Celestial direction finding

in the southern hemisphere

The usual means for celestial navigation are the Sun (during the day) and the stars (at night).

The earth's path along its orbit around the Sun seasonally allows the night side (the part facing away from the sun) to view different parts of the sky. Therefore, different constellations are available in different seasons. During the day, the Sun obscures the remainder of the sky. Earth's rotation about its axis causes constellations to appear to rise in the east and set in the west during the course of the night. Latitude (distance from the equator) determines how far north or south one can see, whereas factors such as cloud or local topography may also prohibit visibility of a desired portion of the sky. Which constellations are available for direction finding therefore depend on one's location, local weather, the time of day, and the season. Local obstructions (such as hills, mountains, and trees) may further limit your choice.

The most versatile methods use constellations in the circumpolar portion of the sky, i.e. that part of the sky surrounding the south celestial pole which is generally visible to you. Of these, the most commonly used (and easiest to find) is the Southern Cross. How high up it appears in the sky is again dependent on latitude, date & time, etc. It is thus useful to have alternative means, even though these may not be available all the time.

In the northern hemisphere, Polaris (the "pole star") is relatively bright, and is close enough to the north celestial pole to be a useful marker. Unfortunately, the southern polar region is devoid of bright stars. The brightest well-positioned star, Sigma Octantis (also known as Polaris Australis or the "southern pole star"), is over a degree from the actual pole. Unfortunately, at magnitude 5.44, it is very faint (only 1/25th as bright as Polaris) and on the threshold of visibility in dark conditions. Although you could still pick it up in binoculars if you are familiar with that part of the sky, it is generally only of use to assist in aligning equatorial mounts carrying a good telescope.

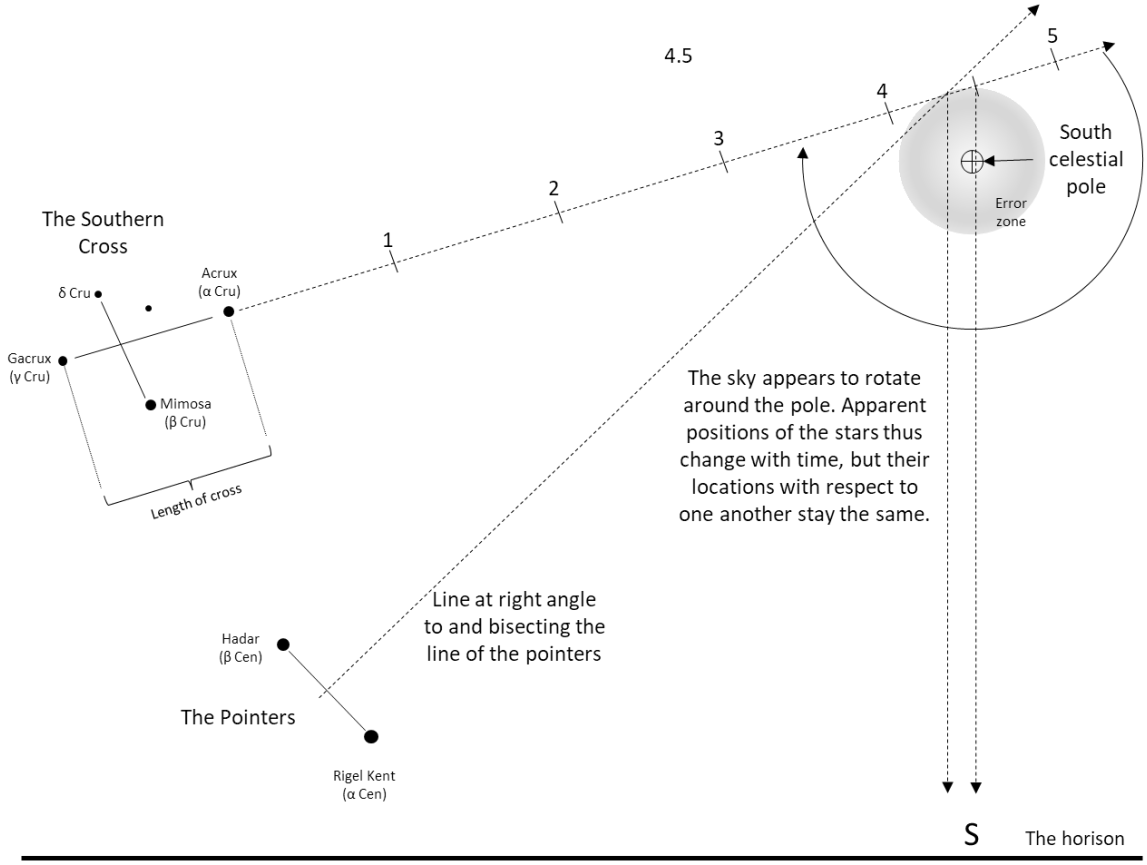
Using the Sun

The Sun is a star. It appears bright, simply because Earth is very close to it. It rises approximately in the East and sets approximately to the West, the closest to true east/west being at the time of the equinoxes. Due to the inclination of the Earth's axis with respect to the plane of Earth's orbit, the Sun appears to move north and south of the celestial equator during the course of the year, causing the seasons. You can thus use it to get only approximate directions at sunrise or sunset. Towards mid-day, as it appears highest, it is roughly north, this being most obvious around the winter solstice. Unfortunately, the closer to the equator you are, the more difficult it is to use these methods with any confidence. Using the sunrise/set and noon positions is thus a last resort in South Africa.

A more time consuming but also more reliable method is as follows:

- Plant a stick about 1m long in the ground, such that it is erect and cannot move
- Mark the end of the stick's shadow with a small stone (something unaffected by wind)
- Wait 20 to 60 minutes, during which the shadow will progressively shift
- Place another stone at the new end of the stick's shadow
- Draw a line (or place a straight stick) on the ground to make a line through the 2 stones
- This line approximates the east-west direction
- Placing another stick at right angles will give the north-south direction

Using the Southern Cross



Not having a convenient pole star in the southern hemisphere, there are two common methods of finding south by means of the constellations Crux (the Southern Cross) and Centaurus. The two brightest stars in Centaurus are quite prominent, being labelled alpha and beta in order of diminishing brightness (and commonly known as Rigil Kentaurus and Hadar respectively). A line through them "points" at the small constellation Crux, usefully helping to avoid confusing that with the larger "false cross" (an asterism formed by four bright stars in the constellations Vela and Carina) nearby.

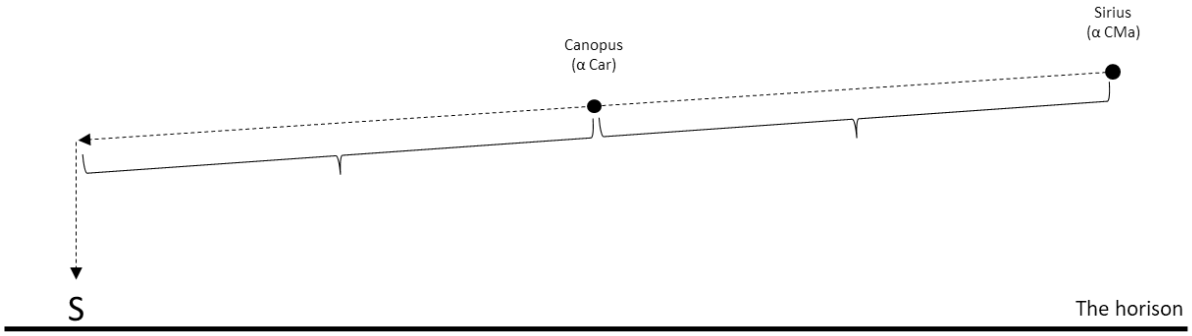
Method 1: Project a line through the long arm of Crux, extending 4½ times the length of the cross. That takes you close to the south celestial pole. Dropping a line straight down get you close to due south.

Method 2: Bisect the line joining the pointers and take a line from there perpendicular to the pointers. Where that intersects the line from the Southern Cross, drop a line to the horison.

It is useful for confidence to use both methods, and check that the results agree. However, as can be seen from the diagram, neither method is 100% accurate, as they miss the south celestial pole. Still, they are good enough for most practical purposes. Because there will be times when Crux, the Pointers, or both may be obscured by terrain or clouds, it is important to know alternative methods.

Note: In order to conveniently fit the page, the diagrams here show the stars involved in a relatively horisontal arrangement. In reality, this won't always be the case due to seasonal shifts and the time of night, so expect the constellations to be rotated from the depicted positions. Also, despite these methods using rather prominent stars, you do still need to learn your way around the constellations to be comfortable about accurately identifying them.

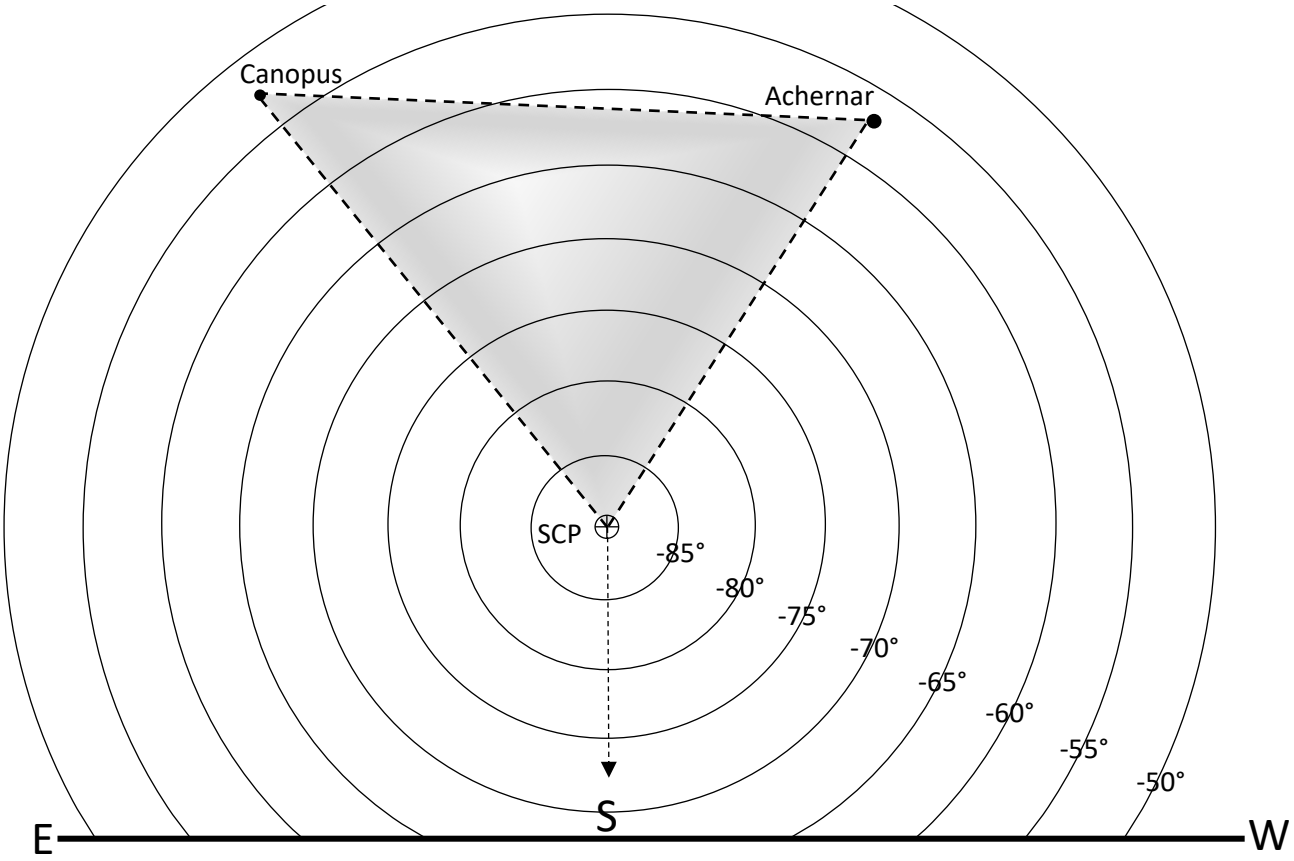
Using Sirius and Canopus



This is conceptually simple. Locate Sirius, the brightest star of all, found in the constellation Canus Major (the big dog). Take a line from Sirius through nearby Canopus - the brightest star in Carina (the ship's sails) and second only to Sirius in brightness - and extend it the same distance. Dropping a line straight down to the horison gives South. Although it is reasonably precise, the problem is judging the distances over a fair swath of sky. As with other methods, it may be that one or other (or both) are not visible due to season, time, terrain etc.

Using Canopus and Achernar

This one is a bit tricker, as it involves a larger area of sky, your knowledge of bright stars in different constellations, and your ability to imagine.



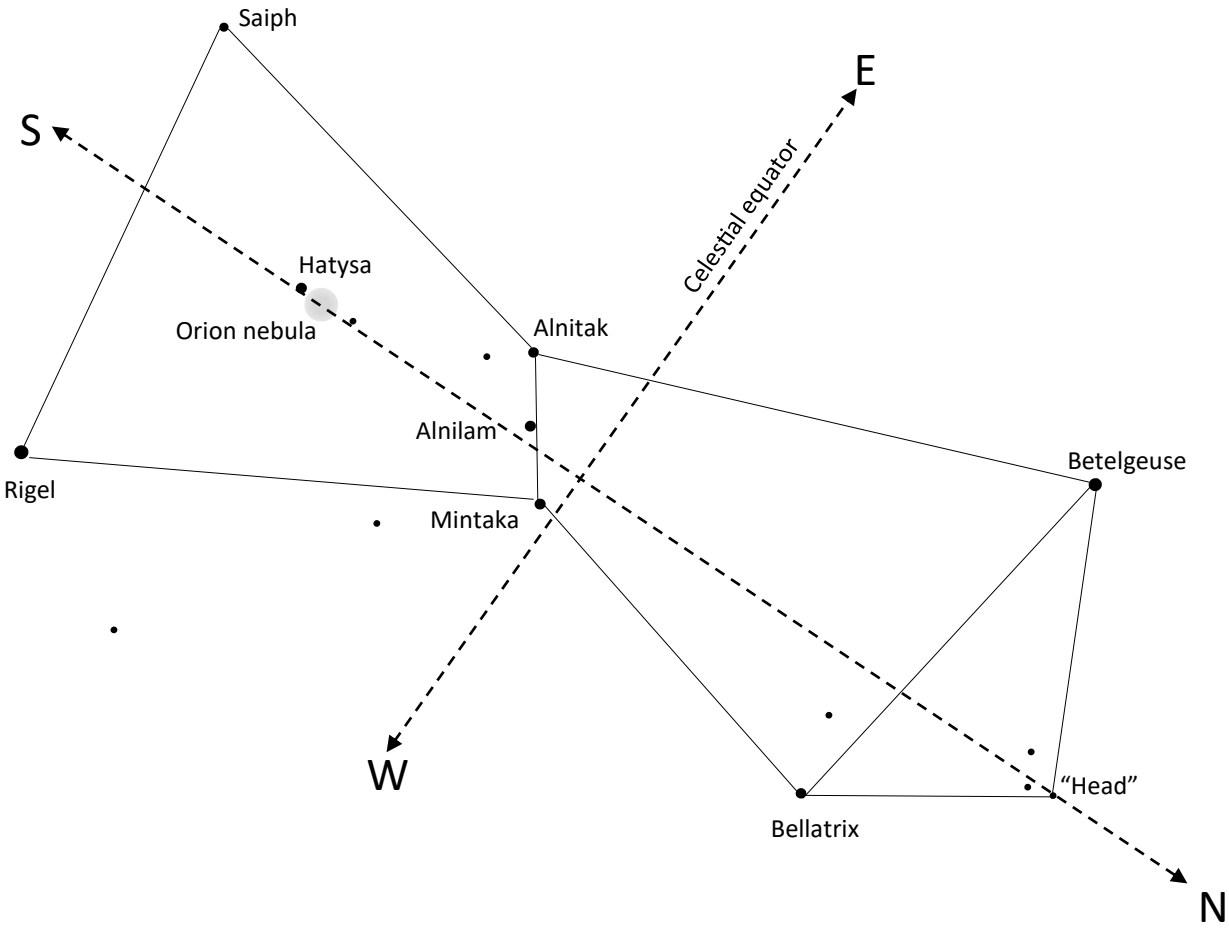
Canopus, Achernar and the South Celestial Pole (SCP) are arranged in an approximately equilateral triangle. As long as you can see both stars, you can estimate the position of the south celestial pole in the sky (even if it is not visible) - and from there drop a line to the horison to get South. Again, this depiction is a snapshot in time. The sky appears to rotate from east to west about the SCT. Therefore, you must be able to recognise the stars even when they are not in a horisontal line as depicted.

The numbered circles in the diagram are the lines of declination, equivalent in the sky to the lines of latitude on Earth. They are provided to give a sense of scale. (0 is the celestial equator, + is North and – is South. The SCP is at -90°.)

Note: *When depicting a spherical surface on a flat (plane) surface, the result is always distorted.* This is true for all maps and charts. In making star charts, the cartographer chooses a "projection" that, for the area depicted, should minimise distortion. In general, the wider the area depicted, the worse the distortion becomes - particularly towards the edges.

Using Orion

Orion (the legendary hunter), is one of the better-known constellations. Nearby Sirius, the visually brightest star in the sky, helps to locate it. The three bright stars Alnitak, Alnilam and Mintaka, close together and virtually in a line, are a prominent feature known as the "belt". These signify the waist of Orion. The fuzzy patch which is the great nebula of Orion, together with Hatysa and a sprinkling of fainter stars, are visualised as being the sword hanging from his belt.



A useful fact is that Mintaka lies almost on the celestial equator. This means that as Orion rises, Mintaka is essentially due East, and when it sets Mintaka is due West. Also, the great nebula together with Hatysa, Alnilam and the "head" of Orion all lie more or less on a line running North-South. With practice, you can thus get a reasonable idea of direction whenever the entire constellation is visible.

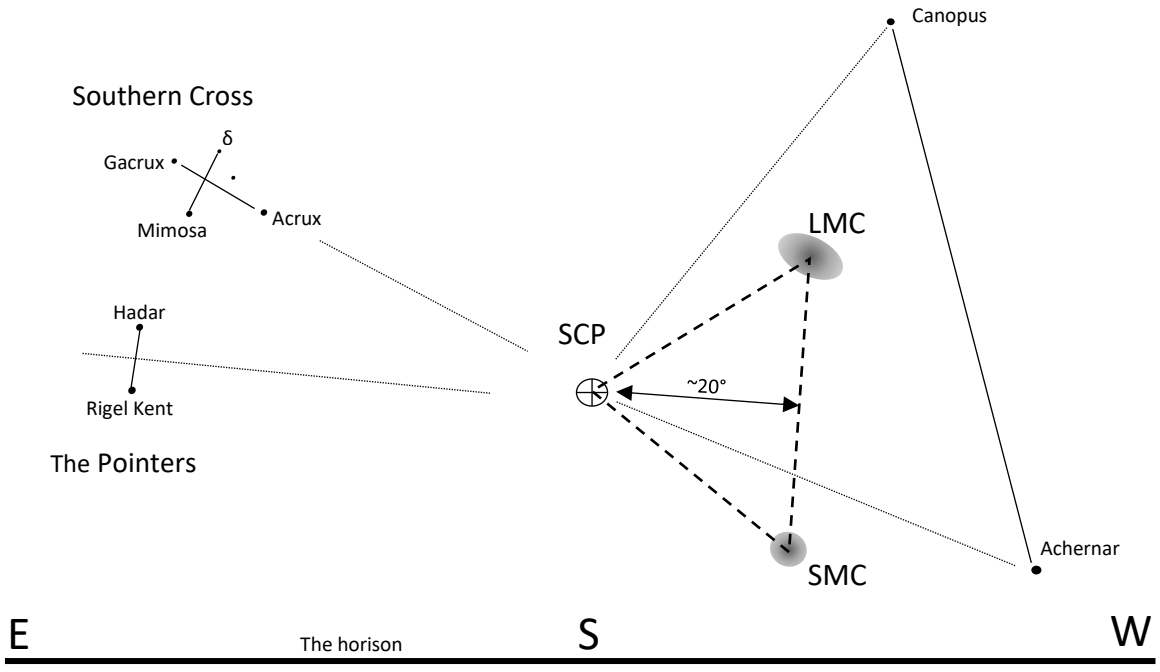
Using the Magellanic Clouds

The Magellanic clouds are two irregular (amorphous, unstructured) dwarf galaxies that orbit the Milky Way. The Milky Way itself is the medium-sized spiral galaxy in which we live. It is more or less lenticular in shape, like a common magnifying glass. Because we are inside - though close to the outer edge of - the Milky Way, we see it edge-on as a hazy band of celestial objects (mostly stars, but also globular clusters, nebulae, etc.). Based purely on their apparent size, the Magellanic Clouds are simply differentiated as "small" and "large" to denote which one we are referring to, abbreviated as LMC/SMC. Like the Milky Way, they appear as faint hazy patches. You need a relatively dark environment in order to see them; it is difficult from the city due to light pollution overwhelming them.

They are positioned about 25° from the SCP, the LMC being roughly in a line between the SCP and Canopus, and the SMC being roughly in a line between the SCP and Achernar.

Note: If you hold your hand out at arm's length in front of you and spread your hand so that the fingers are as wide apart as possible*, the distance from the tip of your thumb to the tip of your small finger is approximately 20°*.

Because of their diffuse fuzzy nature, they are not very good for celestial navigation. However, in the unlikely event that they are visible when Canopus and Achernar are not, you can use them in much the same way. You can also bisect a line between them, and the SCP will be about 20°from the intersect. If they are positioned in a horisontal line, South is directly below the midpoint between them. Needless to say, these methods are imprecise, but better than nothing. This diagram illustrates it, together with other methods described, for you to appreciate the relative sizes and locations.



Resources

You really do need to go out and directly familiarise yourself with the sky. The next best thing to the actual sky is to visit a planetarium which simulates the experience of being outside at night. Readily available “PC Planetarium” software is also very useful for training/learning.

Excellent free multi-platform multi-lingual **software** is available for the **PC**, e.g.

- Stellarium: https://stellarium.org/
- Kstars: https://kstars.kde.org/

As sitting at a desk is very different from seeing the actual sky, you should concentrate on learning patterns.

Paid **smartphone applications** are useful and interactive, e.g.

- SkySafari: https://skysafariastronomy.com
- Star Walk: https://starwalk.space/en
- SkyView: https://apps.apple.com/us/app/skyview/id404990064

Mobile applications can certainly help guide you whilst outside - but these will not allow your eyes to properly dark adapt, thereby preventing you from seeing fainter stars. Turning the screen brightness way down will certainly help. Some applications have a setting to display only in red light, in order to minimise the problem.

A **planisphere** is a map depicting somewhat more than half of the sky, able to rotate in a sleeve about the celestial pole. An aperture in the sleeve allows a portion of the map to be visible, so as to simulate what can be seen at a particular date and time. Graduations allow you to set those parameters. To view it at night, *use a very dim red light, in order to preserve your night vision*.

Durable cardboard and plastic planispheres are commercially available. A printable do-it-yourself version is available at

- ASSA: https://assa.saao.ac.za/how-to-observe/getting-started/planisphere