TRANSIT

The June 2012 Newsletter of

NEXT MEETING at Wynyard Planetarium

Friday 8 June 2012, *7.15 for 7.30 pm*

Presidential address:

***The Sky at Night*'s 55th anniversary celebrations at Sir Patrick's Moore's home in Selsey**

Jack Youdale FRAS, *Hon. President, CaDAS*

Contents

Editorial

Rod Cuff

We offer a warm welcome this month to new members Gerald & Marlene Pearson, Melissa Ozcan and the McLaney family. We're glad to have you with us, and hope you enjoy *Transit* as well as our monthly meetings.

Talking of transits: later this week (at the time of writing) the **Transit of Venus** happens, as everyone remotely astronomically interested must know by now. I've already sent out by email a poster describing how CaDAS is marking the event, but to recap: Weather (including clouds) permitting, there will be a **public observing session** outside the Wynyard Planetarium from 4 a.m. to 6 a.m. (BST) on Wednesday 6 June. We're planning to have around ten telescopes set up to enable **safe** filtered observation of the Sun. The transit will be well under way when the sun rises soon after 4.30 am, and will be complete at 5.55 a.m. (There's further discussion of the transit in Rob Peelings *Skylights* article on page 3.)

CaDAS is having a little **celebration at the end of our normal Planetarium meeting this coming Friday, 8 June**, after the talk from our President, Jack Youdale. Among other things this is to mark thirty years of Jack's annual talks to CaDAS – quite a feat – and to mark a few other things too. There will be food! There will be tea and coffee! There will be very short speeches! Do please stay and help send us all off for the summer in good spirits.

The current issue of *Transit* is remarkable for two things. Firstly, it has stunning solar photographs by Keith Johnson, whose facility with this sort of thing continues to leave me fairly boggle-eyed. Secondly, and unusually, I've included a couple of items not written by a member, at least one (and probably both) of which will be new to you. There is a good archive of AAVSO articles that the one on page 10 is taken from (I chose it because of the answer to question 7 of May's quiz … see page 15).. And no doubt I'll include one in future issues from time to time.

This is the last regular issue of *Transit* for the current season, although I may produce another sometime in July if you send lots of good stuff in, so please don't let me stop you! Normal service will resume with the September issue, which will be guest-edited by Andy Fleming. If you have any material for either issue, please send it to me if it's ready before the end of July, but after that send it instead to Andy (fleming5ln@btinternet.com).

Many thanks, as ever, to this month's contributors.

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(01287 638154, mobile 07775 527530)

Letter

'Forensic astronomers'

from Neil Haggath

Ray Worthy's article, 'Tidal influences', in *Transit*'s May issue, concerns the self-styled 'forensic astronomers' of the University of Texas. I don't know which 'obscure' science magazine Ray was referring to, but the names of Don Olson and Russell Doescher are quite familiar to any regular reader of *Sky and Telescope*, to which they have been frequent contributors for many years. The other name Ray mentioned, Roger Sinnott, has been one of the editors of *S&T* for some 30 years.

Olson and Doescher, often assisted by some of their research students, have published at least a couple of dozen articles in *S&T* about aspects of their 'astronomical detective work', in which they use astronomical evidence and calculations to solve a variety of 'mysteries' or controversies. Many of these are of purely academic interest, such as establishing the dates on which famous historic photos were taken, or on which famous works of art were painted, from the positions of astronomical objects in the pictures with respect to known landmarks.

Some of their work, however, involves far more serious topics. *S&T* published an article on the research that Ray mentioned, concerning the possible contribution of exceptionally high tides to the sinking of the *Titanic*. Another, a few years ago, concerned the role played by the tides in the choice of date for the D-Day landings.

Best wishes – Neil

OBSERVATION REPORTS AND PLANNING

Skylights – June 2012

Rob Peeling

Hours of darkness

Date (all times BST)	***Sunset***	***Full darkness***	***Sunrise***
1 June	21:28	None	04:46
30 June	21:41	None	04:46

'Full darkness' starts as astronomical twilight ends (when the Sun is 18° below the horizon). As you can see from the table above, full darkness isn't reached at all at our latitude in June. The best you can expect in the month is nautical twilight (12° below the horizon), with civil twilight in the periods immediately after sunset and just before dawn.

The Moon

	4 June	11 June	19 June	27 June	
	Full Moon	**Last Quarter**	**New Moon**	**First Quarter**	
Rise	21:44	00:55	04:46	14:05	BST
Set	04:40	13:17	21:27	00:22	BST

The planets

Saturn is visible moving from south towards the west throughout the night. The planet is lying northwards of the bright star, Spica (alpha Virginis). **Mars** is further west beneath the tail of Leo.

The transit of **Venus** at sunrise on Wednesday 6 June is THE event of the month. Miss this and the next one is not until 2117. At little risk of giving offence, I doubt any of us will be witnessing that one. You'll have to be patient even to catch a transit of Mercury. The next is on the afternoon of 9 May 2016.

In the UK the Sun will rise with the transit of Venus approaching its end. You'll need to set up your equipment before sunrise at around 04:44 BST. Venus will appear against the Sun's disk about a minute later. The transit will end with 3rd and then 4th contact about an hour later.

Please don't forget to take proper care and precautions to observe the transit, as you will be observing into the full blinding light of the Sun.

I will miss the pleasure of observing with others at the planetarium. Looks like I'll be on my own, but I should get a good horizon from on the top of the Chilterns. I hope we all get clear skies throughout the UK. Good luck!

Deep sky

Orphiuchus

The constellation of Ophiuchus is well placed to the south at 23:00 in the middle of June. The star **Rasalhague**, or **α Ophiuchi**, is bright, prominent and easily found below and to the west of Vega. Use Rasalhague as a guide to three bright open clusters that I always seek out in Ophiuchus. The first, **IC 4665**, is so large and bright that it is a very easy binocular object. IC stands for Index Catalogue and was Dreyer's extension to his original NGC catalogue. IC 4665 can be found by sweeping down to the horizon from Rasalhague to the next bright star, β Ophiuchi. As seen with binoculars, the cluster is a little above and to the left of β.

The other two clusters are similarly bright and lie to the east of IC 4665. They can be seen with binoculars but are probably best seen with a telescope at low power. Look up and to the east of β Ophiuchi for the wide, bright, pair of **71 & 72 Ophiuchi**, which lie one over the other. Now scan down and further east amongst brightish stars. The nearest cluster to 71 & 72 is **NGC 6633** and a little further on **is IC 4756** (this cluster is actually in Serpens Cauda).

If you fancy a little challenge, then how about tracking down **Barnard's Star**? It is near 66 Ophiuch, which is close by and east of β Ophiuchi. This red dwarf is neither bright nor impressive. However, it is the second-nearest stellar system to our Sun and shows the greatest proper motion of all stars. It moves across the sky so fast that you will need a star chart showing its exact position for this year, otherwise you won't be able to tell which one of the several faint stars in the field of view is actually Barnard's Star.

Hercules

Go back to Rasalhague and look for a nearby brightish star to the west of it. This is **α Herculis** or **Rasalgethi**, an excellent colour-contrasting double. Moderate power is enough to split it and see the orange primary and the much dimmer greenish or bluish secondary. The orange star is a red supergiant with a diameter greater than that of the orbit of Mars.

Almost overhead, you will find the famous **'Keystone' asterism**, representing the body of Hercules. The fantastic **globular cluster M13**, halfway up the western side of the asterism, is easily the best globular cluster visible from Teesside, and from a really dark site is a naked-eye object. I have seen it naked-eye just once – can you see it too? Less well known is the faint galaxy **NGC 6207** nearby. You'll need a dark night to find this galaxy with a telescope.

There is a second prominent globular in Hercules, **M92**. Take the midpoint of the northern edge of the Keystone and look further north (towards the head of Draco) for a moderately bright, wide pair of stars. Use these as pointers to guide you a bit further north. M92 should be picked up as fuzzy blob in your finder or binoculars.

A third globular in Hercules, **NGC 6229**, is not bright and is tricky to find –but have a go!

Solar imaging

Keith Johnson

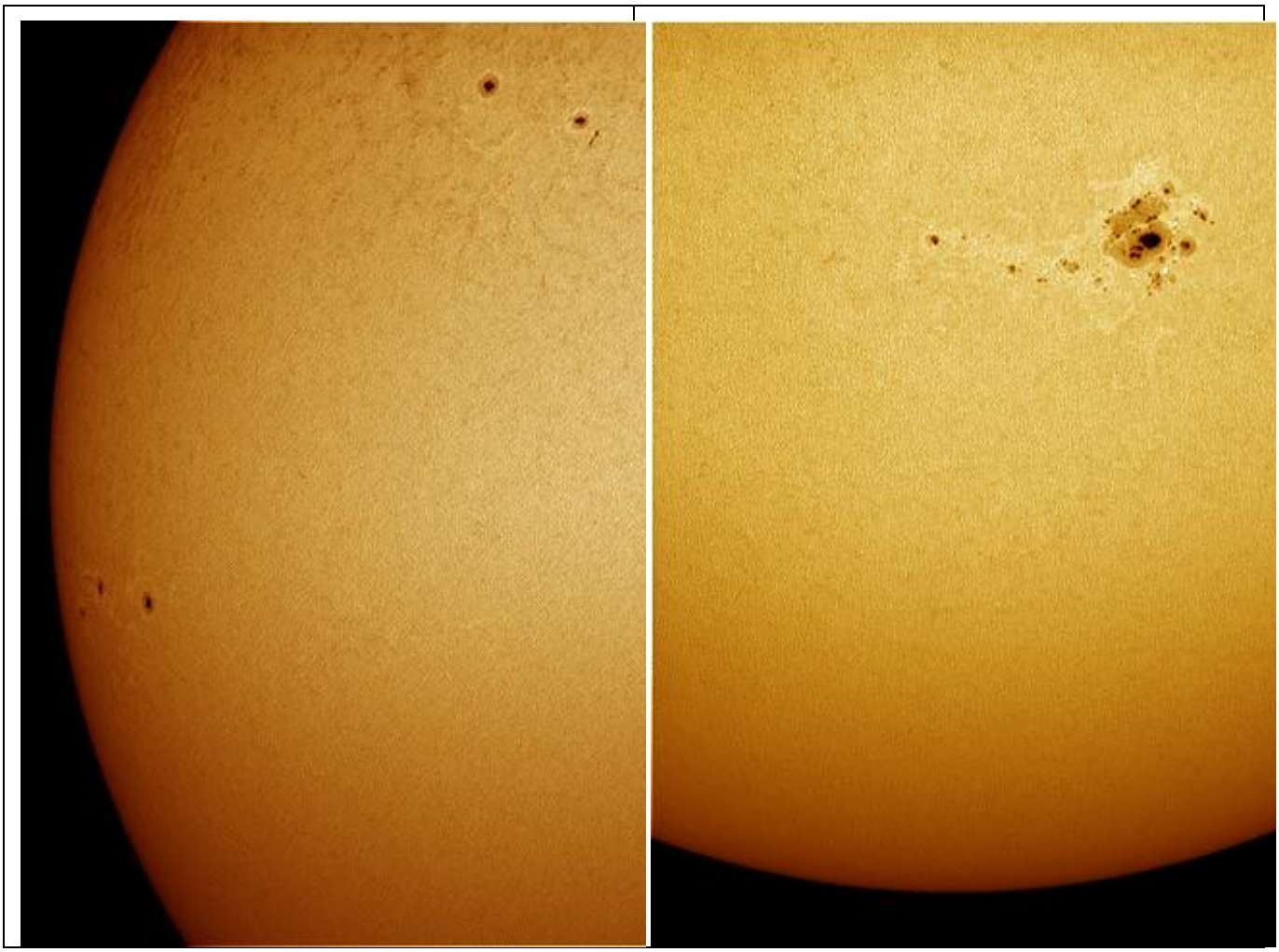
After borrowing Jürgen's hydrogen-alpha filter, I was eager to try it out, and at last could do so on the morning of Saturday 12 May. I managed to capture a series of solar AVIs – over 50, in fact – and have been practising with the hardware and software, hoping that it all comes together in time for the Venus transit. Anyway – here are some of the final results of processing the captured AVIs. I was using the following equipment:

Hardware:

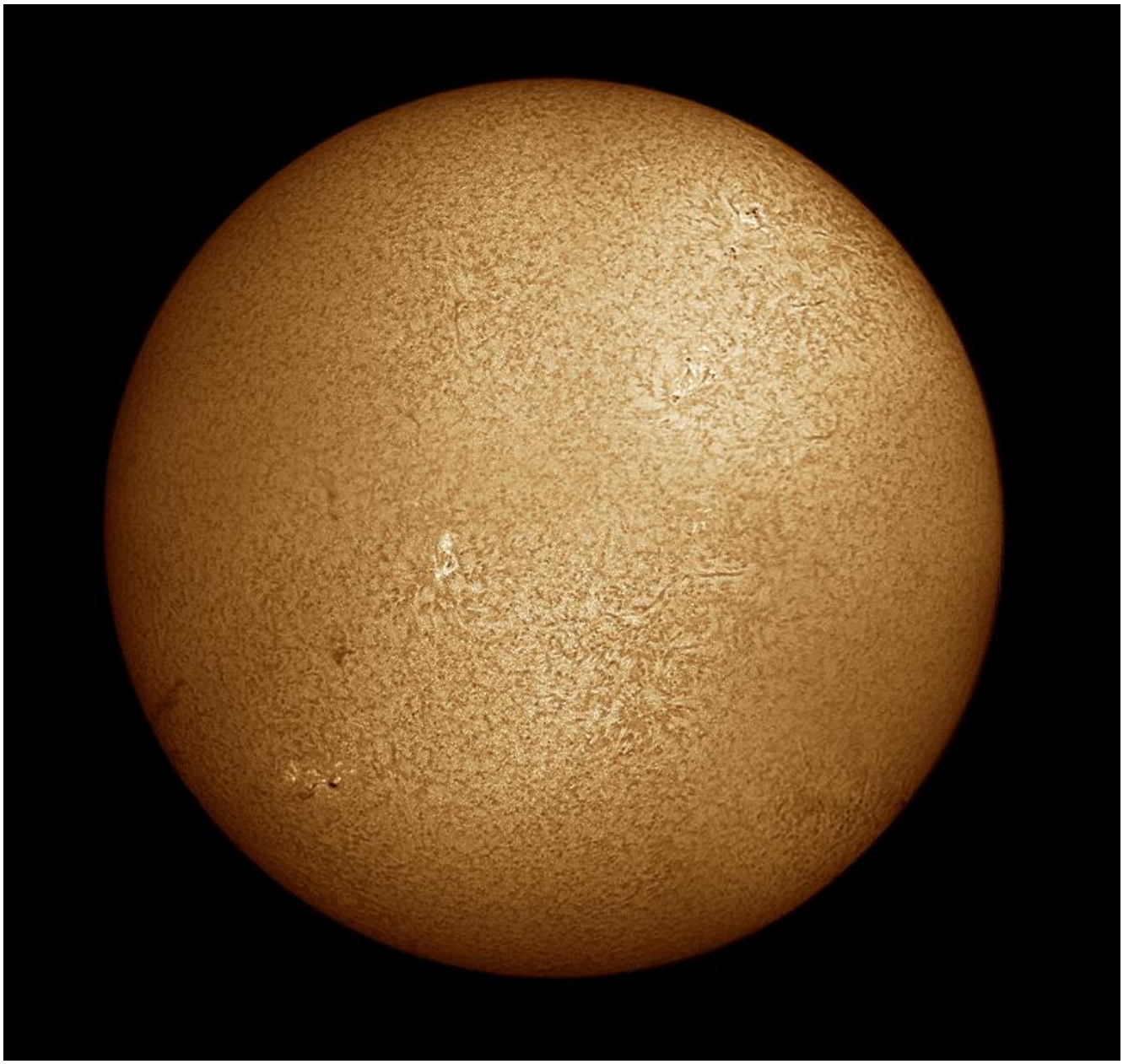
40mm Coronado Hα filter
DMK 21 mono USB II camera.
EQ6 Pro. Skywatcher mount
80mm ED doublet refractor

Software:

Lucam Recorder
Autostakkert II
Registax version 6
Adobe Photoshop CS2



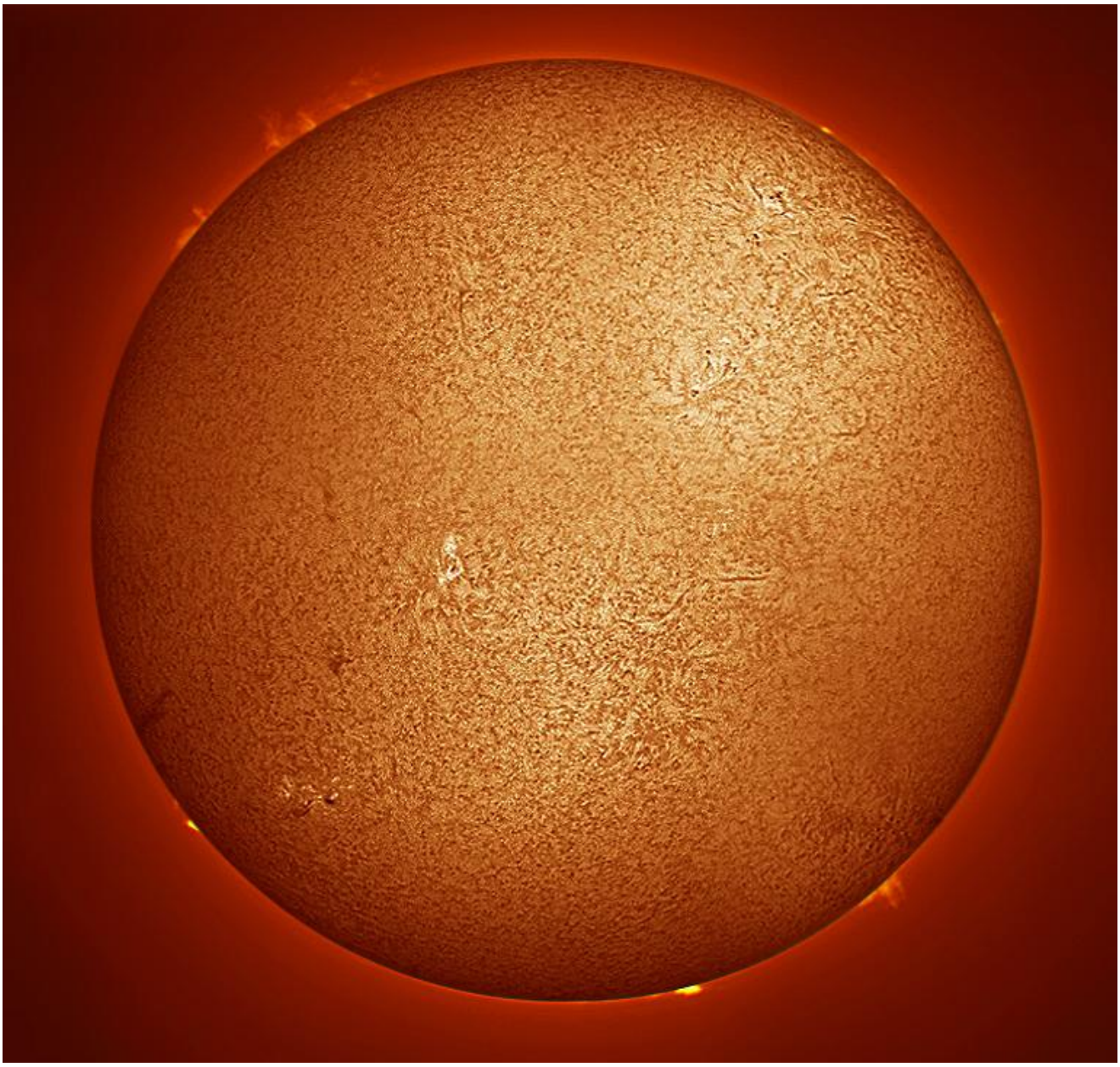
I've subsequently bought a specialist solar telescope, an H-alpha Lunt 35mm Deluxe. Here's a first-light image from 26 May, using the DMK 21 camera. It's a mosaic of six aligned and stacked AVIs, with wavelets applied in Registax v6 and with false colour applied in Adobe Photoshop CS2.



Finally, I tried putting together a composite image of the Sun from all AVIs captured on 26 May, as follows:

- The base was the set of AVIs that resulted in the surface-detail mosaic image above.
- To that I added the result of processing a further six AVIs to create a mosaic of the prominences.
- (Each AVI was aligned and stacked in Autostakkert II and each set of stacked results made into a mosaic.)

- Each mosaic was then adjusted slightly (slider 1 only) in Registax v6.
- Both results were then combined in Adobe Photoshop CS2 and false colour added, to produce the finished article shown below.



An interview with Dr Nicholas Patrick

Jonathan Whiley

[This article was first published in the Saltburn magazine* Talk of the Town *in February this year, and is printed by kind permission of Mr Whiley and his publisher, Ian Tyas. Many thanks both to them and to John Crowther for sending me a copy. – Ed.]

For most young boys it is a distant dream that will never become a reality. But one Saltburn-born man has gone where only a select few have ever ventured before – outer space.

In 2006, Dr Nicholas Patrick, dubbed 'the world's highest-flying Yorkshireman', became only the fifth Briton to go into space and has since clocked up a staggering 638 hours outside the Earth's atmosphere.

The 47-year-old, who was selected by NASA in 1998, said that it was his Yorkshire roots that helped to inspire his career path. Speaking from the Johnson Space Centre in Houston, Texas, he said: 'One of my earliest memories of wanting to become an astronaut was walking in the Yorkshire Moors, going to Roseberry Topping and seeing Captain Cook's monument. He went on so many voyages of discovery and, twinned with watching the Apollo 11 landings, that really inspired me.'

The father-of-three left Saltburn at the age of four-and-a-half when his parents, Gillian and Stewart, pursued work in America. But he was soon to return to England, securing a place at Harrow Boarding School in London, before attending the University of Cambridge.

Unlike most students, Dr Patrick spent his summer months at university working as a civil engineer, inspecting bridges in New York and Connecticut.

After graduating with a degree in Engineering at the age of 22, he moved back to the US, where he completed a PhD at the Massachusetts Institute of Technology.

It was in 1998 that Dr Patrick first arrived at NASA's Johnson Space Centre for astronaut training and he has never looked back since.

'Sometimes you have to pinch yourself – it is a dream come true,' Dr Patrick said. 'I wanted to become an astronaut since the age of five. To be a part of NASA is fantastic – people are very interesting, very smart and work very hard and they are passionate about the idea of space exploration.'

Dr Patrick's first space flight experience came in December 2006 when he joined six crew members aboard the STS-116 Discovery shuttle for a 12-day mission, which included four spacewalks.

The STS-116 crew members gather for a group portrait in the Destiny laboratory of the International Space Station. From the left (front row) are astronauts Bill Oefelein, pilot; Joan Higginbotham, Nicholas Patrick and European Space Agency (ESA) astronaut Thomas Reiter, mission specialists. From the left (back row) are astronauts Mark Polansky, commander; Sunita Williams, Expedition 14 flight engineer; ESA astronaut Christer Fuglesang and Robert Curbeam, mission specialists. Photo credit: NASA

'You are strapped in and spend three hours lying on your back and everyone is working around you to make sure everything is how it should be,' he said. 'They close the hatch and it shakes and shudders – it is like a giant hand picking up a toy shuttle. And then it dies down as you accelerate, and eight-and-a-half minutes later you are outside the atmosphere and into orbit travelling at 17,500 miles an hour. It is incredibly exhilarating.'

Four years later, he took part in his second mission, aboard STS-130 Endeavour, travelling an eye-watering 5.7 million miles and completing 217 orbits of the Earth.

'I don't think I'll ever forget it,' Dr Patrick said. 'The views of the Earth were just breathtaking. As an astronaut you are doing one of two things – either training for a mission or carrying out a technical job. The missions are very exciting and require a lot of preparation – in the last week before a mission, you have to remain in quarantine so you don't get sick. They are full of incredible experiences – like nothing you have ever had in your life. But the technical jobs can often be the most rewarding.'

And it is not only spacewalks that Dr Patrick has taken part in, having commanded a team in the unique Aquanaut mission, NEEMO, in 2005. The 10-day underwater mission saw the crew conduct a series of 'moonwalks' off the coast of Florida to test concepts for future lunar exploration.

Astronauts gather for a photo outside the Aquarius underwater laboratory during NEEMO, the NASA Extreme Environment Mission Operations project. Photo credit: NASA

'You are on the sea floor and it is like walking on the moon – you are one-sixth of your weight,' Dr Patrick said.

His work as an astronaut has not gone unnoticed – in November last year he accepted a prestigious Interplanetary Society pin in to mark his achievements. The silver lapel badge was given to all UK-born astronauts who have had the honour of orbiting the earth. Dr Patrick said that it was 'an incredible gesture' and that he was 'extremely proud'.

Despite spending much of his career stateside, Dr Patrick believes he will always have a special place in his heart for a corner of North-East England.

'My grandparents always lived in Yorkshire,' he said. 'I have lots of memories. I came back last month [November]. I visited Teesside University and it was really lovely to go back and see how little things had changed, in a good way.

'Houston is so big that it is impossible to know everyone. I lived in the village of Kirby with my parents when I was younger and when I came back I stayed in the same house. It was a lovely place, it was an old cottage and I have very fond memories.'

As for the future – Dr Patrick is currently working on NASA's Orion project – a spaceship they believe can take humans much deeper into space, to planets such as Mars.

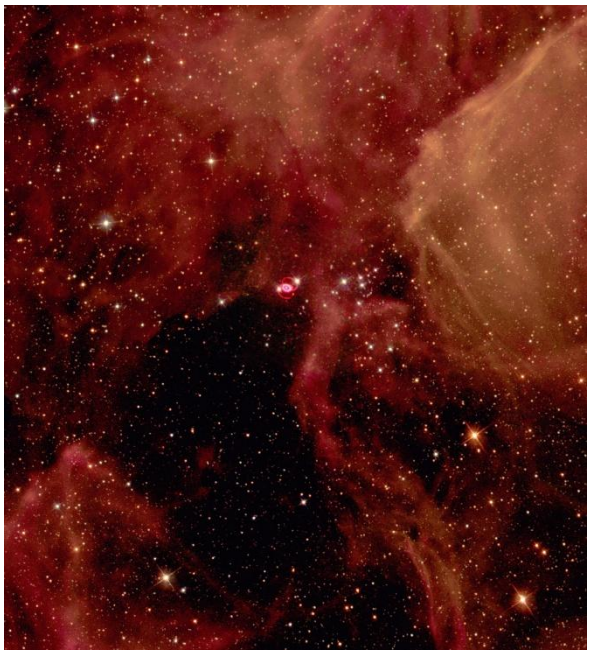
'I would love to take part in a longer mission – it would be about six months and would be very exciting,' Dr Patrick said.

If past experience is anything to go by, he had better fasten his seat belt.

Supernova! A quarter-century perspective on 1987a

C. C. Petersen

The Spacewriter's Ramblings

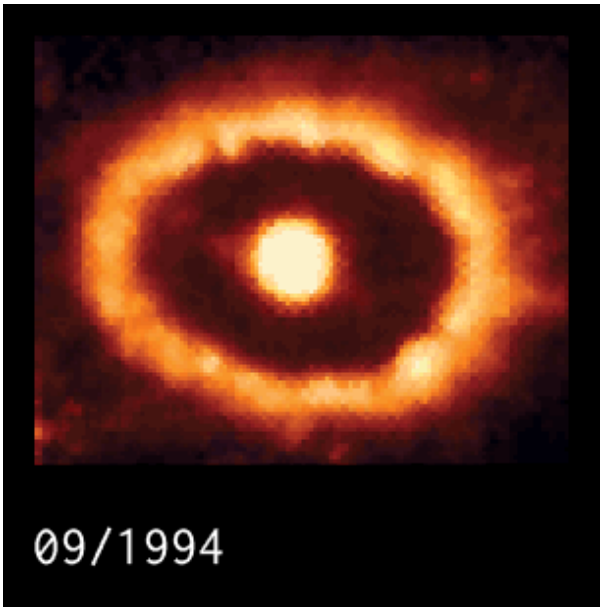


Supernova 1987A, in the Large Magellanic Cloud, a nearby galaxy. Astronomers in the Southern hemisphere witnessed the brilliant explosion of this star on 23 February 1987. Shown in this NASA/ESA Hubble Space Telescope image, the supernova remnant, surrounded by inner and outer rings of material, is set in a forest of ethereal, diffuse clouds of gas. This three-colour image is composed of several pictures of the supernova and its neighbouring region taken with the Wide Field and Planetary Camera 2 in September 1994, February 1996 and July 1997. *Courtesy Hubble Heritage Team (AURA/STScI/NASA/ESA).*

It had to have been quite an exciting thing for Ian Shelton and Oscar Duhalde when they first saw a brightening star on a photographic plate that hadn't been there the night before. Or for Albert Jones of New Zealand, and Rob McNaught in Australia, who saw the same brightening and

must have wondered 'What??!'. In Chile, Ian stepped outside the Las Campanas Observatory in Chile to visually check that area of the sky. Sure enough, there was a hugely bright star in the Large Magellanic Cloud that wasn't that bright the night before. All three observers had discovered the supernova of the century, named Supernova 1987a. It was the last explosive gasp of the dying blue supergiant star Sanduleak –69° 202 (called the 'progenitor star'), and an eye-opener for scientists studying supernovae, particularly a type called 'core collapse' or Type II.

When massive stars like the one that died to form Supernova 1987a come to the ends of their lives, they have basically run out of fuel to consume in their cores. Stars begin by fusing hydrogen to helium in their cores. The result is heat and light. Eventually the star runs out of hydrogen as fuel, so it begins to fuse helium, then carbon, and so forth, until it gets to iron. At that point, fusing iron takes more energy than the process can put out, and that's when the fusion action stops. Dead. And there's no way that the core can support the mass of the layers above it. So, it collapses. The outer layers collapse, too, and when they hit the core, they rebound out, forming a huge shock wave that blows everything but the core out into space. That's what we detect as a supernova.

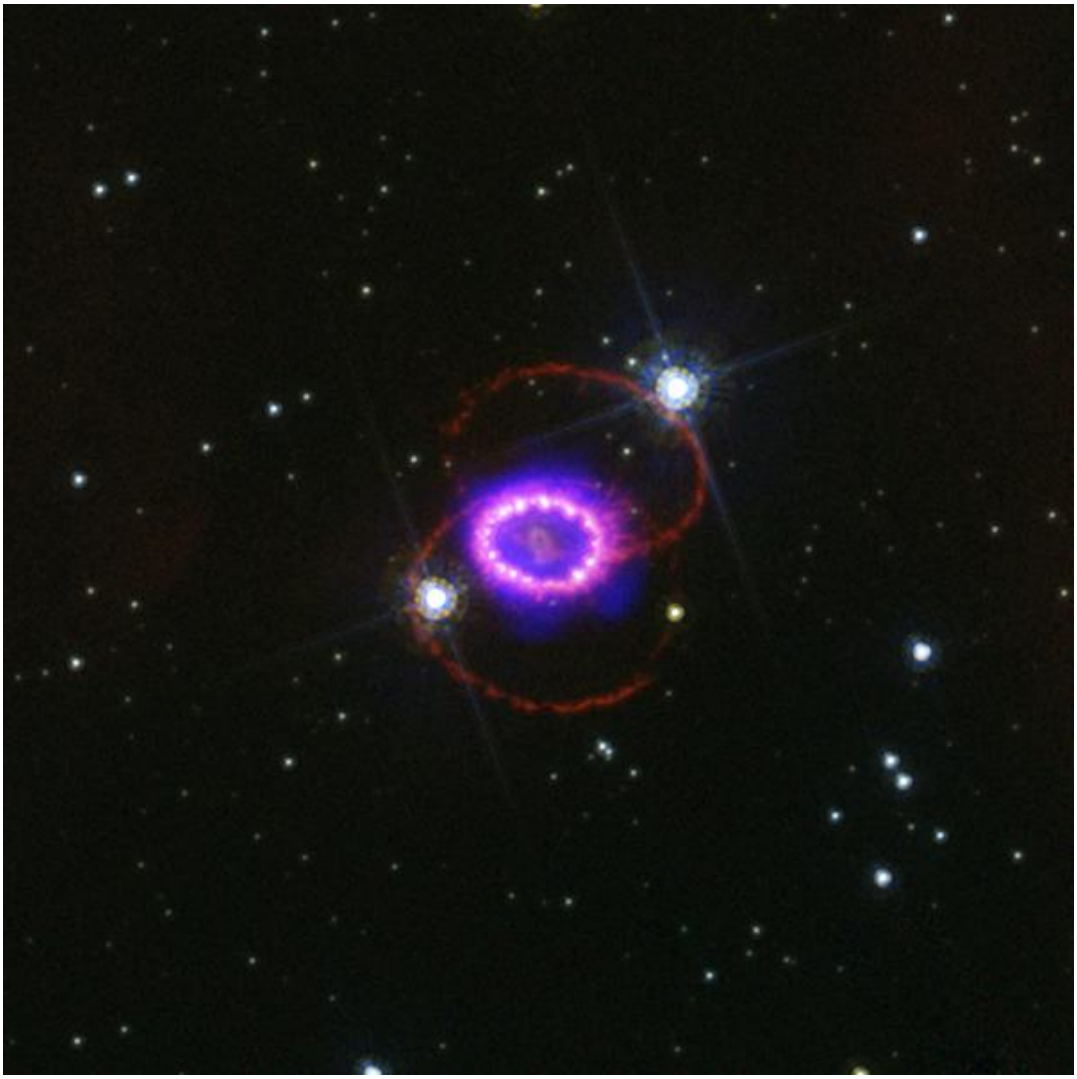


Click on this image to see a time-lapse video of Hubble images showing the sequence of ring expansion around Supernova 1987a. Courtesy Mark McDonald via Creative Commons Share-Alike Licence.

Supernova 1987a was surrounded by an expanding ring of debris. Astronomers immediately began looking for that ring, and eventually the Hubble Space Telescope took images and data of it a few years later. Today, 25 years after the first detection, astronomers are still watching the debris expand. As it does, it collides with material (gas and dust clouds) that the star shed earlier in its death process. When the shock wave and expanding debris make contact with that material, everything lights up.

Supernova 1987a has given astronomers new insight into the types of stars that become Type II supernovae. For one thing, at the time of Supernova 1987a's discovery, blue supergiants were not considered likely supernova candidates for a variety of reasons. Yet, here was one exploding in a supernova. So, astronomers had to go back and re-examine their ideas and theories about these kinds of high-mass stars.

The progenitor star, Sanduleak –69° 202, just wasn't on people's radar as a possible supernova candidate. It didn't show any hints that it was about to blow itself up. That raises a lot of questions about what we know of high-mass stars and their death cycles.



A composite image of supernova 1987a taken 20 years after the explosion was first detected. Data came from NASA's Chandra X-ray Observatory and Hubble Space Telescope. Credit: X-ray: NASA/CXC/PSU/S.Park & D.Burrows.; Optical: NASA/STScI/CfA/P.Challis

The outburst was visible to the naked eye, and is the brightest known supernova in almost 400 years. This shows the effects of a powerful shock wave moving away from the explosion. Bright spots of X-ray and optical emission arise where the shock collides with structures in the surrounding gas. These structures were carved out by the wind from the destroyed star. Hot-spots in the Hubble image (pink-white) now encircle Supernova 1987A like a necklace of incandescent diamonds. The Chandra data (blue-purple) reveals multimillion-degree gas at the location of the optical hot-spots. These data give valuable insight into the behaviour of the doomed star in the years before it exploded.

The progenitor star was very compact and blue; not the kind of star to explode like this. So, there had to be another influence. It turns out there was more than one star involved; this system was a binary. One idea is that both the progenitor star and its companion were engulfed in an envelope of material. The companion may have dissolved in some way, and that affected the progenitor star, and helped send it down the road to supernova-hood. There are other explanations, and current and ongoing studies of the supernova remnants and the

immediate neighbourhood may help solve the mystery of why a blue supergiant exploded as it did.

Once the explosion DID occur, aside from the shock wave and light, there was also a huge burst of neutrinos – fast-moving particles that whiz across space. One expert estimated that 10^{57} neutrinos were generated by the explosion, speeding away in all directions. A few of them hit Earth and were detected by the Kamioka experiment in Japan, and by detectors in Cleveland[1] and the former Soviet Union.

All in all, only 19 neutrinos were detected from 1987a, but they told astronomers a story of core collapse inside a massive star. They also suggest that a neutron star formed in the wake of the core collapse of the supernova 1987a progenitor star. As of today, that neutron star has yet to be observed. There are a number of reasons for that, including the formation of a black hole at the same site. Astronomers are still looking.

So, 25 years after the appearance of Supernova 1987a, there's still something to study. The continued expansion of the shock waves and debris rings into the surrounding material in interstellar space will provide much data about the material and those interactions. The search for the neutron star (or whatever's left of the progenitor star) continues. And astronomers continue to use this event to bolster and tweak theories about massive stars and their ultimate ends. It's been a fascinating quarter-century, and the data continues to flow. No doubt the Hubble Space Telescope and ESA's Herschel Space Observatory will continue to watch this object, as will other facilities (such as the Gemini Observatory) around the world. It will probably be a target for the James Webb Space Telescope. So, stay tuned for new images and data to mark the 25-year mark of this cosmic event. Supernova 1987a might have exploded, but it's not dead yet.

This content distributed by the AAVSO Writer's Bureau.

Comments on *Transit*'s May issue

John Crowther

I was fascinated by both Neil's and Ray's articles in May's edition.

Modern scientific measurement is extremely exact – Neil told us that the calendric timing of our journey round the Sun is now accurate to an eighth of a day in 400 years. The tiny bit left over works out at 0.0003096 day per year. So what's that in recognisable time? Not worth bothering with, especially to a poor mathematician like me.[2]

Ray's article included a diagram of tidal bulges due to the gravitational attraction of the Sun and Moon being lined up each month. Is the one furthest from them caused by the combined attraction of the Sun and Moon whilst the liquid oceans lag behind?

[1] *[Ohio! – Ed.]*

[2] *[Ooh, I can't let that statement pass! It's about 27 seconds per year, or roughly half an hour in an average lifetime. – Ed.]*

This will be to do with the Moon and Earth revolving around a common centre of gravity below the Earth's crust but not at its centre.

The maze-like channels between the Arctic islands north and east of Canada were shown in the Google Earth picure, which also showed glaciers from which icebergs calve and begin their slow journey into the North Atlantic. It was these many channels that made the discovery of a north-west passage so difficult. It took over a century to find, with Captain Cook being one of the first to make an attempt towards the end of his third voyage. From the 'Asia' side of the American continent, the north-east passage was simpler, but still not practical until the invention of modern powerful icebreakers.

Ray ended his article with another 'what if?' linked with the *Titanic*. There seem to be around twenty such what-ifs, with his, linked to geography and weather patterns, being new to me.

Some vaguely astronomically linked ones include:

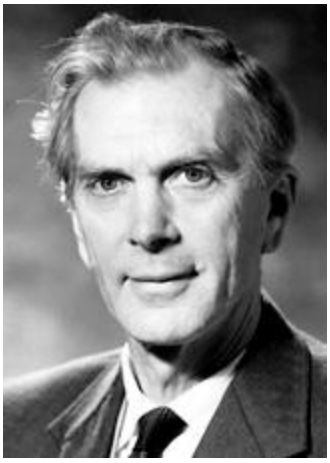
- What if the cupboard that contained the field glasses or binoculars had not been locked?
- Were prismatic binoculars with a wider field of view and a greater magnification invented before 1912?
- What if the lookout position (entered from within the hollow mast) had been higher?
- What if the sea had been rougher and white-capped in the moonlight – or even had there been some illumination due to the re-reflection, from a low and continuous cloud base, of light reflected upwards from the ice?

Finally, to me as an HG Wells enthusiast, the 19 VLA dishes in the Atacama Desert resemble fighting machines from *The War of the Worlds* ready to advance.

THE TRANSIT QUIZ

Answers to May's quiz

1. Why have some astronomers recently been looking at the Moon to detect signs of life on Earth? **Scientists at the VLT in Chile have been analysing reflected Earthshine for telltale wavelength and polarisation patterns that signal vegetation, atmospheric gases, the presence of oceans etc on Earth itself. This is a proving exercise for the future examination of light reflected from an exoplanet by its parent star.**



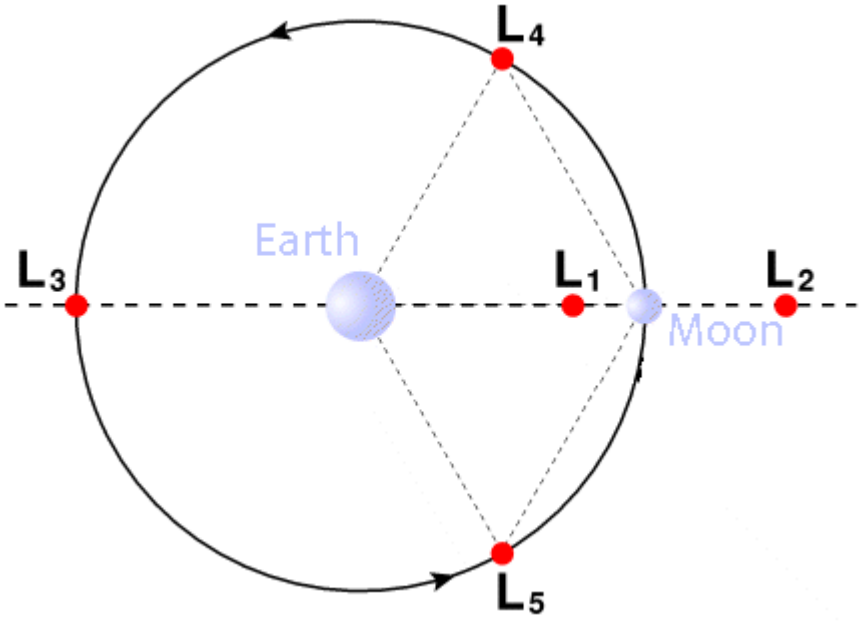
2. Who was the first Professor of Radio Astronomy at Cambridge? **Sir Martin Ryle (1914–84) – *see right.***

3. Who proposed the 'dirty snowball' theory of comets? **Fred Whipple (1906–2004).**

4. Before 1977, we thought Saturn was the only ringed planet. We now know that Uranus and Neptune have rings too. How many? **Uranus has 13 and Neptune 6. As far as we know today …**

5. Herschel, Planck, WMAP, H2L2 and the James Webb Space Telescope: what did/do/will these space telescopes have in

common? **They all are or will be orbiting around the Earth–Sun system's L2 Lagrangian point – *see below.***



6. And what about the Pioneer, Voyager, Galileo and Juno missions? **They're all missions planned to add greatly to our knowledge of Jupiter. Juno will get to the Jupiter system in July 2016.**

7. What's the next in this series: 185, 1054, 1572, 1604, ….? **1987. These are the only years we know of in which naked-eye supernovae were recorded. The first four were in our galaxy, but SN1987A was in the Large Magellanic Cloud. (See the article on page 10.)**

8. Which astronomer became a member of the House of Lords in 2005? **Lord Rees of Ludlow (Sir Martin Rees).**

9. What's the largest telescope open for public viewing in the UK? **The 28-inch (71-cm) reflector at the Royal Observatory, Greenwich – *see right: image by Duncan Kopernicki.***

10. Oceanus Procellarum (Ocean of Storms) is the largest lava plain on the Moon at 811,000 sq. miles. The second largest is one of the 'Maria' – which one? **Mare Imbrium (Sea of Rains), at 332,000 sq. miles.**

June's quiz

1. What's the link between Apollo 11 and Amazon's founder, Jeff Bezos?

2. What's the Astronomer Royal's salary**?**

3. The Milky Way's principal disc is about 100,000 lightyears across. About how thick is it?

4. NGC 6572 in Ophiucus is nicknamed the Blue Racquetball. What kind of object is it?

5. Which planet has a satellite called Belinda?

6. The Tarantula Nebula (NGC 2070) is in the constellation of Doradus. What else is it in?

7. Within our solar system, what is a Hirayama family?

8. What two related solar system bodies did Asaph Hall discover in 1877?

9. It has the greatest annual proper motion of any naked-eye star, and was also the first to have its parallax measured, in 1838. What is it?

10. Which observatory is 80 km north-east of San Diego?