TRANSIT

The January 2011 Newsletter of

NEXT MEETING

14 January 2011, *7.15 pm for a 7.30 pm start*

Wynyard Planetarium

Galaxies with proper names

Dave Newton, *Sunderland A.S.*

Contents

Editorial

Rod Cuff

December's weather probably sorted out the really hardy observers from the rest. Beautiful as some of the crystal-clear nights were, I used the fact that often the stars appeared to be twinkling wildly to convince myself that seeing would be poor and therefore I needn't feel obliged to stand for hours with snow half-way up my calves and in temperatures of many degrees below freezing.

And so I studied last month's lunar eclipse from the relative warmth of a downstairs room with a clear north-west view, knowing that the aforesaid hardy observers would be bound to come up trumps – and so it proved. Take a bow, Keith Johnson and John McCue, whose photographic output appears in this issue.

This month there is of course another eclipse, this time a partial solar eclipse visible at sunrise on 4 January. Rob Peeling gives more details in *Skylights*; please do your stuff again, photographers! It's likely to be an eclipse that more than the usual number of people will know about, as the first of Brian Cox's three nightly *Stargazing Live* TV programmes will be flagging it up on BBC Two the evening before. Required viewing or recording for most of us, I imagine.

There are three good and varied 'general' articles this time, too. Many thanks to all contributors to this issue. And to everyone reading this and to their families – I hope you have a stimulating and happy 2011.

Finally, a reminder that our AGM and Members' Night will be on 11 February. Committee members will be elected or re-elected; if you are interested in being on the committee, please contact the General Secretary, Alex Menarry (general-secretary@cadas-astro.org.uk). And if you'd like to present a short talk during the second part of the evening, please contact the Meetings Secretary, Neil Haggath (meetings-secretary@cadas-astro.org.uk).

The copy deadline for the February issue is **Friday 28 January**.

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

Letters

I really wish I didn't have to write this…!

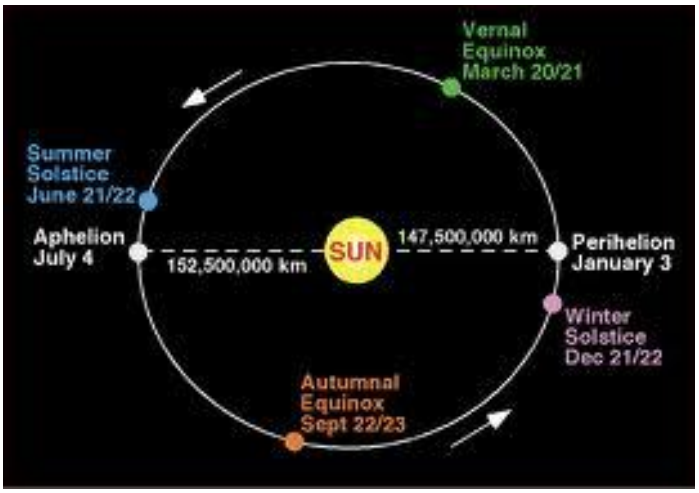
from Neil Haggath

On Sunday 18 December, I came across yet another appalling example of the state of today's education system. A news item on the website of my supposedly 'reputable' ISP, concerned with the latest update on the snow and cold weather, included the following brilliant insight:

'It may get even colder on Tuesday, with the Winter Solstice – the time when the Earth is furthest from the Sun.'

Er – WHAT???!!! (Bangs head on wall once again…) Is it any wonder that so many people today live in a state of total ignorance, and labour under idiotic misconceptions, when supposedly 'reputable' media propagate this kind of senseless drivel??

Evidently, the genius who wrote this piece of garbage actually thinks that summer and winter are caused by the Earth being closer to and further from the Sun! (Sadly, he's not alone; an appallingly large proportion of people today apparently share the same delusion.) I can only assume that he is so staggeringly ignorant as to not even *know* that the seasons are reversed in opposite hemispheres. **DUH!!!!**



For the record, just in case anyone doesn't know, the Earth is in fact *closest* to the Sun just a few days after the *Northern* Winter Solstice, at the beginning of January, and furthest from it at the beginning of July. As we all know, the seasons have nothing whatsoever to do with the Earth's distance from the Sun, and everything to do with the tilt of its axis.

Of course, the Earth–Sun distance *does* vary; this is where the misconception arises, especially as the Earth's elliptical orbit is usually exaggerated in diagrams in popular books. In reality, it's so close to circular that if it were drawn to scale, you would have to look closely to tell the difference. The distance varies by only 3%; the difference in temperature due to this variation is minuscule, compared with that due to the axial tilt.

When I was at school in the 1970s, we were taught about the Earth's axial tilt and the cause of the seasons in geography classes, at the age of 12. (I personally understood it several years before that, owing to my interest in astronomy, but that was the age at which it was taught at school.) I honestly have no idea what they are actually teaching kids at school these days!

Neil

Weather predictions

Keith Johnson

As some of you may know, I use a number of websites for weather prediction when planning any imaging session. There is, however, one site that gets the weather forecast prediction bang-on every time, and the satellite imagery is amazing, too. Check out www.yr.no/satellitt/europa_animasjon.html – but please bear in mind it can take about 30 seconds for all of the animation to load.

Keith

Skylights – January 2011

Rob Peeling

The Moon

4 January	12 January	19 January	26 January
New Moon	First Quarter	Full Moon	Last Quarter

A **partial solar eclipse** is visible at sunrise on 4 January. *Ed is organising public observing that morning at the Planetarium.*

The extent of the eclipse is very variable across the United Kingdom, with the maximum in London being 67%, decreasing to 38% in Edinburgh. Teesside will be somewhere in between. First contact is at 06:40 UT and final contact at 11:01 UT. This event will be well worth observing. I remember watching a similar sunrise partial eclipse at the Planetarium. The Sun was a gorgeous cherry colour as it rose with a dark cut-out. Wonderful!

Atmospheric phenomena

Given the cold weather we've been having, ice crystals are likely to be about, high in the sky. This could lead to interesting phenomena around the Sun, such as 22° circles and sundogs. It would be worth keeping a look out for these things. www.atoptics.co.uk is a mine of information on what it is possible to observe. In October there was considerable excitement in Johannesburg when I was there because a 22° circle was observed around the Sun by many people. On the day I'm writing this, I was delighted to see my first sundogs from a train travelling along the north coast of Lake Ontario. The sky wasn't particularly clear and the Sun was partially obscured by cloud, but the small rainbow arc about 20° away to one side of the Sun was very clear.

The planets

In January the evening sky continues to be dominated by **Jupiter**, with **Venus** prominent as the Morning Star. There are four nights in the month where more than three events involving the moons of Jupiter and/or the transit of the Great Red Spot occur between 18:00 and midnight. These are the best nights to observe Jupiter in terms of interest.

Jan 03 18:28 Great Red Spot transit
Jan 03 19:10 Io shadow transit start
Jan 03 19:24 Ganymede shadow transit end
Jan 03 20:06 Io transit end
Jan 03 21:23 Io shadow transit end

Jan 10 18:32 Ganymede transit end
Jan 10 19:18 Great Red Spot transit
Jan 10 19:50 Io transit start

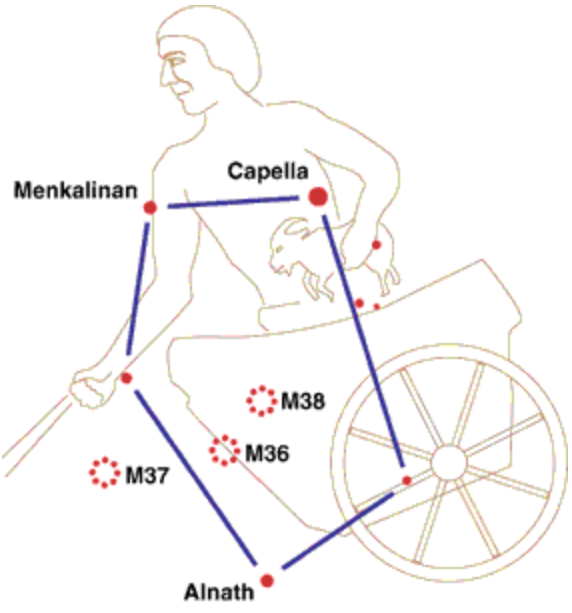
Jan 10 20:40	Ganymede shadow transit start
Jan 10 21:06	Io shadow transit start
Jan 10 22:05	Io transit end
Jan 10 23:19	Io shadow transit end
Jan 10 23:25	Ganymede shadow transit end
Jan 17 19:42	Ganymede transit start
Jan 17 20:07	Great Red Spot transit
Jan 17 21:49	Io transit start
Jan 17 22:48	Ganymede transit end
Jan 17 23:02	Io shadow transit start
Jan 26 18:20	Io transit start
Jan 26 19:27	Io shadow transit start
Jan 26 20:35	Io transit end
Jan 26 21:40	Io shadow transit end
Jan 26 22:35	Great Red Spot transit
Jan 26 22:51	Callisto transit start
Jan 26 23:49	Callisto transit end

Meteors

The **Quadrantids** are the principal shower for January, lasting from 28 December to 7 January with the maximum on 3 January. According to David Levy this shower yields 40–200 meteors per hour and they tend to be bluish. Stockton skies will yield a much lower rate.

Deep sky

January is a good month to study **Auriga**. There are, of course, the three **Messier open clusters M36, M37 and M38**. These are all easy binocular objects and it is interesting to compare and contrast the spread and richness (number of stars) you can see in each cluster. With binoculars, also look for the well-known **Leaping Minnows asterism** to the west of M38. This is visible with the naked eye at dark sites, as indeed the Messier clusters may be – I haven't succeeded in seeing them this way, though.



Look out for the smaller but easy-to-find **cluster NGC 1907**, roughly 0.5° south of M38 – so it should be visible in a low-power view of M38.

Another interesting target is the **cluster NGC 1931**, which lies about midway between the star φ (phi)

Aurigae and M36. It is a bright but seemingly fairly sparse cluster that contains a triple star in the middle. It also contains some quite bright and easy nebulosity (*see the picture on the next page*). It can sometimes look a bit like a planetary nebula.

NGC 1931 (*Al and Andy Ferayorni/Adam Block/NOAO/AURA/NSF*)

To the north-west of the western of the two 'minnows' (in the Leaping Minnows asterism), which contains 16, 17, 18 & 19 Aurigae, is the **variable star AE Aurigae**. This is surrounded by the **Flaming Star nebula, IC 405** (*see below*).

It's not the easiest nebula to spot, but in a good clear sky and perhaps with the help of a CLS or UHC filter the areas closest to the star may be seen. It is a favourite for imagers.

AE Aurigae is an example of a 'wandering star'; it is believed to have originated in the region of ι (iota) Orionis and been ejected from Orion because its binary companion went supernova. The nebulosity is the result of its encounter with a gas cloud in its travels.

IC 405 Flaming Star Nebula (*Brian Lula*)

Total lunar eclipse, 21 December 2010 (1)

Keith Johnson

Using a digital SLR camera, I captured a total of 75 frames of the pre-Christmas total lunar eclipse. I've chosen four of them (*below*) to create an attractive sequence. I've also sent them to the BBC's *Sky at Night* team, so they *may* turn up in next month's programme …

Equipment:

- 127mm Triplet refractor
- EQ6 Pro mount
- Canon 1000D DSLR camera

Total lunar eclipse, 21 December 2010 (2)

John McCue

Here's a preliminary picture of the eclipse just before it went completely into the Earth's shadow. It set before it could emerge from the shadow, but it was a fascinating sight.

GENERAL ARTICLES

Star of wonder[1]

John Crowther

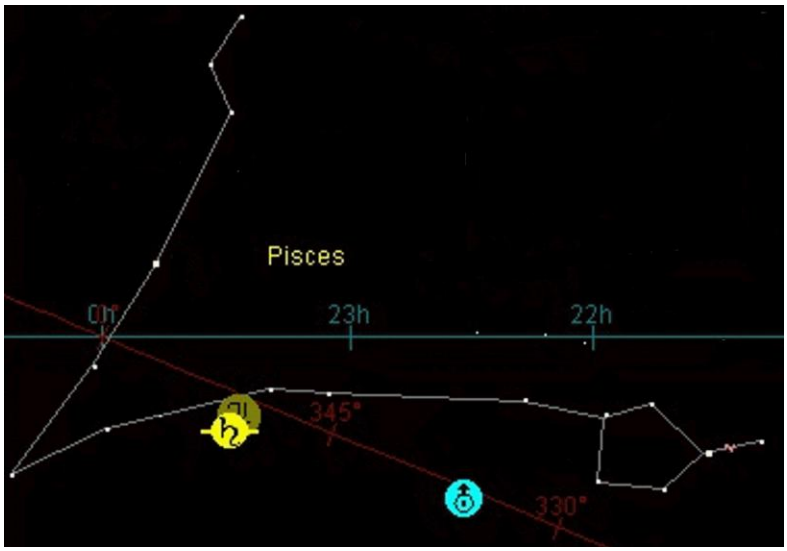
The birth of Jesus is described in only two of the Gospels, Matthew and Luke, and only Matthew mentions the story of the 'wise men' following a star. For most of 2000 years people have wondered about the star – what was it? Did astronomers record anything strange and could we try to pin down the year and date of Jesus' birth? Or was the whole thing invented as a poetic way of

[1] *[This article is adapted from one in the Winter 2010 issue of a religious magazine called 'The Server', but covers a topic of historical interest to both believers and non-believers (well, this one, anyway!). I'm not sure whether John is the original author or not – apologies to the otherwise anonymous author if it's the latter case. – Ed.]*

stressing how they believed Jesus was revealed for all people, not just one privileged race?

It is interesting to look at what historians and astronomers have suggested. It seems likely that the Roman monk who worked out our dating system in the sixth century got his sums wrong. Jesus was probably born between what we call 8 BC, the date of the great census that Luke mentions as Mary and Joseph's reason for going to Bethlehem, and what we call 4 BC, the year in which Herod died. This gives a range of four years to search records for eclipses, comets and odd astronomical occurrences. In the story, it was visible to the wise men, but not to Herod; it seems to have disappeared while the men were on their journey to Judea, and then re-appeared in time to guide them to Jesus. One contender to be the star has always been Halley's Comet, which appears every 76 years and moves predictably. Astronomers can say with certainty that it would have been visible in 12 BC – four years too early.

In the seventeenth century the Czech astronomer Johannes Kepler formulated the basic means by which scientists understand how planets move. In 1603 he observed a conjunction of Jupiter and Saturn in the constellation of Pisces. This is what happens when two planets come into close alignment, so that from Earth they seem to be almost touching one another, and for Jupiter and Saturn this happens about every 20 years. But much more rarely an extraordinary thing occurs. This conjunction becomes visible on three separate occasions in the same year. Kepler's calculations, which modern astronomers have confirmed, show that this happened in the year we call 7 BC, which is within the right period of time.



Who were the wise men? Matthew calls them *Magi*, from the Greek meaning magicians or astrologers. They were a religious group in the Middle East and looked to the stars for predictions. They would have accepted the fact that planets and the Zodiac influenced people in specific ways and they would know of prophecies from the surrounding nations, especially those that spoke of important changes to a nation or of the birth of a significant person. They would have accepted Jupiter as the planet associated with leaders and kings, Saturn as the 'protecting' planet of the Jews, and Pisces as particularly influential on the area of Judea itself. They would have known about Jewish prophecies announcing the coming of a new king. Put it all together, and the conjunctions in 7 BC spelled out quite explicitly to them that the prophecies were about to be fulfilled. The new king of the Jews was about to be born in Judea.

So far, so reasonable, even though most people would now rationally accept that astrology is largely superstition. But for the wise men of the Gospel, the event was something they had to respond to. Modem astronomers have calculated the exact days when the three conjunctions would have been visible in 7 BC: 27 May, 6 October and 1 December. Accepting their theory, that allows the wise men to observe the 'star' at the

time of the first conjunction, recognise its importance, prepare themselves and set off on a journey that could have taken three months. The second appearance of the 'star' may well have been what they observed as they journeyed from Herod to find Jesus, who may therefore have been born sometime in September.

For an Anglican, it would be a shame to lose all the midwinter trappings of the Christmas story; but for an honest Christian it's a useful reminder that 25 December was settled on as the date to think of Jesus' birth centuries later, when it was found to be the best and most appropriate way of Christianising the old Roman winter festivals that centred around that day.

[Why was Jupiter associated with kings? Venus is brighter – but of course it's not a night-long object.]

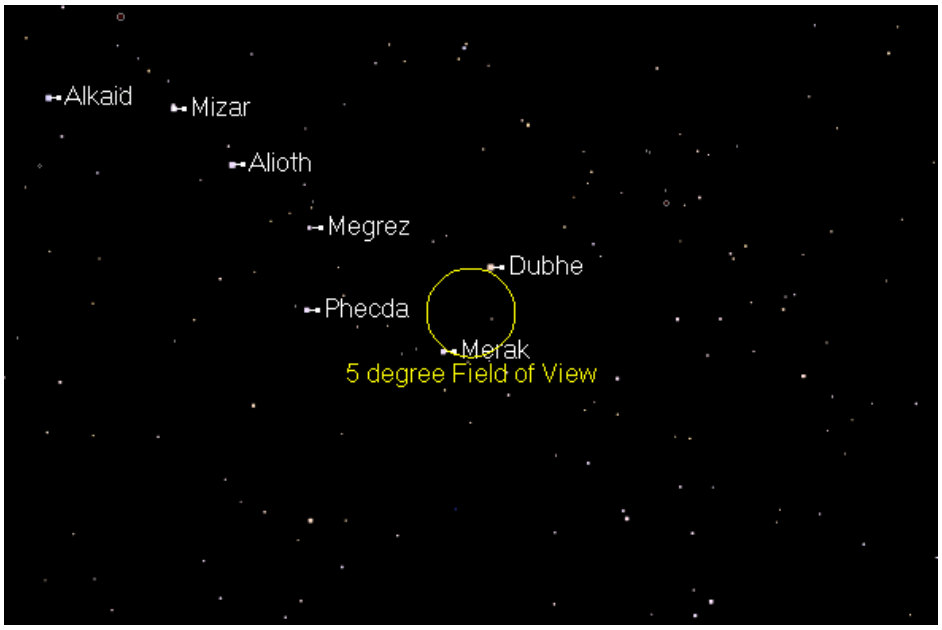
Look again at the Big Dipper!

Andy Fleming

If there's one constellation in the Northern Hemisphere that most living there learnt as a child, it's The Plough, or Big Dipper. Truth be told, it's not actually a constellation at all; it's called an **asterism** -- a pattern of stars seen in Earth's sky that is not an official constellation. Like constellations, they are composed of stars which, while they are in the same general direction as we look at them, are not physically related, often being at significantly different distances from Earth. The Big Dipper (named after the huge soup-ladle farmers' wives would use to serve up to the farmhands at the end of a busy day's work) is actually part of the sprawling constellation of **Ursa Major**, home to wonders aplenty in terms of deep-sky objects.

Here, though, we're just going to concentrate on the Big Dipper. To observers in North America, Europe and Asia, both it, and indeed Ursa Major itself, are circumpolar collections, meaning that they're visible every night throughout the year -- their stars never set.

And so to a tour of the stars of this asterism, all visible with the naked eye in all but the most appalling light pollution. Binoculars will start to reveal its true beauty, and a small telescope will give superb details of the multiple-star members.



Starting in the top right hand corner of the bowl of the ladle, **Dubhe** (alpha Ursae Majoris [α UMa / α Ursae Majoris]) is the second-brightest star in the constellation of Ursa Major, and is about 124 light years away. It is typical of a red giant, an evolved helium-burning star. It is also a

multiple star, orbited by a main-sequence companion, Dubhe B, at a distance of about 23 astronomical units (AU), as well as a close pair, Dubhe C, at a distance of about 8000 AU.

Journeying anticlockwise, we come to **Merak** (beta [β] UMa). Both it and Dubhe are familiar to Northern Hemisphere observers as the 'pointer stars' in the Big Dipper, and a line connecting them and moving north extends to Polaris, located at the North Celestial Pole in the current epoch. Merak is fairly typical for a main-sequence star of its type, although, being slightly hotter and larger than our own Sun, it shines several times brighter. The star is surrounded by a cooling disk of dust, much like those discovered around Fomalhaut and most notably Vega. No planets have been discovered orbiting Merak, but the presence of the dust indicates that they may exist or be in the process of forming.

Moving to the left of the bowl we come to **Phad or Phecda** (gamma [γ] UMa). It's an average main-sequence star not unlike our Sun, although somewhat hotter, brighter and larger.

At the top left of the bowl is **Megrez** (delta [δ] UMa). Megrez has an apparent magnitude of +3.32, making it the dimmest of the seven stars in the Big Dipper. Located 81 light years away, it is a bluish-white main-sequence star. It has two faint companions, the 11th-magnitude δ UMa B, 190 arcseconds away, and the 10th-magnitude δ UMa C, 186 arcseconds away.

Moving to the left, we first come to **Alioth** (epsilon [ε] UMa). This is the brightest star in the entire constellation of Ursa Major, at magnitude +1.76. It is the star in the tail of the bear closest to its body, and thus the star in the handle of the Big Dipper closest to the bowl. Historically, the star was frequently used in celestial navigation in the maritime trade, because it is listed as one of the 57 navigational stars.

Further out along the handle of the Big Dipper, we arrive at **Mizar** (zeta [ζ] UMa), 78 light years away. It is a quadruplet system of two binary stars, with an apparent magnitude is +2.23. Its name comes from the Arabic *mīzar*, meaning a waistband or girdle.

With normal eyesight one can make out a faint companion just to the east, named **Alcor**, or 80 UMa, at magnitude 3.99. Mizar and Alcor together are sometimes called the 'Horse and Rider', and the ability to resolve the two stars with the naked eye is often quoted as a test of eyesight, although even people with quite poor eyesight can see the two stars. They lie three light-years apart, and though their proper motions show that they move together, it was long believed they do not form a true binary-star system, but simply a double star. New data reveals that Alcor actually is itself a binary, consisting of Alcor A and Alcor B, and that this binary system is most likely gravitationally bound to Mizar, bringing the full count of stars in this complex system to six.

Lying at the end of the handle is **Alkaid** (eta [η] UMa). It has apparent magnitude +1.9, and is a young bluish-white main-sequence star. Burning at 20,000 K, it is one of the hotter stars visible with the naked eye.

So go and enjoy the Big Dipper, arm yourself with some 10×50 binoculars, and see how many double stars you can resolve in this lovely asterism!

Chasing chickens

Ray Worthy

'What on Earth has chasing chickens got to do with CaDAS?' I can imagine you thinking. Stick around and you'll find out.

After a long absence from CaDAS regular meetings, I was taken to the *Hamilton Russell Arms* pub, where I met several new members who knew nothing about the history of how the Wynyard Planetarium (*left*) began. Well, it had to have started somewhere and at sometime, and so it did. This is the story.

When I took early retirement from the classroom to embark upon the planetarium business, I found the experience quite exhilarating. When I started *making* domes, as opposed to just using them, the feeling was intensified. Instead of being confined between the four walls of the classroom, I found that I was travelling the length and breadth of the land, with ventures into Europe and the USA. Furthermore, the cost of the travel could be legitimately charged to the business.

Quite early in this phase of my career, I found myself in the warren of corridors and offices behind what was then the London Planetarium. There was some meeting or other, I forget what. It was there that I met Johan.

Johan Gijsenbergs[2] was a young planetarian from Belgium. Even then, he had a brilliant track record. From scratch, he had taken upon himself to construct a planetarium in the town of his birth – Genk, not far from the German border. Because of his drive and determination, he had managed to get funding from various bodies, including the European Union, and had constructed the Europlanetarium, which gave star shows in three or four languages. It was a story any one of us would be proud of.

As I mentioned, I've forgotten exactly what the meeting was about, but I do remember that Johan was preparing to submit a report about his visit to a planetarium somewhere. Johan and I found that we got along very well indeed, and soon I was perusing his report before it was published. I had to take him aside and explain that he could not print it. He was writing in English, which is not his native tongue. He had done very well, but, scanning the finished piece, his eye did not pick up a crucial mistake. He had wanted to say how hospitable the staff of a particular institution had been but had made a typing error.

He had written something like this: 'On my visit, I was made very welcome by all the gays on the staff.' He had failed to pick up the significance of the 'a' instead of the 'u'.

After he had got the point, Johan was mortified and asked me to have a look through other English articles he had written. I offered any help I could give.

Later, after the meeting, Johan told me about a project he was engaged upon at home.

The area around Genk had been a flourishing mining district rather like County Durham, but had to come to terms with the fact that the industry had gone away. The local Chamber of Commerce was trying to put together some multi-lingual brochures extolling the beauties and traditions of Genk. Johan was responsible for the English version. He asked me if I could possibly give his writing the once-over. I agreed to undertake the task, and when I got home the e-mails started flooding in.

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[2] *[Johan gave a talk to CaDAS about planetaria in December 2002. – Ed.]*

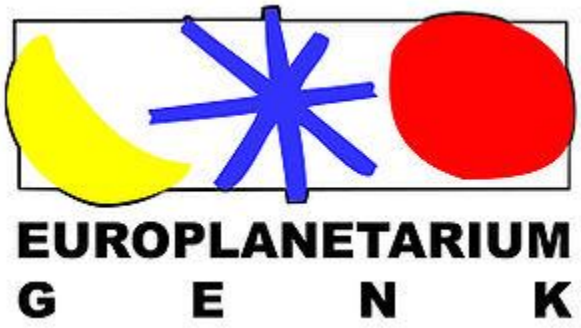
Now, we reach the 'chasing chickens' bit. All over Europe, Shrove Tuesday gives rise to various archaic and peculiar customs. We have an example in our own backyard. Sedgefield village is the host to a strange game of football; the field is the whole village and the game can go on all day. In the past it has put many a man in hospital.

The peculiar ceremony in Genk is one in which hundreds of chickens are let loose in the streets of the town. There is a competition to see how many chickens one can pick up and tuck underneath one's arms. Each competitor has to pass through a certain doorway set up for the purpose. Of course, the fun comes when that extra chicken has to be picked up with one's arms already full of struggling fowls. Apparently, the whole town turns out and has a great time.

In the version presented by Johan, he had written the memorable sentence, 'People go round the town catching hold of cocks liberated by members of the public.'

Once I had come across that sentence, I realised that I had to do a really thorough job. The task of getting the nuances right was surprisingly difficult. I had to work with Johan's version and someone else's French edition. It took me about three weeks.

Towards the end of that summer, I had to go over the Channel. I remember that one of the places I had to visit was Sorbiers, a suburb of Saint Etienne in France, the home of the Cosmodyssée Dome.



Johan invited my wife Josie and me to spend a few days with him and see the places we had written about. We cemented our friendship by laughing all the time. The visit was memorable. We had been given a grand tour of the Europlanetarium and were mooching about underneath the floor of the main dome theatre. Johan opened a cupboard door, and there before us were the rusty remains of a Spitz A1 projector. It had been built in 1950 to train American Air Force pilots in their astronavigation.

It was a surprise to Johan. He had forgotten all about it and had not seen it for several years. The projector had been owned by someone who had died and whose widow had donated it to the Brussels Planetarium. At that time, the Director was a man called Gerard Bodifée, famous in Belgium as a science writer. During the period when Johan was getting his act together, Gerard passed the Spitz over to him as a back-up. It was never used, because Johan got a substantial grant from the European Community and was able to afford a brilliant Zeiss.

Johan realised that I was examining the Spitz with great interest. I knew it would be too bulky to take on tour inside an inflatable dome, but my eyes must have been sparkling, because he said to me, 'Can you think of a good home for it?'

'Could I?' I thought.

'I'm sure I can,' I answered, and told him about CaDAS.

Josie and I could not be allowed to take it with us straight away. Some formalities had to be gone through with the trustees, so we had to go back to Genk just before Christmas. As we came out of the Tunnel into France, we were hit by a snowstorm, and by the time we reached Brussels, there were drifts four feet deep. It was not so bad when we pushed our way through to Genk, but it was bitterly cold.

So, finally we brought the Spitz to Hartlepool, where it lay in my workshop – sorry, garage.

As soon as the festivities were over, John McCue came over and we began to assess what had to be done. It was at once apparent that all the electrics were shot. Being laid up in a cupboard for all those years had done them no good at all. The mechanical parts were not too bad, so we thought that we should go ahead. This is where the talents of some of our members came to the fore. Ron Peacock put in some sterling work, as did Ed Restall.

I personally didn't do much, as the enthusiasm of the others took the problems away from me. The only sphere of knowledge I could offer was that of modern sub-miniature halogen-cycle lamps. These tiny lamps, created for dentists and doctors, were ideal for my requirements in the mobile planetarium business. With filaments no longer than a millimetre, they were brighter than what was formerly available by a long chalk.

All in all, as far as I can recollect, that phase took nearly three years of patient work. It was only then that we could see that the scheme was practical and we could begin to think of building the planetarium itself.

Many years ago, when I was working in the Research Department in ICI Nylon, I was required to build all manner of esoteric constructions. I remember that, at one time, I was really struggling with the construction of a vapour-phase chromatograph. There were no others in the country. I can remember the guiding dictum lain down by my boss. He said, 'Cut out the frills. Get something working. All the rest will follow later.'

So, here am I passing on this advice to the next generation, YOU: get something working and others will see and offer to help.

Bringing home the Spitz (*see the picture above*) acted like the start of a snowball, which grew and grew. A Planetarium Committee was formed and, despite vandalism and foot & mouth disease, the Planetarium took shape. The finished result is so cosy and attractive that I get goosebumps whenever I enter the place.

Answers to December's quiz

The questions were all about the Sun.

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

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? ***220 million years**. The Sun and solar system are about 4.6 billion years old, so we've been around **about 21 times**.*

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? *The core extends about 25% of the way to the surface, so occupies roughly 100% × $(0.25)^3$ or **1.6%** of the Sun's volume.*

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? ***About 10 days**.*

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)? ***Hans Bethe**.*

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

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? *The **Zeeman** effect, or Zeeman splitting. It was predicted by Hendrick Lorentz and first measured experimentally by Pieter Zeeman; they shared the 1902 Nobel Prize for Physics.*

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? ***About 2000–4000 K**.*

9. What do the initials CME stand for? ***Coronal Mass Ejection**.*

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. ***Hale***.
    - The line joining the centres of a pair of spots tilts (forward) more for higher-latitude pairs. ***Joy**.*
    - New sunspots appear nearer and nearer to the equator as the solar cycle progresses. ***Spörer**.*

December's quiz

If you can't wait until next month, answers to these questions are all in the January issue of *Sky at Night* magazine.

1. In what year did Apollo 14 land on the Moon, and who was its captain?
2. Which planet has Helene as one of its moons?
3. Which comet was visited by NASA's Deep Impact spacecraft on 4 November 2010?
4. What's the name of the annual conference & exhibition for amateur astronomers held in Kensington Town Hall every February (4–5 February this year)?
5. What have 21 December 2010 and 15 June 2011 got in common?
6. What is the usual name for 'failed' stars of between about 5 and 90 Jupiter-masses?
7. What part of the electromagnetic spectrum does NASA's Fermi space telescope study?
8. … And what about NASA's Chandra space telescope?
9. While we're on space telescopes: which one has just had its planned launch date delayed from June 2014 to September 2015 at the earliest?
10. What are parhelia better known as?