

Summary Notes - Topic 6: Celestial Observation (Part One)



6.1 Recognising Astronomical Phenomena

Observing the night sky reveals a variety of celestial objects, including:

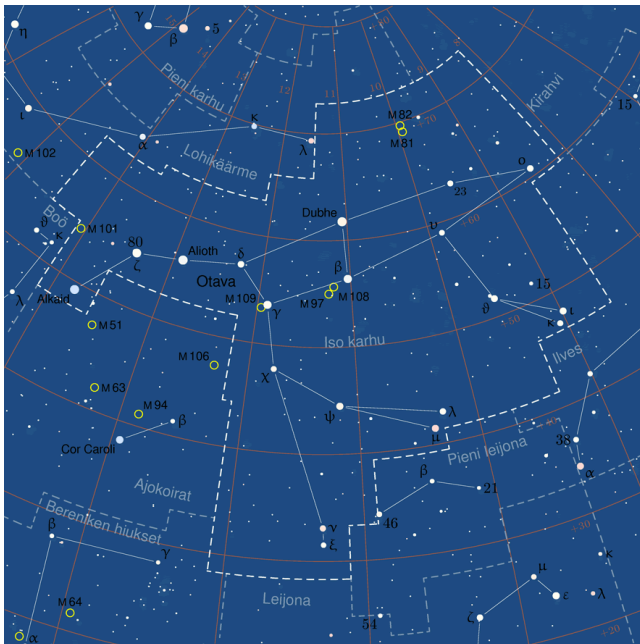
- **The Sun & Moon** – The brightest objects in our sky, the Sun is vital for life, while the Moon's phases and surface features can be observed with the naked eye.
- **Stars & Double Stars** - Stars appear as points of light in the sky. They are like our Sun and can vary in size and heat. Although they are bright they are millions of miles away, the nearest is 4 light years away. They may twinkle towards the horizon.

Many stars are binary stars and consist of two or more stars that share a gravitational bond. These are called double stars although this name also applies to stars that look binary because of the angle we see them but are not connected.

Many of the stars in the sky are binary stars. This means they are actually two stars that orbit around a common centre of orbit. Some stars like Castor in the constellation Gemini have more than one binary pair. There are six stars made up of three sets of binaries orbiting each other.

Some stars look close to one another in the sky but are not related; they can be millions of kilometres, even light years apart. A further star may be brighter than the closer star but much further away. These are called optical double stars.

- **Planets** - Planets are typically brighter than stars, they do not tend to oscillate (twinkle) due to being closer than stars. Mercury is difficult to view due to being closer to the Sun, only visible pre-sunrise and post-sunset. Venus is visible in the early morning and evening. Venus, Mars (bright and somewhat red) and Jupiter are brighter than any star. Saturn is slightly less bright than the star Sirius but from northern latitudes it appears brighter as it is higher in the sky.



- **Constellations** - A constellation is a group of stars that appear to make a pattern in the sky. When we look at them they look close together, but in reality they are usually very far apart and may not be part of the same group of stars they appear next to. At different times of the year we can see different constellations due to the rotation of the Earth and the tilt of our axis, in the same way we have seasons. As our planet rotates we appear to stay still while the sky rotates.

- **Asterisms** - An asterism is a pattern of stars that may or may not be linked to a constellation. Examples are the Plough in Ursa Major, the pattern made by the saucer shaped brighter stars, or the Summer Triangle, a shape formed between the bright stars Vega (constellation of Lyre), Deneb in Cygnus and Altair in Aquila.

- **Clusters** - There are clusters of stars around the galaxy. These have sometimes been mistaken for galaxies but we know they are not as there are usually only several thousand stars quite close to our galaxy, if not in it. If they actually were galaxies there would be millions of stars there and they would be much further away. In fact we can see clusters of stars in other galaxies. There are two types you should know about:



- **Open clusters** - Open clusters are groups of stars close to each other in space. They form no specific symmetry and are usually very bright, indicating that they are young stars. There can be anywhere from a dozen to thousands of stars making up no particular shape, and these are found around the galactic plane. A good example of an open cluster is the Pleiades, or Seven Sisters, above the constellation Taurus. You can compare your eyesight to a friend by seeing how many you can spot with your eyes. From a city you may see seven, the record is nineteen!

- **Globular clusters** - Globular clusters are spherical shaped with more stars nearer the nucleus. They resemble a fuzzy ball. These clusters are located around the galactic nucleus. The stars are usually very old red giants and white dwarfs packed tightly together. There are thought to be between 100,000 to over a million stars in a typical globular cluster. An example of a globular cluster is M13 in Hercules.




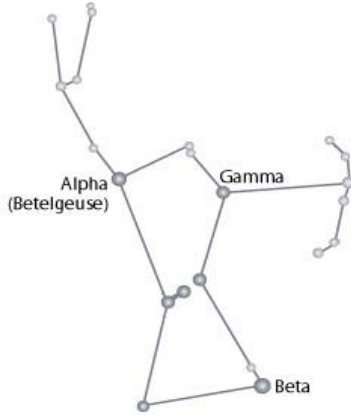

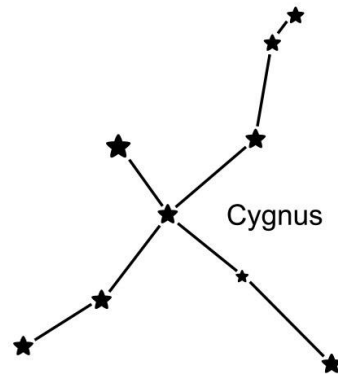





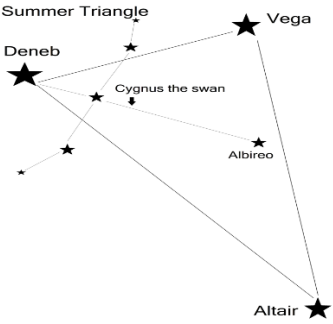

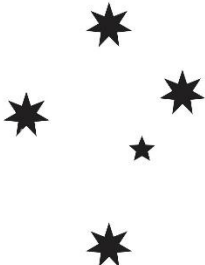

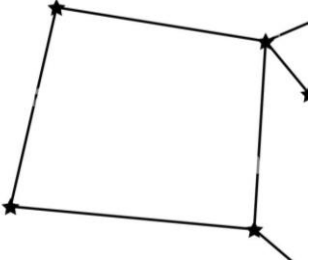
- **Comets** - Comets have vast trails of ice and dust over a large portion of the sky, thinning to a dense core. It's movement over a short period of time is clearly noticeable. Most comets are visible to the naked eye.
- **Meteors** - Meteors are short lived but very bright streaks of light that move across the sky in a matter of seconds.

- **Nebulae** - Nebulae (the plural of Nebula) are blurry patches of light in space that are not other galaxies but are in fact mostly in our own galaxy. They are places where stars are born, are dying or have died.
- **Supernovae** - Very few Supernovae events happen that are visible to the naked eye, only a handful have been recorded in the last millennia. The supernovae that occurred in 1054 (now the Crab Pulsar/Nebula) was visible in the night sky for nearly two years and was visible in the daytime sky for over 20 days.
- **Aurorae** - The solar wind interacts with the atmosphere to create spectacular displays of light and colour in the sky. In the northern hemisphere this is called Aurorae Borealis. In the southern hemisphere this is Aurora Australis.
- **Artificial Satellites** - Slow moving, very faint objects, orbiting in a polar orbit and viewable on the meridian. The ISS (International Space Station) moves over the course of the sky over a matter of minutes. It can be brighter than the planets and is unmistakable in the sky.
- **Aircraft** - Multiple bright white and red lights slowly moving over the sky. You've seen a plane at night time.

6.2 Recognising & Drawing Key Constellations and Asterisms

Key Constellations & Asterisms:

Name	Constellation	Shape
Cassiopea CAS (The Queen)		
Orion ORI (The Hunter)		
Cygnus CYG (The Swan)		

Name	Asterism	Shape
The Plough		
The Summer Triangle		
The Southern Cross		
The Square of Pegasus		

Example Question 1.

Answer the questions with a cross in the boxes you think are correct . If you change your mind about an answer, put a line through the box and then mark your new answer with a cross .

Figure 1 shows a group of seven bright stars in the night sky.



Figure 1

(i) Label the position of the Pole Star in Figure 1. Use the label **P**.

(1)

(ii) Label the position of the star Arcturus in Figure 1. Use the label **A**.

(1)

(iii) The stars in Figure 1 form the asterism called the:

(1)

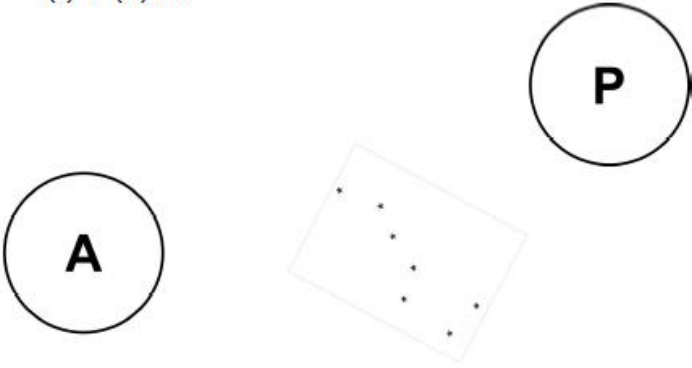
- A** Plough
- B** Seven Sisters
- C** Southern Cross
- D** Summer Triangle

(iv) The stars in Figure 1 are part of the constellation called:

(1)

- A** Cassiopeia
- B** Orion
- C** Pegasus
- D** Ursa Major

(Total for question = 4 marks)

Question number	Answer	Mark
	(i) P (ii) A: 	(1) (1)
	(ii) A Plough (iv) D Ursa Major	(1) (1)

Example Question 2.

(i) Draw a sketch of the seven brightest stars in the constellation of Orion.

(2)

(ii) Label the position of the bright star Betelgeuse on your sketch.

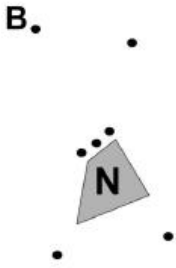
Use the label **B**.

(1)

(iii) Label the position of the Orion Nebula on your sketch.

Use the label **N**.

(1)

Question number	Answer	Mark
	(i) Stars arranged with correct topology Proportions of pattern (approximately) correct 	(1) (1)
	(ii) Position of Betelgeuse correctly labelled (B)	(1)
	(iii) Position of Orion Nebula correctly labelled (N)	(1)

Pointers Using Asterisms:

Using The Plough

The two stars on the pan end of Ursa Major point (from bottom, Merak, to top Dubhe) to **Polaris** in Ursa Minor. This is the star that marks the celestial north pole and has been useful to navigators for centuries because it points north. If you were at the North Pole, **Polaris** would be directly above your head.

This star is a small fraction away from the North Pole but it is pretty near. The Plough is also useful to find **Arcturus**, a red star in Bootes. Follow the path of the 'handle' of the Plough to find Arcturus.



Orion



The stars in the belt of Orion can point westwards and down to the brightest star **Sirius**, the Dog Star, in the constellation of Canis Major (The Great Dog).

If you follow the path of the 3 stars in the opposite direction you will come to the bright red star **Aldebaran** in Taurus and the **Pleiades Cluster**.

Square of Pegasus

If you use the bottom right and top left stars of the square you can use a line to find the **Andromeda Galaxy** which is barely visible on a clear night in an area of low light pollution.

Using the top right and bottom right stars of the square you can follow the line down to **Fomalhaut**. Bear in mind that Fomalhaut is only visible from southern parts of the UK for a few months of the year and will be very near the horizon.



Example Question

Figure 2 shows part of the constellation of Pegasus.

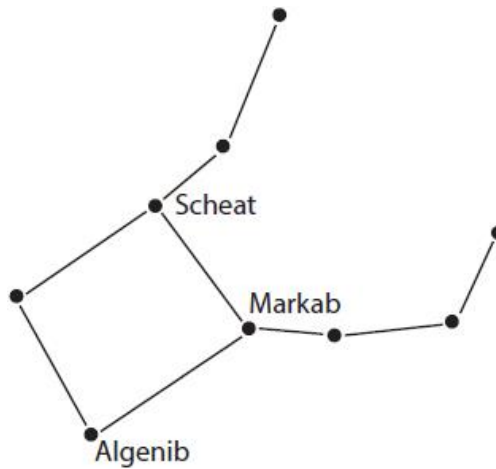


Figure 2

(i) Draw an arrow on Figure 2 to show how this constellation may be used to find the star Fomalhaut.

(1)

(ii) Show the approximate position of the Andromeda Galaxy (M31) on Figure 2. Use the letter **X**.

(1)

(Total for question = 2 marks)

Question number	Answer	Acceptable Answers	Marks
(i)	Fomalhaut marked in the direction shown.	Projection of the line downwards	1
(ii)	Andromeda galaxy marked within the indicated area.		1

6.3 Understanding Cultural Variations in Constellation Names

- Different cultures have **unique interpretations** of star patterns.
- **Greek & Roman mythology** forms the basis for most Western constellations.
- **Chinese astronomy** has a different system with its own named stars and asterisms.
- **Indigenous cultures** often use stars for navigation and storytelling.

A common astronomical constellation to look out for is Ursa Major, Latin for 'Great Bear'. Like many of these constellations it doesn't look a bear. There is a Greek mythological behind the constellations where the Great and Little bears (Ursa Minor) were thrown into the sky by Zeus.

Ursa Major is a familiar constellation in the northern hemisphere and its prominent asterism has different names. In the UK and Ireland it is known as a plough because it looks like the agricultural tool. Other countries have different names for it; Great Wagon (Scandinavia), Saucepan (Holland), Salmon Net (Hungary), 'Seven stars of the north' (Korea) and 'Big Dipper' (USA).

6.4 Using Star Charts & Apps to Identify Objects

Star maps and charts

Star maps and charts are published in books, newspapers and magazines. They tend to show what is in the sky during a month or season. Frequently there are two maps, one showing the view of east to west towards the south, the other showing the view of west to east towards the north. On star maps, brighter stars appear as a larger dot and smaller stars as a smaller dot. Some maps are equatorial with the northern constellations stretched.

Planisphere



A planisphere is a quick and easy way to find out what stars are viewable at any time. It consists of two discs fastened to each other. On one of them is a hole so that a portion of the disc underneath can be seen. Around the edge are hours of the day. On the underneath disc is a star map showing every constellation available for viewing from a general location e.g. Northern Europe. Around the edges are equally spaced days of the year. The edge of the round area represents the horizon. The ecliptic is a line through which the Sun and planets appear to move, and cuts through constellations known as the Zodiac. The two discs are fixed at the pole axis (so Polaris is not shown).

To find the stars available on 4th September at 10pm you would move the hour dial that says 10pm on the overlay next to the date on the underlay and point the planisphere north to see a representation of the stars available in the sky at that time.

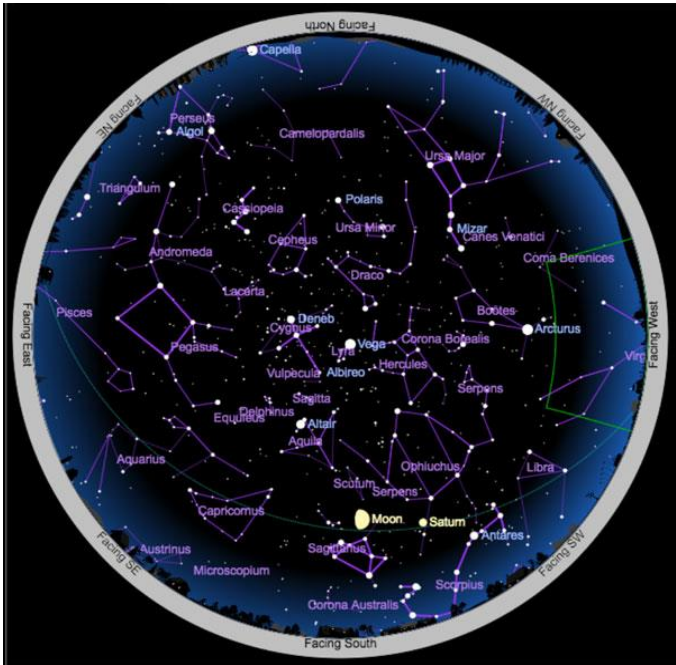
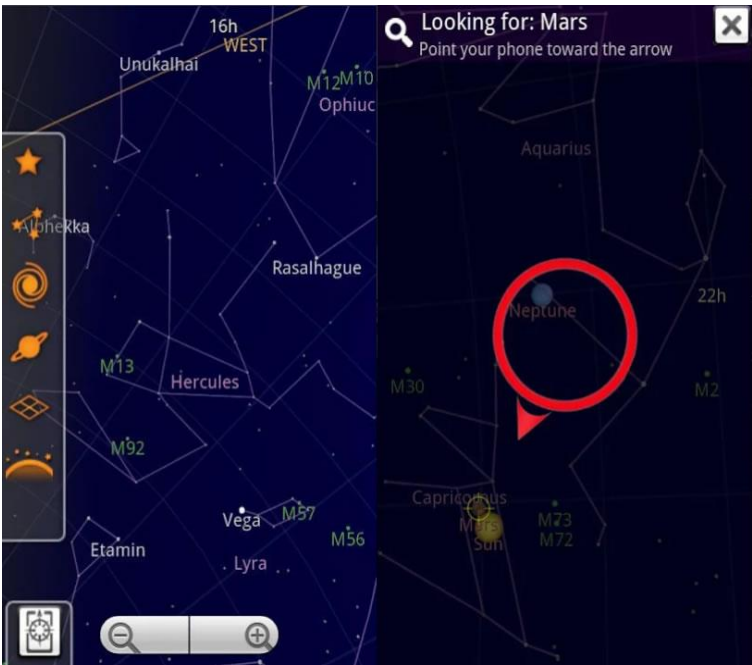


Software

Software can show the sky at any given moment and can offer other features like 3d maps of planets or ability to change location or time etc. Stellarium is free and is updated with new features and objects. Celestia is also a well regarded.

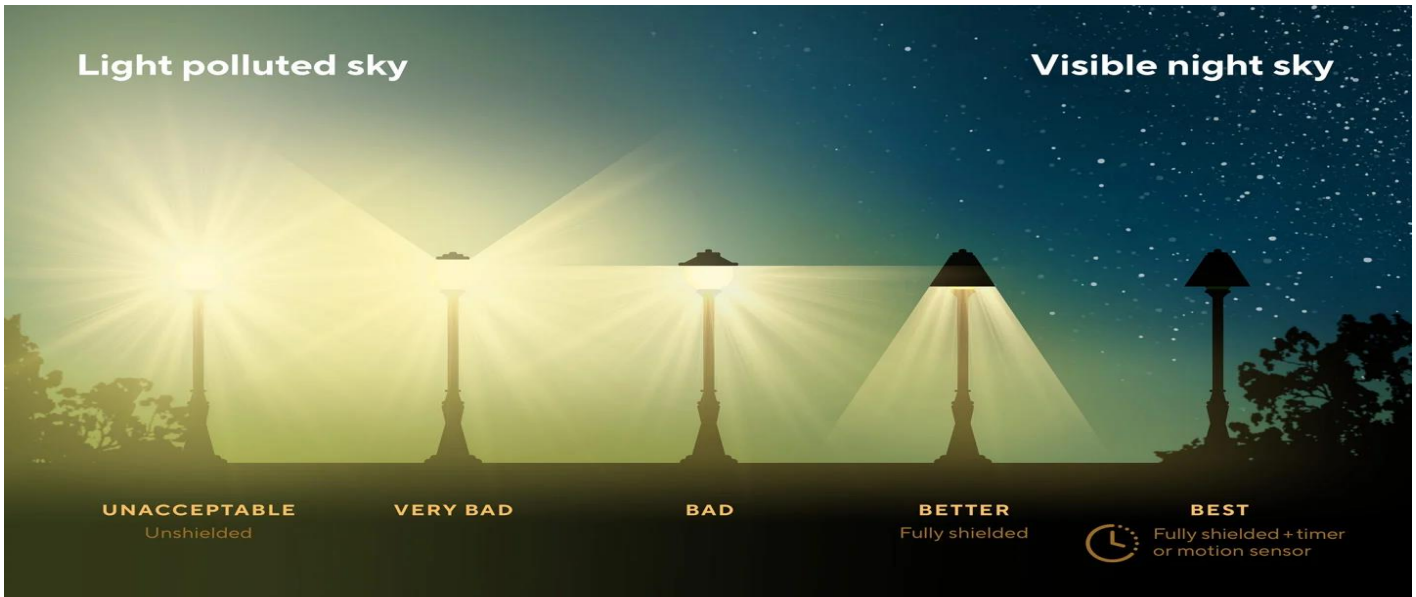
Apps

Apps can be downloaded on Apple and Android phones. Some are free, some are paid for. Good apps include features such as being able to point your device to the sky and identify stars, planets and constellations. Some may connect with a small telescope that can then be controlled by your mobile device. There are many available for both Android and IOS. Experiment by downloading a few free ones to compare. Some are easier to use than others and others may have functionality that you may not need. Just as a quick comparison, Google Sky Map for Android is very easy to use and is perfect for casual observations and finding things quickly. Star Chart for IOS is slightly harder to use but has detailed maps and information about other celestial goings on. Both are great at what they do. Find what is best for you.



6.5 Light Pollution & Its Effects

6.14 Factors Affecting Visibility



Light pollution

Optical light from human sources. If you go to the countryside or area outside a town on a clear night you will see many more stars than you would do in the city. The reason why you cannot see so many stars in a city is light pollution.

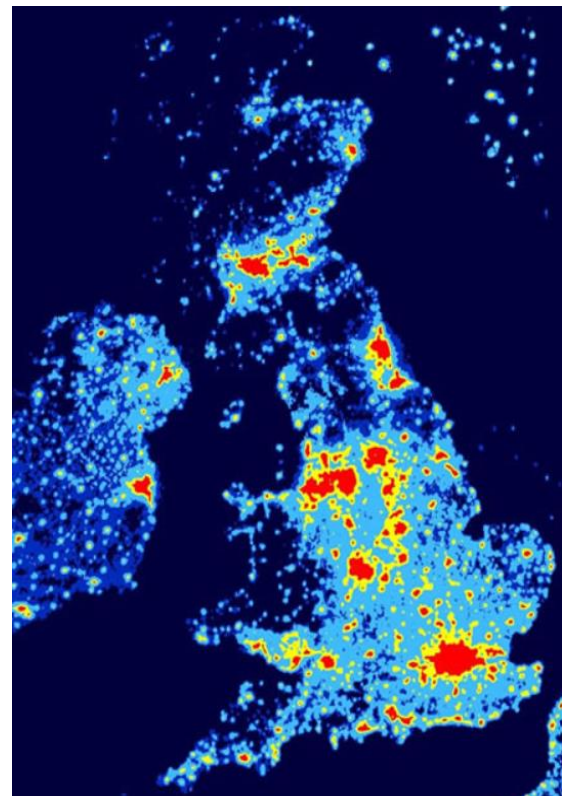
This is the result of so many lights in a built-up area shining upwards and obscuring the night sky. There is a Campaign for Dark Skies which advises local authorities on planning city lights.

Rising and Setting

The Sun's rising and setting usually bring redder skies. This is caused by the angle of the sun being acute so sunlight having to travel further through Earth's atmosphere and the light being scattered towards the red end of the visible spectrum. Stars and planet light also has to penetrate thicker atmosphere and clear viewing is difficult. Objects at these angles appear to 'twinkle'. Incidentally at sunrise and sunset the Sun can appear

Viewing Conditions

Saharan dust or volcanic ash in the upper Earth atmosphere can obscure viewing by refracting light/ Human pollution from cars and industries in built up areas.



Weather Conditions

There is a joke that Astronomers sometimes become knowledgeable about clouds. We get a lot of cloud in Britain. It's not just what we would typically call bad weather however. During cloudless nights in summer we can experience warmth from Earth 'shimmering' stars, in winter ice particles in the upper atmosphere can obscure viewing.

Landscape

Mountains, Trees and natural features can block access to the sky

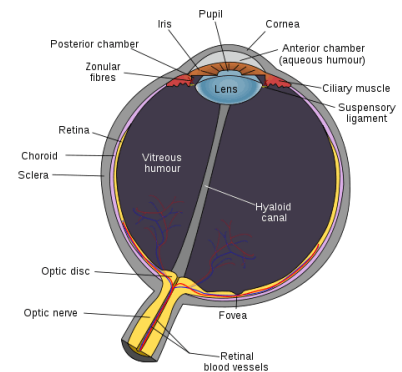
Other Celestial Bodies

It goes without saying the Sun blocks light from most objects when risen apart. We can still see the Moon (except the days of a new Moon) and only the brighter planets at dusk or dawn. Astronomers tend to dislike stargazing during a bright Moon. This is because the Moon is so bright it obscures light from stars.

6.13 Naked Eye Observing Techniques

Dark Adapted Eye

It can take typically 7 minutes for your eyes to become used to darkness and up to 30 minutes to become totally adjusted to the dark conditions of observing. Astronomers take care to ensure they do not ruin their adapted eyes by using torches or bright lights. This is why red torches are used at night time and software from computers is set to a red tint. It is also a reason why it is best to look for faint objects when the Moon is not well lit or is low in the sky.



Averted Vision

When we look straight at a faint object it can 'disappear' only to reappear when we look at an area near it. This is because the centre part of the inside of the eye (the fovea) contains rods which help us distinguish bright light and colour. Areas around the fovea are cone cells which are more sensitive to faint light, making it easier to see faint detail at night.

Relaxed eye

By straining at objects or squinting eyes we place stress on them which makes it harder for the eye to refocus on objects. By relaxing our eyes when we look through a telescope or by using an eye patch we can improve our vision.

6.15 The Milky Way as Seen from Earth

The Milky Way is named because it looks like a path in space that looks 'Milky'. With the naked eye it looks like a fuzzy light irregular column in the sky. We only see this bright long area, we can't make out any stars that we could see with binoculars. With binoculars, the Milky Way's haziness is cleared a little and we can make out individual faint small stars.

Using a telescope we can see that the Way comprises of countless stars which we see clearly. Sweeping along the Milky Way continues; if we move the telescope away from the Milky Way a little, we will see less stars.

What we see of the Milky Way is actually plane of our own galaxy.

All other stars we see in the night sky with naked eye are part of the Milky Way and they are only our close neighbours.

The Milky Way is part of a group of 30 or so galaxies called the Local Group. This group is one of many in an even bigger group called a supercluster which is part of the Universe.

The Milky Way is just one of billions of galaxies in the Universe.



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