TRANSIT

The December 2010 Newsletter of

Cleveland & Darlington Astronomical Society

NEXT MEETING

10 December 2010, *7.15 pm for a 7.30 pm start*
Wynyard Planetarium

Meteor Crater, Arizona
Graham Darke, *Sunderland A.S.*

Contents

Editorial

Rod Cuff

Many thanks to Andy Fleming, who did a great job as guest editor for last month's *Transit*. Andy is one of the most helpful and active members of our Society, and I suspect you'll see his name up in editorial lights on some future editions as well. In the meantime, he has an article in this issue too – see page 12.

Many of you will know that our reigning Yorkshire Astromind, ace observer and committee member Rob Peeling is now working in the South and will be moving there permanently with his family next summer. Rob will very much be missed, but we wish him well in his new environment. I'm pleased to say that he will try to keep up his monthly *Skylights* articles as long as he can, although there will be occasions when the pressure of work and travel may prevent that. In those cases, I'll get inventive …

This month's *Skylights* points out that there's a total lunar eclipse on the morning of 21 December. All you photographers out there, please get up early and send in your pictures of the event for the January issue. If the sky is cloudy, please hire a plane to take you up. Now you know what to ask Father Christmas for.

This month, Mike Gregory regretfully signs off his observing sessions after number 500. Mike, I do hope you change your mind and keep going – please send more reports if you do.

It being December, this is the month when Barry Hetherington publishes (through *Transit* and the less well-known *BAA Journal*) a list of astronomical anniversaries falling in the coming year. I see that 2011 is the 200th anniversary of the birth of Thomas Wright, after whom the Thomas Wright Trophy (holders: CaDAS) is named – maybe Neil can do something extra spectacular for next October's competition.

Many thanks to all contributors to this issue, along with apologies for it being published later than usual. And to everyone reading this and to their families – may you have an enjoyable and stimulating festive season ahead, ready to resume astronomical life anew in 2011!

The copy deadline for the January 2011 issue is **Wednesday 29 December**.

Rod Cuff, info@cadas-astro.org.uk*,1 Farndale Drive, Guisborough TS14 8JD (01287 638154)*

Letters

Correction!

from Neil Haggath

I have to correct one of your quiz answers for the October quiz…

John Goodricke was not the first to discover that a star could vary in brightness! He was the first to explain a star's variability – not the same thing at all. In fact, he didn't even discover the variability of Algol, which he made his name by explaining.

The first star discovered to be variable was Mira, by Holwarda in 1638. The second was Algol, by Geminiano Montanari in 1669.

Goodricke's achievement was to correctly explain the variability of Algol – which of course isn't a true variable star at all, but the first known eclipsing binary. He later discovered the variability of Delta Cephei, the prototype Cepheid variable.

[Oops – I'm glad you're there to keep me honest, Neil… — Ed.]

Can you take Edgar on?

from Pat Duggan

Edgar needs a home, and a little companionship, preferably a man. Edgar is a mornings and evenings person, although he does like to spend the middle of the day asleep, in a tree. He will go anywhere on a leash or your arm. He is 18 months old and is a registered, ringed, pet barn owl. His present people don't want him anymore, so he has come to live with me so that I can find him a loving home.

'Ed' is just like a big budgie and likes to be a pet in that he seems interested in what people are doing and has been transferred to a nice big (dog) cage in my house with easy-to-change newspaper underneath, but he comes out for walks on my shoulder on his leash so that he's not bored. Ed would be very good company for a retired person and less likely to get 'dumped' a second time.

I have his international registration and ring documents as it is an offence not to have them.

Astronomers seem to make their own telescope sheds and enjoy nature and the countryside. Ed apparently gets excited watching action and colour changes on computer screens, and most astronomers seem to use laptops now. Maybe a CaDAS member could be right for Ed?

(I will understand if you say this is not an astronomy matter, but he does love the night sky, so could you stretch a point?)

[How could I resist? I'd love to have Edgar myself, but … sigh … If you think Ed might be for you, please call Pat on 01609 883440 for more information. — Ed.]

Wishes sometimes come true

from John Crowther

Last month I wrote, 'We look forward to his [Ray's] future articles.' Without knowing this, Ray filled about six pages, which included rhyming couplets to summarise his prose.

Articles written by us old-timers interest other old-timers, but whether I'm referring to years of membership or years of life I'm not saying…

I mentioned the war years a few months back, so Ray's opening verses brought back memories:

> *The fear of Hitler's air force keeps the sky so clear and dark,*
> *No glim of earthly light is seen from the long grass in the park.*

I was brought up in Whitby, a relatively safe place that billeted evacuees. Yet it was just outside the town, near the Guisborough road, that Group Captain Townsend (as he became) shot down the first German raider of the war. The place is marked with a memorial column.

During the nights of the blackout, we children thought that the stars were street-lights in heaven, which links with Ray's line:

> *The galaxies are corpuscles flowing in God's blood.*

From the 1950s I too remember *The Listener*, the BBC weekly magazine, and I had a BBC booklet about relativity. It covered a series of lectures given by Bondi, Gold and Hoyle. One was called 'An end to model-making'. In a way, Ray proved this wrong with his model planetaria, for can't we class them as miniature universes? Not all that many years ago I crawled through the airlock tunnel of one and sat with other watchers on the plastic floor.

More wishes for articles from Ray some time in the future, please!

[Ray has already sent me one, John; I hope to include it in January's issue. — Ed.]

OBSERVATION REPORTS AND PLANNING

Skylights – December 2010

Rob Peeling

The Moon

5 December	13 December	21 December	28 December
New Moon	First Quarter	Full Moon	Last Quarter

A **total eclipse of the Moon** is partially visible early in the morning of Tuesday 21 December. You'll need a good horizon to the north-west, because the Moon will be setting as the eclipse occurs. It will also be getting light. Twilight begins at 06:10 UT and sunrise is at 08:25, more or less as the Moon sets (before the end of totality).

Circumstances of the eclipse (for Stockton-on-Tees)

Moon enters penumbra:	2010 Dec 21 05:27:32
Moon enters umbra:	2010 Dec 21 06:32:06
Start of totality:	2010 Dec 21 07:40:10
Maximum eclipse:	2010 Dec 21 08:16:45
End of totality:	2010 Dec 21 08:53:22
Moon leaves umbra:	2010 Dec 21 10:01:27
Moon leaves penumbra:	2010 Dec 21 11:05:53

The planets

Jupiter remains prominent. There are some indications that the South Equatorial Band may be about to reappear.

Uranus is close by Jupiter. You'll find it somewhat to the west of Jupiter and a little to the north of the star 20 Piscium.

Neptune is setting by around 21:00 mid-month, so it's too low in the sky to make much of. If you've not seen it, you'll have another chance next autumn.

Saturn can be seen rising in the east if you're up and about early in the morning. It is well up by 05:00 UT in the middle of the month, with **Venus** just following it above the horizon at this time.

Meteors

The **Geminid** meteor shower reaches maximum on 13–14 December.

Deep sky

Owing to the complications of starting a new job and moving house, I have been doing very little observing myself lately. However, I was able to catch a couple of views of the skies of South Africa while on a business trip. My first chance was while sitting outside having dinner at a restaurant in a school in Johannesburg. The sky was heavily light polluted as clouds cleared, but I was still able to see **Orion** rising upside-down (Rigel above Betelgeuse). With my bearings established, I was able to identify Sirius and, sweeping upwards to another extremely bright star, was able to identify **Canopus**. Almost overhead was another bright star which I correctly guessed to be **Achernar**, marking the southern end of Eridanus.

A couple of nights later I was staying at a country hotel near Rustenburg. The sky was clear and dark but I couldn't safely leave the security of the hotel compound with its lights. With 8×40 binoculars and a star atlas I was able to star-hop from Achernar to find the huge, bright globular cluster **47 Tucanae** and the **Small Magellanic Cloud** as a dim but obvious glow next to it. Using Canopus as a starting point I was also able to find the **Large Magellanic Cloud** with my binoculars, with the **Tarantula Nebula** as a startlingly bright, large patch within it.[1] To my surprise I couldn't find the Southern Cross or Centaurus. After a while I realised that they were below the horizon at the time I was observing. As I'll be travelling fairly regularly to South Africa in my new job, I hope I shall get to see it some other time.

Getting back to the northern hemisphere: try to find **NGC 752**, an open cluster in Andromeda. Look for the two stars marking the shortest side of Triangulum (β and γ Tri). Using these stars as pointers, move about twice their separation distance up towards Andromeda. This cluster is one of Sir Patrick Moore's Caldwell objects (#28) and is an excellent low-power telescope target as well. It's unusual because the stars are quite old for a cluster – about one billion years. This is definitely a naked-eye object with averted vision, even in quite poor skies. It's not quite as bright as **M44**, though.

When you've finished enjoying the spectacle of **M42**, see if you can find the nebula **M78** for a change. It lies north of Orion's Belt. While not as breathtaking as M42, it is still an interesting object. This is a reflection nebula rather than an emission nebula because the embedded stars are cooler than those of the Trapezium. I usually see a fuzzy area with two stars embedded in it.

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[1] *[I too was enjoying views of the Magellanic Clouds last month, from the largely unpolluted skies of Madagascar. It's ridiculously exciting to see these things for yourself. I doubt that native-born New Zealanders get too excited about seeing the Pole Star when they come north … – Ed.]*

M78: *APOD* 2005 November 4, Stephan Messner

I have lots of other favourite targets in Orion.

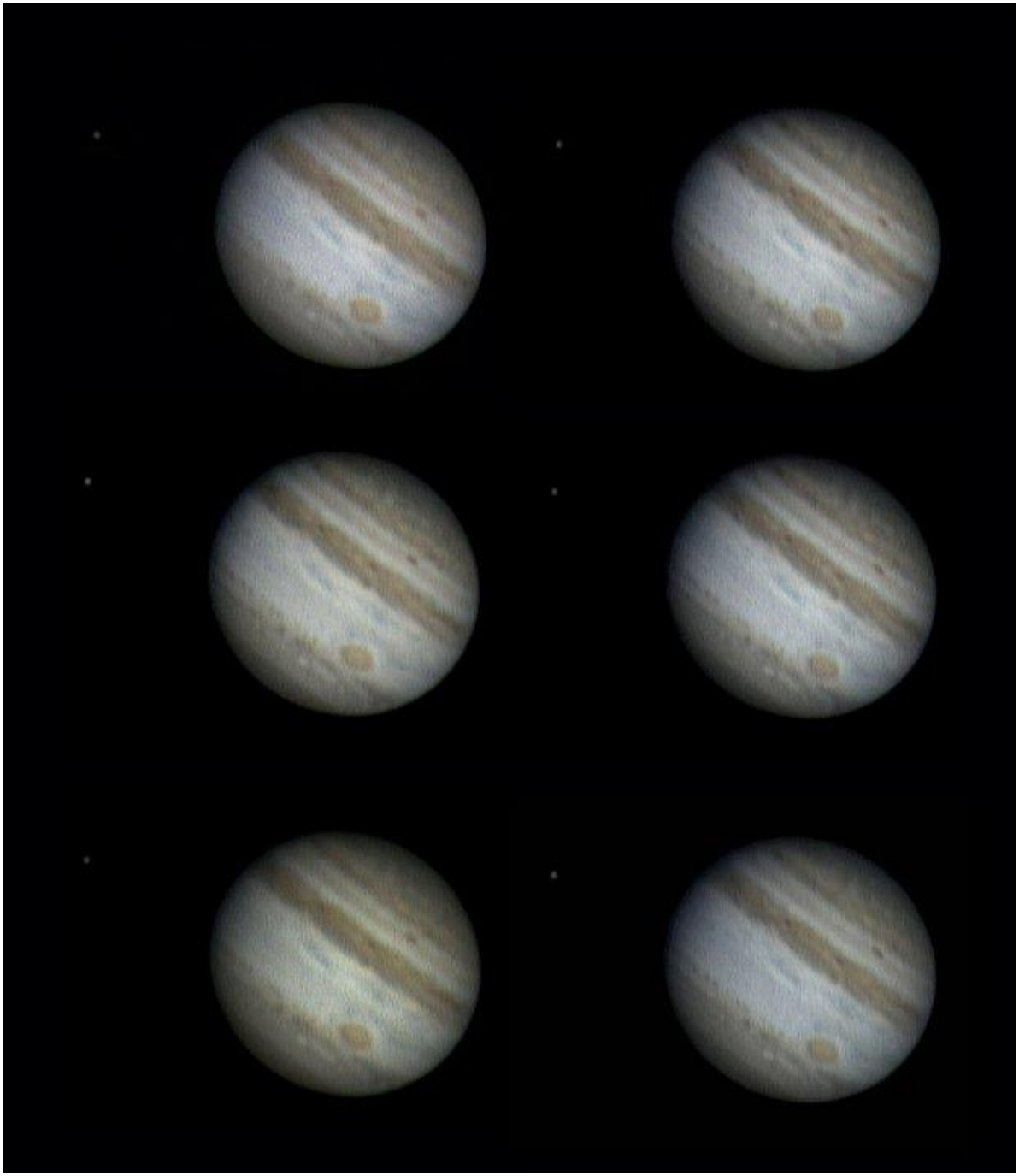
- With M42 itself, try to see the bands like the gills in the 'fish's mouth', which is the darker bay reaching in towards the Trapezium within M42. They can be faintly visible in good conditions, and a filter may help.
- Try to follow the huge arm of nebulosity east and down from M42 towards **iota (ι) Orionis**, which is itself surrounded by nebulosity and is a good triple star.
- Just to the south-east of iota is the obscure but bright cluster of **Collinder 72** (not marked on maps).
- Further south again is the small but bright nebula **NGC 1999**.
- **M43**, just north of M42, is a glow around a star; it's quite elusive in poor sky conditions.
- Further north still is the obvious bright open cluster **NGC 1981**.
- Look carefully at the stars between M43 and NGC 1981. Can you spot any nebulosity here? For imagers, this is the **Running Man Nebula**.
- Finally, with dark skies, aim the telescope at Alnitak (zeta [ζ] Orionis) at the left (eastern) end of the Belt. Nudge eastwards to put bright Alnitak just out of the field and see if you can spot the **Flame Nebula, NGC 2024**. It may require a filter to pull it out. It's well worth a look if you can see it.

Jupiter and Ganymede

Keith Johnson

If ever there was a time when I wished that all of you were witness to an extraordinary event, it was on the evening of Saturday 30 October 2010. Superb seeing was evident as soon as I set up the scope, with the results shown below.

Alas, the seeing deteriorated just before I could increase the magnification in order to image Ganymede on its own.



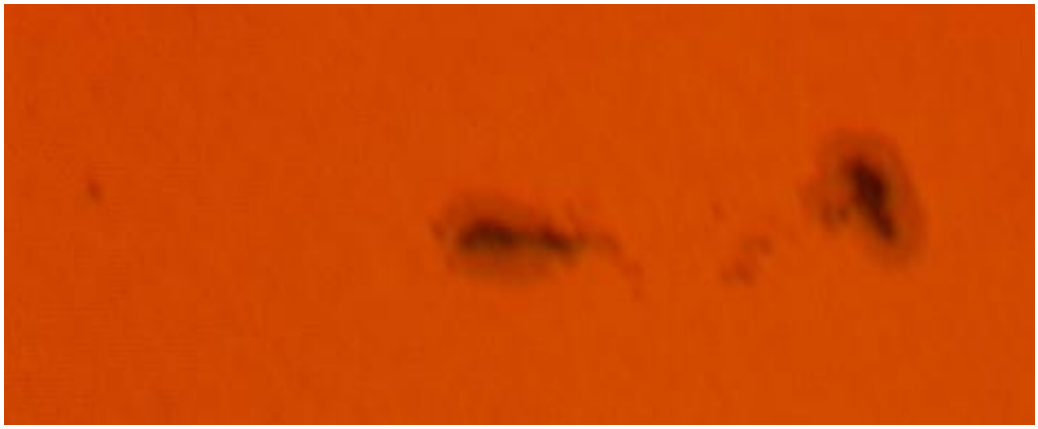
Capture details are as follows:

- 90-second AVI captured @ 10 frames per second
- Celestron C9.25" f/10 Schmidt–Cassegrain OTA
- EQ6 Pro mount using computer telescope control via Skymap Pro.9
- TouCam Pro II webcam
- 4 × Imagemate with infrared blocking filter
- Image processing in Registax 5, with Photoshop used to make the mosaic

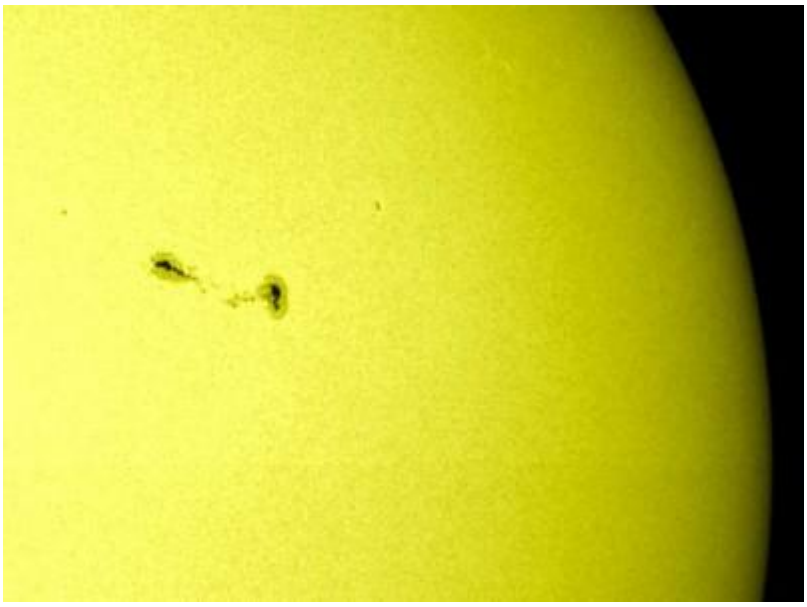
Sunspot group 1124

Rod Cuff

After much muttering and perspiring under a black cloth on a typically dazzling, low-sun winter's day, I captured this image of **sunspot group 1124** just before noon on 15 November 2010.



Comparing it to a SOHO image taken at much the same time (see below), I'm pleased to find that it's captured the subtle detail of the penumbral areas, including the regions between the major spots and also the modest trailing spot seen at far left.



Capture details:

- 120-second AVI captured @ 15 frames per second (163 frames stacked)
- Meade ETX-125 125cm f/15 SCT with full-aperture solar filter
- TouCam Pro II webcam
- Image processing in Registax 5 and Photoshop

My 500th observing session: Wednesday 6 October 2010[2]

Mike Gregory

Sadly, the light pollution is dreadful where I live and, despite many pleas to neighbours to angle down their security lights, my pleas fall on deaf ears so I have just about come to the end of telescope observing.

Since my marathon 69-night stay in various NHS establishments four years ago, I've maintained a prodigious keep-fit schedule by cycling on the roads and in the gym as well as working with weights. But I'm never going to be fit enough to observe with my refractor away from my home base, as it takes about thirty minutes to set it up from the back of my car. Last March I attended York A.S.'s Star Party at the top of Sutton Bank in temperatures down to –7.5°, and it took me about two hours to get my refractor up and running, not being helped by lots of people wanting me to help them sort out their telescopes.

Well after midnight, I was the only person left there and was still trying to pack everything away. On that night I decided that, whenever it came, my 500th observing session would have to be the last unless some miracle took place. As I type this, I am still waiting for that miracle; but here is my log from that subsequent 500th observing session, which took place on 6 October 2010.

According to my observing record, tonight was observing session number 500 since purchasing my refractor in May 2001. I had hoped I could have found a dark-sky site for this occasion, the favourite venue being the Ribblehead area, as I once paused there and the night sky was the blackest and clearest I have seen before or since; but as ever I had to settle for my back garden.

I set my refractor up at 20.00 BST but skimped on the polar aligning, as I could not easily see the Pole Star and just guessed where it might be. Then I used Alpheratz to align the Goto system, which was to work quite well over the next five hours.

I started observing in ***Cassiopeia*** with a look at **Σ 3053** (also known as 'Little Albireo' as it looks like a dimmer miniature of the real Albireo). Though it shows as a double at 25×, 80× is needed to show the colours. The spectrum suggests pure orange and white, but it usually shows up as a soft yellow shade with a bluish white companion; tonight with a background of bluish white sky over central Middlesbrough (as though dawn was just minutes away), the colours are simply not evident!

Σ 10 is a rather nondescript pair of white stars of mags 8.0 & 8.5 with a separation of some 18 arcsec. There has been almost no movement between them since first measured by FGW Struve in 1832. According to the WDS catalogue, a wide third star at mag 8.6 was recorded in 2000, but I cannot see it.

[2] *[Mythological illustrations of some of the constellations that Mike observed are from* Urania's Mirror*, a set of cards published anonymously in 1825. Ian Ridpath has a nice webpage about it. – Ed.]*

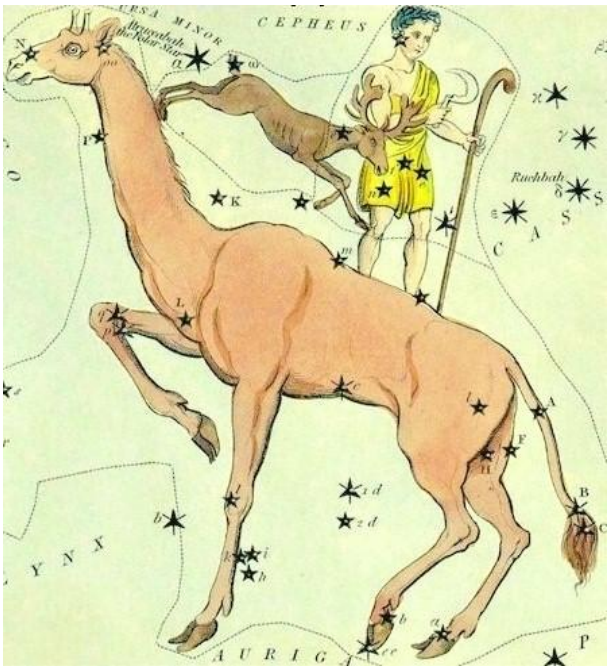
Now I am looking at the gravitationally bound **Achird (η Cassiopeiae)**. Colours are yellow and red, but tonight the secondary looks yellowish too. The orbital period is said to be 480 years.

Then to **ι Cassiopeiae**, a triple star. All three components can be seen at 80×, but 160× really does not improve the view. Eight years ago this triple always looked crisp and sharp at 118× even from my garden!

Now I am looking at **Σ Cassiopeiae**, which is said to have a green companion. The colours are actually pure blue and a softer (whitish) blue, so by contrast the dimmer star can look greenish. On this night 118× separates them, but both look bluish to my eyes.

As I am now in the region where **Comet Hartley** might be, I decided to fit my two-inch 38mm eyepiece that produces almost a 3° field of view, though the thought that this heavy eyepiece might end up bouncing off my concrete patio did not fill me with much confidence. However, it did not, but neither did I find the comet, although five nights back I came across a greyish blue 'out of focus' star that I thought might have been the comet.

*I next moved into the constellation of **Camelopardalis**, which had come into view above neighbouring trees.*



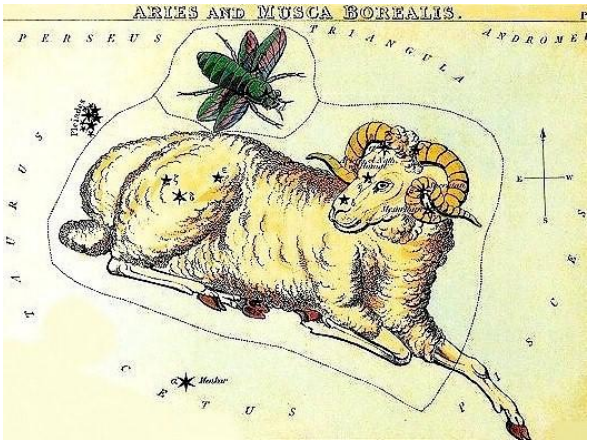
My first target here was the triple star **Σ 396**, which was easily split as a double system at 25×. However, the third component is both very wide and very dim at magnitude 10.8 and hardly worth the trouble of searching out.

Σ 419 splits nicely at 80×. Both components are, as much as makes no difference, magnitude 7.8 (actually 7.76 & 7.81) and the separation is 2.9 arcsec.

Σ 485 AE is another pair with almost equal magnitudes, situated in the very loose open cluster NGC 1508. Both stars are brilliant blue. Quite impressive at 25×, and at 80× at least another six faint stars can be seen – miniature diamonds in the night sky – the A star also being catalogued SZ Cam, an eclipsing binary with a period of 2.6 days. Additionally the primary star has a mag 12.9 companion (AB) at a distance of 6 arcsec as measured by the Rev. Espin in 1909 & 1925 and given the catalogue number Espin 2603. All told there are about 14 stars catalogued here and there is much confusion between the various catalogues themselves.

Σ 550 is also **1 Camelopardalis**. When conditions are clement, this rarely visited star is one of the finest doubles in the night sky. On this night, at 80×, the primary appears to be of the palest yellow-white whilst the secondary is a bluish white, but when viewed from a dark-sky site the secondary star takes on a vivid electric blue tint.

*Now I have moved towards the south-east and the constellation of **Aries** (my star sign, I think), which is beginning to climb out of the evening haze.*



Σ 291 ABC consists of a white primary with a yellow-white secondary separated by 3.3 arcsec. At 25× this pair appears to be elongated, but at 80× the stars are clearly separated, and the considerably dimmer and wider third component can also be made out.

Σ 311 is **π Arietis** and another triple system though seemingly beyond me on this night; I did manage to see all three components on 1 October 2007.

*Now I have moved up a few degrees to **Triangulum**.*

In my catalogue **6 (ι) Trianguli** is described as 'exquisite', but it has been a year or more (actually August 2008) since I last saw it nicely displayed. 80× magnification is not high enough and 160× just too high.

Σ 232 is a neat CPM (common proper motion) pair with almost equal magnitudes of 7.8 & 7.9 and a separation of 8 arcsec.

Σ 239 is another neat CPM pair, though with a separation twice that of the above double. Colours are almost pure yellow for both stars!

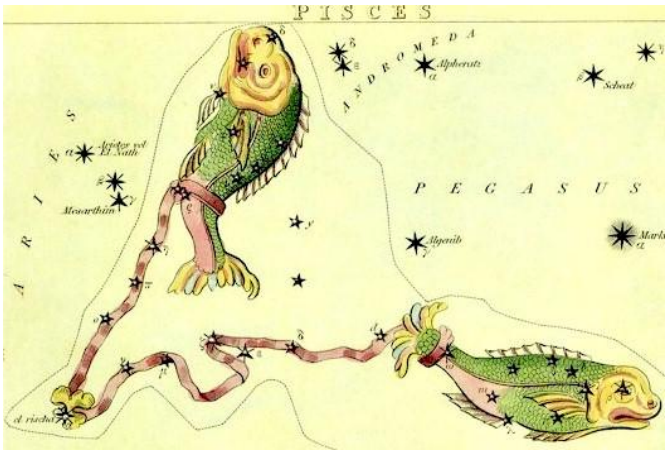
The primary component of **Σ 285** is an orange star. The separation is just 1.8 arcsec and it overpowers the secondary by a factor of almost 2×.

*Now for a change, as I am looking at the **Pleiades** star cluster at 27× using my 38mm 2-inch eyepiece, which gives a magnification of 26× and a FOV of almost 2.7°. This is enough to encompass the full field of the Pleiades, which could not be accomplished when using my 40mm 1.25-inch eyepiece in the same telescope. Alcyone, the brightest star in the cluster, and its three dim companions look very neat.*

Moving into ***Perseus***, **Σ 331** is a bright and beautiful blue white & almost pure white CPM pair with magnitudes of 5.2 & 6.17. The separation is 12 arcsec.

Σ 369 looks to be an interesting pair. So interesting in fact that I forgot to record what I might have seen...

*I have moved into **Pisces**, which is now positioned higher and to my south.*



Σ 61 is better known as **65 Piscium**. I first came across this beautiful dandelion-yellow CPM pair about the same time as I found 1 Camelopardalis. The magnitudes are almost equal at 6.3 but the separation is relatively close at 3.3 arcsec, so a really good night is required to see 65 Piscium at its best. Sadly I doubt if this will ever be possible again from my back garden.

Still in Pisces, **Σ 88** is another impressive and almost equal-magnitude CPM pair. Colours are also almost identical at B9.5 & A0, whilst the wide separation is easy on the eye. This is another very neat pair.

Although not quite as imposing as Σ 88, **Σ 90** is another neat CPM pair consisting of two yellow-white stars.

Σ 100 is also **ζ Piscium** and yet another wide and bright mid-yellow pair. There has been no definite movement between them in about 180 years, the secondary star being the GB system *B* 1029 and frequently unresolved even in professional telescopes!

Σ 202 is also **α Piscium (Alrischa)**, a whitish GB pair with a period of 720 years. Magnitudes are 4.1 & 5.2 whilst the separation is 1.7 arcsec. This pair just about separate in my 102mm refractor, which is quite good going because throughout this observing session my immediate neighbour's internal and external lights have illuminated my journey.

*Now I am observing in **Auriga**. Earlier this year I laid siege on several nights to **Σ 644** and finally managed to split it into orange & blue components on the night of 18 January in temperatures of –6°. With a separation just a little tighter than Alrischa, Σ 644 is the tightest pair I have definitely separated So could I split it again on this night? I could not even find it (though I since have, and it separated quite easily).*

OΣ 545 is also **θ Aurigae** and something of a challenge for a 102mm lens. In fact the *Cambridge Double Star Atlas* states that it is a target for 'larger scopes and steady nights', but on this night (actually morning now) in generally hopeless conditions, it can be seen double at 160×. Strangely enough, it seems to be better to look at it with both eyes open, one on the eyepiece and the other looking at my garden fence. θ Aurigae is a CPM pair with a very wide and dim third star that is probably unrelated.

Thus ended my 500th observing session.

GENERAL ARTICLES

When it comes to stars... size matters!

Andy Fleming

One of the really awesome and mind-blowing aspects of astronomy is the sheer immense scale of the distances between planets, stars, galaxies and galaxy clusters.

Our everyday terrestrial notions of scale, size and distance must be discarded, even if we just consider a journey between the Earth and Mars. Kilometres are the first to fall as units of measurement, then astronomical units (AU) (one AU is the distance between Earth and the Sun). When we start to consider interstellar distances, we have to look at light years as units of measurement (the distance that light travels in one year).

If distances become truly 'astronomical', then it comes as no surprise that sizes and masses follow suit. We all think that the Sun is massive, and it is, having a radius of 695,990 km, or 109 times that of the Earth. With a mass of 1.989×10^{30} kg, the Sun has the equivalent of 333,000 Earth masses, and yet it is still just a run-of-the-mill yellow dwarf-class G2 star. Although many

stars, such as our nearest neighbour Proxima Centauri, are considerably smaller than the Sun, and red dwarf stars are very common, there are also stars that are very much more massive.

The largest and most luminous star known is VY Canis Majoris, a red hypergiant located in the constellation Canis Major. At between 1800 and 2100 solar radii (approximately 2,750,000,000 km across), it is a single star nearly 5000 light years from Earth, and is quite probably the largest star in our galaxy. To gain some perspective of its size, if the Earth were to be represented by a sphere one centimetre in diameter, the Sun would be represented as a sphere with a diameter of 109 centimetres, at a distance of 117 meters. At these scales, VY Canis Majoris would have a diameter of approximately two kilometres!

Of course, this is all very interesting information, and will certainly entertain your friends, but a star's size is intrinsically involved in determining attributes such as its luminosity, colour, temperature and lifespan. Put simply, when it comes to stars, size really does matter!

Generally speaking, the larger a star, the greater its mass, and hence the higher its gravity. High-mass stars with stronger gravity have greater pressure in their cores, leading to higher temperatures and hence much faster nuclear fusion reactions, whereby the star's hydrogen fuel is converted into helium with the release of massive amounts of energy. This energy creates a radiation pressure, and while gravity tries to contract the star, this radiation pressure simultaneously tries to expand it. The result is a stable hydrostatic equilibrium that can last for millions, if not billions, of years.

However, once a star runs out of hydrogen fuel and starts to fuse helium into even heavier elements, this equilibrium cannot continue, and it won't be long before the star is no longer what could be regarded as a normal stellar main-sequence object. Because high-mass stars burn their fuel much, much more quickly because of the greater core pressure caused by gravity, they live relatively short lives. They live fast and die young as supernovae – the James Deans of the stellar zoo.

As an example, the star Rigel in the constellation of Orion, a hot blue supergiant with a diameter sixty times that of the Sun, has a mass of seventeen times that of our star, and hence 40,000 times its luminosity. Under its massive core pressure, its nuclear fusion reactions will race away and quickly run out of fuel in only 20 or 30 million years. Our Sun, on the other hand, has

enough hydrogen fuel to burn at its present leisurely pace for ten billion years or more – and small red dwarfs with lower pressure and lower temperatures will undergo nuclear fusion for much longer. With smaller mass and less gravitational pressure, Proxima Centauri, for example, will live for at least 20 to 30 billion years.

An interesting consequence of a star's size and temperature is its brightness. Generally speaking, a larger-mass, main-sequence star will have a higher temperature and be bluer in colour, while a smaller, cooler star will be redder – the inverse of the colour conventions used on our terrestrial devices warning of hot or cold temperatures!

So the next time you gaze in turn at brilliant blue-white Rigel, white Sirus and yellow Arcturus with your telescope or binoculars, you're looking at stars of decreasing masses and sizes. And remember – when it comes to stars, size really does matter!

Centenaries for 2011

Barry Hetherington

911 A nova appeared in June near α Herculis.

1011 Ch'ŏn Huo born; president of the Bureau of Astronomy in China.

A nova appeared in February between σ and φ Sagittarii.

1111 Al-Shafii al-Ghazzali died; wrote a treatise on the motion and nature of stars.

1311 Liu Chi born; compiled the first Ming calendar.

Qutb al-din al-Shirazi died; proposed a revision of the solar calendar.

Dietrich of Freiberg died; a German Dominican optician; wrote on comets and haloes.

1511 Giovanni Battista Amico born; wrote descriptions of models for planetary motions employing only homocentric spheres.

Robert Recorde born; one of the first people in England to adopt the Copernican System; wrote on solar and lunar eclipses.

Erasmus Reinhold born; a German astronomer; calculated a set of tables of the motions of the celestial bodies based on the Copernican System.

Caspar Vopel born; a maker of globes, armillary spheres, nocturnals, quadrants and maps.

A fall of meteorites occurred on the plain of Crema in September.

An astronomical clock installed in the Town Hall, Tubingen.

1611 John Blagrave died; an English mathematician; wrote *The Art of Dialling*.

Johann Hewelke (Hevelius) born; a German observational astronomer; built an observatory in Danzig; observed the phase of Mercury; published an atlas of the Moon and a celestial atlas.

John Pell born; wrote on quadrants and sundials – still in manuscript.

Johannes Sachariassen baptised; made observations of the Moon.

Sunspots observed by Johannes Fabricius on 27 February and by Christopher Scheiner in November.

The name *telescope* was devised by Ioannes Demisiani, mathematician to Cardinal Gonzaga, and announced at a banquet given in Galileo's honour by Federico Cesi and the Accademia dei Lincei.

De Maculis in Sole observatis by Johannes Fabricius, giving an account of his and his father's observations of sunspots.

Dioptrice by Johannes Kepler, wherein he set out the theoretical basis of lenses and explained the principle of the telescope.

1711 Ruggiero Giuseppe Boscovich born; a Jesuit mathematician, physicist and astronomer; designed the Brera Observatory and became its first director.

Richard Dunthorne born; a British amateur astronomer; he built an observatory at St John's College and donated the instruments for it; published tables of Jupiter's satellites and wrote on the motion of the Moon.

François Jacquier born; a French mathematician; edited an edition of Newton's *Principia.*

Eusebio Francisco Kino died; wrote *Libra astronomica y filosofica.*

Mikhail Vasilevich Lomonosov born; a Russian physicist and astronomer; observed the 1761 transit of Venus from St Petersburg, and deduced that the planet had an atmosphere.

Jan Lulof born; a Dutch astronomer; wrote several works on astronomy.

Alexandre Gui Pingre born; a French theologian and astronomer; established and appointed Director of the St Genevieve Observatory, Paris; observed the 1753 transit of Mercury and the 1761 transit of Venus.

Thomas Wright born (*see right*); an English religious philosopher and lecturer on astronomy; wrote on the structure of the universe.

Eustachio Manfredi became astronomer to the Bolognese Institute.

The first building of the Berlin Observatory came into operation.

Altdorf Observatory built.

1811 Louis Antoine de Bougainville died; a French admiral and explorer, and a founding member of the Bureau des Longitudes.

Auguste Bravais born; a French natural philosopher; wrote on astronomy.

Robert Wilhelm Eberhard von Bunsen born; a distinguished German chemist; studied the solar spectrum, with Kirchhoff, which led to the discovery of spectral analysis and the invention of the spectroscope.

Jan Frederik van Beek Calkon died; a Dutch astronomer.

John William Draper born; an English–American chemist; the first person to photograph the Moon.

James Melville Gillis born; an American astronomer; helped to found the Naval Observatory in Washington and became its director.

Edward Claudius Herrick born; an American scientist who wrote on meteor showers and the possible inter-mercurial planet.

Urbain Jean Joseph Leverrier born; a French mathematician and astronomer; independently calculated the orbit and position of Neptune; investigated the stability of the solar system; appointed Director of the Paris Observatory.

Karl Ludwig von Littrow born; an Austrian astronomer; succeeded his father as Director of the Vienna Observatory; wrote on astronomy.

Elias Loomis born; an American scientist; wrote on astronomy; he bequeathed the sum of $300,000 to the observatory of Yale College.

Nevil Maskelyne died; appointed Astronomer Royal in 1765; founder of the *Nautical Almanac*; measured the density of the earth.

Peter Simon Pallas died; a German naturalist and explorer; acquired the 680 kilogram 'Pallas' stony-iron meteorite in 1772.

Henrich Wilhelm Mathias Olbers put forward his theory of comet tails.

John Pond appointed Astronomer Royal for England.

Calton Hill Observatory, Edinburgh, established.

A portraiture of the heavens as they appear to the naked eye by Francis Wollaston published; in ten plates.

The Dorpat Observatory completed; the cruciform building was designed by the architect Johann Wilhelm Krause.

1911 G. Bruno van Albada born; a Dutch astronomer; worked at the Warner and Swasey Observatory; Director of the Bosscha Observatory in Lembang, Indonesia; Director of the Astronomical Institute of the Municipal University in Amsterdam.

Luis Walter Alvarez born; an American experimental physicist and inventor; built a cosmic ray detector.

Leslie Francis Ball born; an English amateur astronomer, astronomical artist and lunar cartographer.

Edward George Bowen born; helped to develop radio astronomy in Australia; helped in the construction of the Parkes radio telescope and the Anglo-Australian telescope.

James Cuffey born; an American astronomer who specialised in photoelectric photometry.

George Davidson died; an English born American astronomer and geographer; built an observatory in San Francisco.

Julena Steinheider Duncombe born; worked at the US Naval Observatory as an observer and astronomical computer.

Williamina Paton Stevens Fleming died; a Scottish-born American astronomer who discovered white dwarfs; discovered 222 variable stars.

William Alfred Fowler born (*see left*); an American astrophysicist; worked on the synthesis of the elements in the stars.

Louis C. Green born; an American astronomer; studied stellar spectroscopy and stellar evolution.

Samuel Herrick born; an American astronomer; worked on celestial mechanics and astrodynamics; worked on astronautical navigation.

Hendrik R. Hudson born; assistant Director of Agnes Scott College's Bradley Observatory, Decatur, Georgia.

Bagrat Konstantinovich Ioannisiani born; a Soviet designer and builder of astronomical instruments; worked at the State Optical Institute and at Pulkovo Observatory.

Luigi G. Jacchia born; an Italian physicist who studied the Earth’s upper atmosphere by analysing satellite orbital data.

Mstislav Vsevolodovich Keldysh born; a Soviet scientist and one of the leading figures of the Soviet space programme.

Hideo Kihara born; established the Kihara Observatory; founder of the Nayoro Astronomical Club; observed sunspots.

Vladimir Alekseevich Krat born; Director of the Pulkovo Observatory; worked on solar physics, binary stars, eclipsing variables and cosmogony; a pioneer of Soviet balloon astronomy.

Werner Lohmann born; worked at the Heidelberg Königstuhl Observatory and later at the Rechen-Institut.

William Thynne Lynn died; an English astronomer who worked at Greenwich Observatory; studied the proper motions of stars.

Evald Rudolfovich Mustel' born; a Soviet astrophysicist; worked at the Simeiz Observatory and the Crimean Astrophysical Observatory; editor of the *Astronomicheskij Zhurnal*; worked on solar and stellar physics.

Erik V. Petersen born; a Danish amateur astronomer; used the refractor at the Copenhagen University Observatory to take 712 plates on which he measured 2562 positions of asteroids.

Paris Marie Pismis born; a Turkish-Mexican astronomer; studied galaxies and nebulae.

Eugene Rabe born; worked at the Astronomisches Rechen-Institut; worked at the Cincinnati Observatory; did research on the motions of the Trojan asteroids.

Jean Charles Rodolphe Radau died; a mathematical astronomer; studied planetary perturbations; one of the founders of the *Bulletin Astronomique*.

Grote Reber born; an American radio engineer; in 1937 he built the first radio telescope in his back garden with a receiver 31 feet in diameter.

Olof E.H. Rydbeck born; a pioneer radio astronomer; founder of the Onsala Space Observatory.

Carl Keenan Seyfert born; an American astronomer; studied stellar and galactic astronomy; a class of galaxies is named after him.

Hyman Solomon Spigl born; an Australian astronomer and surveyor; government astronomer of Western Australia.

Karlis Augustovich Šteins born; Director of the Latvian University's Astronomical Observatory; studied comets; designed astronomical instruments.

George Johnstone Stoney died; an Irish physicist; assistant to William Parsons, third Earl of Rosse at Birr Castle; studied solar physics.

William Sutherland died; a Scottish born Australian physicist; studied the origin of the spectra and the source of the Earth’s magnetic field.

Gordon Webb Wares born; a Canadian born American physicist; pursued experimental and observational astrophysics.

Francis Richard Wegg-Prosser died; an English mathematician; wrote *Galileo and his Judges*, 1889.

Dai Wensai born; a Chinese astronomer; Director of the astronomy department of Nanjing University; worked on stellar spectroscopy, stellar astronomy and the origin of the solar system.

Harry Wexler born; an American meteorologist; worked on weather satellites.

Kenneth Osborne Wright born; a Canadian astrophysicist; worked at the Dominion Astrophysical Observatory; studied stellar atmospheres and eclipsing binaries.

Mikhail Kuz'mich Yangel' born; a Soviet designer of space-rocket systems.

Romuald Zalubas born; a Lithuanian physicist; studied the solar spectra.

6 Libræ occulted by Jupiter III (Ganymede) on 13 August.

Ejnar Hertzsprung noticed that the colour of Jupiter’s satellite Io was orange.

The D-ring of Saturn observed by R. Jonckheere in Lille in November.

A fall of meteorites at Tonk, India, on 22d January.

Nikolaj Sergeevich Maizov deeded his private observatory at Simeis to the Pulkovo Observatory; it was officially opened the following year.

Michigan University observatory obtained a 37-inch reflector.

R.W. Wood obtained ultra-violet photographs of the Moon and planets.

The American Association of Variable Star Observers founded by Edward Charles Pickering and William T. Olcott.

The American Meteor Society founded by Charles Pollard Olivier.

THE *TRANSIT* QUIZ

Answers to November's quiz

You were asked to fill in the gaps …

1. The closest and brightest of the red long-period variable stars is **MIRA**.

2. The greatest apparent magnitude of the planet Venus is **–4.7**.

3. The **W.M. KECK OBSERVATORY** consists of two 10 metre telescopes, situated at the summit of Mauna Kea, Hawaii.

4. The bright and compact astronomical radio source at the centre of the Milky Way, thought to be a super-massive black hole, is known as **SAGITTARIUS A*** (pronounced SAGITTARIUS A-STAR).

5. The constellation Horologium was originally named in honour of Christian Huygens. It is more commonly known as **THE CLOCK**.

6. The three chemical elements created at the time of the Big Bang were **HYDROGEN**, **HELIUM** and traces of **LITHIUM**.

7. As a distant galaxy recedes, the frequency of the light received by an observer on Earth decreases. It is said that the light of the galaxy is **REDSHIFTED**.

8. Valued at approximately 72 km/s per megaparsec, this parameter is commonly known as the **HUBBLE PARAMETER** (or Hubble Constant).

9. The visually disappointing long-period comet designated C/1973 E1 observed by the crew of Skylab 4 and Soyuz 13 is commonly known as Comet **KOHOUTEK**.

10. Discovered by William Herschel in 1784 and designated NGC 6992, this difficult-to-find deep-sky object is otherwise known as the **VEIL NEBULA**.

December's quiz

I'm doing a distance-learning course in solar astrophysics this year (well, someone has to keep English universities solvent…), so the Sun is much in my mind just now. With the solstice due later this month, meaning that summer is almost *here, this month's quiz focuses on our nearest star.*

1. About 71% of the Sun's mass is hydrogen. What gas makes up a further 27%?

2. How long does the Sun take to orbit the centre of our Galaxy? And so, roughly how many times has it completed the full circuit?

3. The core is where all the nuclear fusion and energy production gets done. What percentage of the Sun's volume does the core occupy?

4. Energy diffusion from the core to the outer edge of the radiative zone (at about 70% of the Sun's radius) takes around 170,000 years. How long does it take to travel the remaining 30% through the convective zone to the surface?

5. Who first showed (in 1939) that the source of the Sun's energy was nuclear fusion (he won the Nobel Prize for Physics in 1967 for this)?

6. What is the scientific name for the study of the internal structure of the Sun by measuring solar oscillations and vibrations?

7. Because the Sun has strong magnetic fields, some of the lines in its spectrum are split into two or three components. What's this effect called?

8. Sunspots appear dark because they're cooler than the temperature (5780 K) of the general photosphere. What sort of temperature range do they have?

9. What do the initials CME stand for?

10. Whose names are attached to each of these 'laws' of sunspot behaviour?
    - In a pair of sunspots, the leading and trailing spots have different magnetic polarities.
    - The line joining the centres of a pair of spots tilts (forward) more for higher-latitude pairs.
    - New sunspots appear nearer and nearer to the equator as the solar cycle progresses.