TRANSIT

The October 2010 Newsletter of

Cleveland & Darlington Astronomical Society

<u>NEXT MEETING</u> (*NB the venue this month!*)

8 October 2010, *7.15 pm for a 7.30 pm start*
Grindon Parish Hall, Thorpe Thewles

Thomas Wright Trophy quiz competition

Between CaDAS (*holders*), Durham AS and Durham University AS

Quizmaster: Neil Haggath

Contents

Editorial

Rod Cuff

Prompted by Neil, I'd like to draw your attention to an online petition at http://scienceisvital.org.uk, summarised there as follows:

> *We are a group of concerned scientists, engineers and supporters of science who are campaigning to prevent destructive levels of cuts to science funding in the UK.*
>
> *The UK has a proud history of excellence in science, technology, engineering and mathematics. We are world-leaders in many fields of research, producing over 10% of global scientific output with only 1% of the global population, and despite spending less on science per capita than most of our competitors.*
>
> *Investing in research enriches society and helps drive the economy. It led to our preeminent position in the 20th century, and will be vital in meeting the challenges of the 21st – whether they be in energy, medicine, infrastructure, computing, or simply humanity's primal desire for discovery.*
>
> *Our world-class research universities and institutes which attract excellence and investment from around the world have made us a global hub for science. Nations such as the United States, China, Germany, and France have all recognized the importance of investing in science especially in austere times – it could be catastrophic for the UK to do the exact opposite.*

Although investment in astronomical research is only a small fraction of what's under review, the possible cuts could put Britsh astronomy under grave threat. I've signed the petition – I urge you to consider doing so yourself.

Looking more locally, we're now nicely into the observing season, if only there were clear skies that would allow some observing. Jupiter is the dominant feature in the southern sky at the moment, at its closest for decades and well served by Keith's pictures in this issue. Rob's *Skylights* lists many interesting sights to see as the planet's satellites pass in front of or behind the planet, and his Lyra tour this month is one I certainly want to explore if weather permits.

However, I'm away for the latter half of the month. November's *Transit* will be in the very capable hands of guest editor Andy Fleming (who also has an article in this month's issue). **If you have any items for the next issue *before* October 14, please send them to me; but from the 14th on, please send them to Andy (contact details for both of us are below).**

The copy deadline for getting material to Andy for the October issue is **Wednesday 27 October**.

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Paul Duggan

John McCue

Members will know from last month's *Transit* of the recent death of Paul Duggan. It is with great regret and personal sadness that I submit this short appreciation. A fuller tribute to Paul's work will follow soon.

Paul, who lived under the dark skies of Osmotherley, was a long-standing member of our society. He was a dedicated teacher and regularly visited local community groups with his wife Pat, also a CaDAS member, to pass on his enthusiasm for the exploration of the universe.

My own fond memories of Paul are of his unstinting and selfless efforts, again with Pat, as part of the volunteer team (mainly comprising members of our society) that fitted out the interior of Wynyard Planetarium before its opening in 2005. During my time at the planetarium it was always a pleasure to see Paul and Pat arrive, sharing their time and knowledge with me and borrowing telescopes and books. That the planetarium continues to provide a service for local schools and community groups would have pleased Paul and is a testament to his enthusiasm and dedication.

OBSERVATION REPORTS AND PLANNING

Skylights – October 2010

Rob Peeling

The Moon

7 October	14 October	23 October	30 October
New Moon	First Quarter	Full Moon	Last Quarter

Planets

Jupiter is the second brightest object (after the Moon) in the night sky at the moment. Try http://acquerra.com.au/astro/software/jupiter.html for predictions of the transit times of the Great Red Spot. I can remember seeing it myself once while I was still at school. Dave Blenkinsop has shown me a sketch of the Great Red Spot he made this year with a 6" telescope. It should be easier with the South Equatorial Belt missing. Part of the process causing the belt to disappear seems to have darkened the spot. Dave's suggestion is to use a blue filter, if you have one, to increase the contrast of the red colour against the surrounding white zones.

Here's a table of events involving the Galilean moons. I've used colour to link them into blocks that could be covered in one observing session.

1 Oct	21:01 UT	Europa transit ends (shadow still in transit)
	21:34	Io disappears behind Jupiter
	21:38	Europa shadow transit ends
2 Oct	00:06	Io reappears from Jupiter's shadow
	20:58	Io transit ends (shadow still in transit)
	21:18	Io shadow transit ends
8 Oct	20:33	Europa transit starts (moon in front of Jupiter's disk)
	21:29	Europa shadow transit starts
	23:16	Europa transit ends
9 Oct	20:29	Io transit starts
	20:59	Io shadow transit starts
	22:43	Io transit ends
15 Oct	21:03	Ganymede shadow transit starts
	21:25	Ganymede transit ends
	22:49	Europa transit starts
16 Oct	00:03	Ganymede shadow transit ends
	22:14	Io transit starts
	22:54	Io shadow transit ends
17 Oct	00:29	Io transit ends
	01:09	Io shadow transit ends
	22:24	Io reappears from Jupiter's shadow
22 Oct	21:52	Ganymede transit starts
23 Oct	00:50	Ganymede transit ends
	01:06	Ganymede shadow transit starts
	01:06	Europa transit starts

24 Oct	00:01	Io transit starts
	19:32	Europa disappears behind Jupiter
	21:16	Io disappears behind Jupiter
25 Oct	19:19	Io shadow transit starts
	20:42	Io transit ends
	21:33	Io shadow transit ends
30 Oct	01:21	Ganymede transit ends

Uranus is made an easy target by its proximity to Jupiter. In October, a couple of stars of similar magnitude to Uranus (20 and 24 Piscium) get in on the act, so be careful. Uranus lies all month north-east of Jupiter (up, to the left). Jupiter starts the month above and to the left of two stars. On 6 October, Jupiter crosses between the two. Thereafter 20 Piscium is between Jupiter and Uranus. It is a wide double with a 9th-magnitude companion at a separation of 176” roughly due west. Of spectral type G8, it may well look yellowish in a telescope when compared against blue-green Uranus, so it shouldn’t really be hard to tell it apart from the planet.

Neptune spends October near to μ (mu) Capricorni. It should be readily visible in binoculars or a finder to the north-east of μ at the start of the month and slightly west of north at the end. You shouldn't find any other stars of a similar brightness to confuse you in the area. The nearest of similar magnitude to Neptune is due west of μ.

Meteors

The **Orionid** shower peaks on 20/21 October. These meteors are derived from Halley’s Comet.

Comet 103P/Hartley

Discovered in 1986 and returning every 6½ years. It is expected to be at 6th to 5th magnitude at the start of October, which will be the easiest time to observe it because it will be high in the sky in the evening. Late in the month it will be a morning object but brighter. It should be particularly easy to find on the following nights:

1 Oct Just to the south (below) of Shedir, α (alpha) Cassiopeiae

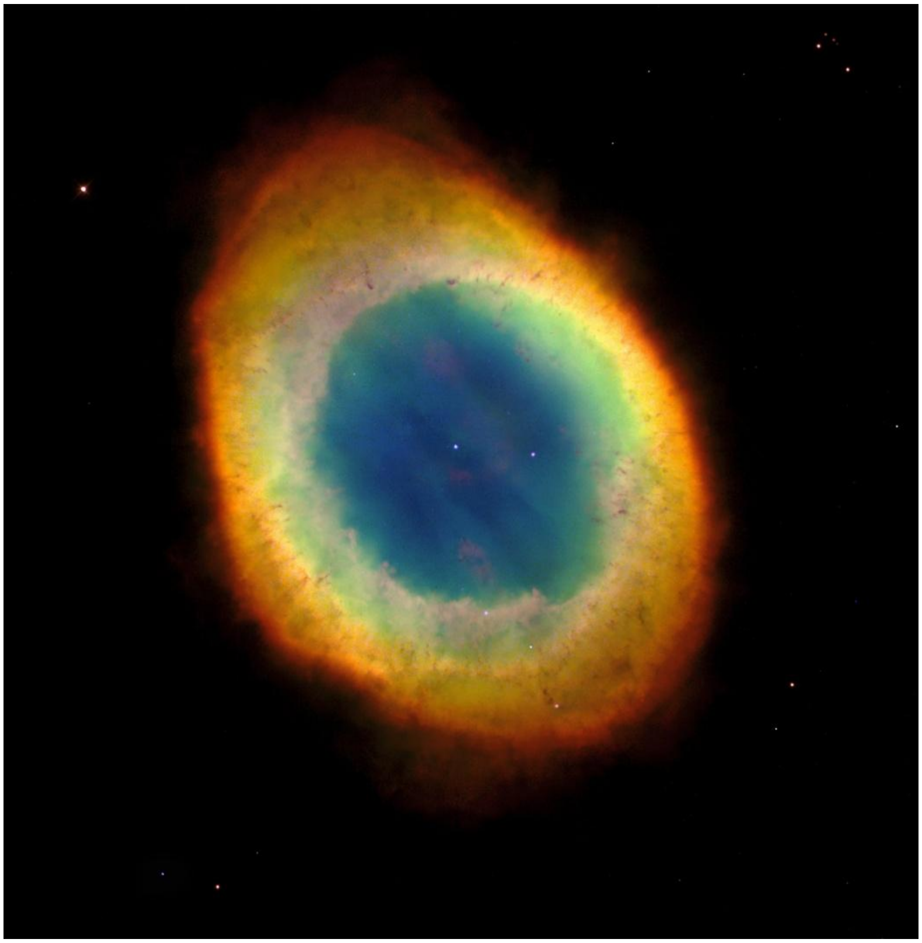
9 Oct To the east of the Double Cluster in Perseus

11 Oct To north-east of η (eta) Persei

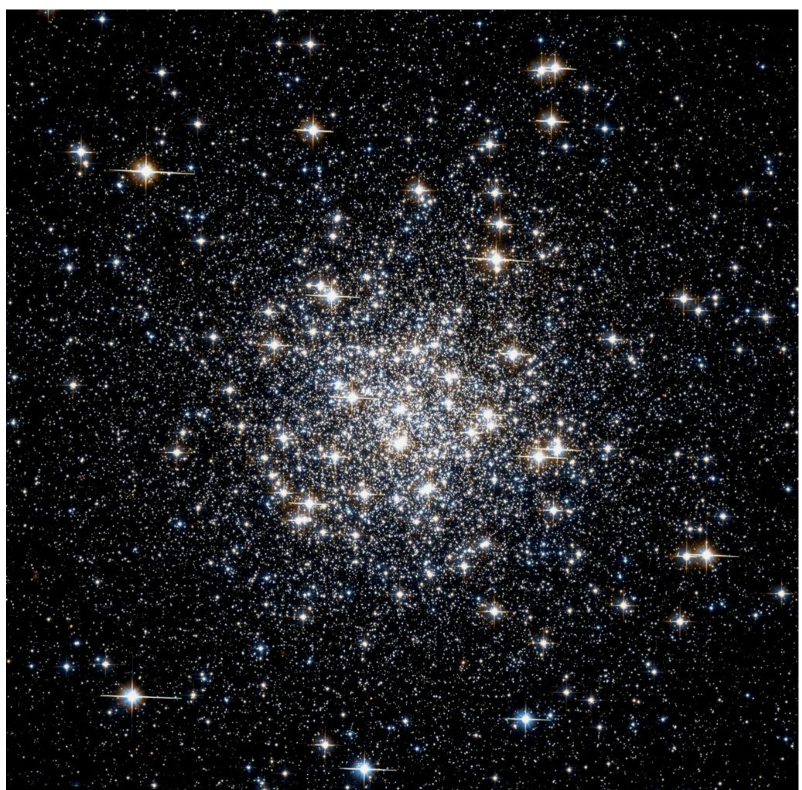
19 Oct Near to ε (epsilon) Aurigae (the Kids)

Deep-sky objects

This month I'll focus on objects in **Lyra**. Let’s start with the one everyone has heard of, **M57 or the Ring Nebula** (*see next page*). Use your finder to aim your telescope exactly halfway between β (beta) and γ (gamma) Lyrae. With a low-power eyepiece, M57 should be visible as a tiny smoke ring. Increase the power and you should be able to see, as John Herschel did, that the ring is not empty. There is a faint mistiness filling it. Also check the shape; the ring isn’t anywhere near a true circle.



The other Messier object in Lyra is **M56**. Look with low power half-way between γ Lyrae and Albireo in Cygnus. M56 is a prominent circular fuzzy beside a star. High power will resolve the stars in this globular cluster (*see right*).



Now focus on **Vega** with high power and look for its companions, two faint stars nearly opposite each other with Vega in the middle. This is an *optical* alignment, with the companions in the distant background behind nearby Vega. The companions are listed in the Washington Double Star Catalogue (WDS) along with a gaggle of other ones too faint to detect without a CCD.

Now try **ε Lyrae**, which should be visible in the finder as an obvious wide double if Vega is in the centre of the field. This is the famous **double-double** and high power (~100×) should split the two pairs for you. Note the way the pair are orientated at right angles to each other. Now look for a star between the pairs, but slightly off to one side. Look carefully near this star for two faint ones actually between the pairs. These are William Herschel's *debillisimae*. There is another, fainter one too, first seen by Lord Rosse with his 6-foot-diameter telescope, the Leviathan of Parsonstown.

Now look for the wide binocular double **δ (delta) Lyrae**. Even in binoculars this is a colour-contrasting pair, consisting of blue δ^1 and orange δ^2. Look more closely with a telescope and the pair are part of a sparse but definite open cluster called **Steph 1**. Swing over to **ζ (zeta)** to find that this star too is a wide double.

Using Vega and ζ Lyrae to mark the base, look for κ (kappa) Lyrae in the finder to define a long, thin triangle. Aim right in the centre of the triangle and examine the area with low power. It will be frustrating initially, but suddenly you'll notice a deep-red star and wonder why you didn't notice it earlier. This is a carbon star and a long-period variable called **T Lyrae** and one of my favourite red stars.

The next target is **β Lyrae or Sheliak**, which is well known as a variable of the eclipsing-binary type. Compare its brightness night on night using binoculars against γ and ζ to see the change. It matches γ at its brightest and ζ at its faintest. In the telescope you will see β as a small group of four stars (all in the WDS).

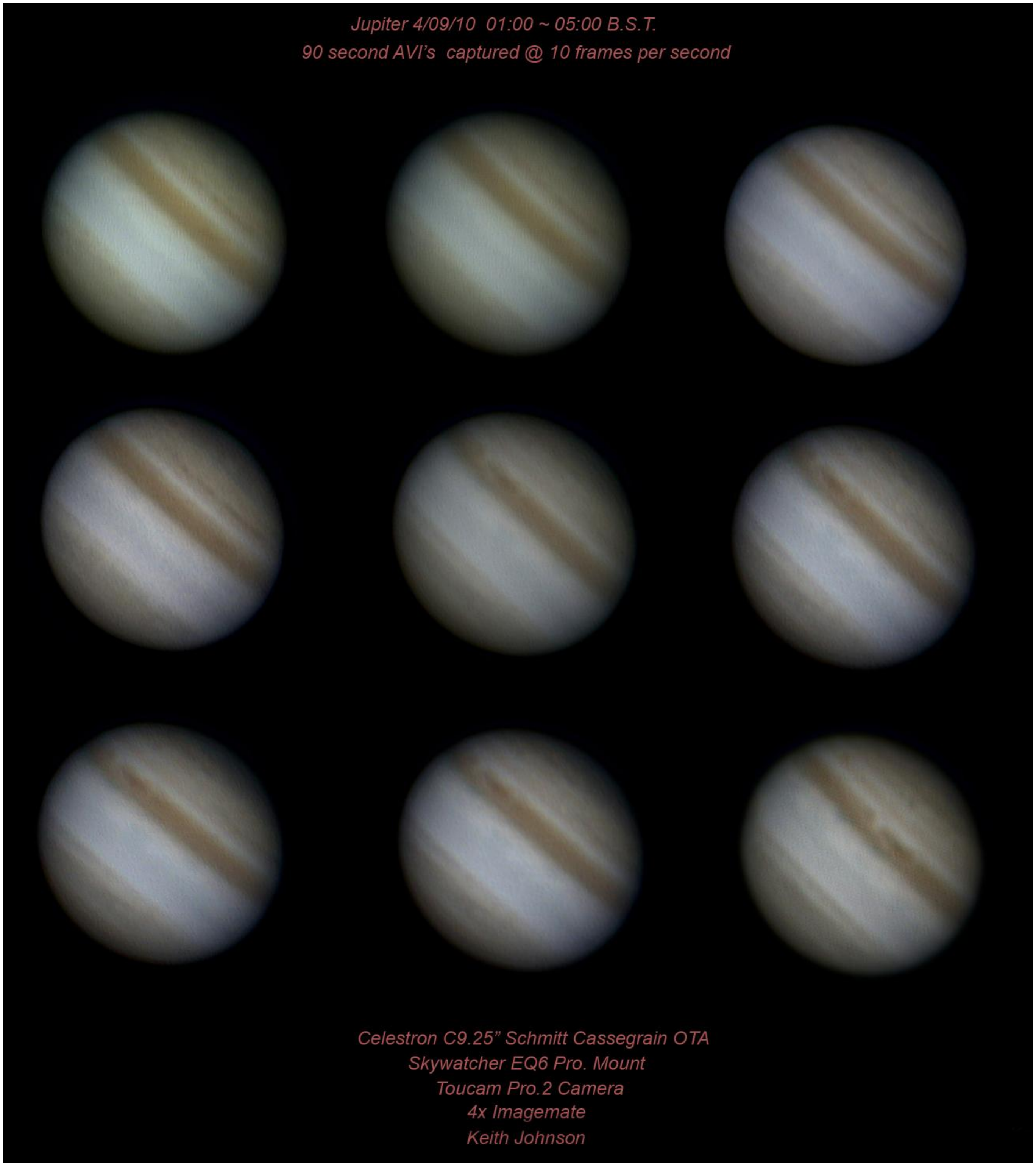
Well to the north of Vega is the long-period variable **R Lyrae**. The deep yellow colour is obvious for this red giant. A slightly more challenging target to the west of R Lyrae is the galaxy **NGC 6703**. It is small but fairly bright. A far more demanding target is the open cluster **NGC 6791**, which is to the far east of Lyra near to θ (theta) Lyrae. I can barely detect it from my garden, but it is described as rich and so may be a good bet from a dark site. If frustrated, then don't despair. Switch to θ and η Lyrae instead. With a telescope, both are easy, wide doubles.

A Jupiter sequence

Keith Johnson

I had an enjoyable evening at the Wynyard Park Planetarium on Friday 3 September, but after returning home at 0100 BST I saw that the sky had improved dramatically. It looked as though there could well be steady seeing conditions, the ideal situation when imaging the planets.

I couldn't resist having a look with the telescope… and so started an imaging session that would last the next 4 hours! I've put the results into the display below – in the final picture, the Great Red Spot is just beginning to come into view.


Jupiter 4/09/10 01:00 ~ 05:00 B.S.T.
90 second AVI's captured @ 10 frames per second
Celestron C9.25" Schmitt Cassegrain OTA
Skywatcher EQ6 Pro. Mount
Toucam Pro.2 Camera
4x Imagemate
Keith Johnson

A Jupiter one-off

Rod Cuff

I can't compete with Keith's marvellous work, but just to encourage others to try to capture Jupiter images via a webcam, here's one from 1 September at 0035 UT. North is down. So far this season, as is obvious too from Keith's sequence, the usual South Equatorial Belt to match the prominent brown North EB is missing.

The tiny dot (1 arcsec) near the top right-hand corner is Europa, the smallest of the Galilean satellites, and perhaps the Solar System's best bet for finding evolved life-forms outside Earth.

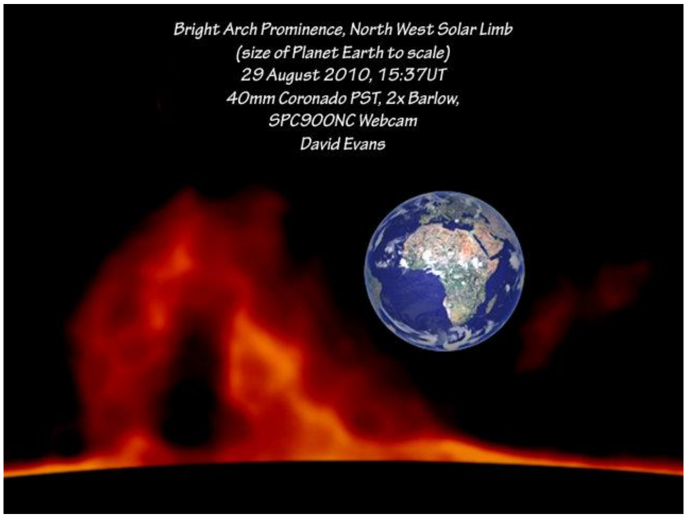
Taken from Guisborough, N Yorks, using an 8" LX-90, 2.5× PowerMate, ToUcam Pro 2 webcam with IR filter, and wxAstroCapture software. Post-processing with Registax 5 and Photoshop.

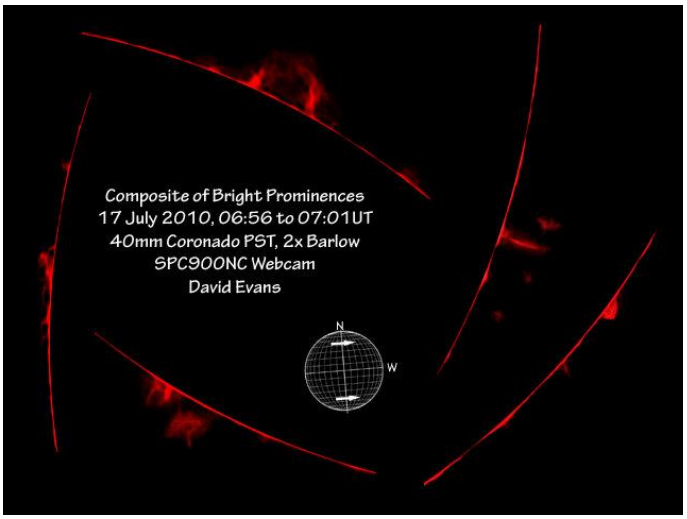
Solar observing, summer 2010

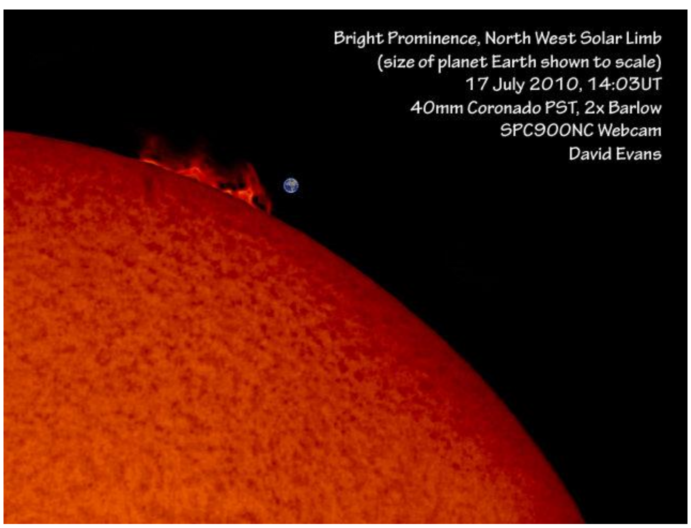
Ed Restall (CaDAS and Wynyard Planetarium)

This somewhat lacklustre summer saw three solar observing events organised and supported by CaDAS members. With the Sun actually showing signs of waking from a prolonged period of low activity, sadly encompassing International Heliophysical Year, our astronomers were keen to show people something other than the blank solar disk of recent years.

Two events took place on the weekend of Saturday 17 and Sunday 18 July. The weather forecast wasn't encouraging – neither Ra, Aten nor Helios was smiling upon us – but both events went ahead as planned.





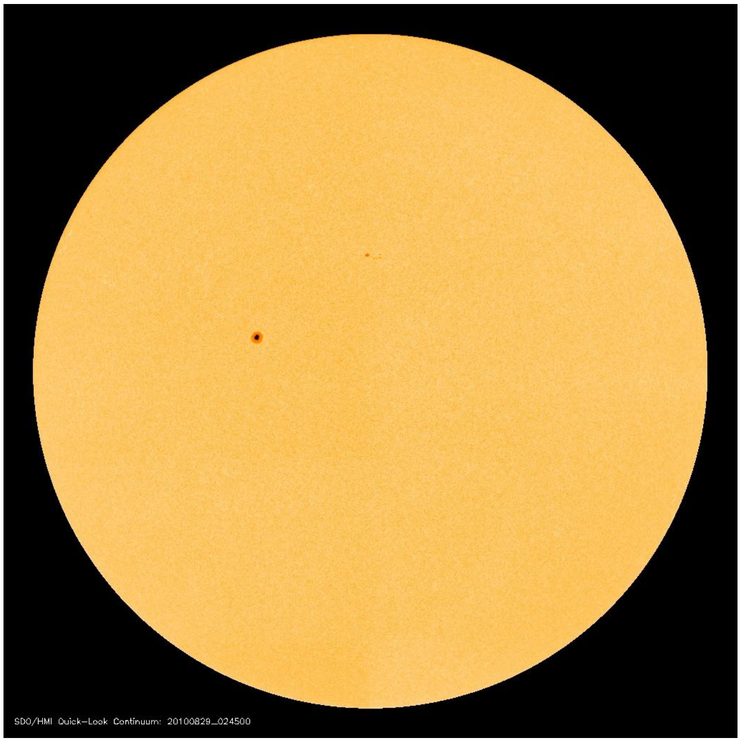


The event on Saturday 17th was at Durham University's NetPark, organised as part of Brainwave 2010 by Jürgen Schmoll, supported by the Planetarium and members of Durham AS & CaDAS. Patches of clear sky danced around the Sun, providing teasing glimpses of the solar disk. Two telescopes were set up: an 80mm refractor (SkyWatcher PRO) using Baader white-light solar film, and an 80mm Vixen refractor using a hydrogen-alpha filter. One sunspot (1087) was observed, as were three relatively large prominences spaced roughly equally around the solar disk (with two smaller ones visible at higher magnification).

On Sunday 18th at Wynyard Planetarium the event was part of the Wynyard Woodland Park Country Crafts Day, which is always well attended by members of the public and an ideal outreach opportunity. Sadly the weather was overcast, with only rare glimpses of the solar disk through thinning cloud. Reflectors ranging from 6 inches to 10 inches were set up with Baader white light, 1000 Oaks and hydrogen-alpha filters, but no observing was possible. Everyone spent most of the day explaining what people should have seen, with the aid of the solar observing station inside; the only thing actually visible to visitors were the Fraunhofer lines through a handful of home-made solar spectrometers.

One further event took place at the Planetarium on the Sunday of the last weekend in August (29th) as part of the annual *Secrets of the Sun* star show, held at this time every year. The weather again wasn't ideal, with sunshine and showers, but there were plenty of opportunities to view the Sun through white light, 1000 Oaks and hydrogen-alpha filters. Five telescopes were trained on the solar disk: two 6″ equatorially mounted

Newtonian reflectors (white light and eyepiece projection), a 6″ Dobsonian (1000 Oaks), an 80mm Vixen (hydrogen-alpha) and a 10″ Dobsonian (1000 Oaks). One clear sunspot (1101, with 1102 emerging), several small prominences and some filaments were visible in hydrogen-alpha; CaDAS members talked plenty of visitors through the details of the solar activity that they were seeing.



Despite the unfavourable weather conditions, on all three days lots of people turned up and were very interested, taking free information such as star charts, Moon calendars and Sun posters.

I'd just like to take this opportunity to raise the importance of testing your solar filters before using them. A cursory examination of most solar-film filters isn't good enough – you need to hold them close to a very bright light source in a darkened room and examine for pinprick-sized holes and/or changes in the light attenuation across the whole area of the filter. This is especially important when dealing with the eyesight of members of the public! Please note: don't hold them too close to the light source (particularly in the case of 1000 Oaks film) as they have a habit of spontaneously combusting … sorry, Dave ;o)

Solar film, of white-light or 1000 Oaks variety, has a limited lifetime, which can be shortened further by exposure to moisture and flexing/wrinkling. Even glass substrate filters are prone to degradation with age and must be checked very carefully before use. If you are assisting with solar observing at the Planetarium, please make sure that the Planetarium Director checks your filters before they are used with members of the public and that you are familiar with the appropriate Risk Assessment (copies available upon request or on the Planetarium website).

Thanks once again to everyone who helped out with these events – and fingers crossed for clear daytime skies at future events as the Sun approaches the predicted peak of its activity in 2012/13.

Photos:

Brian Woosnam, Llandrillo Astronomy Society

David Evans, Coleshill Astronomy

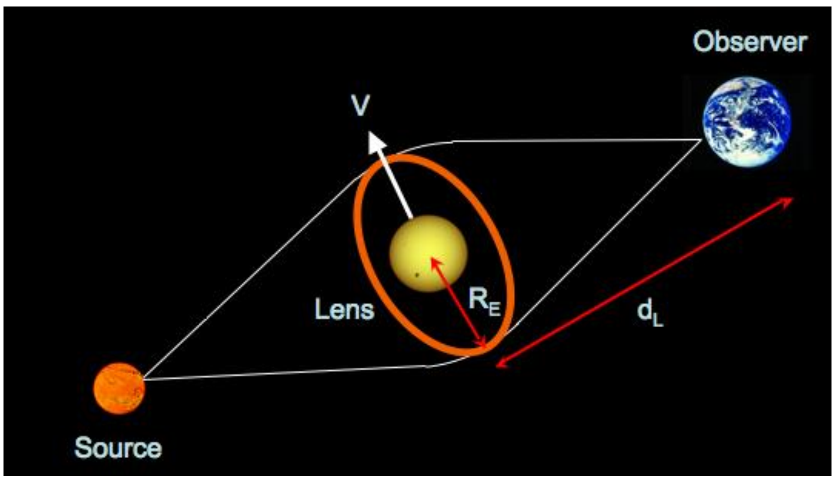
NASA SDO, Solar Dynamics Observatory

The Lost World of Barnard's Star

Andy Fleming

These days, it is accepted as a scientific fact that we live in a universe teeming with planets orbiting other stars. Indeed, as of 24 September, there are 490 worlds that we know of orbiting stars other than our Sun. Detecting these planets has become a routine voyage of discovery engaging well-tested and accepted methods.

The primary methods include **radial velocity** (Doppler displacement of spectral lines in the star's light due to the star 'wobbling' as it orbits the common centre of mass of the star and its planetary companion), and the **transit** method (a dip in starlight as an exoplanet moves across the disc of the star, thus reducing the amount of starlight). Other successful methods include **astrometry**, where there are minuscule changes over time in a star's precise co-ordinates in the night sky because of its orbit around the stellar system's centre of mass, and **microlensing** (a bending of light from a distant star due to the gravity of the foreground star and its associated planet – *see below*).



Finally, of course, there's the most spectacular method, one that will become more important as detectors improve -- that of **direct imaging**, as in the cases of Fomalhaut b and Beta Pictoris b and associated stellar debris discs, as observed by NASA's Hubble Space Telescope (HST).

However, it has always been this way. Speculation has always run wild about whether planets orbit other stars, and by implication about the possibility of extraterrestrial life. Indeed, the Roman Catholic monk Giordano Bruno was burnt at the stake in 1600 by the Inquisition for the trouble he caused by publicising the then heretical view that the universe was teeming with other worlds and with life.

Throughout the nineteenth century, theories ebbed and flowed about the formation of planets and the circumstellar discs from which they arise. One particularly popular anthropocentric theory suggested that our star was unique in the Milky Way in possessing a solar system. It had hypothesised that this had come about through a ridiculously improbable event -- a close pass of another star had ripped material out of our Sun, which eventually coalesced to form planets.

However, in order for the question to be resolved, the whole issue of exoplanets would have to await better technology and observations, not better theories. After all, other stars are at gargantuan distances from the Earth; the nearest, Proxima Centauri, is part of the Alpha Centauri triple system and is nearly 40 trillion kilometres distant. Whatever detection methods are employed, the effect of planetary companions will turn out to be almost infinitesimally small.

Proxima Centauri is a dim red dwarf -- its larger Sun-like siblings Alpha Centauri a and b are so bright that the pale reflected light from the parent star of any planetary companions would be completely emasculated by the star itself. Even a Jovian mass giant would be a billion times fainter than the central star. As an analogy to illustrate the immense technical difficulties involved with direct imaging, think of a dim candle placed a couple of metres from a floodlight viewed via a telescope from a vantage point a thousand kilometres distant. What would be your chances of viewing the dim candlelight?

It's not surprising then, that the first 'discovery' of an exoplanet, on this occasion via the technique of astrometry, turned out to be a false alarm. The whole field of extra-solar planet detection commenced in earnest thanks to one man -- Peter van de Kamp (*see left*). Van de Kamp had been a professor at the University of Virginia for several years before going to Swarthmore College in 1937 and becoming director of its Sproul Observatory.

The next year, he began a long-term search for very low-mass companions to stars. One of the first stars he put on the search programme was Barnard's Star. This is the second-closest star system to our own, at 6 light years distance. Unfortunately, it's an M-type dwarf, so it can't be seen by the naked eye, but it can easily be seen with a small telescope.

Van de Kamp started collecting data on Barnard's Star in 1938, and continued taking data for roughly 25 years. In 1963, he finally felt confident enough to present his first excruciatingly difficult astronometrical measurements. He and his colleagues were looking for variations of plus or minus 1 micron in the position of the star on a photographic plate! In other words, they were endeavouring to measure the photographic centre of these little blurry dots on the photographic emulsions to a staggering 1 part in 100. They would have 10 people measure the same plates independently, and then try to average over whatever individual systematic errors they would introduce, to find the true photographic centre of the positions.

After looking at some 2400 plates, van de Kamp found evidence that there was a small 'wobble' in Barnard's Star, which fitted with the curve that would result if it were being orbited by a planet about 1.6 times the mass of Jupiter at a distance of 4.4 AU. The peculiar attribute of the star movement, though, was that it didn't fit into a neat sine curve, which would indicate a roughly circular orbit like our own Jupiter's. Instead, it had a little bit of a cusp to it.

However, most astronomers could live with a planet with a quite elliptical orbit, and Barnard's Star's planetary companion soon became the textbook example of an extra-solar planet. However, all was not well with the data that lay behind van de Kamp's momentous discovery, and ten years later in 1973 the astronomer George Gatewood would reveal major flaws in van de Kamp's observations.

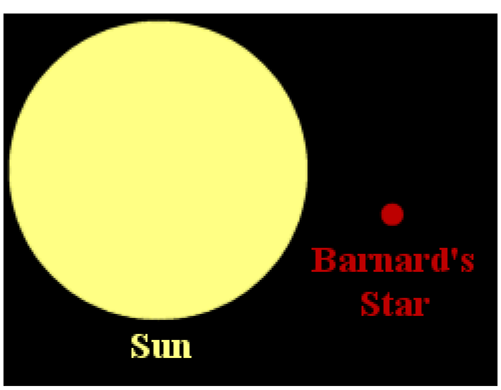
Gatewood had been undertaking his Ph.D. in astrometry at the University of Pittsburgh and, although he was reluctant at first, his professors were extremely keen that he study Barnard's Star. And so, unbeknown to him, Gatewood was to become reluctantly involved with a profound cosmic controversy. While studying Barnard's Star, he undertook his own observations and measurements, using different telescopes: the Allegheny Observatory's Thaw Refractor, and some plates taken from the Van Vleck Observatory.

In total, Gatewood produced 240 plates, and for his thesis project he set about reducing the data from them. Instead of their being reduced by individuals sitting at a plate-measuring machine, they were automatically reduced by a new, state-of-the-art plate-measuring machine produced by the U.S. Naval Observatory. Of equal importance, the data was reduced using a different technique from that used before. Gatewood's thesis adviser, Heinrich Eichhorn, was one of the fathers of analytical astrometry, and it was Eichhorn's technique that was invoked for the data analysis.

Their results on Barnard's Star were published in 1973, and were bad news for van de Kamp – some of the data points in which they had the most confidence did not fit van de Kamp's curve. Without confrontation, they quietly stated that they had found no evidence whatsoever for Peter van de Kamp's planet. And it got worse -- that same year, another paper was published in the *Astronomical Journal* by John Hershey, who was also working at the Swarthmore College Observatory.

Hershey had studied a star called Gliese 793, another low-mass M-type dwarf star, and found that, if he plotted the astrometric wobbles of Barnard's Star and Gliese 793 together, both of them took a jump in one direction in 1949, and in 1957 took another jump in the opposite direction. The implications of Heshey's data were devastating for van de Kamp's 'discovery': either both stars had exactly the same planet orbiting them, or else there were major systematic errors in the latter's observations.

It turned out that van de Kamp's observations were riddled with major systematic inaccuracies. In 1949, there had been a major change in the telescope; they put in a new cast-iron cell to hold the Swarthmore College refracting lens. They also changed the photographic emulsions they were using, which made an enormous difference when measuring objects in size down to one-hundredth the size of a star's blur. In 1957, they made another change – a lens adjustment.



And so it was, that after a lifetime's work, much of it studying Barnard's Star, van de Kamp discarded forty years' worth of data. Still continuing to believe that the star should possess a planet, he started anew with more observations. However, by the autumn of 1973, following his discredited observations, most astronomers were no longer prepared to give his work much credence and the field of exoplanet research fell into a deep sleep for two decades.

Roll the clock forward 22 years: and on 6 October 1995 Michel Mayor and Didier Queloz announced the verified discovery of the first genuine exoplanet, orbiting a Sun-like star located 50.9 light years (15.6 parsecs) away in the constellation of Pegasus. The discovery, via the radial velocity method, of 'Belleraphon' (as the planet became known) orbiting 51 Pegasi was made in France at the Observatoire de Haute-Provence, using the ELODIE spectrograph.

It turned out that this planet from hell was a gas giant, approximately half the mass of Jupiter, but with an orbital period of just over four days -- a fraction of that of Mercury around our star. In the intervening years, a host of such 'hot Jupiters' have been discovered, and they're unlike anything in our solar system. They're located so close to their stars that they have atmospheric temperatures nearing 1000 °C, they're tidally locked to their stars, and hence must have turbulence and winds to dwarf anything in our solar system. The smart money is placed on a theory that suggests that such planets have migrated from original positions in their solar systems similar to that of our own Jupiter.

And what of Barnard's Star? The HST's fine-guidance sensor team, led by Fritz Benedict of the University of Texas, has been following the star to ascertain whether it has planetary companions, but has so far drawn a blank. Instead, Barnard's Star is more useful for debugging mechanical problems on the HST, because when the star seems to wobble, it usually means that there's something wrong with the space telescope!

For now though, the jury's still out on whether our very closest stellar neighbours possess Earth-mass planets. Astronomers are fairly certain that these stars do not possess gas giants, and speculate that Earth-mass planets may be orbiting any of the stars in the Alpha Centauri triple star system, for example. The habitable zones of these stars lie at a distance similar to that of our Sun's, and are close enough to the stars to ensure that gravity from their stellar companions would not eject terrestrial-sized rocky worlds from the triple system. There may indeed even be Earth-mass planets orbiting Barnard's Star. And a final resolution to these questions won't be long in coming, either -- a Planetary Society project is underway called FINDS Exo-Earths (an acronym for Fibre-optic Improved Next generation Doppler Search for Exo-Earths).

This new high-end optical system has been installed on the 3-metre telescope at the Lick Observatory, dramatically increasing discoveries of smaller exoplanets and playing a crucial role in verifying Earth-sized planet candidates from the Kepler planet-hunter mission.

Peter van de Kamp believed in another world orbiting Barnard's Star, but his observations and data were not repeatable or verifiable -- a situation that ultimately is not worth much in science. With only the relatively primitive technology of the early twentieth century, he believed too much. Ironically, however, the next generation of telescopes may yet prove his beliefs to be correct.

Between a rock and a hard place

Ray Worthy

Many of you astronomers will appreciate this. It is that whenever any of us announces that we dabble in astronomy, just about the most common question which crops up is, 'Do you think that there can be life anywhere else?'

Whenever this occurs, I often ask the questioner about his or her knowledge of the extent of life here on our own planet. To be more specific, I ask the question, 'What is the most common form of life on Earth?'

When they ask for clarification, I can narrow the terms of reference to either numbers of individuals or even simple biomass. I have not met anyone outside the scientific disciplines who answers correctly. The answer is the bacterial community that inhabits the rocks of the Earth. Even from a mile deep down a mine, newly cut rocks can be brought to a laboratory and cultures of living bacteria can be grown. The extent of this ecosystem has been appreciated only in the last ten years or so, and it has been calculated that the biomass of these living creatures exceeds the weight of all other life forms by a factor of hundreds.

In the 1950s, I was working at ICI at Billingham when it was discovered that a water-cooling tower was falling down and no one could see why. After a long time and many investigations, it was discovered that bacterial action was damaging the concrete. The microscopic little so-and-sos were actually eating away the concrete.

I'm writing this in early September 2010, and what I am about to reveal comes hot off the press and is the reason why I'm stimulated to write this piece.

A Dutch microbiologist, Dr H. Jonkers, has made a self-healing concrete. During his study of these rocky extremophiles he made a discovery, put two and two together and will probably strike it rich. I hope he does.

Engineers and architects had shown him how concrete, whether reinforced or not, deteriorates when it gets wet. Surrounding the steel reinforcements is a region where microscopic cracks appear that are undetectable to the naked eye. Anyway, they are usually in places where the human eye has no access, in underground tunnels and suchlike.

Dr Jonkers knew that concrete presents a highly caustic environment, so he scoured the Earth for hot volcanic springs with caustic pools, such as the one illustrated above. From this source, he extracted some suitable bacteria.

He spent several years finding out what exactly it was that they ate to get their energy and enjoy their peculiar lifestyle. Then he put spores of this bacterium together with its chosen food and mixed them into some concrete.

As soon as cracks appear in this new concrete, be they microscopic or not, water gets in and activates the spores. The nascent bacteria do their thing and begin to spew out calcite, which is a form of calcium carbonate. This seals the cracks before they develop too far, and this in turn shuts off the water supply. At this point, the bacteria return to the spore state.

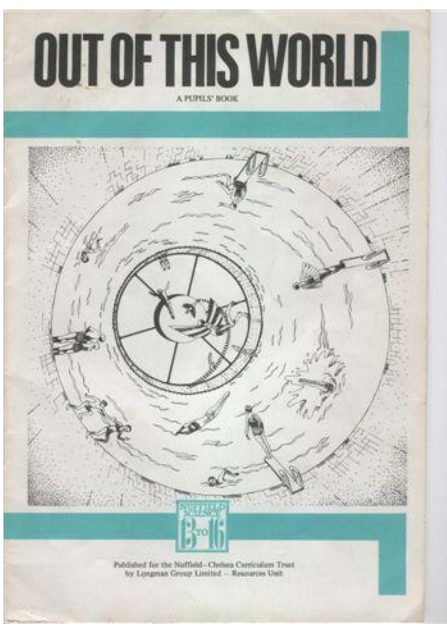
The reinforced concrete found in buildings today has a lifespan of possibly 60 years. This new form of self-healing material is estimated to last at least 200 years.

[Ray first heard about this on the BBC's Material World podcast of 2 September – see www.bbc.co.uk/programmes/b00tjrp4 – Ed.]

Out of This World

Ray Worthy

It isn't generally known, even among my friends (either of them), that, once upon a time, I wrote a book. Straight up! It was entitled 'Out of This World'. When it was all finished and printed, I was invited to the printer's warehouse near York Station to see the result. It was an astonishing sight. There they were, a hundred thousand of them, sufficient for a class-set in each of the country's secondary schools. They were stacked from floor to ceiling. Strictly speaking, it was not a book proper to stand on its own, but was the separate Astronomy module in a series of other science modules, and consisted of a pupil's book and a teacher's book.



It came about like this. It was known that I taught O-Level Astronomy after school in a sort of club situation. The older members of CaDAS will remember that I used to bring a minibus-load of pupils to the meetings. It was rare enough for someone to take notice. The powers that were, up in the echelons of education, asked me to sit on a committee to discuss adding astronomy to the National Curriculum. I was in two minds about this, but when I was told that I would have to give up a day's slog at the chalkface and take a train down to London, well, I thought that I might just consider it. My pupils would have to do without me for a day. As much as I considered myself a round peg in a round hole and loved the job, the relief offered by a trip down to Chelsea College would be very welcome.

One thing led to another as it often does, and before very long I was asked to undertake writing the Astronomy module for the new 13–16 syllabus, sponsored by the Nuffield Foundation. I looked forward to many trips to Chelsea to 'consult' with the editors. In practice, there *were* some trips, though nowhere near the number I had envisaged.

Looking back, I think what had persuaded them to use my talents was that I took the view that existing textbooks in astronomy were simply not suited for use in a classroom. There was little offered that would keep a class occupied. I told the story of a teacher in Leeds who erected a telescope on the school roof and brought the whole class of boys onto the roof after dark to view the sky. What he had not taken into consideration was that only one kid at a time could look through the eyepiece. One boy had a haversack in which he had a football. Soon a kick-about developed and the boys forgot where they were. The outside-right fell off the roof and luckily only broke his leg.

If the book was to do any good, it had to include class exercises. It is not the purpose of this article to detail the contents of the module. If you do actually wish to view the contents of this 1970s effort, please apply in the usual way on the back of a ten-pound note. However, I will give the gist. There were photographs supplied by NASA of various planets, moons and suchlike, and the pupils had to analyse what they saw and write down their own conclusions. In this respect I got something wrong here. I was leading the pupils to come to the conclusion that the Valles Marineris on Mars was evidence of Martian tectonic activity. At the time, this was the received wisdom, but now this idea has been discounted.

One idea that was meant to catch the eye was the possible construction of a future space station that revolved to create artificial gravity. This principle was beautifully illustrated in the film *2001* with its wheel-shaped space station revolving to the tune of 'The Blue Danube'. I concentrated upon what could possibly be constructed at the hub of such an assembly. Right round the inside wall of the revolving hub, there could be a swimming pool. The artificial gravity could be just enough to keep the water from falling inwards. In the very centre would be a region of weightlessness, where folks could fly with wings fastened to their arms. I wanted to stimulate the pupils' imaginations.

However, it was all in vain. After three years' preparation, and even as the books were printed and ready for distribution, nemesis came. As I write this, tears are falling down my cheeks. Word came down from the Ministry of Education that the syllabus for which we were working was to be scrapped and would be replaced by another called SCISP, 'The Schools Council Integrated Science Project'.

What a letdown! I and many others who had slogged for three years were absolutely disgusted. My thoughts went to that warehouse crammed from floor to ceiling with the finished product. What happened to them? I was never told. If I had not snaffled a dozen or so 'complimentary' copies on my visit to York, I might be excused for thinking it had all been a dream. It may be a fault in my memory, but I do not remember anyone taking the trouble to apologise.

A couple of years later there was a curious echo of these events. Once again I was invited to attend a meeting about astronomy in the curriculum – only this time it was under the auspices of the Cleveland Education Authority. The initial meeting was to be chaired by someone from Newcastle University. To my surprise, halfway through the meeting, he produced a copy of my module. He proceeded to extol its virtues and it became rather embarrassing. I had to declare myself as the author and showed him my name on the back. He asked me to become chairman and, to this day, I have never seen him again.

A bit of a fiddle?

John Crowther

A new glossy-paged magazine, *How It Works*, is now in the shops. It resembles *Focus* and is also rather like various hardback books (aimed at young people) that have a man-made object shown in 'exploded' form and text taking the reader through it.

How It Works costs £3.99 and examines both living and non-living things. The issue I looked at in a supermarket while my wife was shopping had items ranging from a mosquito to HMS *Victory*, so only a minority of people are likely to be interested in every item.

But it contains astronomy. The current edition examines newly discovered planets orbiting stars, and why the Moon appears to look bigger when close to the horizon. Apparently even NASA can't fully explain this illusion, which is probably linked with the evolution of our brains and the difficulty they have in seeing the sky as a perfect hemisphere.

Some years ago in *Transit* I wrote about ships off Redcar seeming bigger when viewed from behind a foreground of a grassy bank rather than on the distant sea –a similar sort of misperception.

How It Works discusses an optical illusion, using a phrase new to me: 'Ponzo lines'. Two lines of equal length, when placed across a perspective view of railway lines disappearing into the distance, appear to be of unequal length.

But *How It Works* does a fiddle. The lines in the magazine *aren't of equal length to start with*. So if our brains are confused with what shape the sky is, they're further confused by the magazine exaggerating the effect of an optical illusion!

CaDAS NEWS

For sale

Previously advertised at £150 -- now a super bargain!

Bausch and Lomb professional 4.5" reflector

Model 780200. Comes with tripod, 2 eyepieces, balance weight, and various knobs and flexible cables to control the telescope.

£100 ono

Richard Bennett (rosemarie.bennett@ntlworld.com)

THE *TRANSIT* QUIZ

Answer to September's quiz

Here are some literal translations of star names. Each is the 'alpha' star within its constellation. Which stars in which constellations?

1. Ear of grain: *Spica (Virgo)*
2. Rival of Mars: *Antares (Scorpius)*
3. Tail of the hen: *Deneb (Cygnus)*
4. Head of the kneeling one: *Ras Algethi (Hercules)*
5. Scorching: *Sirius (Canis Major)*
6. Bear-guard: *Arcturus (Boötes)*
7. Before the dog: *Procyon (Canis Minor)*
8. End of the river: *Achernar (Eridanus)*
9. Flying one: *Altair (Aquila)*
10. The horse: *Alpheratz (Andromeda)*

October's quiz

A history test this month. Who made the following discoveries and when?

1. Mars has ice caps
2. Oberon and Titania, moons of Uranus
3. Phobos and Deimos, the two satellites of Mars
4. Charon, the satellite of Pluto
5. Each element has its own specific Fraunhofer lines in the electromagnetic spectrum.
6. Infrared radiation
7. Ultra-violet radiation
8. The first indication that a star could vary in brightness
9. The Andromeda Galaxy (M31) is moving towards us
10. Quasars have huge redshifts and so are extremely distant objects