binocular object and can also be seen using a small telescope using a low magnification eyepiece.

The two stars Pleione and Atlas are actually the sister's Mother and Father but they are included in the 7 stars that can be counted with the naked eye.

The 6^{th} and 7^{th} sisters are Celaeno and Sterope (also called Asterope) but the need binoculars to see a separate stars.

The Pleiades can be seen in the eastern sky at this time of the year so go out and find them (a little later in the evening).

So do we need a Telescope?

So the question is ‘Do I need a telescope for astronomy?’ the answer is Yes! and No!

We can go into astronomy to any depth that we choose.

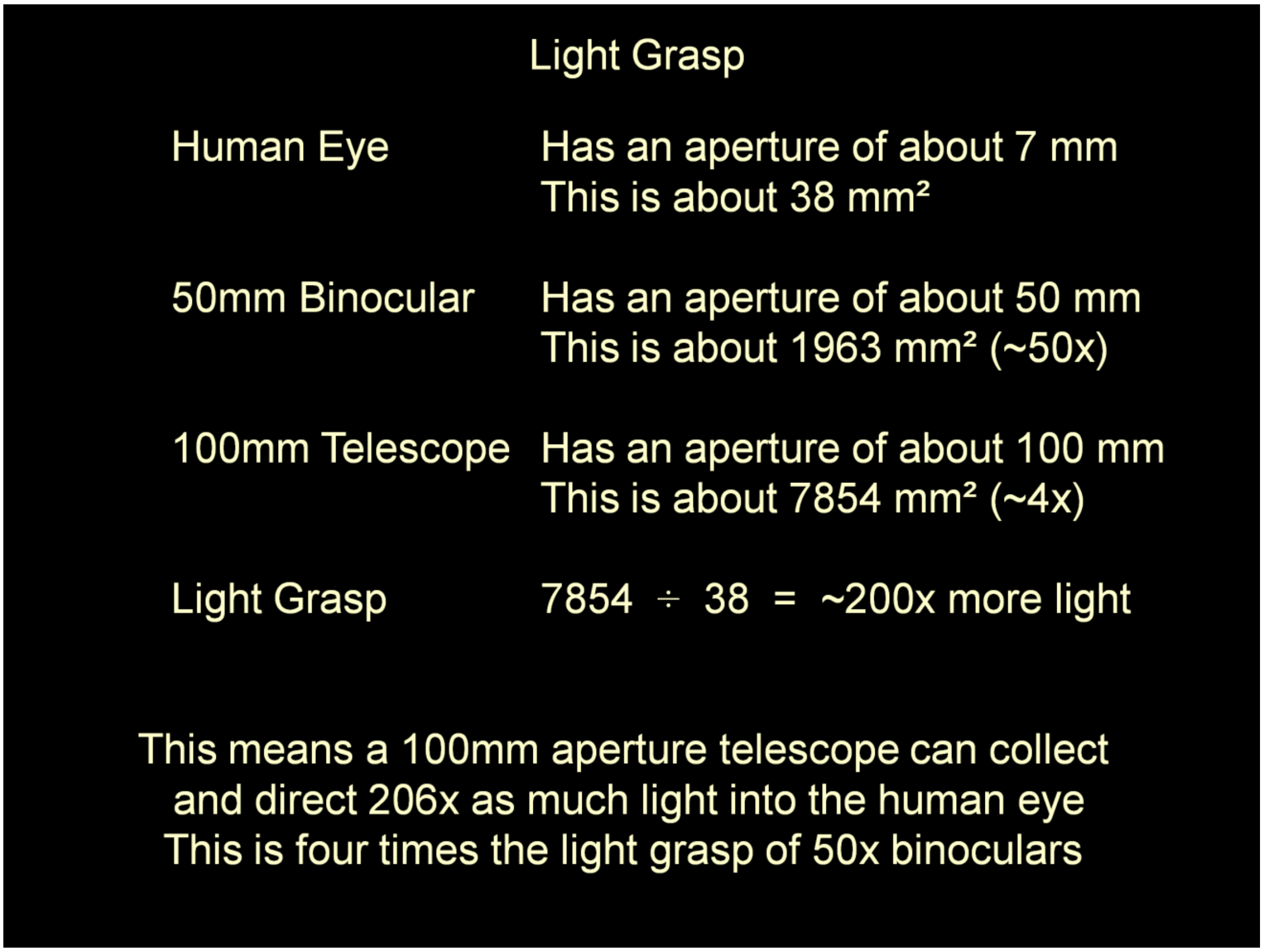
So we can be armchair astronomers and ‘naked eye’ astronomers.

Or we can be the go outdoors and look astronomers.

It can be quite a thrill to observe the night sky objects with our own telescope or even binoculars.

To see the Moon or planets through a telescope really does have the ‘Wow!’ factor.

We can also actually sense the light from these objects directly with our eyes.



Light grasp is a term used to describe the amount of light that is gathered by the main Optic of a telescope.

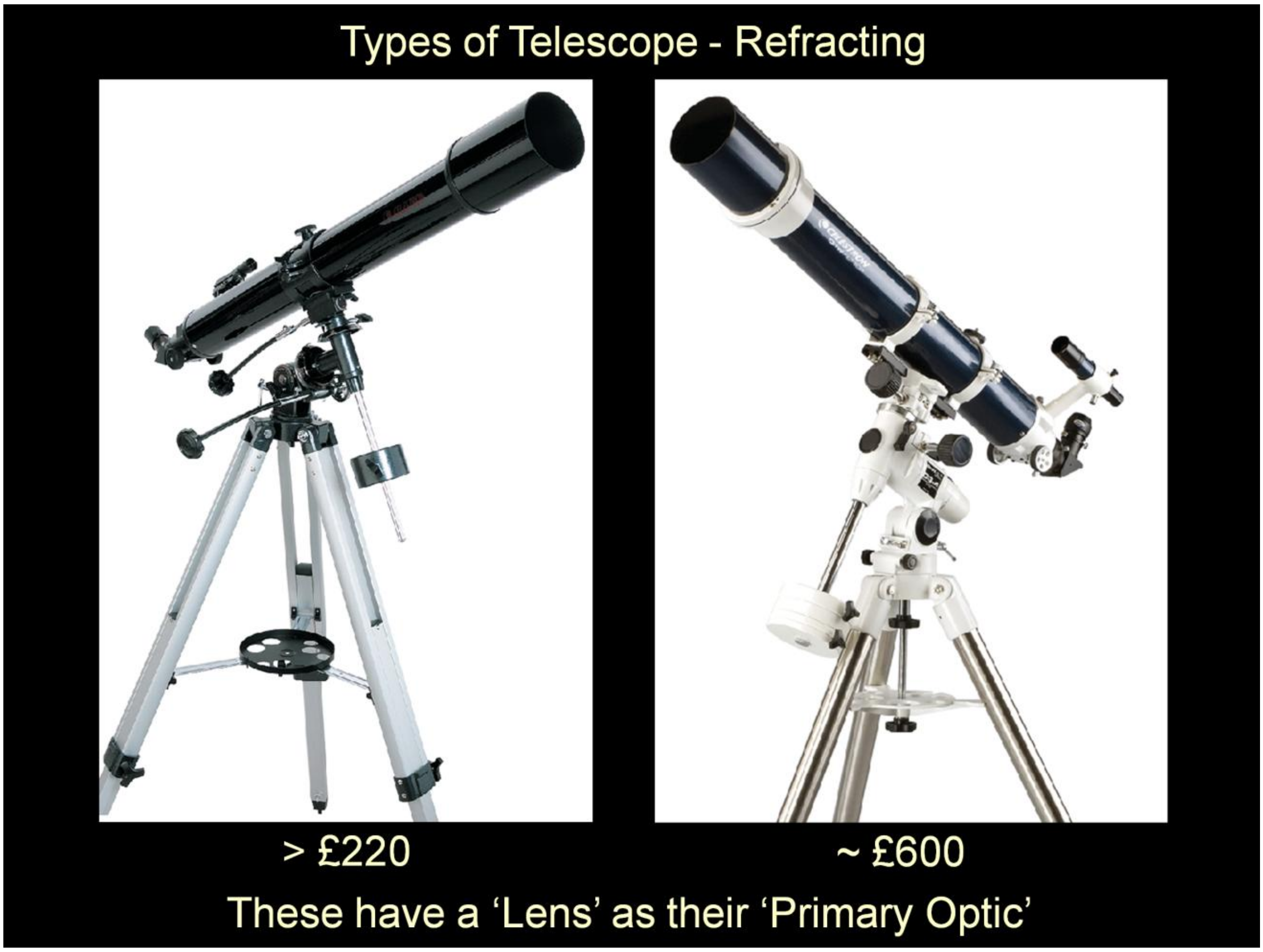
A young persons (pupil the black central part of the eye containing the lens) can open to a diameter of about 8mm (older people 7mm or even 6mm).

So an average human eye lens (7mm diameter or 3.5mm radius) can collect 3.5 x πr^2 = ~38mm².

Telescope main optic Ø100mm (50mm radius) 50 x πr^2 = 7854mm².

So a 100mm aperture telescope will direct 7854 ÷ 38 = 206 times more light into our eye.

We can therefore see objects that are 200 times fainter, with a small telescope, than we can see with our ‘naked eyes’.



Telescopes come in many shapes, types, sizes and costs.

There are two main types of telescope known as Refractor and Reflector.

The picture above shows two example models of Refracting Telescopes.

Refracting telescopes use a glass lens to capture light and direct that light into our eye.

The example on the left is the entry level size that has a 90mm aperture lens.

The telescope on the right has a 120mm aperture and a more robust mounting.

They will cost between £220 and about £600 depending on the specifications.

A smaller 70mm refractor costing about £125 can be used as a beginners first telescope but their performance is a little less impressive.

Reflecting telescopes use a mirror to collect and focus light into our eye.

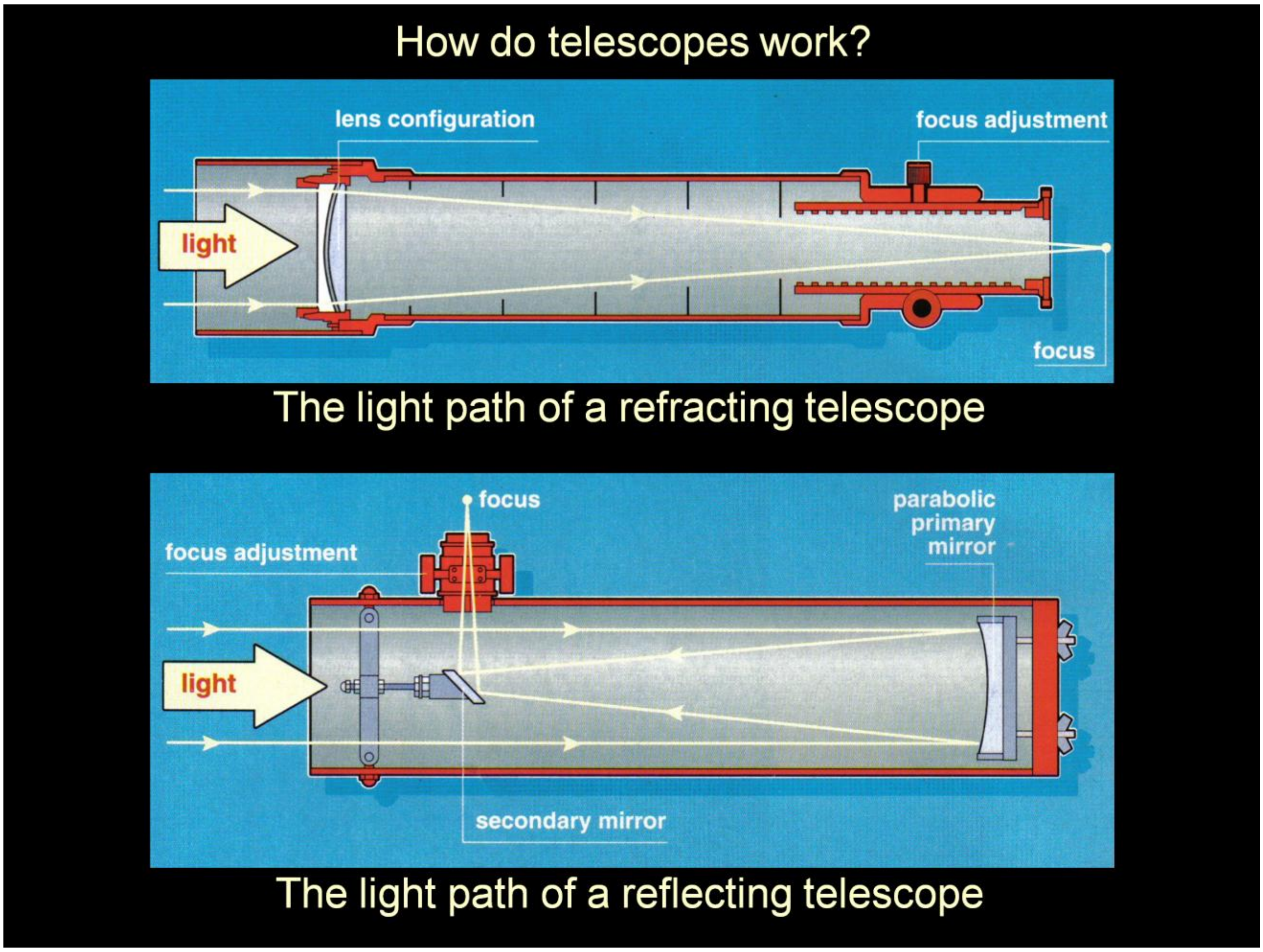
The picture above shows two example models of Reflecting Telescopes.

Refracting telescopes use a ‘parabolic’ (dish shaped) glass disc coated with a thin Aluminium coating to capture light and direct that light into our eye.

The example on the left is mounted on a ‘Dobsonian’ Alt / Azimuth mounting. The entry level is around £300 for a 150mm model.

The telescope on the right is attached to an Equatorial Mounting (explained later).

They will cost between £170 and £600 depending on the specifications.



The diagrams above show the light path through a refracting telescope and a Reflecting Telescope.

The upper diagram shows the objective (light gathering) glass lens on the left.

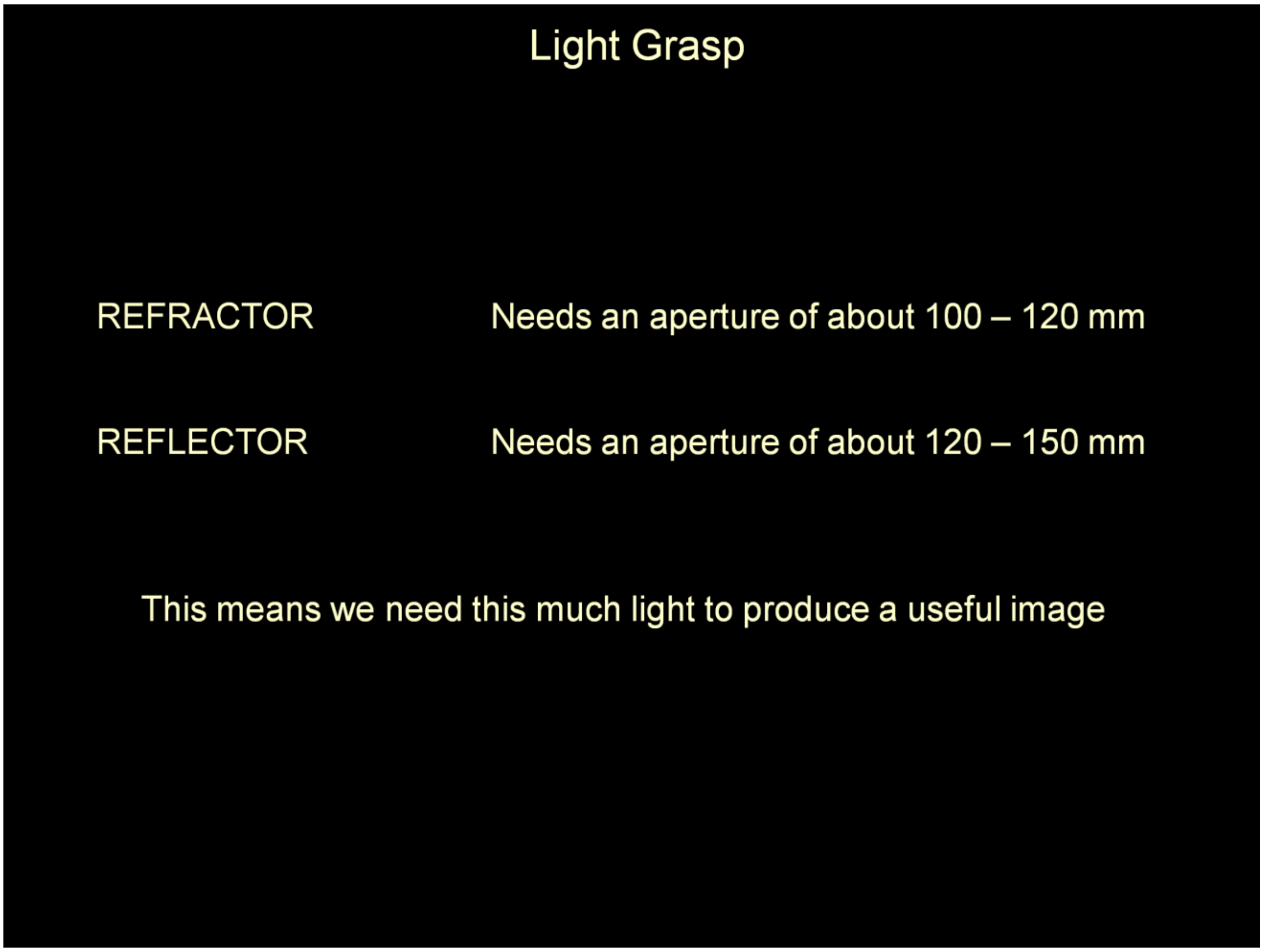
A main optic lens is usually a two or three part compound lens designed to correct colour distortion.

The light is 'bent' by the lens so that it converges into a focal point where an image of the light source is created.

The lower diagram shows the objective (light gathering) Aluminium coated glass mirror at the bottom of the tube on the left.

Light reflected off the curved mirror converges back up the tube and is directed out through a hole at the top of the tube.

This kind of optical arrangement is called a 'Newtonian Telescope' named after Sir Isaac Newton who invented it.



Now we need to consider what kind of telescope we might need but this decision may depend on personal preference.

However there are some overriding considerations first is the aperture of the main optic.

A Refracting Telescope should have an aperture of about 100mm but a 90mm or even 80mm can be accepted but fainter targets will be a little more difficult.

Because a Reflecting Telescope has a secondary mirror, its obstruction does reduce the contrast a little so the main optic should be larger than 120mm.

Any telescope from a main suppier should be a good quality instrument so one of the better known manufacture and supplier should be used.

Magnification

MAGNIFICATION — Is the ratio of the focal length of the lens or mirror to the focal length of the eyepiece being used.

For example we can use a 10mm or 20mm eyepiece

$$\text{Magnification} = \frac{\text{Focal length of mirror}}{\text{Focal length of eyepiece}} = \frac{1000\text{ mm}}{10\text{ mm}} = 100\text{x}$$

$$\text{Magnification} = \frac{\text{Focal length of mirror}}{\text{Focal length of eyepiece}} = \frac{1000\text{ mm}}{20\text{ mm}} = 50\text{x}$$

There is a common misconception that a telescope has a certain magnification but it is the eyepiece used that dictates the magnification of the system.

The telescope has the task of capturing a lot of light and focusing that light to form a bright image but the size of the image depends on the focal length of the telescope.

An Eyepiece can be thought of as a microscope. It has two functions 1) it transforms the light rays into a parallel beam so it can enter the eye 2) it magnifies the image.

The longer the focal length of the telescope the larger the imaged formed will be. The shorter the focal length of the eyepiece the greater the magnification produced.

So a 1000mm focal length produces an image of a fixed size. A 10mm focal length eyepiece will give a magnification of 1000 ÷ 10 = 100x magnification.

The same 1000mm focal length telescope using a 20mm focal length eyepiece will give a magnification of 1000 ÷ 20 = 50x magnification.

Focal Ratio

FOCAL RATIO Is the ratio of the focal length of the lens or mirror to its diameter, this is expressed as the f number.

$$\text{Focal Ratio} = \frac{\text{Focal length}}{\text{Dia of optic}} = \frac{1000\text{ mm}}{100\text{ mm}} = f10$$

This gives an overall classification of a telescope

The focal ratio is used to describe size the optics of a telescope.

We have seen that the larger the main optic the more light it can collect.

Another important optical design feature is the focal length of the main optic.

The longer the focal length of the main optic the larger the image produced will be.

A short focal length will produce a wide field of view and a longer focal length will produce a narrower field of view but the image will be larger.

So using the same eyepiece (perhaps a 10mm eyepiece) the effective magnification will depend on the focal length of the telescope.

A 1000mm focal length telescope will have 1000 ÷ 10 = 100x magnification.

A 500mm focal length telescope will have 500 ÷ 10 = 50x magnification.

So the view obtained will depend on aperture and focal length called ‘Focal Ratio’.

Short focal length telescope will produce a wide field of view with a smaller image whereas a longer focal length will produce a narrower field of view and larger image.

So a short a focal ratio f5 will have wide field and a long focal ratio f10 a narrow field of view but the larger the main optic the brighter the image will appear.

What do we want the telescope for?

MOON AND PLANETS	$f15$	An aperture of about 100mm will do Long focal length, high magnification up to 1500mm length up to 250x
STAR CLUSTERS GALAXIES NEBULAE	$f5$	As large an aperture as budget allows Short focal length, wide field of view 750mm length between 25x and 100x
GENERAL PURPOSE	$f10$	100mm Refractor or 150mm Reflector Medium focal length, good field of view 750mm to 1000mm focal length magnification between 25x to 200x

A beginner to the hobby of astronomy may not have a particular type of target in mind so a general purpose telescope may be the best bet.

So a 100mm aperture and 1000 focal length Refractor or a 150mm aperture with a 1000 to 1200mm focal length Reflector may be best.

A shorter focal length will give a wider field of view and a longer focal length will give a narrower field of view but a higher magnification.

A long focal length would be better for seeing more detail on the Moon and the bright planets.

For looking at large objects and wide area of sky a shorter focal length and a low magnification will be better.

A telescope is required to see the craters and other features on the surface of the Moon in detail. A high as possible magnification can be used.

Using a suitable Solar Filter the fine detail of sunspots can be observed. However daytime heat haze is likely to cause the image to be unstable.

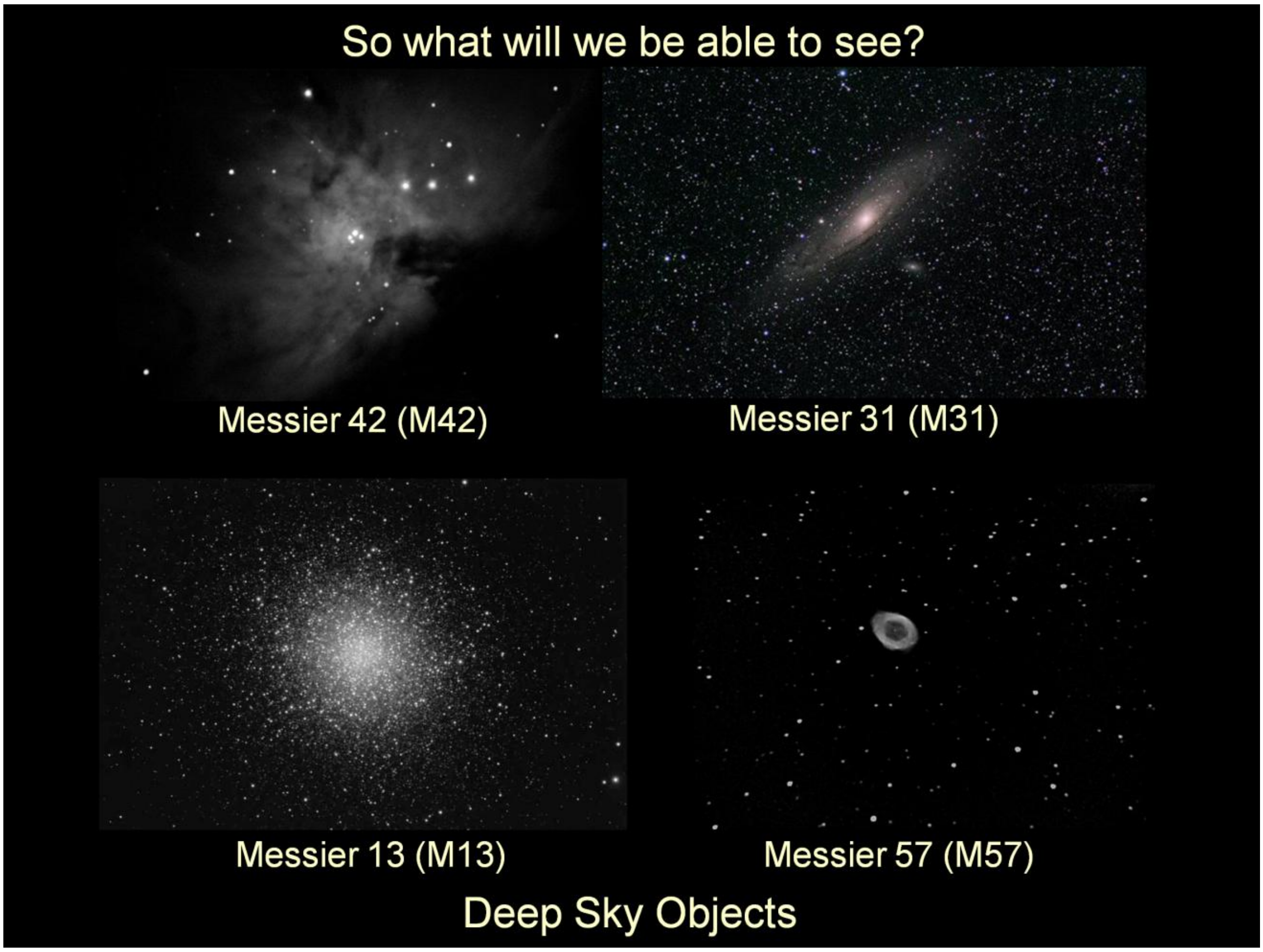
Observing the brighter planets Jupiter, Saturn, Mars and Venus is very rewarding. High magnification is required if the atmospheric turbulence permits.

Jupiter and Mars have the most striking markings but the surface markings on Saturn are more subtle however the beauty of the ring system compensates for this.

Venus is covered in white cloud so no detail can be seen but the phases (like those of the Moon) are interesting to follow.

The moons of Jupiter and Saturn can also be seen. Jupiter’s four brightest moons are very easy to see and can be watched as the disappear behind or in front of the planet.

Saturn’s moons are not obvious and easy to monitor as the moons of Jupiter but it is good to hunt them down especially on a very clear and dark night.



The extra ‘Light Grasp’ and ‘Magnification’ of a telescope allows the observer to see objects and detail beyond the reach of Binoculars.

Messier 42 is part of a vast cloud of Hydrogen close by in our galaxy. Stars forming in the in the Hydrogen are illuminating the Nebula (gas).

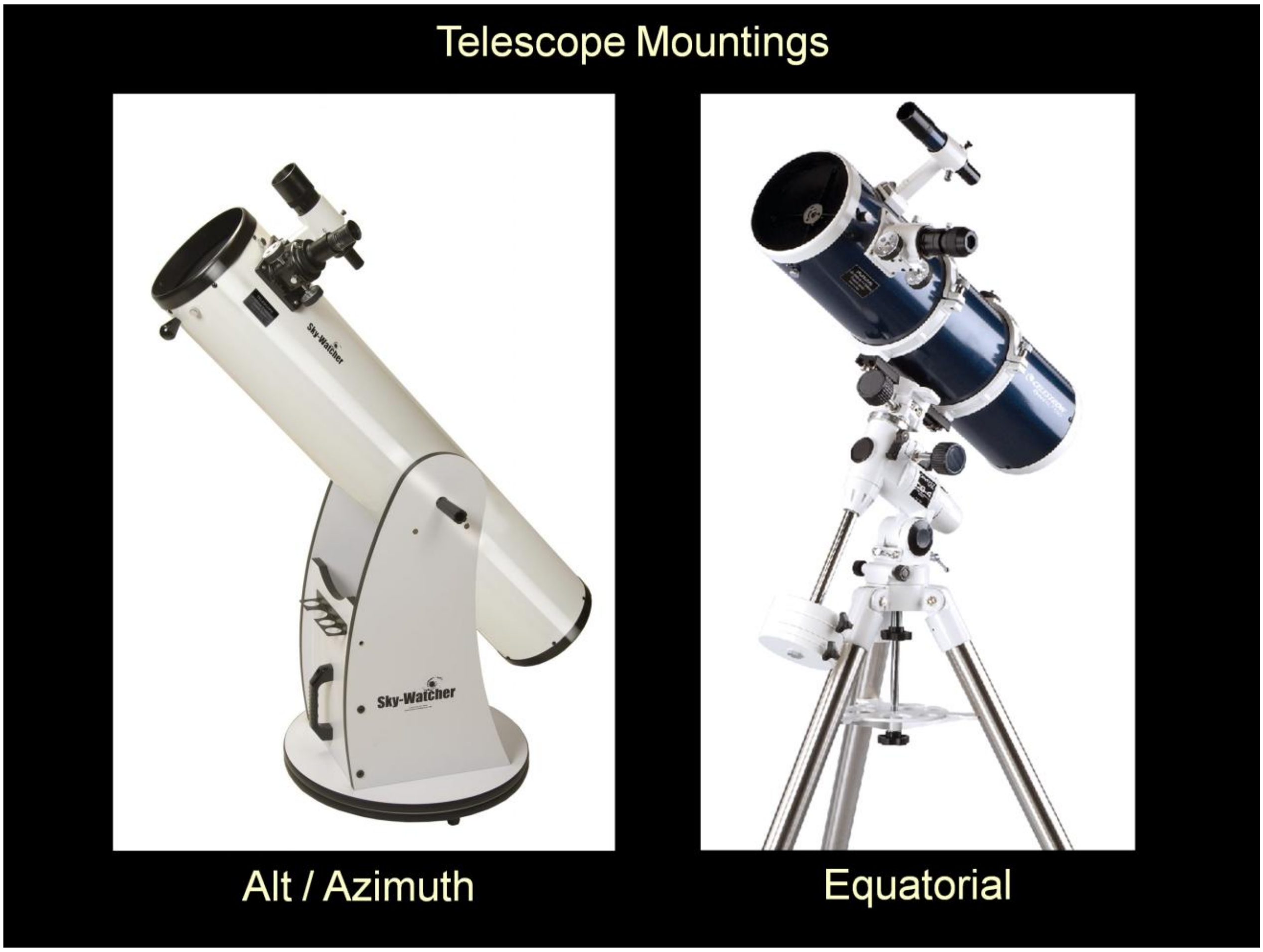
The brightest and nearest giant spiral galaxy is Messier 42 (M42) in the constellation of Andromeda can be seen using a ‘beginners’ telescope.

Messier 13 is a Globular Cluster of about a million stars. It is the closest and brightest of a number that can be seen.

Globular Clusters are thought to be the remains of smaller galaxies that have ventured to close to our Giant Spiral Galaxy (the Milky Way).

Messier 57 is known as the Ring Nebula and is what is known as a ‘Planetary Nebula’. It actually has nothing to do with being a planet.

It is the remains of a star similar to our Sun that has used up it supply of Hydrogen gas fuel. It has collapsed leaving a bubble of gas around it.



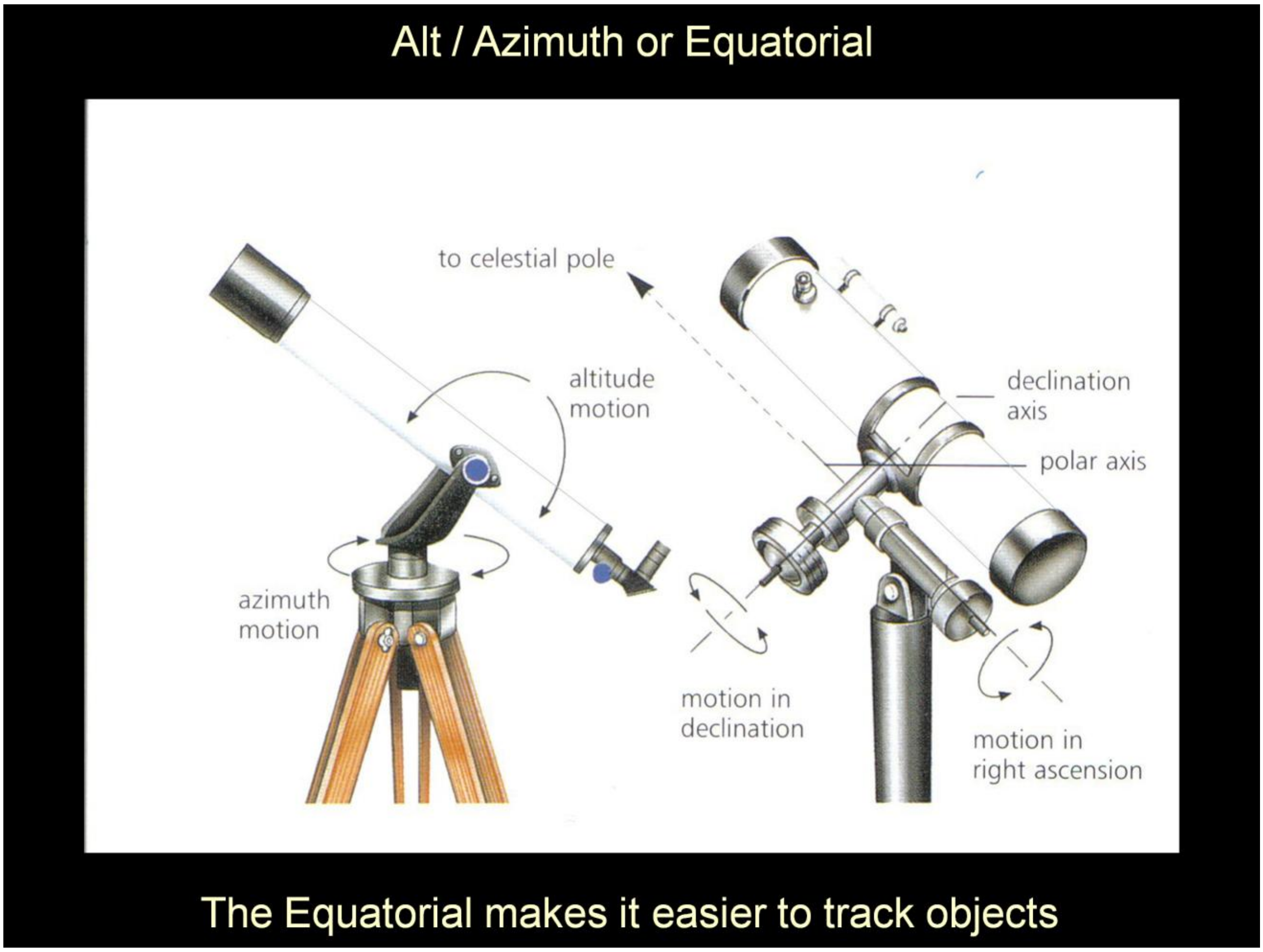
Mountings for a telescope tube assembly come in two basic types (1) an Alt / Azimuth Mounting and (2) an Equatorial Mounting.

The Alt / Azimuth Mounting is a simple horizontal rotating axis and a Altitude mount to allow the tune to be pointed up and down.

The advantage is that it is simple but it requires simultaneous movement in both axes to track an object as it appears to move across the sky.

To overcome this problem the horizontal axis ‘Azimuth’ is tilted to the same angle as Earth so just this axis needs to be rotated.

In this Equatorial Mounting the Azimuth Axis is called ‘Right Ascension’ (RA) and the Altitude Axis is called ‘Declination’ (Dec).



The telescopes in the diagram above show the Alt / Az type mounting on the left and the Equatorial Mounting on the right.

We can see the Azimuth rotates east (left) and west (right). The Altitude moves the telescope up and down.

On the Equatorially mounted telescope, on the right, the Azimuth axis (now called Right Ascension or RA) is tilted to align with the axis of rotation of Earth.

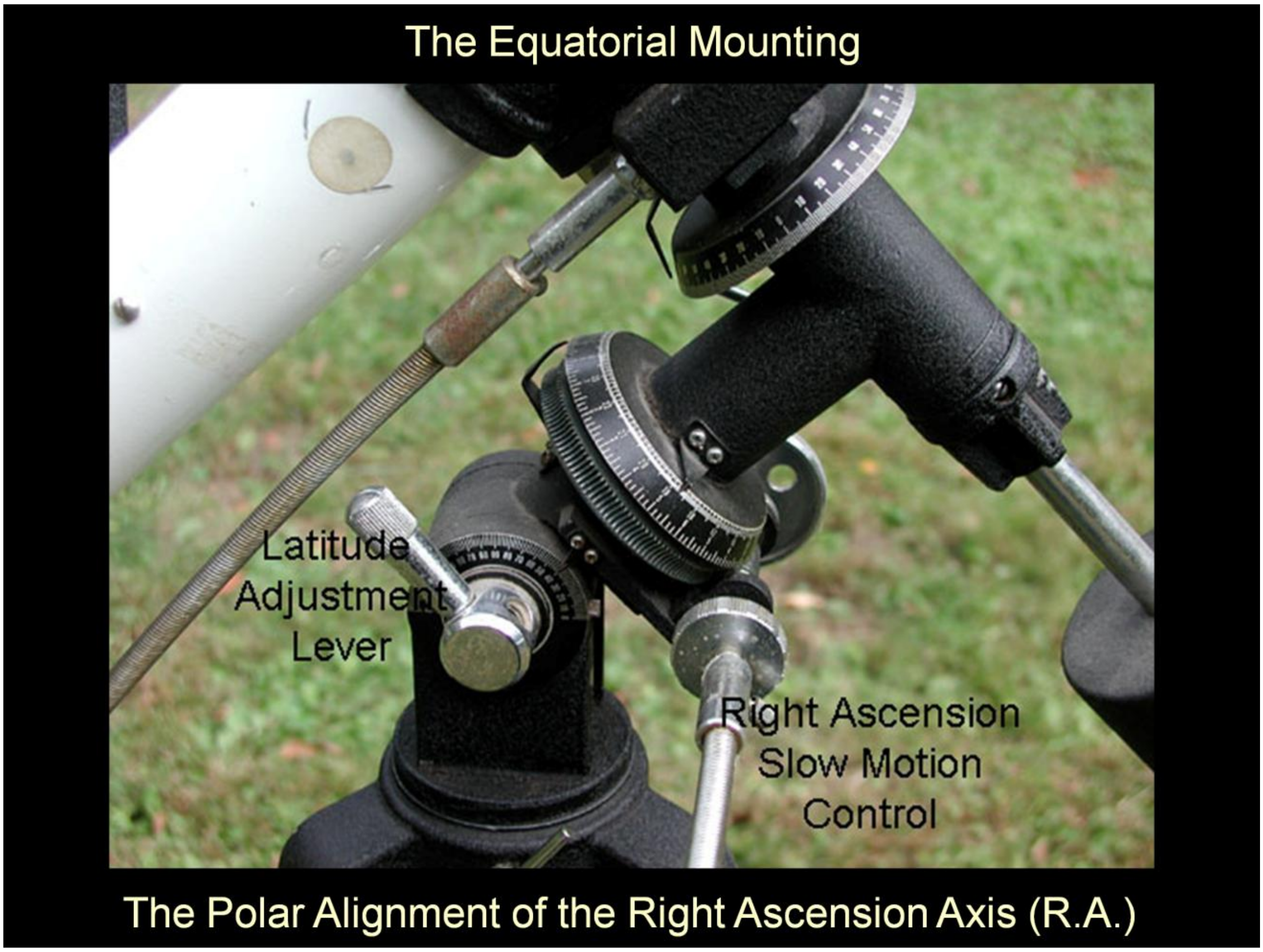
Fortunately for us in the northern hemisphere the star Polaris is very close to where the Axis of Earth points to on the sky (North Celestial Pole).

This makes it easier to align the RA axis on the Equatorial Mounting to the North Celestial Pole.

By driving the RA axis as 1 rotation every 24 hours the telescope rotates at the same speed as Earth rotates on its axis.

This is very useful in that the telescope can follow any object by adjusting this one axis.

So we can point the telescope at an object and the mounting can track that object.



Equatorial Mountings are usually fitted with a scale and pointer to help with aligning the RA axis on to the North Celestial Pole. This is shown as the Latitude Adjustment on the picture above.

All we need to do is loosen the Latitude Adjustment Lever and align the pointer on the to the Latitude of our observing site.

The Latitude of Newbury is 51.4º North so about 51º to 52º will be good enough for us.

Then make sure the Latitude Adjustment Lever is re-tightened.

We will not need to change this unless the are observing a long way from home.

On this simple hand driven mount, rotating the RA Slow Motion Control Knob will allow the telescope to track a selected object.

The telescope shown above has been set up with the RA axis pointed to the North Celestial Pole. The telescope tube is pointed towards the south.

It is essential to be comfortable and steady when using a telescope so sitting down is the best way to use a telescope.

If it is not possible to sit and observe it is useful to have the back of a chair or the handle on a set of steps to lean on to stop us swaying around.

Also remember to start observing dressed in warm clothes it does get colder at night even during the summer.

Remember it is difficult to warm up after we have become very cold so it is best to start warm and stay warm.

IN SUMMARY

1. Binoculars are very useful but have limits
2. Magnification beyond 10x needs to be supported
3. Binoculars over 70mm are heavy and need support
4. A telescope is required to see detail on objects
5. Generally the bigger the aperture the better
6. We can choose a Refractor or Reflector
7. We can choose Alt / Az or Equatorial mountings
8. A longer Focal Length for Moon and Planets
9. A shorter Focal Length for wide field observation
10. Always wear suitable warm clothes

This presentation can be found on

The Beginner’s Website:

www.naasbeginners.co.uk

A copy of this presentation, with notes, is available on the Beginners website.

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