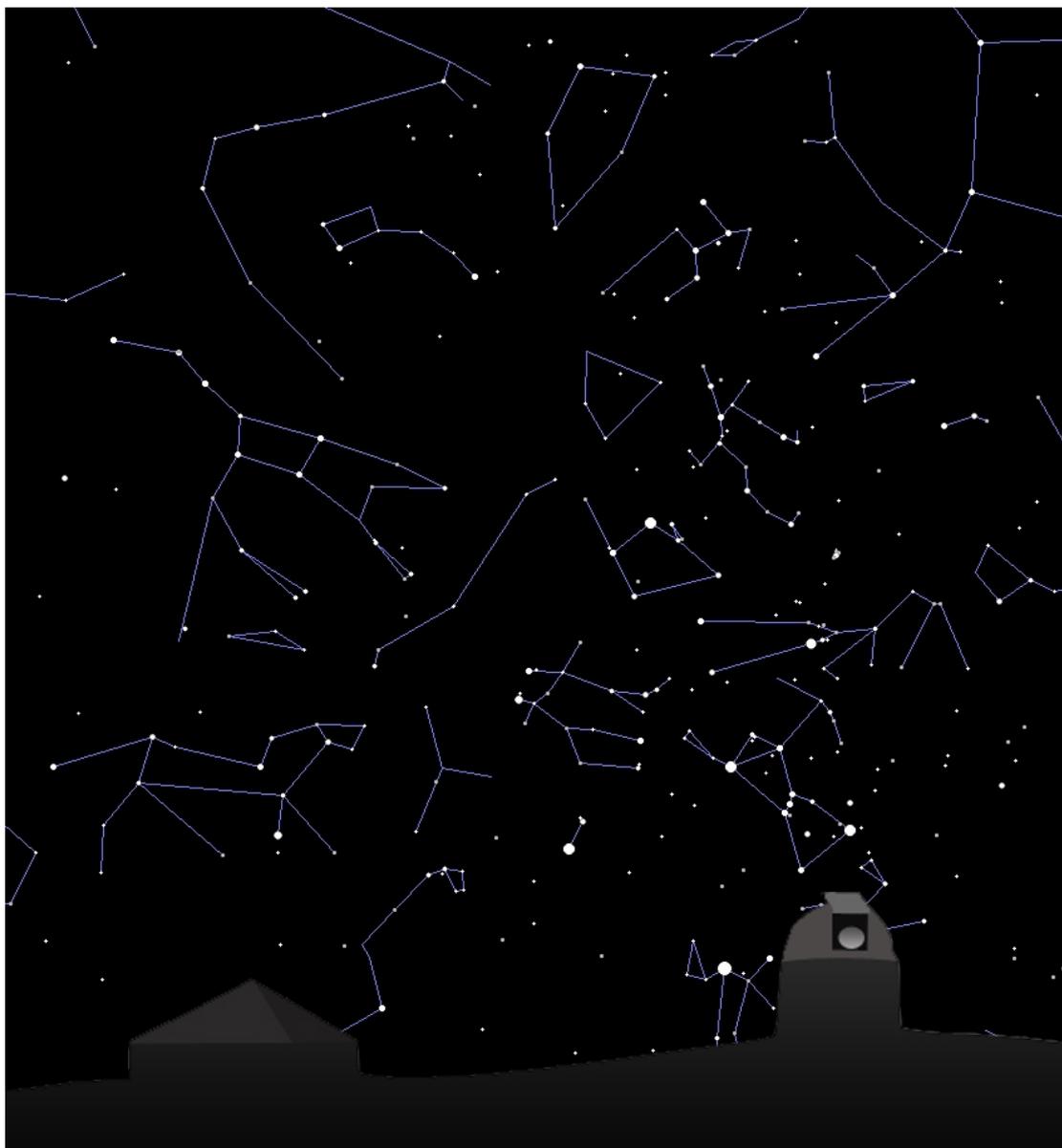




Wynyard Planetarium & Observatory



Winter Observing Notes



Tour of the Sky with the Naked Eye

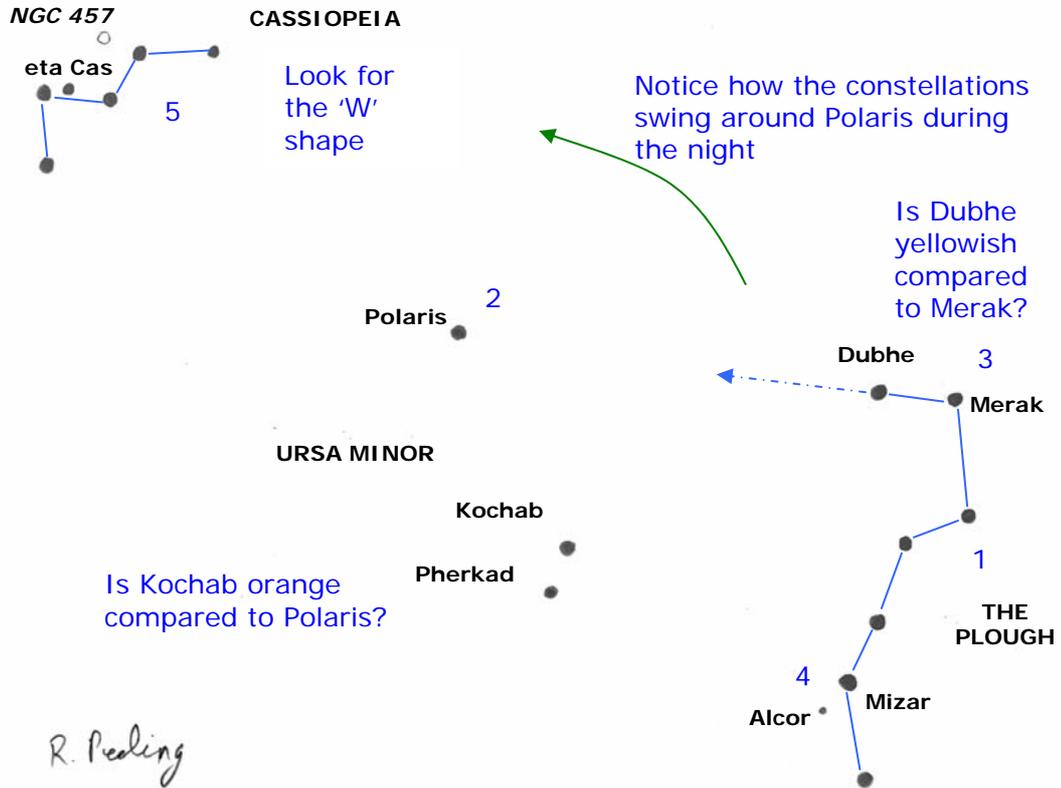


Figure 1: Sketch of the northern sky in winter.

North

1. On leaving the planetarium, turn around and look northwards over the roof of the building. To your right is a group of stars like the outline of a saucepan standing up on it's handle. This is the Plough (also called the Big Dipper) and is part of the constellation Ursa Major, the Great Bear. The top two stars are called the Pointers. Check with binoculars. Not all stars are white. The colour shows that Dubhe is cooler than Merak in the same way that red-hot is cooler than white-hot.
2. Use the Pointers to guide you to the left, to the next bright star. This is Polaris, the Pole (or North) Star. Note that it is not the brightest star in the sky, a common misconception. Below and to the right are two prominent but fainter stars. These are Kochab and Pherkad, the Guardians of the Pole. Look carefully and you will notice that Kochab is slightly orange when compared to Polaris. Check with binoculars.





Polaris, Kochab and Pherkad mark the constellation Ursa Minor, the Little Bear.

3. The left-hand pointer is named Dubhe. The right-hand star is Merak. Many star names are Arabic in origin due to the Islamic astronomer Al Sufi who published his "Book of Fixed Stars" in the 10th Century. Instead of using names, astronomers can also indicate a star by various numbering schemes or catalogues. Using Greek letters followed by the latin name of the constellation is a system originally devised by the German astronomer [Johann Bayer](#) in 1603, in his star atlas [Uranometria](#). Using this system, Dubhe and Merak become alpha and beta Ursae Majoris.
4. The second star inwards from the end of the 'handle' is zeta Ursae Majoris or Mizar. Look carefully close to the left and slightly below Mizar. Can you see a faint star? Its name is Alcor. There is a story that seeing Alcor was an Arabic test for eyesight. If so, then it wasn't a very hard test. It is a better test for how clear the night sky is though. If you can't see Alcor then it's probably not a good night to look for other things either.
5. Roughly continuing the line from the Pointers, through Polaris but swinging a little upwards is another bright group of stars high in the sky. They lie in a upside-down 'W' shape (Yes, an upside down 'W' is an 'M' but everyone always describes the shape as a 'W'). This is the constellation Cassiopeia. Continue the tour but look north again after at least 30 minutes and note how the Plough and Cassiopeia seem to have swung round Polaris slightly. This is caused by the Earth spinning on its axis to create day and night. Polaris lies on the axis (more or less directly above the north pole) and this is what makes it the Pole Star.





West

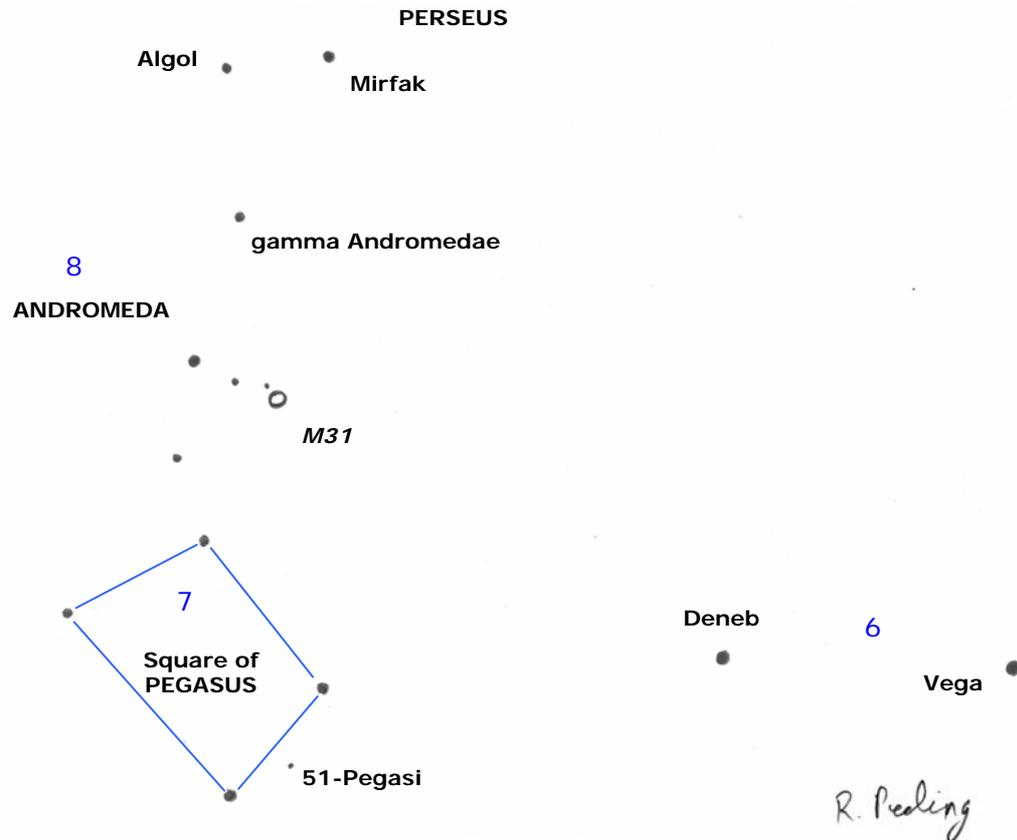


Figure 2: Sketch of the western sky in winter.

6. Half-turn to the left (north-west) and look for two low down and bright stars. The highest star is Deneb and it marks the tail of Cygnus, the Swan. Close to the horizon and to the right is Vega in the constellation Lyra.
7. Turn to face fully west and look up. Can you pick out the Square of Pegasus? It is tipped over on its side so you may see it as diamond rather than a square. In the middle of the lower right-hand side lies the star 51 Pegasi which was the first sun-like star to be discovered to have a planet orbiting it. The planet is the size of Jupiter but much hotter because it is closer to the star than Mercury is to our Sun. A number followed by the latin name of the constellation is another way of naming stars, this was devised by the English astronomer [John Flamsteed](#) in 1712.
8. The highest star of the square and a sweep of three more stars up to the left mark the constellation Andromeda. The stars of Andromeda more or less lead the way to the





brightest star in Perseus, alpha Persei or Mirfak which is more or less directly overhead in the winter. To its left is another bright star called Algol, the Demon Star. If you watch at the right time (times can be found using the internet), the Demon will very slowly wink at you! It takes about 8 hours from start to finish. This happens because a larger, fainter companion star is passing in front of the bright star usually seen. This type of star system is called an eclipsing binary.

South

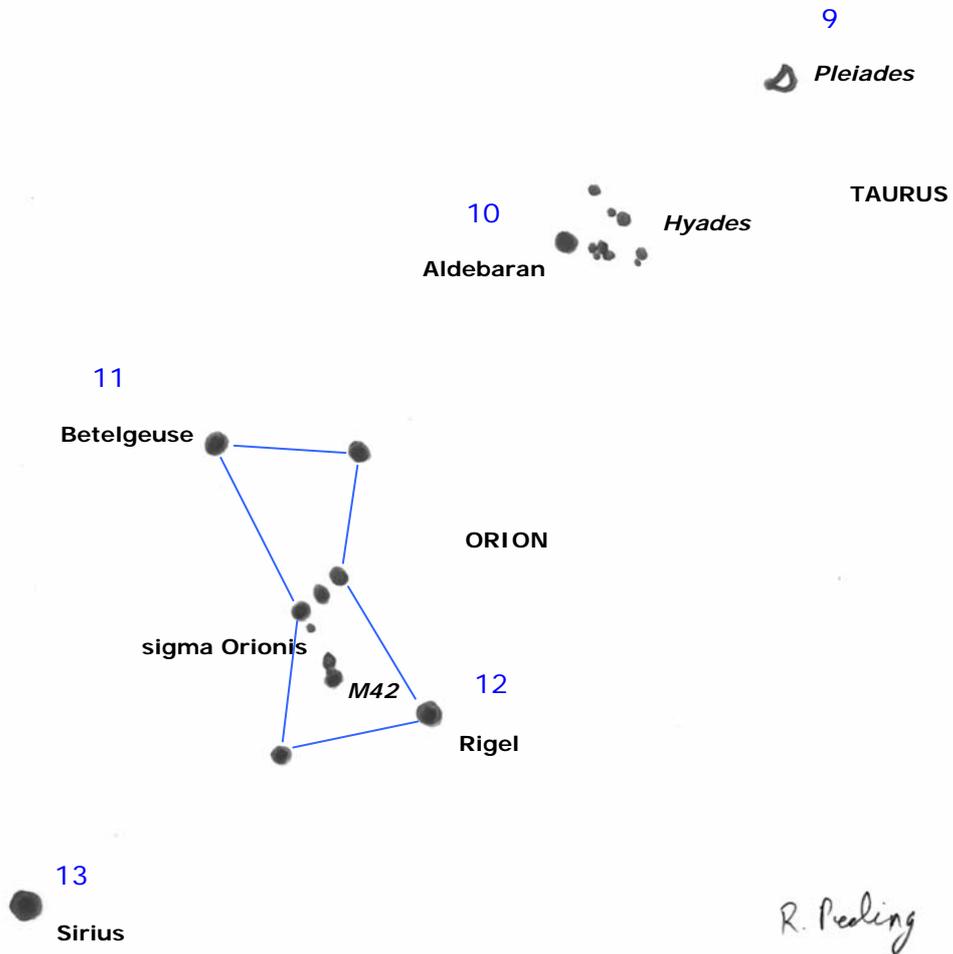


Figure 3: Sketch of the southern sky in winter.

9. Turn again to face south. Directly in front of you and high up you will be able to see the Pleiades or Seven Sisters as small glittering group of stars. How many stars can you see? Most





people report six. They are arranged in a pattern like a mini version of the Plough. Now try binoculars and then a telescope. How many stars now? The Pleiades is a fairly typical open cluster that happens to be fairly close to Earth at *only* 378 light years away, which makes it big, bright and easy to see. A light year is the distance that light travels in one year, roughly 6 trillion miles. The cluster actually contains several hundred stars. In Chinese star maps this is *mao*, the *Hairy Head* of the white tiger of the West. In Japan this cluster is Subaru (check the logo of a certain car maker).

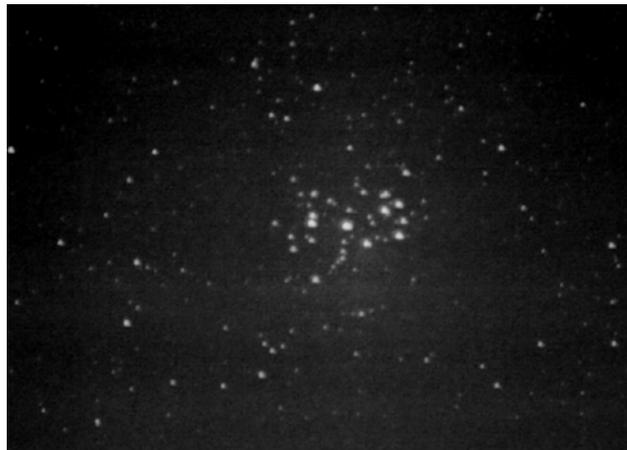


Figure 4: The Pleiades, a 20 min exposure with an SLR camera and 135mm lens, by Rob Peeling.

10. Now look below and to the east (left) of the Pleiades to find a bright yellowy looking star. This is Aldebaran, the eye of the bull in the constellation Taurus. Aldebaran is at the top of the lower leg of a vee-shaped group of stars. This is another open cluster called the Hyades, although Aldebaran is not actually part of this cluster because it is much closer to the Earth at a distance of some 65 light years. The Hyades are rather older but even closer to the Earth than the Pleiades at 151 light years. It was the first cluster to have the distances to its stars individually measured which makes it an essential early step in astronomers' ladder of distance used to measure the size of the Universe. The Hyades are well worth scanning with binoculars. The very large size of the cluster makes it a less satisfying telescope object because it is much larger than the field of view.
11. A bit further down and to the left we come to the unmistakable constellation of Orion, the Hunter. The line of three bright stars making the Hunter's belt is obvious. Four





more bright stars mark his shoulders and knees. Look carefully at the left shoulder. You should see that the star has a definite orange tint to it. This star is Betelgeuse and it is a red supergiant. This means the star has run out of hydrogen fuel and has started using helium instead, which is a key milestone in the countdown to stellar death. The star has swelled up enormously and the surface is quite cool which is why it is reddish in colour. If Betelgeuse replaced our Sun in the Solar System, all the planets out to Mars and most of the asteroid belt would be *inside* the star.

The size of Betelgeuse compared to the orbits of planets in the Solar System

Diagram after J.W. Kaler, *Extreme Stars*

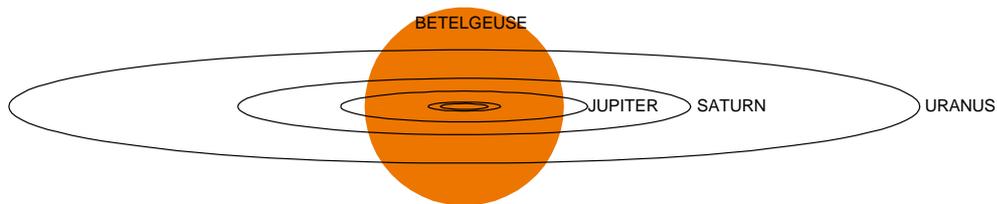
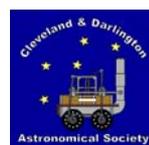


Figure 5: The size of Betelgeuse.

12. Moving to Orion's right knee, you will see a bright, bluish star. This is Rigel and it is another type of supergiant, a blue supergiant naturally. Betelgeuse would have looked something like this before it started to run short on fuel. Like Betelgeuse, Rigel is much more massive than our Sun but less mind-bogglingly large. It shines as brightly as Betelgeuse because although smaller, it is much hotter at about 11,000 K compared to 3500K for Betelgeuse. There is a chance that both of these stars are heavy enough to become supernovae at some time in the future.
13. Further down into the southeast from Orion you will see the brightest star in the night sky. This is Sirius, the Dog Star in the constellation Canis Major. Even though it looks brighter than Rigel and is at a similar temperature, Sirius is actually by far the smaller star. It looks as bright as it does because it is very close, only 8.6 light years. In fact it is suspected to be part of the same cluster of stars that make up most of the Plough right behind your head! What you can't see, and it is a difficult telescope observation even for experts is that the Dog Star has a pup. Orbiting Sirius is a white dwarf,





which is the burned out remnant of another star, formed at the same time as Sirius but originally rather heavier. A white dwarf is what our Sun will eventually become when it runs out of fuel in 5 billion years time.

East

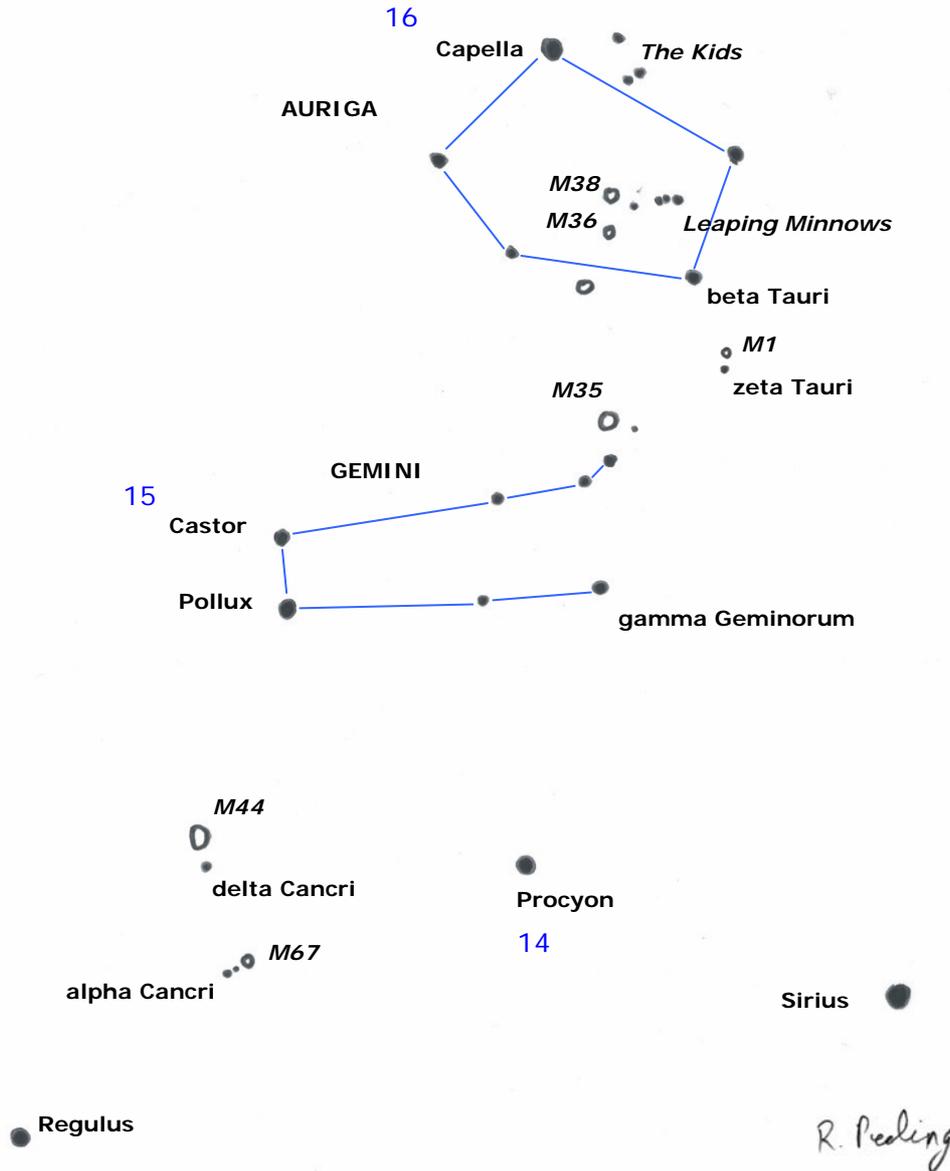


Figure 6: Sketch of the eastern sky in winter.

14. Finally turn to face west. Look up and to the left of Sirius for the next bright star. This is Procyon in the constellation





of Canis Minor, the little dog. Coincidentally, Procyon is another nearby star with a white dwarf orbiting it.

15. Above Procyon lies the constellation of Gemini with the two bright stars, Castor and Pollux marking the twins heads at the left-hand end of the constellation. Castor is the top one.
16. Further up still and more or less overhead is another bright star. This is Capella in the constellation of Auriga, the charioteer. It has a delicate lemony tint to it. Auriga is a rich constellation for binoculars.

Observing With Binoculars

Some objects have already been mentioned which repay more detailed inspection with either binoculars or telescopes. The list is now expanded to include some more objects that can be seen using binoculars. Note that they are all worth looking at with telescopes also.

North (refer to figure 1)

Mizar/Alcor – multiple star system in Ursa Major

Have at another look at Mizar and Alcor using binoculars. Can you spot a faint star between them but to one side to form a triangle? This was called Sidus Ludovicianum in 1723 by the courtiers of Emperor Ludwig V who erroneously believed it had appeared suddenly (perhaps they needed to butter up the Emperor).

West (refer to figure 2)

M31 – the Andromeda Galaxy

M31 is a spiral galaxy very similar but rather larger than our Milky Way. It is on collision course with us but don't worry, impact is in 2 billion years time. It is 2.9 million light-years away. This makes it the furthest object easily seen with the naked eye. However this isn't normally possible from the Planetarium because the sky is never dark enough but it can be seen by naked eye from up in the Cleveland Hills. To find it start with the top star of the Square of Pegasus and count two more stars along into Andromeda. Now count upwards another two stars and search for a milky patch close to the final star. In good conditions you will see that the brightness is concentrated in the middle but that it spreads outwards a surprising distance. Don't miss an opportunity to view M31 with a telescope. On a good night with a wide field lens you can see two





more galaxies at the same time as M31. These are its satellite galaxies M32 and M110, which orbit the Andromeda galaxy just like the two Magellanic Clouds orbit our galaxy (the Milky way).

M31 is the Messier number of this object. The Messier catalogue was compiled by Frenchman Charles Messier in ~1780 as a list of 110 fuzzy objects he didn't want to mistake for the comets he was searching for. Ironically his list of reject objects is now the most used reference to some of the most beautiful and interesting objects in the sky for modern observers.

South (refer to figure 3)

Two of the greatest binocular objects anywhere in the sky have already been mentioned in these notes, the Pleiades and the Hyades and amazingly there is a third great object in this part of the sky.

M42 – The Great Orion Nebula

Start from the left-hand side of Orion's belt and scan down the line of stars that forms the Hunter's sword. You should find what seems to be a fuzzy area around a star. This is the closest area of star formation to Earth lying about 1270 light years away. In this region of the galaxy there is a vast cloud of hydrogen with dense knots in it collapsing to form new stars (see figure 7). Near the closest edge of the cloud some massive young stars have formed in last few ten thousands of years. The vast output of ultra-violet light from these few bright stars has blasted a hole in the side of the cloud and ionised the gas that is left to fluoresce like a gargantuan neon sign. Meanwhile smaller stars like our Sun and smaller are still forming and astronomers can detect dusty disks around them that may develop into planetary systems in the future. The main gas cloud and the new stars formed from it include most of the constellation of Orion. Betelgeuse, Rigel and all the belt stars are all examples.

East (refer to figure 4)

M35 – open cluster in Gemini

Look at the area of sky between Betelgeuse and the twins Castor & Pollux. Roughly where the twins' feet should be is the third brightest star in Gemini after Castor & Pollux which is gamma Geminorum or Alhena. Now look upwards about 1/3rd of the way from Alhena towards beta Tauri/Alnath for a short line of three stars





and centre your binoculars on the highest star of the three. Above and to the left at roughly 10 o'clock you should see a faint fuzzy patch which is M35. With a telescope the cluster will resolve into individual stars. M35 contains ~200 stars and like the Pleiades is young at ~110 million years old.

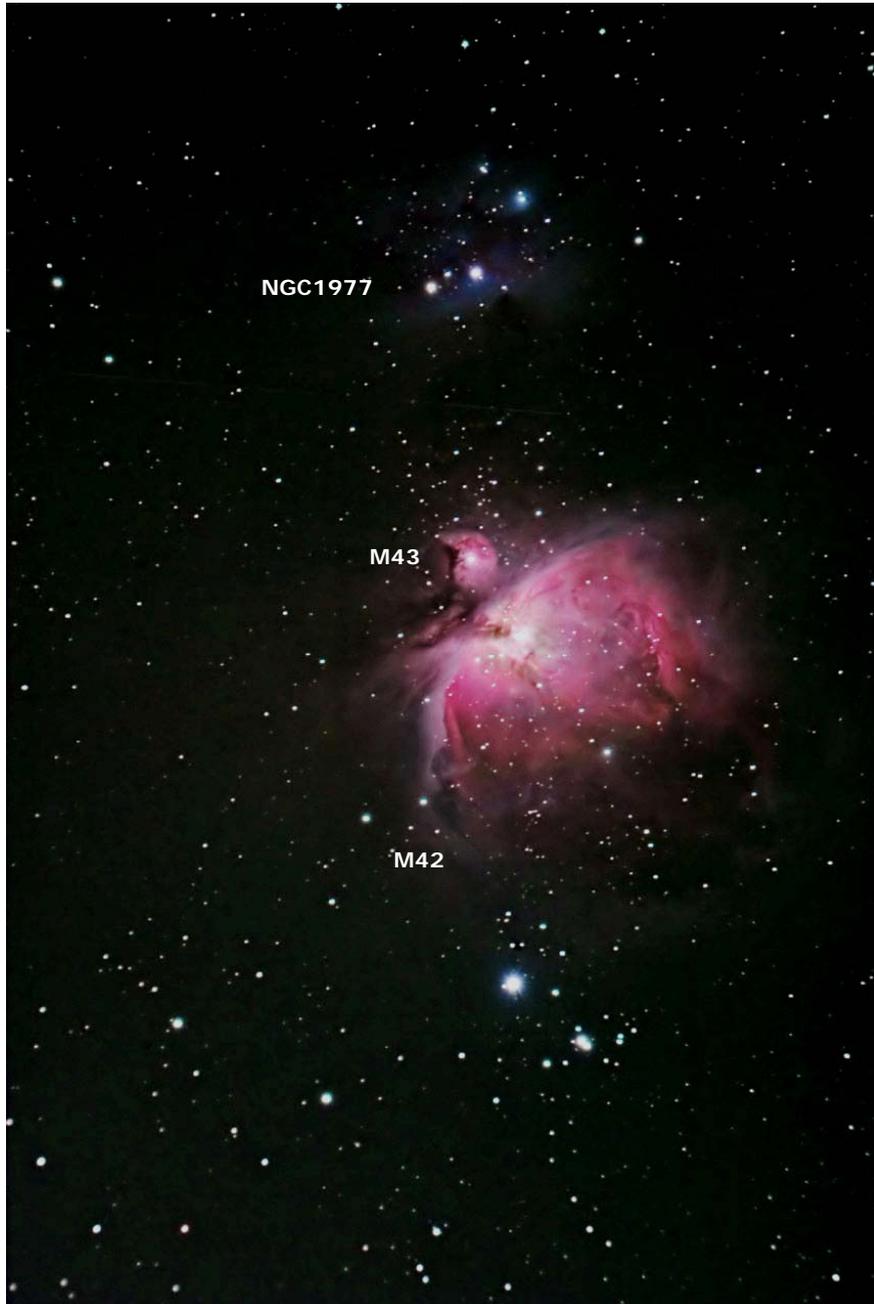


Figure 7: The Great Orion Nebula (M42) and NGC 1977, a stacked image of several exposures taken with a Canon 300D digital SLR through a reflecting telescope, by Juergen Schmol.





An asterism & open clusters in Auriga

Centre your binoculars on the star Alnath or beta Tauri and sweep gently upwards roughly a quarter of the way to bright Capella. Two quite distinct, bright curves of stars should come in view. This is the asterism called the Leaping Minnows. Look above the left-hand group in the asterism for a small milky grey patch. This is the open cluster M37. Now look below and to the left of the same group for another, smaller fuzzy patch which is M36. Keep scanning past M36 and look for a third patch, M38, nearer the size of M37. Like M37, M36 & M38 are open clusters. All three are worth closer inspection with a telescope.

M44 – Praesepe or the Bee-Hive, an open cluster in Cancer

Centre your binoculars on the middle of the triangle made up by Regulus, Procyon and Pollux in the constellation, Cancer. Close to this centre point you should find the large, bright open cluster M44, also known as Praesepe or the Beehive. In Chinese constellations Praesepe has the more alarming name of **Tseih She Ke**; "Exhalation of Piled-up Corpses". At a dark site, such as out on the North Yorks moors it is possible to see M44 with the naked eye. A low power lens is needed with a telescope to fit the entire cluster into the field of view. M44 lies so close to the ecliptic which is the path across the sky travelled by the Sun, Moon and the planets. This means the occasional astronomical treat with M44 and a planet or the Moon visible in your binoculars at the same time. The Moon goes by once a month and so in winter and spring when Cancer is in the sky there should be an opportunity to catch the two together.

Observing With a Telescope

Where appropriate, comments have been made on viewing the objects described with a telescope throughout the preceding notes and so only a few additional objects are suggested here.

Mizar – multiple star system in Ursa Major (figure 1)

Look at Mizar with your telescope. Almost any magnification will be sufficient to show it to really be two stars. This was first noticed in 1650. The two are 500 Astronomical Units (1 AU is the distance from the Earth to the Sun) apart and take 5000 years to orbit each other. What your telescope can't show you is that both stars are themselves pairs. The brighter one, Mizar A consist of two similar stars, each about 2.5 times our Sun's mass orbiting each other every 20.5 days – they are therefore closer to each other than Mercury is to the Sun. The other pair, Mizar B are about 1.5 times the Sun's mass and orbit each other every six months. All four are





considerably hotter and the Sun and the bluish white colour should be noticeable in the telescope.

eta Cassiopeiae – colour contrasting double (figure 1)

Look in the finder between alpha and gamma Cassiopeia. You will see a single star and a pair of stars, centre the telescope on the single star and try medium to high power and it should split into a pair. The brighter yellow looking star is similar to our own Sun. The fainter reddish star is quite a bit smaller. Until recently it was thought to be a red dwarf, the smallest class of normal stars. Around 2001-02 research showed that it belongs in the next class up.

NGC 457 – the Owl Cluster, an open cluster in Cassiopeia (figure 1)

This is a very attractive and bright cluster that gets its name because it appears to consist of a body with outstretched wings with the two brightest stars making the Owl's eyes (see figure 8). Depending on your telescope and when you look it won't necessarily be the right way up. With the finder, follow a line out from epsilon through delta Cassiopeia and centre on the next moderately bright star you can see, fairly close to delta Cassiopeia. Start with low power to find the Owl and then go to moderate power to frame it with the field of view of your telescope.



Figure 8: NGC 457 the Owl Cluster. Sketch by R Peeling using 150mm Newtonian telescope with 10mm Plossl lens, 04-Jan-2005.

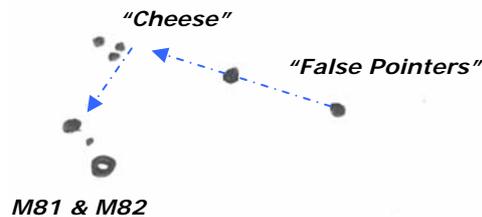
M81 & M82 – two galaxies in Ursa Major (figure 9)

It is possible to find these galaxies with binoculars but only on a very clear night from the Planetarium site. Start from the Pointers in the Plough and look above and to the right for another pair of stars that seem to echo the pointers. Through the finder use the "false pointers" to track up and left to a small triangle of stars, "the cheese". The short side of the triangle points left to two stars fairly





close together. Pick the fainter one and aim slightly below and to the left. With a low power lens both galaxies should come in view as faint milky or fuzzy patches. M81 appears as a plump oval while M82 is distinctly elongated and is sometimes called the Cigar galaxy. They are genuinely associated in space about 12 million light years away. Within the last 200 million years they passed close to each other and M82 came off worse and still shows the effects. M82 is an example of a starburst galaxy because it is undergoing a paroxysm of new star formation caused by its close encounter with M81.



R. Peeling

Figure 9: Finding M81 & M82.

gamma Andromedae – colour contrasting double (figure 2)

Start from the top-left star in the Square of Pegasus. Count out 3 stars along Andromeda to well over towards Perseus and Cassiopeia. Through the telescope with medium power it should split into a pair. The brighter star is yellow-orange and the other is white/blue.

The Trapezium – young stars powering the Orion Nebula (figure 3)

Have another look at M42, the Great Orion nebula and look closely at the group of stars in the centre of the nebula. You ought to be able to separate out four stars (change to a higher power lens if necessary), which comprise the Trapezium although it is in fact a small cluster of stars. The brightest of the four is theta 1 Orionis C and is the source of the vast majority of the ultraviolet radiation





that cause the whole nebula to glow. At ~40,000 K it is in the league of the hottest 'normal' stars.

Sigma Orionis – multiple star in Orion (figure 3)

Find a brightish star just below the left-hand star in Orion's belt. In the telescope this will split into a small associated group of stars. This multiple group is something like what the Trapezium will become once the fierce radiation from theta 1 Orionis C has driven away all the gas in the nebula around it.

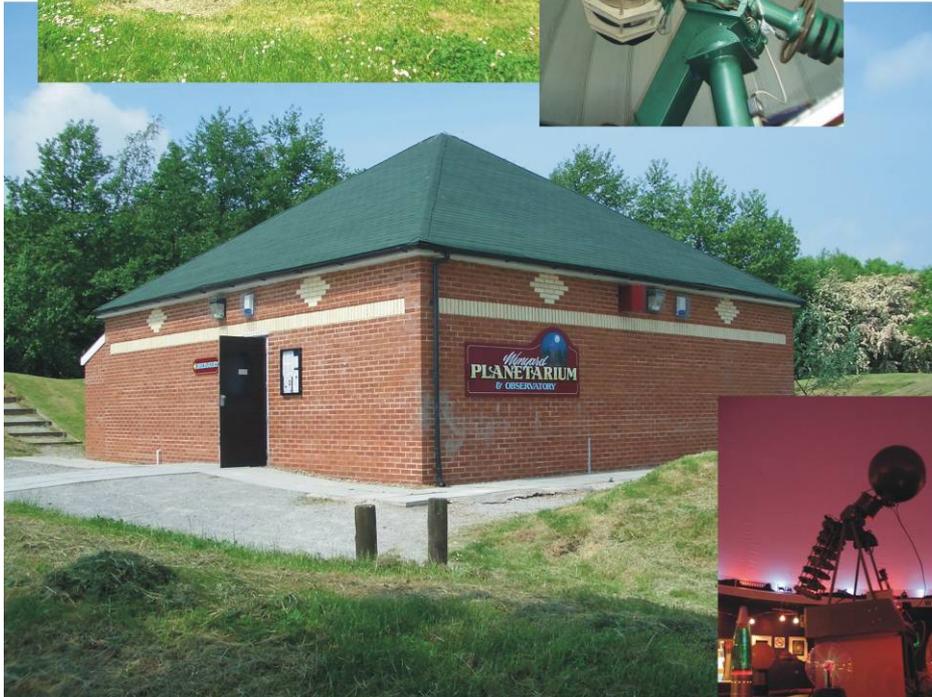
M1 – the Crab Nebula, remains from a supernova in 1054 (figure 6)

Chinese and Islamic astronomers observed this supernova. At one time study of this object was so intense that it was joked that there were only two branches in professional astronomy, the Crab Nebula and everything else. In the centre and powering the glowing nebula lies a neutron star or pulsar. Whilst you won't be able to directly observe this star, which is the corpse of the star that went supernova in 1054, you can consider its utter weirdness. Its temperature is so high (> 1 million degrees) as to be meaningless. It contains between 1.5 and 2.5 times the mass of our Sun in a sphere no bigger than Teesside. It spins 30 times a second and is made of neutrons at a density similar to the nucleus of an atom. If that is not enough then its stunningly intense magnetic field causes it to emit light, radio, and gamma rays in tight beams like a lighthouse as it spins. Hollywood couldn't invent something this strange. To find it, first locate beta Tauri or Alnath with your naked eye and look for another prominent but not bright star below it. This is zeta Tauri and you should centre your telescope on it. Using a low power eyepiece, gentle move upwards and slightly to the right until zeta Tauri is right on the edge of the field of view. Now look really carefully for a very faint patch of greyness somewhat towards off-centre in the field of view. It is not very bright and so is easily missed.

M67 – One of the oldest open clusters known (figure 6)

Look for the moderately bright star, delta Cancri somewhat to the left and below M44. Keep moving the finder in the same direction to find alpha Cancri, a star of similar brightness which will come into the view of the finder at 1 o'clock roughly as delta Cancri disappears off the edge at 7 o'clock. Now scan to the right using a low power lens in your telescope. As alpha Cancri slips out of view, M67 should just be appearing at the opposite side. This cluster is 2600 light years away, containing ~ 300 stars. It is between 4-5 billion years old making it a similar age to our Sun. Compare this to the age of either the Pleiades or M35.





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