Stargazey Pie!

A slice of Highlands astronomical life!

Tues 6th January 2015

HAS Meeting Notices December 2014

1. **Current News and Dates for your Diary**

- Evening sessions at the observatory are under way: Forthcoming sessions are:
  Friday 16th January (Public)
  Saturday 17th January (Members)
  Friday 23rd January (Public)
  Saturday 24th January (Public) in association with the Outreach Day at Eastgate

  Wrap up warm and always check the website (www.spacegazer..com) to check whether the session is running. Clear skies!

- **January Outreach Day at the Eastgate Centre, Inverness** – we will be holding our annual outreach day at the Eastgate Centre on 24th January.This will be followed by a public viewing at the Observatory – we will need volunteers to help with both – if you are able to assist for an hour or two at the Eastgate or Observatory please let Pat Escott know. Many thanks.

- **The next meeting is on Tuesday 3rd February 2015** - this will be: “Astro Question Time” - a rare opportunity to find out the answers to anything astronomical you always wanted to know but were afraid to ask. Our panel of expert committee members will be ready and waiting!

- **Astrofest 2015** – “The world's premier space conference and exhibition” will be held over 6 and 7 February in London: www.europeanastrofest.com

- **Talk in Fort William 24 February, 7pm - “From Ben Nevis to the Edge of the Universe”** The William Cameron Memorial Lecture will be held at Caol School Gym Hall – talk by Professor John C Brown, 10th Astronomer Royal for Scotland, suitable for all ages, Tickets £5 (16 and under £3), on the door, or if you want to book in advance, let a committee member know and we will make inquiries as to how to do this.

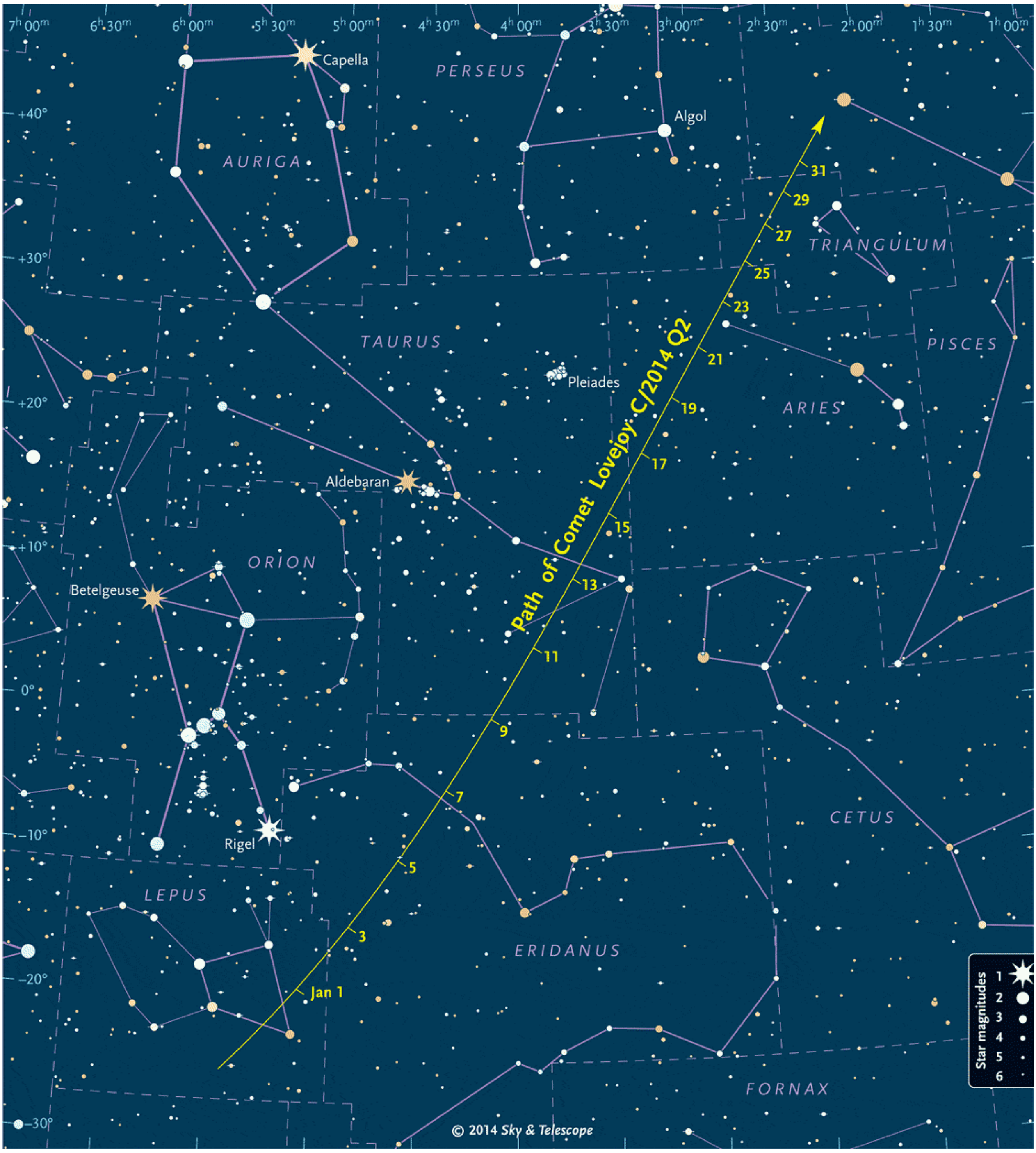
- **Replacement of telescope mount –** installation of the new mount for the large telescope at the observatory has not been straight forward but is now just about there. Paul provides an update after the summary of Maarten’s talk – see below.

- **Suggestion Box** – at reception. Don't forget to let us know if you have any ideas you would like the committee to look at – this is your Society, please help the committee to provide what you are looking for. Or of course speak to a committee member.

- **Aurorae and Telephone alerts** – should you see an aurora, noctilucent clouds, or anything else of astronomical interest, please alert Paul or Pauline. It is never too late at night to let us know. PLEASE NOTE, the wording of the telephone alert is a little strange. If you receive a telephone call with a disembodied voice beginning, “This call will not cost you anything...” - please don't hang up, it is your aurora alert! Alerts can also be sent by text to your mobile – if you would prefer this option please check with Ronnie that we have you signed up for this.

- **On-line Payments to HAS –** it will very soon be possible to make payments (e.g. membership) to HAS on-line. We will keep you posted as to progress.

- **Look out for:** 1) Jupiter will be in opposition on 6 February - i.e. the Earth will be between the sun and Jupiter. Look east at nightfall, overhead at midnight, or to the west before dawn. It will shine from the constellation of Cancer, but the nearest bright star is Regulus in Leo. It will be the nearest Jupiter comes to earth until 2019.
  2) on the morning of the 24th Jan between 0628-0653, three of Jupiter's moons will cross its disc...this is very rare and will be a wonderful thing to see, weather permitting (telescope needed)
  3) a comet moving past Orion, Taurus and Perseus.



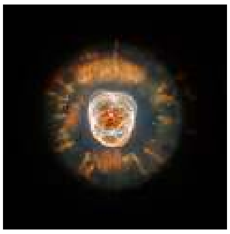
Main Event: Planetary Nebulae by Maarten de Vries

Maarten has had an interest in astronomy from an early age as he used to pass a telescope shop on his way to kindergarten. Observations were initially made with the naked eye but he began using optical aid once he moved to the Highlands of Scotland. He has been a member with HAS since 1998, being part of the Committee, setting up our website, being a major player in the Observatory and has even had a brief stint as Chairman when he stood in for Eric Walker. His main interest is deep space especially using video cameras to image deep space objects.

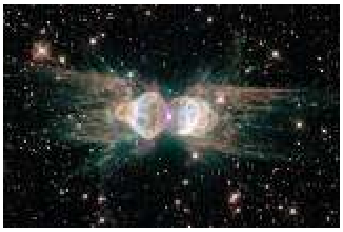
In his research for this talk, Maarten found that there is very little information about planetary nebulae, in fact, there isn't even a definition. Two books have proved quite useful: "Planetary Nebulae, how to observe them", (which is exactly what the book is about) and the second book is from Cambridge Astrophysics series, "The Origin and Evolution of Planetary Nebulae" by *Sun Kwok* whose book consists of maths from page 30 and doesn't stop until the very end!

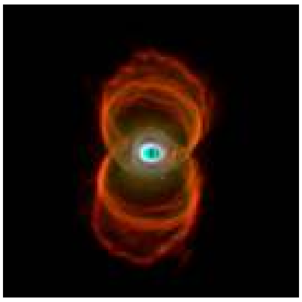
Planetary nebulae are not easy to observe and are not considered as important as some other deep sky objects, which is a shame, since they are, perhaps, the most beautiful phenomena in the universe. To prove his point, Maarten showed us a number of photographs demonstrating their amazing shapes, colours and intricate structures.


M27, Dumbbell Nebula is the nearest


Eskimo Nebula


Cat's Eye Nebula


Ant Nebula


The Hourglass Nebula


...and Maarten couldn't help showing off his latest interest, Seoras.

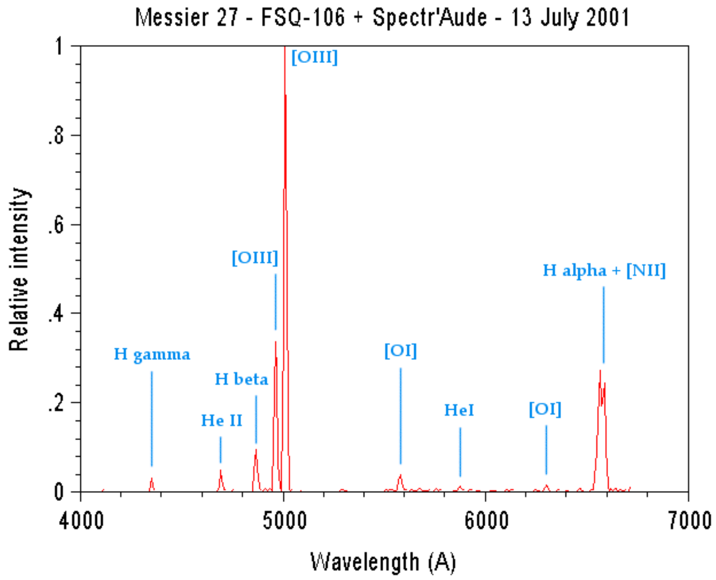
Maarten took pictures of M27 and M57, through his telescope using his video setup. These are black and white images, and are what you would expect to see through a telescope – no colour filters.

Messier recorded 4 planetary nebulae; M27 being the first but he had no idea what they were as he couldn't see the central star.

Then in 1791, Herschel found a nebula with a star in the centre, NGC1517, and wondered if planetary nebulae were associated with a central star and not unresolved star clusters as had been originally thought.

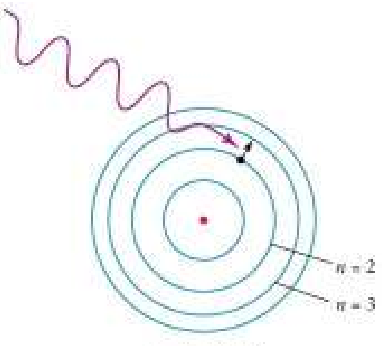
He also coined term planetary nebula because some have a disc-like shape, just like a planet, and a colour similar to Uranus, which he discovered.

However, planetary nebulae have nothing to do with planets.



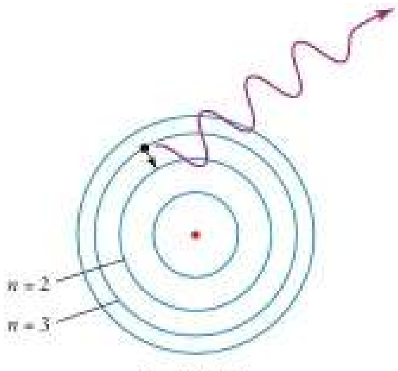
William Huggins was the first to produce a spectrum of a planetary nebula. It gives off very little light but shows a number of peaks. These peaks correspond to 'forbidden lines' (depicted in square brackets), so called because we do not have them on Earth (gases cannot be rarefied sufficiently on Earth because we cannot get a good enough vacuum). Forbidden lines can only occur in very low-density gas environments.

The largest peak here (graph on the left) is due to oxygen, which has a wavelength of about 5000 A. This gives a green light to which our eye is most sensitive at night hence why many planetary nebulae look green.

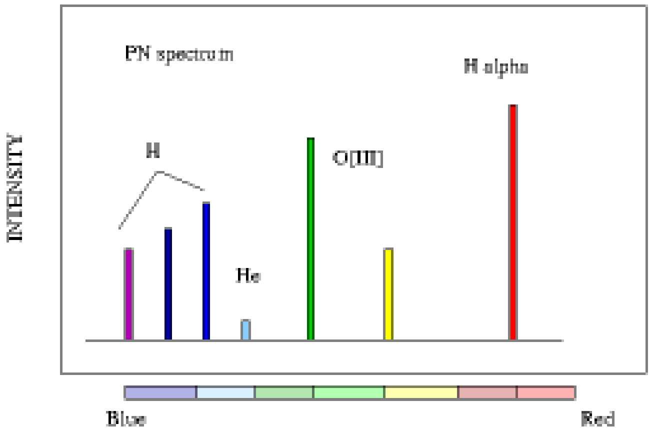


a Absorption

In an atom, protons are surrounded by electrons in 'energy levels'. If the right amount of energy is absorbed by the atom, the electron can move up an energy level (even leave the atom altogether) and if it drops down an energy level, it will emit a photon of that energy.



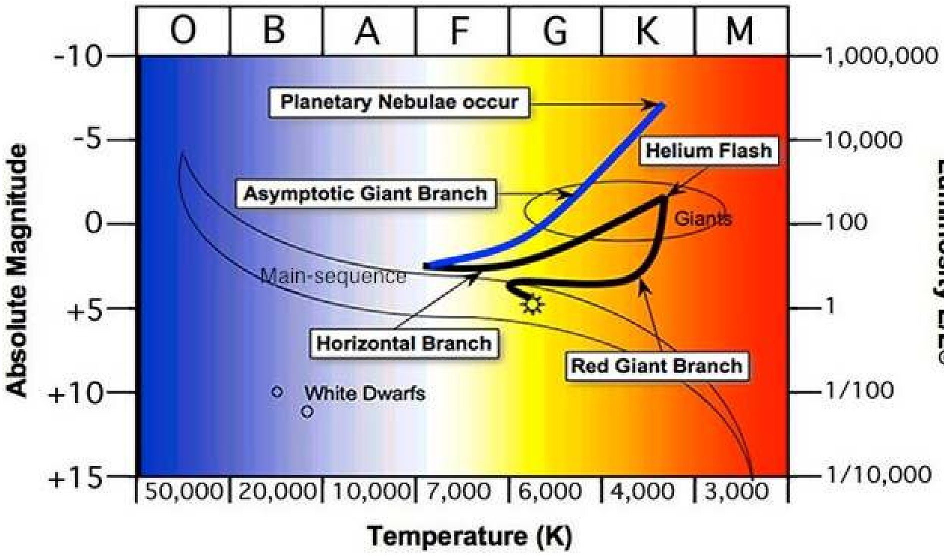
b Emission



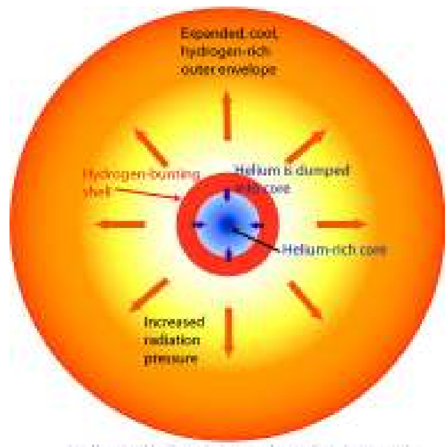
In a planetary nebula, where the density of gas is very low, and collisions between atoms are unlikely, exited electrons can spontaneously drop down an energy level emitting a specific wavelength of light which, in turn, tells us which atoms are present in the nebula. For example emitting a wavelength of light at around 5000 A produces green light and is due to oxygen III [OIII], which results in a forbidden line. Specific colours of light are due to the precise quantities of energy released. It is the forbidden lines that give the planetary nebulae the particular colours that we see.

If we look at the continuous spectrum of a planetary nebula it shows an increase in the emission of ultraviolet and infrared radiation. The ultraviolet peak is due to the very hot central star remnant and the infrared peak is due to the warm dust within the nebula. Most of the ultraviolet light is absorbed by hydrogen and helium within the nebula and as a result, these gases become ionised; the electrons freed from hydrogen and helium atoms excite oxygen or other gases and when they release energy they produce the forbidden lines. Dust can absorb some of the energy so it glows in the infrared. Energy taken from fast moving electrons or bent electrons produces the middle part of the planetary nebula's continuous spectrum. As we cannot reproduce the same conditions on Earth, the environment of a planetary nebula is considered an ideal laboratory to study the interactions between radiation and matter.

A planetary nebula is produced when a star that is 0.5 to 8 solar masses runs out of its hydrogen fuel and dies. Anything bigger explodes as a supernova. These low to intermediate mass stars undertake a period of stellar evolution where they end up on the asymptotic giant branch (AGB) of the Herzsprung-Russell diagram (below).

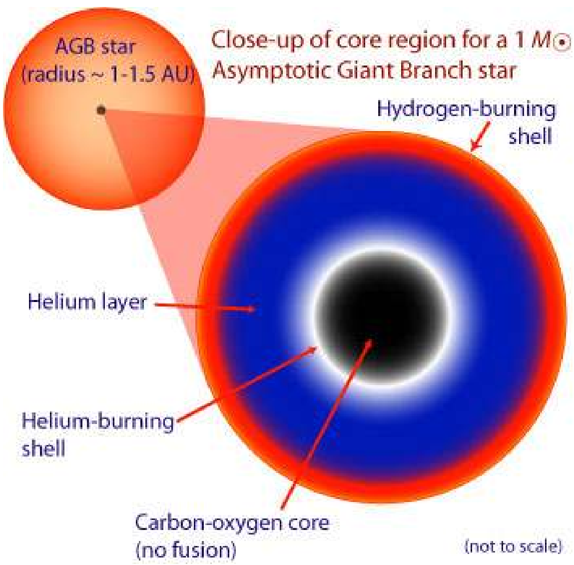


During its lifetime, a star will fuse hydrogen to helium in its core. This creates an outward pressure to balance gravity. However, when hydrogen in the core is used up (core is now converted to helium), nuclear fusion reactions stop and the star begins to contract under gravity. The temperature increases and a shell of hydrogen around the core begins to fuse to form helium and the outer layers of the star expand and cool to form a red giant star (below).

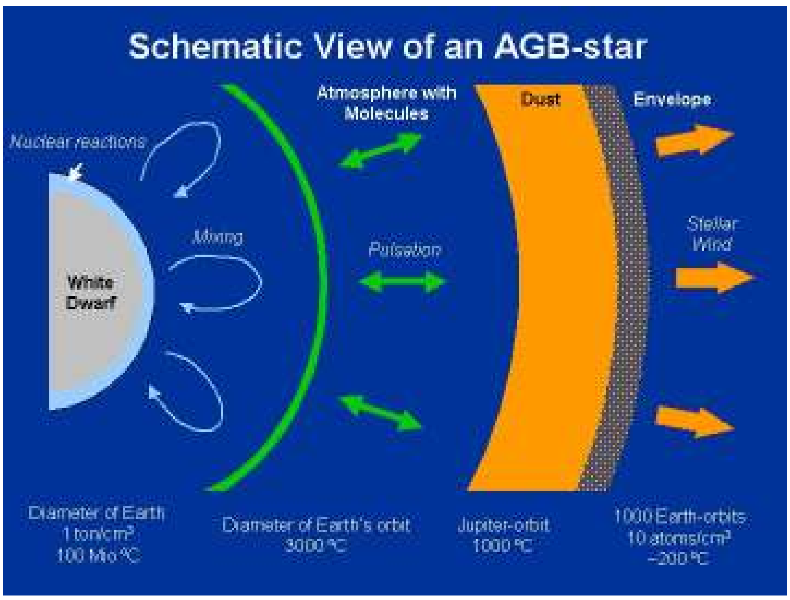


Hydrogen Shell Burning on the Red Giant Branch

The helium core continues to heat up and suddenly, for those stars up to 2.25 solar masses, the helium in the core is ignited in a flash known as the helium flash. Stars between 2.25 to 8 solar masses will also burn helium but not as a flash. Helium is now being converted to carbon and oxygen and the star shrinks a little.

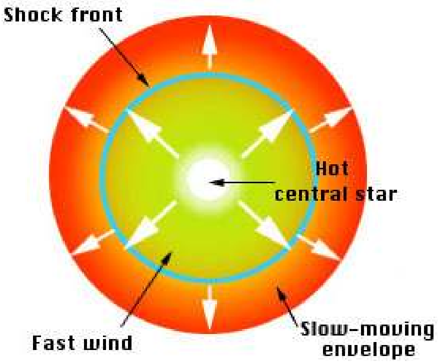


In early AGB stars, a shell of helium fusion begins around the inert carbon and oxygen core. Then when the helium runs out the core contracts, the inner layers heat up and hydrogen burning occurs in a shell around the core. Over time, this is eventually converted to helium, which can ignite explosively in a process known as a helium shell flash that causes the outer layers of the star to expand further and it becomes an even larger red giant star. The star also becomes disrupted due to convection currents dredging up the carbon and oxygen, which were in the core, to the outside, and other atoms such as nitrogen and neon can be made.

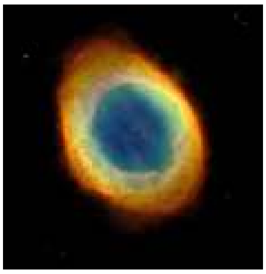


A helium shell flash can happen every 10,000 to 100,000 years so can occur three to ten times. The increase in luminosity may last several hundred years and is known as a thermal pulse. This is in addition to the more frequent pulsation that occurs in this type of star that makes it known as a long-term variable star.

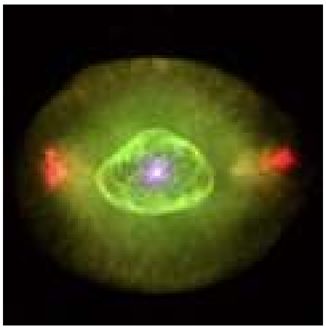
The pulsations as well as a strong stellar wind produced by the star during this phase means a lot of mass is flung away from the star. This produces a shell of gas several light years across.



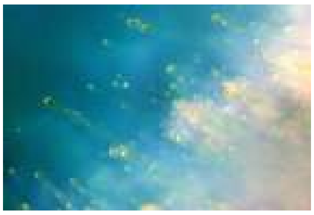
Once the star has puffed off the rest of its envelope, what is left is a very hot remnant star with an even faster stellar wind, which catches up with the first gas envelope thrown out by the earlier and slower stellar wind (see left). This can produce shells or bubbles of gas surrounding the central star like those around M57 (see right). The central star produces a huge amount of ultraviolet radiation, which ionises and excites the gases, and this makes them glow; the colours depend on the gas.



Planetary nebulae can be about one light year in diameter – this is a quarter of the way to Alpha Centauri so they are huge. They may last only a few tens of thousands of years hence the reason why we don't see very many even though stars are plentiful. Over time they will expand and disperse until eventually they are too far from the central star for it to have any effect and at this point we can no longer see the planetary nebula. The central star becomes a white dwarf rich in carbon and oxygen. Our Sun will become a planetary nebula but not for another five billion years or so.



No one is really certain how they get their shapes. It may be due to their magnetic fields, any companion stars, the distribution of stellar envelopes or, perhaps the most likely, an imbalance in the densities on the surface of the AGB star: a slight imbalance will become magnified during the shedding process. Although simple density changes explains most structures it doesn't explain some of the very intricate structures and 'flyers' (the coloured bits at the edges of planetary nebulae – see left) or cometary knots (see right).



<u>How to observe planetary nebulae</u>

Required:

Dark sky
Good seeing
Med and high power telescope
Plenty of aperture
Wide-angle eyepiece to find it initially
[O111] filter 500nm to increase contrast
Ideally a Go-To telescope as they are very faint and small and are difficult to find accurately
Our observatory with its 14" telescope and good pointing accuracy
Video camera useful
Lots of practice

Maarten concluded by telling us about the planetary nebula challenge he has developed for both beginners and the more advanced observer. Ask the Committee if you wish a copy.

Thank you Maarten for an excellent talk giving us a detailed insight into the beautiful and spectacular planetary nebulae.

After Maarten's talk, Paul explained how setting up the new EQ8 mount in the dome had been achieved quite accurately, but there had been a problem. "The mount made a nasty noise as it rotated in the declination axis. We knew that during its transportation to us the foam-filled carriage box had been dropped by the carrier so hard that the heavy mount compressed the foam and part of the mount punched through the bottom of the box. The implication was that the mount had been damaged, perhaps the sensors.

After a certain amount of 'discussion' with the suppliers and the manufacturers, it was agreed that we would be supplied with a replacement mount. This has arrived and has been mounted, and runs as sweet as a nut. Spiffing! Of course we now have to polar align this new one, so all we need is a starry night . . ."

Next month, we will have a panel to try to answer all those questions that have kept you awake at night... Afterwards, there will be the usual tea, coffee and biscuits while you mull over and discuss the answers with fellow members.

Clear skies!

Pauline Macrae