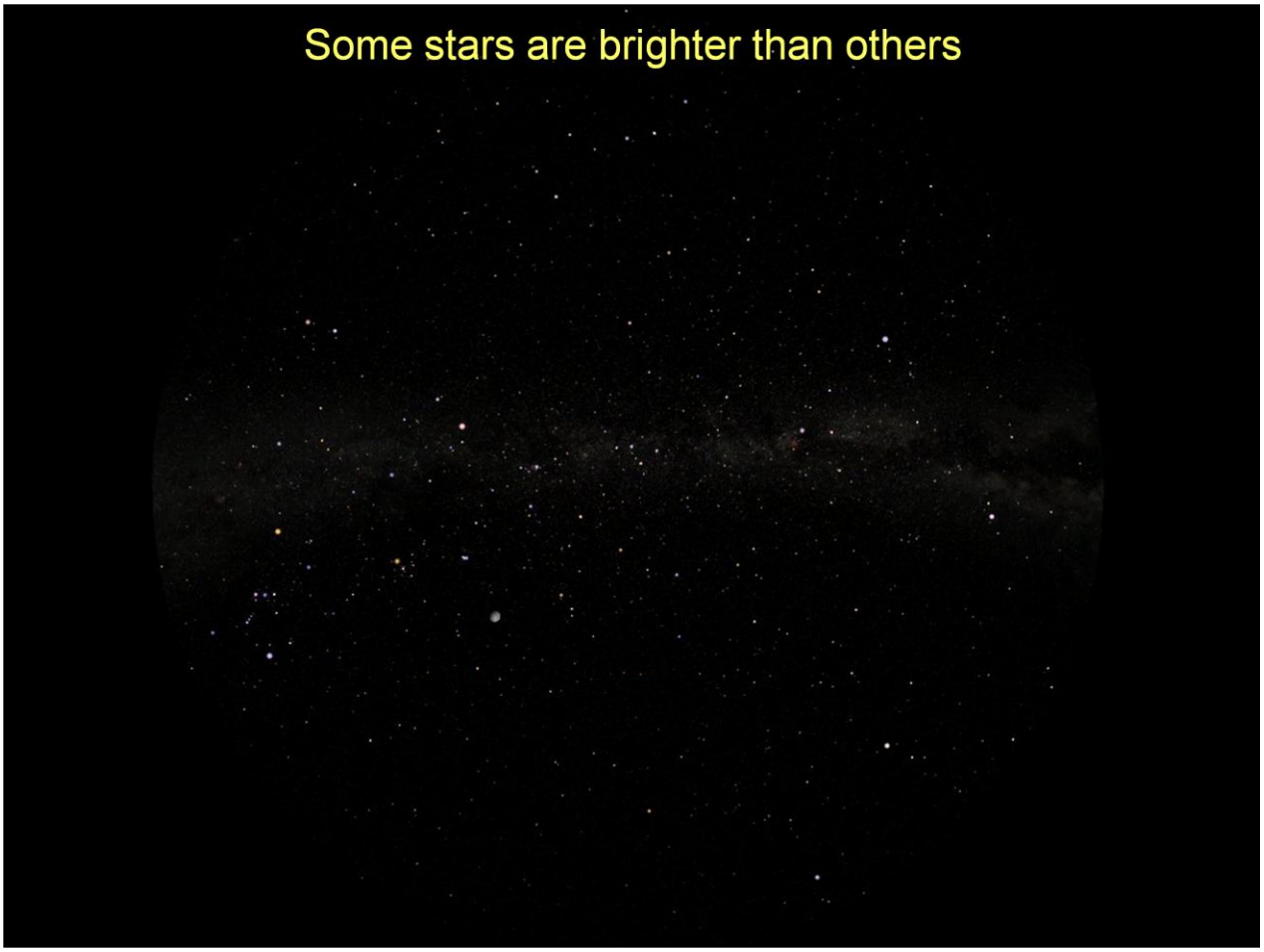
Finding our way around the night sky

1st Wash Common Cubs

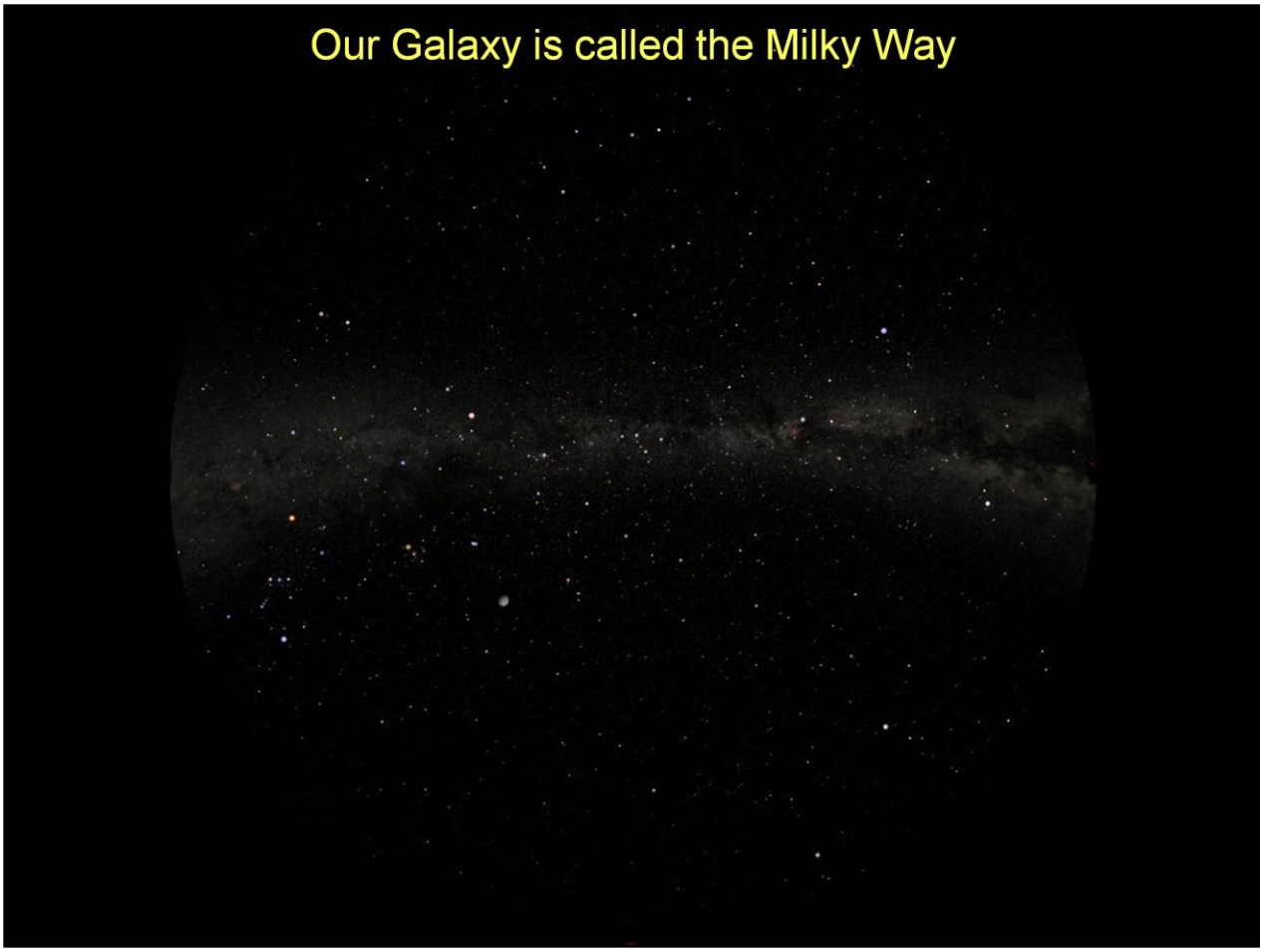
7th December 2021

Steve Harris
Julie Armstrong
Peter Bendall
George Sallit



To the naked eye (the astronomical term for look without optical aid) all the stars look very similar. Some stars look brighter than others and some of the brighter stars may show a hint of colour but it is very subtle.

One thing we will notice, is some stars appear to form a loose pattern or group. We as humans do have an ability to make patterns, groups or shapes out as we look around us. Some examples are seeing rocks that look like an animal or a human head or face. We also se the shapes of animals in the clouds on a bright day. So it is not surprising that we see patterns in the night sky. The picture above shows the night sky with the ‘naked eye’ stars in their relative positions.



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The misty band that stretches diagonally across the sky is the Galaxy that our star the Sun resides in and we call the Milky Way. Our Sun is just one of the 200 billion stars that comprise the Milky Way that is classified as a Giant Spiral Galaxy.

Galaxies can be thought of as islands of stars in the vast emptiness of space. Galaxies can vary in size from a few millions of stars (Dwarf Galaxies) up to those like our Galaxy that has 200 billion stars and the largest of all Galaxies called Giant Elliptical Galaxies that can have over a trillion stars. (A trillion is a million times a million or 1,000,000,000,000).

The chart above shows the sky as if we were looking straight up into the whole sky so it appears like a spherical dome with the stars printed on it. Where the sky meets the land around us is called the Horizon. The Horizon stretches all around us in all directions.

The Northern Horizon is at the top of the chart, South is at the bottom, East on the left and West to the right these are called the Cardinal Points of the Compass. The half way points between the Cardinal Points are marked with the two letters of the Cardinal Points to each side: NW, SW, SE and NE.

The view we see here is as if we are looking straight up to the point directly overhead that we call ‘the Zenith’. So it doesn’t matter where we are in the world the point directly above our head is the ‘Zenith’.

The only signposts or markers in the night sky are the stars.

The stars all look the same but some are brighter than others.

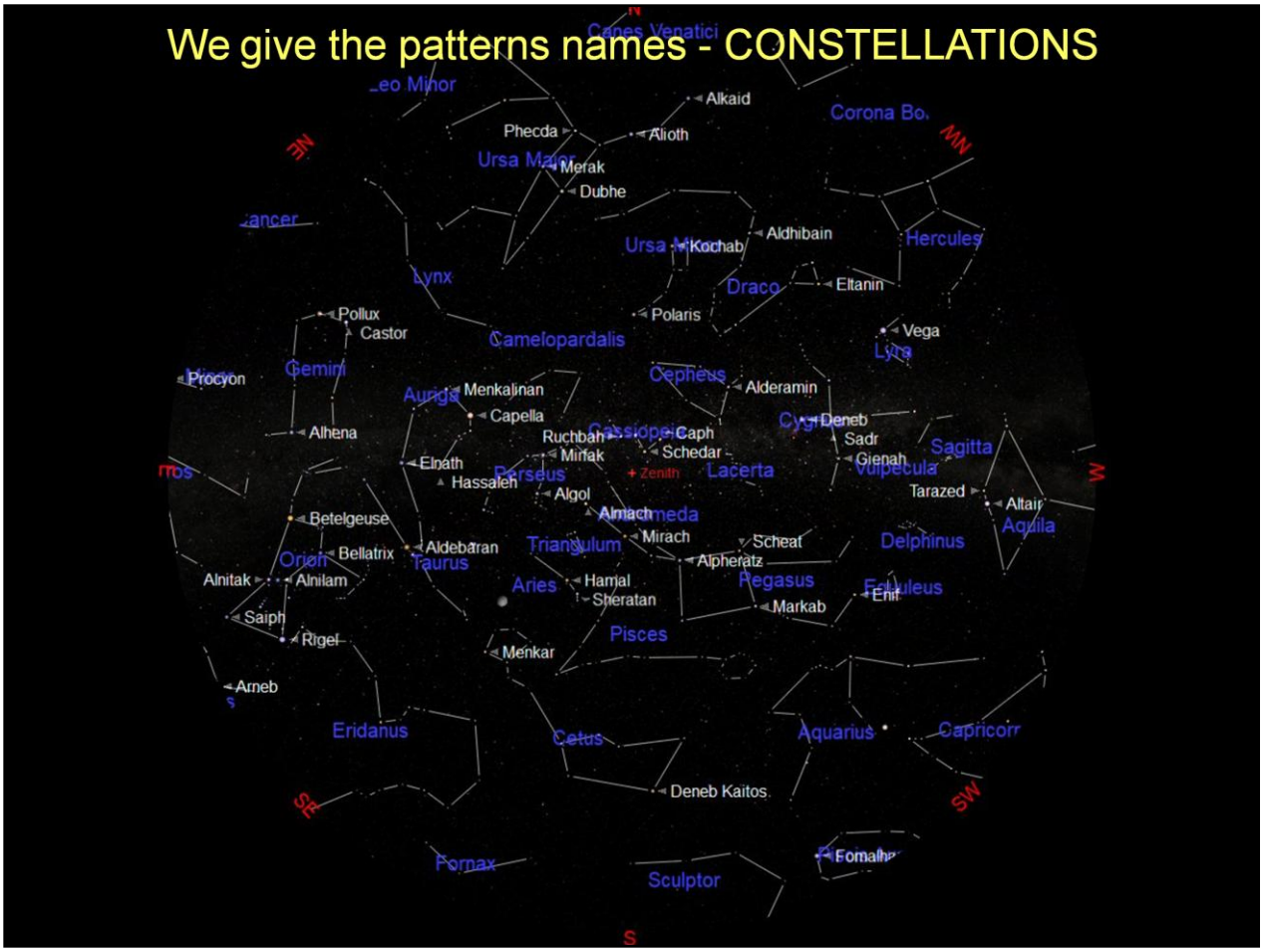
The bright stars are easier to find so we give them names so we can identify them.

Most names are very old and originate from ancient Greek, Roman or Arabic.

We humans are very good at identifying patterns or groups of things.

Our eyes tell us that some stars appear to be in groups or look like patterns.

If we join up the stars that appear to form a group with ‘dot to dot’ lines we can recognise the 88 internationally accepted patterns that we call ‘CONSTELLATIONS’.



We give the internationally recognised constellations names.

The names of the constellations are mainly very old.

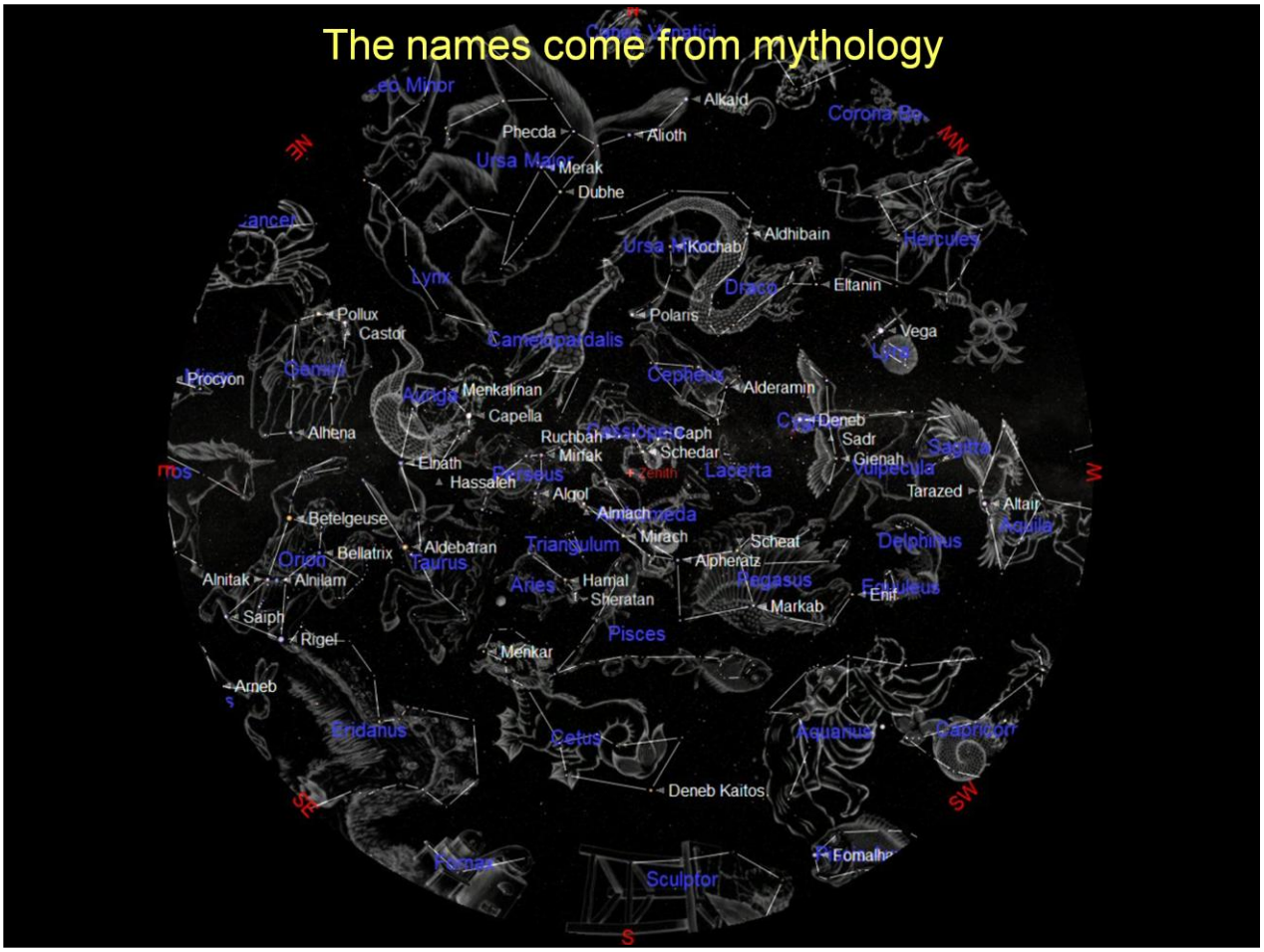
Constellations help us identify areas of the night sky.

They are rather like the counties on maps of England.

Ursa Major, shown at the top (North) of the chart above is one of the best known.

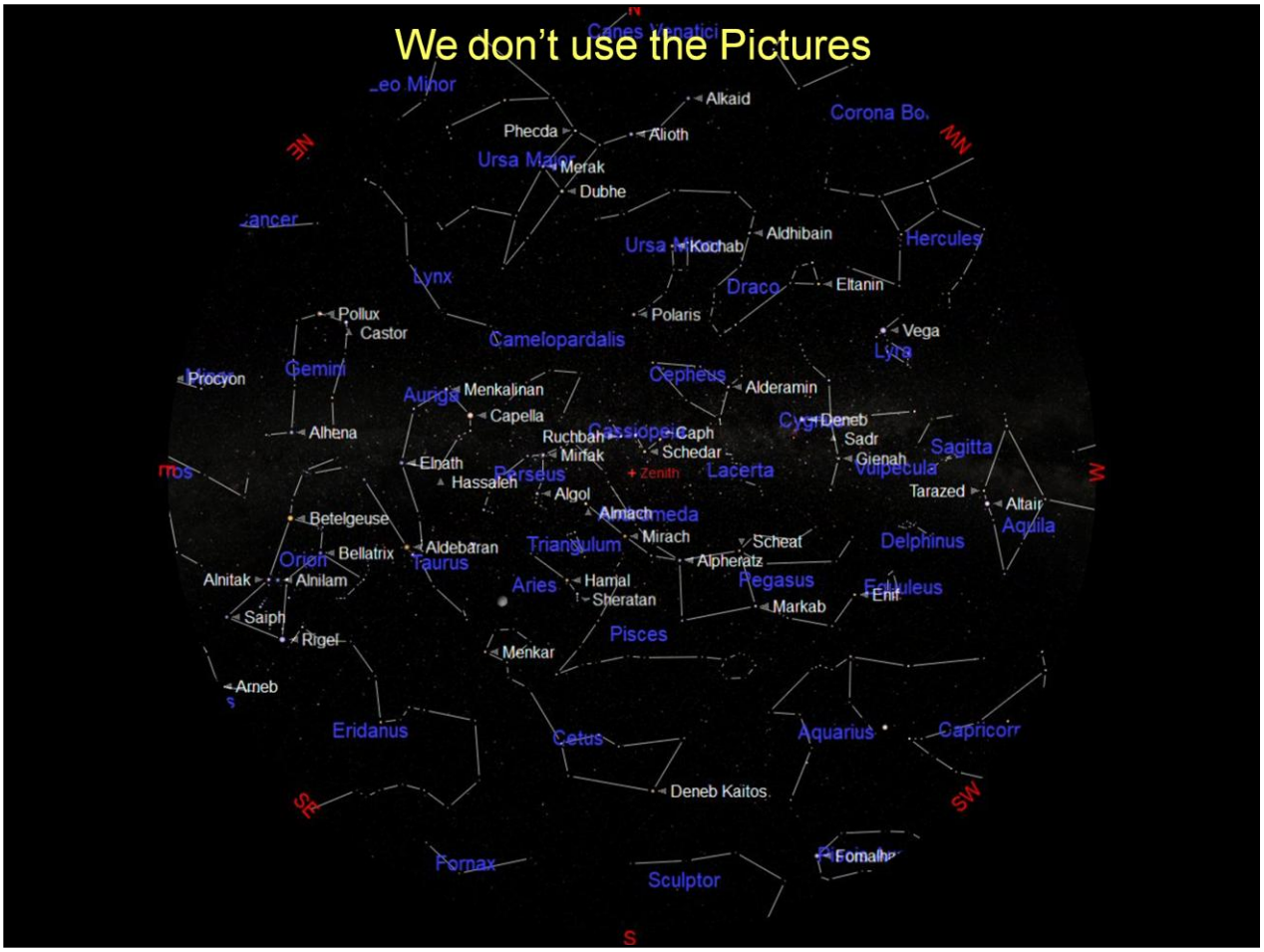
It is also called the ‘Plough’ or the ‘Big Dipper’ by the Americans.

The main shape (asterism) does look remarkably like a Saucepan..



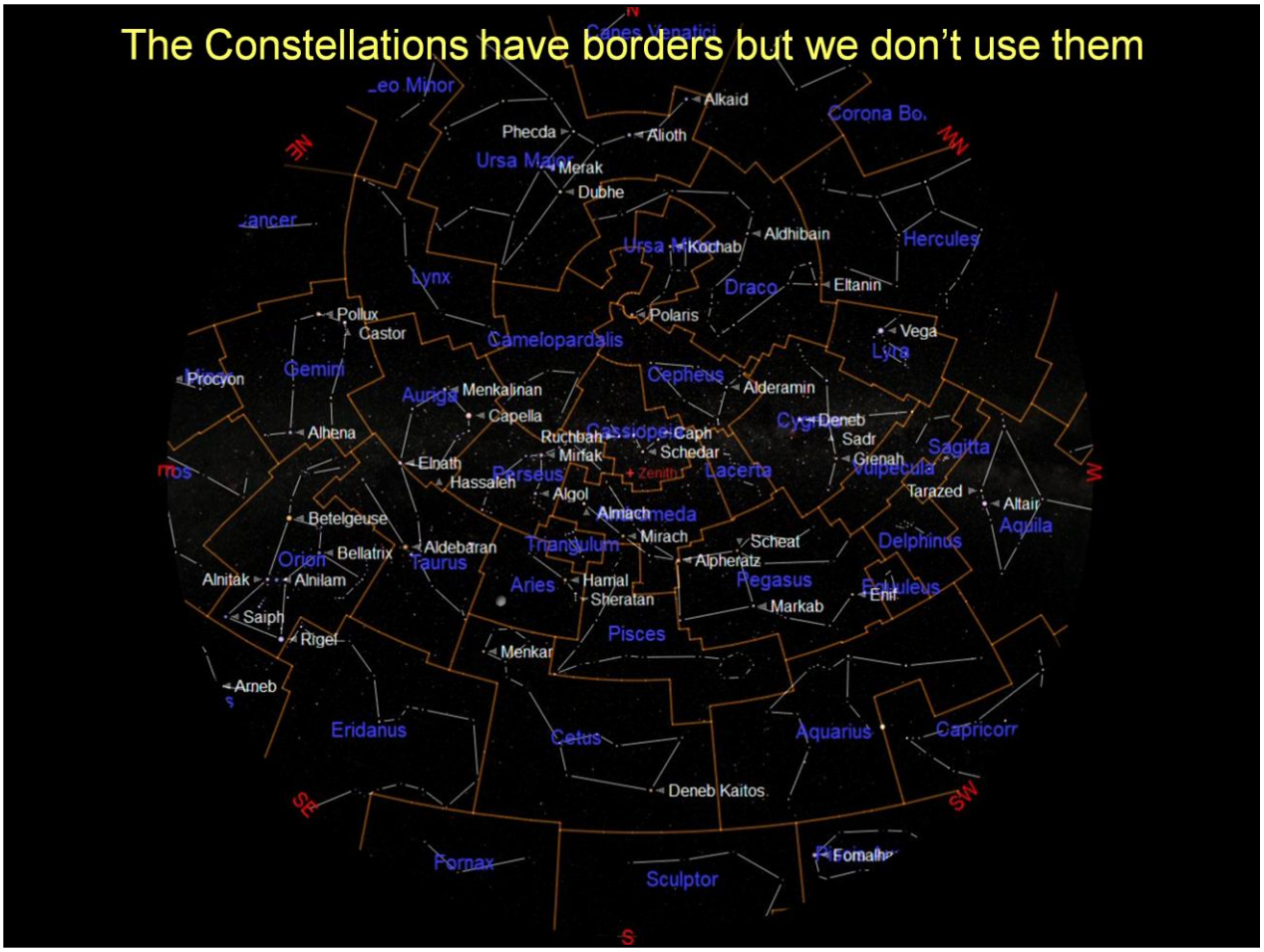
In the past star charts were very artistically drawn. They were lovely to look at but scientifically they were not much use. Some artists even moved the position of the stars to fit their elaborate pictures better. The chart above has illustrations superimposed on the modern stick-man constellation figures. It can be seen that very few illustrations look anything like the star pattern it is supposed to represent. Having said that it can also be seen that the stick figures are not much better.

However the stars on modern charts are in the proper position relative to all the other stars. The stick figures just join the brighter stars to make the recognised grouping easier to remember. However they do not necessarily resemble the mythological character that they represent. Stick figures are not so ‘pretty’ but they are more scientific.



The 'stick patterns' link stars into recognisable Constellations.

The names of the Constellations are used to identify areas of the night sky.

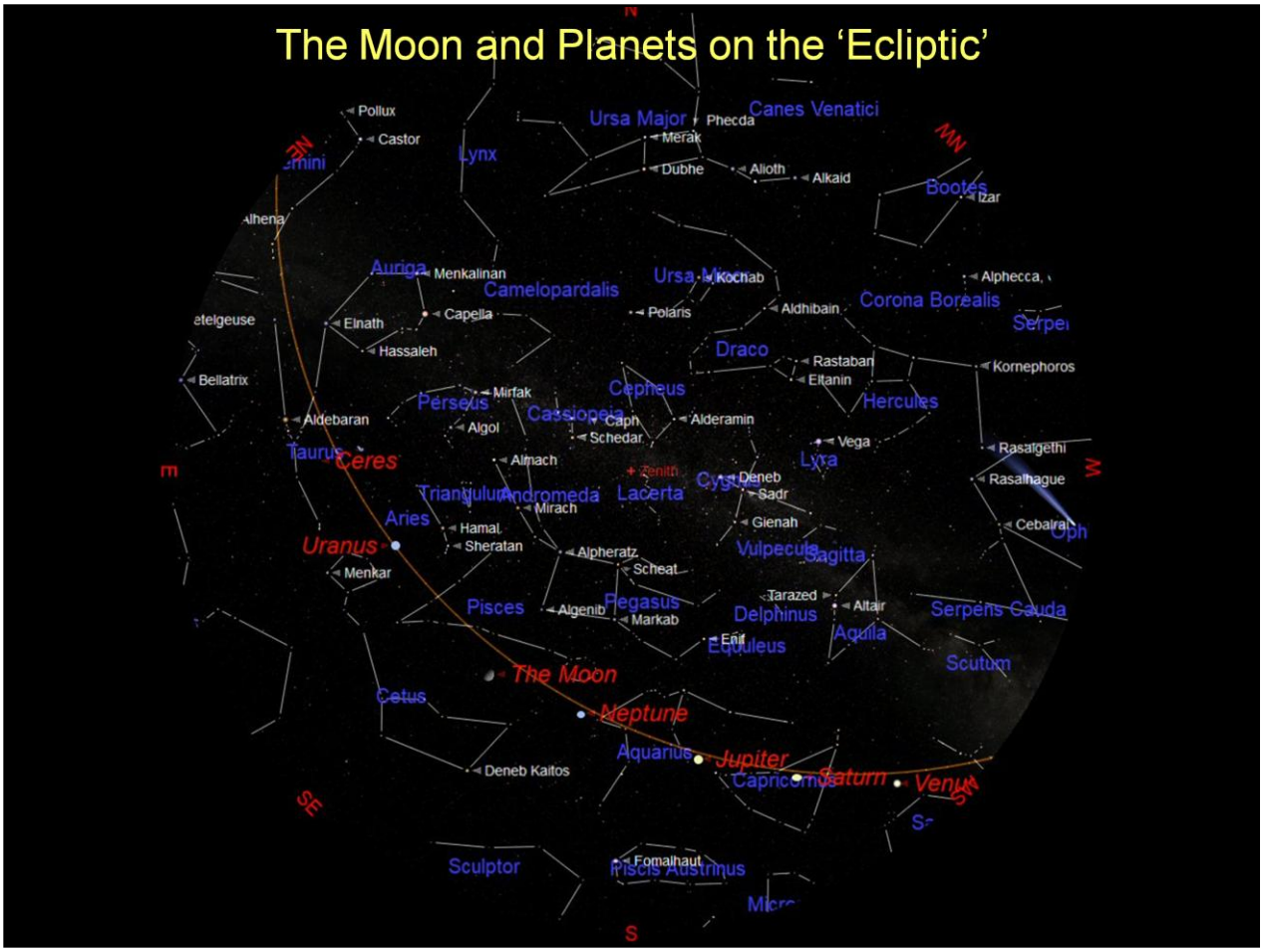


The Constellations do have set borders but we can't see them in the sky.

So we don't generally use these borders.

But if we want to give an object a location in the sky we do use the borders.

So we need to look a star charts to determine which constellation the object is in.



There is an imaginary line that the Sun, Moon and Planets appear to move along as they cross the sky due to the rotation of our planet Earth.

We call this imaginary line the 'Ecliptic' and it is also known as the Zodiac.

It is the line that represents the plane where the planets move around the Sun along their orbits.

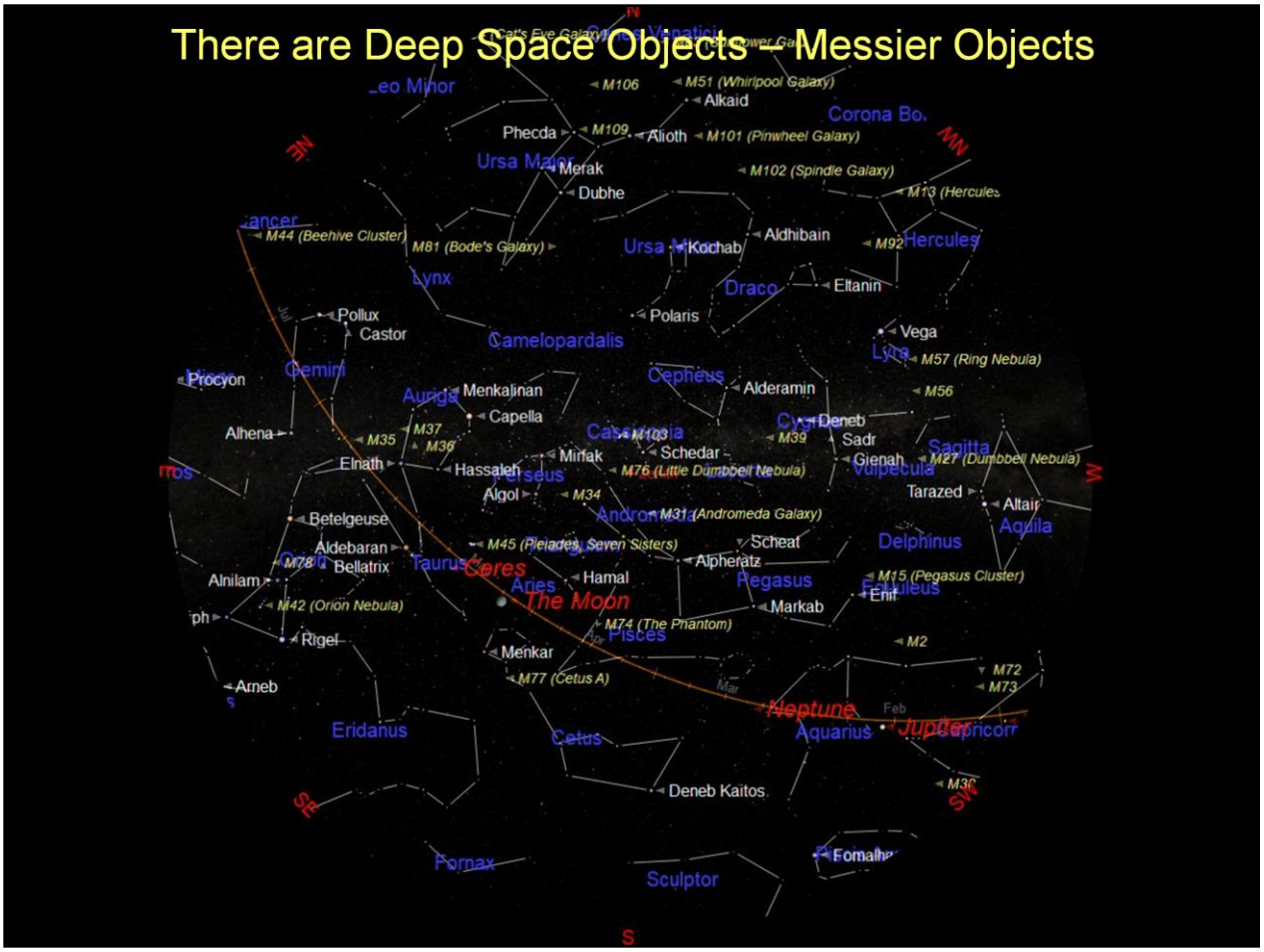
Our planet Earth rotates on an axis (North and South poles) that is tilted over at 23.4º compared to the Sun's axis and the orbital plane of the planets.

So our view of the sky from Earth is tilted and this causes the Ecliptic to appear to move up and down as we orbit the Sun giving us our Seasons.

This is why the Sun appears higher in the sky during the summer and lower during the winter.

We can see the outer planets Saturn, Jupiter, Neptune and Uranus and where they appear in the night sky on the chart above.

At the moment we can also see Venus but it is very low in the south west in early evening soon after sunset.



We need to be able to recognise the brightest constellations then we can use them to find the fainter constellations.

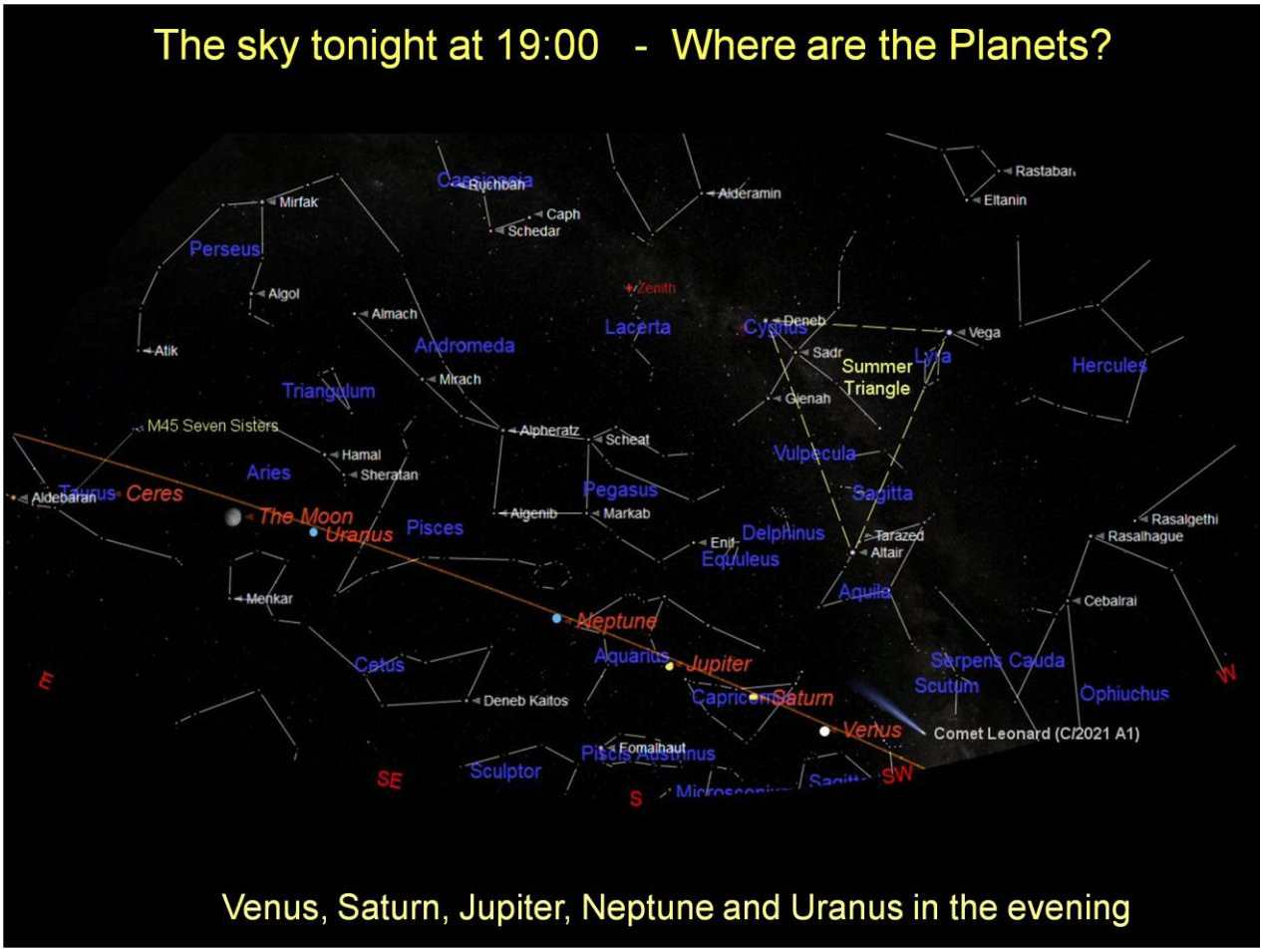
We then use the constellations to find the interesting Deep Sky objects.

These are the objects that reside outside of our Solar System.

These objects include Galaxies, Star Clusters and Nebulae.

The brightest and easiest of these objects to see are listed in the Messier Catalogue and are labelled as Messier 31 or (M31) for example.

Messier Objects are the first Deep Sky Objects to look for using a telescope.



We can see Venus, Saturn, Jupiter, Neptune and Uranus as they appear to move along the Ecliptic from east to west as Earth rotates from west to east.

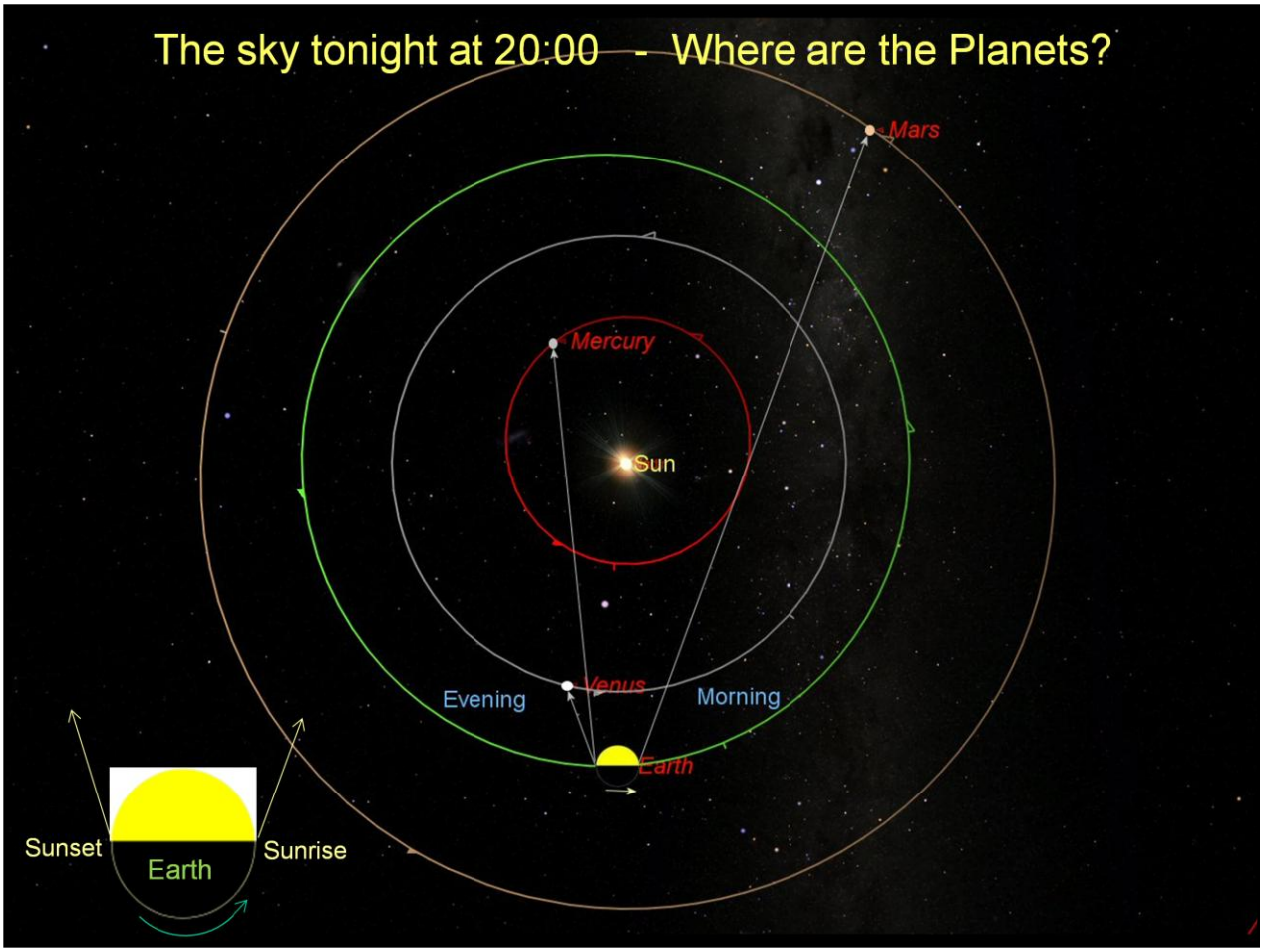
This is rather like looking out of a train window as the train begins to move out of the station.

If you are not aware that the train is about to move then it may appear to be the station that is moving.

As we (on Earth) are moving from west to east (right to left) the sky appears to move in the opposite direction from east to west (left to right).

The planets will begin to disappear over the western horizon, First Venus soon after sunset then Saturn at 18:00 and followed by Jupiter at 21:30.

Neptune sets at midnight and finally Uranus sets at 05:00 in the morning.



This chart above shows where the inner planets are located compared to Earth tonight.

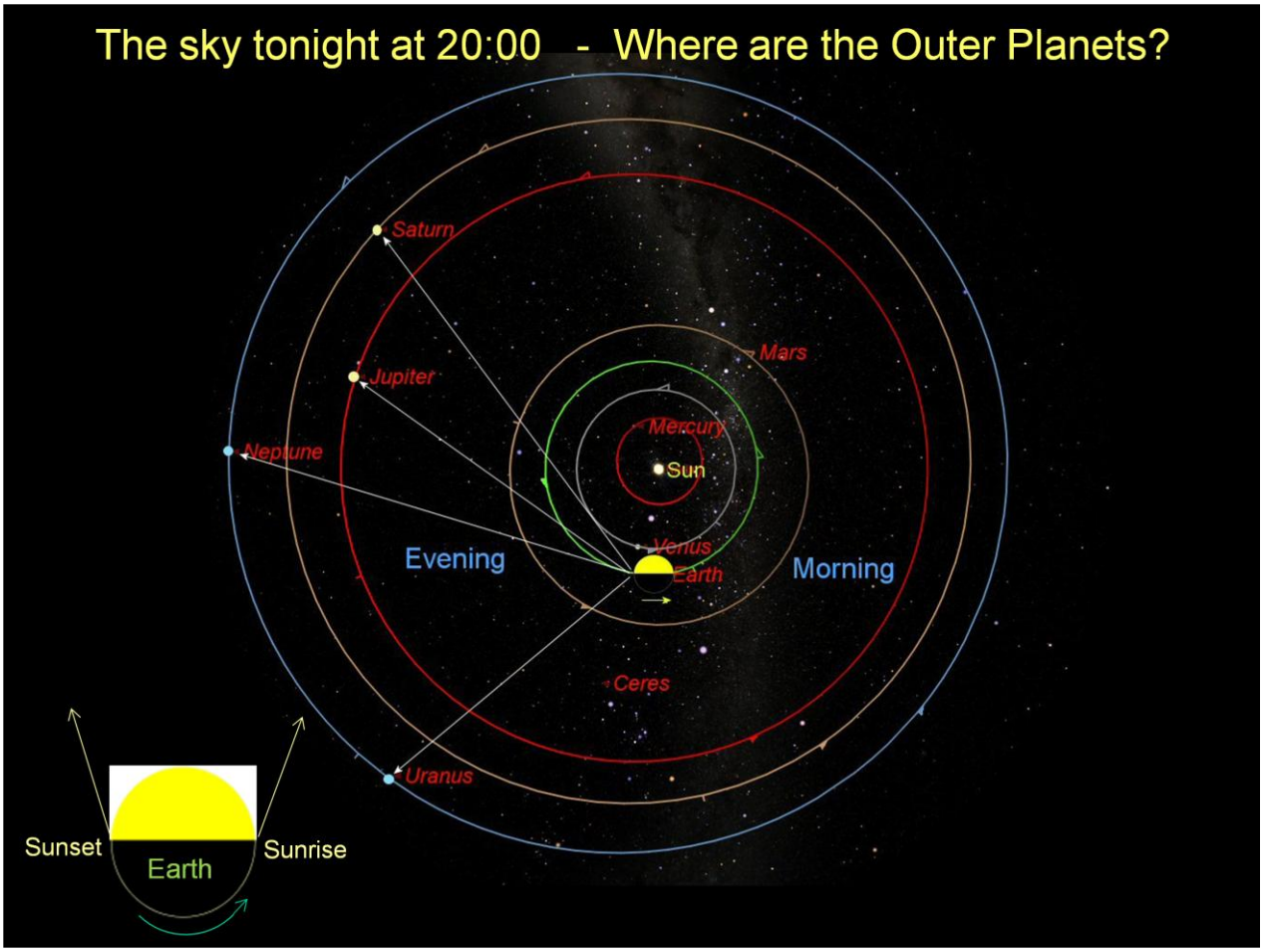
As shown on the chart the side of Earth facing the Sun is in daylight.

So we can only see planets that are closer to the Sun in the morning or evening sky.

This means they only appear when the Sun is below the horizon and the sky is beginning to darken.

So as Earth rotates clockwise, as we are looking down on the chart, sunset will be on the left side of Earth and Sunrise will be on the right. At sunset when the Sun has gone below the western horizon we can see Venus in the evening sky. In the morning before the Sun rises over the eastern horizon we can see Mercury above the horizon.

Mars is too close to the Sun and cannot be seen.



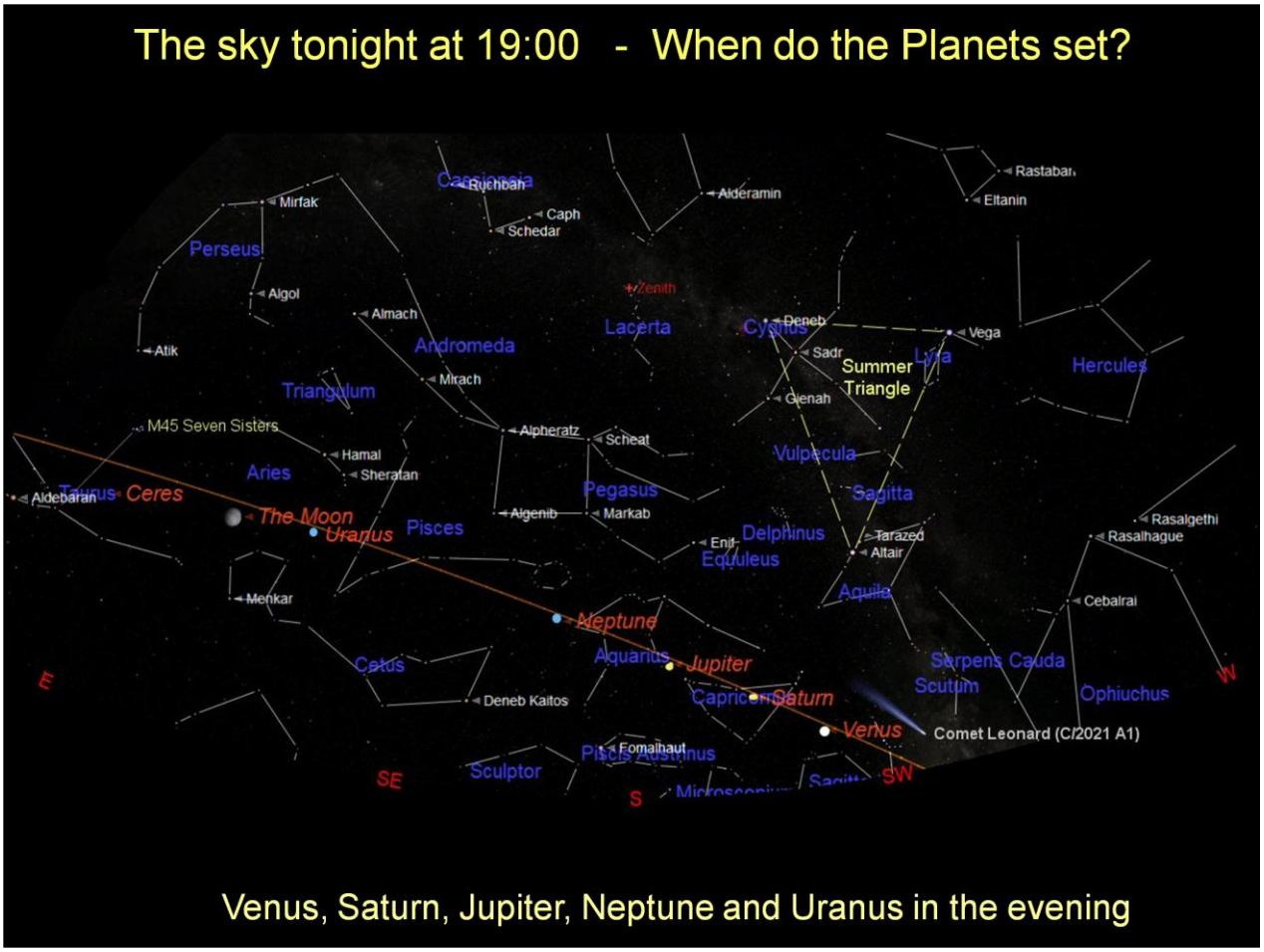
The chart above shows where the outer planets are located compared to Earth.

As shown on the chart the side of Earth facing the Sun is in daylight.

So we can only see planets that are closer to the Sun in the morning or evening sky.

This means we can see any planets that are in the sky on the dark side of Earth.

So as Earth rotates clockwise, as we are looking down on the chart, sunset will be on the left side of Earth and Sunrise will be on the right. After sunset when the Sun is moving over the western horizon we can see Saturn first in the eastern evening sky. We can then see bright Jupiter followed by the faint Neptune and finally Uranus rises in the east.



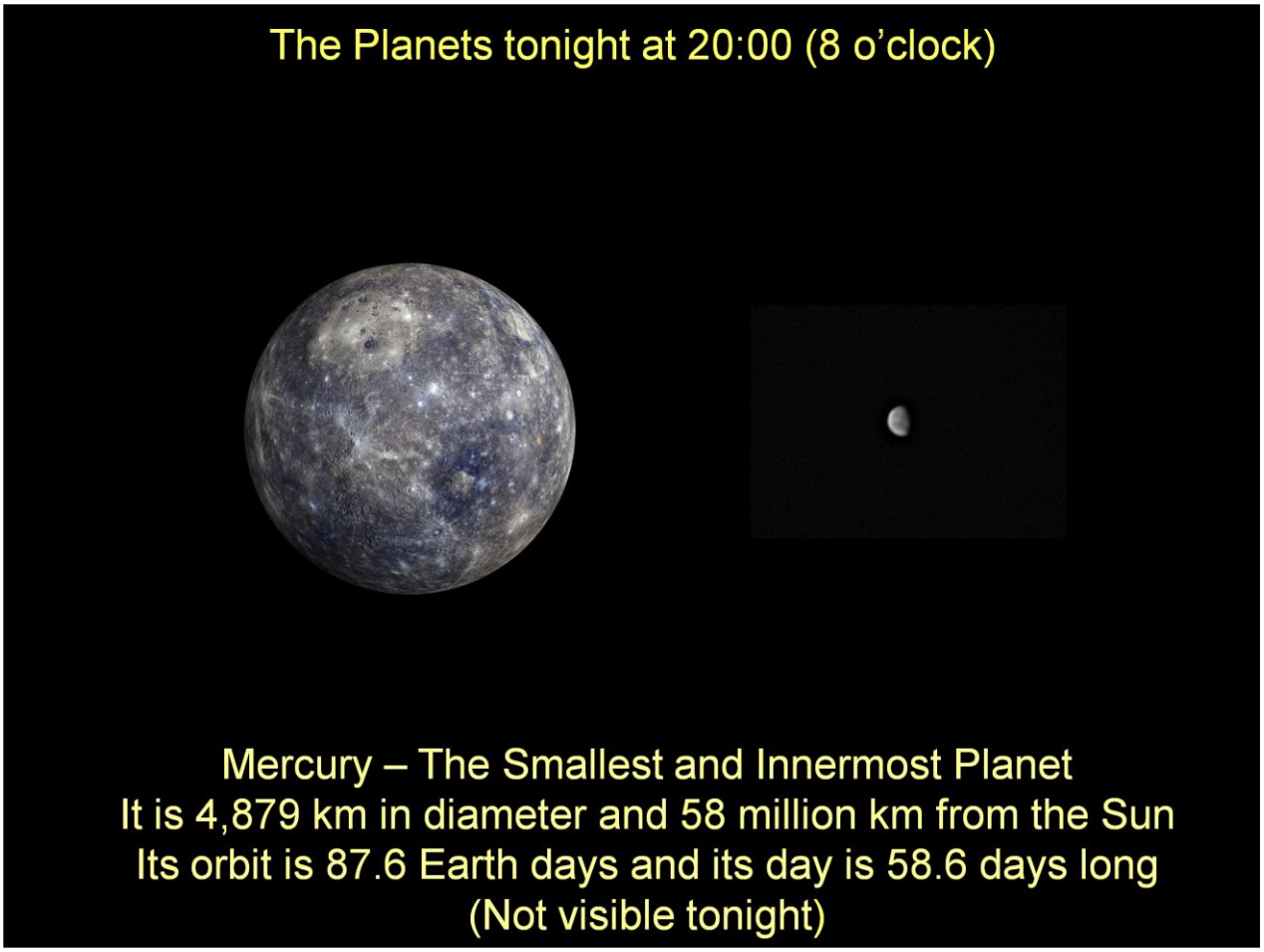
The planets will begin to disappear over the western horizon.

First Venus set over the western horizon soon after sunset.

Then Saturn sets at 18:00 and is followed by Jupiter at 21:30.

Neptune sets at midnight.

Finally Uranus sets at 05:00 in the morning.



Mercury is the smallest of the eight main planets in our Solar System.

It is 4,879 kilometres in diameter which is just 0.38 of the diameter of Earth (12,756 kilometres) and not much bigger than our Moon (3476 kilometres).

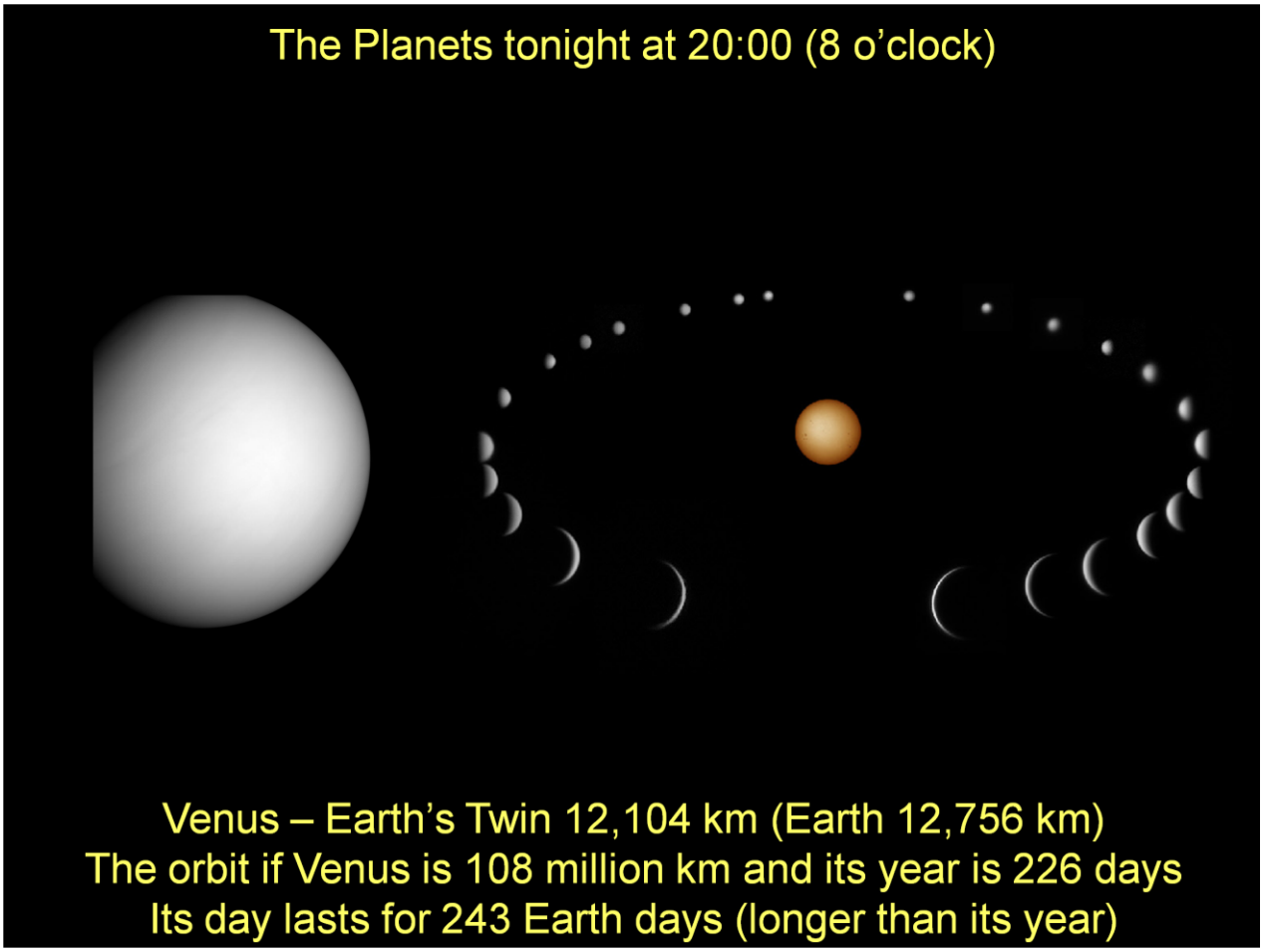
This smallest planet does not have any moons.

Mercury is also the planet with the closest orbit to the Sun and is just 57.9 million kilometres from the Sun.

Being the closest planet to the Sun it also has the shortest orbit that is 0.24 Earth years or about 87.6 Earth days.

Its rotation (day) is surprisingly long at 58.6 Earth days. This means its day is not much shorter than its year.

It rotates three times for every two of its orbits around the Sun.



Venus is 12,104 kilometres in diameter so is slightly smaller than Earth that is 12,756 kilometres in diameter.

It orbits 108.2 million kilometres from the Sun compared to Earth's orbit 149.6 million kilometres from the Sun.

It is thought that the two planets have similar composition with one exception being the amount of water they have.

The amount of water may have been similar in the past but Venus appears to have lost the majority of its water.

Venus is closer to the Sun and appears to have suffered a 'runaway greenhouse effect'. The additional heat from the Sun may have caused the surface temperature to rise and the Carbon that is trapped in the rocks on Earth was released into the atmosphere on Venus to form Carbon Dioxide (CO_2). The Carbon Dioxide allows the heat from the Sun to reach the surface but prevents it from being radiated back into space. The temperature then steadily increased in a runaway manner until it reached the 467°C surface temperature we see on Venus today.

We can see the phases of Venus (like our Moon).

Earth is the third planet from the Sun and almost the twin of Venus.

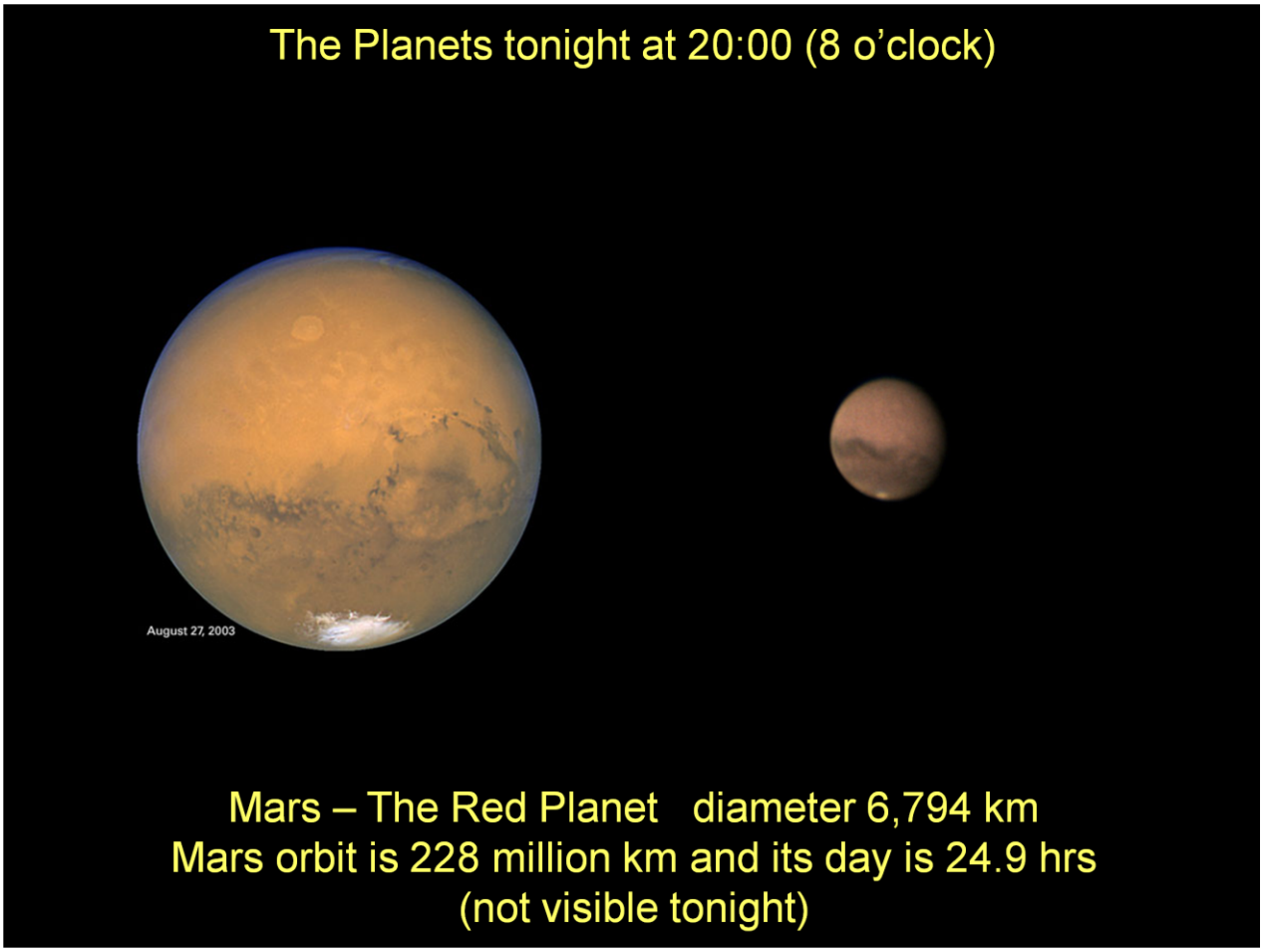
It is 12,756 kilometres in diameter and has an orbital period (1 year) of 365.25 Earth days.

Earth has its orbit right in the centre of the Habitable Zone where Water can be Solid (ice), liquid (water) and gas (steam / vapour)

The axis of Earth is tilted at 23.4º and this is why we have seasons.

Our single natural Moon is the largest of all the Moons compared to the size of the planet it orbits.

All the outer planets Jupiter, Saturn, Uranus and Neptune have many Moons.



Mars is the fourth planet from the Sun and the second smallest planet in the Solar System after Mercury.

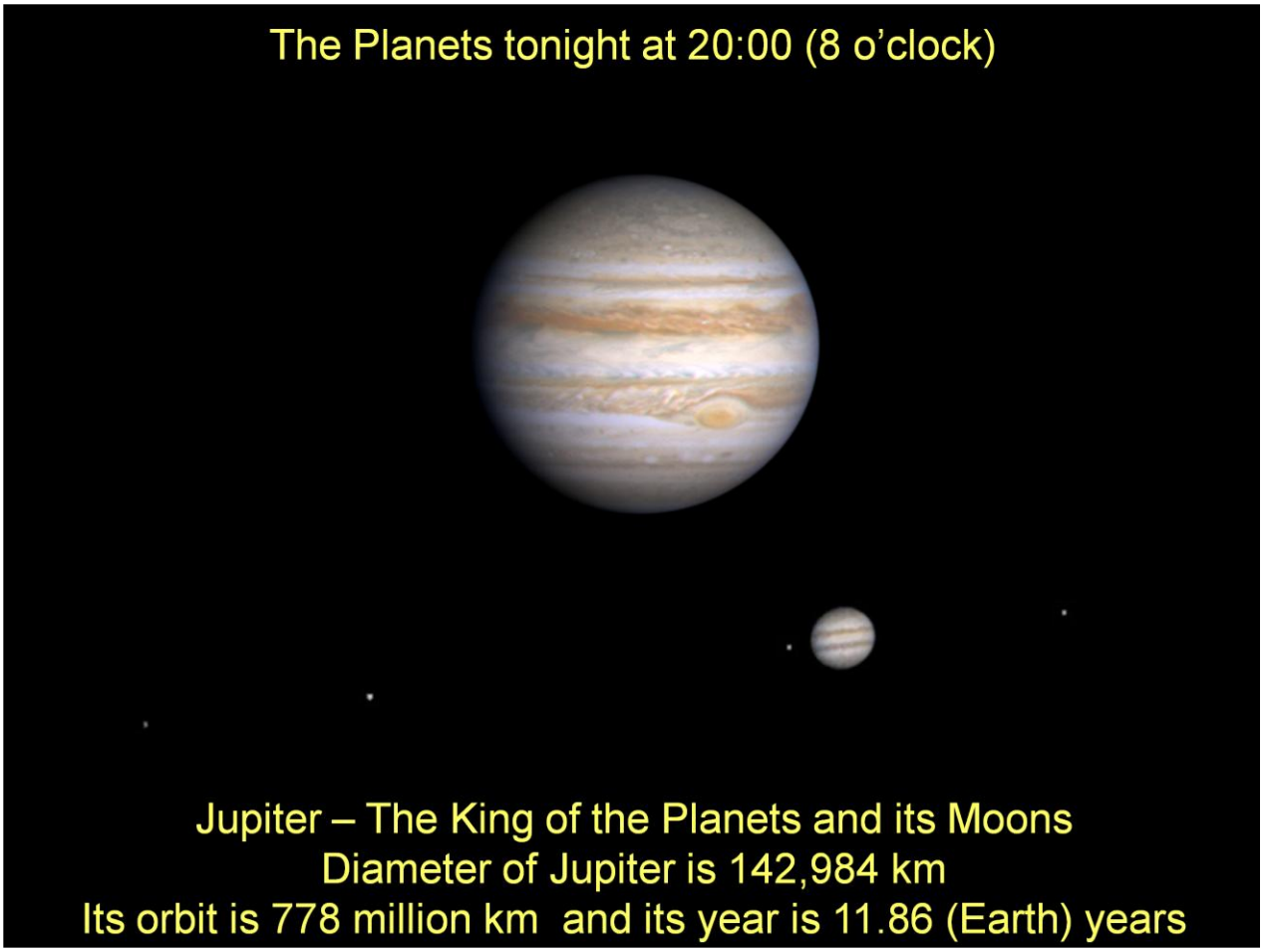
It is about half of Earth's diameter at 6,794 kilometres and has an orbital period (year) of 686.7 Earth days. A day on Mars is equivalent to 23.9 hours.

Mars is called the 'Red Planet' because of the reddish iron oxide prevalent on its surface. This gives it a reddish appearance that is distinctive among the astronomical bodies visible to the naked eye.

Mars is a terrestrial (rocky) planet with a thin atmosphere, having surface features reminiscent both of the impact craters of the Moon and the valleys, deserts and polar ice caps of Earth.

The rotational period and seasonal cycles of Mars are similar to those of Earth, as has as similar tilt Earth that produces the seasons.

Mars has two moons: Phobos and Deimos both are small and irregularly shaped. These may be captured asteroids that have ventured too close to Mars.



For those who are lucky enough to have a larger telescope a closer study of the features in Jupiter's cloud system can be achieved.

The darker bands on the clouds are known as 'Belts' and the lighter ones known as 'Zones'.

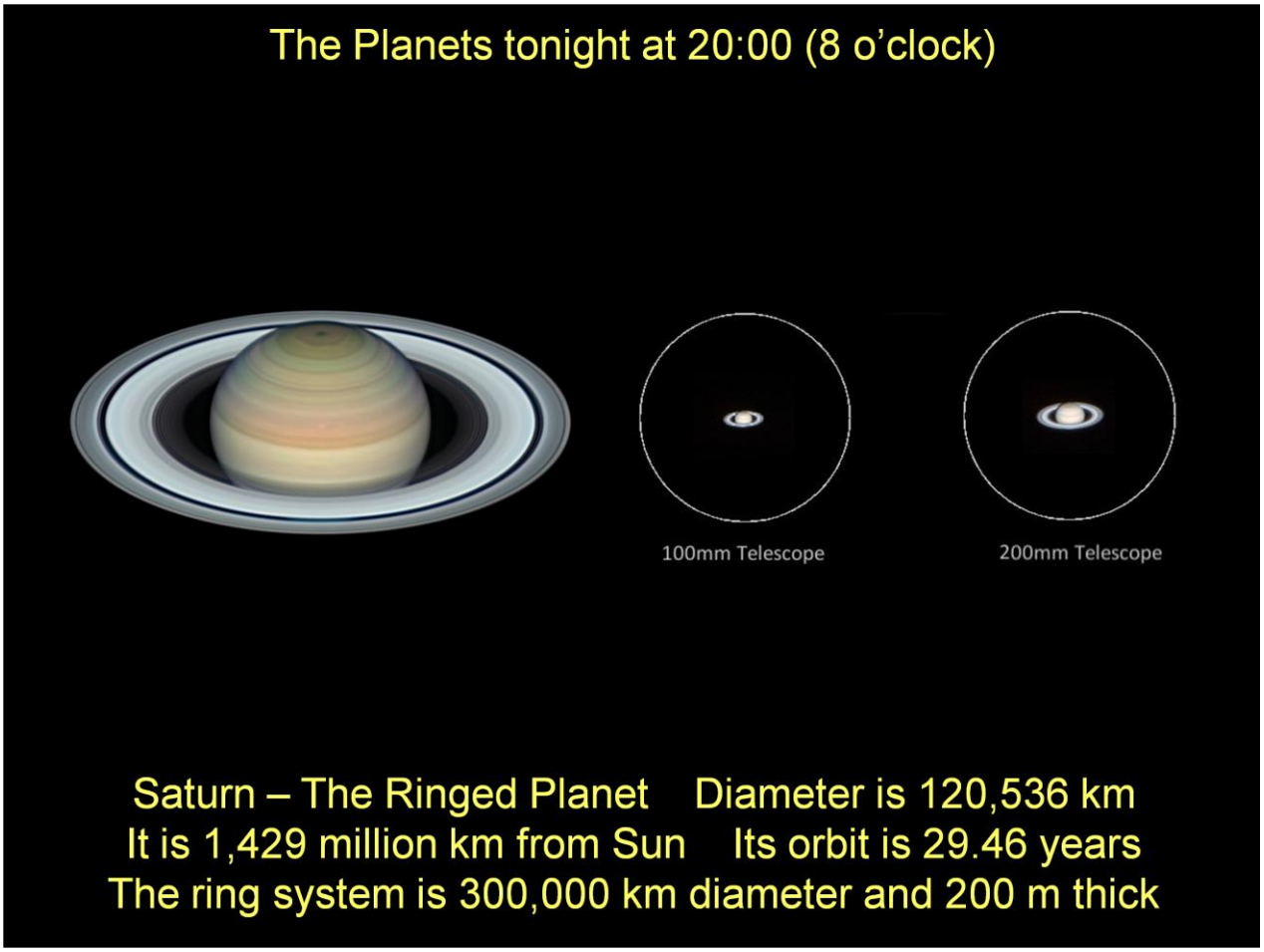
The most famous feature in the cloud system is the 'Great Red Spot' (GRS). This huge storm has been raging for at least 350 years.

Jupiter has about 80 moons comprised of 4 large ones (about the size of our Moon) and many more smaller moons.

The four largest and brightest moons are called Io, Europa, Ganymede and Callisto and can also be seen as they orbit the planet.

It is interesting to monitor their positions and how the move around Jupiter.

They can also be seen to pass behind Jupiter or pass in front where they cast their shadows on to the surface of Jupiter.



Saturn is the second largest planet in our Solar System and is a Gas Giant like Jupiter.

The planet itself is 120,000 km in diameter at the equator but is flattened to 108,000 km at the poles due to its rapid rotation.

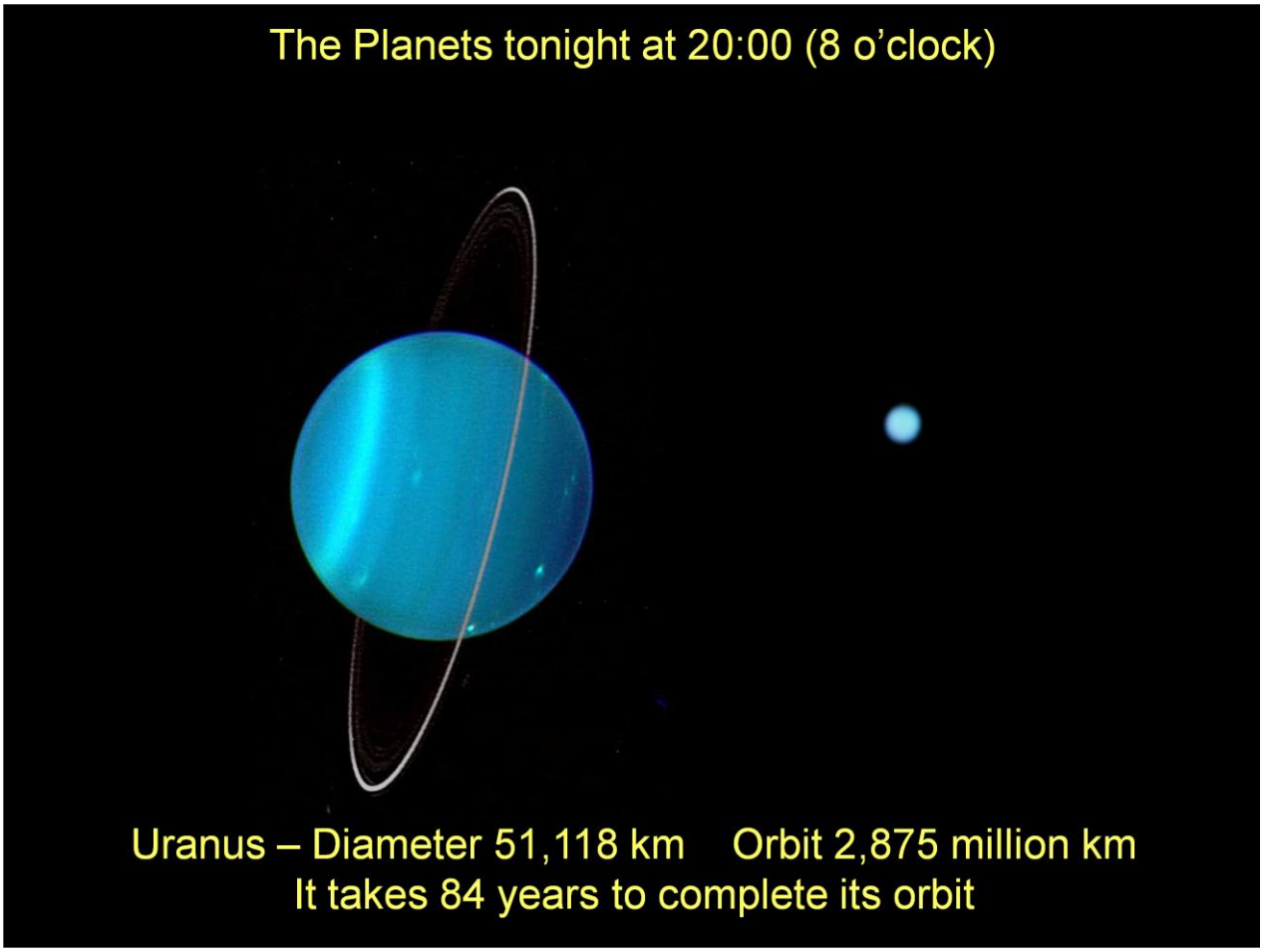
The rings are 275,000 km (170,000 miles) across but are mostly less than 30 metres thick.

The rings are made up of millions of small pieces of mainly water ice and varying in size from a few millimetres to a few metres across.

Saturn is approximately ten times further out from the Sun than Earth therefore we always see Saturn fully illuminated and never see phases.

However we do see the rings from a different aspect over the course of Saturn's 29.46 (Earth) years orbit around the Sun.

Saturn has one large moon called Titan and about 60 smaller moons. About 5 can be seen using a telescope.



The outer most planets are Uranus and Neptune that are known as the Ice Giants.

Jupiter and Saturn are over ten times the diameter of Earth but Uranus and Neptune are about four times the diameter of Earth so are still regarded as giants.

Both of the Ice Giants appear blue using a telescope but look more like 'fuzzy stars' than the other planets.

Uranus is 51,118 km in diameter this is about 4 times the diameter of Earth. It orbit is 2,875million km from the Sun and takes 84 Earth years to complete one orbit.

Uranus has a very odd tilt on its axis, it is actually tilted over almost 90° on to it side compared to all the other planets.

This gives a very strange combination of days and seasons on the planet. Each pole (north and south) face directly towards the Sun once a year, (every 84 Earth years).

Uranus has 4 moons over 1000 km in diameter 2 over 100 km and 9 with about 50 km diameter.

Like Uranus, Neptune is composed mainly of Hydrogen with rock and metal core and an atmosphere approximately 10,000 km deep.

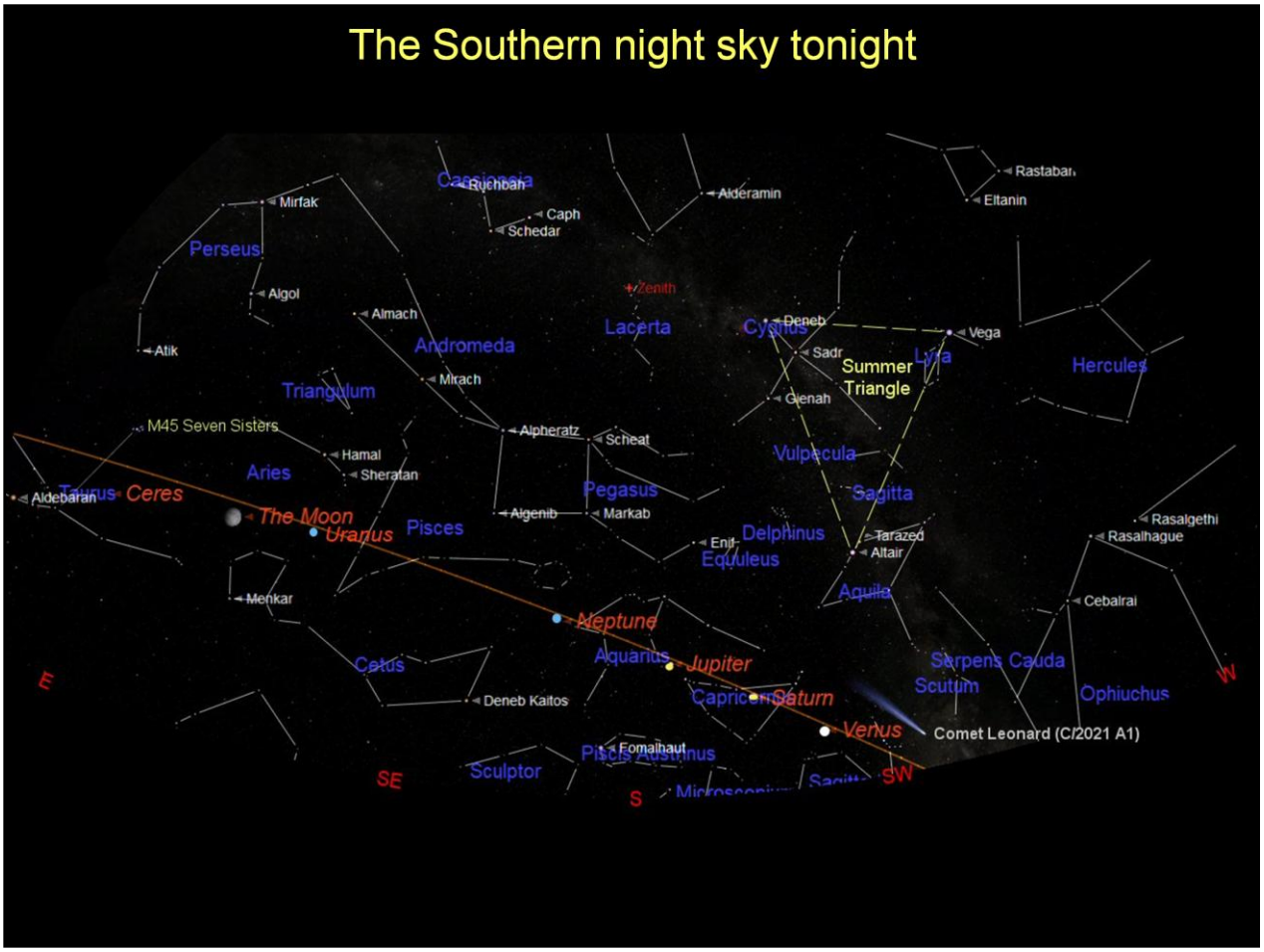
Neptune is the densest of all the giant planets with a density of 1,640 kg/m^2.

Surprisingly the atmosphere of Neptune is much more turbulent than that of Uranus despite receiving less than a quarter of the heat and light from the Sun.

It is thought that there is a heat source in the core that drives the weather systems.

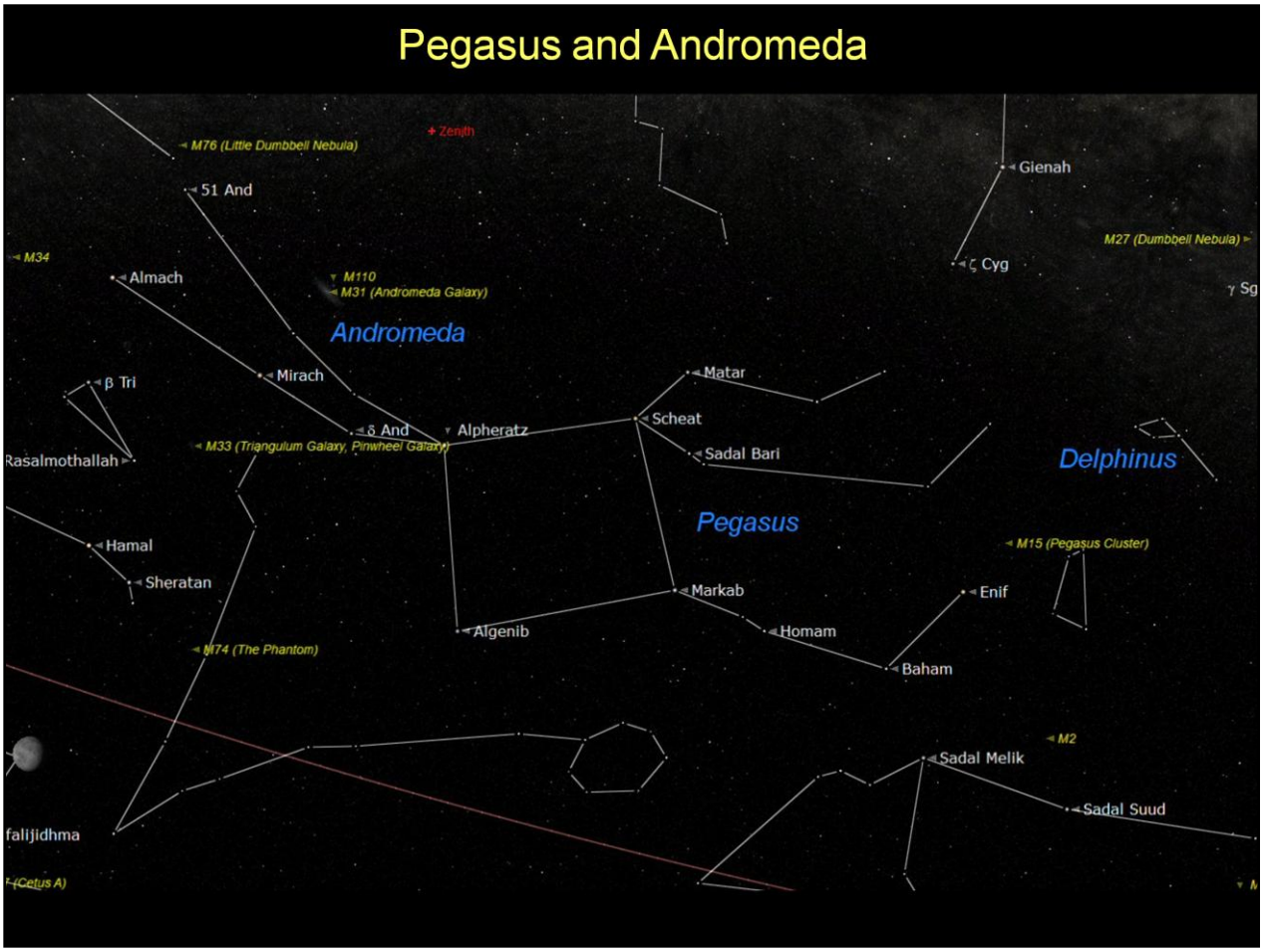
Despite the extremely cold atmosphere at -214°C, Neptune has some of the most violent storms in the solar system, with winds in the storms reaching speeds of over 300km per hour.

Neptune has one fairly large moon called Triton which has a diameter of 2720 km and 7 other moons up to 400 km in diameter.



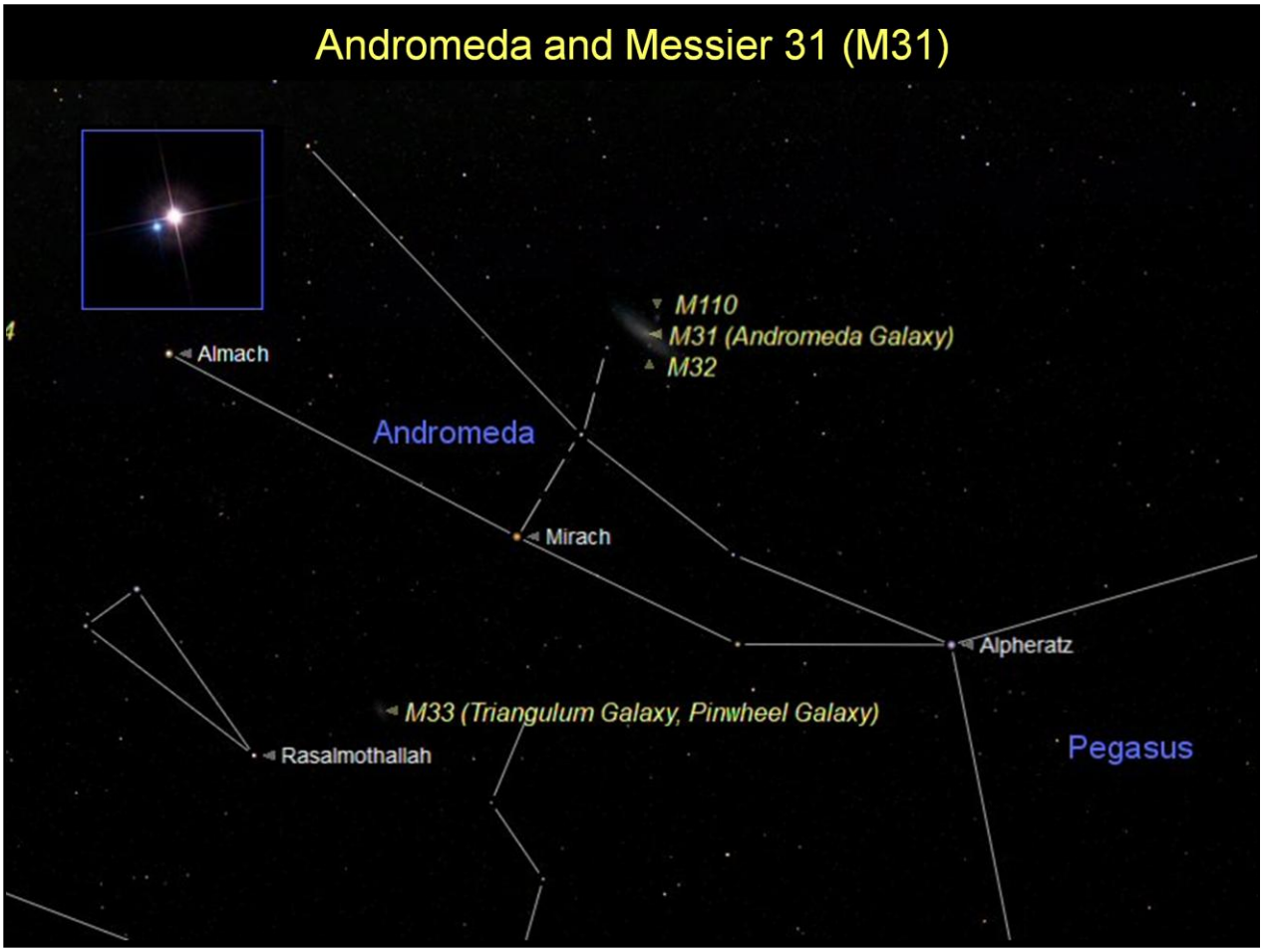
The constellations of Pegasus and Andromeda share and are joined at the star Alpheratz. Alpheratz is actually designated as belonging to Andromeda but looks to be more a part of Pegasus as it is required to complete the familiar 'Great Square of Pegasus'. It is larger than may be expected which sometimes makes it a little difficult to initially identify. However once it has been identified it is easy to find again in a clear dark sky. Pegasus is named after the mythical winged horse and with Andromeda included to provide the wings and a lot of imagination the stars could be said to resemble the flying horse.

The easiest way to find Andromeda is to first locate the Great Square of Pegasus. Once the square is found, the pointer to Andromeda is the top left star of the square named Alpheratz. Strangely Alpheratz is officially not part of Pegasus but is designated as Alpha (α) Andromedae. From Alpheratz follow the fairly obvious lower line of stars to the left (east). Locate the second star in the line which is shown as Mirach on the chart above. From Mirach follow a slightly fainter short line of stars to the north (above) Mirach to the second star. Just to the right of this star is the faint fuzzy patch of light that is M31 the Great Andromeda Galaxy.



Prominent is the southern sky is the constellation of Pegasus (the Winged Horse). The main feature of Pegasus is the square formed by the four brightest stars. This asterism (shape) is known as the Great Square of Pegasus. The square is larger than might be expected but once found is easier to find again. There is a very nice Globular cluster in Pegasus it is known as Messier 15 (M15).

The constellation of Andromeda shares the star Alpheratz with the Great Square of Pegasus. Andromeda is just two fairly distinct diverging lines of stars that are joined to the star Alpheratz.



The constellation of Andromeda shares the star Alpheratz with the Great Square of Pegasus.

Andromeda is just two fairly distinct diverging lines of stars that are joined to the star Alpheratz.

The star Almach at the end of the lower line is a beautiful double star one blue and the other golden.

The main interest in Andromeda is the Great Spiral Galaxy Messier 31 (M31).

To find M31 from Alpheratz hop along two stars along the lower line to Mirach.

The from Mirach two stars up and M31 is just to the right of the second star up.

The picture above shows M31 imaged through a telescope and is much clearer than can be hoped to be seen with the naked eye. However a pair of binoculars will enable the galaxy to be seen. A small telescope will show a cigar shaped hazy patch with a brighter spot in the middle. Larger telescopes will show it more clearly but photographic imaging is required to reveal its true nature as shown above.

M31 is the closest and brightest spiral galaxy and can just about be seen as a small smudge of light with the naked eye in a clear dark sky. It can be seen as a small cigar shaped patch of fuzzy light using a good pair of binoculars. However a telescope is needed to see it well and the bigger the telescope the better it will appear.

M31 can be thought of as the twin sister of our galaxy that we call the Milky Way. Our Milky Way contains about 200 to 300 billion stars and M31 may have as many as many as 400 billion stars. They are the two largest galaxies in or local group of about 30 galaxies. M31 and our Milky Way are actually rushing towards each other and will collide in about 5 billion years time. They will not crash but will merge into a larger Elliptical Galaxy.

M31 looks very much the same as we think the Milky Way would appear when viewed from M31.

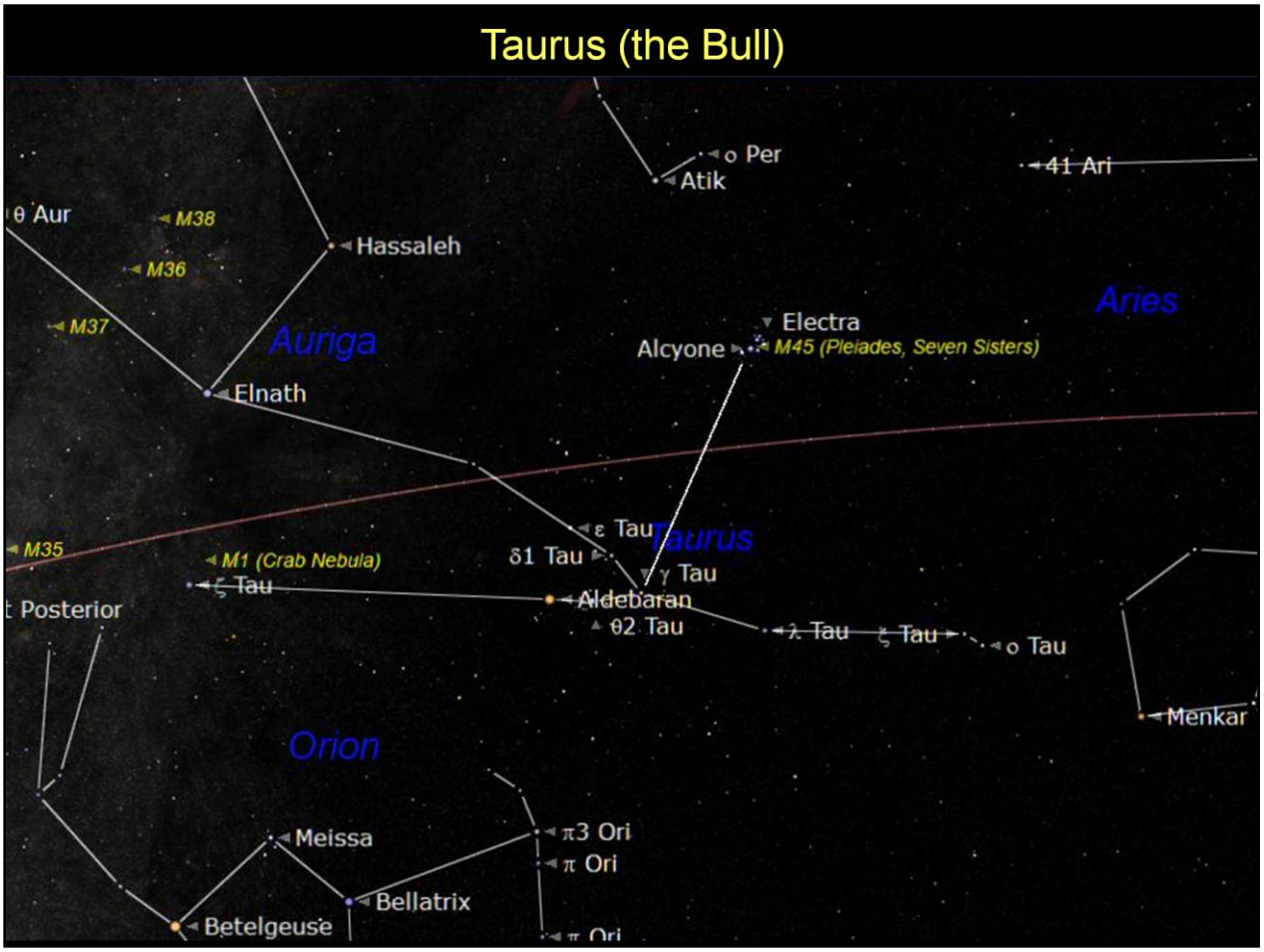
They are both Giant Spiral Galaxies and have a bright central spherical bulge of stars which curved spiral arms are wrapped around.

The Milky Way is slightly different to M31 in that its central bulge is thought to have a bar comprised of stars protruding on opposite sides of the bulge.

The spiral arms of the Milky Way appear to emanate from the ends of the bars making it a Giant Barred Spiral Galaxy.

There are smaller galaxies that orbit the giant Spirals that we can see around M31 and we have two orbiting our galaxy.

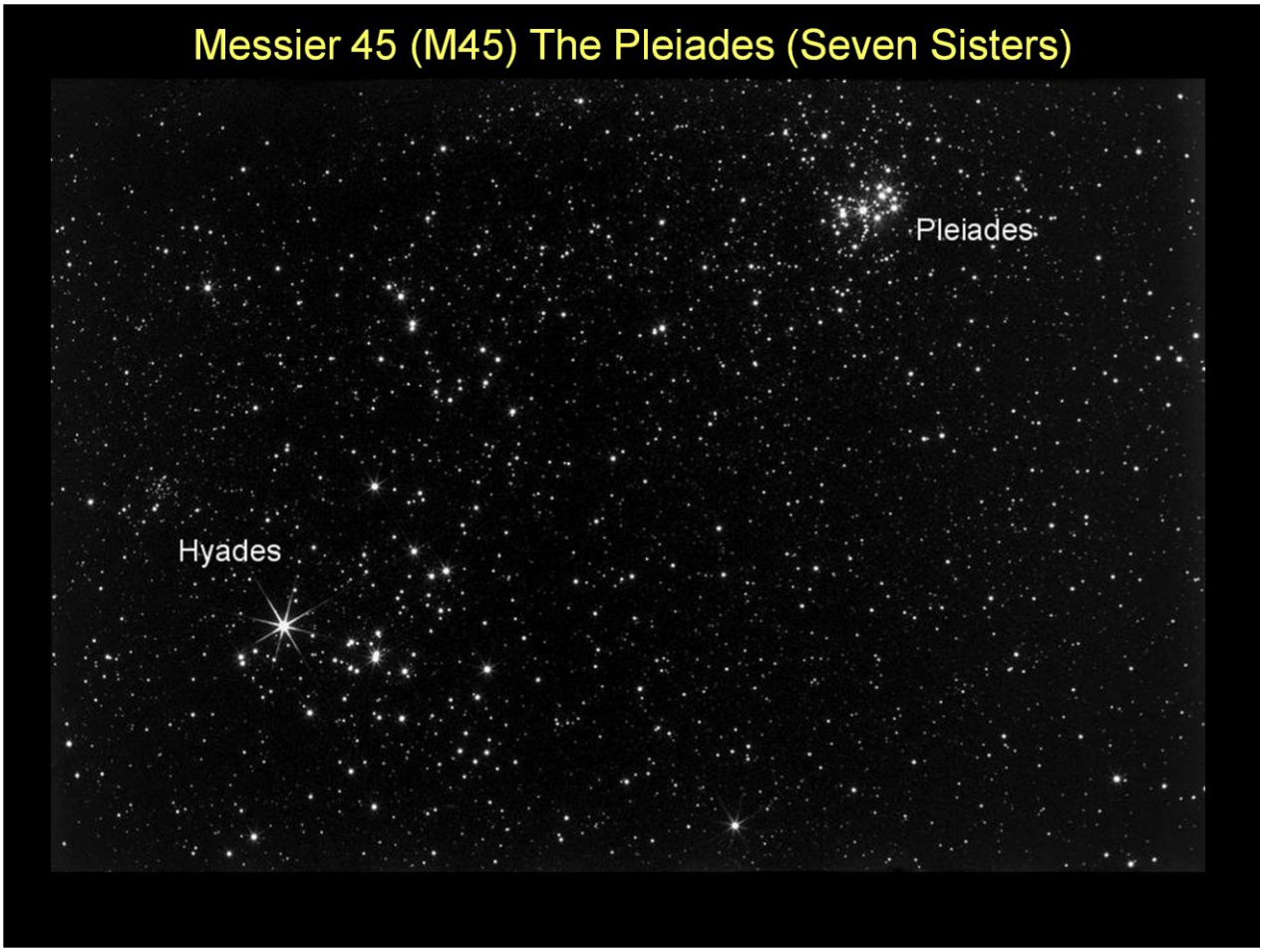
Two of these smaller galaxies associated with M31 can be seen in the image above.



Moving into view in the southern sky is the constellation of Taurus (the Bull). The most obvious star in Taurus is the lovely Red Giant Star called Aldebaran. It appears slightly orange to the 'naked eye' but it is very obviously orange when seen using binoculars or a telescope.

Aldebaran is located at the centre of the 'flattened' X shape formed by the brightest stars in Taurus. At the end of the top right (upper west) arm of the 'X' is the beautiful 'naked eye' Open Star Cluster Messier 45 (M45) known as the Pleiades (or the Seven Sisters). It really does look magnificent when using binoculars.

Surrounding the bright red star Aldebaran is an older and more dispersed Open Cluster of Stars known as the Hyades.



There is a bright red star Aldebaran located at the centre of Taurus. It is easy to find and therefore helps to identify the constellation of Taurus.

It is in fact a Red Giant Star and that is why it appears distinctly orange.

A Red Giant is a star similar to our Sun (perhaps a little larger) that is approaching the end of life as a normal star.

Surrounding the bright red star Aldebaran is an Open Cluster of Stars known as the Hyades.

The real jewel of Taurus is without doubt the beautiful Open Cluster, Messier 45 (M45) also called the Pleiades or the Seven Sisters.

An Open cluster is created as stars form in a giant cloud of gas and dust called a ‘Nebula’.

The Open Cluster Messier 45 (M45) also called the Pleiades or the Seven Sisters

It is visible to the ‘naked eye’ (just using our eyes) initially looking like a patch of light.

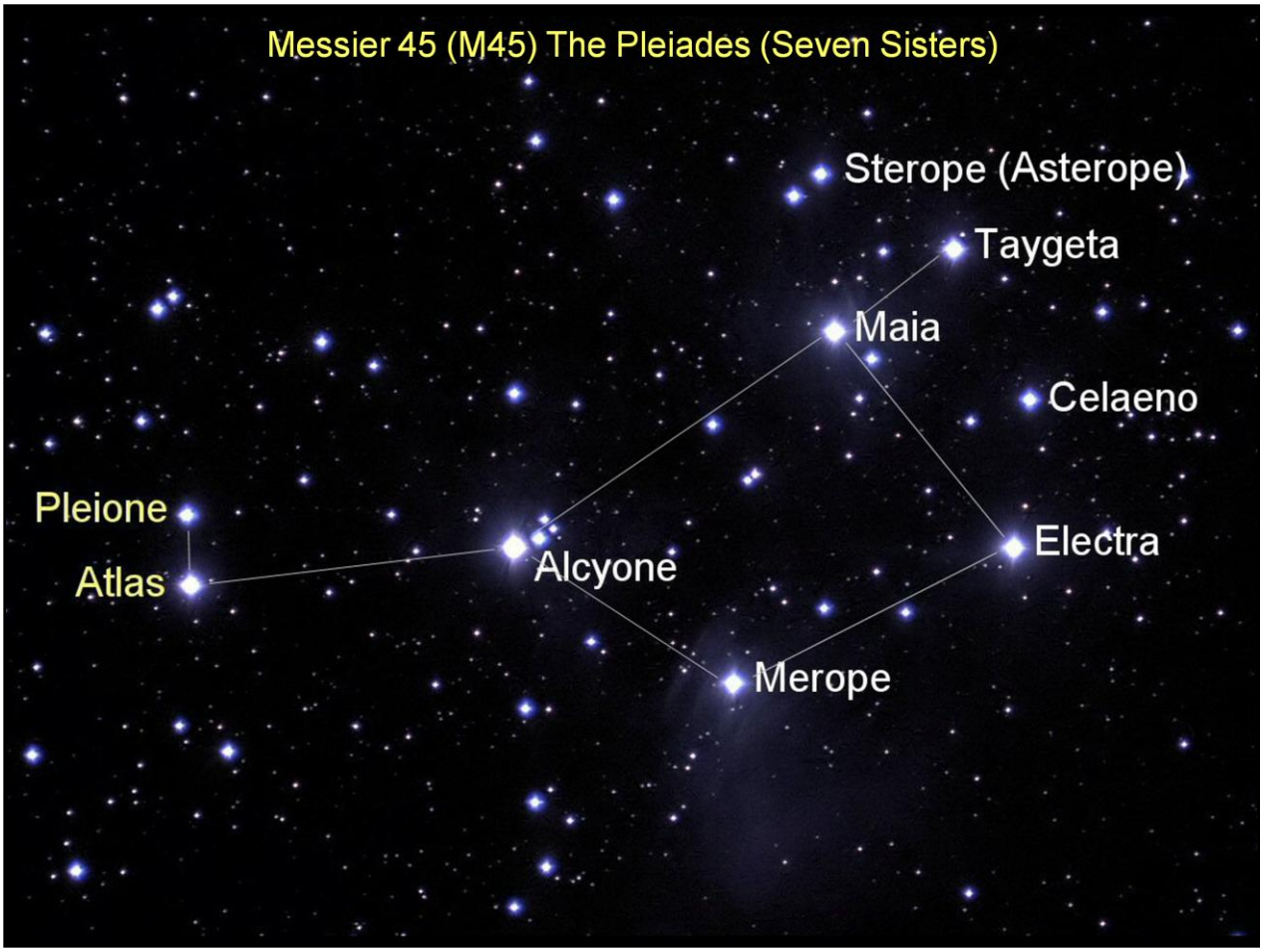
Closer observation will reveal a cluster of up to seven stars.

Using a good pair of binoculars many more stars will be seen (about thirty bright stars).

There are in fact about 300 young stars in the cluster that is estimated to be about 100 million years old.

M45 is one of the closest open clusters to us and is just 400 light years away.

M45 is close to us and therefore the stars do appear to move but so slow to us that it is imperceptible. However over a long period of time (for us) they will appear to be moving so after about 50,000 years they look completely different.



In Greek mythology the Pleiades (Seven Sisters) are the seven daughters of the Titan god called Atlas and his wife the sea-nymph Pleione.

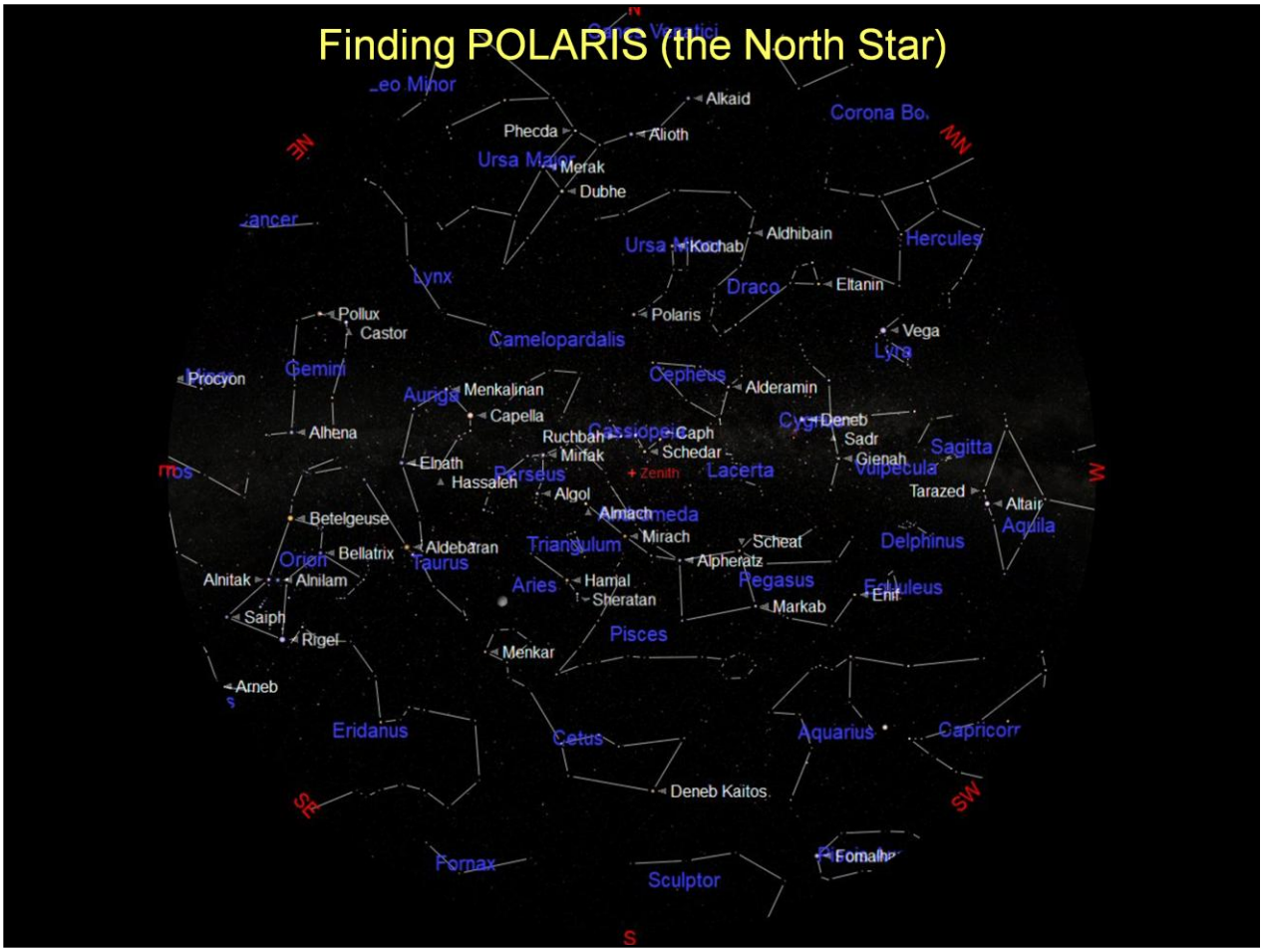
There are in fact about 300 young stars in the cluster that is estimated to be about 100 million years old.

M45 is one of the closest open clusters to us and is just 400 light years away.

The seven brightest stars seen using our ‘naked eyes’ form the pattern shown by the lines above.

Father Atlas and Mother Pleione are included in the ‘naked eye’ pattern.

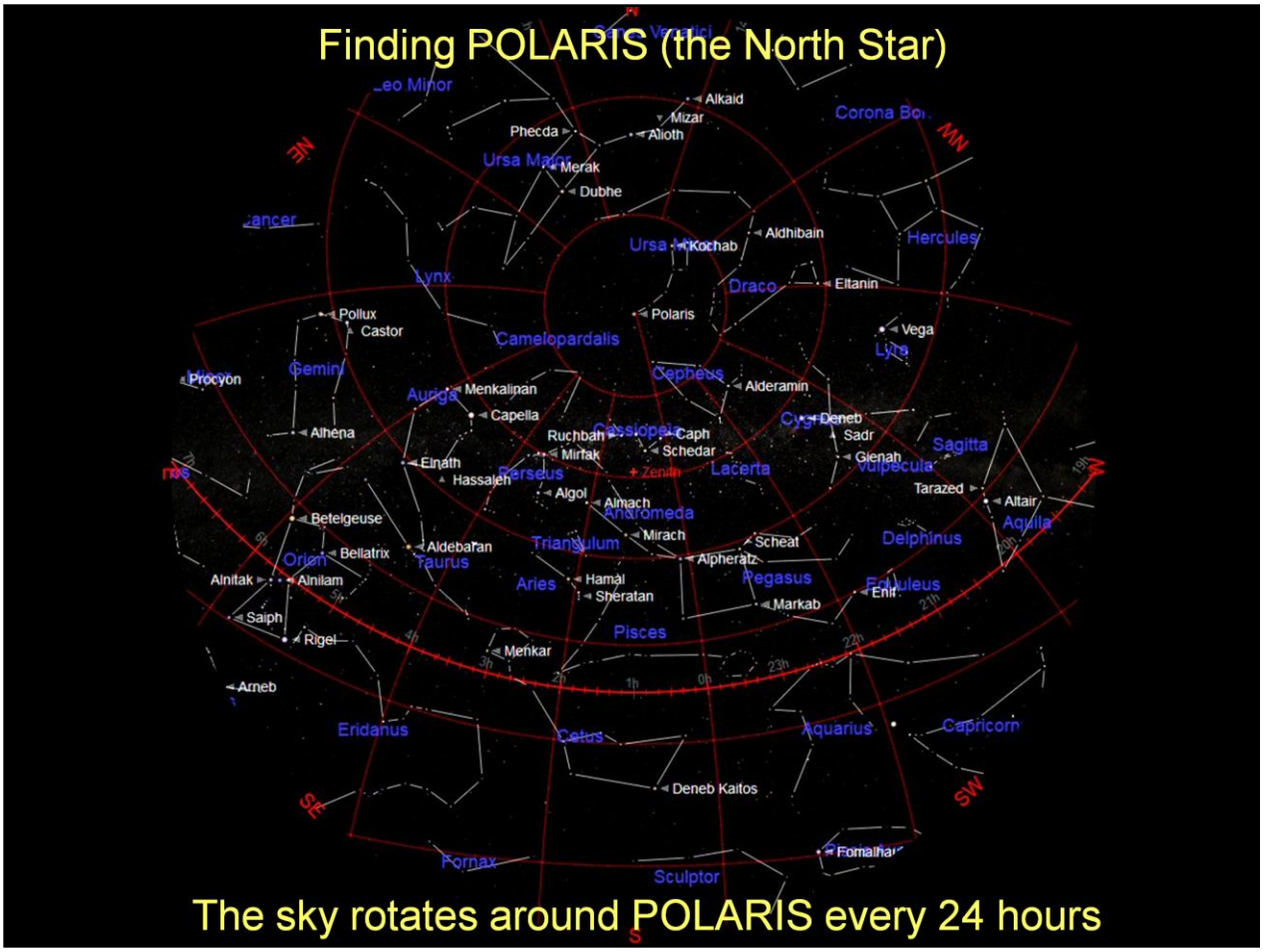
However the 6th & 7th sisters are actually Sterope (also called Asterope) and Celaeno.



One of the constellations is certainly the most recognisable, this is Ursa Major (the Great Bear) also known as the ‘Plough’ or ‘the Big Dipper’ in the USA. It has very little resemblance to a bear and looks much more like a ‘Saucepan’.

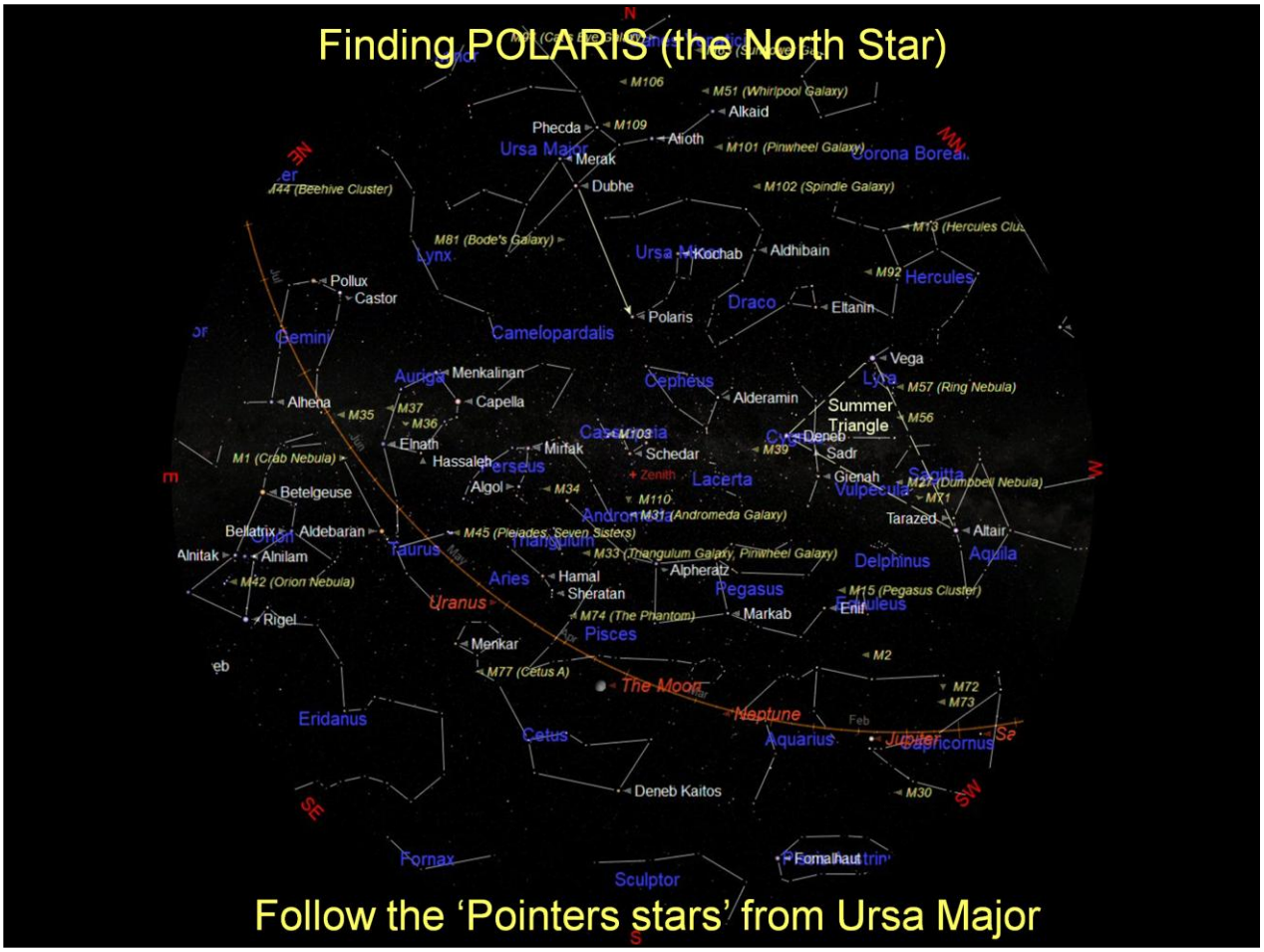
Ursa Major is low in the north at this time of the year as can be seen on the chart above. The point in the sky directly overhead of the observer is called the ‘ZENITH’ and is shown in red on the chart. The chart shows the sky as it will appear at 22:00 on 15th October.

Ursa Major is a circumpolar constellation, this means it never disappears below the horizon from the UK and so is always visible somewhere in the night sky throughout the year. All the stars in the night sky appear to rotate around a point in the sky that we call the ‘North Celestial Pole’. This point is located very close to the star Polaris in the constellation of Ursa Minor (the Little Bear) also called the Little Dipper in the USA..

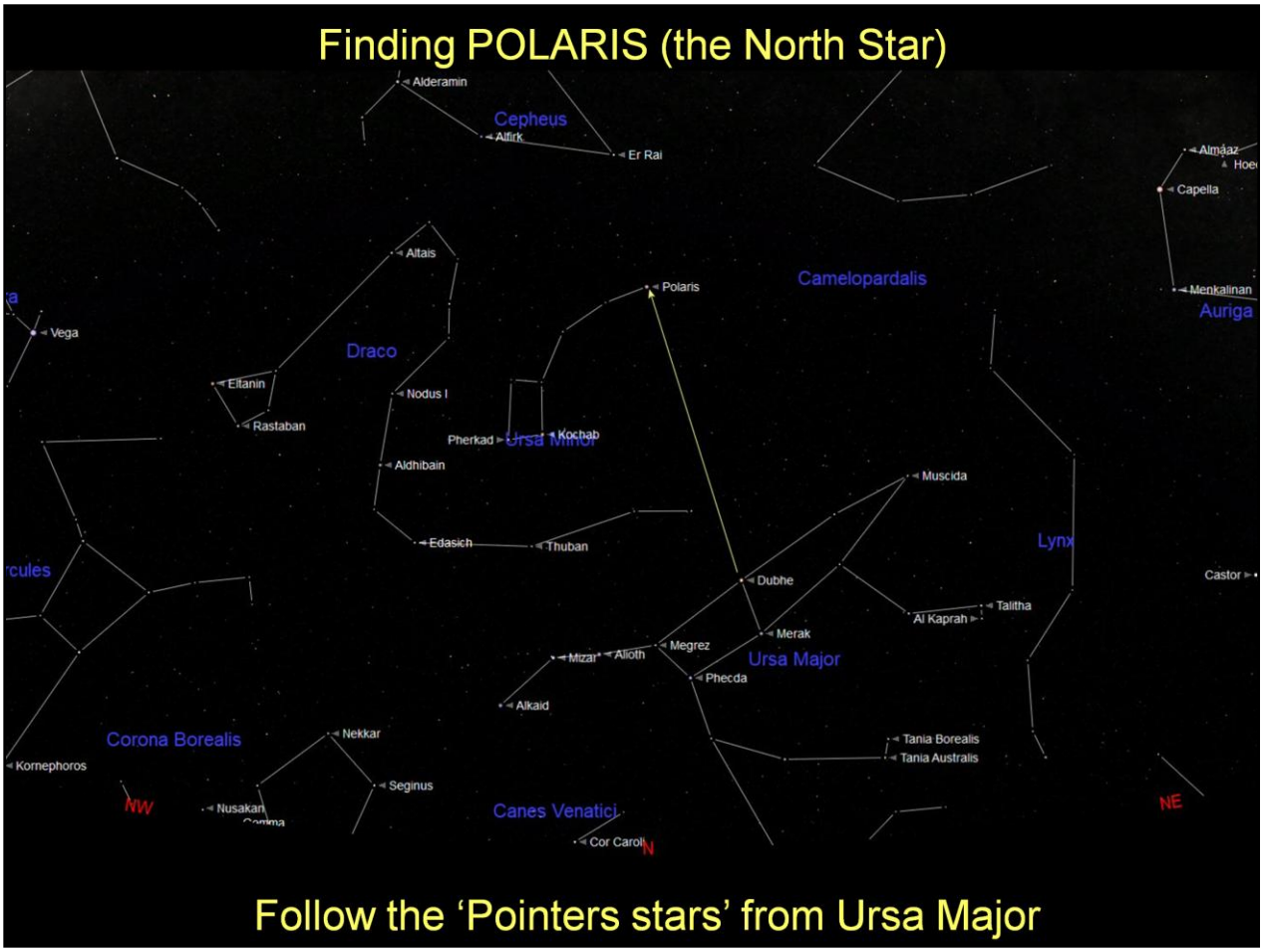


Our planet Earth rotates around the North Celestial Pole once a day (24 hours). As Earth rotates the sky appears to rotate above us. As the sky appears to rotate, Ursa Major and the other constellations will appear to move around the North Celestial Pole in an east to west direction. It will appear to move anticlockwise around Polaris as shown on the chart above (handle behind). The movement is slow and not perceivable in real time.

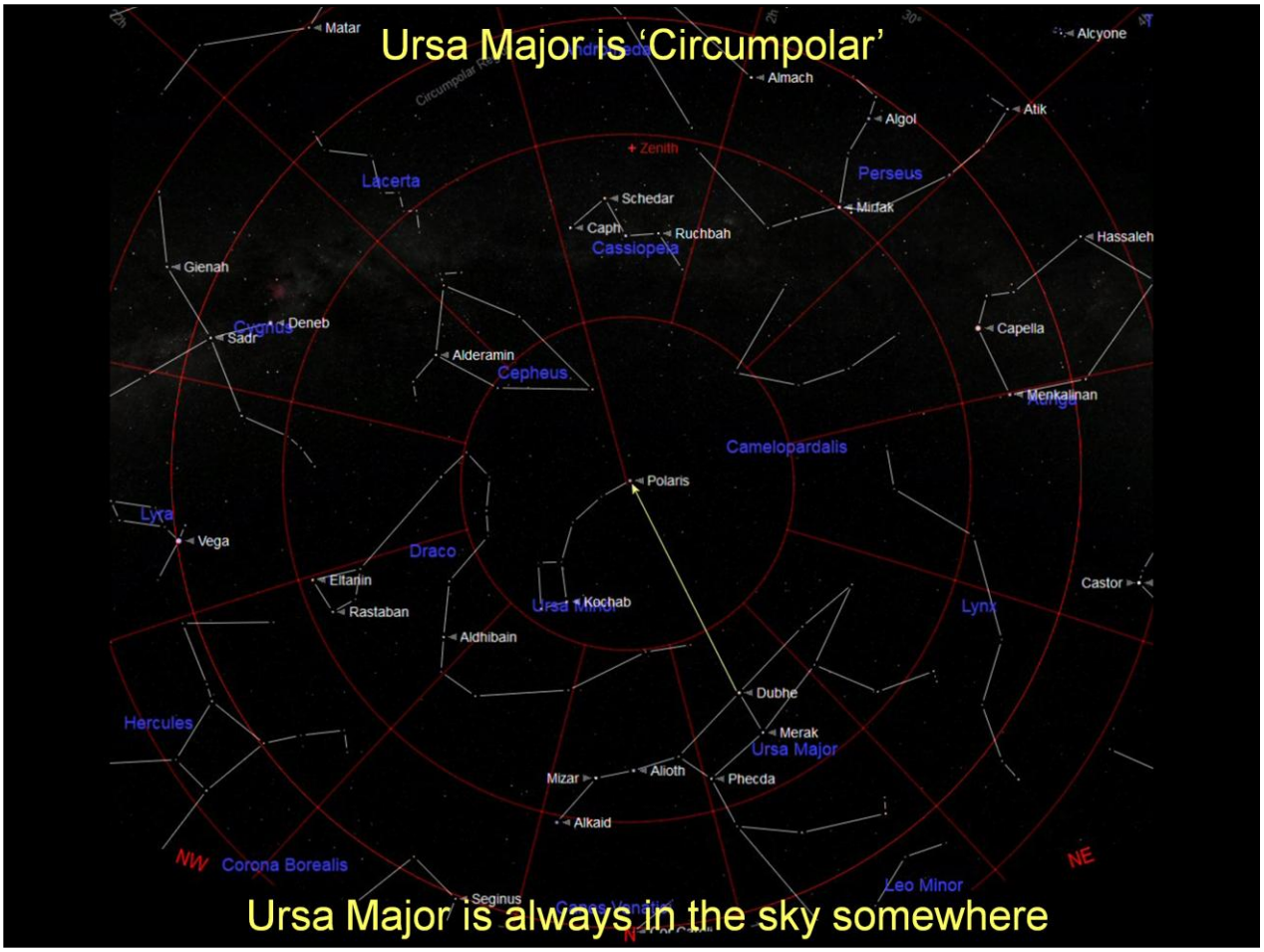
The axis of rotation of our Earth is tilted over at 23.4º to the axis of rotation of our Solar System. So we see our axis of rotation 38.6º to the north of our Zenith (the point directly overhead). We do not normally notice that we have a slightly odd view of the sky due to this tilt of Earth. Astronomers are acutely aware of this strange perspective we have of the sky as we need to take account of it when we are observing the moving sky.



Polaris can always be found by first finding Ursa Major. Then by following the two stars opposite the handle of the 'saucepan shape', up out of the pan and looking about five times the distance between the pointer stars. See the arrow on chart above.



The chart above shows the position of Ursa Major in the north during the winter months, north is marked with a red N on the northern horizon. The chart above shows in more detail how to follow the two pointer stars to guide us to the 'North Star' Polaris. Polaris is always north of the Zenith (the point directly overhead so this tells us which direction is north.



Ursa Major is a ‘Circumpolar’ constellation this means is never sets over the horizon.

The sky appears to rotate around the Pole Star once every year.

Therefore Ursa Major is always in the sky somewhere.

The stars move around Polaris (the North Star)

A long exposure image of Polaris

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So we see our axis of rotation 23.4º to the north of our Zenith (the point directly overhead).

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Beginner's Website:

naasbeginners.co.uk