TRANSIT

The Newsletter of

Cleveland & Darlington Astronomical Society

05 July 2009

Not really astronomical in nature but a fantastic image of an erupting volcano taken from the ISS

Front Page Image – SARYCHEV PEAK VOLCANO from the ISS : Perfect timing. On June 12th, just as Russia's Sarychev Peak volcano was erupting for the first time in 20 years, the International Space Station flew directly overhead. Astronauts had their camera ready and snapped one of the most dramatic Earth-science photos ever taken from space:

Visit our new CaDAS website: http://www.cadas-astro.org.uk.

Next meeting : September 11, 2009, subject to be advised.

Please note the venue for the next meeting :-

7.15pm for a 7.30 pm start, Wynyard Woodland Park Planetarium

Last meeting : 12 June 2009, CaDAS Annual Presidential Presentation – "Meteors and Meteor Astronomy" by Jack Youdale F.R.A.S.

The CaDAS President gave his usual high standard of presentation to the Society. The subject of meteors and meteor astronomy were not only covered thoroughly but showed how deeply involved Jack had become involved, with his friend David Sinden, in the practical observation and recording of meteors and fireballs. This was in the days before the availability of digital technology when every piece of Jack's observing equipment was hand built and old-fashioned photography was the name of the game. Time and patience were of the essence and frustratingly not every observing session produced results.

Jack gave everyone in his audience the challenge to go out there and take his own efforts a step or two further using whatever technology is now available. The most important factor in observing and recording meteors, as well as in any other aspects of astronomy, is following the scientific method – absolutely accurate information wherever possible and then pass the results onto bodies such as the BAA where your findings can be collated and disseminated to others sharing the same interest.

For those astronomers not so scientifically minded Jack highlighted with his undeniable enthusiasm the sheer pleasure of just being out at night and observing meteors, whether they are seen in vast numbers during the occasional meteor storms, the regular meteor showers or just spotting a sporadic meteor during a regular observing session.

It was a great pleasure to all of us to have Jack's family attend the talk and to see him receive an award from the Society for his 30 years as President and to celebrate the delivery of his 30th Presidential Address. An excellent buffet followed the award presentation.

Wanted – urgently

A new Editor for the Transit magazine, no previous experience required, please contact Bob Mullen b2mullen@hotmail.com if interested.

Letters to the Editor -

From the CaDAS Committee

Advice to Members on the Use of Laser Pointers for Astronomical Purposes

There has been a developing interest in the use of laser pointers in astronomy for both educational purposes, to indicate the position of objects or constellations in the night sky to others. In addition there has been commercial promotion of the same lasers as finder devices attached to telescopes. The principal attraction is that the green beams look so cool.

The Health Protection Agency (HPA) gives the following advice:

"The HPA considers the professional use of a Class 1 or Class 2 laser pointer as a training aid in the workplace to be justified, and regards these Classes of laser product as being generally adequate for such use. The use of Class 3R laser pointers up to 5 mW may be justified for some applications in the workplace where the user has received adequate training.

The HPA advises that the sale of laser products to the general public for use as laser pointers should be restricted to Class 1 or Class 2 devices which should be classified in accordance with the requirements of the current British Standard and should be sold with sufficient accompanying information to enable the user to operate the product in a safe manner. Toys should be Class 1 or of such low output that they do not need to be classified.

After seeking advice from NRPB (now the Radiation Protection Division of the HPA) the then Department of Trade and Industry urged Trading Standards Authorities to use their existing powers under the General Product Safety Regulations 2005 [4] *to remove laser pointers of a Class higher than Class 2 (as defined in the British Standard) from the general market. Such devices are too powerful for general use as laser pointers and present an unacceptable risk in the hands of the consumer because they may cause eye injury in normal reasonably foreseeable use."*

Note that Class 2 have an output of 1mW or less and therefore virtually all green laser pointers offered commercially are of Class 3R or higher. Class 2 are unlikely to be useful as pointers in the night sky.

Cleveland and Darlington Astronomical Society Committee is therefore extremely concerned at the safety and personal legal liabilities issues facing the Society's members if they purchase and use such devices.

Basically there are two risks

The first is that according to the detailed HPA guidance, any laser >5mW is potentially powerful enough for there to be a risk of eye damage.

The second hazard is that someone, either a well-meaning member of the general public or perhaps the police take the unconsidered view that the use of lasers is a public danger and acts accordingly. The recent imprisonment of two persons using lasers (in an undoubtedly malicious manner) near Teesside Airport should be considered a warning that things could get pretty uncomfortable for our members all too easily.

Most of you are aware that green laser pointers are routinely used at the Planetarium as an aid at Public Observing sessions. However, you may not know that their use at the Planetarium is strictly controlled by Director with the aid of a laser policy regulated by Stockton Borough Council Health & Safety, where approved laser users only may use them outside the planetarium, having signed the appropriate responsibility forms and read the Risk Assessment & good practise guidelines. This policy takes into account the guidance mentioned above from the HPA.

The committee strongly recommends to all the Society's members not to use laser pointers outdoors for any purpose

Note: The other common use of lasers in astronomy is in collimating devices for reflecting telescopes. These devices should cause no concern but the committee does recommend that members check that the power output of any such device they use is below 5 mW.

Dear Editor

I recently attended an informal meeting, hosted by Sunderland AS (Chairman Graham Darke) and attended by 8 local Astronomical Societies, to explore if there would be any merit in some sort of co-operation between local AS's. The meeting took the form of a presentation by each representative, describing their own Society. The 8 societies involved were Sunderland, South Shields, Northumberland, Keilder Observatory, Newcastle, LUNA (based in Newcastle),

Durham and CaDAS, with about 30 people at the meeting.

After a poor reception 10 or 15 years ago for the general idea of a local group, this time the approach is softly, softly, to tease out ideas and level of interest first. One popular proposal was to draw up a forum or data-base of local speakers, who would be prepared to give lectures to the North East Societies. If anyone is interested in giving lectures locally, would you please contact me with the type and length of talk you are prepared to give? I will then pass the information on to Graham Darke. I will be joining the forum, offering presentations I have prepared for our own Member's Nights.

If members have any comments, suggestions or ideas, which can be discussed the next time the group meets, please let me know.

Yours sincerely,
Alex Menarry
General Secretary
12/6/2009

Skylights – July 2009

from Rob Peeling

The Sun

We won't be able to see anything from Teesside of the solar eclipse on 22nd July. However some of the Society's members are travelling to see the event. I hope they will proudly show us some of their photos at the September meeting. Good luck and clear skies!

The Sun remains virtually spot free. Have a look for some other effects while we wait for greater solar activity. Look for the limb darkening effect. The edge of the Sun should appear slightly less bright than the centre of the disk. This is because our line of sight penetrates deeper into cooler portions of the photosphere at the edges and is one of the lines of evidence that the Sun is gaseous not solid.

Confusingly, radio astronomers report limb *brightening* of the Sun. The reason for the effect is much the same but the cooler atmosphere emits more in the radio band than the lower hot parts of the photosphere – hence the brightening.

Also examine the solar disk carefully for signs of granulation (looks like a graininess over the disk) caused by small cells of circulating gas in solar surface.

Also look for signs of filaments – brighter streaks and lines which are prominences seen end on.

As always: NEVER look at the Sun directly through any sort of camera, binoculars or telescope. Either use purpose made objective filters or use projection.

The Moon

7 July	15 July	22 July	28 July
Full Moon	Last Quarter	New Moon	First Quarter

During morning twilight on 7th July, the Moon will occult part of the Pleiades. This will be between 03:00 and 04:20 BST.

Planets

Venus, Jupiter and Mars are all early morning objects at present.

Noctilucent Clouds

Between mid-May to mid-August is the best time for observing noctilucent clouds. The reasons and origins of these clouds are still mysterious. They are completely different to the tropospheric (weather) clouds found in the lower 10km of the Earth's atmosphere. Noctilucent clouds exist at around 80km high in the atmosphere and seem to be ice crystals. They can only be noticed when the Sun is well below the horizon and therefore only illuminates these very high clouds, which is of course how they get their name. When they are visible the lower, normal clouds are dark to look at which is how you tell the difference. Noctilucent clouds can be quite bright and are white or an attractive bluey-white colour.

http://www.kersland.plus.com/ is the Noctilucent Cloud Observers' homepage and contains plenty of information on how to record observations and the different types to be seen, together with photos to help you see what to look for.

Observing Report for May/June 2009

Michael Roe and Dave Blenkinsop saw a small pair of spots a few days before the 12th June meeting and Keith Johnson imaged some prominences in Hα light on 31st May.

Michael Roe has been sketching globular clusters. I have managed little observing due to the late twilight. I managed a couple of sessions in late May and like Michael, looked at a number of globular clusters and also some planetary nebulae. My notes for the most interesting planetary I found are below:

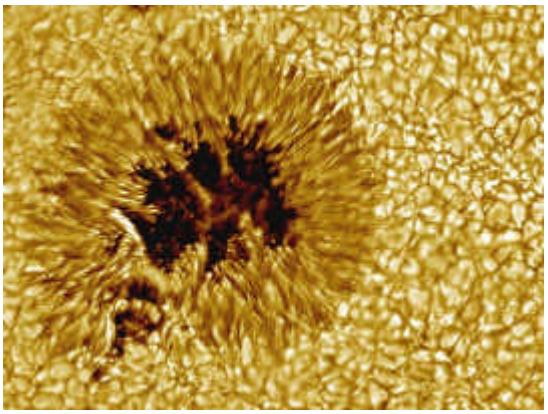
24th May 2009, 23:24 UT (12" Dobsonian)

Found planetary nebula NGC 6309 north of eta Ophuichi. Difficult object. There is a confusing double star nearby. Through the 15mm lens it appears almost like a double star. The object is distinctly elongated. Quite small although Sky Atlas 2000 implies a larger object. UHC filter confirms that it must be the planetary but it still seems to be a double star. Long thin object. Very strange.

Checking on the Internet resolves the mystery. This is the Box Nebula. The reason for the double appearance is that is adjacent to a star which lies on the principle axis of the nebula itself which also accounts for the skinny, elongated appearance. Others refer to the same object as the Exclamation Mark nebula.

On the 14th June at 07:01UT, I was able to find Jupiter in broad daylight with my 6" on an equatorial mount by aiming at the moon measuring off the difference in RA and dec to centre the planet. All there was to see was a pale white disk with slight indications of banding. The moons were, of course, not visible.

The Sun's Jet Stream and Sun Spots



left : image from NASA)

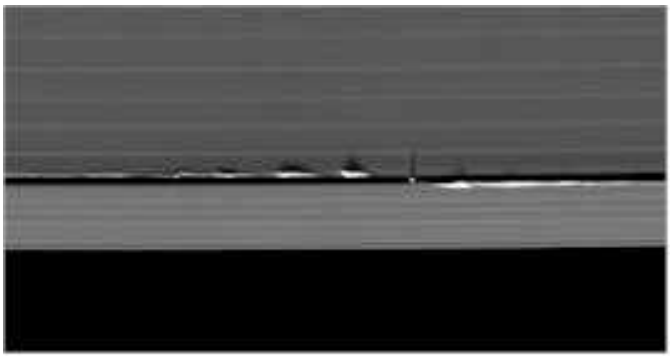
The Sun normally undergoes an eleven-year cycle of magnetic activity related to sunspots, solar flares, and the interplanetary storms called "CMEs." The current "solar minimum" quiet period has been unusually long and deep, scientists with the National Solar Observatory (NSO) in Tucson, Arizona, used long-term observations from the NSO's Global Oscillation Network Group (GONG) facility to detect and track an east-to-west jet stream, known as the "torsional oscillation," at depths of ~1,000 to 7,000 km (about 600 to 4,000 miles) below the surface of the Sun.

The Sun generates new jet streams near its poles every 11 years; the streams migrate slowly, over a period of 17 years, to the equator and are associated with the production of sunspots once they reach a critical latitude of 22 degrees. Scientists found that the stream associated with the new solar cycle has moved sluggishly, taking three years to cover a 10-degree range in latitude compared to two years for the last solar cycle, but has now reached the critical latitude. The current solar minimum has become so long and deep, some scientists have speculated the Sun might enter a long period with no sunspot activity at all. The new result both shows that the Sun's internal magnetic dynamo continues to operate, and heralds the beginning of a new cycle of solar activity.
Since the current minimum is now one year longer than usual, the scientists conclude that the extended solar minimum phase may have resulted from the slower migration of the flow.

Saturn's Approach to Equinox Reveals Never-before-seen Vertical Structures in Planet's Rings

Provided by SSI, Bolder, Colorado

An embedded moon in a very narrow gap can have a smaller mass than that inferred by earlier techniques.



Never-before-seen looming vertical structures created by the tiny moon Daphnis cast long shadows across the rings in this startling image taken as Saturn approaches its mid-August 2009 equinox. NASA [View Larger Image]

In images made possible only as Saturn nears equinox, NASA's Cassini spacecraft has uncovered towering vertical structures in the planet's otherwise flat rings that are attributable to the gravitational effects of a small nearby moon.

The search for ring material extending well above and below Saturn's ring plane has been a major goal of the imaging team during Cassini's "Equinox Mission," the 2-year period containing exact equinox — the moment when the Sun is seen directly overhead at noon at the planet's equator. This novel illumination geometry, which occurs every half-Saturn-year, or about 15 Earth years, lowers the Sun's angle to the ring plane and causes out-of-plane structures to cast long shadows across the rings' broad expanse, making them easy to detect.

In recent weeks, Cassini's cameras have spotted not only the predictable shadows of some of Saturn's moons, but also the shadows of newly revealed vertical structures in the rings themselves. And these observations have lent support to the analysis that demonstrates how small moons in very narrow gaps can have considerable and complex effects on the edges of their gaps, and that such moons can be smaller than previously believed.

The 5-mile-wide (8-kilometer) moon Daphnis orbits within the 26-mile-wide (42-kilometer) Keeler Gap in Saturn's outer A ring, and its gravitational pull perturbs the orbits of the particles forming the gap's edges. The eccentricity, or the elliptical deviation from a circular path, of Daphnis' orbit can bring it close to the gap edges. There, its gravity causes larger effects on ring particles than when it is farther away. Previous Cassini images have shown that as a consequence the moon's effects can be time-variable and lead to the waves caused by Daphnis to change in shape with time and with distance from the moon.

However, the new analysis also illustrates that when such a moon has an orbit inclined to the ring plane, as does Daphnis, the time-variable edge waves also have a vertical component to them. This result is backed by new images taken recently near equinox that show the shadows of the vertical waves created by Daphnis and cast onto the nearby ring match the characteristics predicted by the new research.

Scientists have estimated, from the lengths of the shadows, wave heights that reach enormous distances above Saturn's ring plane — as large as 1 mile (1.6 kilometers) — making these waves twice as high as previously known vertical ring structures and about 150 times as high as the rings are thick. The main rings, named A, B and C. are only about 30 feet (10 meters) thick.

"We thought that this vertical structure was pretty neat when we first saw it in our simulations," said John Weiss, a research associate of Cassini imaging team leader Carolyn Porco, in Boulder, Colorado. "But it's a million times cooler to have your theory supported by such gorgeous images. It makes you suspect you might be doing something right."

Also presented Thursday is a refinement to a theory used since the Voyager missions of the 1980s to infer the mass of gap-embedded moons based on how much the moons affect the surrounding ring material. The researchers conclude that an embedded moon in a very narrow gap can have a smaller mass than that inferred by earlier techniques.

One of the prime future goals of the imaging team is to scour the remaining gaps and divisions within the rings to search for the moons expected to be there. "It is one of those questions that have been nagging us since getting into orbit, "Why haven't we yet seen a moon in every gap?"' said Porco. "We now think they may actually be there, only a lot smaller than we expected."

A Life Under the Stars

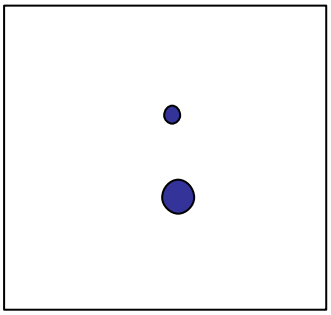
from David Blenkinsop

A night under double stars

It was the 15th June. I put my 6" Dobsonian in the back yard in the day time to check the mirror alignment and made some adjustments so I was looking forward and as keen as ever to try it out.

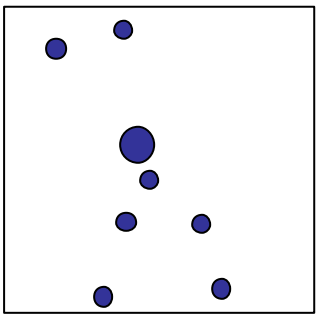
At about midnight I put a board up to on the shed roof to hide some of the light pollution. I got out my old Norton's Atlas and Webb's to check out the double stars in Hercules. Before going to Hercules here are two doubles, beta Libra is listed as green, try this one out, it looks white to me but alpha is a good wide double for binoculars. Also have a look at zeta Corona Borealis, at 50x we can see it as a bright wide double with sigma 1964 another wide double in the same field of view when seen at 330x, that is with a 2x Barlow and a 6.4mm eyepiece.

Now on to Hercules.



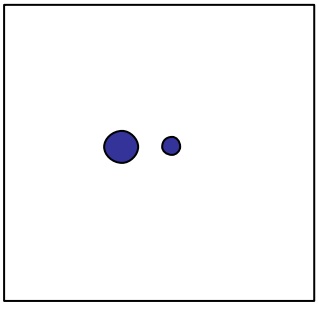
- gamma Her, is bright with a faint coma at 3.8 and 8.2 magnitudes at 40" seperation.

Gamma Her seen at 70x



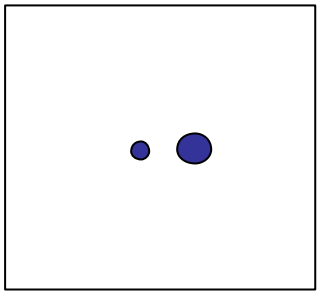
- kappa Her, both stars are yellow in a nice field at 5.0 and 6.0 magnitude at 31" separation

kappa Her seen at 50x



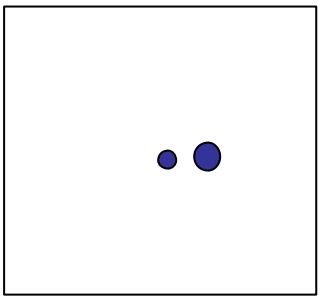
- alpha Her, a wonderful double, yellow and blue at 3.0 and 6.0 magnitude at 4.6" separation.

alpha Her seen at 165x



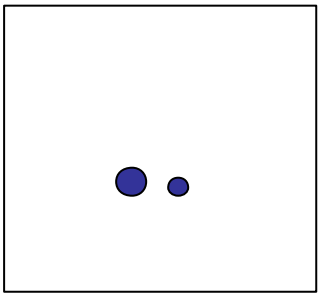
- delta Her, a bright star and faint coma. delta is surrounded by faint stars

delta Her seen at 50x



- lambda Her, is a yellow or orange star, a bright and faint pair at 3.8 and 9.5 magnitude at separation 30".

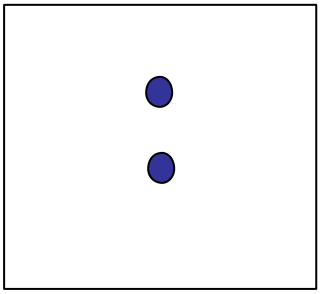
lambda Her seen at 50x



- Three minutes east and three degrees down is sigma 2232.
I can split this one at 70x but much better at 165x.
7.0 and 8.0 magnitude at separation 6.5"

sigma 2232 seen at 165x

How about a little known star cluster? Moving on east we come to X1, nu, omicron and 99. Sweeping up at 50x about two field widths from 99 we should find D0D2 9. I saw about 15 or 50 stars of 8.0 or 9.0 magnitude. I must look for this on a darker night.



- South of omicron is 100, this is easy at 50x, they look like cat's eyes at 5.9 and 5.9 at separation 14"

100 Her seen at 50x

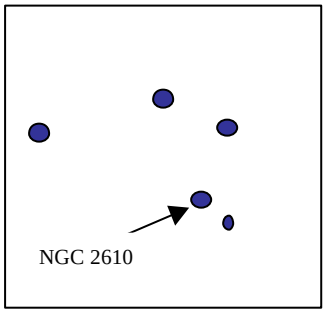
95 Her, two stars at the same brightness, pale yellow and pale blue at 4.9 and 4.9 magnitude at separation 6". I can split this one at 50x but better at 165x.

Different observers do see different colours in these stars from what I see, what colours do you see?

The time was now 2.17am, the sky was becoming light, don't you just love these light nights?

On 17th June at about 11.30pm, in the twilight, I could see from my backyard a noctilucent cloud display. I phoned Steve Sawdon and John Fadian and let them know. I then walked to find a better place to see it from which was across Albert Park. Later on I had a look at NGC6210, a planetary nebula in Hercules.

On the night of 18th June a patch of noctilucent cloud was seen , it did not last very long this time. More were seen at about 2.30am.



NGC 2610 seen at 50x

I went back to NGC2610. If you find star 51 in Hercules, with a low power eyepiece just down and west is a little group of stars. At 50x it is just a star point, if you continue to look it will disappear, look to the side and it comes back again. It was the same at 70x, what we call blinking. It is well seen at 165x , at 330x it looked grey. A good size with a fuzzy edge, I could not see the central star.

M13 is just about partially resolving with high power. The sky is too light at this time of year. That's it, I am just going out again to look at more double stars.

Charles Messier

Written by Tammy Plotner

Most of us know the name of Charles Messier, the French astronomer and comet hunter who published perhaps one of the most celebrated catalogues of astronomical objects of all times, but how much do you really know about the man? Why not step inside a take a look a what make this curious astronomical character one of the most celebrated observers of all time.

Charles Messier was born on June 26, 1730, the tenth son in a wealthy family of 12 children from Lorraine, France. Times were very tough back then… Even for the rich. Half of his brothers and sisters died while Charles was still quite young. By the time he'd reached 11 years old, Charles father had also died, but he was left in the care of his 24-year old brother – Hyacinthe – a Navy curator. As luck would have it, while his brother was gone, young Charlie would fall from a window in his house while playing and break the long bone in his thigh. Well, medical attention then wasn't the same as it is today. A neighboring farmer took him in and cared for him as best he could, writing to Hyacinthe that the lad would have full recovery. However, when the older Messier brother returned, he realized how impaired this injury had made him, so he removed him immediately from the local school, took care of his education, and trained him for eight years for administrative and methodical work. Although we can imagine that young Charles felt a bit restricted during that time, what he learned would serve him well – precise observing methods and an eye for fine details.

Charles Messier was bitten by the astronomy bug at age 14 when a a great 6-tailed comet appeared and he had a chance to witness an annular Solar eclipse from his home town on on July 25, 1748. About a year later, his schooling would end and like most young men, he'd drift for awhile, not too sure of what direction he wanted life to take him. Well, in 1751, that part of present-day France was reorganized, (Off with their heads, you know…) so Hyacinthe decided to stay loyal to a certain faction and it was time to put 21 year old Charles to work. There were two positions open: one with the curator of the palace and one with the astronomer. Guess which position he took? So, on September 23, 1751 Charles Messier left for Paris to work for the Naval Astronomer in the unheated hall in the Royal College where his fine handwriting netted him the job of copying maps. Besides that, the Observatory director, Delisle, kinda' liked him… So he taught him about his instruments, how to make observations and introduced him to his assistant and they both let him keep their notes.

As an astronomer, Charles Messier's first documented observation was of the Mercury transit of May 6, 1753. Delisle himself had introduced Messier into the beginnings of astronomy and drove home the point of calculating exact positions of all observations and documenting them. This well-learned lesson was a skill that would eventually immortalize Messier's observations and in 1754, he was officially employed as a Depot Clerk of the Navy.

And still dreamed about the stars…

Somewhere in 1757, Charles Messier started looking for comet Halley. The comet was expected to return in 1758, but at the time these orbital calculations were little more than guesswork. Observatory Director Delisle had calculated an apparent path where he expected comet Halley to appear and young Messier drew up a star chart for him. As luck would have it, there was an error in Delisle's calculations and no matter how valiantly and determined Messier was to find the comet, it was never there. At least until the night of August 14, 1758 when he accidentally tripped across another comet. Carefully documenting his observations, Charles followed it telescopically until November 2, 1758 and after comparing notes with contemporaries, realized this particular comet had been discovered on May 26, 1758, by De la Nux. Even if it wasn't Comet Halley, or a new discovery, his observing time wasn't wasted… It was the beginning of a new era.

While he was documenting and following De la Nux's comet, Messier discovered another comet-like patch in Taurus on August 28, 1758. Being the good observer that he was, he recorded its position, returned later, and when he discovered it wasn't moving – realized he'd located a nebula. He measured its position on September 12, 1758, and it later became the first entry in his famous catalog, Messier 1 or M1. Realizing he was on to something, Messier then began to sweep the heavens with his telescope, searching along Delisle's path for comet Halley and recording objects "which could be mistaken for comets" along the way.

Comet Halley was finally recovered by German amateur astronomer, Johann Georg Palitzsch, on Christmas night 1758. However, for Messier, his "Ah ha!" moment wouldn't come until January 21, 1759, nearly a month later. Although he remained loyal to his teacher, Messier began to have doubts about Delisle's computations, and after a few independent observations he found Comet Halley on his own. Of course, Delisle wouldn't admit that he was wrong. He told Messier to continue to observe along the lines he'd given him and simply refused to announce his discovery to the French academic world. Like all good employees, Messier simply took it in stride, stating: "I was a loyal servant of M. Delisle, I lived with him in his house, and I conformed with his command." When Delisle finally realized the error and announced Messier's recovery of Comet Halley on April 1, 1759, the other French astronomers believed they were a victim of an April Fool's joke and didn't believe it. To make matters worse, Delisle even refused to publish another of Messier's comet discoveries made in early 1760…

Well, 28-year old Messier might have had a weak leg, but he had one heck of a strong back bone, because despite the ridicule and suppression, he became more determined than ever to prove them wrong about his abilities. Delisle was getting old and less inclined to observe… Allowing Messier to take over more and more. Messier recorded his second "nebula," M2, previously discovered by Jean-Dominique Maraldi, and plotted it on a chart showing Comet Halley's track. He observed the transit of Venus of June 6, 1761, and the appearance Saturn's

rings. He observed Comet 1762 Klinkenberg from May to July, 1762, and on September 28, 1763, he discovered Comet 1763 (Messier), and the next one, Comet 1764 Messier, on January 3, 1764. He had hopes to enter the French Royal Academy of Sciences in 1763, but it was a dream that didn't come true… and a bitter let down for Charles Messier.

While searching for nebulae during 1770, Messier went off the beaten path. This led to 19 original discoveries that weren't documented in any catalogs by other astronomers he could get in touch with. Devoting his life to astronomy, he used every clear night to advantage, continuing to discover comets and add objects to his catalog. At age 40 he married (after 15 years of dating), and a year later, on January 10, 1771, Messier independently co-discovered the Great Comet of that year. On February 16, 1771 he presented the first version of his Catalog of Nebulae and Clusters of Stars, with the first 45 objects, to the Paris Academy of Sciences. This was his very first memoir and during that same year that he was finally officially made the "Astronomer of the Navy".

A year later Madam Messier gave birth to a son… And within two weeks they were both gone.

If you think today's scandal sheets at the grocery store checkout are bad, then know they couldn't hold a candle to what aristocracy could do back then. According to research, a malicious legend is reported by Jean-Francois de Laharpe, written in 1801, that the death of Messier's wife had prevented the discovery of another comet which would have been his thirteenth, and Messier was more desperate because of the lost discovery than of the death of his wife (especially as this comet was discovered by Montaigne, whom he didn't like). Anyway, Messier observed this comet March 26 – April 3, 1772. On April 5, 1772, he added another cluster to his list, M50. But after that, Messier seemed to lose his spark for observing and a great deal of his life's work went on to his assistant, Pierre Mechain. It would be some five years before Messier would take his observing back up in earnest – and 10 years before his passion for hunting comets would return again.

It was about this time that another famous astronomer (Sir William Herschel) began to make his mark in astronomy – and with his superior telescope, put the aging Messier and his work into the past. In less than a year's time, Charles would accidentally fall once again – this time a 25 foot drop into an ice cellar – from which it took the 50-year old over a year to recover from his injuries. When he returned, he went back to scanning the skies for his beloved comets, but his heart really wasn't in it. He did discover several more comets, and went on to write many great works. Mechain left to become the director of the Paris Observatory and France fell once again. (Off with their heads). His fortune gone and his observatory falling apart, Charles Messier finally received national attention when Napoleon himself, in 1806, presented him the Cross of the Legion of Honor – the medal you see him so proudly wear in all his portraits.

As time passed, the old man Messier did as many old men do… Retired on their laurels and perhaps spent a bit too much time reflecting on the past. Unfortunately, Charles spoiled a great deal of his astronomical reputation by writing a rather detailed autobiography, which ended up tying the great comet of 1769 to Napoleon, who had been born that year. Even though in his mind, it might have been a good political move, it was suicide to the scientific world. No one could believe he would actually equate the appearance of a comet with Earthly events. As Admiral Smyth said: 'The last comet put astrologically before the public by an orthodox astronomer'. Quietly going blind, Messier suffered a stroke in 1815, and lived for another two years… to meet the age of 87.

Although you may argue that Messier's Catalog was not particularly scientific… It wasn't arranged by Right Ascension and Declination… Nor was it broken down by object type… What Charles left us was a legacy. Within the Messier List is every known type of object: galaxy, globular cluster, open star cluster, supernova remnant and planetary nebula. His observations were made with a small telescope that averages out to about what a modern 102mm would be today. He couldn't resolve things. He made mistakes. He was human.

He was Charles Messier.

The Mapping of the Moon

By Michael Roe

The first maps of the Moon really began with the first telescopes despite the fact that the dark markings of the Moon are easily seen by the unaided eye. Around 1609 Thomas Harriot in England and Galileo Galililei used early telescopes to draw these first lunar maps, good enough to reveal the dark mare areas and large craters.

left : A composite lunar drawing by Thomas Harriot from 1612 or 1613

Later maps by Helvelius in 1647 then Riccioli in 1651 were better but still crude. Ricioli invented names for many lunar features used ever since.

The problem with mapping the Moon visually is it is very difficult. Try it yourself, use any telescope with low magnification able to how all the Moon in the field of view, then draw it. Not easy, is it? I have tried it myself, first in 1974 with a 2 ½ " refractor and more recently with an 8" Schmidt Cassegrain. I am very good at drawing but it is still difficult, all that detail and getting the Mare shapes and sizes correct. Still, my results were quite good.

This is what the early pioneers of lunar mapping were doing. It would take weeks to draw even this kind of small-scale map. Later astronomers with better telescopes using higher magnifications took years to produce better large-scale maps of the Moon with more details. I have seen the Moon at high power many times and the amount of detail is incredible. I wouldn't even try to map the Moon at this level of detail. Yet some observers did try, many maps were never completed.

I saw on a video once some amazing Lunar drawings of large areas of the Moon, well paintings really, done in the 1700s by a professional portrait painter turned astronomer, sadly I can't remember his name but he was exceptionally good.

Other observers made Lunar maps such as Tobias Mayer in 1775. But it took until 1837 for a large accurate map of the Moon to appear, drawn by Wilhelm Beer and Johann Madler, a small copy I have seen looks rather splendid. Plato crater appears black! This map was the best available until 1878 when Julius Schmidt made a better lunar map. These maps were around 30" across I believe. By this time photography was becoming more important for lunar mapping.

By the 1890s photographic atlas' of the Moon were produced, the astronomer W.H. Pickering produced his atlas in 1904. But lunar photography was still crude. It took many more years to improve the resolution and most lunar cartography was visually drawn maps produced by amateur astronomers.

In the1950s H.P.Wilkins, with some help from Patrick Moore, drew a huge map of the Moon. He called it the 300" Map, I wonder if an enormous map 25 feet across covering the Moon's diameter still exists somewhere? I saw a reduced copy in a book in a book in Brotton Library many years ago called "Our Moon" by Wilkins and Moore. The map was in 25 sections and about 35" across. This book was a complete description of the Moon's features and contained many photographs and drawings. Unfortunately it disappeared around 1980 and I have never seen another copy since!

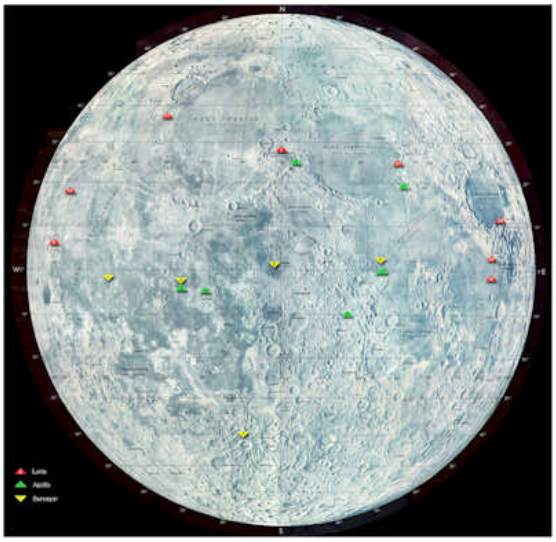
Still, I do have a similar much older book. "The Moon" by Edmund Neison, printed in 1876, with maps in sections and description of features.

Most of these old lunar maps had drawn outlines like a ring of craters quite unlike the Moon as we see it. Of course comparing a large scale Ordnance Survey map with an aerial photograph of any place shows how different maps and reality can be. Some lunar maps give a more realistic shadow view such as Anton Rukl's map in the 1976 book "The Moon, Mars and Venus", of course some detail can be hidden in the shaded areas.

More modern photographic atlas' were produced in the 1950s onwards. Some showed the difficult-to-observe libration zones - slithers of the Far Side. Then space flight appeared. In 1959 the Russian Lunik 3 sent back the first fuzzy images of the Far Side of the Moon. Immediately maps were made, I saw one in a 1970s encyclopaedia, when features such as Tsoilkovsky and The Sea of Moscow appeared. Unfortunately the Soviet Mountains turned out to be a mistake, they were in fact non-existent!

More spacecraft appeared in the 1960s, mostly American. The Rangers photographing the Moon before crashing into it, then the five Lunar Orbiters taking thousands of photographs in lunar orbit. Then the manned Apollo missions, from 1969 to 1972, took many thousands of photographs from orbit. Apollo 15, 16 and 17 had two special mapping cameras to photograph large swathes of the Moon but only near the equator. So, amazing detailed maps of the Moon were made, well, sort of!

In fact NASA did make a large map, 16 miles to the inch or 1,000,000 to 1 scale, with a projection like Earth maps so all craters are round, except truly oval craters like Schiller. But this map was made around 1960 from the best telescopic observations, even Patrick Moore contributed.



left : a typical NASA reference lunar map

And all the spacecraft data? Well, maps were made, in fact all Far Side lunar maps could only be made from spacecraft photos. The more detailed maps were copied and overlain with geological information. But a whole Moon map was made from the Lunar Orbiter photographs in more detail than telescopic maps. I know because I have a jigsaw Moon globe that is made from these photographs. NASA must have a better globe and maps stored away that only experts have seen. My book "The International Atlas of Lunar Exploration" shows a few samples of these maps.

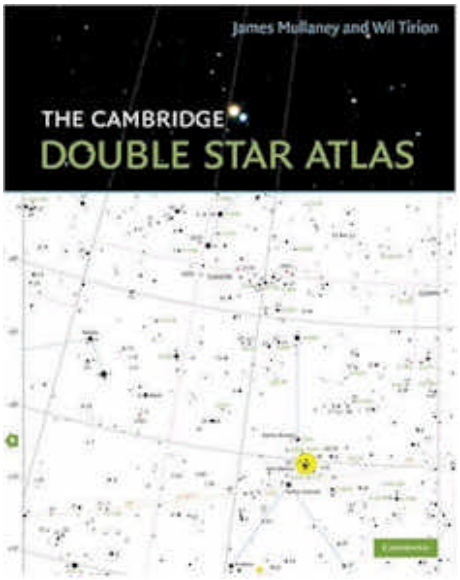
The problem with Lunar Orbiter photographs is that some areas were unseen in shadow near the South Pole. Other areas, Mare Crisium to Mare Fecundatis and parts of the Far Side were badly photographed, fuzzy or faint. Other areas were seen with sharper resolution than other regions, so making a whole Moon map was very difficult yet the NASA cartographers somehow managed.

For many years no spacecraft orbited the Moon until In the 1990s Clementine did. This spacecraft sent back millions of images, all at Full Moon phase! So most images were useless except around the Lunar Poles although an atlas was made.

Since then other spacecraft from China, Japan and India have orbited the Moon. By the time you read this the American Lunar Reconnaissance Orbiter should be photographing or imaging the Moon to make maps for manned landings in the far future. We might just get decent maps of the Moon at last, lets hope so!

Book Reviews: The Cambridge Double Star Atlas

Written by Mark Mortimer



Some of the best tourist discoveries occur off the beaten track. Plan to go somewhere, choose a fortuitous route and voila, a petite patch of paradise opens up in front of you. The same can be true for planning a night of star hunting. Dial coordinates into a 'go-to' satellite and you will immediately see your target, if all works well, but, you won't see anything else. However, take "The Cambridge Double Star Atlas" by James Mullaney and Wil Tirion, then star-hop to your destination, and who knows what you will find.

By using this atlas, you should still easily find some choice targets. It's a book aimed at the amateur astronomer and it well hits its mark. For starters, it's in a very large format. Central to the book are 30 maps, each shown across two pages. These wonderfully laid out guideposts show the glow from the Milky Way

equator, constellation boundaries, significant stars and, of course, the double stars themselves. And to ease the viewer along the way, many clusters, nebulae and galaxies also grace the pages. The typical but necessary coordinates surround the pages' edges; right ascension across the top and declination along the sides. With this, and a red flashlight, star hopping should be a breeze.

The book also has a sampling of 133 of what the authors consider showpiece double and multiple stars. Hence with this, the reader can start by choosing a target, learning about its discovery, determine where it is shown in the atlas and then setup the hops to get the wonder into the eyepiece. And with descriptions like the "Easter Egg" double, seen as striking yellow and ruddy-purple or garnet jewels, the reader will quickly fall into the joy of viewing the variety and splendor of the night-time spectacle.

Two final sections round out this great atlas. The first is a brief introductory section that shares the particular pleasures of viewing multiple star systems. Then, in Appendix C, there's a listing of the Cambridge Double Start Atlas target list. These presumably include all the nearly 2,400 double and multiple stars of the nearly 25,000 stars plotted on the 30 maps. Most of these are purported to be viewable with typical "backyard" telescopes in the 2-inch to 4-inch range, so there's no need to worry about not being able to see most of them.

So whether you're on a star-finding challenge or a personal quest for striking images, "The Cambridge Double Star Atlas" by James Mullaney and Wil Tirion is a fabulous resource. Well laid out, fully detailed and insightfully described, it has the details to get you where you want to go and perhaps place you beside many other fabulous, fortuitous views.

MULTIPLE STAR & OTHER OBSERVATIONS IN EARLY MAY

from Mike Gregory

O. S. 017/09 - Friday May 1st 2009 - I set up my refractor on the rear lawn in ever worsening light pollution and had no real plan after looking at Saturn but I did go through my list for Canes Venatici, looking at the globular cluster, M3, at various magnifications before deciding that 25x was as good as anything, then the gold and blue pair, 2 CVn, and the deep red variable carbon star, La Superba or Y CVn, which looked more a creamy yellow than red, though it is probably at its brightest presently. Dave Blenkinsop says it looks a creamy yellow through his 250mm Dob too!

Cor Caroli looked superb and, yes, the secondary does show a slightly ashen mauve hue, whilst Struve 1755 appears to have a white primary and a bluish secondary but not sure. Burnham quotes Sun yellow for the primary! Struve 1768

(25 CVn), a contrasting GB pair is a tougher proposition and I cannot say I have managed to separate them tonight though I did manage the feat on March 4th of this year apparently.

Then I moved across to Alkurhah (xi Cepheus) and this pair was nicely separated at 118x though, perhaps, nicer at just 59x, but I decided to call it enough for the evening. However, the Moon could be seen low in the northwest so I viewed it at 59x and 118x, both unfiltered and with a pale blue filter, and though the proximity of my house wall degraded the view at times, overall the view was as good as anything I had seen lately!

Everything put away at 00.30 (GMT) Saturday but, at the present time, the astronomical flame is still flickering erratically. If only I could observe away from Homebase just once in awhile!

O. S. 018/09 – Sunday May 3rd – By mid evening it looked as though it might be clear after sunset so I left the tripod and mount set up in the garage and, about 22.00 BST, I was able to carry the tripod out of the garage already set up. I polar aligned for that time and used Alphecca to set up the Gotostar, then had a look at Saturn despite the proximity of the nine days old Moon, but my alignment must have been a little out as Saturn just appeared on the edge of a two-degree field, so I went into the synch mode and after that the system proved to be very accurate.

I decided to have a look at the GB star, Porrima, gamma Virgo, but as I did not have the co-ordinates to hand, I went for Struve 1788, another GB pair in Virgo, and found this double easily, nicely split at 118x with a yellow-white primary – well more pure yellow to me and with magnitudes of 6.7 & 7.7, a separation of 3.5 arc-seconds and an estimated period of some 2,600 plus years. However, it proved to be well away from Porrima so I had to go indoors to find the co-ordinates. That done I was able to slew on to this famous double and it appeared to be elongated at 118x and, maybe, separated at 200x though just two years ago it was beyond most amateur's telescopes. I even went up to 240x and then to 300x. These last two magnifications seriously overpowered the conditions but I feel sure I would have more success on a Moon-free night!

Surely this is cheating! I have just slewed from gamma Virgo eastwards to kappa Herculis and there is my target nicely centred in the field and separated at 59x without any further input from me though it would not be classed as much of a challenge to a 102mm lens; but no success with my next target, Struve 2015 AB as this pair are much closer and dimmer.

My next target pair was Struve 2021 Aa-B with almost equal magnitudes of 7.43 & 7.48 and a separation of 4.2 arc seconds. Nicely split at 59x and not really better at 118x. However, here I am observing in trainers and I am feeling the cold

so, after a poor view of the Moon, as it was rapidly disappearing behind my chimneystack, I retired at 00.15 (Monday) morning!

My current list of multiple stars, taken from the Orion Skywizard electronic finder catalogue, has just about been exhausted so I am now typing up a more in-depth catalogue, cross referencing with Burnham's Celestial Handbooks, Sky Catalogue 2000.0 and the Smithsonian Astrophysical Observatory's digital catalogue. Currently I have a long way to go!

O. S. 019/09 – Sunday May 10th – I set my refractor up on the lawn at 22.00 BST and used Alphecca to set up the Gotostar. All ready to go at 22.15!

My first target was to be Alya (delta Serpens) but Alya was still below the horizon so I went for Izar (epsilon Bootes) first and this yellow and blue pair were comfortably separated at 118x but not at 59x so I tried 80x (25mm eyepiece & 2x Barlow) and Izar was just separated. My next target was pi Bootes, which was easily separated at 59x and just at 40x, then to xi Bootes, which was also easily split though the colours were a bit uncertain – to me they appeared yellow/white and bluish – then on to a much tougher challenge, the 225 year period 44 Bootes which has a separation of just 2.2 arc seconds, the primary overpowering the secondary by almost a full magnitude. Both components are similar to the Sun in colour but the secondary star, a spectroscopic binary in its own right, looked orangeier to my eyes!

Now nicely warmed up (or should this be cooled down because its like January in May presently) so I moved into Hercules with the idea of working through my latest list of multiple stars in that constellation.

An easy target to start with is wide kappa Her with magnitudes of 5.0 & 6.2 – the primary is almost pure orange and the secondary orange with a tinge of red. Some sources suggest this pair is gravitationally bound but Sky Catalogue 2000.0 does not list this pair as so!

Struve 2015 is a relatively tight pair with a separation of 2.9 and magnitudes of 8.2 & 9.5; it splits nicely at 81x. The primary is a white star and there has been no movement between the pair since first measured by FGW Struve in 1829.

Next to Struve 2021 Aa-B, which I looked at seven nights ago but this surely is cheating as the Gotostar put it right into the centre of a 0.6º field without any further slewing from me. Magnitudes are almost equal at 7.4 & 7.5 and the separation is 4.2 arc seconds. The primary is an orange star.

Then to Struve 2051 which has a relatively wide separation of almost 14 arc seconds and magnitudes of 7.7 & 9.4. Hence the primary overpowers the secondary by 4.25 times but nicely split at 81x. The primary looked Sun yellow and the secondary greenish to my eyes though the spectrum suggests orange for

the primary. Quite impressed though as mag 9+ stars are not easily seen above suburban Acklam!

My next target was Struve 2056, which has similar magnitudes to the above pair but with little more than half the separation. Nevertheless, reasonably easy to separate. The primary star is almost pure white.

Struve 2063 also has a white primary but it overpowers the secondary by a factor of almost 16 times. Nicely separated at 80x though there has been no recorded movement between the pair in over 160 years. Then to a very dim pair, Struve 2068, with magnitudes of just over 9.0 and a separation of 5 arc seconds. At first there was no sign until I looked up to find a cloud drifting across but when it clear this dim pair were easily seen, the primary being a yellow/white star with more yellow than white according to its spectrum.

Finally to Struve 2079 which is much easier than the previous pair. In fact, no challenge at all at 80x!

At midnight it is clouding over, so time to dismantle my refractor with eight doubles to put in my observing record, seven of them new to me.

O. S. 020/09 – Tuesday May 12th – I set my refractor up beneath a deep blue sky at 23.00 BST to the background music of Middlesbrough's anthem, the whirling rotors of that confounded police helicopter and it's searchlight beam accompanied by barking dogs. So what is the point of all these hapless security lights?

Recommencing where I ended in Hercules two nights back, my first target was Struve 2087 AB, a sun-yellow primary star of mag 8.8 but the secondary is almost its equal at 8.9. Separation is 5.2 and closing but only by 1.3 arc seconds in almost 180 years.

Then I got myself into a right astronomical muddle! Struve 2097, with both magnitudes well into the nines and a separation of 2.0 arc seconds was quite an easy target. Perhaps my information was incorrect so I moved quickly on to a triple star, Struve 2098 AB & AC, which proved to be easy, all three components virtually in a straight line (HIP 82058; 82060; 82064). Then I moved on to Struve 2104, and I quickly realised that this was the same star as Struve 2097 as the co-ordinates are almost identical. Obviously stars at mag 9+ are too dim to be seen in my observing conditions.

[With hindsight, when I searched for Struve 2097 I actually found Struve 2104 and, later, managed to find Struve 2104 again. Struve 2097 is probably too dim and close to find easily from my back garden]

Struve 2107 AB is a very interesting GB pair with an orbital period of 260 years. The magnitudes are 6.9 & 8.5 hence the primary is just over 4x brighter than the secondary. In 1828 FGW Struve measured the separation at 1.1 arc seconds at position angle 149º whereas in 2001 the Smithsonian Astrophysical Observatory record the pair at 1.4 arc seconds at position angle 98º whilst 2009 computer simulations suggest the separation has opened out to 1.53 arc seconds and the position angle closed to 79º though the normally conservative Sky Catalogue 2000 quotes 1.5 for the year 2020. Whatever, a tough challenge for a 102mm lens but on this night I can definitely see a dim star just above, almost touching, the primary star at 160x. So, unless my eyes deceive me, this is one of the tightest pairs I have ever separated. Perhaps I should have a try later for OS 525 in Lyrae.

[Later I checked the above findings with two computer programmes I have and both, broadly, put the secondary star where I saw it]

Now I am looking at Struve 2135 that has magnitudes of 7.6 & 8.9 and a separation of 8.4 arc seconds. Just separated at 80x, the primary star looks orange as the spectrum suggests. Then onto Struve 2137 but the secondary component has a magnitude of 10.03 and this is just too dim for Acklam skies!

My next target is Rasalgethi (alpha Hercules), which is nicely split at 59x though the colours are not all that apparent. Perhaps yellowish and greenish at 118x! Well, maybe! Rho Hercules has similar magnitudes and separation to Rasalgethi but rho possesses two almost brilliant white stars and these show up much better in the eyepiece. Rho is situated on the top left corner of the Keystone.

Then I looked for Struve 2162 but the magnitudes are just two dim at 9.4 & 9.6 so I moved into nearby Lyrae and easily found the wide yellow and blue pair, OS 525, but zero signs of the close companion to the primary star. The reason was soon obvious, as the inside of my refractor lens has completely dewed over so time to retire indoors at almost 01.00 (Wednesday).

Answers for the quiz questions from the June 2009 issue

From Rod Cuff

Where in the Universe? A pictorial challenge. Of what, where and when was this image taken

answer - the Tadpole galaxy, taken by the Spitzer Space Telescope. The Tadpole is a disrupted barred spiral galaxy located 400 million light years from Earth, located in the constellation Draco. Its "tail" is about 280 thousand light-years long.

Q 1. What's next in each of these series?

(a) Potsdam 1899, Meudon 1891, Lick 1888, Yerkes 1897, ...?

(b) Centaurus, Draco, Hercules, Ursa Major, Virgo, ...?

(c) Europa, the Moon, Io, Callisto, Titan, ...? [largest Moons – Ganymede]

A 1. (a) Paris 1900. This is the list of the five biggest refracting telescopes ever built. Although the famous 40-inch Hale telescope at the Yerkes Observatory in Wisconsin is the largest still in existence, a monster 49-inch, operated on its side (!), was built for the Paris Exposition in 1900. It was not a success, though. See more about it, and the count-up from the ninth largest refractor, at www.flamsteed.info/fasother6_files/page0001.htm .

(b) Hydra. This is a list of the largest constellations in terms of sky area: in fact, they're the only ones to have an area of over 1000 square degrees. There's a load of stuff about all constellations at www.dibonsmith.com/constel.htm .

(c) Ganymede. This is a list of the largest satellites in the Solar System, with Jupiter's Ganymede having a diameter of 5270 km, making it larger than Mercury. There's a nice semi-interactive, fully illustrated display of Solar System satellites at www.astro.umd.edu/~hamilton/ASTR330/ch7.2.pdf .

Q 2. What do the members of each set have in common?

(a) Algol, Mira, Rasalgethi, Mintaka, Proxima Centauri

(b) M13, M3, 47 Tucanae, Omega Centauri

(c) Alpha Centauri, Polaris, the Trapezium, Mizar, Castor

A 2. (a) They're all variable stars. All types of variable stars are thoroughly explained, with graphs of typical light patterns, at www.aavso.org/vstar/types.shtml .

(b) They're all globular clusters within our galaxy – and some of the most splendid (www.astropix.com/HTML/L_STORY/STARLIST/GLOBULAR.HTM). Only the first two, though, are visible from Britain. I recently glimpsed Omega Centauri (http://apod.nasa.gov/apod/ap020416.html) very low down in the sky from the southern tip of Portugal, but 47 Tucanae (http://apod.nasa.gov/apod/ap970919.html) isn't visible from Europe.

(c) They're all multiple stars, each with at least two companions. Their orbits are predictable only over relatively short time-frames (so called 'three-body' problems are not solvable exactly, and many systems eventually become mathematically chaotic. New research on this aspect of the Solar System recently hit the news – see http://4engr.com/press/catalog/3997). But you can see lots of animations of particular stellar orbits at www.solstation.com/orbits.htm .

Q 3. Who in the world of British astronomy are these people?
(a) Andy Fabian (b) Roger Pickard (c) Helen Walker (d) Jack Youdale
(e) Robert Kennicutt (f) Lord Rees (g) John C. Brown

A 3. (a) President, Royal Astronomical Society (http://heritage.stsci.edu/2008/28/bio/bio_primary.html).
(b) President, British Astronomical Society (http://tinyurl.com/njyvo4).
(c) President, Society for Popular Astronomy (www.popastro.com – I can't find a section just about Helen Walker).
(d) President, Cleveland & Darlington Astronomical Society – the most prestigious position in British astronomy ? (http://cadas-astro.org.uk – no biog of Jack, though ... ?)
(e) Plumian Professor of Astronomy, University of Cambridge (www.ast.cam.ac.uk/~robk), following in the footsteps of Airy, Eddington, Jeffrey, Hoyle, Rees (see below!) ...
(f) Astronomer Royal (www.ast.cam.ac.uk/staff/mjr).
(g) Astronomer Royal for Scotland (www.johncbrown.org).

Q 4. What do these strange words signify?
(a) gegenschein (b) saros (c) Brocken Spectre (d) Lunokhod

A 4. [Quotes are from the relevant Wikipedia article, but the links give more information or pictures.]
(a) 'a faint brightening of the night sky in the region of the antisolar point' (http://apod.nasa.gov/apod/ap990625.html).
(b) 'an eclipse cycle with a period of about 18 years 11 days 8 hours ... that can be used to predict eclipses of the Sun and Moon' (http://eclipse.gsfc.nasa.gov/SEsaros/SEsaros.html).
(c) 'the apparently enormous and magnified shadow of an observer, cast upon the upper surfaces of clouds opposite the sun' (www.touchingthelight.co.uk/features/brocken.shtml).
(d) 'Lunokhod ... 1 and 2 were a pair of Soviet robotic lunar rovers landed on the Moon in 1970 and 1973, respectively' (http://apod.nasa.gov/apod/ap990109.html).

Q 5. What do these abbreviations stand for, and what do they refer to?
(a) LMC (b) ZHR (c) RA (d) ESA (e) IAU

A 5. (a) Large Magellanic Cloud – a small galaxy in our Local Group, and the third nearest to us (http://delphes.net/messier/xtra/ngc/lmc.html).
(b) Zenithal Hourly Rate – the number of meteors that would be visible in one hour under a clear, dark sky if the radiant of the shower were overhead. It all gets a bit mathematical (http://skytour.homestead.com/zhr.html)!
(c) Right Ascension – the celestial equivalent of longitude, and so called

because if you face the north celestial pole, the stars will rise (ascend) on your right (http://everything2.com/title/right%2520ascension).

(d) European Space Agency – Europe's increasingly effective rival/partner for NASA (www.esa.int).

(e) International Astronomical Union – the people who demoted Pluto to a dwarf planet (boo!), and who have given our Society's founder, Dr John McCue, his own official observatory code (hooray!).

Q 6. Astronomers use some words or terms, sometimes for historical reason, in ways that that are different from their day-to-day meanings outside astronomy. What do these mean to astronomers?

(a) metal (b) early galaxy (c) late-type star (d) coma (two meanings!)

A 6. (a) Any element other than hydrogen or helium. So, astronomically speaking, oxygen, nitrogen, carbon ... are metals.

(b) Any galaxy-type on the left-hand side of Edwin Hubble's 'tuning fork' diagram – so, an elliptical or a rather vague spiral. The diagram classifies galaxies by their shape (www.astr.ua.edu/keel/galaxies/classify.html). Hubble and others once thought that galaxies evolved over time from ellipticals into spirals – unfortunately, the misleading terminology has stuck.

(c) A relatively cool star, of spectral type K, M, R, N or S (http://tinyurl.com/klnuua). This also dates from a time when astronomers had the wrong idea, in this case thinking that stars generally evolved through a sequence of spectral types.

(d) The first astronomy-specific meaning is to do with comets: it's the visible cloud of gas and dust that surrounds a comet's nucleus when it is heated during that part of its orbit that brings it closer to the Sun (www.windows.ucar.edu/tour/link=/comets/coma.html). The other meaning concerns the optics of telescopes: light passing through the outer areas of a lens or reflected off a curved surface will focus at a different distance than will the light passing through/reflected from the centre (http://starizona.com/acb/basics/equip_optics101_coma.aspx). This can produce a 'tail' on star images near the edge of the visual field, so that they look like little comets – see the first def

N.B. The next set of quiz questions will resume in the September Transit

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