Astronomy

Astronomy has held us in wonder since ancient times and was one of the first disciplines to become a science starting with people like Kepler in 1609 who worked out the mathematics of planetary movements and Galileo who developed the first telescope capable of seeing moons around Jupiter. Much has changed since then with most major Solar system bodies been studied in detail from orbit.

With all the high tech equipment astronomy still has a lot to offer the Scout with a good telescope and a clear night sky. Being a proficiency badge a Scout is free to select any number of options they are interested in that cover investigation, skill and an activity. This activity has been written to help Scouts pick out ideas they could use towards the badge and provide some guidance and limitations to expect when observing the night sky.

This activity is written by ASF Knox District in Melbourne so many links and references are to Melbourne based clubs and organisations. Similar organisations exist in all capital cities across Australia. You only need start searching on the net to find them.

Equipment

Telescopes

The typical telescope seen in various shops will NOT give you a view of planets and stars as expected. They are fine for distant objects on earth like a distant tower or mountain top but useless for planets. The ability of a telescope to enlarge a distant image depends on the diameter of the primary mirror or lens. Most common telescopes seen in shop windows have primary mirrors of around 100mm diameter which is too small to see planets with. Unless the primary mirror is at least 150mm or best at 200mm you are better off with a simple pair of binoculars. The primary mirror diameter can easily be guessed at by looking at the diameter of the telescope tube. The length of the tube has little effect on the power of the telescope, generally more expensive telescopes are shorter and more compact with extra elements in the tube compressing the optics.

Telescopes normally come with several eye pieces. These give you different magnifications from times 45, 80 to 160. At times 45 you get a clear view of the moon and surrounds, 80 Jupiter and its moons, 160 Jupiter. At the higher magnifications you don't get much more detail, just a larger image and a narrow angle of view making pointing the telescope a challenge. For starters use the lower magnification eye piece first then experiment with the others.

You could complete the badge without a telescope but it's well worth finding a trusting friend or adult who is willing to lend you one. Also you will miss the chance of seeing Saturn with its rings, and Jupiter with its cloud bands and moons.

If thinking of buying a telescope the best type to look for as your first would be a 150mm Newtonian on a Dobson mount. Australian Geographic shops are the easiest place to start looking but check around on the internet. These days many telescope supplies only sell over the internet and may be cheaper than a regular shop. OzScopes at http://www.ozscopes.com.au/ have a good range and at time of writing sell a 150mm Newtonian for $350.00.

Another option is to join an Astronomy club like the Astronomical society of Victoria (ASV) that hire out telescopes to members. To join the ASV cost $70.00 per year and telescope hire for three months $50.00. This works out a lot cheaper than buying one out right. There will be conditions with most clubs and most likely you can only join as a junior member under an adult.

Binoculars

Binoculars will not only enlarge the object but also collect more light allowing you to see things too faint by eye. When selecting one for astronomy, pick one with a magnification of around 8 to 10. The other important thing is the diameter of the front lens, the larger the more light it collects letting you see fainter objects. Binoculars are usually labelled with the magnification and front lens diameter as 10x30 meaning magnification of 10 and lens diameter 30mm. For astronomy an 8x40 is excellent. At the extreme end you can get 15x70 but with such high magnification you will have a lot of trouble pointing at the object you're trying to observe.

Kmart $15.00 specials

At time of writing Kmart sell a 7x50 for $15.00. They do work but like anything you pay for quality. These have a very narrow field of view and distort the image around the perimeter. They also break up the light in colours so you get yellow tinges around everything you look at. It is possible to view stars with them but far from easy and will give you a headache if you attempt to look too long through them. If you have a pair, give them a go but don't go buying one for this activity alone. A good quality 8x40 is the better option with prices going from $50.00 up to $100.00.

Star charts

Are available on various web sites, one on the SFA web site at
http://www.physics.sfasu.edu/observatory/obs.htm
Well worth printing out but they compress a huge area of the sky onto a few sheets of paper making it difficult to identify stars.

Another more complete star chart can be found on Astrovisuals Astronomy web site at
http://www.astrovisuals.com.au./
They offer a set of 18 A4 star chars covering the entire sky in good detail including a CD containing a copy of the same charts. It's not free however and charge $14.00 plus postage for the set.

At the end of this activity are a number of sheets showing parts of the night sky with stars that are fairly easy to identify. Printing these off and laminating them will help once outside looking up trying to identify stars and constellation.

Google sky map (PC or tablet only)

https://www.google.com/sky/

Well worth using to help locate stars. The web site uses many stored photos taken by large observatories and allows us to zoom in and see what detail mainstream observatories are capable of.

Google sky mobile app

When you have no idea where and what you're looking at, this phone app will always help. The app can be down loaded to any smart phone and cost nothing. Simply hold the phone up over the night sky and the screen displays what stars and planets are in that patch of the sky.

Badge

The badge requires you to investigate, develop a skill, and run an activity. Below are a few ideas you could use to achieve that. Pick one or more from each section below you would like to do. If you think of other ideas not listed here, ask your leader or PL if they think it's OK before attempting it.

Investigate

Many of these will depend on your age and how much your school has covered on the topic. If the idea below makes no sense, try googling it or asking an adult. If that doesn't help, pick something else that you're more comfortable with.

- Investigate star life cycles. From dust cloud – ignition – yellow dwarf – red giant – white dwarfs. What's going on inside them?
- Investigate how we know what stars and made of. Clue, star light spectra.
- Investigate how planets move around a star. Is it a circle, egg shape, what? Can this shape be drawn? Clue, Kepler worked this out in 1609.
- Investigate how we know how far away stars are. Clue, parallax.
- Investigate how astronomers measure star brightness. What scale do they use?
- Investigate how your telescope works. How many mirrors and what shape are they ground to. How do you calculate its magnification?
- Optical telescopes are astronomers' main tools. Investigate other tools they use that don't depend on light.
- Investigate a few ways you can tell a planet from a star.
- Investigate one space mission and describe its path through space and some of the instruments it is carrying.
- Investigate how astronomers record positions in the night sky using Declination and Right ascension.

Skill

- Set up a telescope and find different types of objects in the sky such as normal stars, double stars, star clusters, globular clusters, nebulas'.
- Set up a telescope and observe any planets in the night sky. Note only Venus, Mars, Jupiter and Saturn can be seen with any detail with a back yard telescope.
- Using binoculars try finding and identifying objects that are too faint to see by eye.

- Locate the position of the South Pole and check that the night sky rotates the way you expect it to and try measuring its rotation speed over an hour or more. Star chars at the end of this activity may help you do this.
- Over a period of a month locate a planet in the night sky and try measuring its position and see if it changes to that of the stars near it.
- Planets move across the night sky following a line astronomer's call the ecliptic plane. In the night sky work out what stars the ecliptic passes close to and try identifying any planets along this line.
- Look up the position of a star such as Sirius at Right ascension 06:45 Declination -16^{o} 42'. Using this work out where you expect to see it and try identifying it in the night sky.

Activity

Astronomy is a science that relies mostly on observation so does not easily lend itself to an activity. Most of the following ideas are ways of involving other Scouts in your troop, teaching them some of the things you have learned doing this badge. For night sky activities you will need a cloud free sky so make sure you have a backup plan should it be cloudy.

- With a telescope invite your patrol or troop out and show them some of the more interesting objects you have discovered such as planets, nebulas' globular clusters.
- Run a night session where Scout patrols have to locate as many star constellations as possible. Get them to locate objects like the cross, pointers, South Pole, Orion, Scorpio. You will need to check that these objects are above the horizon on the night you run this.
- On a Scout night with a telescope explain how you set up a telescope and point it at an object and focus it.
- Using large magnifying glasses or curved makeup mirrors get your patrol to focus a bright image onto a plane and explain how all lenses and mirrors have a set focal length.
- Organise a trip to an observatory.
  Around Melbourne there is Mount Burnett, Melbourne observatory.
  World class observatories. Anglo Australian Telescope, Parks radio telescope.

More Info

From here on the rest of this activity is here to help you find and investigate interesting things in the night sky. If you're stuck for ideas or can't make sense of something astronomical read on and you may find what you need.

Your first night of Observation

First print out the star charts at the end of this activity and laminate them. Start with the chart "Crux and South Pole" as this area in the sky is always visible throughout the year from most cities in Australia.

Try finding the southern cross and pointers using the chart. During winter evenings the cross will be pointing upright high up in the sky. During summer evenings it will be upside down and close to the horizon towards South. In spring sideways pointing right, autumn pointing left. As it gets dark the first stars to spot are often the Pointers near the cross called alpha and beta Centauri. There often referred to as the Pointers as a line at right angles to them point towards the south pole. Try working out roughly where the south pole is in the sky. Throughout the night the entire sky will rotate around the pole in a clockwise direction.

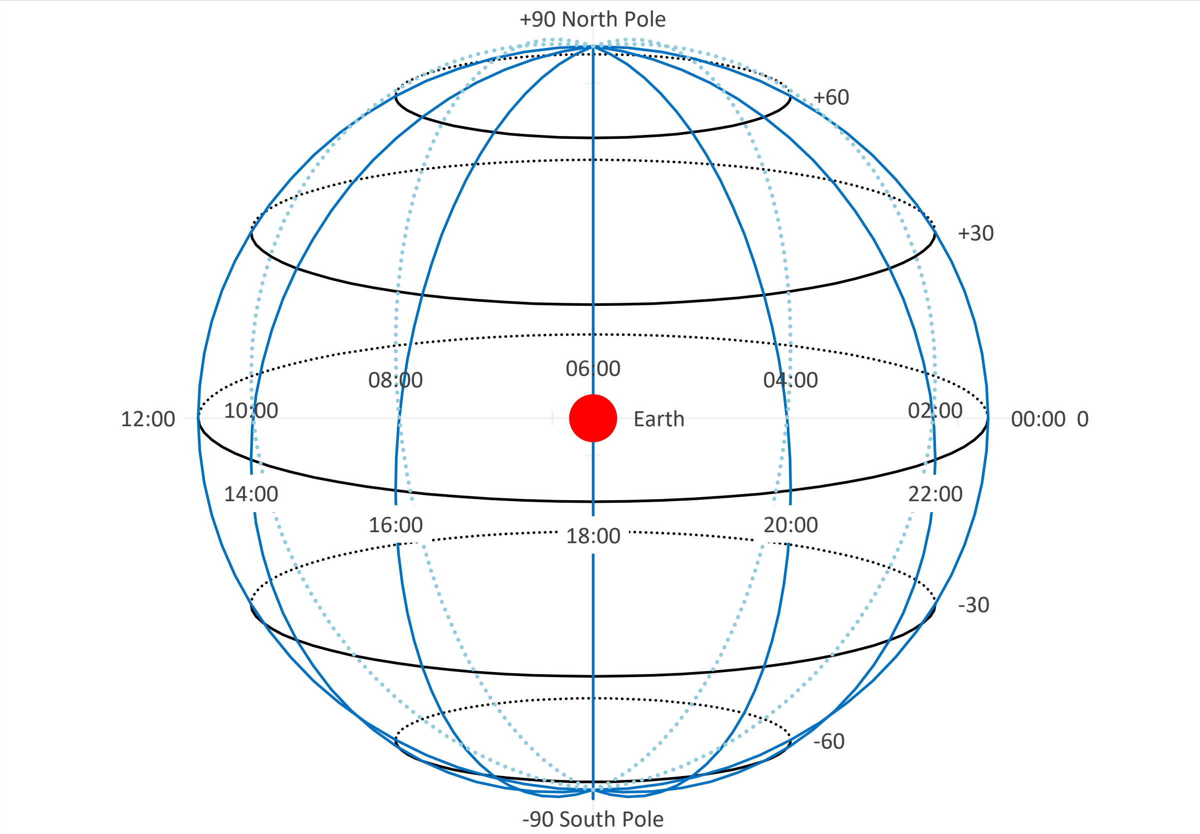
On the chart find NGC 4755 (sometimes called the jewel box) near beta crux. Try finding it in the night sky, it will just be a faint smug by eye. Depending on how dark your sky is you may only be able to spot it with binoculars. If you have a telescope point it at beta crux then pan towards NGC 4755. It's only 1.5^{o}, about two moon diameters away. If successful, you should find a tightly packed group of stars. These are known as open clusters and are formed form the same cloud of gas and dust. Over time the stars slowly break away from each other and wander around the milky way alone as our Sun does.

From here on the sky is yours to observe. Stars will only ever be seen as bright points of light in binoculars and telescopes as no telescope on earth is large enough to see its disk. Planets, nebulas, and clusters are the objects of choice for the back yard astronomer and telescope.

During winter evenings our night sky is in the direction of the Southern Cross and Scorpius out on RA 12:00 to 18:00. During summer evenings our view is the opposite side of the South Pole from the Cross looking out towards Orion at RA 00:00 to 06:00. Depending on the time of year pick out objects high in the evening sky. Objects around the Cross and Scorpius are good for winter, while Orion and the Magellanic Clouds are high in summer.

Celestial Coordinate System

Astronomers record positions in the night sky using a grid system that is similar to the joins in a blow up beach ball. Imagine being in the centre of a giant beach ball looking out noticing all the join lines. Above and below you all the lines come to the same point (our North and South Pole). Around the pole are set of circles each bigger than the next until you are looking horizontal at the equator.



Celestial Coordinate System

When looking up at night, try to imagine these lines drawn onto the night sky, the North/South lines all coming together at the South Pole with circles around the pole each bigger than the next until they reach the equator. All the North/South lines are straight; the lines around the pole are circles except for the equator.

Our Celestial Coordinate grid is marked off in angles with the equator being zero degrees (0°). Swinging down to the South Pole we go from 0° to minus 90°. Swinging up to the North Pole we go from 0° to plus 90°. This angle is called the **declination**. Going around the equator (East West) it's not that simple because the earth itself rotates in that direction. Astronomers measure the East/West angle from a fixed point in space which is roughly opposite to the Southern Cross. The east/west angle is measured in units of 24hours and minutes where 0 to 24 hours equals 360°. This angle is called the **Right Ascension**. To give a star position in celestial coordinates like the top star of the Southern Cross (Gamma Crux) we could look it up in Wikipedia at RA 12:31 Dec -57° 6'. Find Gamma Crux in the sheets at the end of this activity and see if it does have those co-ordinances.

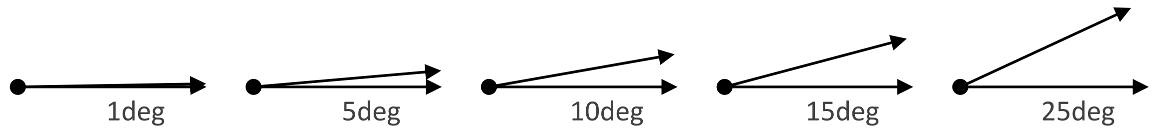
During the night a star's declination will not change but it will move across the sky in the RA direction as the earth rotates. Some telescope mounts are designed to rotate the telescope and part of the mount at the same speed as the earth but in opposite direction so the telescope remains pointing at the same point in space. These mounts are called equatorial mounts.

Measuring Angles Between stars

From our fixed position on earth we can't tell a star's distance. It can be close or far, bright or dim; so a bright distant star could look the same as a dim close star. We only know a star's position as an angle to other stars. For this reason, astronomers often refer to stars' position as an angle from a known star. An example could be at 7deg West of Gamma Centauri lies Omega Centauri.

Estimating angles up in the night sky is easiest using your out stretched hand. Holding your hand up to the sky at arm's length you can make angles of:

- 1^o – Width of your little finger. The moon is 0.8^o across.
- 5^o – Width of your three middle fingers held together.
- 10^o – Width of your closed fist.
- 15^o – Distance between your index and little finger held apart.
- 25^o – Distance between thumb and little finger held apart.



This has the advantage of not needing anything other than your own hand which can always be found at the end of either arm and not easily lost in the dark.

Using Binoculars

You will need something in the range of an 8x30. (8 is the magnification and 30 is the diameter of the front lens). Observing with binoculars can take some time and practice, when going from eye to binoculars it's difficult to see how much the image has been enlarged and more stars are visible than by eye. Here is a way to get started.

You may find it easier to be in a kneeling position with your elbows resting on something like a high stool holding your binoculars close to your eyes. That way you will be able to move your head looking direct at the stars or through the binoculars without moving the binoculars. Find a small set of stars with an easy shape to recognise like three in a triangle. Try locating them through the binoculars. Once you have, switch back and forth and try getting used to how much the image is being enlarged. Now scan away from the stars you have identified and try locating more distant stars from the first. This technique of locating stars and objects is called star hopping where you identify one or more stars in a patch of sky then more away in the direction of the object you wish to target. Using this technique, you can find objects too faint to see by eye but visible in the binoculars.

Things to Know About the Night Sky

Observing the night sky can be frustrating with persistent cloud, trees, the moon, buildings, street lights all getting in the way of what you want to see. All astronomers, amateur and preferential alike suffer the same frustration so don't give up. For a start pick easy objects to identify, such as some of the star constellations at the end of this activity then go for fainter objects near stars you can identify. When clouds continually cover the night sky for days on end be patient and ready as it will clear eventually.

Star Names, Constellations and Nebula's

Over the centuries stars, star groups and nebulas have acquired a number of names as understanding and technology has improved. This may be confusing as the same object may have several different ways of being identified. Below are the main ways they may have acquired such names.

Constellations and Star Names

In ancient times people remembered star positions by imagining images the stars could represent. These groups of stars became known as the constellations such as Crux, Centaurus, etc. The image the ancients put to them means nothing today but the area and stars within them has become a common means of naming stars. Within each constellation stars are given a Greek letter followed by the constellation name they're in. So the Southern Cross is called Crux and has stars Alpha Crucis, Beta Crucis, Gamma Crucis and so on. The name change of Crux to Crucis is the Greek possessive way of saying the star belongs to Crux, like I'm an Australian living in Australia. In many star charts the Greek letter is used such as π for pi. A list of all Greek letters is at the end of this activity. This naming convention is known as the "Bayer designation". A full list of all constellations can be found in Wikipedia.

In some cases, individual stars have acquired their own names such as Betelgenuse, Bellatrix and Sirius which you may recognise as characters out of Harry Potter. These same stars also have their Bayer designations of Alpha Orionis, Gamma Orionis and Alpha Canis Majoris. Astronomers may use either name but tend to go with an individual star name if it is well known.

Messier Objects

Many objects in the sky show up as small glowing clouds rather than a bright point like a star in a telescope. These objects were listed by Charles Messier in 1771 and became known as Messier objects with numbers going from M1 to M100. No one knew what they were at the time but as technology improved it became clear that they were either gas clouds (nebular) within our own galaxy, or far distant galaxies way outside our own. They have remained of great interest to astronomers who often refer to them by their M number such as the Andromeda Galaxy has an Messier number M31.

New General Catalogue (NGC)

Similar to the Messier objects but a larger and more complete list of distant galaxies and nebulas. The list was first issued in 1895 and has been revised several times up until recent years. It remains the most complete list to date listing many thousands of objects. The Andromeda Galaxy has an NGC of NGC 224. Whether you call Andromeda our closest spiral galaxy Andromeda, M31 or NGC 224; all is correct.

More Distant Objects

Astronomers are yet to see the most distant galaxies. The bigger the telescope, the longer the exposure and the more galaxies they find. Naming such distant objects or giving them a number becomes pointless so they simply record its position in Celestial Coordinates like RA 12:48 15.230' DEC +17° 46' 26.45''. This particular galaxy known as PGC 043234 (yet another name) has a large black hole at its centre which swallowed an entire star during 2015 and was observed using many telescopes on earth and space.

Double Stars

Double stars are where more than one star is locked into orbit around each other. These are quite common and make up about one third of all stars in the night sky. They can be as close together to the point of almost touching, rotating about each other once every few hours; or so distant that they take hundreds of thousands of years to do one rotation.

Most double stars are too close to see in a back yard telescope and look like just one star but a few can be seen and are a great challenge to ammeter astronomers. If a double star can be separated with a telescope most star charts will tell you the separation as an angle in arc seconds (that's one sixty of one sixty of a degree). A good 200mm telescope can see double stars down to 6 arc seconds apart, a smaller telescope (150mm) down to 10 arc seconds

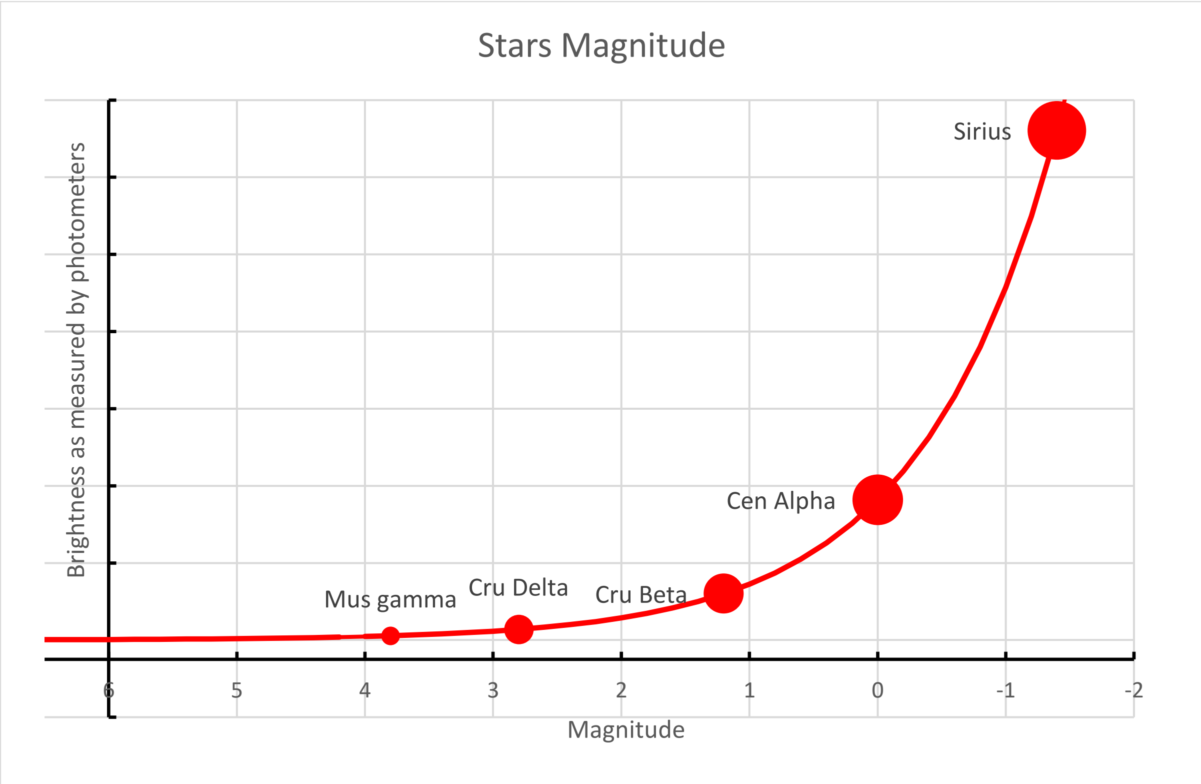
One good example is Beta Scorpio at Dec -5° RA 16:05 which has one bright star with a very close fainter companion 13 arc seconds apart. Another well-known one is Alpha Centauri. This double star rotates once every 80 years but from 2012 to 2019 will be only 5 arc seconds apart and too close to separate with most telescopes. After 2019 they will be 8 arc seconds apart and once again appear as a double star.

Double stars are important to astronomy as it gives astronomers the only way to measure the stars' mass. Two heavy stars will rotate faster around each other than two light stars and astronomers can use this to calculate the mass of each. The mass of a star is the most important thing to know about a star. Stars like our sun will shine for ten billion years or more but there are many heaver stars that are ten times the mass of our sun and burn much faster and hotter. Within ten to a hundred thousand years such stars run out of fuel and end in a supernova.

Stars Brightness

A star's brightness was initially judged by eye and given a number referred to as its **apparent magnitude** from one to six, with one being the brightest and six barely visible. Later on with telescopes and devices called photometers it was found that the difference in brightness from one magnitude to the next was about two 2.5 times so a magnitude one star was 2.5 times brighter than a magnitude two star. Or a magnitude one star would be 2.5 x 2.5 a magnitude three star. So the difference between magnitude six and one was actually 2.5 x 2.5 x 2.5 x 2.5 x 2.5 = 97.6

This scale of magnitude has been kept by astronomers and extended to include objects duller than magnitude six going down to eleven, and brighter objects than magnitude one going from one to zero, minus one and even minus twenty-seven which our sun shines at during the day. The dullest stars that can be seen depend on how dark your sky is, typically magnitude four is the limit from cities like Melbourne.



The size of the red circles shows the magnitude of a few stars in the star charts at the end of this activity. Sirius is the brightest star in the night sky at magnitude -1.4 near Orion. Gamma Mus a faint star near Crux at magnitude 3.8 would be too faint to see unless out in the country away from city lights.

Safety

If you have a telescope or binoculars out during the day never look at the sun through them. A telescope with a main mirror of 150mm concentrates the light in the same way as a magnifying glass, and should you look at the sun with a telescope it will blind you instantly!

With all optical equipment dust and finger prints on the optical surfaces is a constant problem. Always put the covers back on when not in use. If they do need cleaning, ask an adult of better still ask at a camera shop for advice, as cleaning lens or mirrors can result in scratching and ruining them.

Useful links and References

Wikipedia.
Good for info on any star, nebular or cluster. For a star, type in the star letter and constellation like Alpha Centauri. For nebula's or clusters type in either the NGC or Messier number NGC 6681 or Messier 70

http://www.ozscopes.com.au/
OzScopes. One of the few remaining suppliers of telescopes and accessories in Australia. Sells mostly on line but do have a display in Bayswater Melbourne.

http://www.bintel.com.au/
A good telescope shop in Sydney

https://eyes.nasa.gov/
A free PC app that can be downloaded to any PC. Using photos from space missions it lets you view planets from all angles, dragging and rotating as you please. Well worth playing around with it.

Astronomical Society of Victoria
http://asv.org.au/

Mount Barnett observatory.
http://mtburnettobservatory.org/

Melbourne observatory.
http://www.rbg.vic.gov.au/visit-melbourne/attractions/melbourne-observatory

Anglo Australian Telescope
https://www.aao.gov.au/

Parks radio telescope
http://www.parkes.atnf.csiro.au/

Astronomy 2016 Australia. http://www.quasarastronomy.com.au/index.html
Comes out in paperback each year and available most places like Australian Geographic shops. Includes star charts showing planet locations for that year. At $28.00 they're rather expensive for what you get.

Norton's Star Atlas by Ian Ridpath.
Has become the standard book for all astronomers for many years covering everything an ammeter astronomer could ever want to know. It's expensive and quite technical and probable not a good choice if you're just starting out.

Greek letters

Name	Symbol	Name	Symbol	Name	Symbol
alpha	α	iota	ι	rho	ρ
beta	β	kappa	κ	sigma	σ
gamma	γ	lambda	λ	tau	τ
delta	δ	mu	μ	upsilon	υ
epsilon	ε	nu	ν	phi	ϕ

zeta	ζ	ksi	ξ	chi	χ
eta	η	omicron	ο	psi	ψ
theta	θ	pi	π	omega	ω

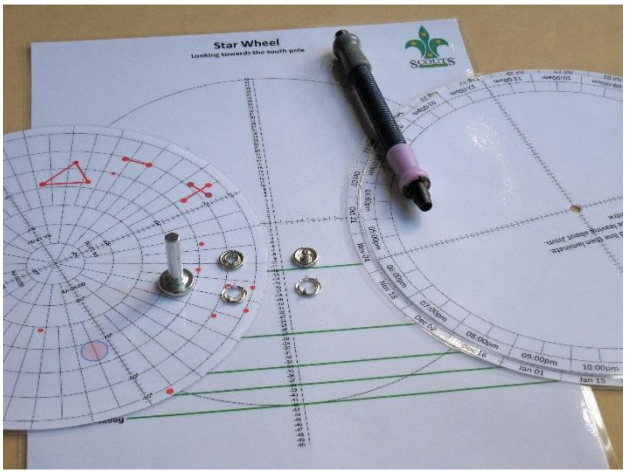
Star Charts

The star charts at the end of this activity are to help you get started identifying a few constellations and interesting objects near them.

Print them in landscape mode and laminate them. This keeps them dry and stiffens the paper which helps when holding them up to the night sky when trying to identify stars. With a head torch raped in red cellophane hold the star chart up to the sky and try to match the constellation The scale will match with the chart held about 25cm away from your eye.

Star Wheels

The star wheels on page 14 to 17 will help you work out when and where parts of the night sky will be visible as the night passes or in weeks to come. Print out the four pages and cut out the three round disks (Star wheel, 24 Hour time wheel, Year time wheels). Laminate the three wheels then cut away the excess laminate leaving 2mm around the edge. Laminate the back A4 page (Star Wheel, looking towards the south pole).



Punch a 4.8 mm hole in the centre of the 24hour wheel and Year wheel. Regular hole punches won't reach the centre of the disk, I found an "eyelet setter" spring loaded tool worked best. To attach the three disks to the back page use gripper press studs. You may need raid your parents sowing box for the press studs. Hammering the prongs into the studs can be tricky so experiment on waist laminated paper before attempting on the back sheet and star disk.

Put the disks together in order on the back A4 sheet, year time wheel, 24hour time wheel, star disk.

The green lines across the back sheet indicate where the horizon to the South will cut off your view of the sky depending on your latitude. The more South you are the higher up in the sky the South pole will be. If you lived at the South Pole it would be direct over head with the entire sky rotating above you. If North of the equator like the Philippines at 14deg you would never see the South Pole.

To work out what part of the sky will be visible either later in the night, or several weeks later (same time). Find the Southern Cross in the night sky then rotate the star wheel to match. Rotate the 24hour wheel and year wheel to match the current time and date at the bottom, blue arrow. Place a paper clip over the three disks locking them together. To work out which way and how much the sky will move over the coming hours rotate the three disks together to the new time. If you want to know where the sky will be in a few weeks' time then rotate the disk to the new date.

Stars and Objects of interest

Here are just a few stars and objects to look for.

Bayer designation	Right ascension	Declination	Name	Apparent magnitude	Distance in light years	Comments
Cen alpha	14:39	-60º 50’	Pointers	+0.01	4.32	Closest main sequence star
Cen beta	14:04	-60º 22’	Pointers	+0.61	390	Giant star
Cen omega	13:27	-47º 28’		+3.9	15800	
Cen proxima	14:30	-62º 41’		+11.1	4.24	Closest star
Cir alpha	14:42	-64º 58’		+3	54	Has a faint double 13” away
CMa alpha	06:45	-16º 42’	Sirius	-1.46	8.6	Our brightest star
Cru alpha	12:27	-63º 06’		+0.8	321	
Cru beta	12:47	-59º 41’		+1.2	280	
Cru delta	12:15	-58º 45’		+2.8	345	
Cru gamma	12:31	-57º 07’		+1.6	88	Red giant
M6	17:40	-32º 13’	Butterfly cluster	+4.2	1600	
M8	18:04	-24º 23’	Lagoon Nebular	+6	5000	
M80	16:17	-22º 29’		+7.87	32600	
NGC 104	00:24	-72º 05’	47 Tucanae	+4.9	16700	
NGC 1976	05:37	-05º 23’	Orion nebular		1344	
NGC 4755	12:54	-60º 20’	Jewel box	+6	6.4	Open cluster
Ori alpha	05:55	+07º 24’	Betelgenuse	+0.42	643	Red supergiant
Ori beta	05:14	-08º 12’	Rigel	+0.13	860	blue-white supergiant
Ori gamma	05:25	+06º 21’	Bellatrix	+1.64	250	blue-white
Pleiades	03:47	+24º 07’			444	Open cluster
Sco alpha	16:29	-26º 26’	Antares	+0.96	550	red supergiant
Sco beta	16:05	-19º 48’		+2.62	400	Double star 13” apart
Mus gamma	12:32	-72º 08’		+3.84	325	Faint Mag 4 star near Crux

Constellation abbreviations used in this activity

Abbreviation	Constellations	Location
Car	Carina	RA 09:00 Dec -60
Cen	Centaurus	RA 13:00 Dec -60
Cir	Circinus	RA 15:00 Dec -60
CMa	Canis Major	RA 07:00 Dec -20
Cru	Crux	RA 12:00 Dec -60
Eri	Eridanus	RA 03:00 Dec -20
Lep	Lepus	RA 06:00 Dec -20

Lup	Lupus	RA 15:00 Dec -45
Mus	Musca	RA 12:00 Dec -70
Oph	Ophiuchus	RA 17:00 Dec +00
Ori	Orion	RA 05:00 Dec +05
Sco	Scorpius	RA 17:00 Dec -40
Tri	Triangulum	RA 16:00 Dec -45
Vel	Vela	RA 09:00 Dec -50

Locating Planets

All the planets orbit the sun on the same plane as earth within a few degrees. As they go around the sun, we on earth see them slowly moving across the night sky against the stars all following the same line called the ecliptic. The ecliptic line passes through the head of Scorpius and to the south of Orion which is marked as a blue line on the charts at the end of this activity. The sun also follows this line throughout the year and as planets pass close to the sun, we sight of them and can only catch them either just after sun set or sun rise. To estimate where alone the ecliptic line a planet will be lookup its rise and set time for your city. If in Melbourne a good web site is https://museumvictoria.com.au/planetarium/discoverycentre/rise-and-set-times/ . If the planet has a rise time close to sunset, it will be towards the east on the ecliptic at sun set and be visible for most of the night. For every hour before or after sun set the planet will be 15^{o} higher or lower at sun set. Using star charts find the area along the ecliptic you expect a planet to be, identify all the bright stars and if there's a star not marked on the chart it should be the planet you're looking for.

Another clue is planets don't usually twinkle. In a telescope they appear as a small round disk and have a constant brightness. A star on the other hand always appears as a shimmering point of light like a small torch dropped to the bottom of a pool. The shimmering is caused by the atmosphere, like looking through the top of a fire, and places a limit on all telescopes ability to see sharp detail. Building telescopes on high mountains where the air is thinner helps, but only in space above the earth atmosphere can a telescope see without any shimmering.

Jupiter and Saturn are the best targets for astronomers as they're large gas giants further away from the sun than earth so we always see them from the sun lit side. Earth orbit is much smaller to that of Jupiter and Saturn so they appear to stay much the same size and brightness throughout the year with apparent diameters of 44 and 19arc seconds.

Venus and Mars are much closer and similar in size to earth so we see them from different angles to that of the sun and different distances. Throughout the year they will change in brightness and apparent size going from apparent diameters of 5 to 20 arc seconds. Mars is bright when close but we only get a good look at it for a few months every two years. Even then Mars can be too far for good observing due to its highly elliptical orbit. Year 2003 was the closest we ever get and the next good year will be July 2018. Venus is the brightest object in the night sky other than the moon but is covered on hazy clouds so you can never see its surface. Only from orbit using radar has the surface been mapped.

Star Wheel and Star Chart slides

The follow pages are to be used outside and help identify stars and constellations.

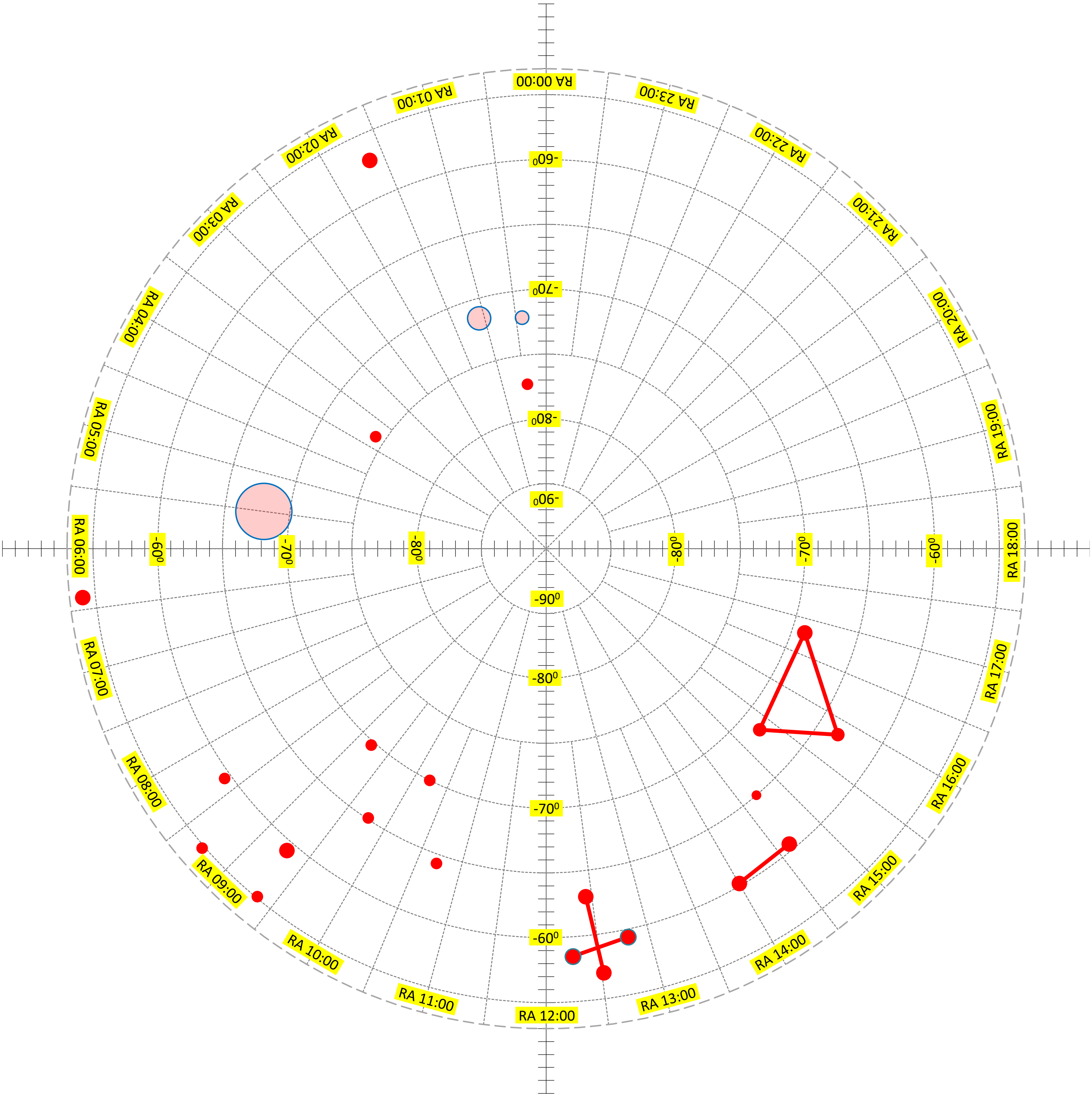
Print out the star charts on A4 sheets, landscape mode. Laminate them which stiffens the sheet so you can hold it up to the night sky beside the stars your trying to find.

Print out the star chart pages in A4 portrait mode. Making the star wheel is explained earlier in this activity.

Star Wheel

Looking towards the South Pole

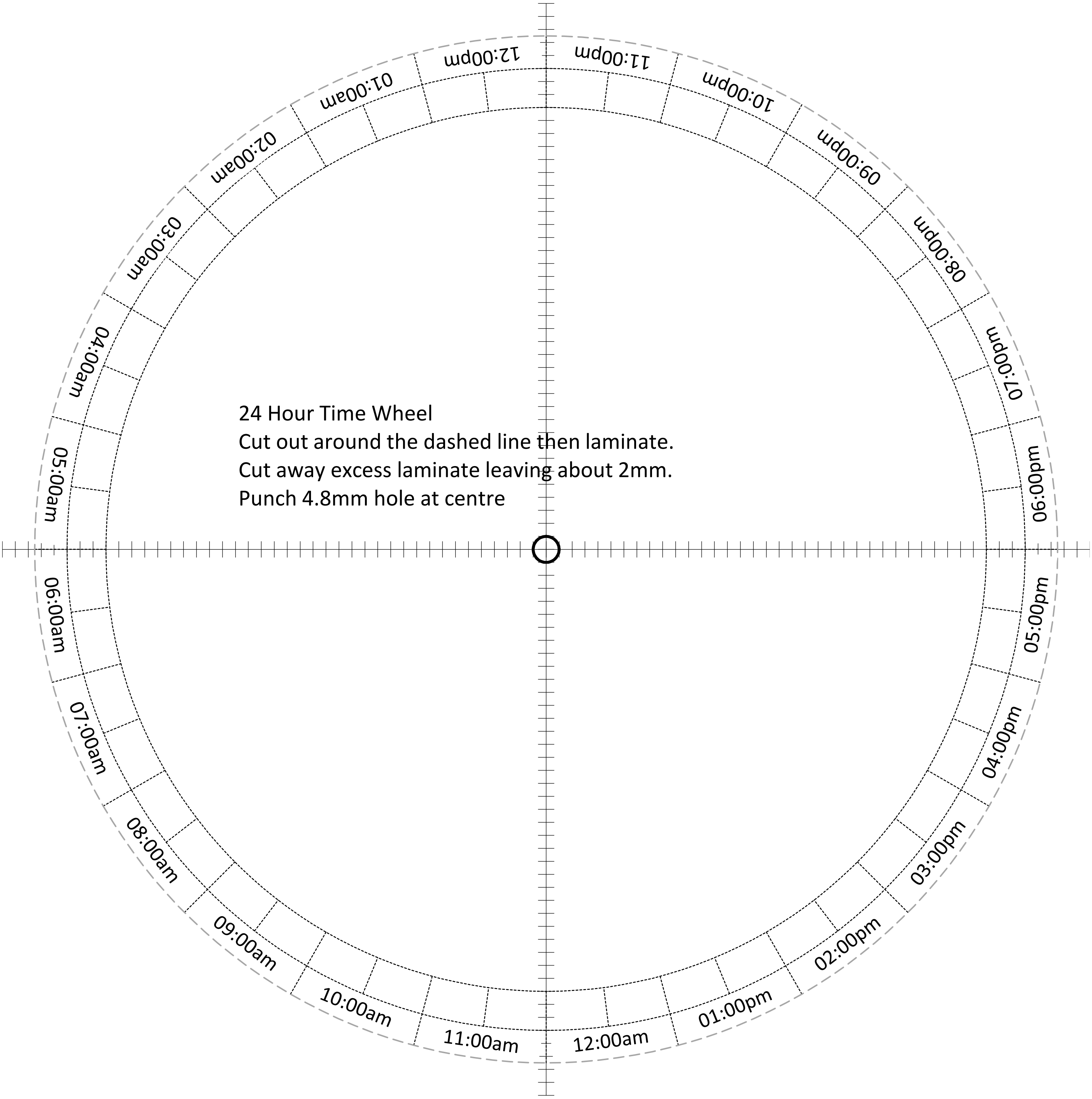
Cut out around the dashed line then laminate



Star Wheel

24 Hour Time Wheel

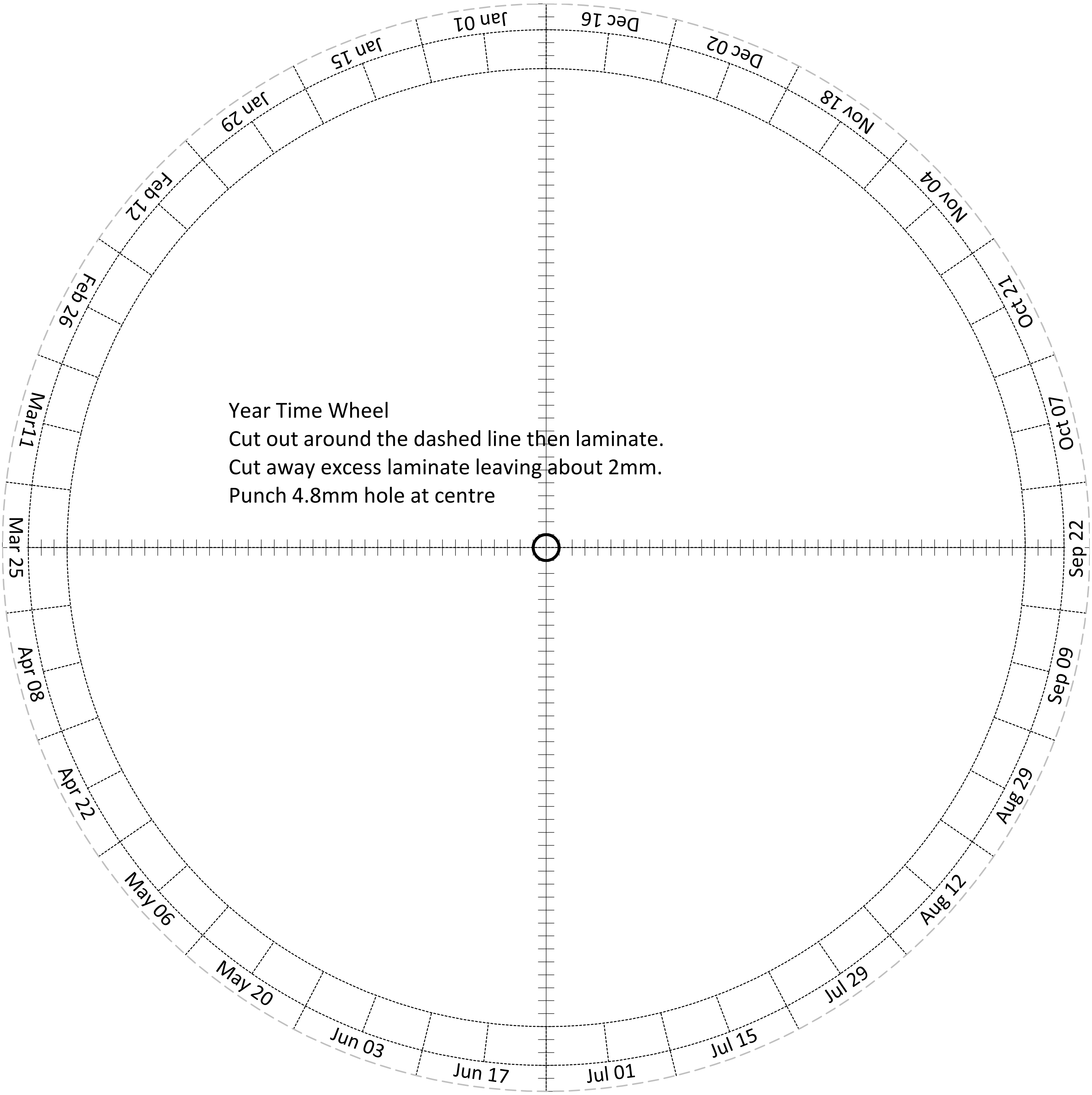
Cut out around the dashed line then laminate



Star Wheel

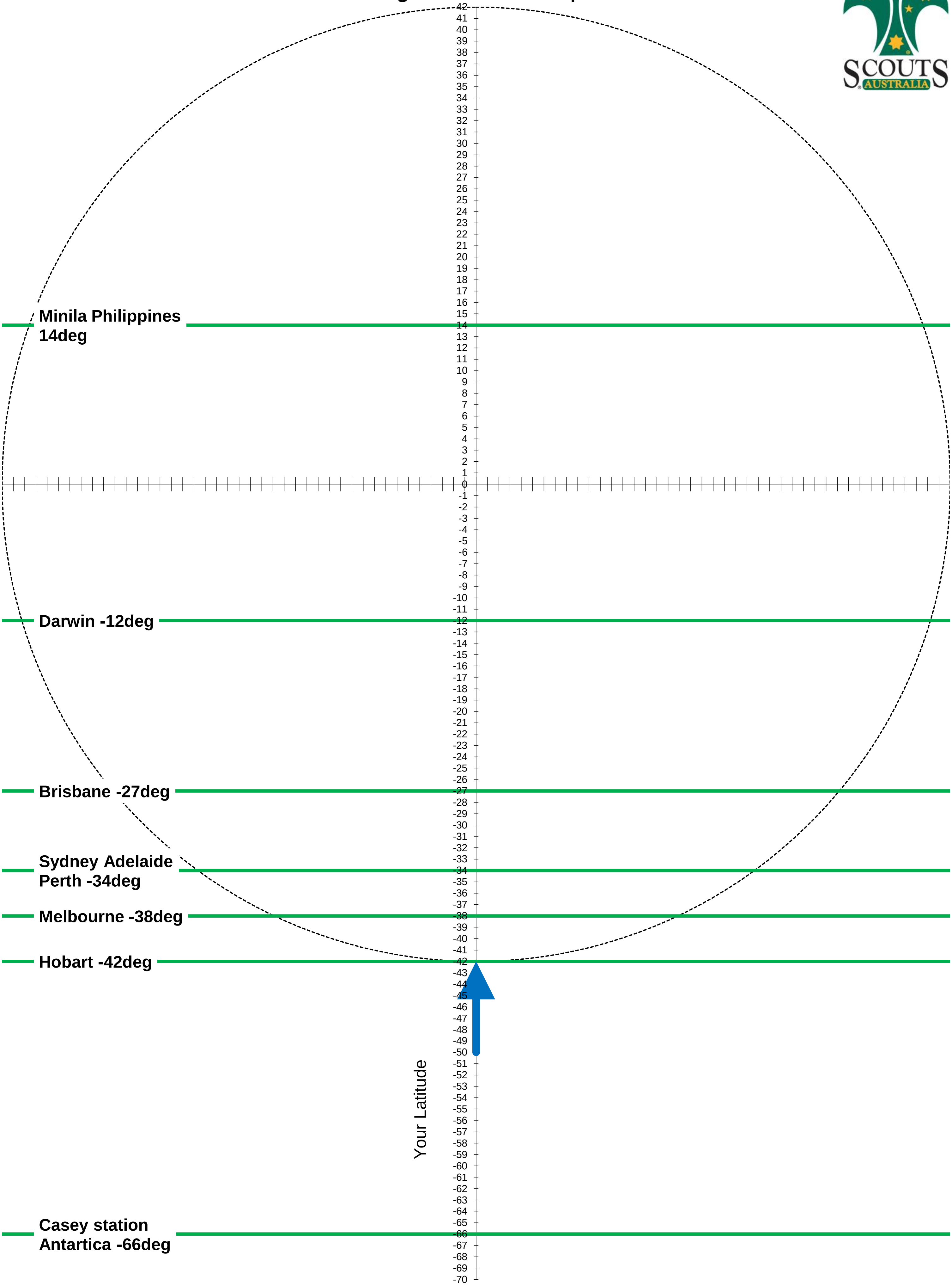
Year time Wheel

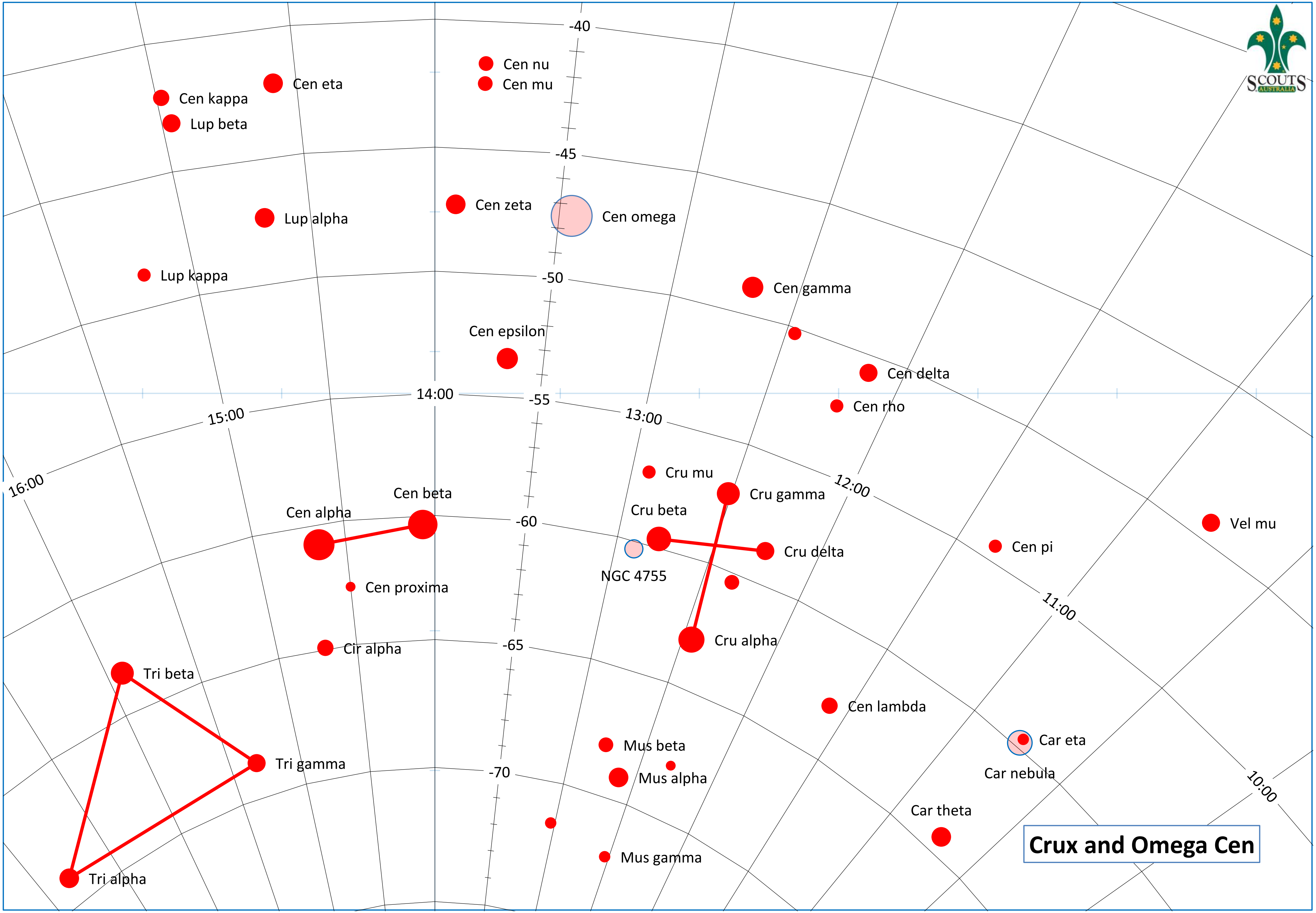
Cut out around the dashed line then laminate



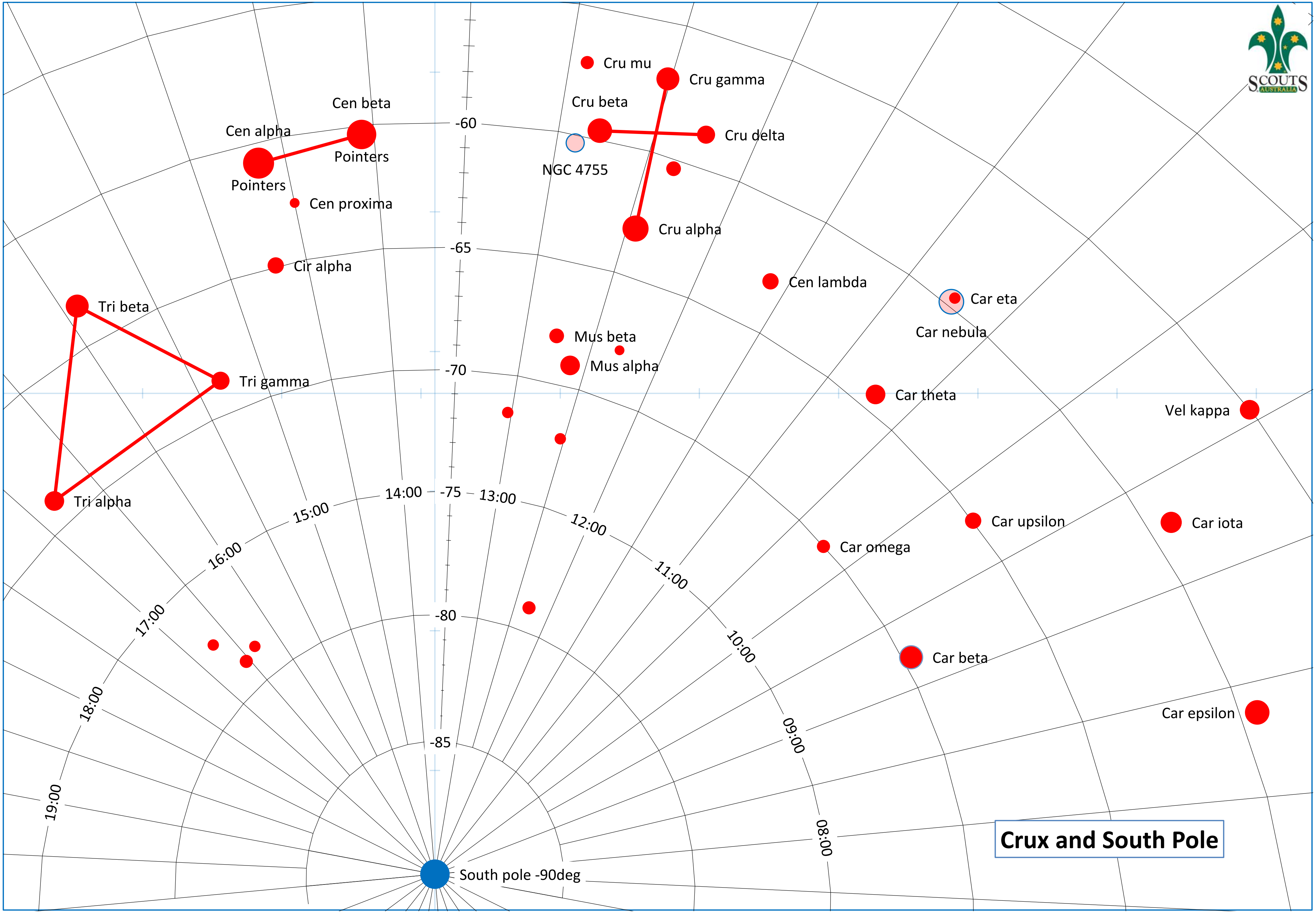
Star Wheel

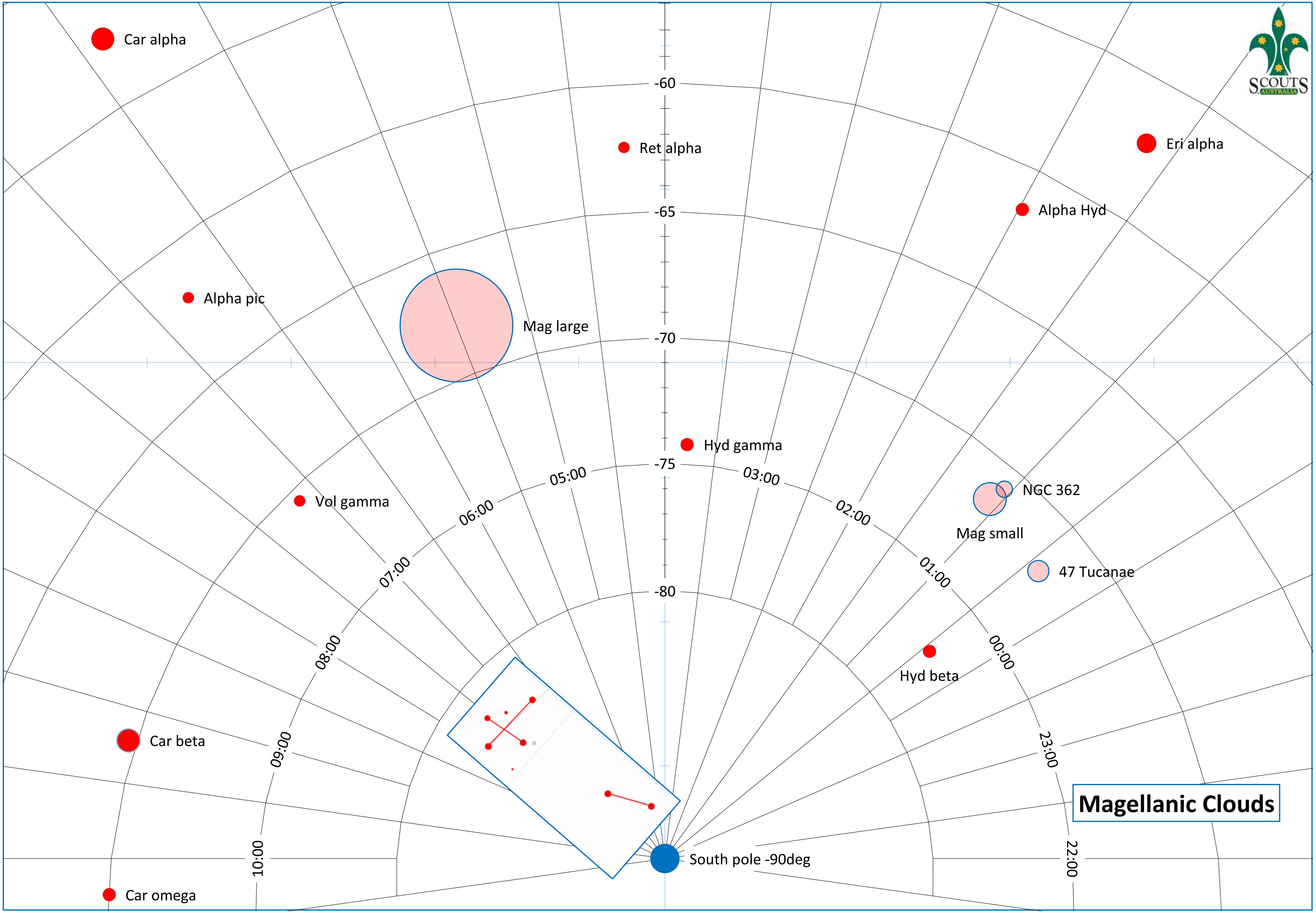
Looking towards the south pole

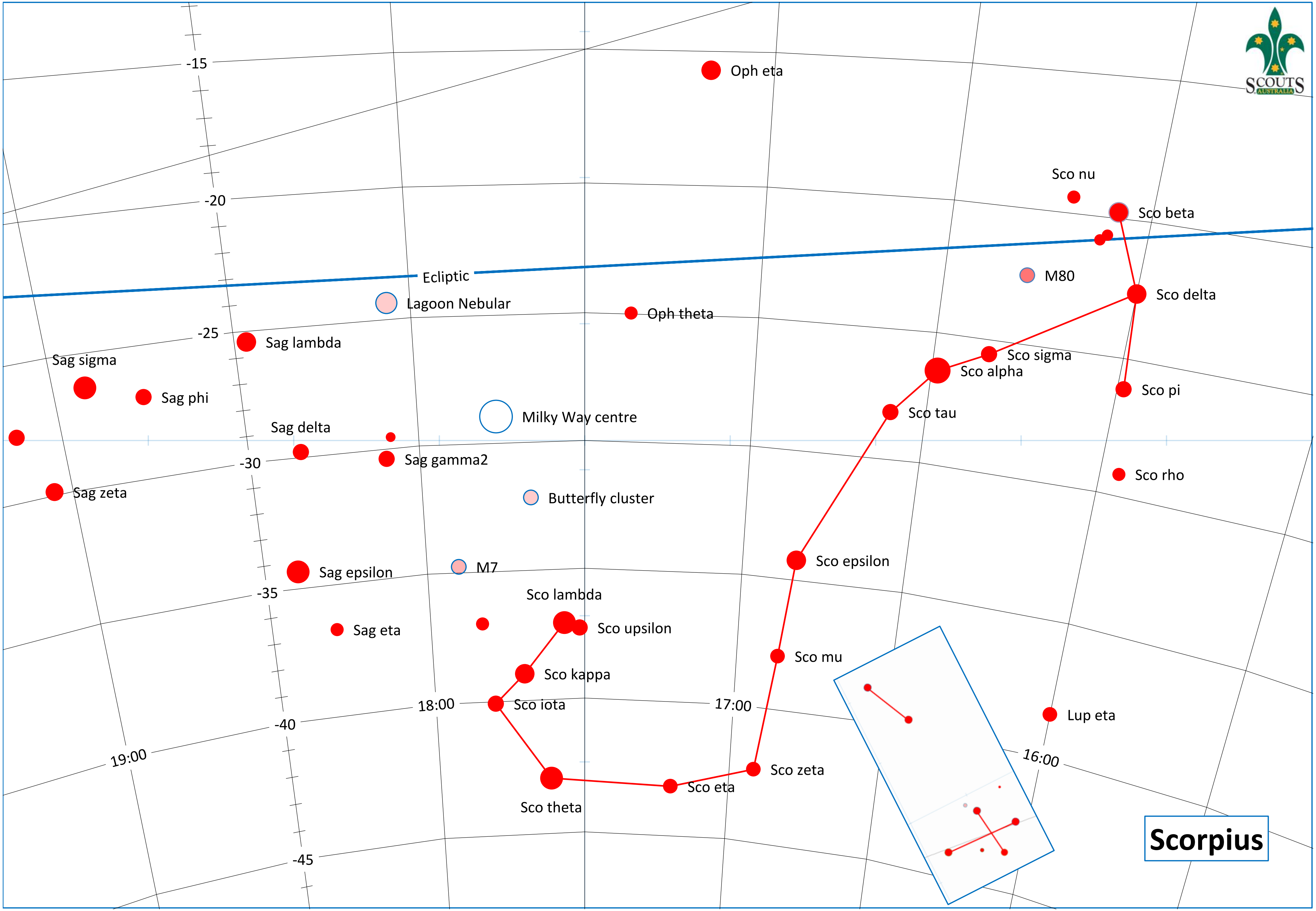


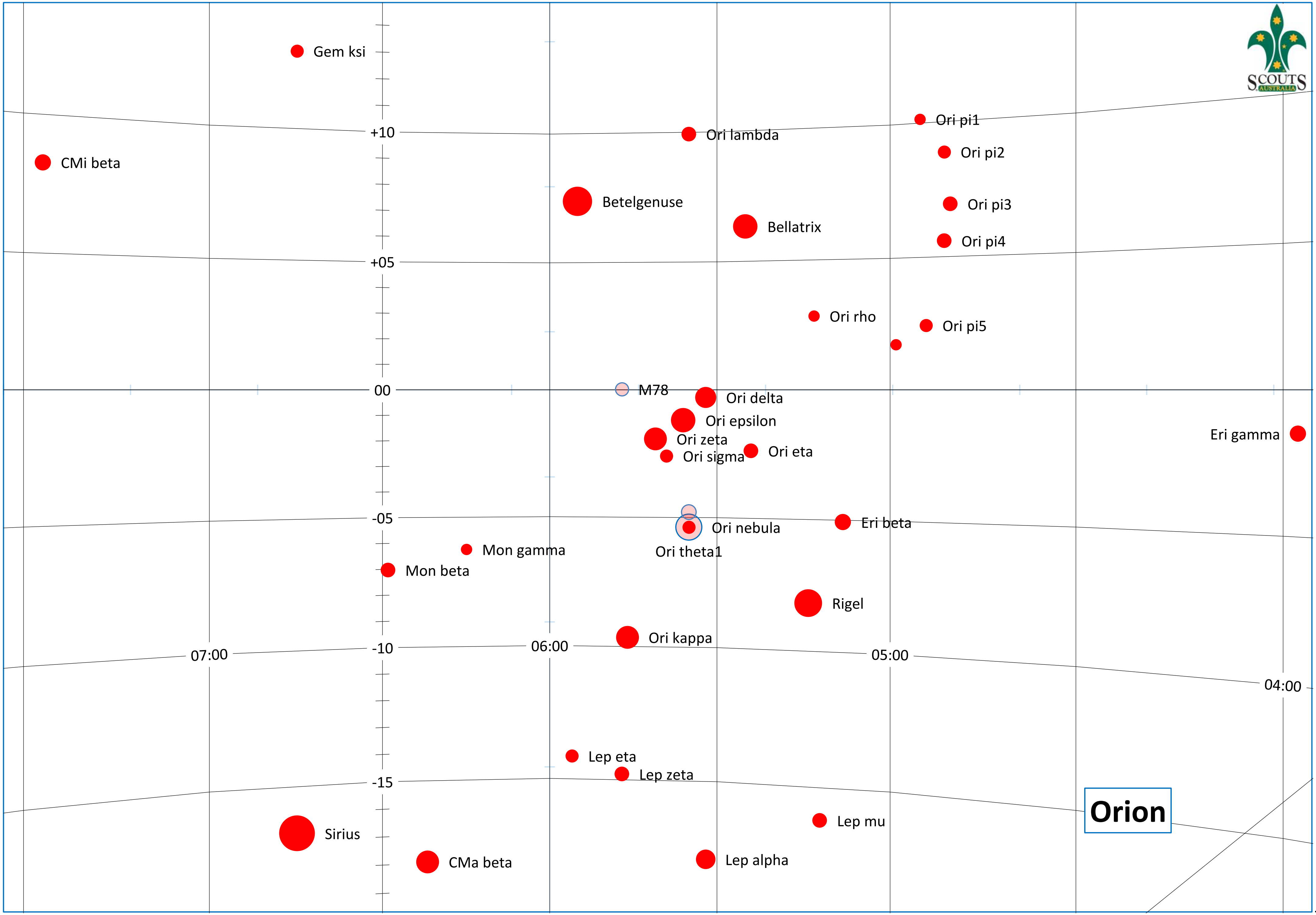


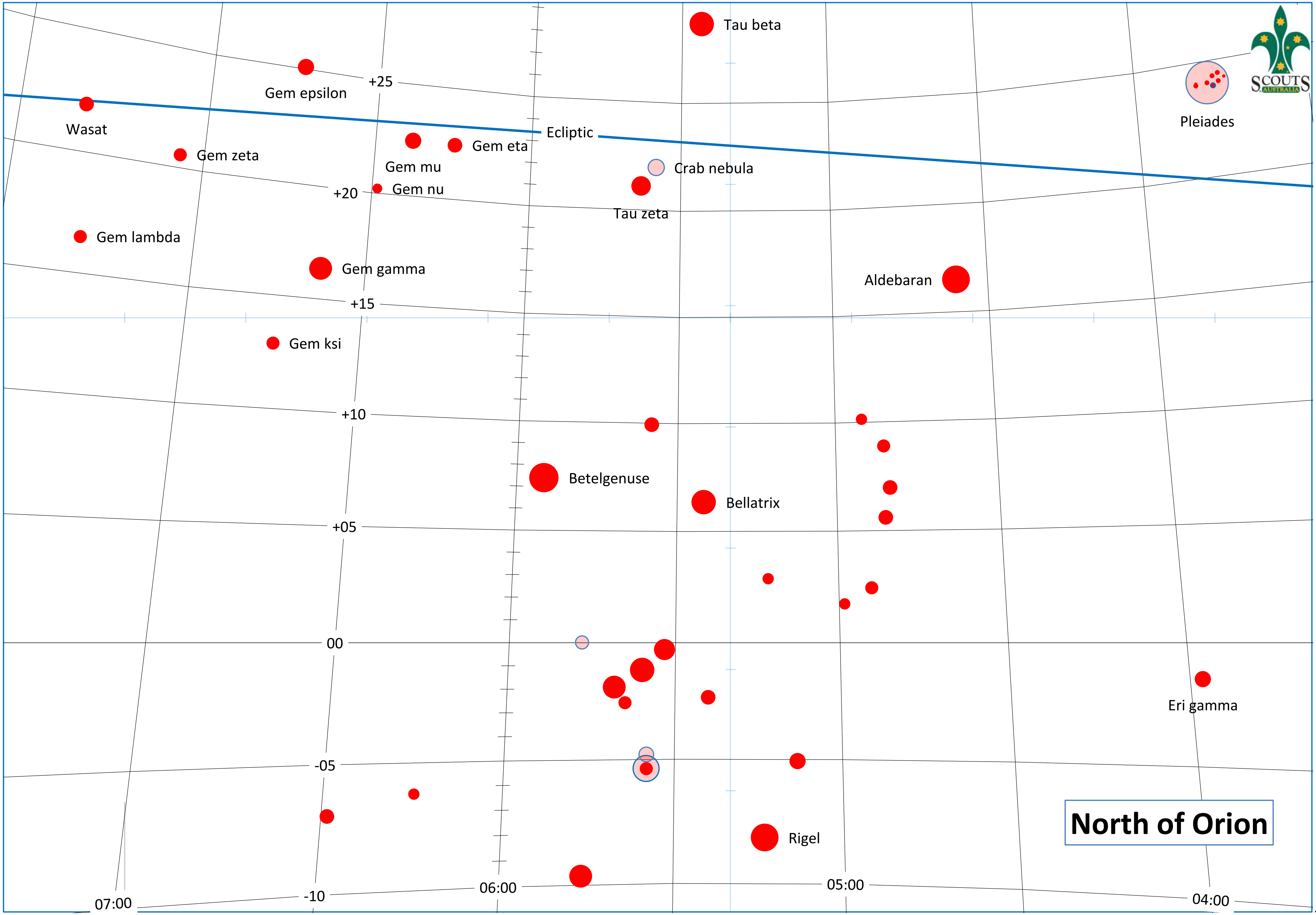
Crux and Omega Cen


Crux and South Pole
Cru mu
Cru gamma
Cru beta
Cru delta
Cru alpha
NGC 4755
Cen beta
Cen alpha
Pointers
Pointers
Cen proxima
Cir alpha
Cen lambda
Car eta
Car nebula
Tri beta
Tri gamma
Tri alpha
Mus beta
Mus alpha
Car theta
Vel kappa
Car upsilon
Car iota
Car omega
Car beta
Car epsilon
South pole -90deg
-60
-65
-70
-75
-80
-85
13:00
14:00
15:00
16:00
17:00
18:00
19:00
12:00
11:00
10:00
09:00
08:00
SCOUTS
AUSTRALIA


Car alpha
-60
Ret alpha
Eri alpha
-65
Alpha Hyd
Alpha pic
Mag large
-70
Hyd gamma
-75
05:00
03:00
Vol gamma
06:00
02:00
NGC 362
Mag small
07:00
01:00
47 Tucanae
-80
08:00
00:00
Hyd beta
Car beta
09:00
23:00
Magellanic Clouds
10:00
South pole -90deg
22:00
Car omega


Scorpius
Oph eta
Sco nu
Sco beta
Ecliptic
M80
Sco delta
Lagoon Nebular
Oph theta
Sag lambda
Sag sigma
Sco sigma
Sco alpha
Sco pi
Sag phi
Milky Way centre
Sco tau
Sag delta
Sag gamma2
Sco rho
Sag zeta
Butterfly cluster
Sag epsilon
M7
Sco epsilon
Sco lambda
Sco upsilon
Sag eta
Sco mu
Sco kappa
Sco iota
Lup eta
Sco zeta
Sco eta
Sco theta
-15
-20
-25
-30
-35
-40
-45
19:00
18:00
17:00
16:00


Gem ksi
+10
CMi beta
Ori lambda
Ori pi1
Ori pi2
Betelgenuse
Bellatrix
Ori pi3
Ori pi4
+05
Ori rho
Ori pi5
00
M78
Ori delta
Ori epsilon
Ori zeta
Ori sigma
Ori eta
Eri gamma
-05
Ori nebula
Eri beta
Mon gamma
Ori theta1
Mon beta
Rigel
Ori kappa
07:00
-10
06:00
05:00
04:00
Lep eta
Lep zeta
-15
Sirius
Lep mu
CMa beta
Lep alpha
Orion
SCOUTS
AUSTRALIA


Tau beta
Gem epsilon
+25
Wasat
Ecliptic
Pleiades
Gem zeta
Gem mu
Gem eta
Crab nebula
+20
Gem nu
Tau zeta
Gem lambda
Gem gamma
Aldebaran
+15
Gem ksi
+10
Betelgenuse
Bellatrix
+05
00
Eri gamma
-05
Rigel
-10
07:00
06:00
05:00
04:00
North of Orion