Observer's Guide to PNs

By Rob Horvat (WSAAG) Mar 2020

This document has evolved from a supplement to **Night-Sky Objects for Southern Observers** (**Night-Sky Objects** for short), which became available on the web in 2009. The document has now been split into two, this one being called the **Observer's Guide to Planetary Nebulas**.

The maps have been designed for those interested in locating planetary nebulas by star-hopping around the constellations. However, like Night-Sky Objects, the resource can be used to simply identify interesting galaxies to GOTO.

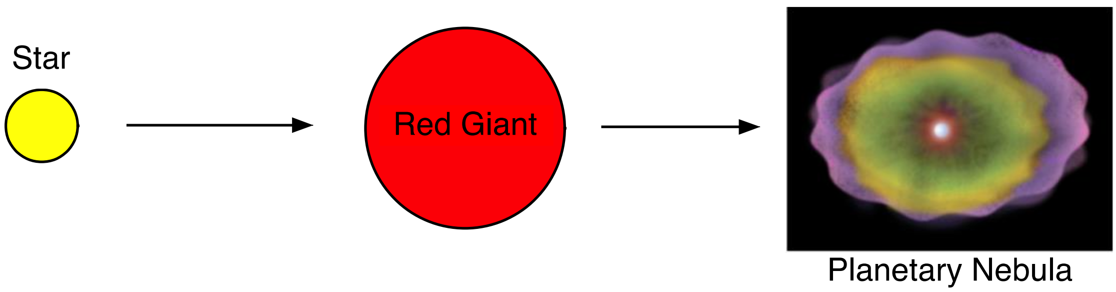
As with Night-Sky Objects, the maps have been designed and oriented for southern observers with the limit of observation being Declination +55 degrees. Facing north, the constellations are inverted so that they are the "right way up". Facing south, constellations have the usual map orientation. Pages are A4 in size and can be read as a pdf on a computer or tablet.

Planetary Nebulas

Planetary nebulae or nebulas (PNs) are faint objects. None are visible to the naked eye. They are not related to planets as the name would suggest but originate from stars. William Herschel may have coined the term as he thought they resembled the giant gas planets (he discovered Uranus in 1781). However, only about 20% are roughly spherical and larger nebulae appear more grey than blue-green through a telescope.

There are about 3,000 known PNs in our galaxy. The comparative rarity of PNs is probably due to the fact that this phase of a star's evolution is relatively short – possibly only 10,000 years. Most are found near the plane of the galaxy with the greatest concentration near the galactic center.

PNs are formed when a star of 1-8 solar masses nears the end of its life (above this mass, the star blows up as a supernova). Stars get their energy by converting core hydrogen into helium under intense gravitational pressure. This process can continue for billions of years (e.g. our Sun is about 4.5 billion years old). When the star runs out of hydrogen, the more massive helium core shrinks and helium begins to fuse to carbon and oxygen at a much higher temperature. The atmosphere expands enormously and the outer layers get cooler – the star becomes a red giant. As more helium is fused, the temperature rises further and radiation pressure ejects the outer atmosphere. The exposed core sends streams of ultraviolet photons into the ejected atmosphere and ionises it. It then becomes a planetary nebula. Most of the light is green due to oxygen ions (OIII). The central star begins to cool as a white dwarf. Eventually, it will no longer have the energy to irradiate the distant cloud of gas.



Planetary nebulae spread heavier elements created by stars into the interstellar medium. Subsequent generations of stars have higher proportions of C, N and O, which affect stellar evolution.

The typical planetary nebula is about one light year across. There is much debate about the mechanism that produces so many different shapes. Some astronomers believe a central binary could produce some of the more complex shapes. New evidence also indicates magnetic fields around the central star might be a factor in producing the remarkable variety.

Surface Brightness

Apparent or visual magnitude is a measure of the overall brightness of an object as if it were a small point of light like a star. This becomes very much an approximation for larger visual objects such as large nebulae, which often have irregular boundaries and uneven surface brightness.

For larger objects, surface brightness (SB) can sometimes be a better indication of brightness. However, the figure tends to be an average for the whole surface as, for example, nebulae have irregular shapes with brighter and darker regions.

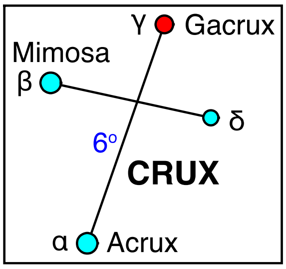
SB can be measured in magnitudes per square arcsecond or, as measured here, in magnitudes per square arcminute. To illustrate the range, globular cluster Omega Centauri (naked-eye) has SB 11.2, the globular cluster M22 about 11.7, galaxy NGC 253 (visible in binoculars) about 12, galaxy M49 (easily seen in a 6-inch telescope) about 13, and galaxy M74 (very diffuse in a 12-inch scope) about 14.1 mags/square arcmin.

For objects of similar visual magnitude, the smaller the apparent surface area of the object, the higher the SB.

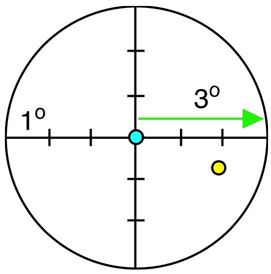
For example:
Many PN are smallish. Their visual magnitude is a pretty good idea of brightness. NGC 3242 (**Ghost of Jupiter**) in Hydra has magnitude 7.3 and diameter 25” (seconds of arc). It is quite bright as expected and can be picked out with binoculars.

But some are quite large. NGC 7293 (**Helix Nebula**) in Aquarius has magnitude 7.3 and size 20’ (minutes of arc). From the magnitude alone, you might assume it to be of similar brightness to the Ghost of Jupiter. However, the Helix Nebula is much larger visually and has a pretty low surface brightness of 13.8. It is quite diffuse in 12-inch Dob.

Use of Finderscopes



As a reference, the long axis of the Southern Cross from Acrux (α Crucis) to Gacrux (γ Crucis) is almost exactly 6 degrees.



For the star-hopper, the standard no-frills 8x50 finderscope has a field of view of around 5.7 degrees or approximately 6 degrees. The crosshairs divide the field into 4 quadrants, each of about 3 degrees radius.

With the finderscope view at right, the blue and the yellow stars depicted would be separated by about 2 degrees.

Using this type of finderscope, assuming reasonably dark skies, stars down to about 7th magnitude should be easy enough to pick out, stars of 8th magnitude are do-able but 9th magnitude stars are pushing it. Of course, other factors such as the altitude of the object, dew on lenses, cloud or haze will affect the sighting of any object.

Index for Planetary Nebulas

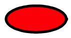
A lot of these planetary nebulas can be seen with a good 8-inch telescope under dark skies. Larger apertures will show more detail for smaller nebulae using higher magnification. This, of course, depends heavily on how good the seeing conditions are.

Symbols used for objects:

Planetary nebula 

Open Cluster or emission/reflection nebula 

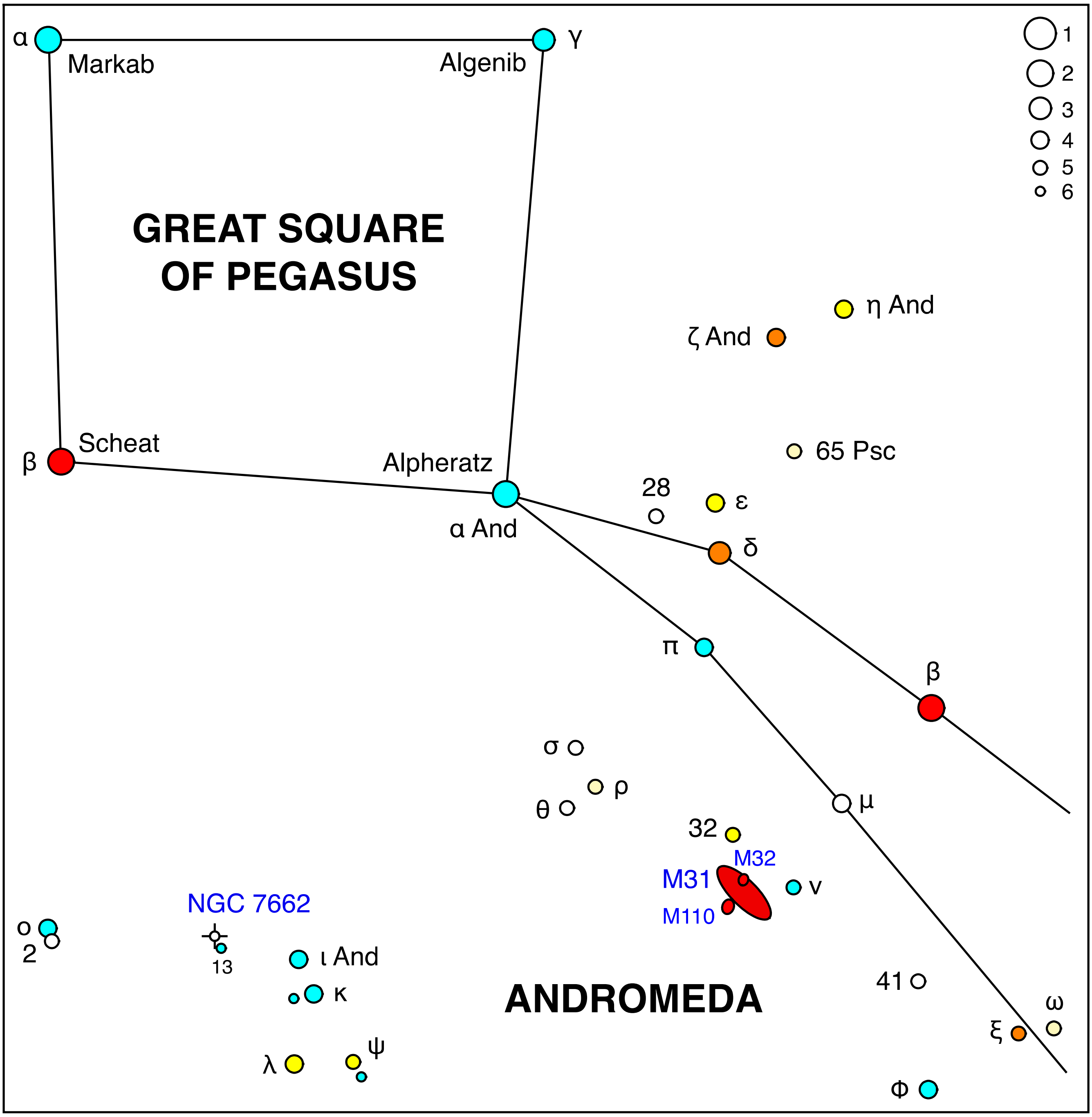
Globular cluster 

Galaxy 

The Greek Alphabet

alpha	α	nu	ν
beta	β	xi	ξ
gamma	γ	omicron	ο
delta	δ	pi	π
epsilon	ε	rho	ρ
zeta	ζ	sigma	σ
eta	η	tau	τ
theta	θ	upsilon	υ
iota	ι	phi	φ
kappa	κ	chi	χ
lambda	λ	psi	ψ
mu	μ	omega	ω

Blue Snowball (NGC 7662)



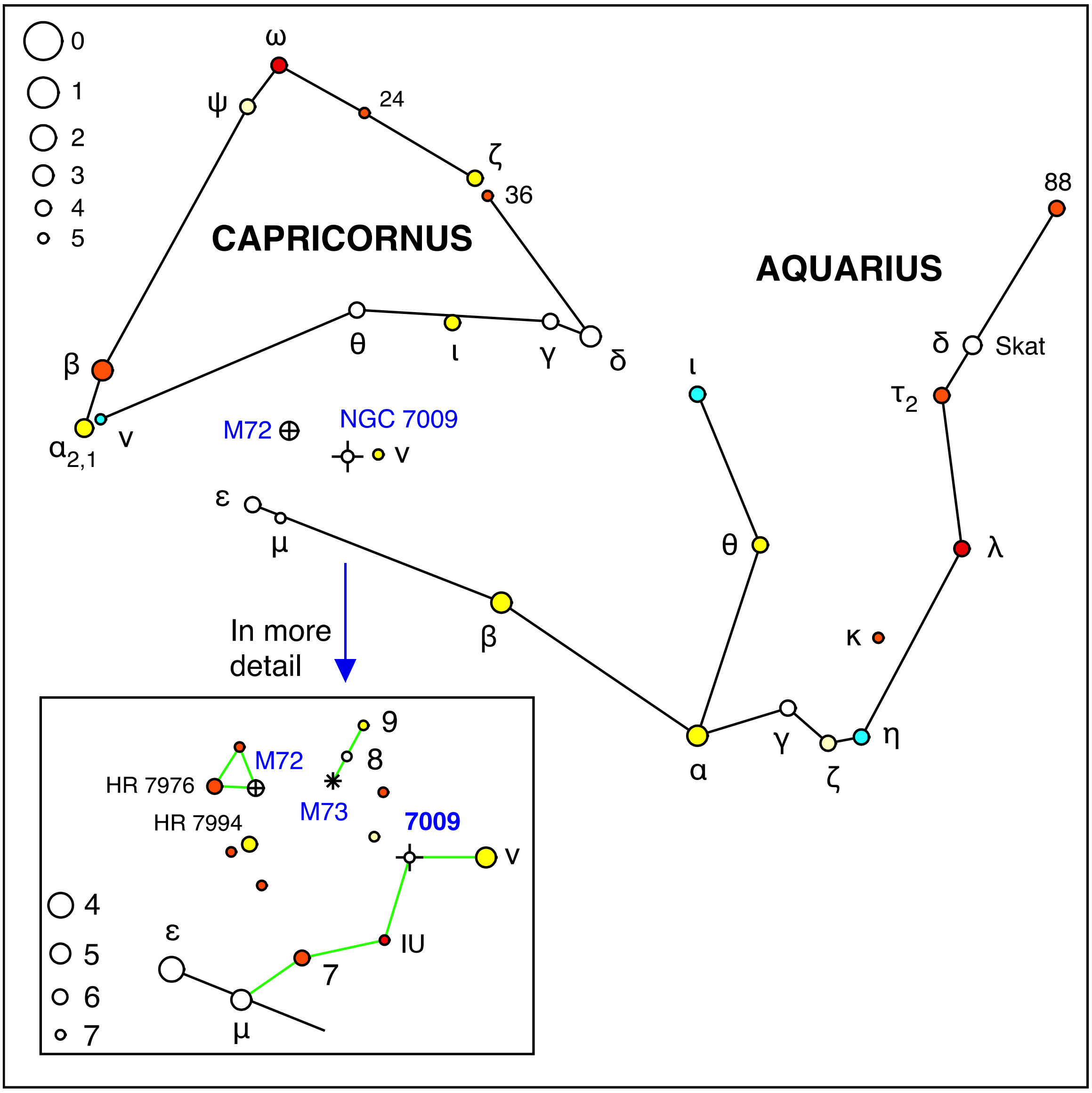
The **Blue Snowball (NGC 7662)** is a blue-green planetary nebula in Andromeda. The nebula has magnitude 8.4 and size 30".

Its distance is not well known. Estimates for distance are anywhere between 2,000 light years and 5,600 light years. The central bluish dwarf varies in magnitude between 12 and 16.

An 8-inch Dob will show its blue-green disk but the double-shell structure will be difficult to see even at culmination when it is just 14 degrees above horizon. It lies about 2.4 degrees from Iota (ι) Andromedae and 26' from the blue-white B9 star 13 Andromedae (magnitude 5.8).

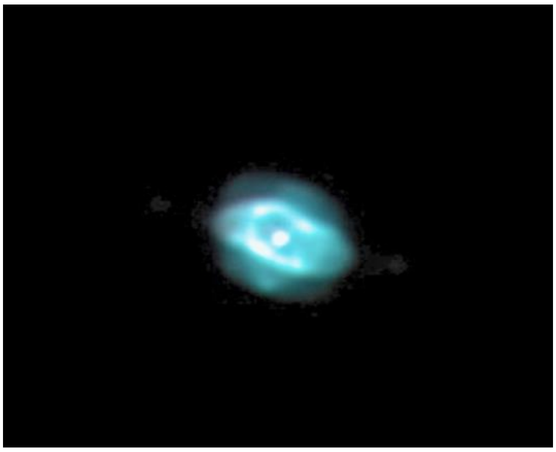
Blue Snowball – HST: NASA, ESA & A. Hajian

Saturn Nebula (NGC 7009)



The **Saturn Nebula (NGC 7009)** is a fairly bright blue-green planetary nebula about 1.3 degrees west of Nu (ν) Aquariii.

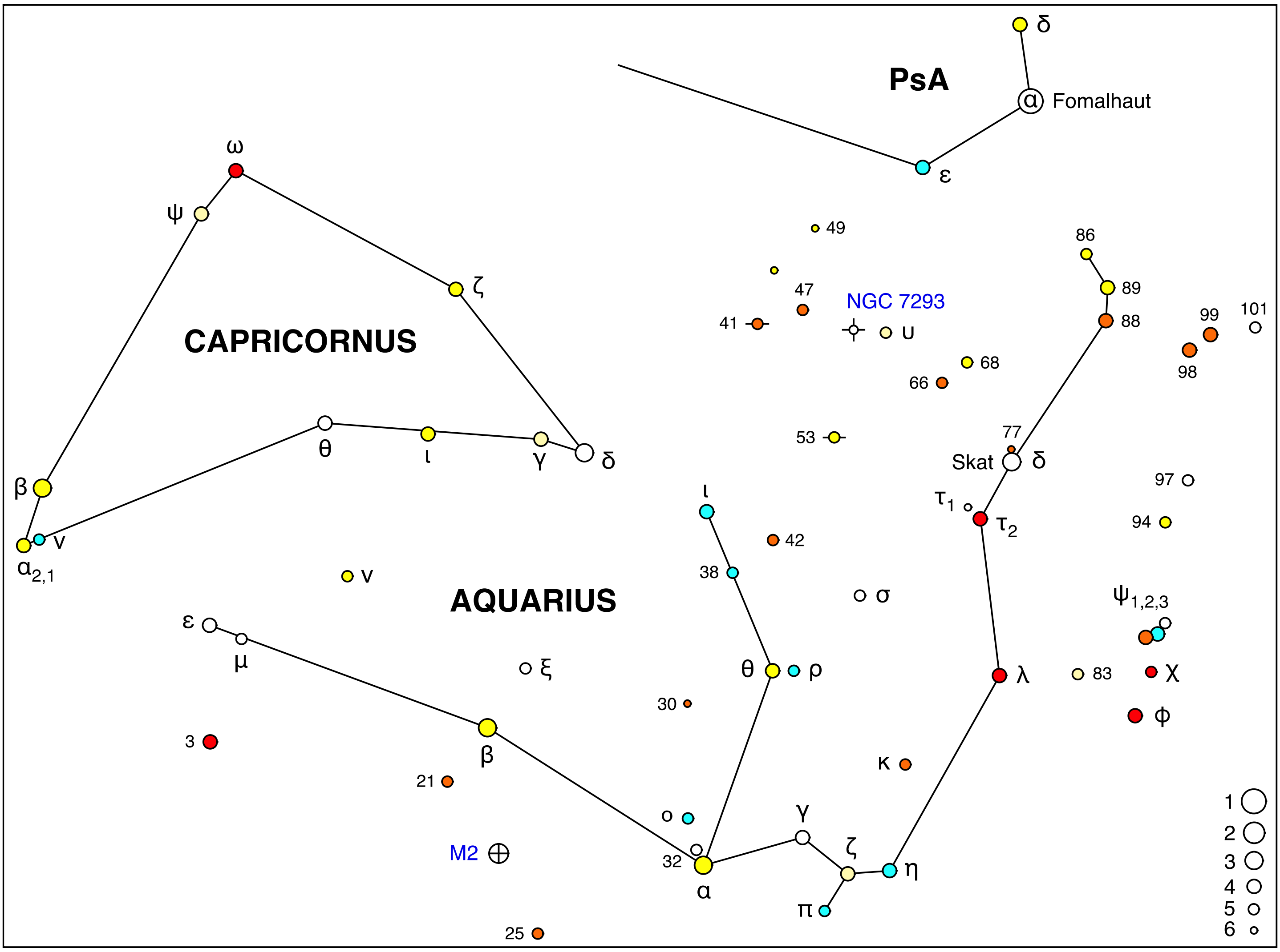
The nebula was discovered by William Herschel in 1782 but Lord Rosse (1850) gave it the name Saturn Nebula when he saw projections off the main disk. Aligning with the main axis, the projections end in ansae ("handles"), which are caused by jet like streams of gas. Distance is about 3,800 light years.



NGC 7009 has visual magnitude 7.8 and apparent size 30" x 25". Its physical size would be about 0.6 light years. The central remnant white dwarf is a relatively bright magnitude 11.5.

Visually, it shows a bright elongated inner shell surrounded by a fainter rounder envelope, together with extensions off the main body. Central star is hard to see. The ansae are just visible in this photo of the Saturn Nebula by David Lloyd-Jones.

Helix Nebula (NGC 7293)



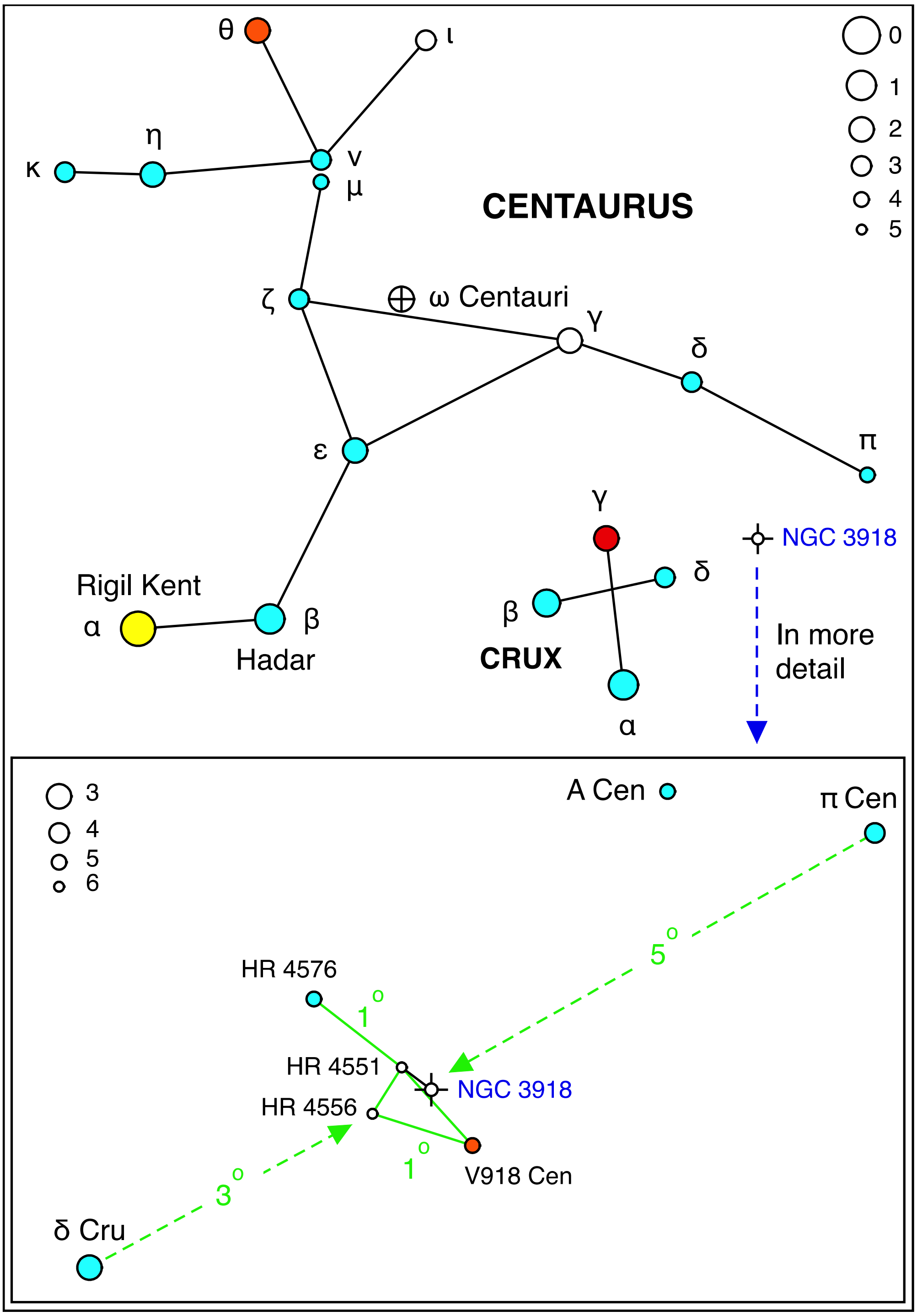
The **Helix Nebula (NGC 7293)** is a relatively large planetary nebula. Its name derives from its helical appearance (an illusion). It is also referred to as the "Eye of God". It is the closest known planetary nebulae at only 655 light years distance. With dimensions of 15' x 12', the nebula is be about 3 light years across. In comparison, the Ring Nebula (M57) in Lyra is about 1 light year across.

The Helix is thought to be a prolate spheroid (like a rugby football) with its axis roughly at 30 degrees to our line of sight. Concentration is denser around the equator. In photographs, it looks rather similar to the Ring Nebula with its darker central region and brighter outer shell. Visual magnitude is 7.6 but its light is spread over a large area, so it has a very low surface brightness.

In binoculars, it is seen as a large ghostly oval region. On low power in a telescope, it is a visually challenging object and its ring hard to detect. It is located about 1/3 of the way from Upsilon (υ) to 47 Aquarii.

Helix Nebula by Charles Yendle.

Blue Planetary (NGC 3918)

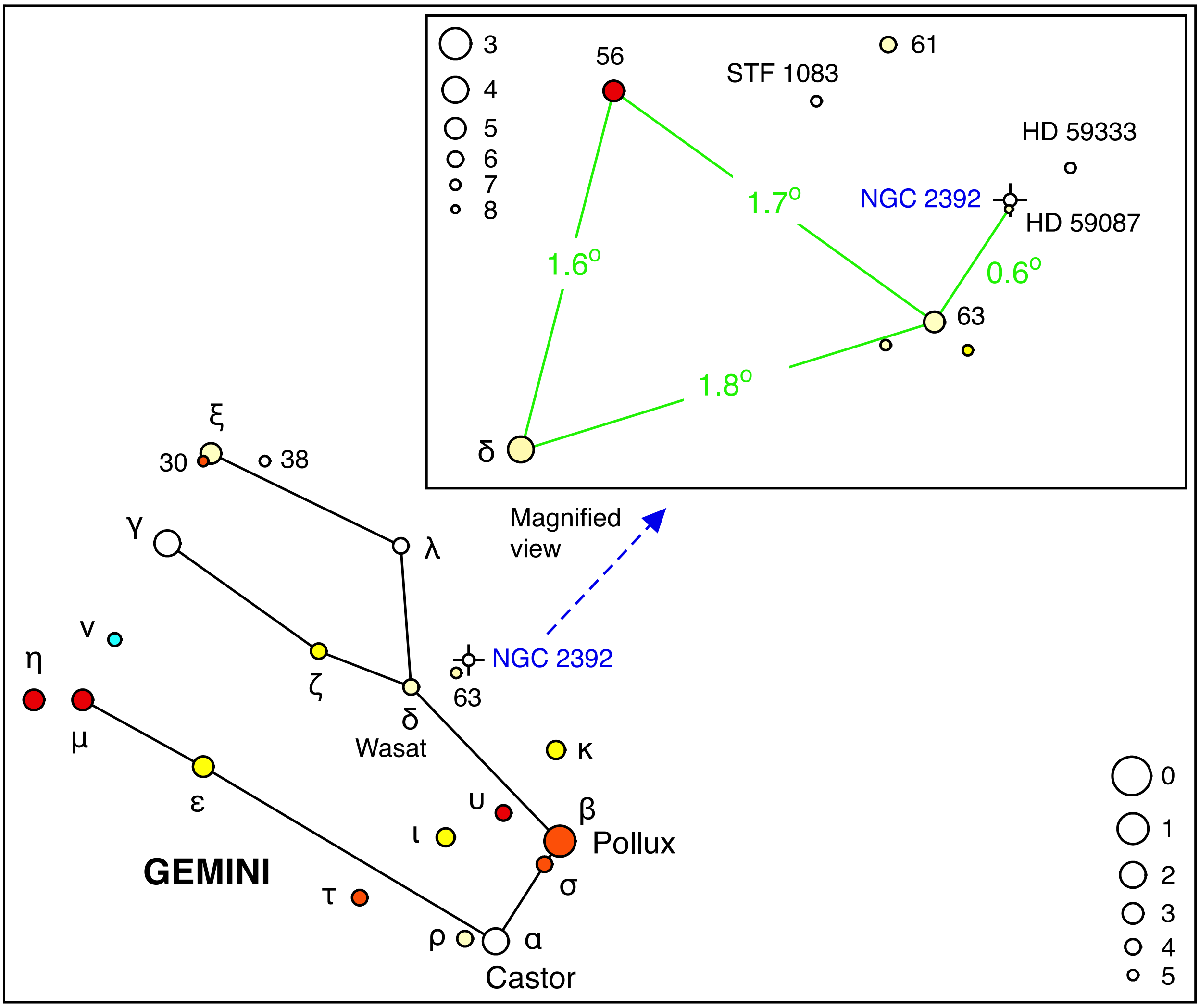


The **Blue Planetary (NGC 3918)** in Centaurus was discovered by John Herschel in 1834. Distinctly blue in colour, it is quite bright at mag 8.2. It is round and only about 15” in size. With a high surface brightness, I have seen no detail in this object. Distance uncertain.

It can be found on a line between Delta (δ) Crucis and Pi (π) Centauri about 3.6 degrees from the former and about 5 degrees from the latter. On the map, V918 Centauri and three other stars nearby help to locate it.

NGC 3918 image at right by David Lloyd-Jones.

Eskimo or Clown Face Nebula (NGC 2392)



NGC 2392 is a planetary nebula discovered by William Herschel in 1787. It is popularly known as the **Eskimo** or **Clown Face Nebula** as it resembles a person's head surrounded by a parka hood or a clown with curly hair.

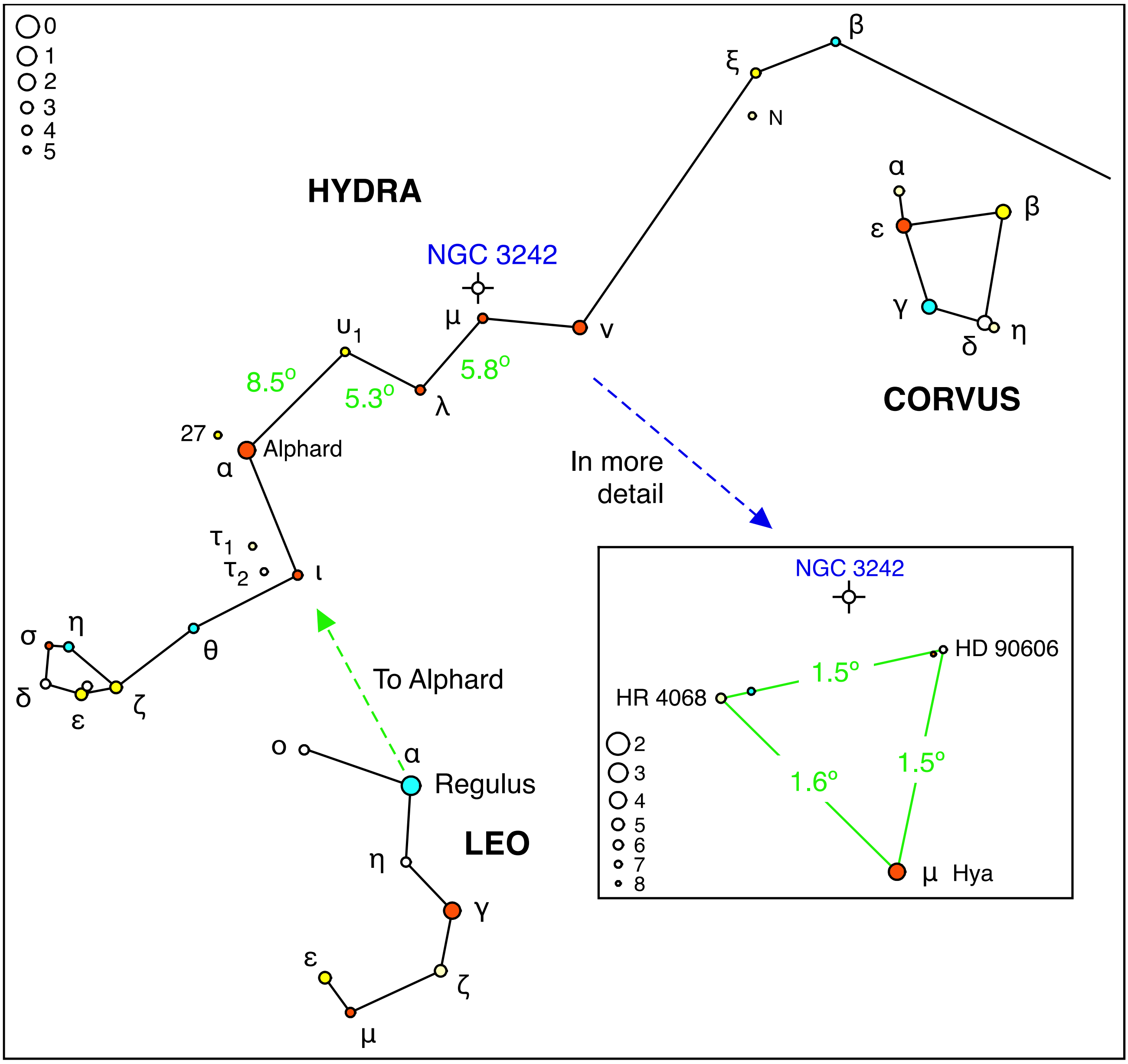
Its distance is about 6,500 light years. NGC 2392 has a double shell structure with a bright inner shell of gas, a dark central region, and a fainter detached outer halo. It is about 50 arcseconds in size with visual magnitude 9.2.

The central star has magnitude 10.5, one of the brighter ones for observers of planetary nebulae.

Less than 2 degrees from Wasat is the star 63 Gem (mag 5.2). NGC 2392 lies near an 8th mag star about 0.6 degrees from 63 Gem.

NGC 2392 image by David Lloyd-Jones.

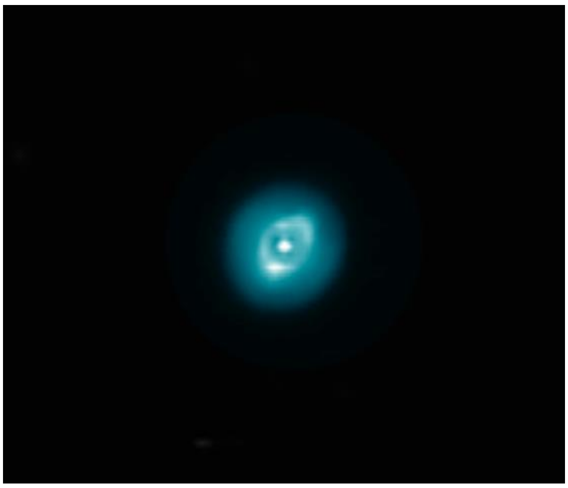
Ghost of Jupiter (NGC 3242) PN



The **Ghost of Jupiter (NGC 3242)** is a bright planetary nebula that can be seen with binoculars. William Herschel discovered it in 1785. Its distance is about 4,800 light years. It has a double shell structure with a bright inner shell surrounded by a fainter blue-green envelope about 40" x 35", which is about the size of Jupiter. Physical size is about 1 light year.

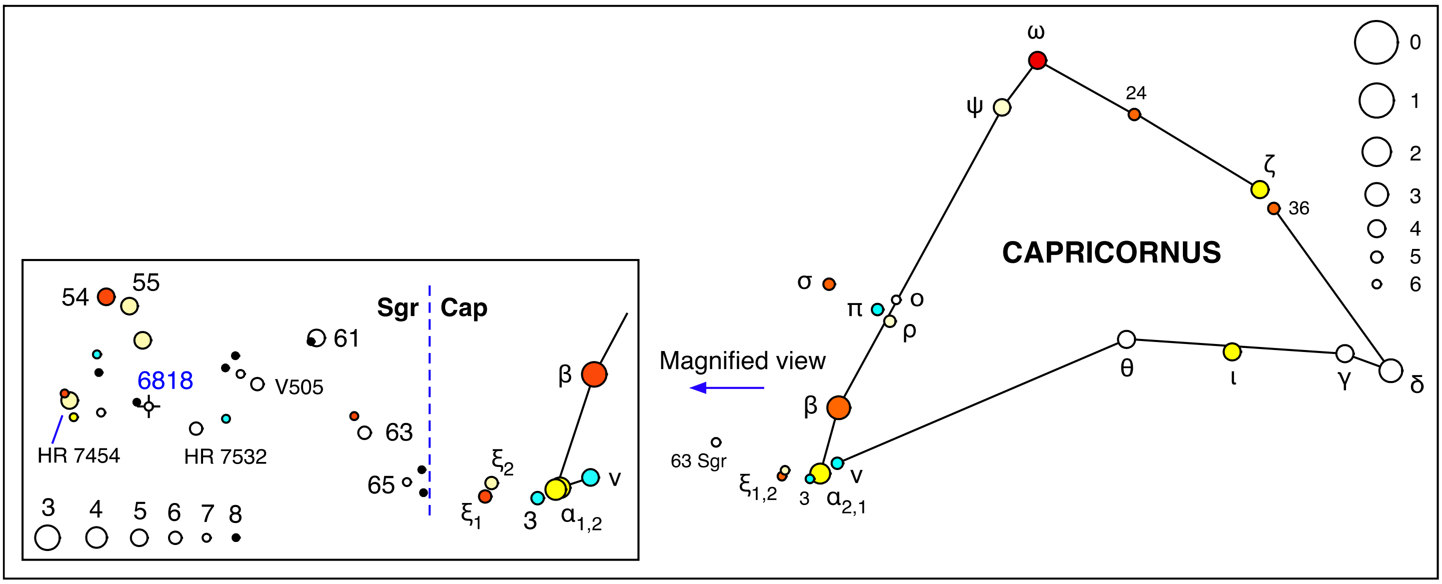
NGC 3242 has visual magnitude of 7.3 and its central white dwarf star is magnitude 12.1.

It lies about 1.8 degrees south (i.e. upwards) of Mu (μ) Hydrae. The wide pairs, one with HR 4068 (12.5' apart) and one with HD 90606 (4.5' apart) can be used to help locate the planetary.



NGC 3242 image by David Lloyd-Jones.

Little Gem Planetary Nebula (NGC 6818)



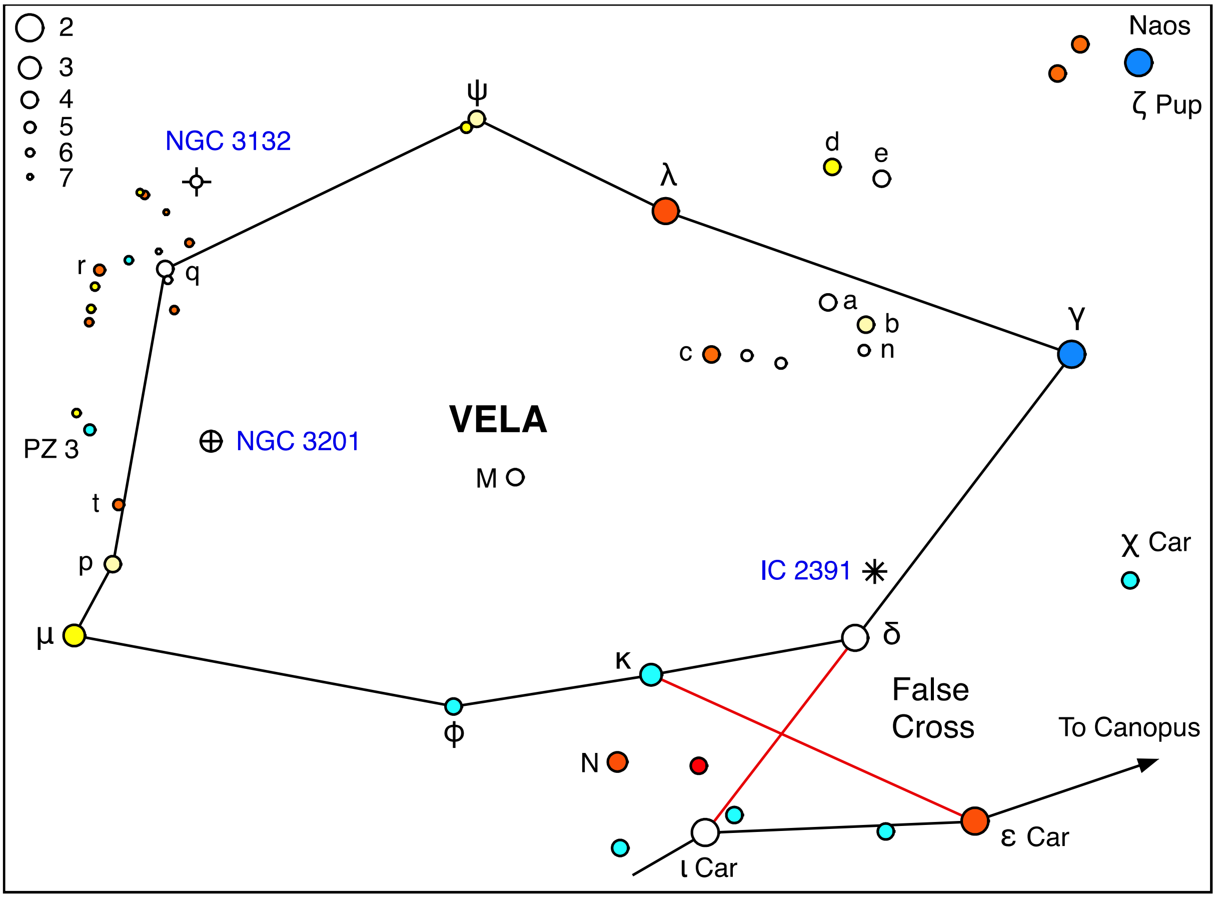
The **Little Gem Nebula (NGC 6818)** was discovered by William Herschel in 1787. It has a distinctly blue-green appearance. Visual magnitude is 9.4 and apparent size about 20" x 15". Distance is uncertain. NGC 6818 has a 15th magnitude central white dwarf.

NGC 6818 is similar to the Blue Planetary (NGC 3918) in Centaurus. It is visually small and somewhat oval with a high surface brightness. Like the Blue Planetary, it is hard to see any structure at all.

Although in Sagittarius, it is probably easier to find from the constellation Capricornus. Start from the line of four stars 3 Capricorni, alpha (α) 1,2 and nu (ν) Capricorni, then use the map to star hop to the nebula.

Little Gem image by David Lloyd-Jones.

Eight Burst Nebula (NGC 3132)



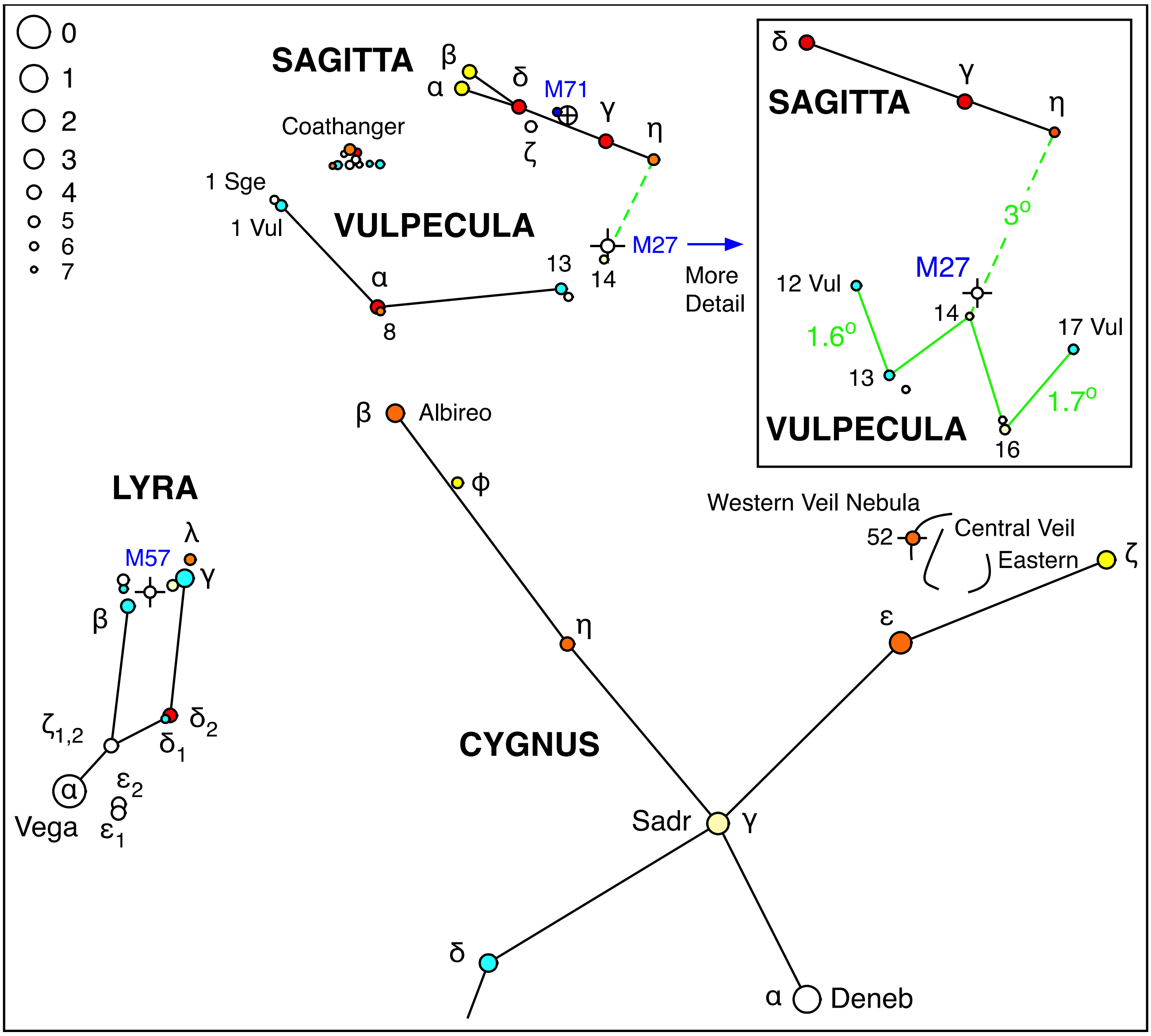
NGC 3132 (Eight Burst Nebula) is a planetary nebula of about 50 arcseconds in size. Its distance is about 2,800 light years. Given that info, its actual physical size would be about 0.7 light years across.

Seen at centre is a magnitude 10 star that is likely a foreground object. The remnant white dwarf is a 16th magnitude star just 1.6" from it, too close and faint to be picked up by amateur scopes. NGC 3132 is magnitude 9.7.

The nebula is often described as being bright but I don't find this to be so and certainly not when compared to say NGC 3242 or NGC 7009.
The outer shell has many darker areas around its perimeter. In my 12-inch Dob with no filter, a haze can be seen around the "central" star and the shell structure is occasionally visible at higher power. For a truly spectacular view of NGC 3132 get a look at it in the Evans 30" Telescope.

Eight Burst Nebula by David Lloyd-Jones

Dumbbell Nebula (M27) & Ring Nebula (M57) PN



The **Ring Nebula (M57)** has visual magnitude 8.8 and size 84” x 65”. At a distance of about 2,600 light years, it would be about 1 light year across. The nebula has the visual appearance of a smoke ring but it is actually a prolate spheroid (like an AFL or NRL football) with its axis at about 30 degrees to our line of sight. The ring appearance is due to strong concentrations of gas around the equator.

Its physical size would be about 1 light year.

The central white dwarf is a faint visual magnitude of 15.8.

M57 is conveniently located close to the line joining Beta (β) and Gamma (γ) Lyrae – about 48’ from Beta and 71’ from Gamma or 2/5th of the way between the two stars.

Image (right) of M57 by David Lloyd-Jones.

The **Dumbbell Nebula (M27)** was found by Messier in 1764. It was the first planetary nebula discovered but he would not have known that at the time. Its distance is about 1,200 light years. Visual magnitude 7.1. The nebula has a fairly large apparent size of about 8' x 6'. This is in part due to its relatively close distance but it is actually quite physically large at nearly 3 light years in size. M27's central star has magnitude 13.5.

Our view of M27 is approximately at right-angles to its major axis. Viewed from its poles, it would appear ring-shaped like M57. It can be faintly picked up with binoculars in a darker sky and looks like a dumbbell or apple core in a telescope. Visually it looks white – no colour as shown in the photograph. Although in Vulpecula, the Dumbbell Nebula is more easily found from the constellation Sagitta – lying about 3 degrees from Eta (η) Sge and near a "W" asterism of magnitude 4.6-5.7 stars. It is only about 24' from 14 Vulpeculae.

Above image of the Dumbbell Nebula taken at Linden
by Charles Yendle.