BBC

LED REVOLUTION: THE RIGHT LIGHT AT NIGHT?

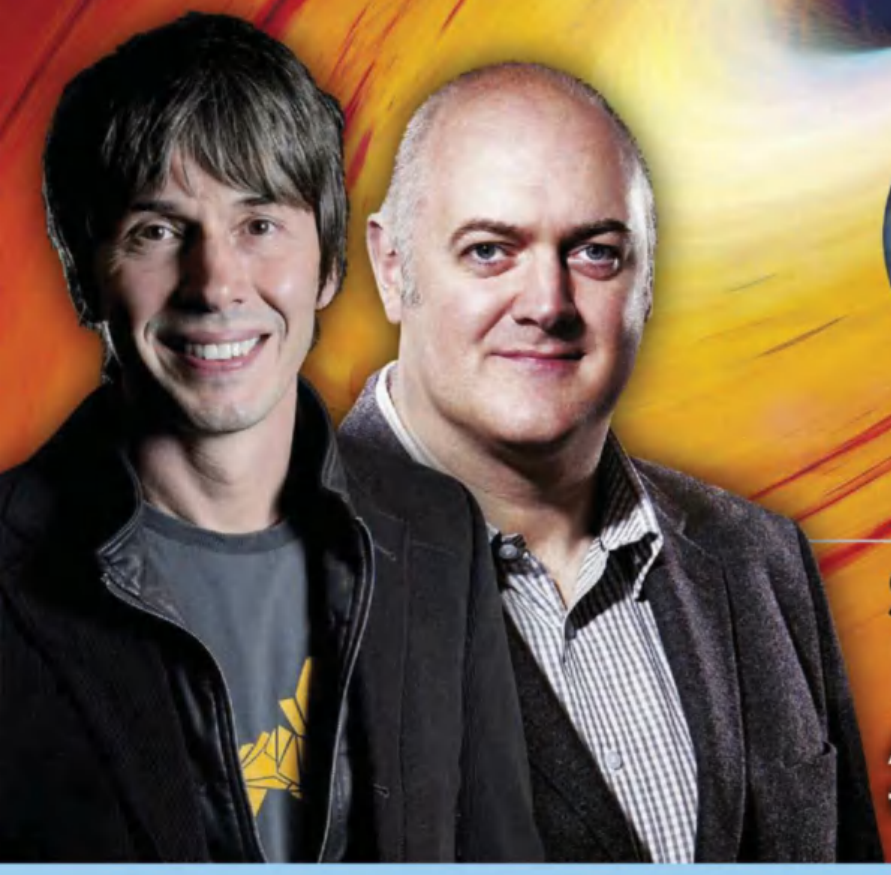
THE UK'S BIGGEST SELLING ASTRONOMY MAGAZINE

Sky at Night

#143 APRIL 2017

Seeing the Galaxy's DARK HEART

How astronomers are revealing the monster black hole at the centre of the Milky Way



THE SKY GUIDE

17 PAGES OF OBSERVING

Jupiter at opposition: big, bright & up all night

STARGAZING LIVE DOWN UNDER

Awe-inspiring views of the cosmos from the southern hemisphere

EXTRA ONLINE

INTERACTIVE PLANETARIUM

SOUTHERN STARS

View a gallery of award-winning Aussie astro images

VIDEO INTERVIEW

The Australian astronomer paving the way for the Square Kilometre Array

CELESTRON®

TECHNOLOGICALLYSUPERIOR

12031 – Advanced VX 8 EdgeHD

Camera not included

ADVANCED VX

A SOLID FOUNDATION DESIGNED FROM THE GROUND UP

Engineered from the ground up with astroimaging in mind, the new Advanced VX series from Celestron sets a superior standard in mid-level telescopes. Advanced VX provides you with many of the features found on Celestron's most sophisticated German equatorial mounts, at an extremely affordable price.

12026 - Advanced VX 8 SCT
12031 - Advanced VX 8 EdgeHD
12046 - Advanced VX 9.25 SCT
12067 - Advanced VX 11 SCT
12079 - Advanced VX 6 SCT
22020 - Advanced VX 6 R
32054 - Advanced VX 6 N
32062 - Advanced VX 8 N
91519 - Advanced VX Mount

WARRANTY 2 YEAR

StarSense™ AutoAlign Accessory

Upgrade your Celestron computerised telescope to a fully automatic computer set up*

- Set your telescope outside, press 'Align' on the StarSense hand control, and sit back. No further user involvement needed!
- StarSense uses an on-board digital camera to scan the sky.
- In about 3 minutes StarSense will gather enough information to triangulate its position and align itself.
- No need to identify or manually locate alignment stars in the sky, StarSense will automatically align your telescope.
- Sky Tour mode will slew to all the best stars, planets, galaxies and more based on your exact time and location.
- Provides advanced mount modelling.

StarSense™ TECHNOLOGY

Celestron SkyPORTAL™ WiFi Module

Control your Celestron computerised telescope using your smart device*

- Control your telescope right from your device using SkyPortal Wi-Fi module and SkyPortal App.
- Tap any celestial object you see in the sky to identify it immediately.
- Slew your telescope to over astronomical 120,000 objects.
- Works with Celestrons' brand new planetarium App, SkyPortal.
- SkyPortal App turns your smartphone or tablet into your own personal planetarium.
- You can listen to hundreds of included audio descriptions and view hundreds of images through your device.
- iOS and Android compatible.
- Download the free SkyPortal App and start discovering today!

iPhones shown not included

Google play

Download on the App Store

Available from specialist astronomy retailers and selected other dealers nationwide.

Celestron is distributed in the UK & Ireland by David Hinds Limited. Trade enquiries welcomed.

** See website for compatibility*

** See website for compatibility*

www.celestron.uk.com

This month's contributors include...

Pete Lawrence
Sky at Night presenter

Pete brings us the best observing targets for the month ahead – including two comets, the Lyrids and Jupiter's opposition. *Page 49*

Elizabeth Pearson
News editor

Elizabeth explains how astronomers worldwide are attempting to see the unseeable – our Galaxy's black hole. *Page 32*

Greg Quicke
Australian astronomer

Outback expert Greg brings inspiration for a southern sky sojourn with 12 of the best sights hidden from the UK. *Page 39*

Niamh Shaw
Scientist & speaker

Niamh reviews *Women Spacefarers: Sixty Different Paths to Space*, recounting the tales of female space pioneers. *Page 102*

Welcome

We celebrate the allure and majesty of the southern skies

Stargazing Live returns to BBC Two in the last week of March, when the team will be visiting Australia to explore the southern hemisphere sky. Those who have seen the night sky from the Outback say it has to be seen to be believed, and on page 39, Aussie astronomer Greg Quicke describes why the southern stars have such an awe-inspiring reputation. We also follow travel writer Shane Cormie into the dusty, red heart of the country on page 45, as he goes on a stargazing journey to one of Australia's most iconic landmarks – Uluru or Ayers Rock.

There's a lot of wilderness in Australia. This makes it a great location for professional astronomers to observe from; indeed, it was from Australia that the first observations of the centre of the Milky Way were made in the 1950s. On page 32 Elizabeth Pearson takes us through how much more we now know about this region, as we anticipate the first images of the supermassive black hole that lurks there. We look at astronomical instruments of a more everyday nature on page 67, where Will Gater is your guide to buying your first telescope. Here we cover all the questions to consider so that you end up with a piece of kit that will take you on a thrilling journey to the stars and planets.

Enjoy the issue!

Chris Bramley Editor

PS Next issue goes on sale 20 April

Become an Insider

The more we know about what you like, the better placed we are to bring you the best magazine possible. So we'd like to invite you to join our online reader panel 'Insiders'.

Just log on to **www.immediateinsiders.com/register** to fill out the short registration survey and we'll be in touch from time to time to ask for your opinions on the magazine and other relevant issues.

How to contact us

Subscriptions, binders and back issues
0844 844 0254
Mon to Fri 8am to 8pm; Sat 9am to 1pm for orders
Editorial enquiries
0117 314 7411
9.30am to 5.30pm, Mon to Fri
Advertising enquiries
0117 314 8365

Subscription email enquiries
skyatnight@servicehelpline.co.uk
Editorial enquiries
contactus@skyatnightmagazine.com
App enquiries
http://apps.immediate.co.uk/support
immediateapps@servicehelpline.co.uk

Editorial enquiries
BBC Sky at Night Magazine, Immediate Media Co Bristol Ltd, Tower House, Fairfax Street, Bristol, BS1 3BN

Sky at Night Lots of ways to enjoy the night sky...

TELEVISION
Find out what *The Sky at Night* team will be exploring in this month's episode on page 19

ONLINE
Visit our website for reviews, competitions, astrophotos, observing guides and our forum

FACEBOOK
All the details of our latest issue, plus news from the magazine and updates to our website

PODCAST
The *BBC Sky at Night Magazine* team discuss the latest astro news in our monthly podcast

iPad/iPhone
Get each month's issue on your iPad or iPhone, now with bonus video and images

TWITTER
Follow @skyatnightmag to keep up with the latest space stories and tell us what you think

CONTENTS

C = on the cover

NEW TO ASTRONOMY?
Get started with The Guide on page 78 and our online glossary at www.skyatnightmagazine.com/dictionary

Features

STARGAZING LIVE

Regulars

APRIL'S BONUS CONTENT

ACCESS THE CONTENT ONLINE AT
www.skyatnightmagazine.com/bonuscontent
ACCESS CODE: 9NSQP6T

Highlights

Telescope Takeover

February's episode of *The Sky at Night* sees Chris and Maggie take control of the powerful telescopes at the Roque de los Muchachos Observatory on the island of La Palma to view a selection of deep-sky objects chosen by viewers. In Pete Lawrence's monthly practical astronomy section, he reveals how to spot the Apollo lunar landing sites from your own back garden.

Video interview: ASKAP astronomy

Radio astronomer Dr Lisa Harvey-Smith discusses the Australian project leading the Square Kilometer Array.

Image gallery: IAPY goes Down Under

The best Aussie astro images from past *Insight Astronomy Photographer of the Year* competitions.

Sneak preview: *Mask of the Sun*

Read a chapter from John Dvorak's new book on how eclipses have shaped our culture, history and lives.

and much more...

- ▷ **Hotshots gallery**
- ▷ **Eye on the sky**
- ▷ **Extra EQMOD files**
- ▷ **Binocular tour**
- ▷ **Equipment review guide**
- ▷ **Desktop wallpaper**
- ▷ **Observing forms**
- ▷ **Deep-sky tour chart**

EVERY MONTH
Virtual Planetarium
With Paul Abel and Pete Lawrence
Explore April's night-sky highlights with Paul and Pete.

***BBC Sky at Night Magazine* is published by Immediate Media Company Bristol Limited under licence from BBC Worldwide, who help fund new BBC programmes.**

EDITORIAL
Editor Chris Bramley
Art Editor Steve Marsh
Production Editor Kev Lochun
News Editor Elizabeth Pearson
Editorial Assistant Iain Todd
Reviews Editor Paul Money

CONTRIBUTORS
Paul Abel, Maggie Aderin-Pocock, Rob Banino, Sean Blair, Steve Brown, Shane Cormie, Adam Crute, Jon Culshaw, Lewis Dartnell, Will Davis, Glenn Dawes, Mark Garlick, Will Gater, Brian Jones, Nicholas Joannou, Pete Lawrence, Chris Lintott, Bob Mizon, Ray Norris, Greg Quicke, Steve Richards, Steve Sayers, Niamh Shaw, Giles Sparrow, Paul Sutherland, Stephen Tonkin, Paul Wootton

ADVERTISING SALES
Advertising Managers
Neil Lloyd (0117 300 8276), Tony Robinson (0117 314 8811)
Inserts Laurence Robertson (00 353 87 690 2208)

PRODUCTION
Production Director Sarah Powell
Production Coordinator Emily Mounter
Ad Services Manager Paul Thornton
Ad Co-ordinator Emily Thorne
Ad Designers Cee Pike, Andrew Hobson
Reprographics Tony Hunt, Chris Sutch

LICENSING
Director of Licensing and Syndication Tim Hudson
International Partners' Manager Anna Brown

MARKETING
Head of Circulation Rob Brock
Head of Marketing Jacky Perales-Morris
Marketing Executive Craig Ramsay
Head of Press and PR Ridhi Radia

PUBLISHING
Publisher Jemima Ransome
Managing Director Andy Marshall

MANAGEMENT
CEO Tom Bureau

BBC WORLDWIDE, UK PUBLISHING
Director of Editorial Governance Nicholas Brett
Director of Consumer Products and Publishing Andrew Moultrie
Head of UK Publishing Chris Kerwin
Publisher Mandy Thwaites
UK Publishing Coordinator Eva Abramik

UK.Publishing@bbc.com
www.bbcworldwide.com/uk--anz/ukpublishing.aspx

EDITORIAL REVIEW BOARD Andrew Cohen, Head, BBC Science Unit; **Deborah Cohen**, Editor, BBC Science Radio; **Michael Lachmann**, Series Producer, *The Sky at Night*; **Clare Matterson**; **Robin McKie**

SUBSCRIPTION RATES
Annual subscription rates (inc. P&P): UK cheque/credit card £62.40; Europe & Eire Airmail £75; rest of world airmail £85. To order, call 0844 844 0260

We abide by IPSO's rules and regulations. To give feedback about our magazines, please visit immediate.co.uk, email **editorialcomplaints@immediate.co.uk** or write to The Editor, *BBC Sky at Night Magazine*, Immediate Media Co., Tower House, Fairfax Street, Bristol, BS1 3BN.

Audit Bureau of Circulations
23,453 (combined; Jan-Dec 2016)

ISSN 1745-9869

COVER MAIN IMAGE: ILLUSTRATION BY MARK GARLICK, DAN HIMBRECHTS/EPA/REX/SHUTTERSTOCK, D.PEACH/CHILESCOPE TEAM, THIS PAGE: SEBASTIAN VOLTMER/CCDGUIDE.COM, NASA/IPL-CALTECH, PAUL WHITFIELD, WWW.SECRETSTUDIO.NET, BBC, CSIRO, PHIL HART

The Cat and the Crustacean

Hot, young stars illuminate a pair of familiar looking nebulae, causing them to glow a beautiful bright red

ESO VLT SURVEY TELESCOPE, 1 FEBRUARY 2017

Just like clouds in the sky over Earth, the cosmic clouds we call nebulae form such intricate, unique shapes that observers can't help but spot familiar objects in them. The nebula in the top right of this image is NGC 6334, known as the Cat's Paw Nebula as it forms a trio of clouds that resemble a feline footprint. At bottom left is NGC 6357, known as the Lobster Nebula, with its dusty tendrils reaching out to the edge of the image.

That these two nebulae appear so close together – as though a cat were waiting to pounce on its unsuspecting prey – is actually an illusion. The Cat's Paw is about 5,500 lightyears away from Earth, while the Lobster is 8,000 lightyears away. Nevertheless, both these cosmic clouds are going through much the same process. They are very active star-forming regions, fuelled by pockets of dust and gas that block out starlight and create the darker patches in the image. The dust and gas are both vital ingredients for the creation of new stars, which beam ultraviolet light that ionises hydrogen atoms, creating the bright, illuminated hue of the two nebulae.

YOUR BONUS CONTENT A gallery of these and more stunning space images

ESO

▲ The tempestuous giant

NASA JUNO SPACECRAFT, 2 FEBRUARY 2017

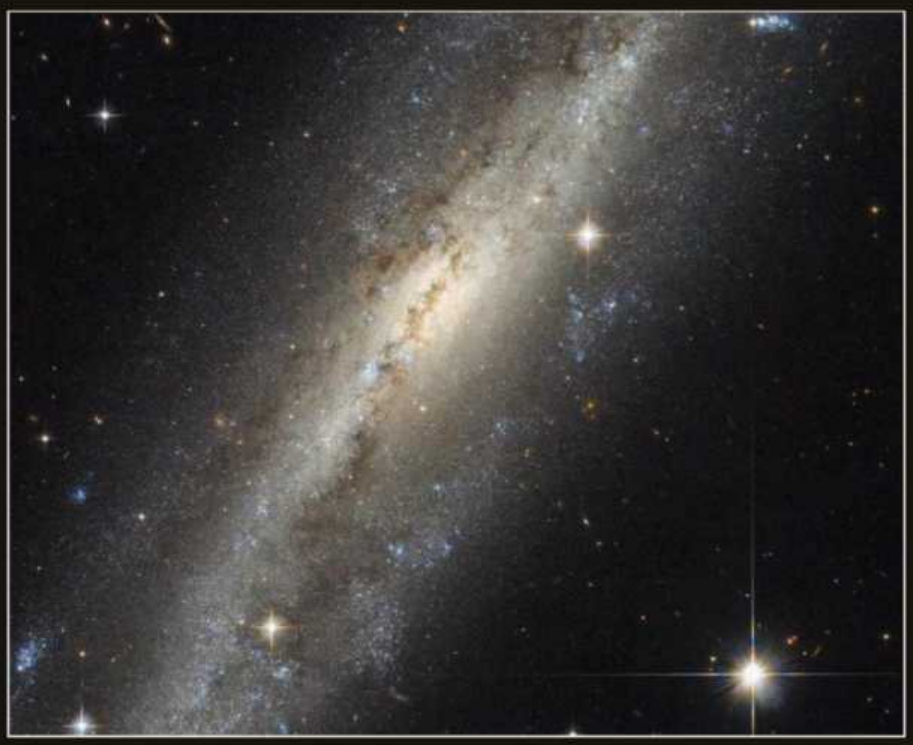
Swirling cyclones and white circular storms dominate this view of Jupiter's south pole, taken 101,000km above the clouds. Like so many of the amazing images we've seen from the Juno mission, this one was processed by a citizen scientist. John Landino used raw Juno data to create a beautiful and scientifically intriguing close-up of Jupiter's turbulent atmosphere.

▲ Explosive galaxy

VERY LARGE TELESCOPE, 6 FEBRUARY 2017

Two supernovae have occurred in galaxy NGC 4981 in recent years: one in April 1968 and one in 2007. The former was an example of a Type Ia supernova. These stellar explosions produce consistent and predictable levels of luminosity and comparing their calculated brightness to their perceived brightness as seen from Earth enables astronomers to measure how far away their host galaxy is. NGC 4981 is over 75 million lightyears distant in the constellation of Virgo.

NASA/JPL-CALTECH/SWRI/MSSS/JOHN LANDINO, ESO, NASA/ESA/R. KIRSHNER/P. CHALLIS/ESO/NAOJ/NRAO/A. ANGELICH/NASA/CXC/SAO, ESA/HUBBLE & NASA, SDO/NASA



◀ Side-on spiral

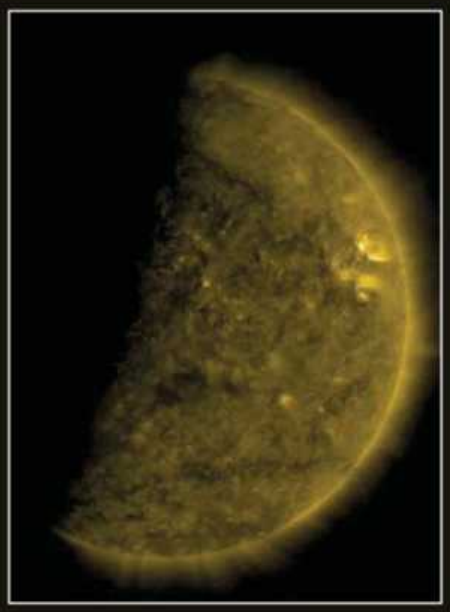
HUBBLE SPACE TELESCOPE, 6 FEBRUARY 2017

NGC 7640 is a barred spiral galaxy in Andromeda, but you wouldn't necessarily know it from this image, as the Hubble Space Telescope has captured it side-on. While the spiral arms may not be visible from this perspective, we can still see the bright bar of stars at its centre; so too the clusters of hot blue stars on the fringes.

▼ Earth's eclipse

NASA SOLAR DYNAMICS OBSERVATORY, 15 FEBRUARY 2017

NASA's orbiting solar telescope managed to capture this image of our planet's shadow blotting out its view of the Sun. This image shows just one of many such eclipses that occurred over a few days, from the perspective of the telescope's orbit, each lasting about an hour.



◀ Birthday blast

HUBBLE SPACE TELESCOPE, 24 FEBRUARY 2017

Thi is supernova SN 1987A, named after the year in which it was discovered, and the Hubble Space Telescope took this image to mark the 30th anniversary of that event. SN 1987A is the closest observed supernova to Earth in hundreds of years and astronomers have been able to follow its development. Rings of cosmic material can be seen around the supernova, glowing with heat energy from the explosion. The origin of these rings is not entirely known, but Hubble observations have helped astronomers conclude they were ejected 20,000 years before the explosion took place.

Your smartphone and your telescope are now best friends...

NEW

Omegon 8" Dobsonian telescope with Push+ object locator

2" CRAYFORD FOCUSER - For sensitive focusing

8" APERTURE - Plenty of light for your introduction to the world of star clusters, nebulae and galaxies

GP RECEIVER - For mounting any telescope with a GP rail

SOFTWARE - The SkySafari® app for Android and PC programs such as Cartes du Ciel® or Stellarium® can be used to control your telescope

BLUETOOTH - Convenient, Bluetooth 2.0 creates a connection to your smartphone - range 10m

SMARTPHONE HOLDER - Suitable for all smart phones up to 75mm in width

DIGITAL ENCODER - Your telescope always knows where it is pointing. The software lets you follow every step and find objects in a jiffy

introductory price

48277 £249.00
Omegon Push+ mount

51434 £489.00
Omegon Push+ mount with 8" Newton (complete telescope)

Enter the product number into the search field!

> Learn more now on Astroshop.co.uk!

HOW TO FIND ANY OBJECT IN THE NIGHT SKY USING YOUR MOBILE PHONE AND TELESCOPE.

Experience a whole new feel to exploring the night sky with the Omegon 8" Dobsonian Push+. This telescope lets you observe each planet and Deep Sky Object. The new Push+ system makes it possible – with the help of a digital encoder and your own Android smartphone. After downloading the SkySafari® app everything is ready to go. Simply select an object and move your telescope in the desired direction. You will see exactly where your telescope is pointing on your smartphone screen. It lets you locate astronomical objects and get to know the night sky at the same time.

Contact

Address
Astroshop.co.uk · c/o nimax GmbH
Otto-Lilienthal-Straße 9 · 86899 Landsberg · Germany

Phone
+49 8191 94049-61

Mail
service@astroshop.co.uk

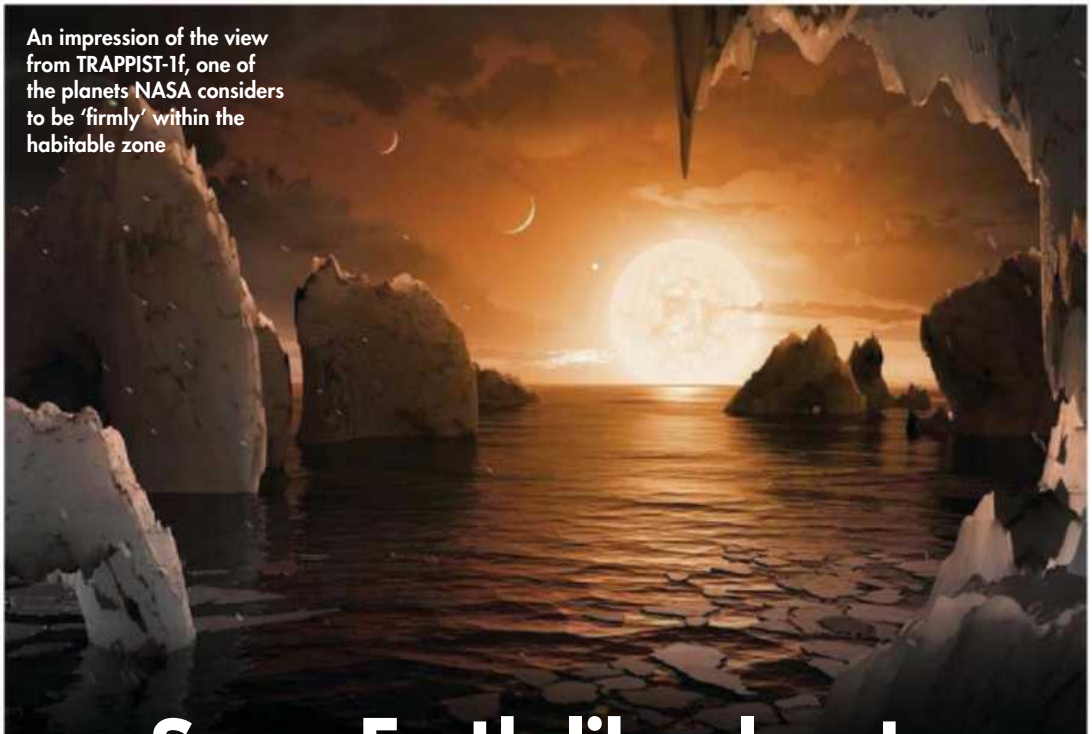
Astroshop.co.uk

Bulletin

The latest astronomy and space news written by **Elizabeth Pearson**

PLUS CUTTING EDGE

Our experts examine the hottest new astronomy research papers



An impression of the view from TRAPPIST-1f, one of the planets NASA considers to be 'firmly' within the habitable zone

NASA/JPL-CALTECH

Seven Earth-like planets DISCOVERED

Life could be hiding a mere 39 lightyears away

Seven Earth-sized planets with the potential to bear life have been spotted around the ultra-cool dwarf star, TRAPPIST-1. Three of these could lie in the habitable zone, and all could potentially have water.

"These planets are among the best that we know of to follow up looking for their atmospheres and biosignatures," says Thomas Zurbuchen, associate administrator for NASA's Science Mission Directorate. "The discovery gives us a hint that it's not a matter of if we discover a second Earth, but when."

The star, which was studied by NASA's Spitzer Space Telescope, is around 1,000 times dimmer than the Sun. However, as all seven planets orbit within 5 million km – one-tenth the orbital radius of Mercury – they receive enough light to make a temperate climate suitable for life possible on each of them. Crucially, the star's low brightness also means there is little glare, and it's expected that this make it much clearer to analyse what's in each planet's atmosphere using spectroscopy. Researchers will only be able to look closely at the system from 2018, following the launch of the James Webb Space Telescope.

"With James Webb, we are going to search for gases that don't belong, that might be produced by life, such as oxygen, ozone and methane," says Sara Seager from Massachusetts Institute of Technology. Meanwhile, the team will search for similar systems around 1,000 of the nearest ultra-cool dwarf stars.

"Historically in exoplanets, when there's one, there's more," says Seager. "With this amazing system we know there must be many more potentially life bearing worlds just waiting to be found."

▸ **See Comment, right**

COMMENT
by Chris Lintott

TRAPPIST-1 is exciting astrobiologists, but it's much more than just as a target for alien hunting. Finding seven worlds all packed into such a small region is surprising; I would have expected interactions between the planets to have torn such a system apart. The planets are in resonant orbits – TRAPPIST-1c orbits five times for every eight orbits of 1b, for example – and that helps, but it's still a striking result.

It's also surprising that all these worlds happen to transit in front of the star. That is, I suspect, a clue as to how they've formed since whatever process has produced such a tightly packed system has kept them in alignment.

Multiply-transiting systems are great, providing much more information about their planets than we'd otherwise have. TRAPPIST-1 is an exciting part of the search for life, but it's also an important step to understanding planets.

CHRIS LINTOTT co-presents *The Sky at Night*

NEWS IN BRIEF

STAR BEATS TO PLANET'S TIME

The brightness of star HAT-P-2 appears to pulse in time to the orbit of its planet, a gas giant eight times the mass of Jupiter. It does so every 87 minutes, an exact multiple of the planet's orbital period.

"We've seen this in systems with two rotating stars that are supermassive, where one can really distort the other, release the distortion, and the other one vibrates. But we did not expect this to happen with a planet — even one as massive as this," says Julien de Wit from the Massachusetts Institute of Technology.

HELP HUNT FOR PLANET NINE

A new citizen science project, Backyard Worlds: Planet 9, hopes to uncover the giant planet that may exist in the outer regions of our Solar System. The project asks users to look through images taken by NASA's WISE space telescope for moving objects.

"People who join the Backyard Worlds search bring a unique skill to the search: the human ability to recognise movement," says Adam Schneider, from the Backyard Worlds science team. Join the hunt at **www.zooniverse.org**.

NASA/JPL-CALTECH X 2; NASA/JPL-CALTECH/MSSS; NASA/JPL-CALTECH/UCLA/MPS/DLR/IDA; HERNAN CANELLAS, SPACE X; NASA/JPL-CALTECH

The curious case of Mars's MISSING ATMOSPHERE

The planet had too little carbon dioxide to insulate itself

Samples taken by the Curiosity rover have revealed that carbon dioxide levels on Mars were too low 3.5 billion years ago to explain the planet's watery past. The discovery raises new questions about theories on how the sedimentary deposits found on the planet's surface came to be.

For the past four years Curiosity has been studying Gale Crater, a region believed to have been created from a series of lake deposits laid over each other billions of years ago. The crater's rocks contain many clays and sulphates, indicating that their surface was in contact with liquid water when they were first laid down. For water to have been present on the surface of Mars, the planet must have been much warmer, and the current best explanation for the planet's temperature change is that it was once insulated by a thick carbon dioxide atmosphere.

If there was carbon dioxide in the atmosphere at the time, then Curiosity would be expected to find minerals called carbonates in the deposits.

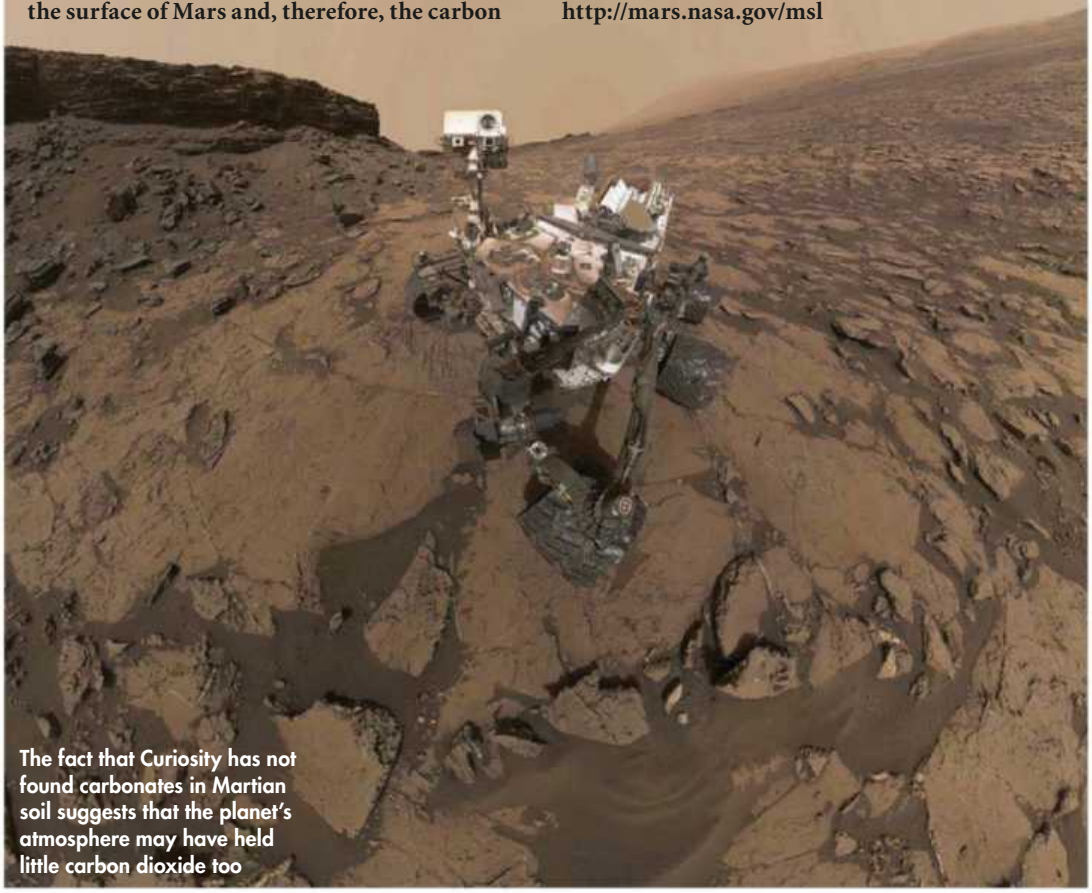
"The rover has not found carbonates, thereby confirming the results of studies by all previous [orbital] probes: carbonates are very scarce on the surface of Mars and, therefore, the carbon dioxide level in the atmosphere was very low," says Alberto Fairén from the Spanish National Research Council.

The measurements taken by Curiosity suggest that at the time the sediments were laid down there was 10 to 100 times less carbon dioxide in the atmosphere than was needed to keep the planet above freezing point.

"This contradiction has two possible solutions," says Fairén. "Either we have not yet developed climatic models which explain the environmental conditions on Mars at the beginning of its history, or the Gale sedimentary sequences really did form in a very cold climate."

The find does not, however, completely contradict the belief that Mars was once a wet planet. The atmosphere could have been composed of another greenhouse gas such as methane or sulphur dioxide. However, the reactive nature of these gases means that they would be very short lived. It's also possible that liquid water could have been insulated under ice caps, or the planet could have temporarily resided in a warmer orbit.

http://mars.nasa.gov/msl



The fact that Curiosity has not found carbonates in Martian soil suggests that the planet's atmosphere may have held little carbon dioxide too

Organic material detected on Ceres

The find will help uncover how similar minerals were created elsewhere

Organic materials have been found on the dwarf planet Ceres in the latest images taken by NASA's Dawn spacecraft. This is the first time these compounds have been definitively detected on a main belt asteroid. Though not biological in origin, such substances are a key to the formation of life.

The deposits appear as red patches on Ceres's surface in images taken by Dawn's visible and infrared mapping spectrometer, and are thought to be tar-like minerals such as kerite or asphaltite, though the precise compound is currently unknown.

Previous studies of the dwarf planet have shown that many of Ceres's geological processes took place in the presence of water and were heated by the planet's internal warmth. It is likely that the organics were created in similar conditions on Ceres, and perhaps on Earth too.
http://dawn.jpl.nasa.gov

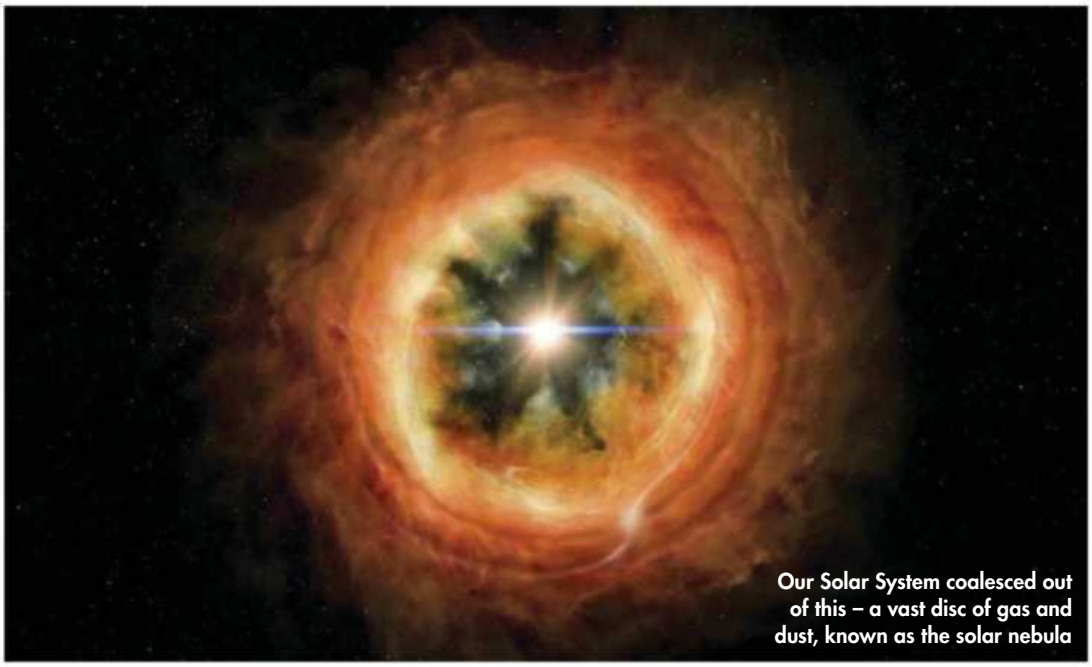
The red patches seen here are tar-like minerals – that they appear in small pockets suggests they formed on Ceres itself

Solar System birth took four million years

Meteorites dating from the early years of the Solar System have recently been used to show that Jupiter and Saturn were born within four million years of its formation.

The meteorites, known as angrites, hold a record of the magnetic field present at the time they formed 4.653 billion years ago. They revealed that the magnetic field present in the solar nebula, the disc of gas and dust that formed the Solar System, was up to 100 times weaker when it was four million years old than it was in the years preceding.

"It's predicted that once the magnetic field drops by a factor of 10-100 in the inner Solar System, the solar nebula goes away really quickly within 100,000 years. So even if the solar nebula hadn't disappeared by four million years, it was basically on its way out," says Benjamin Weiss from the Massachusetts Institute of Technology. This support to the theory that the gas giants were accreted slowly over several million years, rather than rapidly collapsing directly from the solar nebula within 100,000 years.
http://web.mit.edu



Our Solar System coalesced out of this – a vast disc of gas and dust, known as the solar nebula

NEWS IN BRIEF

SPACEX SHOOTS FOR THE MOON

Two eager space tourists have placed a deposit with private spaceflight company SpaceX to orbit the Moon in 2018. Both the company's Dragon 2 crew module and the Falcon Heavy rocket that would propel it to lunar orbit are due to be tested later this year. The first manned Moon mission in over 45 years will start the same place as the first: on 19 February SpaceX began launching rockets from the home of Apollo, pad 39A at the Kennedy Space Center. It later landed its rocket stage at the nearby Cape Canaveral.

JUNO TO STAY PUT

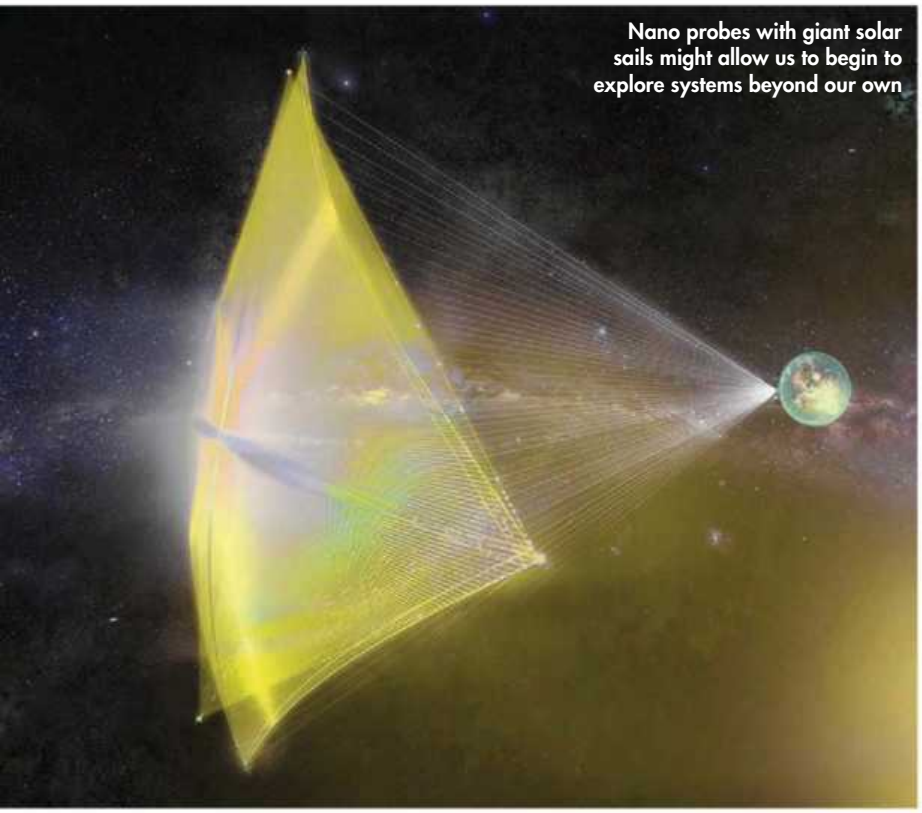
The Juno probe is to maintain its current 53-day orbit around Jupiter instead of moving to a 14-day one, NASA has announced. A problem with two valves on the spacecraft's engines meant that the agency could not guarantee Juno would manoeuvre to the correct orbit. Instead Juno will hold its current position, and continue to take data. The probe will pass as close to the planet as it would have done on a shorter orbit, but there are likely to be fewer of them.

CUTTING EDGE

Our experts examine the hottest new research

Starshot's latest breakthrough

A possible solution to slowing down a nano probe



Nano probes with giant solar sails might allow us to begin to explore systems beyond our own

The great joy with which many of us greeted the discovery last year of a potential planet around Proxima Centauri – the Sun's nearest stellar neighbour – was in part down to the hope that it would inspire innovative thinking about interstellar travel.

Almost immediately, the Breakthrough project, which helps to fund the search for life beyond Earth, put money into a technical study of what it's calling Project Starshot. The project aims to get a small probe weighing just a few grams to the Alpha Centauri system, a group of three stars to which Proxima Centauri belongs. The nominal design features a probe with a solar sail, accelerated to a good fraction of the speed of light by powerful earthbound lasers.

After taking the better part of a century to arrive, the probe would sweep through the system at enormous speed. With the craft racing across a distance equivalent to that between Earth and the Moon in just a few seconds, we'd be lucky to get a single sharp image back. The prospect of waiting a lifetime for such a brief encounter wasn't so inspiring, and deflated excitement for the project.

Luckily, there's a solution. A new paper has found a set of orbits that would swing the probe close enough to a target star so that it could brake using a suitably large sail. The only catch is that it would have to get very close; the proposed solution for the Alpha Centauri system is to get within five million miles of Alpha Centauri A before making similarly close passes of Alpha Centauri B and then finally Proxima Centauri. (The order is dictated by the brightness of the stars; the brighter the star, the greater the mass and the larger the deceleration.)

If you make the sail out of something light and strong, such as graphene, a sail 10,000m^2 across – slightly bigger than two football pitches – could slow a 10g probe down from travelling at nearly five per cent of the speed of light to being in a stable orbit around one or more of the stars in the system.

> *"We need to get a probe on the way in the next few years in order to take advantage of this new technique"*

Such a mission would still take time – the probe would take 95 years to reach Alpha Centauri A and then another 46 years to reach Proxima – but would allow detailed study of any planets. It won't be easy, though, as the challenges of accelerating the probe, keeping it on course and ensuring it survives a hostile radiative environment are enormous. And there's one more catch: the geometry works best if the probe arrives when the three stars align in the same plane. Such an alignment is due in 2115, so we need to get a probe on the way in the next few years in order to take advantage of this new technique.

That appears to be an incredibly tall order, but all is not lost if we look beyond the Alpha Centauri system. Sirius, for example, is twice as far away, but it is much more luminous. A probe arriving here could slow down from an arrival speed of nearly 15 per cent of the speed of light. Now that's a prospect worth building a giant laser for.

CHRIS LINTOTT is an astrophysicist and co-presenter of *The Sky at Night* on BBC TV. He is also the director of the Zooniverse project.

CHRIS LINTOTT was reading… *Deceleration of high-velocity interstellar photon sails into bound orbits at Alpha Centauri* by René Heller and Michael Hippke. **Read it online at https://arxiv.org/abs/1701.08803**

BREAKTHROUGHINITIATIVES.ORG

Black hole blows cold

The powerful jets around a black hole could help star birth

▲ Cold gas hugs the outside of the 'bubbles' shown in this composite image of a galaxy in the Phoenix Cluster

A black hole in the Phoenix Galaxy Cluster has recently been observed ejecting streams of cold gas by ALMA. Normally these powerful jets stunt star growth by blasting out radio bright bubbles of plasma in the surrounding gas. Usually, the conditions are too inhospitable for the hot gas to cool and condense, a vital stage in forming stars. In this case, however, the bubbles are sheathed in 82,000-lightyear-long filaments of cold gas, with enough mass to create over 10 billion Suns.

Without a heat source preventing stars from forming, most galaxies would be producing stars at far higher rates than what's observed. It was though that the heat from radio jets might provide the energy needed to stop a galaxy from overcrowding, but this find seems to suggest that the real process is much more complex.

www.almaobservatory.org

Halley's twin seen falling into star

A comet-like object with a composition similar to that of 1P/Halley, but 100,000 times the size, has been seen being ripped apart by a white dwarf. Though the rocky debris of asteroids has been found around such stars, this is the first time that an icy body has been spotted. This adds to evidence that not only do structures similar to the Kuiper Belt exist around other stars, but that they can survive their host's journey from main sequence star to red giant to white dwarf.

Spectral analysis by Hubble and the ground-based Keck Telescopes has shown that the comet was rich in carbon, oxygen, sulphur and nitrogen, all of which are vital components for life.

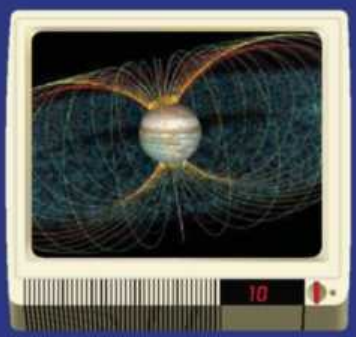
http://hubblesite.org

▲ An illustration of a comet-like object falling towards a white dwarf, as spotted with the Hubble Space Telescope

LOOKING BACK THE SKY AT NIGHT
27 March 1971

On 27 March 1971, *The Sky at Night* team turned their attention to one of the biggest structures in the Solar System: Jupiter's magnetic field. The first sign of the magnetic field came in 1955, when a strong, slowly shifting radio source was seen in the sky by astronomers Ken Franklin and Bernie Burke. They realised that it belonged to Jupiter, and was likely to be caused by electrical disturbances in its atmosphere. When Earth's radiation belts were discovered in 1959, it was realised that radio emissions were likely to have originated from a similar occurrence on Jupiter. The radiation belts are generated by the planet's magnetic field capturing charged particles that then emit electrons, observed as radio emissions.

By 1971, Jupiter's magnetic field was known to be 10 times stronger than Earth's and its magnetic force 18,000 times larger. The first in situ measurements came two years later when Pioneer 10 reached the planet.



▲ A NASA drawing illustrating Jupiter's impressive magnetosphere

NEWS IN BRIEF

EUROPA CLIPPER DESIGN STAGE BEGINS

A NASA mission to stage multiple flybys of Jupiter's moon Europa began its preliminary design phase on 27 February. The agency aims to complete the design of the mission's systems and subsystems by September 2018, planning for a launch date in the 2020s. Once complete the spacecraft, nicknamed the Europa Clipper, will travel to Jupiter and perform 40-45 flybys of the icy moon, taking high resolution images of the surface and investigating its interior.

UK LAUNCHES SPACEFLIGHT BILL

A new 'Spaceflight Bill' has been submitted to Parliament that aims to set the UK on a path to becoming a spaceflight services world leader. The government wants to build a spaceport in the UK within the next decade; this legislation creates the regulations needed to operate it. "It's our ambition as a government, as a collective industry, as a country, that the UK is the best place in Europe for spaceflight operations," says Minister for Aviation Lord Ahmad.

ALMA (ESO/NAOJ/NRAO) H.RUSSELL/ET AL/NASA/ESA HUBBLE/NASA/CXC/MIT/M.MCDONALD ET AL/B. SAXTON (NRAO/AUI/NSF), NASA/ESA AND Z. LEVY (STSCI), NASA/GODDARD SPACEFLIGHT CENTER, NASA/JPL-CALTECH

CUTTING EDGE

Our experts examine the hottest new research

Is life more likely under twin suns?

Planetary systems around binary stars may have the advantage when it comes to habitability

Binary stars could improve the chances of producing planets that can support life

DOTTED ZEBRA/ALAMY STOCK PHOTO

Earth is a world teeming with life; it fills the oceans, smothers the land and soars through the atmosphere. A vibrant biosphere of microorganisms has permeated deep into the planet, while complex, multicellular life forms such as trees and insects cover the surface. In contrast, none of the other planets in the Solar System appear to be alive.

Earth seems to be blessed in that it possesses a number of attributes that have enabled life to emerge and progress. It receives just the right amount of heat from its star (we orbit within the Sun's habitable zone), water was delivered here by impacts early in the Solar System's lifetime, it has active plate tectonics, its climate has remained stable for billions of years, and the atmosphere provides protection from solar winds and extreme ultraviolet radiation. Astrobiologists have long wondered whether Earth is just lucky to possess all of these features, or whether planets with similar characteristics are actually common in the Galaxy. In this month's paper, Ivan Shevchenko at the Pulkovo Observatory of the Russian Academy of Sciences makes the intriguing argument that although these features did come about by chance on Earth, there is a category of planets where they manifest automatically.

Shevchenko argues that planets orbiting binary stars might be automatically set up with many of the prerequisites for life. For example, stellar binaries with an orbital period of between 10-50 days experience a mutual tidal effect that suppresses the stars' magnetic dynamo and reduces the activity of their chromospheres. This means that the stars' solar wind and ultraviolet radiation output is much lower, which is probably good for the survival of any life on the planet. Furthermore, the planet doesn't need a strong magnetic field.

Shevchenko's paper also argues that planets orbiting binary stars wouldn't need to have a large moon (as Earth does) to stabilise wobbles in the planet's spin axis and any resulting effects on its climate. Also the tidal effect of orbiting a stellar binary would enhance seawater wetting and drying cycles caused by tides, which some scientists believe is important for the origin of life.

> *"Planets orbiting binary stars wouldn't need to have a large moon (as Earth does) to stabilise wobbles in their spin axes"*

Shevchenko's main point is that although planets forming around stellar binaries may migrate inwards, they'll always stall on the outer border of the chaotic zone around the binary (due to the gravitational perturbation of the two stars). And that's because at this point there's no more material to drive further migration. For Sun-like stars with binary periods of between approximately 10-100 days this migration stopping point is within the habitable zone. Thus, the really neat outcome, as Shevchenko points out, is that for a certain category of binary stars you might expect planets to be automatically placed within the habitable zone and thus be suitable for life, rather than needing to form there by chance – as happened with Earth.

If Shevchenko is right this would mean that Earth is an oddity that benefits from a number of overlapping lucky circumstances. Whereas the majority of living planets in the galaxy orbit binary stars because they automatically provide many of the prerequisites for life to emerge.

LEWIS DARTNELL is an astrobiology researcher at the University of Westminster and the author of *The Knowledge: How to Rebuild our World from Scratch* (www.the-knowledge.org)

LEWIS DARTNELL was reading… *Habitability properties of circumbinary planets* by Ivan I Shevchenko.
Read it online at https://arxiv.org/abs/1701.03475

Sales reps are available by phone or Live Chat 1400 and 2400 GMT
08-800-8989-0123

Everything for the Amateur Astronomer

ORION®
TELESCOPES & BINOCULARS

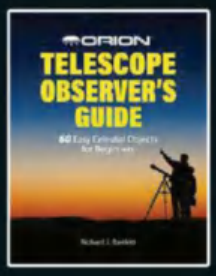
SINCE 41st year 1975

FREE SHIPPING *on order of £100 or more*
Economy Shipping. Some exclusions apply.

OR

£7.95 FLAT-RATE SHIPPING
No minimum order. Some exclusions apply.

NEW PRODUCTS



Orion® Telescope Observer's Guide
#51437 **£19**

Orion® GrandView™ Vari-Angle 20-60x60mm Zoom Spotting Scope
#40908 **£296**

Orion® SteadyPix™ EZ Smartphone Photo Adapter
#5347 **£83**

Orion® 6" f/4 Newtonian Astrograph Reflector Telescope
#10269 **£394**

Orion® 30mm Ultra-Mini Guide Scope
#52053 **£146**

Orion® GrandView™ Vari-Angle 20-60x80mm Zoom Spotting Scope
#40909 **£443**

Orion® 1.25" Twist-Tight Dielectric Mirror Star Diagonal
#40901 **£126**

Orion® 2" Twist-Tight Dielectric Mirror Star Diagonal
#40902 **£199**

Orion® StarShoot™ AutoGuider Pro & 30mm Ultra Mini Guide Scope
#20704 **£522**

Orion® 60mm Multi-Use Guide Scope with Helical Focuser
#13008 **£199**

Orion® StarSeeker™ IV 130mm GoTo-Reflector Telescope
#1316) **£401**

Orion® Atlas™ Pro AZ/EQ-G Computerized GoTo Mount
#10010 **£1,832**

Orion® 8" f/8 Ritchey-Chretien Astrograph Telescope
#8267 **£950**

Orion® StarSeeker™ IV 127mm GoTo Reflector Telescope
#13163 **£480**

Trust
Proven reputation for innovation, dependability and service… for over 41 years!

Superior Value
High quality products at affordable prices

Wide Selection
Extensive assortment of award winning Orion brand products and solutions

Customer Support
Orion products are also available through select authorised dealers able to offer professional advice and post-purchase support

Retail prices shown are current as of 24/02/17 from Orion. Product prices include VAT. Prices are subject to change without notice. Please check ***OrionTelescopes.co.uk*** *for the most current pricing. Dealer pricing and/or promotions may vary.*

Orion® Mini Giant 15x63 Astronomy Binoculars
#9466 **£236**

Orion® StarShoot™ G3 Deep Space Color/Mono Imaging Camera
#53082, 53083 **£398**

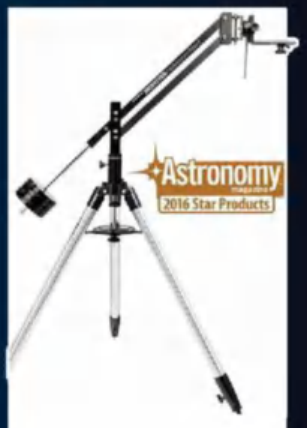
Orion® XT6 Classic Dobsonian Telescope Kit
#20557 **£288**

Orion® StarSeeker™ IV 150mm GoTo Reflector Telescope
#13161 **£473**

Orion® Atlas™ 8 EQ-G Reflector Telescope with GoTo Controller
#24732 **£1,632**

Orion® SkyQuest™ XT10g Computerized GoTo Dobsonian
#10135 **£1,248**

Orion® SkyQuest™ XT8 PLUS Dobsonian Reflector Telescope
#8974 **£480**



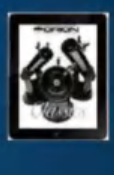
Orion® Monster Parallelogram Binocular Mount & Tripod
#5752 **£452**

ORION AUTHORISED DEALER

Telescope House
Edenbridge, Kent
01342 837 098
sales@telescopehouse.com
www.telescopehouse.com

Orion Telescopes & Binoculars now accepts the following payment options:

mastercard VISA AMERICAN EXPRESS PayPal bacs



OrionTelescopes.co.uk
Shopping has never been easier.
To learn more about Orion products and see a larger assortment, please check out the digital **eCatalogs** on our website!

The Widescreen Centre

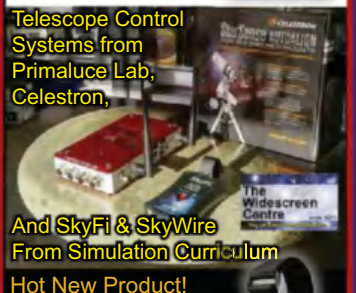
Welcome to the UK's Astronomy Showroom

• Quality • Choice • Expertise • Service •

The Widescreen Centre

News & Events, April 2017

See us next on April 1st at the SPA Convention in Cambridge see www.popastro.com
See us in London's Regent's Park on Monday April 3rd for the annual MoOnday event. www.facebook.com/events/416528415362230/
Later in the month join us at the Spring Equinox Star Party at Kelling Heath April 21st-24th - see www.starparty.org



Hot New Product!

The Widescreen Centre has moved! Visit our new dark-sky site near Ely, Cambridgeshire

Chance to check out our products after dark. Call or email us for our evening openings and events schedule.
Considering a new purchase? Come and see for yourself. Bring your scope and try some new eyepieces!
Or attend one of our night-time or solar events and enjoy the big skies of Cambridgeshire. All welcome!

The Widescreen Centre

01353 776199

• Monday - Saturday 9.30 - 6pm • Sundays, evenings and events - call us!

New Address: 2 Rosemary Lane • Sutton nr. Ely • Cambridgeshire • CB6 2NZ

www.widescreen-centre.co.uk • 01353 776199 • simon@widescreen-centre.co.uk

What's on

Our pick of the best events from around the UK

▲ **The City of Edinburgh prepares for two weeks of science this spring**

Edinburgh International Science Festival

Various locations, Edinburgh, 1-16 April

One of Europe's largest science festivals returns to the Scottish capital with talks, workshops and interactive exhibitions happening across the city. Some of Edinburgh's most popular venues are hosting this year's events, including Edinburgh Zoo, the National Museum of Scotland and the Royal Botanic Garden.

Kids of all ages are invited to help build habitats for a Martian colony in the 'Mars Master Constructors' workshop or design their own little green man in 'Creative Science: Ultimate Aliens'. Simon Watt looks at the science behind space exploration in 'Look Up', while Prof Paul Palmer explores the barrier between Earth and space in 'A Very Short Introduction To… The Atmosphere'. Discover the beginnings of Soviet spaceflight in theatre production 'Cosmonaut' and join science writer Marcus Chown as he leads a discussion with two UK scientists involved in the discovery of gravitational waves.

Electro-rock outfit Public Service Broadcasting will be performing their album *The Race for Space* in its entirety at Edinburgh's Usher Hall on Yuri's Night, 12 April, the international celebration of humanity's first journey into space.

To download this year's programme, visit the Edinburgh International Science Festival website.

www.sciencefestival.co.uk

BEHIND THE SCENES

THE SKY AT NIGHT IN APRIL

BBC Four, **23 April,** 10pm (first repeat BBC Four, **27 April,** 7.30pm)*

Sir Patrick Moore's presence defined the first six decades of *The Sky at Night*

60 YEARS OF SKY AT NIGHT

The Sky at Night marks its 60th anniversary by highlighting some of the major discoveries made in astronomy and spaceflight since the show began. Expect retro clips and special guests as Chris and Maggie look back on 60 years of the TV show that has inspired generations of viewers to gaze at the night sky.

Check www.bbc.co.uk/skyatnight for subsequent repeat times

Leighton Observatory Open Day

Leighton Observatory, Pex Hill, Cronton, 8 April, 1pm-9pm

Join Liverpool Astronomical Society for a day of solar, lunar and planetary observing, including talks and tours of the society's very own Leighton Observatory. Plus, bring your troublesome telescopes for a workshop during which society members will offer advice on how to improve or repair them. The event is free to attend and free car parking is also available.

www.liverpoolas.org

Transient Events in the Universe

Clanfield Memorial Hall, Clanfield, Hampshire, 21 April, 7.30pm

Developments in technology are helping astronomers search for short-lived phenomena in space, such as supernovae and gamma-ray bursts, as well as asteroids and other fast-moving objects. In this talk for Hampshire Astronomical Group, Prof Dame Jocelyn Bell Burnell looks into the search for transient astronomical events. Admission is £3 for non members.

www.hantsastro.org.uk

Spring Star Party

Kelling Heath, Holt, Norfolk, 19-26 April

Norwich Astronomical Society presents a week of observing under the dark skies of Kelling Heath Holiday Park. The Spring Star Party is one of two annual observing events at Kelling Heath, taking advantage of its isolated location away from the light pollution of towns and cities. Visit the event website for details of how to book tickets to one of the UK's most popular star parties.

www.starparty.org

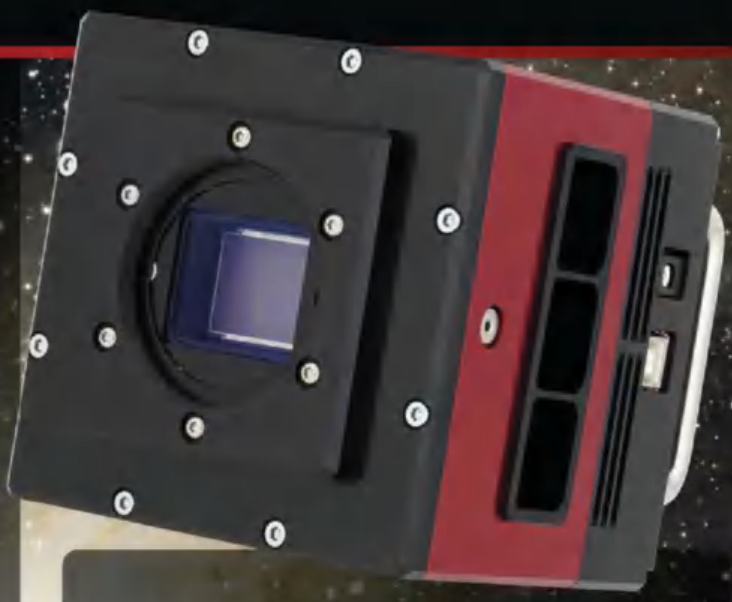
MORE LISTINGS ONLINE

Visit our website at **www.skyatnightmagazine.com/whats-on** for the full list of this month's events from around the country.

To ensure that your talks, observing evenings and star parties are included, please submit your event by filling in the submission form at the bottom of the page.

EDINBURGH SCIENCE FESTIVAL, D GALVIN, NASA, A ROBERTSON, BBC

IN 2008, THE KAF-8300 8MP SENSOR STARTED A REVOLUTION IN LOW COST, HIGH RESOLUTION ASTROPHOTOGRAPHY. NOW IT HAS A SUCCESSOR...



The KAF-16200 boasts nearly twice the number of pixels as the KAF-8300 on an APS-H size sensor with a 35mm diagonal.

This means that the incredible increase in resolution doesn't come at the cost of smaller, less sensitive pixels as it sometimes does. In fact, the pixels on this new sensor are actually slightly larger at 6µm compared to the KAF-8300's 5.4µm. Full well depth has also been significantly increased to allow us to capture accurate star colours and faint details all in the same shot.

But despite its increase in size, the sensor isn't so large as to require specialist astrograph telescopes. From shorter refractors giving incredible widefield views right through to longer focal lengths, the KAF-16200 and it's 6µm pixels are a great match for a huge range of scopes. It can also use 2" mounted filters to add LRGB or narrowband data to your images.

Atik is delighted to announce the Atik 16200 camera that pairs this incredible new sensor with all the great features you've come to expect from an Atik Camera. With class-leading electronics providing very low read noise, powerful cooling to a maximum -50°C delta, a compact curtain shutter, and an on-axis sensor for easy balancing, it's our signature blend of form and function. And of course, you also have access to our powerful and intuitive software as well as our personal Atik support.

LET THE SECOND REVOLUTION BEGIN!

Photo credit: Vince Bygrave

Atik Cameras are available from most major astronomy retailers.

For more information visit
www.atik-cameras.com

ATIK CAMERAS

A PASSION FOR SPACE

with **Maggie Aderin-Pocock**

The *Sky at Night* presenter on why she is quietly hopeful about the latest haul of Earth-like planets

I think I have mentioned before that I am slightly sceptical about the announcement of new Earth-like exoplanets. They seem to occur often: every four to six months everyone gets very excited, but the new discoveries are hard to report on as each one represents a small increment of improvement in Earth likeness. So we have the Earth-like exoplanet orbiting the most Sun-like star, the Earth-like exoplanet most similar in size to Earth, or the one that made the biggest impact previously to this, the closest exoplanet to Earth within its star's habitable zone (although it has yet to be established whether Proxima b is Earth-like and some still want more evidence before believing that it's there at all).

An artist's impression of the seven planets in the TRAPPIST system, which are designated b to h

NASA/JPL-CALTECH

Each of these discoveries is an important step in our knowledge of the range and variation of alien worlds. But amongst the frequent reports sometimes something comes along that is really quite exciting. A bit like buses sometimes a number arrive all at once – and in the case of TRAPPIST-1 that number is seven.

On 22 February an announcement was made that did catch my attention. NASA published a paper in *Nature* about the planetary system around the star TRAPPIST-1, an ultra-cool dwarf star around 44 lightyears from Earth. Ultra-cool stars are much smaller than our Sun and come in at around the volume of Jupiter (that's around a thousand times smaller than the Sun) but they are hotter than brown dwarfs and so are classified as stars. What TRAPPIST-1 lacks in size it makes up for in exoplanets, having a total of seven in orbit around it.

Magnificent seven

Not only does the star have an abundance of planets around it, it happens that they are all Earth- or Venus-sized and three of them sit in its habitable zone, where liquid water could exist. So why is this discovery so much more exciting that the others so far? Firstly, the TRAPPIST-1 system has the largest number of Earth-like planets found to date, orbiting a star not very far away. Next, all the planets in the system could potentially host liquid water but three are very likely to, as they sit in the habitable zone. Stars like TRAPPIST-1 are abundant in our Galaxy and seem to have Earth-like planets around them, which suggests we are likely to find many more planets like these out there.

The orientation of the system also allows us to analyse the planets' atmospheres. Before and after the light from the star passes through the atmosphere of the planets, it's possible to analyse and compare the light's spectral signature and so work out each planet's atmospheric chemistry.

TRAPPIST-1 is dim enough for the atmospheric signatures not to be lost in the glare, but that also means we won't have the instruments sensitive enough to analyse its radiation until the James Webb Space Telescope and the European Extremely Large Telescope come on line in 2018 and 2024. The answers to which types of planets have liquid water and possible signs of life could come soon, and importantly with this discovery, we have a first target to look for them on.

Maggie Aderin-Pocock is a space scientist and co-presenter of *The Sky at Night*

MEADE® INSTRUMENTS

Innovative products for curious minds | *since 1972*

LS LightSwitch ACF Series

THE MOST COMPLETE, TECHNOLOGICALLY ADVANCED LINE OF TELESCOPES AVAILABLE ANYWHERE

LightSwitch™ Technology

Requires no user input. Just flip the switch and the GPS and integrated sensors will have you exploring in minutes. Innovative technology is applied to make the LS simple easy fun.

Astronomer Inside™

The Astronomer Inside will tell you about the planets, stars, constellations, clusters, nebulae, galaxies, and more in an interactive and interesting way.

Advanced Coma-Free™ Optics

With Ultra-High Transmission Coatings as standard, the LS gives you the sharpest, brightest, optical system for its size. The LS is available in two apertures: 6" and 8".

Optional LCD Monitor

The optional 3.5" Colour LCD Video Monitor plugs directly into the built-in camera on the Meade LS LightSwitch™ telescopes.

Other Optional Accessories

Stella Wi-Fi Adapter wireless control of your telescope with your iOS or Android smart phone and tablet. No internet connection required. Stella sets its own Wi-Fi hotspot or can join other Wi-Fi networks. **StellaAccess** app available seperatelly.

LPI-G Lunar, planetary camera and auto-guider. Choice of monochrome or colour. PC with USB 2.0 port, running Microsoft Windows, Mac OSX or Linux is required.

LXPS portable power in the field.

MEADE® INSTRUMENTS www.meade.uk.com

JON CULSHAW'S

EXOPLANET EXCURSIONS

Jon visits Virgo to view a pulsar that's putting the squeeze on physics

With a blend of foreboding and excited curiosity I'm steering my ship, the Perihelion, towards the constellation of Virgo. A 2,300-lightyear voyage lies ahead, to the extraordinary pulsar PSR B1257+12.

Pulsars hold a great fascination for me because of their unfathomable extremes. It's always a marvel to consider their astounding nature, where we see the forces of physics clenched to incomprehensible levels. This particular pulsar has a rapid rotation period of 6.2 milliseconds and, on top of that, it's an astronomical object of 1.4 solar masses with a radius of only 10km. Compressed compression compressed again!

Three confirmed exoplanets are known to orbit PSR B1257+12, each with a rather disconcerting name. The first is extraordinary as it's the smallest exoplanet ever detected. Draugr lies 0.19 AU from its parent pulsar, with an orbital time of 25 days. The name 'Draugr' comes from Norse mythology and means 'undead creatures'. A rather unsettling name for such a tiny exoplanet, only twice the mass of the Moon.

The furthest planet discovered in orbit around this pulsar is 0.46 AU and is 3.9 times the size of Earth. This world is called Phobetor, named after the God of nightmares in Greek mythology. This sounds like an unwelcoming planetary neighbourhood, but the views that I'm hoping will greet us around the middle planet of the system are sure to turn any sense of unease into astonishment. We're taking the Perihelion to the exoplanet Poltergeist, meaning 'mischievous spirit'.

Poltergeist is an imposing, impressive world, approximately halfway in size between Earth and Neptune. It's similar to Mercury in that it takes 66 days to complete a single orbit at 0.36 AU from rapidly spinning PSR B1257+12. Inspired by the Cassini images of the backlit, night side of Saturn, I settle our position at 95,000km from Poltergeist. From here, the searing, flickering illumination of the parent pulsar turns Poltergeist into a feverish silhouette. A magnificent ring system is exposed, like a bulked up version of the rings of Uranus; they've done well to withstand the savage radiation of the pulsar. The view from here is reminiscent of a strobe light tucked behind the neon tube-lit mirror ball in a 1980s nightclub.

Sitting at the heart of this pulsar system is like being in a thunderstorm scene from the opening moments of a Hammer House of Horror episode – you feel an irresistible blend of terror and amazement. Thankfully, the radiation shields of the Perihelion are providing robust protection against the destructive emanations of the pulsar, but it's wise not to remain here too long. With a mind staggered at the violence the Universe can create, I set the Perihelion's course to our next stop. Somewhere calming I think: how about a water world around a red giant? Why not!

Jon Culshaw is a comedian, impressionist and guest on *The Sky at Night*

MAIN ILLUSTRATION: MARK GARLICK; SPACECRAFT: PAUL WOOTTON; PHOTO: EMMA SAMMS

This month's top prize: four Philip's books

The 'Message of the Month' writer will receive four top titles courtesy of astronomy publisher Philips: Robin Scagell's *Complete Guide to Stargazing,* Sir Patrick Moore's *The Night Sky,* Robin Scagell and David Frydman's *Stargazing with Binoculars* and Heather Couper and Nigel Henbest's *Stargazing 2017.*

PHILIP'S

SOCIAL MEDIA

What you've been saying on Twitter and Facebook

Have your say at **twitter.com/skyatnightmag** and **facebook.com/skyatnightmagazine**

@skyatnightmag asked: Which space holiday would you choose, a trip round the Moon or a trip to the ISS?

@sjb_astro I'd go for a trip round the Moon, although my luggage would inevitably end up on the ISS by mistake!

@Hintonwood The Moon every time! I hear the smell on the ISS is something you have to get used to... uuugh

@JessicaP1979 Around the Moon. Would love to see the dark side!

JOHN BRISCOE/ALAMY STOCK PHOTO

Interactive

EMAILS • LETTERS • TWEETS • FACEBOOK

Email us at **inbox@skyatnightmagazine.com**

MESSAGE OF THE MONTH

An astounding difference

I started to take an interest in astronomy about 18 months ago and, almost immediately after getting a telescope, discovered that I was just as into the astrophotography side of it. So with my DSLR camera and some advice from local astronomy groups I was able to take advantage of the fairly low light pollution in my area – helped by the fact that some of the local street lights were out of commission (not my doing, I hasten to add). But then, disaster: the council fixed the lights and the night sky seemed like daylight. Forced out of my complacency I consulted light pollution maps and found a darker spot locally that was within a few minutes' drive. The difference was astounding: more stars, greater brightness, increased colours, all amplified still further with the camera. So many books and websites say a dark sky site makes a huge difference, and they are right. I know I am lucky that I can get to a suitable site easily, but if it's at all possible, find a local safe spot to set up and observe from and prepare to be astounded by the difference!

Steven Chambers, via email

Well said, Steven. There's no bigger incentive for better lighting design to reduce sky glow than seeing a really dark night sky. ***– Ed***

The Orion and Flame Nebulae imaged from Steven's dark-sky site with a DSLR camera

Reader Maxwell Segal plans to build an observatory in Upper Milovaig on the Isle of Skye

The Skye's the limit

My wife and I are in the process of building a house and observatory on the Isle of Skye. Our planned build is on a 2.25-acre plot in Upper Milovaig, near historic Glendale, and is split between an upper and lower field. The house will be built on the upper field, while the observatory is likely to be built below the house, but also on the upper field. The lower field has the remains of two black houses on it, left to ruin following the Clearances in Glendale. We've drawn up plans for the house but we are still undecided about what form the observatory should take or the ideal equipment to go in it. If any of your readers have advice or experience of building an observatory, we would be very grateful to hear it.

Maxwell Segal, via email

Working backwards

After watching a recent episode of *The Sky at Night* TV programme, I got thinking about the Big Bang. If the Universe is expanding could we not back-track on the direction and speed of the various objects and plot the epicentre: the actual spot where the Big Bang ignited?

Malcolm Howell, Wolverhampton

The way the Universe is expanding means that wherever you are in it, everything appears to be moving away at different speeds depending on how far away it is, rather than where the epicentre of expansion is. This makes finding a central spot in that way impossible. ***– Elizabeth Pearson***

OOPS!

In the diagram of the visible light spectrum in the March issue's Image Processing article (page 85), we incorrectly labelled the third narrowband peak from the left as Hb (hydroden-beta), when it should have been Ha (hydrogen-alpha).

BBC

Sky at Night MAGAZINE

SAVE WHEN YOU SUBSCRIBE TO THE DIGITAL EDITION

Available from

Download on the App Store

amazon apps Available on kindle fire

GET IT ON Google play

zinio™

The perfect addition to your stargazing, *BBC Sky at Night Magazine* is your practical guide to astronomy, helping you to discover the night skies, understand the Universe around us and learn exciting techniques for using your telescope.

Enjoy our Premium App experience now available from

Download on the App Store | amazon apps Available on kindle fire | GET IT ON Google play | zinio™

BBC

Sky at Night MAGAZINE

Hotshots

This month's pick of your very best astrophotos

YOUR BONUS CONTENT

A gallery containing these and more of your stunning images

▲ The Rose Galaxies

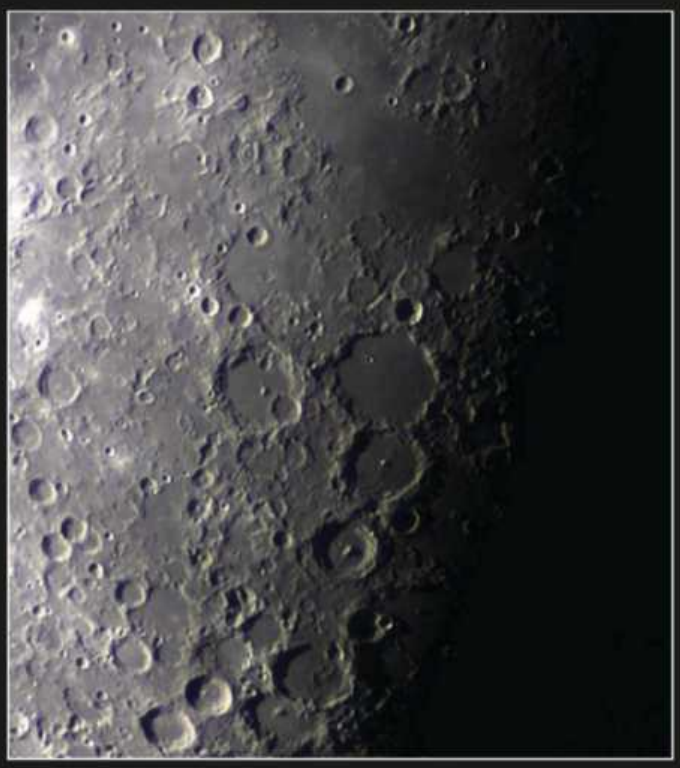
MARK LARGE, COLCHESTER, 14-28 JANUARY 2017

Mark says: "I first came across an image of these galaxies in a calendar I was given at Christmas and knew straight away I had to get them! Having imaged for some time with a modified DSLR, the first thing you notice is how much more time is required with a CCD. It's well worth it, though, to get the amount of data required to produce an image like this. It never ceases to amaze me what's up there and that it's so accessible. As a first image with this camera, I'm extremely pleased with how it has turned out, and also looking forward to the next one!"

Equipment: Altair Astro 10-inch Ritchey-Chrétien astrograph, QSI 683WSG-C-8 mono CCD camera, Sky-Watcher AZ EQ6-GT mount.

***BBC Sky at Night Magazine* says:** "These interacting galaxies are relatively obscure targets, so Mark deserves extra kudos for taking the time to seek them out. The effort and skill required to produce an image like this, capturing distant galaxies and picking out the swirls that make the 'stem' and 'flower' of the rose, makes Mark's image a clear winner."

About Mark: "As a youngster, I used to stare up at the sky and marvel at what you could see on a clear night. I first bought a scope in 2007 when a colleague of mine decided he wanted to get into astronomy. The hobby is something you can really get lost in and astrophotography gives you a permanent record of your hard work and a real sense of achievement. My favourite objects are interacting galaxies and nebulae, which I find awe inspiring."



▲ Crater Ptolemaeus

STEVE WILLIAMS, NORTHAMPTONSHIRE,
4 FEBRUARY 2017

Steve says: "My interest in astronomy dates back over 30 years and the Moon has always fascinated me. On this particular evening, the area around Ptolemaeus caught my attention, especially the details on the crater walls."

Equipment: ZWO ASI120MC CCD camera, Celestron C6-R 6-inch refractor.

▼ NGC 2841

DAN CROWSON, NEW MEXICO, US,
31 JANUARY TO 2 FEBRUARY 2017

Dan says: "Being in Ursa Major, this galaxy is placed well for imaging right now. Images like this one, taken under the dark New Mexico skies, tend to process themselves. I spent less than 10 minutes in Adobe Photoshop to create this result."

Equipment: SBIG STF-8300M mono CCD camera, Astro-Tech 12-inch Ritchey-Chrétien telescope.

◀ The Double Cluster

JASPAL CHADHA,
LONDON,
20 JANUARY 2017

Jaspal says: "I have imaged this object several times throughout the years, as it's a lovely one to observe. I learnt that by lowering my exposure times I was able to keep the star colour well corrected."

Equipment: QHY9s CCD camera, Takahashi FSQ85 refractor, iOptron iEQ45 Pro, chroma filters, light pollution filter.

▲ The Rosette Nebula

MARTIN BAKER, BERKSHIRE,
19, 20 & 24 JANUARY 2017

Martin says: "The Rosette is a lovely looking nebula that I've wanted to try and image for a while. This was my third attempt at combining it into a Hubble-type palette after following a lot of internet tutorials. I'm pleased with the end result."

Equipment: Starlight Xpress Trius-SX694 mono CCD camera, Megrez 72 doublet apo refractor, Sky-Watcher NEQ6 Pro SynScan mount.

Lunar montage ▶

DAVID ETTIE, TYNE AND WEAR,
4 FEBRUARY 2017

David says: "From a light-polluted garden in the northeast of England, the Moon is a fairly natural choice. I alternate between imaging with DSLR and CCD but, in this case, I'd decided a full disc montage was what I wanted. This required three captures at prime focus."

Equipment: Nikon D3200 DSLR camera, Celestron Advanced VX 9.25-inch Schmidt-Cassegrain, EQ wedge.

▲ The Pleiades

ANNE STARTUP, CARMARTHENSHIRE, WALES, 2 JANUARY 2017

Anne says: "I'm quite pleased with the image, in particular the detail in the Merope Nebula. I would have liked to reduce the halos on the brighter stars but I couldn't do that without losing some of the nebulosity."

Equipment: Starlight Xpress SXVR-H694 CCD camera, Altair Astro Wave 4-inch triplet refractor, Sky-Watcher EQ6 mount.

▼ The Crab Nebula

STEVE MACDONALD, EPISKOPI, CYPRUS, 1-3 FEBRUARY 2017

Steve says: "Knowing this supernova remnant was once visible is incredible and being able to see the aftermath of the explosion so far away is just amazing. I'm really happy with the level of detail I managed to extract. The comparison to a brain has been noted by many!"

Equipment: Atik 414EX CCD camera, Sky-Watcher Evostar 80ED Pro refractor, Sky-Watcher NEQ6 Pro SynScan mount.

◀ The Tarantula Nebula

PAUL ALBERS, VICTORIA, AUSTRALIA, 27 JANUARY 2017

Paul says: "I recently made the jump to CCD imaging. This was taken at Briars National Park. One would always like to obtain more data, but given the total for this was 114 minutes, I was quite pleased."

Equipment: QHY9 mono CCD camera, William Optics FLT 110 DDG triplet apo refractor.

ENTER TO WIN A PRIZE!

ALTAIR ✶ ASTRO

We've teamed up with Altair Astro UK to offer the winner of next month's Hotshots a Pegasus DSLR Buddy. Simply connect the device to a 9-15V power supply and the dummy battery slips into your DSLR camera, providing reliable and consistent power for those long imaging sessions. www.altairastro.com • 01263 731505

Submit your pictures via www.skyatnightmagazine.com/astrophotography/gallery or email hotshots@skyatnightmagazine.com. T&Cs: www.immediate.co.uk/terms-and-conditions

STARGAZING LIVE

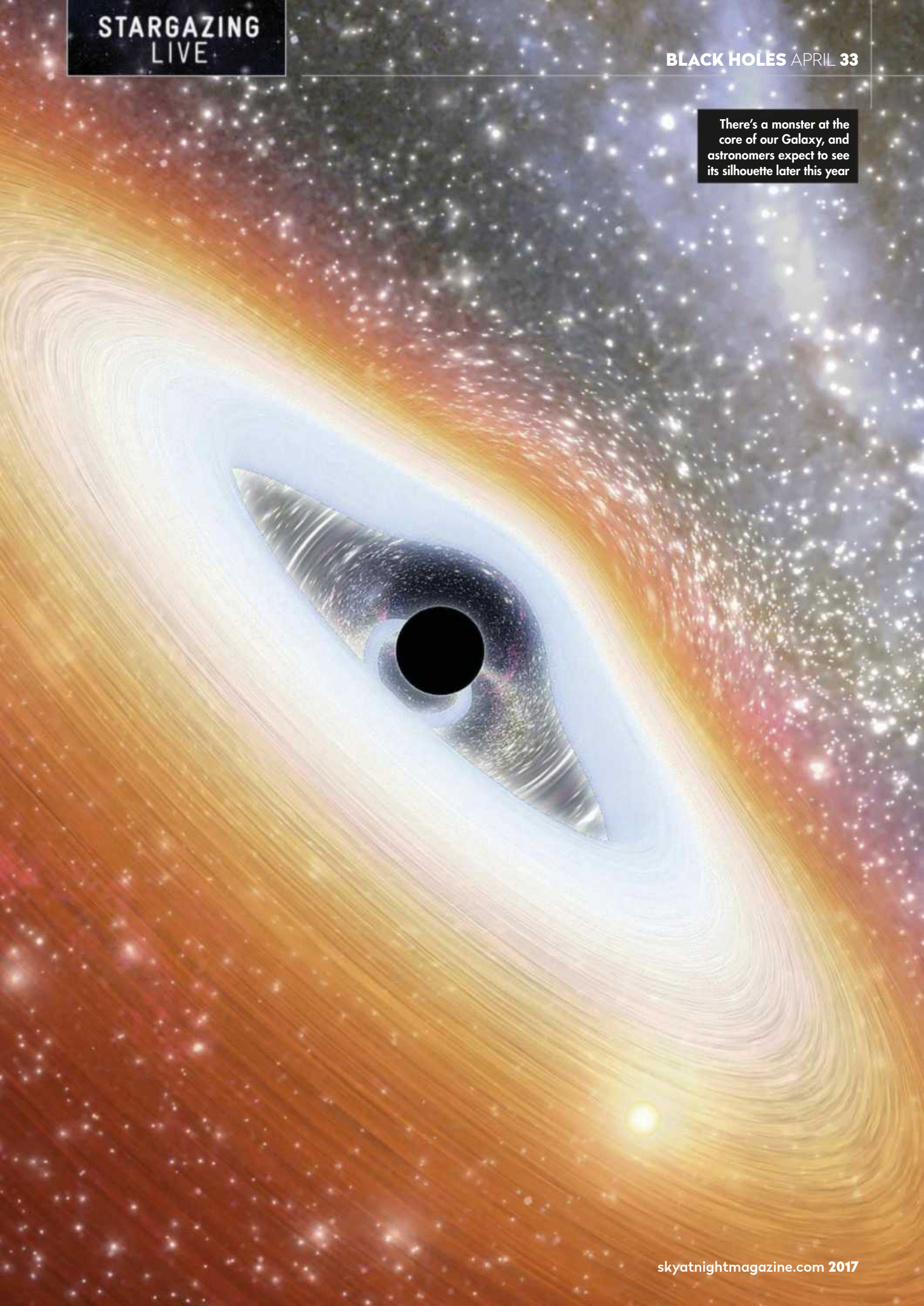
BBC TWO

Tune in to *Stargazing Live* on BBC Two from Tuesday 28 March to Thursday 30 March to discover more about the supermassive black hole at the centre of our Milky Way.

THE HEART OF DARKNESS

At the core of the Milky Way lies an unseen monster. **Elizabeth Pearson** investigates how astronomers are trying to glimpse the supermassive black hole at the centre of our Galaxy

NASA/JPL-Caltech



There's a monster at the core of our Galaxy, and astronomers expect to see its silhouette later this year

At the centre of the Milky Way lies a dark behemoth. One like it is thought to reside in the core of nearly every major galaxy, a hidden heart no one has ever seen – a supermassive black hole.

This body has the mass of over four million Suns but is crammed into a space that's only 20 times our star's diameter. Its gravitational pull is so strong that even light can't escape, meaning that while its influence is felt throughout the Galaxy, we'll never be able to look directly into the black hole.

We aren't completely blind to its mysteries, however. Though the black hole remains shrouded, it's surrounded by a swirling cloud of material known as an accretion disc. As this disc rotates, friction causes the gas and dust in it to heat and glow brightly. The visible part of this glow is shielded by dust, but enough emissions escape at radio wavelengths to create a bright spot 26,000 lightyears away in the constellation of Sagittarius. This radio source is called Sagittarius A* (Sgr A*).

Although enough radio emissions get through the dust for the black hole to be detected, what we can see still seems rather lacklustre compared to what might be expected from looking at the cores of other galaxies.

"The Milky Way's black hole is known to be very inactive. It's radiating several orders of magnitude less than the Eddington luminosity, the maximum luminosity the black hole could have," says Abhijeet Borkar, from the Czech Academy of Sciences in Prague, who was part of a team that spent four years monitoring SgrA* with the Australia Compact Telescope Array.

ABOUT THE WRITER
Dr Elizabeth Pearson is *BBC Sky at Night Magazine*'s news editor. She gained her PhD in extragalactic astronomy at Cardiff University.

"Either most of the energy in the accretion disc isn't emitted as radiation, giving it a low luminosity, or there's no stable accretion disc around the black hole. Instead there's a clumpy, discontinuous disc so there is not enough material falling into the inner parts of the accretion disc to maintain its brightness," says Borkar.

Disquiet in the calm

The does not mean the region is a calm and placid place, however. Despite its quiet background emissions, the material around the black hole regularly flares into brightness.

"We see about four instances of flaring each day, when we observe a six-fold increase in the luminosity of the black hole in infrared and X-rays. At radio and submillimetre wavelengths the luminosity increases by 30 per cent," says Borkar.

The flares typically last one or two hours, depending on the wavelength of light observed. They are also likely to originate from material that orbits around the black hole at speeds so fast that the effects of relativity become apparent.

"It's thought that either the light has been Doppler shifted as it goes around the black hole (creating ▸

TUNING IN TO A BLACK HOLE

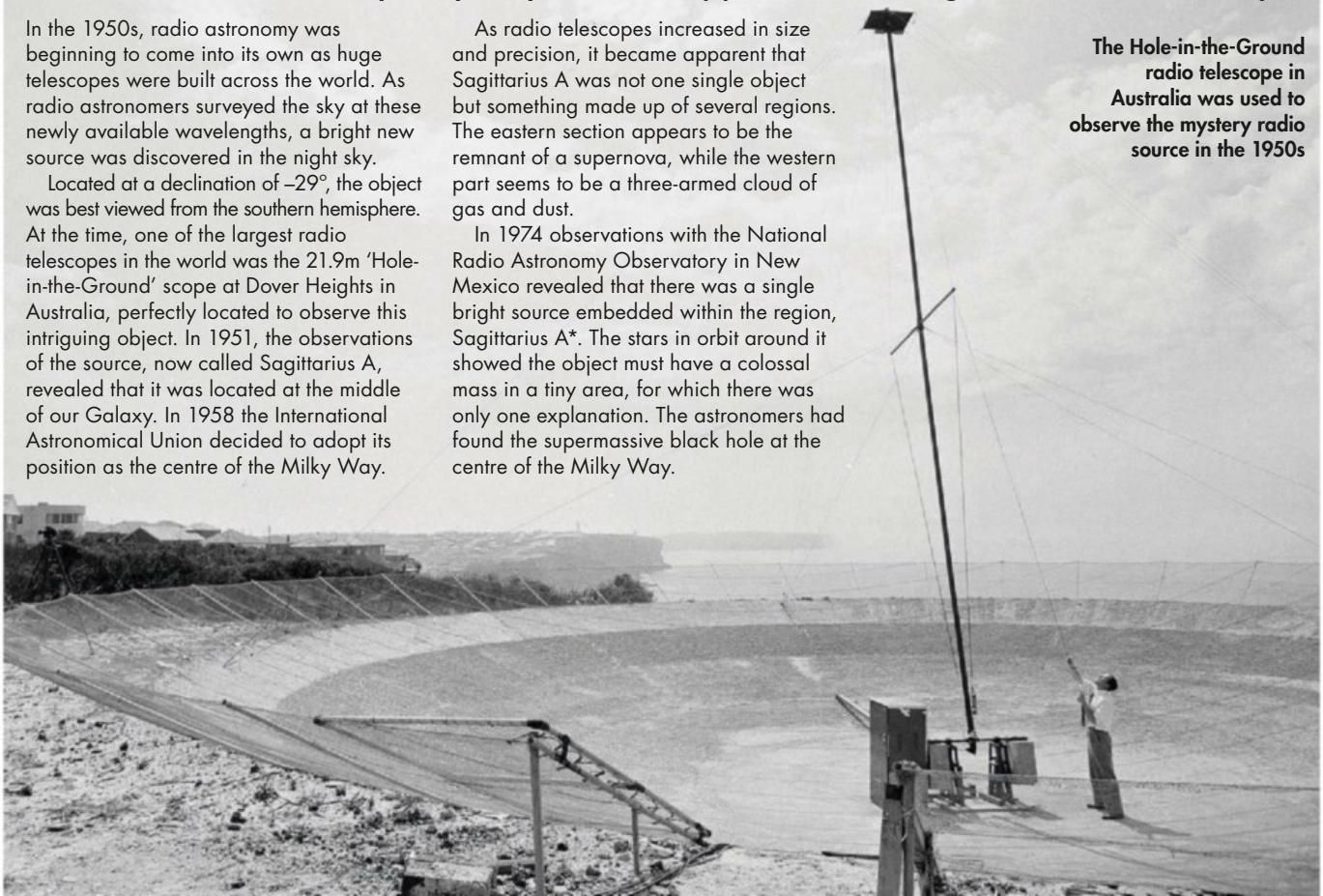
The centre of the Milky Way only became apparent in the age of radio astronomy

In the 1950s, radio astronomy was beginning to come into its own as huge telescopes were built across the world. As radio astronomers surveyed the sky at these newly available wavelengths, a bright new source was discovered in the night sky.

Located at a declination of –29°, the object was best viewed from the southern hemisphere. At the time, one of the largest radio telescopes in the world was the 21.9m 'Hole-in-the-Ground' scope at Dover Heights in Australia, perfectly located to observe this intriguing object. In 1951, the observations of the source, now called Sagittarius A, revealed that it was located at the middle of our Galaxy. In 1958 the International Astronomical Union decided to adopt its position as the centre of the Milky Way.

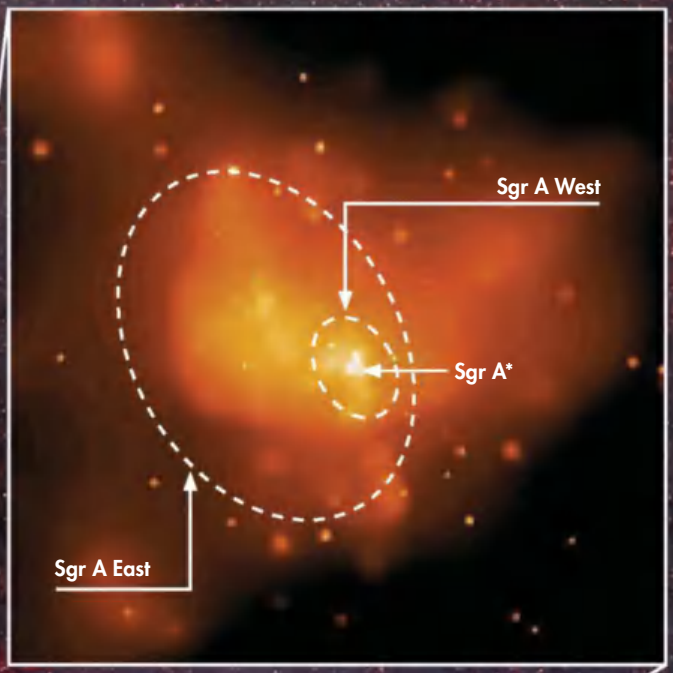
As radio telescopes increased in size and precision, it became apparent that Sagittarius A was not one single object but something made up of several regions. The eastern section appears to be the remnant of a supernova, while the western part seems to be a three-armed cloud of gas and dust.

In 1974 observations with the National Radio Astronomy Observatory in New Mexico revealed that there was a single bright source embedded within the region, Sagittarius A*. The stars in orbit around it showed the object must have a colossal mass in a tiny area, for which there was only one explanation. The astronomers had found the supermassive black hole at the centre of the Milky Way.



The Hole-in-the-Ground radio telescope in Australia was used to observe the mystery radio source in the 1950s

CSIRO, B. SAXTON/NRAO/AUI/NSF FROM DATA PROVIDED BY N.E. KASSIM/NAVAL RESEARCH LABORATORY, NASA/PENN STATE/G.GARMIRE ET AL.



The centre of the Milky Way is home to this radio bright region, the brightest feature being Sagittarius A; inset, Sagittarius A can be split into a series of smaller radio sources, including Sgr A*, our Galaxy's black hole

▸ an increase in luminosity when it's coming towards us) or a blob of material gets caught in the base of a jet and is pushed out. And as it's pushed out it expands," says Borkar.

Similar flares have been seen occurring around many other supermassive black holes, but what causes them remains largely unknown. Our proximity to SgrA* gives astronomers a fantastic view of these strange events: by studying the black hole in our Galaxy, astronomers can learn much about these beasts that lie at the centre of every galaxy.

"Black holes are highly significant astronomically," says Frank Eisenhauer from the Max Planck Institute for Extraterrestrial Physics.

▲ **It's hoped the VLT's drum-like Gravity instrument will help us study stars even closer to the supermassive black hole**

"They influence the full motion of a galaxy much more than stars do. There is a very strong correlation between the size of black holes and the inner parts of galaxies. They can blow the outer dust about and prevent further gas streaming in, so there's a very strong interplay between the formation and evolution of black holes and the centres of galaxies."

Eisenhauer is the principal investigator for the new Gravity instrument on the VLT, which has been specially made to take advantage of our excellent view of SgrA*. Gravity will image the region around the black hole, not only with an increased resolution compared to previous instruments, but also with a higher

THE EVENT HORIZON TELESCOPE

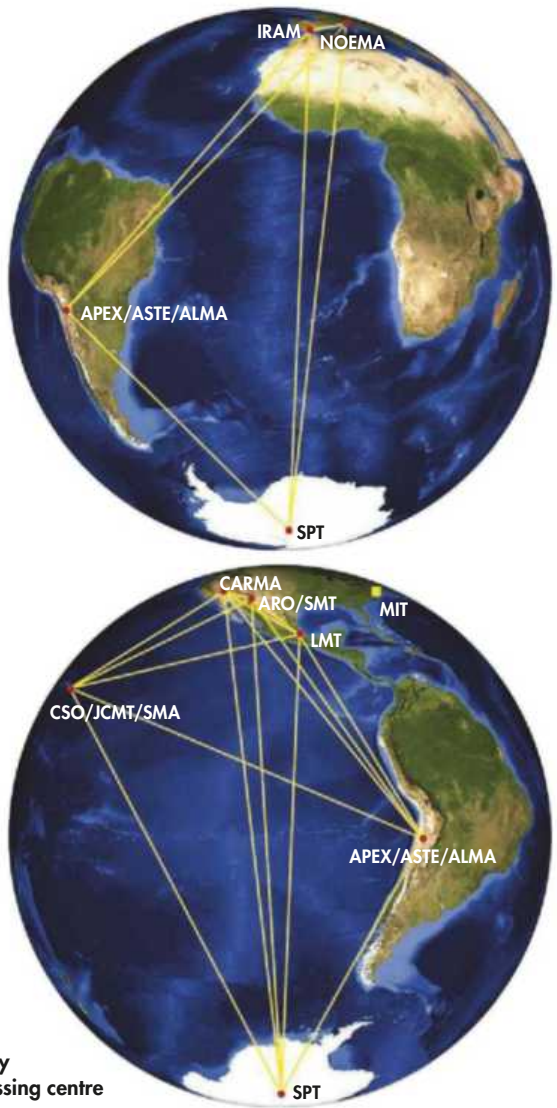
Capturing the heart of our Galaxy requires a telescope the size of the planet

The Event Horizon Telescope (EHT) is one of the biggest projects in the history of astronomy. It aims to combine up to a dozen of the world's premier radio telescopes – from the US, South America, Europe and the south pole – to observe SgrA* in greater detail than ever before.

The telescope works using a technique called very-long baseline interferometry, in which a signal is collected at a number of telescopes. The size of the telescope is not based on the diameter of the dishes, but the distance between them. Each of the scopes has been updated with an atomic clock, the most precise timekeepers on Earth. As well as allowing researchers to make precise timing measurements of the black hole's changing brightness (effectively taking its pulse), the timepieces will make it possible to combine the signals. Using the slight differences in arrival time for the light at each of the scopes, it's possible to reach a much higher precision than can be attained by simply stacking the images together, creating a 'virtual telescope' with the diameter of the Earth.

This huge size is needed as SgrA* is expected to cover a tiny area of sky: around 10 microarcseconds across – the equivalent of looking for a £1 coin on the surface of the Moon. As the smallest angle resolvable is determined by dividing the wavelength of light by the size of the dish, to further boost the angular resolution of the scope researchers will be observing at 1.3mm. This is the shortest wavelength ever used for the technique and will create an even higher resolution scope.

The EHT's first set of observations will be made on 5-14 April 2017. Once they are completed, the data will be transported to the Massachusetts Institute of Technology, where it will take a supercomputer several months to mix the separate signals into one image. By the beginning of 2018, we should have our first real glimpse of our Galaxy's core.



THE EVENT HORIZON SCOPES

APEX: Atacama Pathfinder Experiment
ASTE: Atacama Submillimeter Telescope Experiment
ALMA: Atacama Large Millimeter/Submillimeter Array
CARMA: Combined Array for Research in Millimeter-wave Astronomy
CSO: Caltech Submillimeter Observatory
IRAM: Institut de Radioastronomie Millimétrique
JCMT: James Clerk Maxwell Telescope
LMT: Large Millimeter Telescope
MIT: Massachusetts Institute of Technology
NOEMA: Northern Extended Millimeter Array
SMA: Submillimeter Array
SMT: Submillimeter Telescope
SPT: South Pole Telescope

MPE/GRAVITY TEAM, EVENT HORIZON ILLUSTRATION BY PAUL WOOTTON, X-RAY: NASA/CXC/UMASS/D. WANG ET AL./ OPTICAL: NASA/ESA/STSCI/D.WANG ET AL/IR: NASA/JPL-CALTECH/SSC/S.STOLOVY, C-K CHAN/D PSALTIS/F OZEL X 4

▲ This spectacular image combines infrared and X-ray light to see past obscuring dust through to our Galaxy's core; Sgr A is the bright white region

precision too. This will allow it to look at the stars that lie around the black hole, which are known as S stars.

"These are stars in the centre of our Galaxy that are a few million years old, with masses around 20 times that of our Sun. They trace the gravitational field and are very good test particles because they are frictionless through the vacuum of space," says Eisenhauer.

The motions of the stars are governed by the black hole they surround. It is by monitoring the motions of these stars that scientists have been able to determine the mass and size of SgrA*. The closer the star, the more accurate the estimation, and the VLT's Gravity instrument will help to refine those measurements.

"Gravity will see fainter stars further in, which are on shorter orbits. We hope to find stars that orbit on the order of a few months or years," says Eisenhauer. Currently the closest known star is S2, which takes 15.5 years to complete one lap around SgrA*. In 2018, it will pass through the point of closest approach – a 'mere' 120 AU from the black hole. During this time, it will be accelerated to 30 million km/h, or 2.5 per cent the speed of light. Travelling this fast means S2 will experience the effects of relativity on its motion, giving the Gravity team a fantastic opportunity to put Einstein's equations through one of their most extreme tests yet.

Little kicks

"Most of the time the star follows Newton's laws, but when it comes very close in 2018 it gets a little kick, and the orientation of its orbital ellipse rotates a bit due to the effects of general relativity," says Eisenhauer. "We know so little about black holes, but they are such a fundamental cornerstone for the understanding of relativity and gravity."

▲ The team behind the Event Horizon Telescope have run many simulations to show how matter and light behave near to an event horizon

These observations will test Einstein's theories in the one place where they might falter – at the edge of a black hole. "Relativity has passed every test so far, but it hasn't been tested in a scenario where gravity becomes dominant," says Sheperd Doeleman, an astrophysicist from the Smithsonian Astrophysical Observatory. "Gravity is really the weakest force, so it's only near a black hole that it can play with the big boys."

Doeleman is the director of one of the most ambitious astronomical collaborations ever undertaken, the Event Horizon Telescope, which aims to take the first ever image of the shadow cast by the Milky Way's black hole.

"We can't see the black hole directly because it is surrounded by this event horizon that does not permit information to leave the black hole. Because the gravity around the black hole warps light around it, we expect to see the silhouette of the black hole against the backdrop of superheated gas," says Doeleman. "We expect to see a very characteristic strong lensing feature, a ring of light that indicates the last orbit that photons can move through around the black hole before they themselves are sucked in. You end up with an annulus with a relatively dim interior – the silhouette of a black hole."

The size and shape of this silhouette was predicted by Einstein's theories of relativity, which were laid down over 100 years ago. Comparing the shadow that has been forecast with reality could help to solidify our understanding of them. On the other hand, if the observations do not show what is expected, they could throw Einstein's theories into doubt. Within the next year, humankind should have its best look at the dark heart of a galaxy, and with it may even find the key to unlocking the rules that govern our Universe.

Dr Saunders strikes back

Psychiatrist suffers stroke, then analyses symptoms to help others

Dr Tony Saunders always looked after his health, so it seemed doubly unfair when he collapsed with a major stroke in the gym.

Tony's family were worried that he could die, as stroke takes a life every 13 minutes in the UK. And it's the leading cause of severe adult disability.

Fortunately, with excellent treatment, Tony eventually returned to work.

But Tony noticed that discussing his stroke made him anxious – he even started stuttering.

As a psychiatrist, he identified this as post-traumatic stress disorder. He then realised that, on top of his medical training, he now had valuable first-hand experience of stroke.

So Tony struck back by overcoming his anxiety, and giving talks to medical students. As a result, a new generation of doctors are supporting their patients with powerful new techniques.

This is Tony's legacy. And now you can strike back against stroke too, by leaving us a legacy of your own.

Stroke association

Together we can conquer stroke.

Call 020 7566 1505 email legacy@stroke.org.uk or visit stroke.org.uk/legacy

The busiest portion of the Milky Way and the Magellanic Clouds are visible Down Under

STUNNING SOUTHERN SIGHTS

With *Stargazing Live* on tour under Australia's staggering night skies, Aussie astronomer **Greg Quicke** shows us 12 reasons why they're so good

Southern hemisphere skies have a whole bunch of galactic and intergalactic objects that you simply can't see from the northern hemisphere of the world. Looking high in the northern sky from the UK there's a large circle of circumpolar stars that you'll always see. Looking down, there's an equally large circle of sky below your southern horizon that you'll never see, unless you indulge in that little thing called travel. There's no other way for you to see the dwarf galaxies of Magellan, the two biggest and brightest globular clusters, and the brightest and busiest sections of our own Milky Way Galaxy. Australia is perfectly positioned on our little world to be pointed in the direction of some incredible celestial delights. Here are some of my favourites…

RGB VENTURES/SUPERSTOCK/ALAMY STOCK PHOTO

◀ 1. The Southern Cross

Even though the Southern Cross is well known to people all over the world, not many know how to find it in the sky. It's smaller than most people expect and there are any number of crosses in the sky to confuse it with. Finding the pointer stars of Alpha and Beta Centauri is the key to becoming familiar with this most beautiful timekeeper of the southern skies.

▲ 2. Alpha Centauri

If we travelled to the closest star we can see and then looked back to our own Sun, we'd see a star that looked similar to how Alpha Centauri appears to us from Earth. At a distance of only 4.3 lightyears, the third-brightest star in our skies is the same brightness as our Sun. Getting up close to this deep southern star with a telescope reveals that Alpha Centauri is one of the most beautiful double stars in the sky.

◀ 3. The Jewel Box

With its stars of different colours, the Jewel Box, or NGC 4755, is one of the most beautiful compact galactic open star clusters in the sky. It's easily found with binoculars – next to the leftmost star of an upright Southern Cross. Closing in with a 13mm eyepiece in a 10-inch Dobsonian telescope will blow your mind, especially when you realise that every one of the 100 or so stars you can see is an entire planetary system.

▶ 4. The Milky Way

Our planet orbits one of the 200,000 million stars that form the disc that is our Galaxy. Trace this 'milky way' of star clouds across the sky and keep going when you hit the horizon, and you'll see that it joins up again on the other side. It surrounds us because we're inside the disc. Although you can see the Milky Way in both hemispheres, the brightest and busiest sections are deep in southern skies.

TEAM CEDIC/HERBERT WALTER/CCDGUIDE.COM, TEAM CEDIC/BERNHARD HUBL/CCDGUIDE.COM X 3, ISTOCK X 2, JOHANNES SCHEDLER/CCDGUIDE.COM

◀ 5. The Sagittarius Star Clouds

Embedded in the Milky Way are the magnificent Sagittarius Star Clouds, best seen with a pair of 10x50 binoculars or a rich-field refracting telescope. From Australia, this bulging central region of our Galaxy is visible directly overhead mid-year. Scanning around with binoculars, you're likely to find the Lagoon and the Trifid Nebulae without even trying. While technically both of these nebulae are visible from the UK, in practice they'll always be too close to the southern horizon to see with any clarity.

▲ 6. The Eta Carina region

Just across from the Southern Cross is another incredibly rich region of the Milky Way lying around the star-birthing dust and gas cloud that is the Eta Carina Nebula. You'll easily spend hours with a pair of binoculars exploring this region before diving in deeper with a serious telescope. 'Diamonds and Rubies', the 'Wild Geese' and the 'Five of Diamonds' are great names for some of its awesome star clusters.

▲ 7. The Large and Small Magellanic Clouds

The clouds of Magellan look like two pieces that have broken off the Milky Way. They're visible to the naked eye on dark, moonless nights, separate from the main sweep of our Galaxy. The northern hemisphere has no equivalent to this pair of baby galaxies lying only a couple of hundred thousand lightyears away. They're too big to fit in the field of view of most telescopes, so binoculars are best for scanning around and finding clusters and nebulae embedded within them.

▲ 9. 47 Tucanae

At 17,000 lightyears away, 47 Tucanae is one of the finest and most delicate globular clusters in the sky. Visible with the naked eye, it looks like one of two Mickey Mouse ears on the 210,000 lightyear-distant smudge of light that is the Small Magellanic Cloud. The other ear is mag. +2.8 Beta Hydrus, a mere 24 lightyears away. The compact core of the million or so stars of 47 Tucanae will resolve into individual stars with even an 8-inch telescope.

▼ 8. The Tarantula Nebula

Finding this distinct bright patch of nebulosity in the Large Magellanic Cloud is easy with a pair of binoculars. But pointing a big Dobsonian at it will blow your mind. It's a massive cloud of dust and gas 160,000 lightyears away in another galaxy! If the Tarantula Nebula was 1,500 lightyears away – the same distance as the Great Nebula in Orion – it would fill our sky and you'd be able to read a book by its light.

10. Omega Centauri ▶

Omega Centauri is an unbelievable megacity of perhaps four million stars, compacted into a dense ball 200 lightyears across. It sounds like something out of science fiction. An 11-inch Schmidt-Cassegrain telescope will bring it to life and show you individual stars lying deep inside. This and 47 Tucanae are the two biggest and brightest globular clusters, and they straddle the south celestial pole, meaning you'll always get one or the other above the horizon – sometimes both! They are reason enough for any keen astronomical observer to make the journey to the southern hemisphere.

▼ 11. The Sculptor Galaxy

The dwarf galaxies of Magellan are pretty close to us compared to any full-sized galaxies in our neighbourhood. At a distance of 11.5 million lightyears the Sculptor Galaxy, NGC 253, is easy enough to pick out in the 10x50 finder of a 16-inch Dobsonian. A little star hopping from the mag. +2.2 star Diphda and you'll find it easily. A 21mm eyepiece on the main scope brings this near edge-on starburst galaxy into view. While the Sculptor Galaxy does graze the southern horizon from the UK, you'll have to travel south to see it with any clarity.

▲ 12. Bright stars

Australia scores 12 out of 12 on the brightest star list, while the UK scores seven. Mighty Sirius, in first place, is visible for all of us. To see Canopus or the twin suns of Alpha Centauri you'll have to book a holiday. We all see Arcturus, Vega, Capella, Rigel and Procyon while Achernar is farther south than Canopus. The red giant star Betelgeuse rounds out the top 10 for everyone while the next two, Hadar and Acrux are deep southern stars only. Polaris, the north pole star, is further down the list at number 50. S

ABOUT THE WRITER
A former pearl diver and motorcycle mechanic, Greg Quicke now tours the southern dark skies from Western Australia.

SPECIAL EDITION

STARGAZING LIVE

Start your exciting astronomical adventure with *Stargazing Live* magazine. Join the team on location Down Under, then begin to unravel the mysteries of the Universe with our essential beginner's guides to exploring the night sky, the equipment you'll need to get started (surprisingly little) and how to observe the most spectacular celestial sights awaiting you this spring.

Plus – subscribers to *BBC Sky at Night Magazine* receive FREE UK P&P

Learn the basics of astronomy and the night sky from the planets to galaxies, constellations and mysterious nebulae

Continue your stargazing journey with our easy-to-follow guides to the equipment you'll need and how to use it

What to spot this spring: from top Moon sights and Jupiter at its brightest, to a comet and two meteor showers

ORDER YOUR COPY TODAY

www.buysubscriptions.com/stargazinglive

Alternatively call 0844 844 0254† and quote 'STLHA17'

†Calls will cost 7p per minute plus your telephone company's access charge. Lines are open 8am-8pm weekdays and 9am-1pm Saturday.
*Subscribers to *BBC Sky at Night Magazine* receive FREE UK POSTAGE on this special edition. Prices including postage are: £11.49 for all other UK residents, £12.99 for Europe and £13.49 for Rest of World. Please allow up to 28 days for delivery.

STARGAZING LIVE

BBC TWO

Tune in to *Stargazing Live* on BBC Two from Tuesday 28 March to Thursday 30 March to discover more landmark locations from which to observe the southern skies in Australia.

THE UNIVERSE FROM ULURU

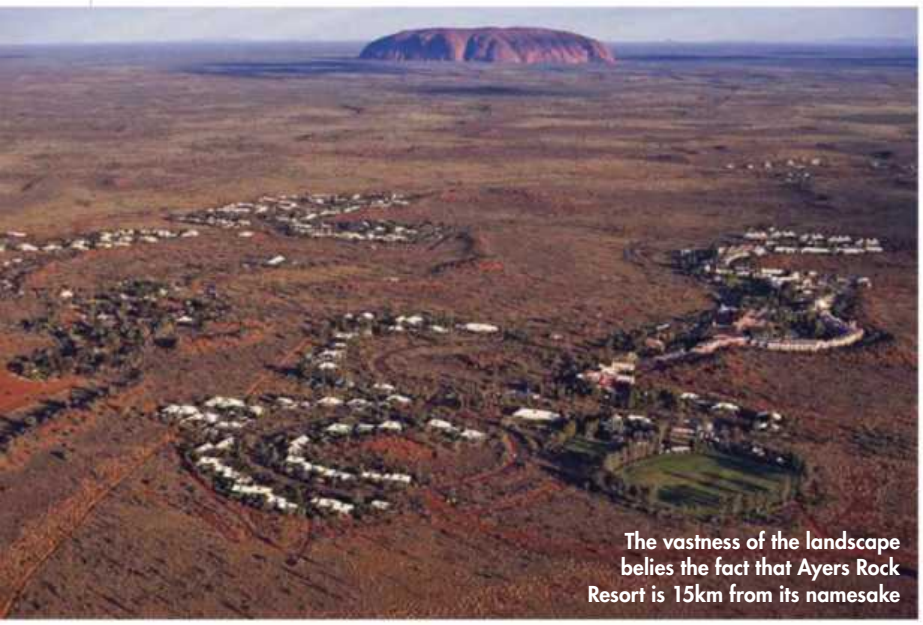
Australian-born travel writer **Shane Cormie** reveals how to plan your stargazing trip to one of the country's most famous natural monuments

"It can't be that red! Is the sky really that big?" These are the sort of comments and questions you get when you show people your photos of Uluru-Kata Tjuta National Park, otherwise known as The Olgas or Ayers Rock. Despite being a World Heritage Site and a much-photographed symbol of Australia, the vastness of the dark skies still mesmerises when you first see it.

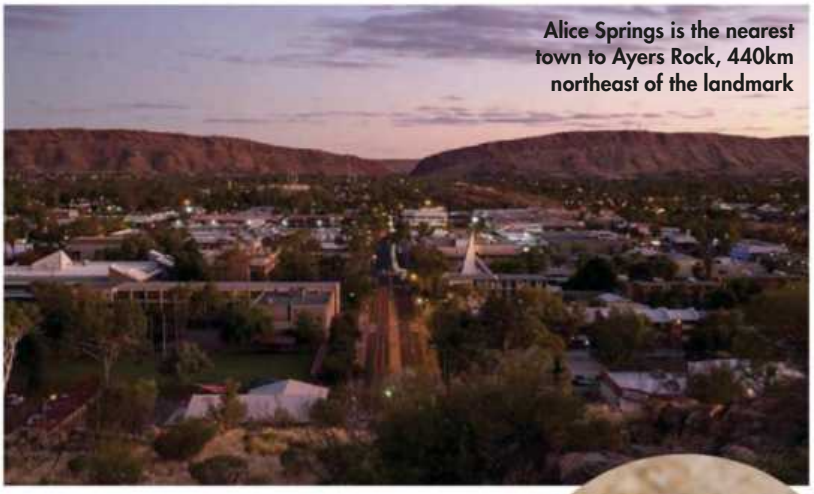
Most visitors spend between two and five nights here and it pays to do your homework before setting off. A good place to start is to decide whether to drive or join one of many organised tours. Book accommodation to fit your budget and prepare for a variety of weather. I've visited three times in the past 40 years and seen rain pour off the rock giving it a dark, Gothic appearance; endured 38°C heat with accompanying legions of flies ▸

BABAK TAFRESHI/SCIENCE PHOTO LIBRARY

Ayers Rock is as gigantic and impressive a sight as the sky above it



The vastness of the landscape belies the fact that Ayers Rock Resort is 15km from its namesake



Alice Springs is the nearest town to Ayers Rock, 440km northeast of the landmark

▸ and basked in perfect, still, cool evenings. If you want to avoid the higher temperatures, think about going during June, July or August, but don't forget to pack some warm clothing as the nights and mornings can be chilly.

Local knowledge

Once you've landed at Ayers Rock Airport, you need to make the rest of the way to Uluru. When people talk about 'the national park', they're referring to an area covering 1,326km^2. Ayers Rock Resort – where you'll find a supermarket, information centre, fuel station, campsite and hotels of up to five stars – is 15km from the rock. The nearest large town, Alice Springs, is 440km to the northeast.

If you need to rent a vehicle, Ayers Rock Airport is served by three international companies: Hertz, Thrifty and Avis. Book early and remember that for most visitors a 4WD vehicle is unnecessary. Signage around the area is good, but bring a map in case you need to stop and get your bearings. Generally, the roads aren't busy unless you count the peak times, territory style, when visitors gather to see the sunrise and sunset. Also, don't forget to call into the information centre before you travel, as conditions in this part of the world can change suddenly – parts of Kata Tjuta are sometimes closed due to expected high temperatures.

One important point that stargazers should bear in mind is to look at the ground as well as the sky. While most visits are hassle free, there's no escaping the fact that Australia is home to some of the most deadly creatures in the world. The king brown snake is one local you do not want to meet! Fortunately most creatures will do their best to avoid you.

Always carry a torch at night, as the terrain can be uneven. A red torch is best as it won't affect your dark-adapted vision. Other welfare tips include wearing a wide-brimmed hat, carrying a supply of insect repellent and a high-factor sunscreen. Drink plenty of water too: the national park guidance is one litre of water, per person, per hour.

Think carefully about what kit you take. While your favourite Pentax scope may seem an obvious choice, do you really want to carry it around in desert conditions? And that's not to mention the hassle of protecting it during the flights there and back. If you go on an organised excursion, the operators may provide equipment, so weigh up the pros and cons, such as loss of flexibility and sharing telescopes. If you're considering purchasing new equipment, try and get it in advance so you have time to familiarise yourself with the features before you arrive.

Don't forget to check with the airlines you'll be flying on, both international and domestic, regarding excess baggage charges or damaged kit. You should also consider how you'll keep your kit safe on the ground. Uluru is covered with red dust that permeates everything. It's also hot. If you do bring your kit, check the manufacturers' recommendations regarding extreme conditions. Some simple tips include keeping the equipment out of the Sun as much as possible, avoiding sudden temperature changes (such as going from the heat outdoors into your air-conditioned hotel room) and keeping your kit covered as best you can. And bear in mind that you don't want to be lugging heavy equipment around in such hot weather.

▲ The king brown snake is very dangerous so watch where you're walking

▼ Lasseter Highway in the Northern Territory connects Yulara, Kata Tjuta and Uluru

Same sky, different sights

So what can you expect to see when you look up into the sky above the Northern Territory? Most visitors from the northern hemisphere look for the Southern Cross, that symbol of Australia and other nearby countries that adorns flags, logos and aircraft, while other popular targets include Scorpius, Orion and Alpha Centauri.

The Milky Way and Large Magellanic Cloud visible above Ayers Rock in Uluru National Park

The Australian sky also contains alternative interpretations for indigenous people. For example, some Aboriginal tribes view the Southern Cross as a stingray, while the Pleiades is said to represent seven beautiful women as seen by a hunter. And with hundreds of Aboriginal groups on the continent, there are many variations. To view the southern sky without some understanding of what it represents to Australia's first peoples would mean only knowing half the picture. [See 'The Astronomy of the Aborigines' on p78 for more.] Get to know Aboriginal interpretations before you go and once you're there, see what indigenous activities are available, especially those focusing on the night sky.

From time to time, Ayers Rock Resort has an Astronomer in Residence Programme. In 2017 this takes place between 25 March and 18 November. Activities range from interactive astronomy sessions during the day to more formal seminars in the afternoon. In addition, 2017 marks the fourth edition of the Uluru Astronomy Weekend, which takes place on 20-22 October and includes classes, lessons and workshops. Hosted by the resort, it's held in conjunction with the ARC Centre of Excellence for All-sky Astrophysics. If you're planning an independent visit, a star chart will make your life easier – they're usually available at the resort shop and Alice Springs Airport.

Most importantly, remember to enjoy your Uluru dark-skies adventure. It's not only a great place to view the cosmos, but also a part of the cultural mosaic that makes Australia unique.

ABOUT THE WRITER
Shane Cormie is an Australian-born travel writer and photographer with a background in tourism and the environment.

REACHING THE RED ROCK

AIRLINES
There are no direct flights from the UK to Ayers Rock Airport, however direct flights operate from Alice Springs, Sydney and Melbourne. Flights to Alice Springs for onward connections include Adelaide, Darwin, Cairns and Perth.
Qantas: **www.qantas.co.uk**
Jetstar: **www.jetstar.com**
Virgin Australia: **www.virginaustralia.com**

COACH
You can travel by coach from Darwin and Adelaide to Alice Springs by Greyhound Australia. Options for travel onwards to Uluru include hiring a vehicle, flying or taking an AAT Kings coach transfer, which takes six hours.
www.greyhound.com.au
www.aatkings.com

TRAIN
The Ghan train travels between Adelaide and Darwin via Alice Springs. This is the nearest railway station.
www.greatsouthernrail.com.au

ACCOMMODATION
Ayers Rock Resort: **www.ayersrockresort.com.au**
Alternative accommodation is available at Curtin Springs, 100km east of Uluru.
www.curtinsprings.com

VEHICLE HIRE
Thrifty: **www.thrifty.com.au**
Hertz: **www.hertz.com.au**
Avis: **www.avis.com.au**

bluedot

with energy

— WINNER —
MIND-BLOWING SPECTACLE
★★★★★
UK FESTIVAL CONGRESS

— WINNER —
NEW FESTIVAL ON THE BLOCK
★★★★★
UK FESTIVAL CONGRESS

"SOMETHING UNIQUE AND OUT OF THIS WORLD"
THE GUARDIAN

"THE BEST GEEKY FESTIVAL EVER"
LONELY PLANET

INTERGALACTIC FESTIVAL OF MUSIC, SCIENCE & THE EXPLORATION OF SPACE

ALT-J. ORBITAL. PIXIES

SOULWAX. GOLDFRAPP. WARPAINT. HAWKWIND. EZRA FURMAN
VITALIC. SHOBALEADER ONE. MR SCRUFF. DJ YODA [HISTORY OF GAMING]
ANDREW WEATHERALL. SHURA. FACTORY FLOOR
MAX COOPER. JOE GODDARD [LIVE]. NIGHTMARES ON WAX [DJ SET]
PRESENTED BY LATE NIGHT TALES

CULTURE: MEN BEHIND THE MASK: FEAT DAVID PROWSE — THE ORIGINAL DARTH VADER & BRIAN MUIR
THE MOOMINS AND THE COMET — SCREENING AND LIVE RE-SCORE. THE SOUND OF UFOS [LIVE] — BRUNO SPOERRI
CARL SAGAN SCREENING AND LIVE SCORE BY EMERALD WEB. FRANK COTTRELL BOYCE. PROF: DAVID NUTT
PROF: DANNY DORLING. ARTHUR MILLER. DELIA DERBYSHIRE DAY — 80th ANNIVERSARY TRIBUTE
THE SCIENTIFIC SECRETS OF DOCTOR WHO. THE DARK WEB EXPLAINED BY C4'S GEOFF WHITE
CAPTAIN SCARLET 50th ANNIVERSARY EXHIBITION. FULL WEEKEND OF TALKS AND DEBATES AROUND FAKE NEWS,
ARTIFICIAL INTELLIGENCE, GAMING, HACKING AND MORE. HOW TO WRITE SCIENCE FICTION WITH SARA MAINLAND,
ADAM MAREK AND ADAM ROBERTS. JOHN ROBERTSON PRESENTS THE DARK ROOM. KNIGHTMARE LIVE
MUSIC: DJ CHEEBA. THE MOONLANDINGZ. BOXED IN. WHYTE HORSES EXPERIENCE. ANNA MEREDITH. JANE WEAVER
RADIOPHONIC WORKSHOP. RIVAL CONSOLES. THE COMET IS COMING. MEILYR JONES. HANNAH PEEL & TUBULAR
BRASS MARY CASIO: JOURNEY TO CASSIOPEIA. MARC RILEY. EDDY TEMPLE MORRIS. RICHARD HERRING. DJ WOODY
SPACE CASSETTE DJS. ANDY VOTEL. AGE OF GLASS. HENGE. IDER. FLAMINGODS. PLASTIC MERMAIDS. DREAM WIFE
KELLY LEE OWENS SPACE AFRIKA. WILL TRAMP. GALAXIANS. SWEAT
XAM DUO. W H LUNG ANNABEL FRASER. LATE NIGHT TALES DJS
GIRL SWEAT PLEASURE TEMPLE RITUAL BAND. ALGORAVE
POST WAR GLAMOUR GIRLS. THE EARLY YEARS. GOAT GIRL
TVAM. LOST COLOURS. MAKENESS. WOVOKA GENTLE
TEAM PICTURE. HORSEBEACH. ETHAN & THE REFORMATION
PRESENTED BY HIGH AND LONESOME:
TRAVELLING BAND. PAUL THOMAS SAUNDERS
JUANITA STEIN. FRANCIS LUNG. ALESSI
CHARLOTTE CARPENTER. ARDYN. SAM AIREY
WE WERE STRANGERS. CHARLIE BARNES. MI MYE
FIGHTING CARAVANS. THESE MEN
THE SILVER RESERVE. KINDEST OF THIEVES
SIMON WIDDOWSON. BEN PIKE
SHADOWLARK
+ FULL SCIENCE BILL COMING SOON

7/8/9 JULY 2017

JODRELL BANK OBSERVATORY. CHESHIRE. EARTH

discoverthebluedot.com

53.2363°N 2.3071°W

Sky at Night MAGAZINE · FOCUS MAGAZINE · Now Wave · MANCHESTER

PETE LAWRENCE

THE SKY GUIDE APRIL

WRITTEN BY
PETE LAWRENCE

Pete Lawrence is an expert astronomer and astrophotographer with a particular interest in digital imaging. As well as writing *The Sky Guide*, he appears on *The Sky at Night* each month on BBC Four.

PLUS

Stephen Tonkin's BINOCULAR TOUR

Turn to page 60 for six of this month's best binocular sights

Jupiter reaches opposition on 7 April, so the distance between us and the Solar System's largest planet is minimised for the current period of observation. The weeks surrounding opposition represent the best time to get a view of this amazing world and its satellites.

APRIL **HIGHLIGHTS**

Your guide to the night sky this month

SATURDAY 1

Mercury reaches greatest eastern elongation and is visible in the west approximately 40 minutes after sunset.

MONDAY ▶ 3

The lighting effect that creates the so-called 'Lunar X' can be seen this evening from 22:20 BST (21:20 UT) onwards.

TUESDAY 4

Io and Ganymede are eclipsed by Jupiter's shadow at 01:40 BST (00:40 UT) and 05:38 BST (04:38 UT) respectively. Io can also be seen coming out of occultation from behind Jupiter's disc after the eclipse, at 03:57 BST (02:57 UT).

THURSDAY 6

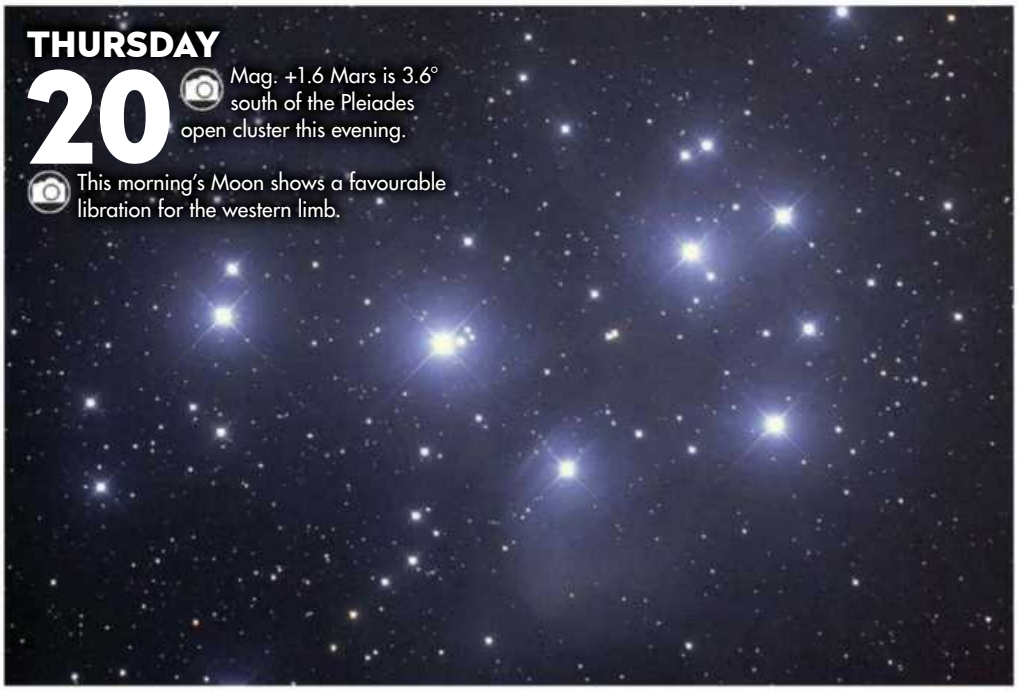
Comet 41P/ Tuttle-Giacobini-Kresak is predicted to be at its peak brightness tonight, approximately mag. +6.6. This places it within easy binocular range.

FRIDAY 7

Jupiter reaches opposition tonight and presents two moon events. Callisto passes just north of Jupiter's northern limb during the early hours, and Ganymede transits Jupiter's disc while perfectly lined up with its own shadow between 19:30 and 21:55 BST (18:30 and 20:55 UT).

MONDAY 10

Tonight's virtually full Moon appears 1.5° to the north of mag. –2.3 Jupiter. The bright planet will easily hold its own against the Moon's formidable glare.



THURSDAY 20

Mag. +1.6 Mars is 3.6° south of the Pleiades open cluster this evening.

This morning's Moon shows a favourable libration for the western limb.

FRIDAY 21

Jupiter is close to the mag. +9.5 star TYC 4960-1087-1 in Virgo this evening.

This is a great time to go galaxy hunting in the Realm of Galaxies as the region gets to a decent altitude with no Moon to interfere.

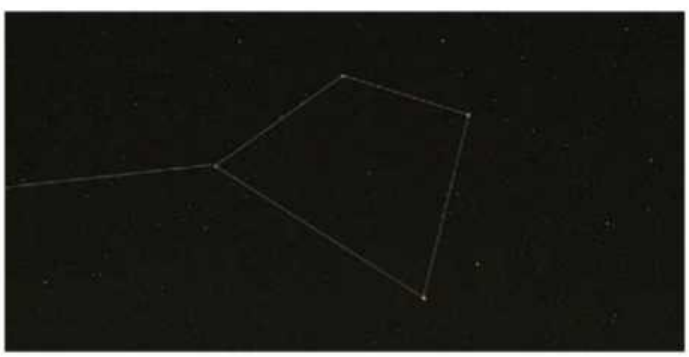
SUNDAY ▶ 23

Look out for the attractive sight of the 14%-lit waning crescent Moon and mag. –4.4 Venus rising in the east from around 05:00 BST (04:00 UT).

MONDAY ▶ 24

Comet 41P/Tuttle-Giacobini-Kresak lies a little over 2° from mag. +3.8 (Iota (ι) Herculis). This star lies 6° south of the Lozenge, a distinctive pattern of four stars forming the head of Draco, the Dragon. The comet is predicted to be around mag. +7.1 at this time.

PETE LAWRENCE X 7



FRIDAY 28

The 7%-lit Moon occults Aldebaran (Alpha (α) Tauri) from 19:08 to 20:00 BST (18:08 to 19:00 UT). From 21:30 BST (20:30 UT), look for the 8%-lit waxing crescent Moon near Aldebaran, with Mars 9° to the right and the Pleiades 6° right of Mars.

WEDNESDAY 5

Jupiter appears close to mag. +11.8 star this evening GSC 4963-352. The star will appear to be virtually touching the planet's northern limb but will be extremely hard to see because of Jupiter's brightness.

THURSDAY 13

The 92%-lit waning gibbous Moon will occult mag. +3.9 Gamma (γ) Librae at 23:34 UT, the star reappearing from behind the Moon's dark edge at 01:48 BST (00:48 UT) on 14 April.

FRIDAY 14

A good opportunity to see Ganymede and its shadow transit Jupiter. The moon passes onto the disc at 22:57 BST (21:57 UT) followed by its shadow at 23:28 BST (22:28 UT). The moon transit ends at 01:01 BST (00:01 UT), the shadow exiting the disc at 01:52 BST (00:52 UT).

WEDNESDAY 19

Comet 41P/Tuttle-Giacobini-Kresak lies very close to mag. +2.8 Rastaban (Beta (β) Draconis) in the early hours. The comet is predicted to be around mag. +6.8 at this time.

SATURDAY 22 ▶

Tonight is the peak of the April Lyrid meteor shower. Expect up to 20 meteors per hour.

Another chance to see Ganymede in transit between 02:12 BST (01:12 UT) and 05:49 BST (04:49 UT).

SUNDAY 30

Venus is at its brightest, shining away in the eastern morning pre-dawn sky at mag. −4.4.

FAMILY STARGAZING — 3 APR

Jupiter can be seen rising just after sunset in the eastern part of the sky. If you have a telescope, point it at the planet and focus. You should be able to spot several dots of light close to the planet's disc. These are Jupiter's four largest moons: Io, Europa, Ganymede and Callisto. How many you can see depends where they are relative to the planet; sometimes some are hidden from view. Their positions change each night so make a game to see how many you can spot. For more family stargazing visit www.bbc.co.uk/cbeebies/shows/stargazing

NEED TO KNOW

The terms and symbols used in *The Sky Guide*

UNIVERSAL TIME (UT) AND BRITISH SUMMER TIME (BST)
Universal Time (UT) is the standard time used by astronomers around the world. British Summer Time (BST) is one hour ahead of UT.

RA (RIGHT ASCENSION) AND DEC. (DECLINATION)
These coordinates are the night sky's equivalent of longitude and latitude, describing where an object lies on the celestial 'globe'.

FAMILY FRIENDLY
Objects marked with this icon are perfect for showing to children

NAKED EYE
Allow 20 minutes for your eyes to become dark-adapted

PHOTO OPPORTUNITY
Use a CCD, planetary camera or standard DSLR

BINOCULARS
10x50 recommended

SMALL/ MEDIUM SCOPE
Reflector/SCT under 6 inches, refractor under 4 inches

LARGE SCOPE
Reflector/SCT over 6 inches, refractor over 4 inches

GETTING STARTED IN ASTRONOMY

If you're new to astronomy, you'll find two essential reads on our website. Visit http://bit.ly/10_Lessons for our 10-step guide to getting started and http://bit.ly/First_Tel for advice on choosing a scope.

THE BIG THREE

The three top sights to observe or image this month

DON'T MISS

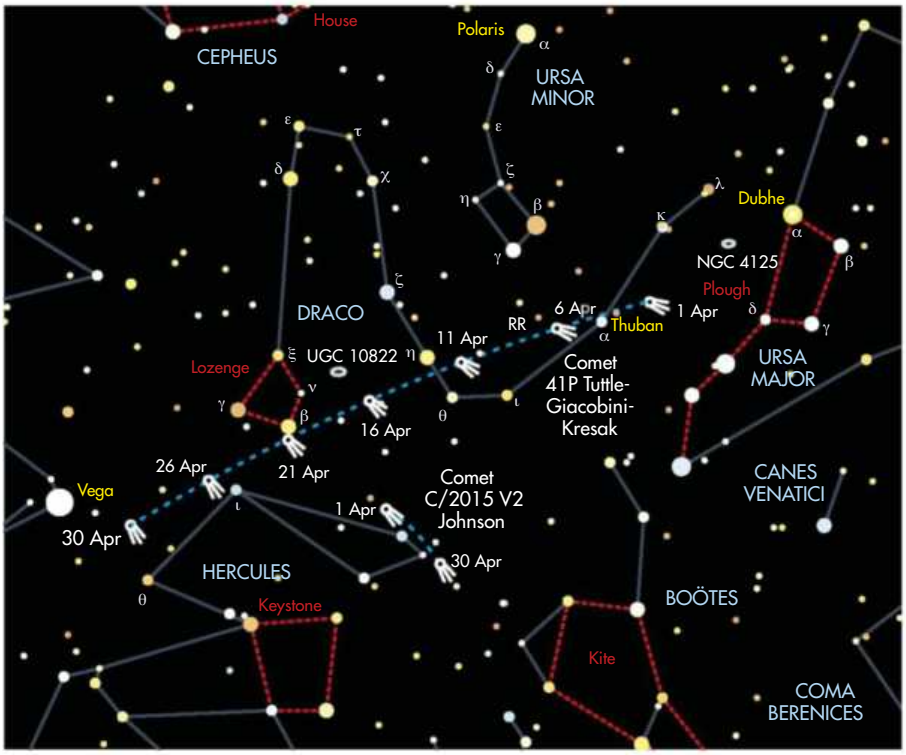
April comets

WHEN: As specified

So far, 2017 has been rather good for comet watchers, with several bright examples being well positioned for viewing from the UK. By a 'bright comet' we mean one that can typically be seen through binoculars.

During April comet 41P/Tuttle-Giacobini-Kresak performs an arcing track that starts off in Draco and ends up in Hercules, close to the border with Lyra. It passes close to the head of Draco from 17-22 April before creeping over into Hercules. Its predicted brightness over this time is expected to vary from mag. +6.7 on 1 April to +7.6 by the end of the month, peaking during 5-11 April at mag. +6.6. This keeps it well within binocular range and its high declination means it'll be a great target to keep an eye on throughout the month.

The comet is also circumpolar during April, which means that it'll be possible to dodge the bright waxing and waning gibbous Moons with a bit of careful timing. The immediate period around the full Moon on 11 April will be a different story, of course.

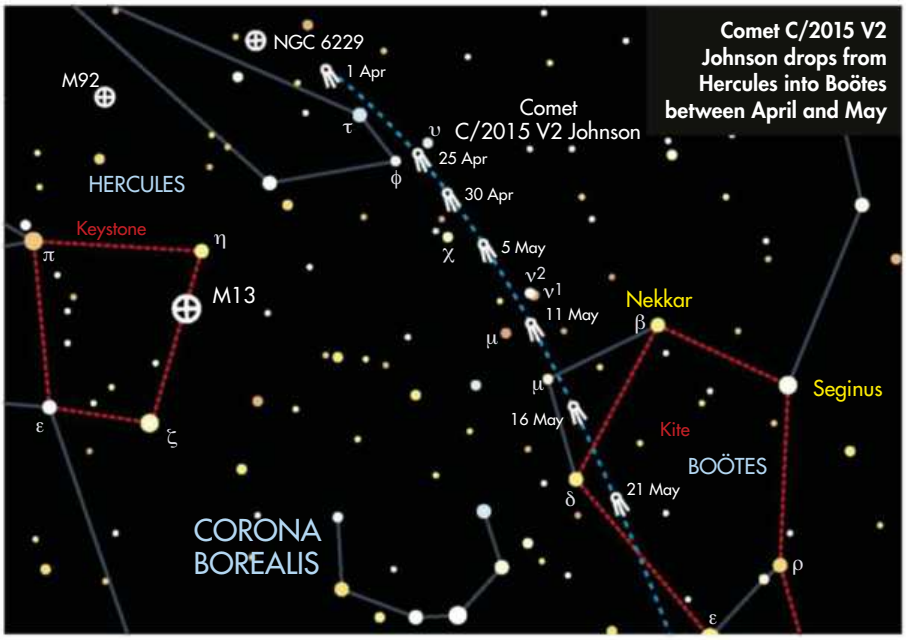


▲ **Comet 41P Tuttle-Giacobini-Kresak makes its way towards the constellation of Hercules throughout April. Positions correct for 01:00 BST (00:00 UT) on dates shown**

Despite its long track, there aren't many deep-sky objects along 41P/Tuttle-Giacobini-Kresak's path. One exception occurs around 14-17 April when it passes a few degrees southwest of UGC 10822, the large and low surface brightness Draco Dwarf galaxy. It passes less than 1° north of mag. +3.6 Thuban (Alpha (α) Draconis) on the night of 2/3 April and slightly less than 2° south of the red semi-regular variable star RR Ursae Minoris (mag. +4.5 to +4.7) on the night of 5/6 April. It passes mag. +2.7 Eta (η) Draconis by a similar distance on the nights of the 10/11th and 11/12th. Finally, it passes 1° west of mag. +2.8 Rastaban (Beta (β) Draconis) on the night of 18/19 April. Each object it passes makes locating the comet relatively easy.

In contrast to the great swathe of sky that 41P passes through, comet C/2015 V2 Johnson travels just 7.5° throughout the entire month, making it much easier to catch and stay with. You can find it in the northern region of Hercules, heading slightly north of mag. +3.8 Rukbalgethi (Tau (τ) Herculis) to pass between mag. +4.7 Upsilon (υ) and mag. +4.2 Phi (ϕ) Herculis around 25 April. Unlike 41P, V2 Johnson is brightening, starting the month at mag. +8.3 and reaching mag. +7.4 by the 30th. This again places the comet well within the range of a pair of binoculars.

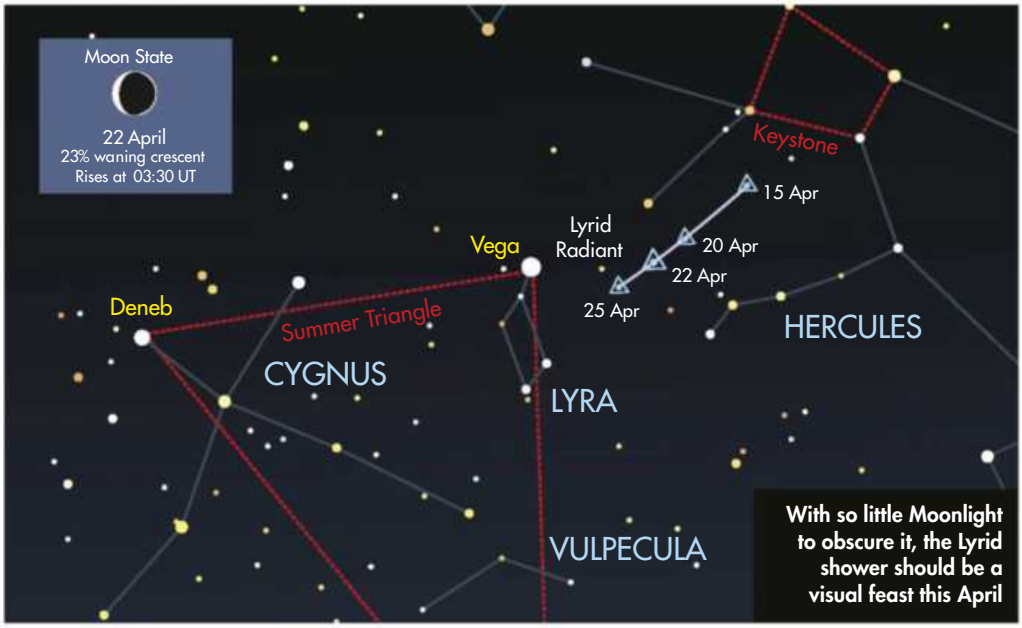
The current motion of C/2015 V2 Johnson is relatively slow against the background stars, offering an opportunity for imagers to take longer exposures of it without significant motion blur due to its own apparent motion. See page 64 for advice on photographing comets.



PETE LAWRENCE X 4

The Lyrids

WHEN: 16-25 April, peak activity should occur on the night of 21/22 April



After the Quadrantid meteor shower at the start of January, there is a pause in significant activity until April when the Lyrids are active. The shower is normally active from 16-25 April with a peak lasting for several hours on 22 April. The peak occurs when the Sun's ecliptic longitude lies between 32° and 32.45°. Although this reflects the position of the Sun along the ecliptic, it's actually a way of expressing the position of Earth around its orbit. Between these points Earth passes through the stream of particles spread around the orbit of long-period comet C/1861 G1 Thatcher, which has an orbital period of 415 years.

The solar ecliptic longitude at peak will be sometime between 05:00 BST (04:00 UT) and 16:00 BST (15:00 UT) on 22 April. Sunrise in the UK is around 5am on 22 April so viewing from around 23:00 BST (22:00 UT) on the 21st until dawn on the 22nd should produce the best results. The following night should also see some Lyrid activity but it will be on the post-maximum decline.

The peak zenithal hourly rate for this shower is around 18 meteors per hour, although higher values have been seen. The maximum rate recorded in recent times was 90 meteors per hour in 1982, although this was only for a short time.

The radiant position – where Lyrids appear to come from in the sky – is relatively close to mag. 0.0 Vega, (Alpha (α) Lyrae). This location continues to gain altitude throughout the night, almost reaching a point directly overhead as dawn approaches. The Moon is new on 26 April this year and won't interfere with the shower.

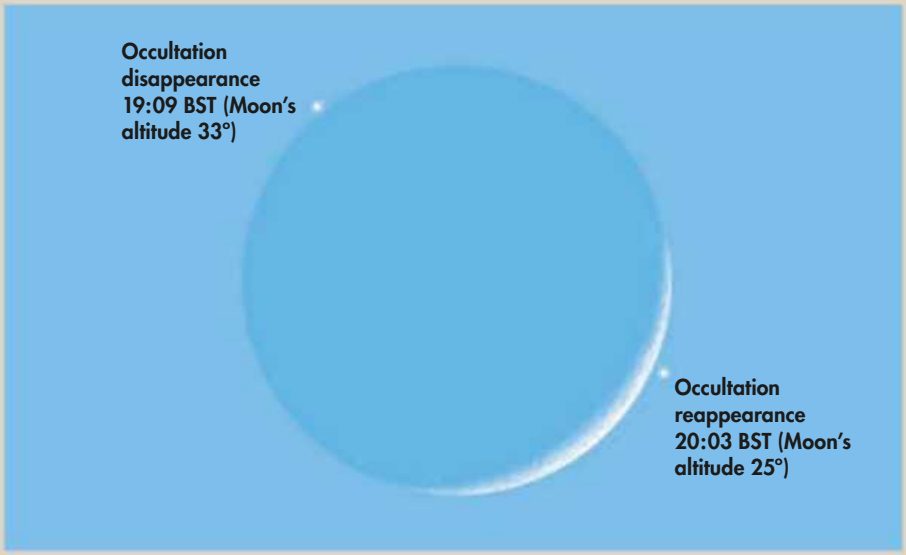
Daylight occultation of Aldebaran

WHEN: 28 April; view from 18:45 BST (17:45 UT) until 20:15 BST (19:15 UT)

The Moon has an apparent diameter of 0.5°. When it's bright in the night sky it looks imposing and large against the background constellations, but really that half a degree is rather small. As it appears to travel around the sky each month, it passes in front of background stars, resulting in an event known as a lunar occultation. Occultations involving bright stars are less common than you might think.

This month there's an opportunity to watch the Moon pass in front of the bright orange giant star Aldebaran (Alpha (α) Tauri) but with a bit of a twist because it takes place during the hours of daylight. Whether you can see Aldebaran during the day really depends on the transparency of the sky but, using a telescope and our graphic as a guide, it's definitely worth having a go at viewing it.

Disappearance occurs on 28 April at 19:09 BST (18:09 UT) when the Moon is 33° above the horizon. Reappearance occurs at 20:03 BST (19:03 UT) with the Moon 25° up. These values are for the centre of the UK, so start observing at least 15 minutes before these stated times to maximise your chances of seeing Aldebaran disappear and reappear.



▲ Lunar occultations are less common than you might imagine, so make sure you take the opportunity to look for this one in daylight. Times are correct for the centre of the UK

THE NORTHERN HEMISPHERE IN APRIL

KEY TO STAR CHARTS

- *Arcturus* — STAR NAME
- PERSEUS — CONSTELLATION NAME
- GALAXY
- OPEN CLUSTER
- GLOBULAR CLUSTER
- PLANETARY NEBULA
- DIFFUSE NEBULOSITY
- DOUBLE STAR
- VARIABLE STAR
- THE MOON, SHOWING PHASE
- COMET TRACK
- ASTEROID TRACK
- STAR-HOPPING PATH
- METEOR RADIANT
- Circlet — ASTERISM
- PLANET
- QUASAR

STAR BRIGHTNESS:

- MAG. 0 & BRIGHTER
- MAG. +1
- MAG. +2
- MAG. +3
- MAG. +4 & FAINTER

COMPASS AND FIELD OF VIEW

MILKY WAY

WHEN TO USE THIS CHART

1 APRIL AT 01:00 BST
15 APRIL AT 00:00 BST
30 APRIL AT 23:00 BST

On other dates, stars will be in slightly different places due to Earth's orbital motion. Stars that cross the sky will set in the west four minutes earlier each night.

HOW TO USE THIS CHART

1. **HOLD THE CHART** so the direction you're facing is at the bottom.
2. **THE LOWER HALF** of the chart shows the sky ahead of you.
3. **THE CENTRE OF THE CHART** is the point directly over your head.

SUNRISE/SUNSET IN APRIL*

DATE	SUNRISE	SUNSET
1 Apr 2017	06:43 BST	19:45 BST
11 Apr 2017	06:19 BST	20:03 BST
21 Apr 2017	05:56 BST	20:22 BST
1 May 2017	05:35 BST	20:40 BST

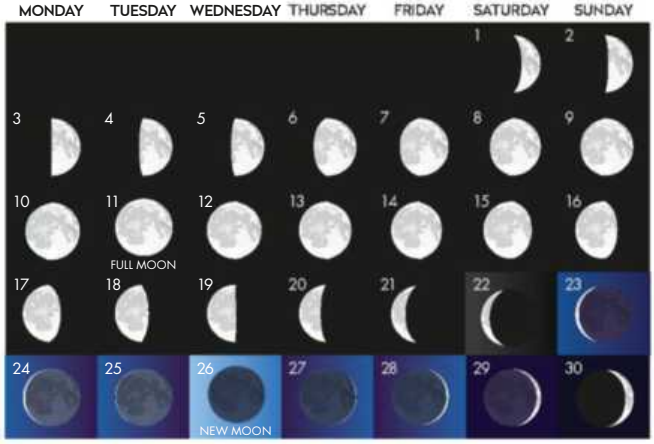
MOONRISE IN APRIL*

MOONRISE TIMES

1 Apr 2017, 09:30 BST	17 Apr 2017, 01:22 BST
5 Apr 2017, 13:22 BST	21 Apr 2017, 04:01 BST
9 Apr 2017, 18:03 BST	25 Apr 2017, 05:47 BST
13 Apr 2017, 22:28 BST	29 Apr 2017, 08:08 BST

*Times correct for the centre of the UK

LUNAR PHASES IN APRIL



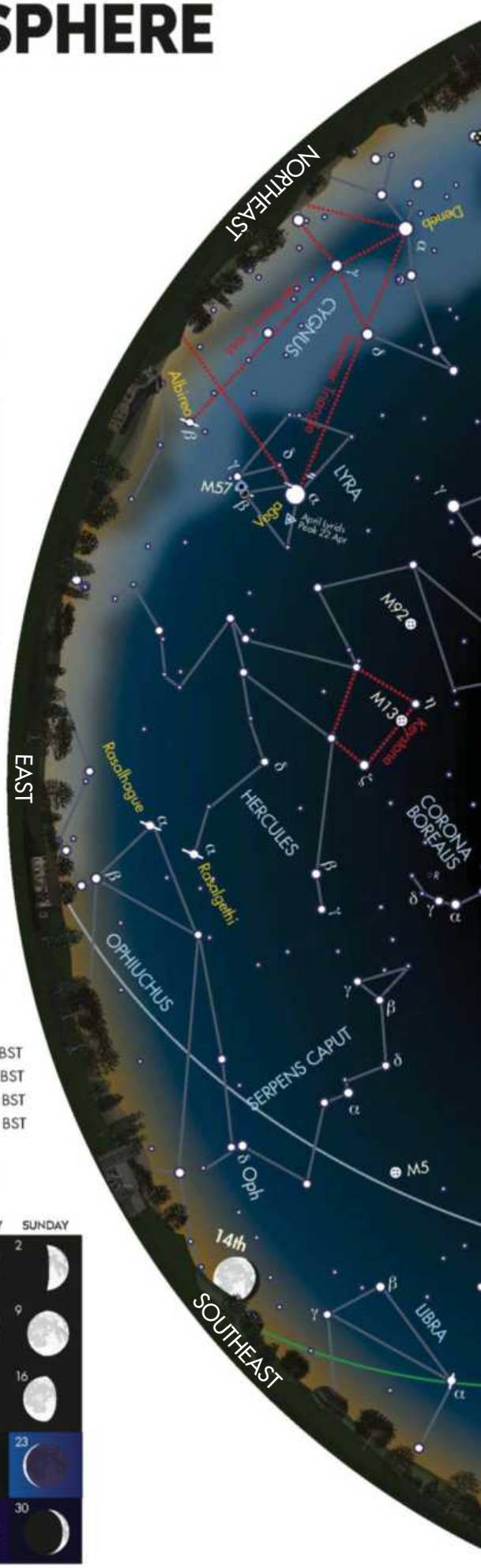


CHART: PETE LAWRENCE

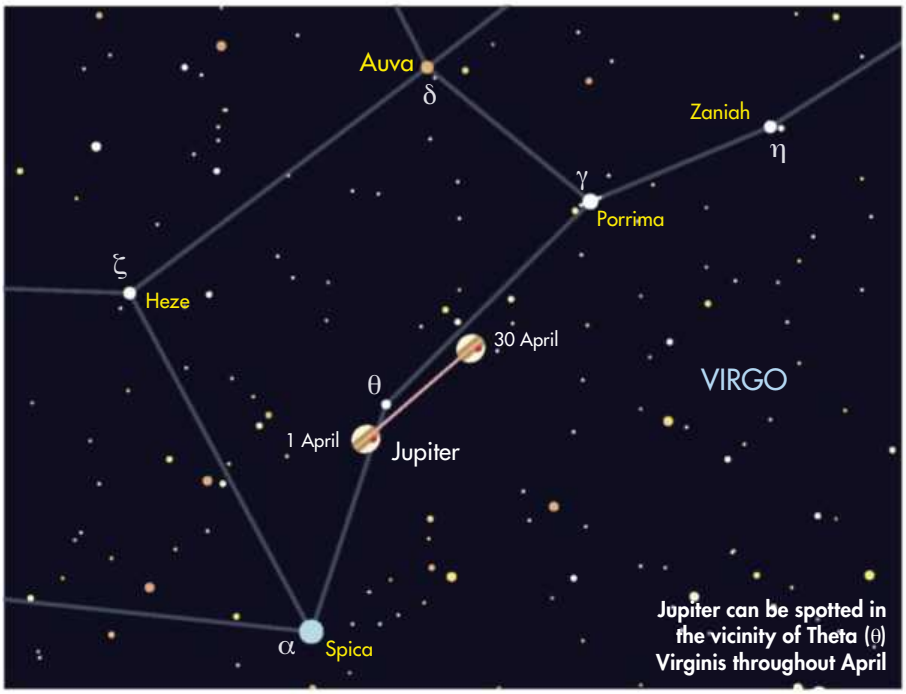
YOUR BONUS CONTENT Paul and Pete's Virtual Planetarium

THE PLANETS

PICK OF THE MONTH

JUPITER

BEST TIME TO SEE: 7 April, 01:00 BST (00:20 UT)
ALTITUDE: 31°
LOCATION: Virgo
DIRECTION: South
FEATURES: Detailed atmosphere, Great Red Spot, Galilean moons
EQUIPMENT: 3-inch or larger telescope



Jupiter can be spotted in the vicinity of Theta (θ) Virginis throughout April

Magnificent Jupiter is at opposition on 7 April, a time when it occupies a position opposite the Sun in the sky and appears closest to Earth for its current period of observation. Between 5 and 7 April, Jupiter lies very close to mag. +4.4 Theta (θ) Virginis, passing the star by around 10 arcminutes in the early hours of 6 April.

On the night of 10 April a full Moon (technically full on the morning of 11 April) lies just 1.5° to the north of the planet. Together they should appear impressive as they arc across the sky. Jupiter moves west among the stars during April, affording us a brief increase in altitude when due south. On the night of opposition it appears 31° high as seen from the centre of the UK, which increases to 32° by 30 April. In terms of magnitude and apparent size, Jupiter appears brightest when it's at opposition, shining away at mag. –2.5. However, there's not much change in this brightness throughout the month. Similarly, the planet's apparent diameter remains around 44 arcseconds for most of the month.

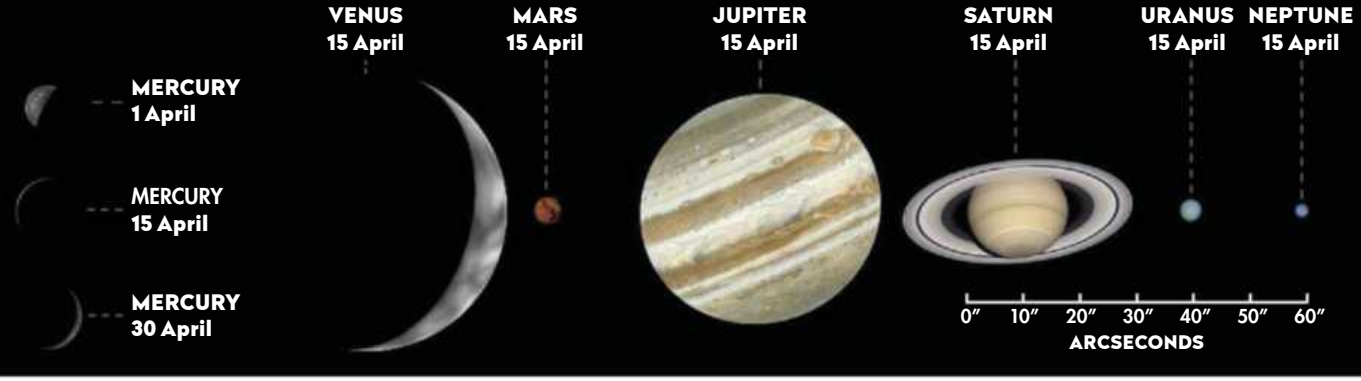
The most prominent features on Jupiter's disc are the two dark belts north and south of the equator, known as the North Equatorial Belt and South Equatorial Belt. There have been some interesting developments within them since the start of 2017. At the start of the year, an impressive white plume erupted in the South Equatorial Belt (longitude System 2, 208°). With further activity expected to persist, and the continuing Juno Mission studying Jupiter at close range, this is a particularly important time to keep track of what's happening on this giant gas planet.


Jupiter and the full Moon as seen on 28 November 2012. On 10 April 2017, Jupiter will be 1.5° south of the Moon

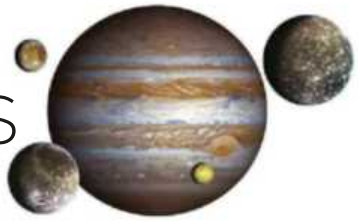
PETE LAWRENCE X 3

THE PLANETS IN APRIL

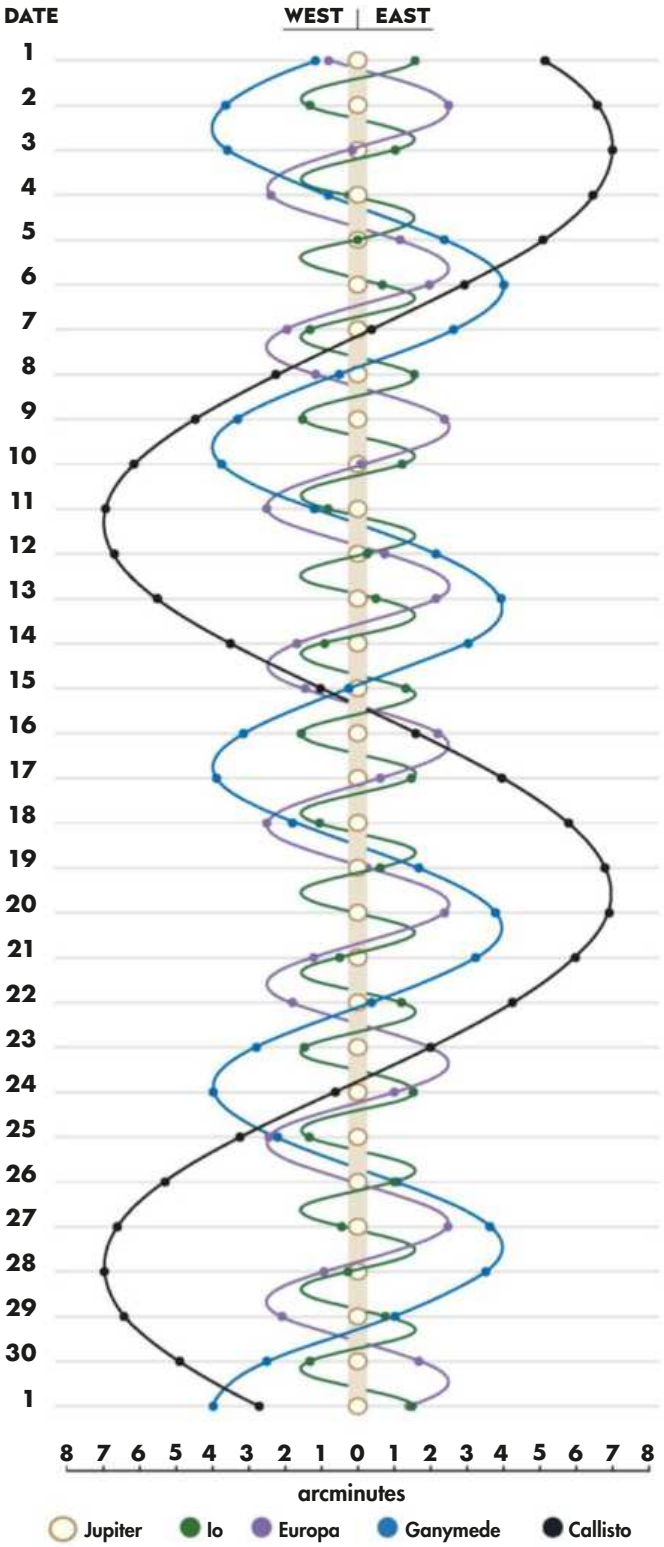
The phase and relative sizes of the planets this month. Each planet is shown with south at the top, to show its orientation through a telescope



JUPITER'S MOONS APRIL



Using a small telescope you'll be able to spot Jupiter's biggest moons. Their positions change dramatically during the month, as shown on the diagram. The line by each date on the left represents 00:00 UT.



SATURN

BEST TIME TO SEE: 30 April, from 04:00 BST (03:00 UT)
ALTITUDE: 15°
LOCATION: Sagittarius
DIRECTION: South

Saturn is a morning object in Sagittarius. By the end of the month it reaches its highest altitude of 15°, as seen from the centre of the UK, shining at around mag. +0.4. The rings are well presented as the north pole is tilted towards us by 26.4°. A 79%-lit waning gibbous Moon lies to the west of Saturn on the morning of 16 April, swapping sides the next morning (17th) when it will appear 71% lit and 5° from the planet.

MERCURY

BEST TIME TO SEE: 1 April, 20:45 BST (19:45 UT)
ALTITUDE: 8° (low)
LOCATION: Aries
DIRECTION: West

Mercury reaches greatest eastern elongation on the 1st and should be visible in the evening sky. The planet sets two hours after the Sun at the start of April, making this a good time to look out for it.

On 1 April it shines at mag. –0.1 and should stand out well against the darkening evening twilight. Its position remains good during the early part of the month, but its brightness drops rapidly. On 7 April, Mercury sets 110 minutes after sunset with a brightness of mag. +1.4. Your last chance to catch it will be around 10 April, approximately 40 minutes after sunset when it'll be shining away at mag. +2.2, low down, close to the west-northwest horizon. Inferior conjunction is on 20 April, after which time the planet reappears in the morning sky, poorly positioned before sunrise. If you can grab a view of Mercury through a telescope, on 1 April it'll appear as a 7.5-arcsecond diameter, 43%-lit crescent. By 10 April its diameter will have increased to 9 arcseconds as its phase decreased to 11%.

VENUS

BEST TIME TO SEE: 12 April, from 05:30 BST (04:30 UT)
ALTITUDE: 3° (low)
LOCATION: Pisces
DIRECTION: East

Venus is a morning object rising approximately one hour before the Sun all month. It's now swinging to a position south of the ecliptic and this will compromise its location. Consequently, despite increasing its separation from the Sun, its visibility in the morning twilight sky tends to remain quite similar throughout the month. It's very bright at mag. –4.0 on 1 April, brightening to –4.4 by the end of the month. Through a telescope it shows a crescent phase, 57 arcseconds across and 2% illuminated on 1 April. It shrinks to 38 arcseconds and 26% illuminated towards the end of the month.

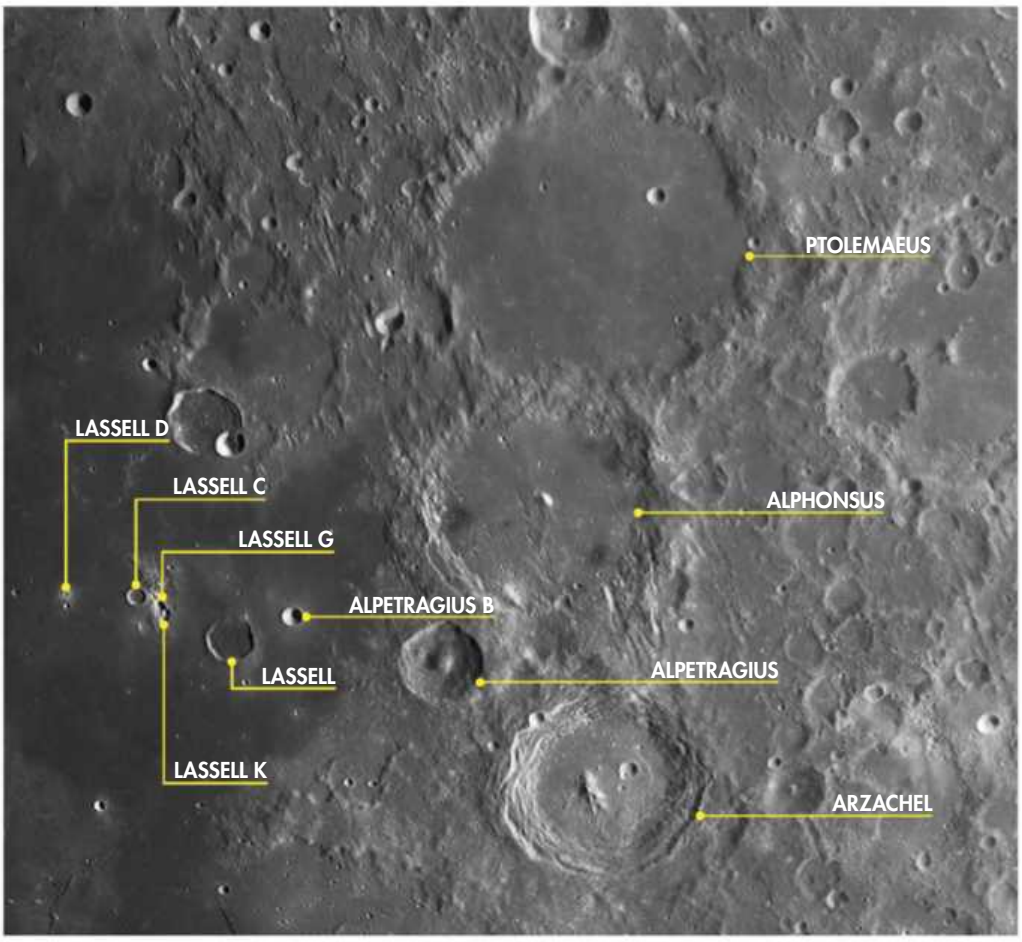
MARS

BEST TIME TO SEE: 18-21 April, from 22:00 BST (21:00 UT)
ALTITUDE: 8° (low)
LOCATION: Taurus
DIRECTION: West-northwest

Mars slowly appears to be creeping closer to the Sun. The planet is now in a far part of its orbit relative to Earth, giving us a view that appears small through a telescope. At the start of the month its apparent diameter is just 4.2 arcseconds, shrinking to just 3.9 arcseconds by 30 April. From 18-21 April, it skirts just south of the Pleiades open cluster, M45, lying 3.5° away at its closest approach on 20 April. By the end of the month, Mars is positioned very low in the sky as darkness starts to fall.

NOT VISIBLE THIS MONTH: Uranus and Neptune.

YOUR BONUS CONTENT Planetary observing forms



PETE LAWRENCE X 3

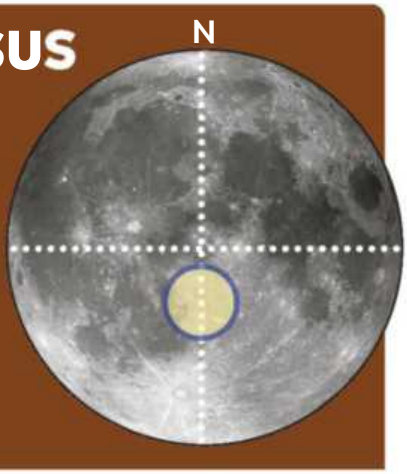
◄ **Alphonsus middle member of a crater trio arranged by order of age; catch it under low lighting to see its best features**

"A central ridge runs north-south through the crater, a feature probably associated with ejecta from the Imbrium impact"

MOON**WATCH**

ALPHONSUS

TYPE: Crater
SIZE: 118km diameter
LOCATION: 2.8°W, 13.4°S
AGE: 3.85-3.92 billion years
BEST TIME TO SEE: First quarter or six days after full Moon (4 April and 18-19 April)
EQUIPMENT: 10x binoculars



Alphonsus is a large crater that sits in the middle of a famous trio of craters running more-or-less up the central meridian of the Moon's face. The most northerly member of this trio is the vast open plain of Ptolemaeus, measuring 154km across. Alphonsus's 118km diameter lies immediately south of Ptolemaeus. There's a bit of a gap below Alphonsus before you reach the final member of the trio, 98km-wide Arzachel. Interestingly, the south-north lineation also reflects a progression of age. Arzachel is believed to be between 3.8-3.85 billion years old, Alphonsus 3.85-3.92 billion years, and Ptolemaeus 3.92-4.55 billion years.

This age progression shows in the craters' appearances too. Arzachel has sharp terraces, a central mountain complex and features crossing its relatively flat floor while at the top of the chain, Ptolemaeus's floor also appears flat but has no central mountains or wall terracing. Catch Ptolemaeus at sunrise or sunset, however, and you'll see evidence of hidden craters buried beneath its lava-flooded surface.

Alphonsus is a blend of the other two. It has a relatively flat floor with a single mountain at its centre. Low lighting reveals a number of interesting formations including a central ridge running north-south through the crater. This raised feature is probably associated with the ejecta thrown out from the impact that formed the Imbrium Basin to the northwest. Many of the grooves in the rim of Alphonsus are also likely to be related to the Imbrium impact.

A number of fine rilles pass across Alphonsus's floor, most evident in the eastern half of the crater. The rim is terraced and shows a lot of detail when the Sun's elevation is low over the crater. However, the most interesting visual features on its floor are a set of dark patches. These are pyroclastic deposits – the result of volcanic eruptions that have shot up through the floor and deposited dark material around a central pit. There are 11 such pits on Alphonsus's floor, the three largest being particularly prominent. One sits close to the western rim, one in the southeast and one in the northeast. Follow the line of a rille north of the main northeastern patch to find a smaller pit with yet another slightly northwest of that.

To the west of Alphonsus lie the dark and smooth lava plains that progress towards the Mare Nubium. The region is punctuated by the 10km-crater Alpetragius B, a satellite crater of the 40km-wide Alpetragius, which lies to the southwest of Alphonsus. Crater Lassell (24km), to the west-southwest of Alpetragius B, is a flooded crater with little more than a rim to define it. A small, rough area sits to the northwest of Lassell, occupied by a curving arc of smaller craters: these are Lassell K (4km), Lassell G (7km), Lassell C (9km). The arc points west toward tiny Lassell D. Despite its size Lassell D is quite visible due to the bright ejecta blanket that surrounds it.

COMETS AND **ASTEROIDS**

Catch 41P/Tuttle-Giacobini-Kresak at its closest approach in a century

▲ **Comet 41P/Tuttle-Giacobini-Kresak passes among the stars of Leo during January 2016**

Periodic comet 41P/Tuttle-Giacobini-Kresak is well positioned in April, passing across a region of sky that is circumpolar from the UK. This coincides with the comet reaching the peak of its predicted brightness in the second week of April, during which time it should be a relatively easy mag. +6.6 binocular comet.

The three names 41P carries represent its original discoverer, Horace Tuttle, and its two rediscoverers, Michel Giacobini and Lubor Kresak. Tuttle spotted the comet in 1858; it was subsequently rediscovered by Giacobini in 1907 and Kresak in 1951.

Two close encounters with Jupiter in 1975 and 1988 have altered the comet's orbit so it now has a period of 5.46 years. Its next perihelion occurs on 13 April 2017 and, thanks to a close pass of Earth on 3 April, this is a good year to try and see it. On 5 April it will pass our planet by a little over 22 million km, the closest approach to Earth for over a century.

This will be an interesting comet to keep an eye on because it has produced outbursts in the past. In 1973 it appeared 10,000 times brighter than predicted for a few days. This raised its brightness to mag. +4.0, taking it into naked-eye territory. Whether anything so dramatic will occur this year is unknown, but even a modest brightening above the predicted model will elevate it to naked-eye status.

The comet should remain brighter than mag. +10.0 from the start of March until the end of May 2017. Throughout this period its high northern declination provides a favourable observing window for the northern hemisphere. You can find a tracking chart for 41P on page 52.

STAR OF **THE MONTH**

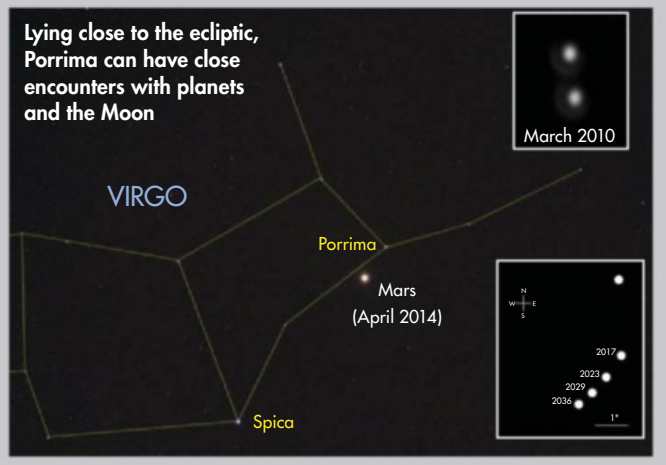
Porrima – the binary star at the bottom of Virgo's bowl that can prove tricky to split

The constellation of Virgo is well positioned during April and May. It's the second largest of the constellations by area and most easily identified because of brilliant-white Spica (Alpha (α) Virginis), and a large semi-circular pattern known as the Bowl of Virgo. The 'base' of the bowl, is marked by mag. +2.7 Porrima (Gamma (γ) Virginis). An alternative name for Porrima is Arich.

Porrima, named after one of the Roman goddesses of prophecy and childbirth (along with her sister, Prorsa), is not a single star at all but a binary system with a period of 168.93 years. Both components are of similar brightness, mag. +3.65 and mag. +3.56. Their colour classification of F0V means that they appear white when viewed through an eyepiece.

Porrima's orbit is interesting because prior to 1990 the star was relatively easy to split using amateur instruments. But the apparent separation then closed so that during the noughties, the star appeared to be single point source when viewed through a telescope. On 1 January 2000, for example, the separation was a tiny 1.49 arcseconds. This had reduced to just 0.41 arcseconds on 1 January 2006.

The last time both stars were separated by their minimum apparent distance – an event called periapsis – occurred in the middle of 2005 and since then, the components have been separating once more. Currently the separation is in the order of 2.5 arcseconds, similar to the apparent diameter of Neptune, and it will increase to 3 arcseconds by 2020/21. This separation places Porrima within range of many amateur scopes once again, making it an interesting target for a long-term observing project.



The Porrima system is located 38 lightyears from Earth and has an estimated age of 1.14 billion years. Both stars have a mass equivalent to 1.3 that of our Sun and a physical separation that averages 43 AU. This is similar to the distance between the Sun and Pluto. The orbit has a high eccentricity that brings the stars as close together as 5 AU and as far apart as 81 AU.

STEPHEN TONKIN'S
BINOCULAR TOUR

A selection of the highlights dotted around the Hercules region are on April's agenda

☑ Tick the box when you've seen each one

1 M92

15x 70 Many fine celestial objects are overlooked because of their proximity to more famous ones. The first stop on this month's tour is one of them. To find M92, start at the northwestern corner of the Keystone asterism in Hercules and imagine a line heading northeast to Iota (ι) Herculis. Two-thirds of the way along this line, the 300,000 or so stars of M92, concentrated into an apparent diameter about one-fifth that of the Moon, shine at mag. +6.4. ☐ **SEEN IT**

2 M13

10x 50 The next stop is M92's famous neighbour, M13, called the 'Great Cluster' with good reason. Situated a third of the way down the western side of the Keystone asterism, it's visible to the naked eye in a reasonably dark sky. Even with small binoculars this mag. +5.8 cluster can be visible under urban skies, although not nearly as splendidly as in darker conditions. In 10x50 binoculars, it brightens appreciably towards the centre. It's about 1,000 lightyears closer than M92, but contains about three times as many stars. ☐ **SEEN IT**

3 30 HERCULIS

10x 50 Also known as g Herculis, this orange star lies 1° to the west-southwest of Sigma (σ) Herculis. Recently, the magnitude of this semi-regular variable star has wavered between mag. +4.4 and mag. +5.5 with a period of 73-93 days between maxima. 30 Herculis has a radius of 230 Suns, larger than Earth's orbit. Despite that, it has a similar mass to the Sun and indicates how our star will evolve. It's soon to lose its outer shell as a planetary nebula, leaving its core to decay as a white dwarf. ☐ **SEEN IT**

4 TAU CORONAE BOREALIS GROUP

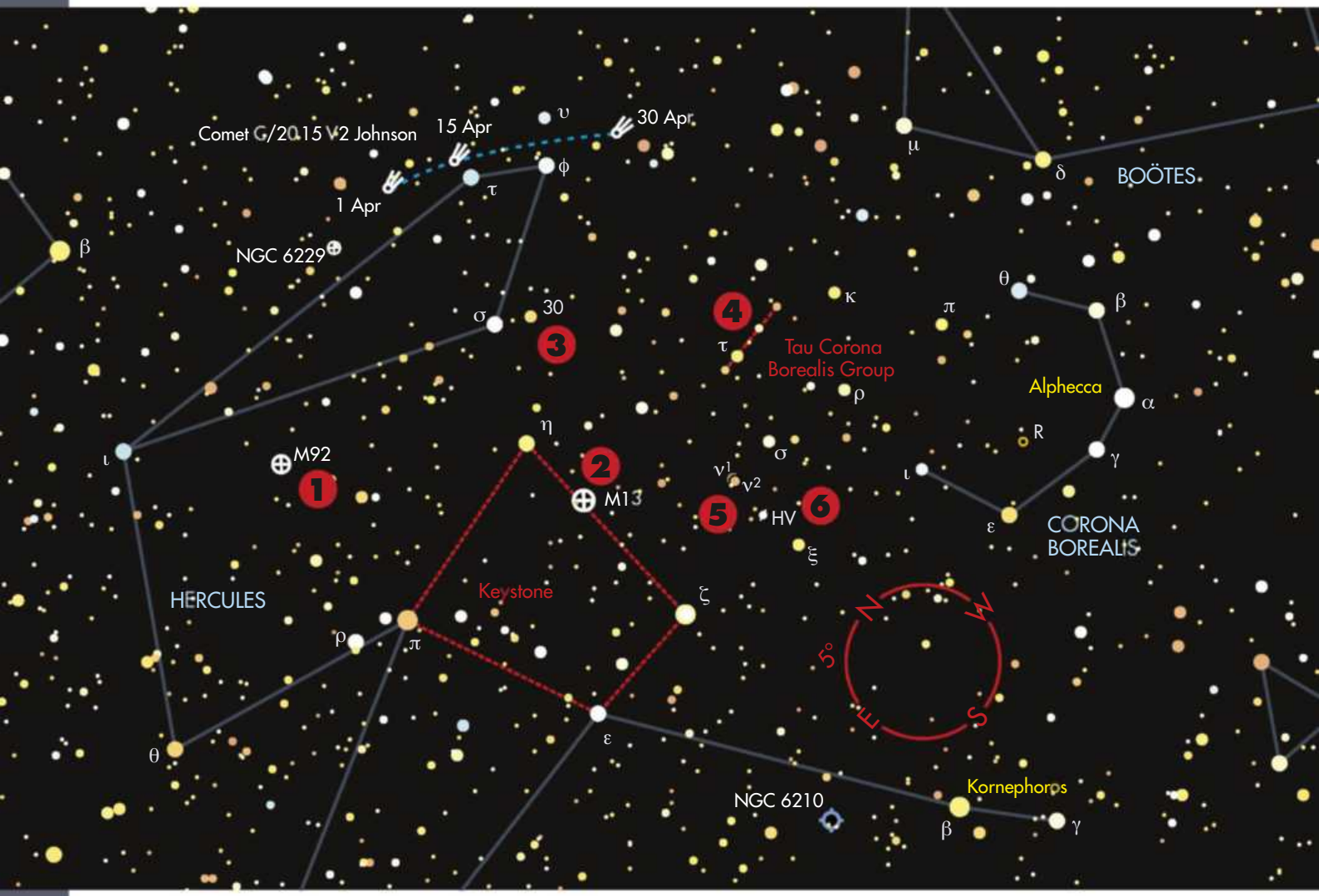
10x 50 From 30 Herculis, scan 6.5° to the southwest to find mag. +4.7 Tau (τ) Coronae Borealis, the brightest in a straight, 2.6° long chain of five stars running east-west. All but the central one shine brighter than mag. +6.0. Notice that the mag. +5.6 stars at each end are a deeper yellow than the others, while the star next to the eastern end is almost white. Under dark skies, you should find that the mag. +7.4 central star easily resolves into a widely separated triple. ☐ **SEEN IT**

5 NU CORONAE BOREALIS

10x 50 Nu (ν) Coronae Borealis appears double to the naked eye and is therefore easily split in small binoculars, where it appears as a wide (6 arcminutes) pair of yellow stars. The stars of this optical (not gravitationally bound) double are remarkably similar, both being giants with masses about 2.5 times that of the Sun. At 555 lightyears, the more northerly star, ν^1, is 10 lightyears further away than ν^2. It shines at mag. +5.2, 0.2 magnitudes brighter than ν^2, owing to its being about 750 million years older and therefore larger and more luminous. ☐ **SEEN IT**

6 HV 38

15x 70 April's tour ends with a challenge. Midway between Nu Coronae Borealis and mag. +4.9 Xi (ξ) Coronae Borealis, find a mag. +6.4 white star. This is the easy part. The challenge, is to see its companion under British skies – try mounting your binoculars. The 'H' refers to William Herschel's double star catalogue; the 'V' tells you that the separation is 30-60 arcseconds. Not only is the companion, which lies in the direction of Nu Coronae Borealis, at the lower end of this range (32 arcseconds), but it's a mere mag. +9.7. Good luck! ☐ **SEEN IT**



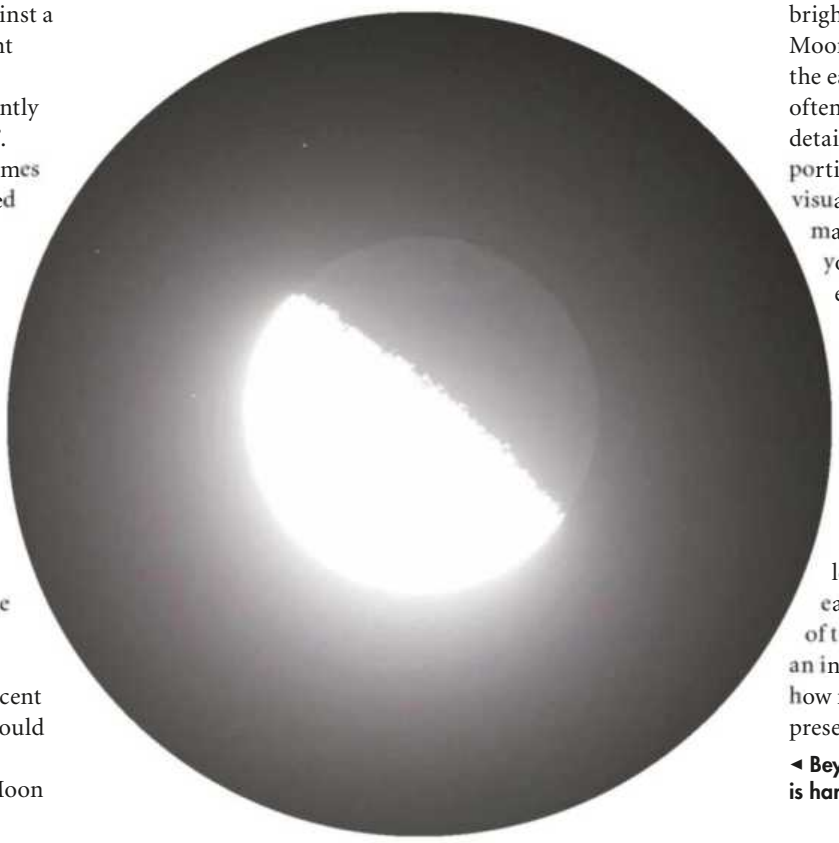
THE SKY GUIDE **CHALLENGE**

See how early and late you can catch the 'old' and 'young' Moons

▲ **Before the Sun's light washes across the face of the Moon, earthshine illuminates the dark portion**

Have you ever heard of the 'Old Moon in the young Moon's arms'? It's the phrase used to describe the effect where you can see the dark portion of the Moon glowing gently against a bright crescent. The bright crescent represents the 'young Moon' and the faintly lit portion the 'old Moon'. The faint illumination comes from a phenomenon called earthshine. Although normally associated with young or old crescent Moons, earthshine can be seen at other times. This month's challenge is to see just how late, or early, the effect can be seen.

The mechanics of earthshine are relatively straightforward. Imagine if you were standing at the centre of the Moon's Earth-facing hemisphere when it was seen as a crescent Moon from Earth. You would be standing in the dark portion, the part of the Moon experiencing lunar night. The Earth would be high in your sky and would be showing the complementary phase to what we were seeing from Earth. This gibbous Earth would appear four times larger than we see the Moon. Earth's reflectivity is also significantly higher. As well as illuminating the lunar surface around you, some of this light will reflect back to Earth and this is what we see as earthshine.



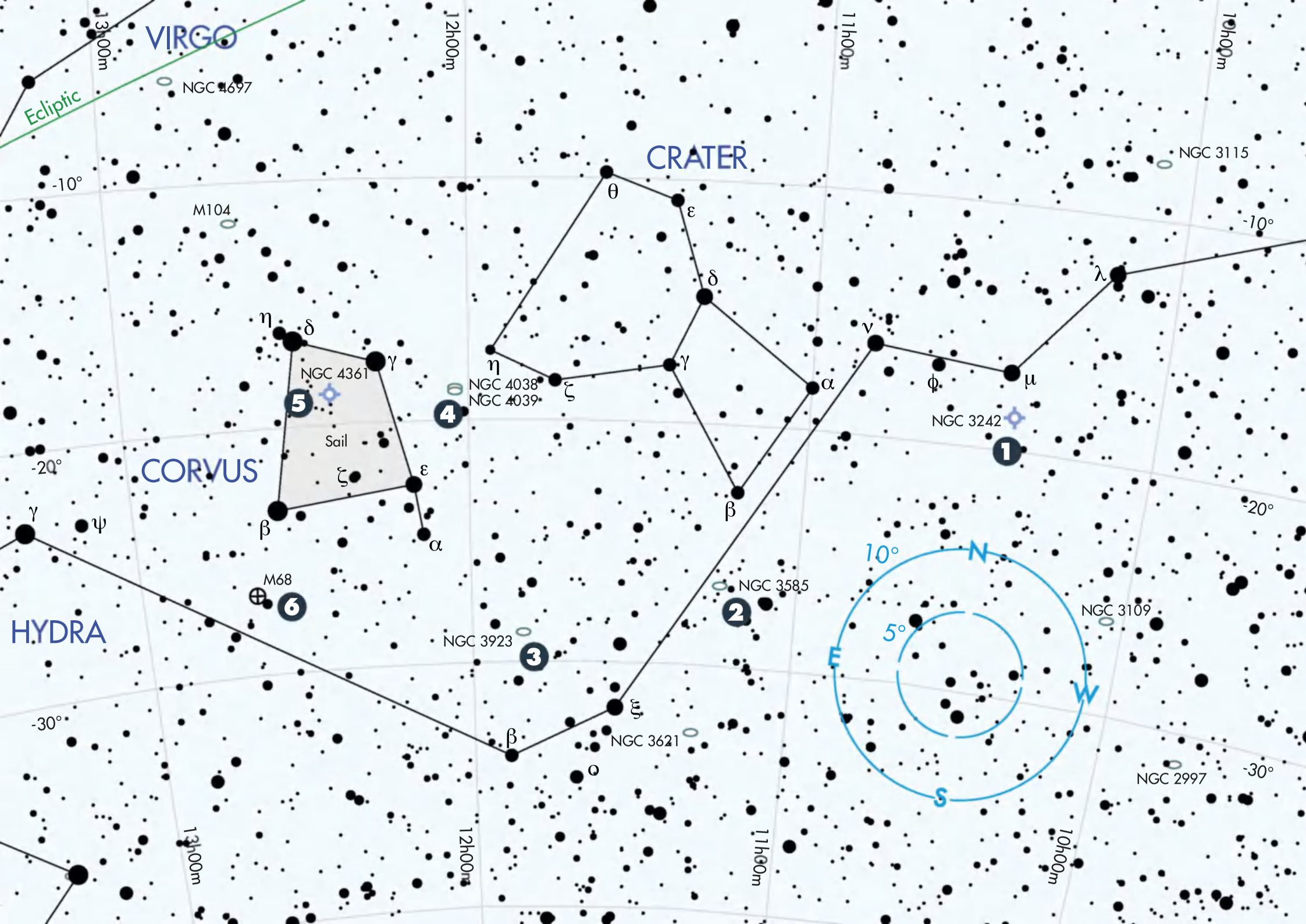
Earthshine is fairly obvious when the Moon appears as a thin crescent because the Moon's sunlit surface is not bright enough to swamp it. Often seen against a twilight backdrop, it's fairly easy for the eye to 'complete-the-circle' and register the earthshine lit portion. As the phase increases, the brilliance of the daytime-lit portion of the Moon quickly overpowers and earthshine is lost from view. Observe the Moon through a telescope or binoculars, however, and you can still see earthshine beyond the thin crescent phase. This is especially noticeable if you place the bright portion out of the field of view. If you're a visual observer, make a note as to how many days past new you can see earthshine through different instruments.

If you're an imager, recording earthshine is relatively easy because all you have to do is to overexpose the brightly lit portion of the Moon enough to reveal it. In the early crescent phases, this often reveals lots of surface detail on the earthshine-lit portion. Again, as with the visual challenge, see how many days past new Moon you can keep track of the earthshine-lit part of the Moon with a camera.

There's a serious side to this challenge too because the reflectivity of the Earth changes over time. More cloud cover increases our planet's reflectivity and leads to brighter earthshine. So keeping track of this phenomenon provides an interesting indication as to how much cloud cover is present on our own planet.

◀ **Beyond half Moon earthshine is harder to see**

PETE LAWRENCE X 3


VIRGO
Ecliptic
NGC 4697
13h00m
12h00m
11h00m
10h00m
-10°
M104
CRATER
NGC 3115
θ
ε
δ
λ
η
δ
γ
NGC 4361
5
Sail
ζ
ε
β
α
NGC 4038
NGC 4039
4
η
ζ
γ
α
β
ν
ϕ
μ
NGC 3242
1
-20°
CORVUS
γ
ψ
M68
6
HYDRA
NGC 3585
2
10°
N
5°
E
W
S
NGC 3109
NGC 3923
3
ω
β
ο
NGC 3621
-30°
NGC 2997

DEEP-SKY TOUR

Hydra and Corvus point the way to April's nebulae, galaxies and clusters

☑ Tick the box when you've seen each one

1 THE EYE NEBULA

Despite being the largest constellation, a lack of bright stars makes Hydra quite tricky to navigate but it's worth persisting because there are some great deep-sky objects here, including the Eye Nebula, NGC 3242. This mag. +8.6 planetary nebula is 1.8° south of mag. +3.8 Mu (μ) Hydrae. It's a surprisingly easy small telescope target, standing high magnification well. It looks oval, similar in shape to Jupiter and this is where it gets its alternative name, the Ghost of Jupiter. One striking characteristic is how sharp its outline appears. It measures 25 arcseconds across and has a central star (mag. +12.0 HD 90255) that should be reasonably easy to see. ☐ **SEEN IT**

2 NGC 3585

The next stop on this month's tour is an elliptical galaxy also in Hydra: mag. +10.0 NGC 3585. To find it, move 5.6° east of Mu (μ) Hydrae to locate mag. +3.1 Nu (ν) Hydrae. From here, draw a line to mag. +3.5 Xi (ξ) Hydrae, 18.5° to the south-southeast of Nu Hydrae. The galaxy lies just west of the point two-thirds along this line. A 6-inch telescope shows a fairly uniform oval, approximately 2 arcminutes in size. The uniformity is broken at the centre where a star-like core can be seen. A 10-inch telescope shows a slightly larger haze with a more defined brighter core region, again with a stellar point at its centre. ☐ **SEEN IT**

3 NGC 3923

NGC 3923 is another elliptical galaxy of similar brightness to NGC 3585. To find it, imagine the line between Xi Hydrae and mag. +4.3 Beta (β) Hydrae as the base of an equilateral triangle. Picture where the other vertice would sit to the north of this line and head 0.75° north of this position. It has a similar overall appearance to NGC 3585, but its core region is not so pronounced. Photographed through professional telescopes, the galaxy appears surrounded by a number of shells, perhaps formed through the cannibalisation of other galaxies. Amazingly, in the case of NGC 3923 up to 42 such shells have so far been identified. ☐ **SEEN IT**

4 THE ANTENNAE GALAXIES

Head north out of Hydra and into Corvus to locate the interacting galaxy pair NGC 4038/4039 (mag. +10.7/ mag. +13.0), the Antennae Galaxies. Locate them by extending a line from mag. +2.9 Algorab (Delta (δ) Corvi) through mag. +2.6 Gienah (Gamma (γ) Corvi) for the same distance again. The Antennae Galaxies sit just south of the end of this line. Through small scopes they appear as a triangular smudge; the combined shape of the interacting galaxy cores. A 10-inch telescope will give them a more rounded appearance, the cores appearing more lobe-like and NGC 4038 to the north being slightly brighter than its companion. A 12-inch telescope again refines the appearance of the lobes, delivering an almost shrimp-like appearance. Dark mottling is very apparent across both galaxies at 200-300x magnification. ☐ **SEEN IT**

◂ **Tangled together, the Antennae Galaxies (NGC 4038/4039) form a triangular, almost heart-shaped smudge**

THIS DEEP-SKY TOUR HAS BEEN AUTOMATED

ASCOM-enabled Go-To mounts can now take you to this month's targets at the touch of a button, with our Deep-Sky Tour file for the EQTOUR app. Find it online.

5 NGC 4361

The constellation of Corvus is small and surprisingly bright compared to its surroundings. Its main form is a quadrilateral pattern known as the 'Sail'. Inside this pattern, 2.5° south-southwest of Delta Corvi in the northeast corner, is the mag. +10.0 planetary nebula NGC 4361. This is visible in a 6-inch telescope as a hazy round patch, not dissimilar to the view you'd get of a tailless comet. A 10-inch telescope will show the mag. +13.0 central star, which appears surrounded by a slightly brighter region roughly 40 arcseconds across. An outer hazy envelope surrounds this region, giving the planetary nebula a more rectangular appearance. The overall size of the nebula including this outer region is about 1 arcminute across. ☐ **SEEN IT**

6 M68

This month's tour ends with bright (mag. +8.2) globular cluster M68. Extend a line from Delta Corvi through mag. +2.6 Beta (β) Corvi and carry on for half the distance again to locate M68 (and incidentally return to Hydra's region of sky). A 6-inch telescope shows a fuzzy circular glow, 7 arcminutes across with a number of resolved outer stars. A 10-inch scope extends the appearance to 10 arcminutes across and shows a mottled, grainy appearance under medium magnification. Increasing power should allow you to resolve M68 all the way across its core. It's 33,000 lightyears away and orbits the centre of the Milky Way in an elliptical fashion. The extremity of its orbit takes it out as far as 100,000 lightyears from our Galaxy's core. ☐ **SEEN IT**

YOUR BONUS CONTENT

Print out this chart and take an automated Go-To tour

CHART: PETE LAWRENCE, PHOTO: DANIEL VERSCHATSE/CCDGUIDE.COM

ASTROPHOTOGRAPHY

Basic comet photography

RECOMMENDED EQUIPMENT

DSLR with 50-200mm lens or telescope attachment, driven tracking mount

Comet photography is challenging but the end results are worth the effort, as seen here with comet C/2014 Q12 Lovejoy

It's often said that comets are like cats because they do whatever they please. There are various ways to interpret this. Although we're pretty good at predicting the brightness of a comet, there's always room for surprise. Remember the really faint comet 17P/Holmes that unexpectedly brightened half-a-million times to become a naked-eye object in 2007? Then there was the 'comet of the century', C/2012 S1 ISON, which gave us a tantalising show before perihelion. Despite predictions of grandeur, the perihelion passage proved its undoing: it didn't survive and was consigned to the damp squib pile.

This month sees the appearance of two reasonably bright comets, which – fingers crossed – have a decent chance of behaving themselves. Bear in mind, however, that 'reasonably bright' is used here in the context of comets, so both will require at least binoculars to see.

The comets in question are 41P/Tuttle-Giacobini-Kresak and C/2015 V2 Johnson, and they will each exhibit quite different motions across the night sky. As luck would have it, both appear against a dark sky, thus eliminating one of the trickiest hurdles of comet photography: unevenly lit twilights. C/2015 V2 Johnson doesn't move a huge apparent distance during the month, its track measuring around 7.5°. Assuming a simple linear motion throughout April, this would have it moving 15 arcminutes a day, or around 38 arcseconds per hour. In reality the apparent motion is faster at the end of the month, but not by much. Comet 41P is a different matter altogether, sweeping an arc measuring in excess of 50° during April. Using similar maths, that works out to around 4.2 arcminutes per hour.

The relative motion of a comet caps the length of exposure you can take with a tracking mount. Expose for too long and accurate polar alignment may give you nice sharp stars but the comet will appear blurred. Expose too briefly and you may not capture enough light to show much detail. The relatively slow motion of C/2015 V2 Johnson works in your favour here, allowing you to take longer exposures without too much relative motion blur. If you're attempting to photograph 41P Tuttle-Giacobini-Kresak, however, a different strategy is required: shorter exposures. Setting your camera's sensitivity to a mid-range ISO can work well but will lead to noisier images. Here, stacking on the head of the comet can work wonders, smoothing random noise and allowing you to bring out more detail. The problem is that stacking on the comet will simply reverse the original motion blur issue, giving you a sharp comet but with a trailed stars.

There's a solution but it requires a bit of processing. The basic technique is to separate the star image from the comet. This will ultimately allow the sharp star field to be recombined with the sharp comet. Various programs offer methods to do this. The freeware DeepSkyStacker, for example, has a dedicated comet stack mode. The powerful, commercially available PixInsight package also has routines that can do this by employing a defined processing workflow.

KEY TECHNIQUE

PICK THE RIGHT TRICK

Comets are beautiful objects to photograph but can present something of a challenge because of their apparent motion against the stars. If you have an equatorial mount with an RA drive, tracking the stars typically doesn't help because a comet's motion will normally be at a different rate and in a different direction. Unless you have more sophisticated equipment capable of auto guiding on the head of the comet, tricks need to be employed to get a crisp and detailed shot. There are various ways that this can be achieved, the real skill being deciding which method to use.

Send your image to: hotshots@skyatnightmagazine.com

ALL PICTURES: PETE LAWRENCE

STEP BY STEP

STEP 1

Choose your equipment. A DSLR with a short to mid focal length lens (up to 100mm) may be used on a fixed tripod. Divide 500 by the focal length to give a guide exposure in seconds. A camera and lens combo works well with a tracking mount, as will a camera attached to a scope. Watch the field of view doesn't clip off a long comet tail.

STEP 2

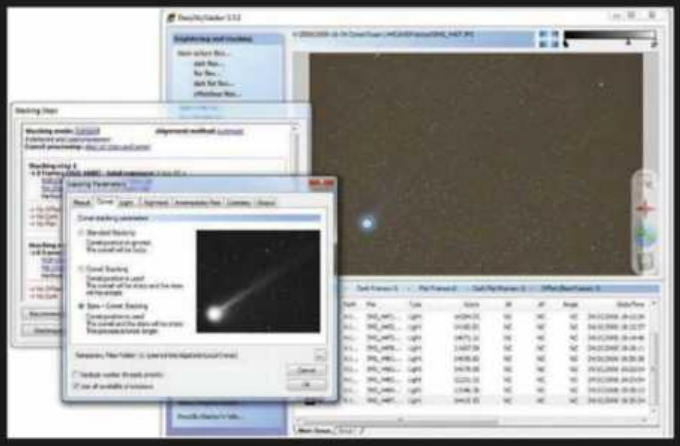
Focus the camera on a bright or mid-bright star or planet and then swing it into position so the comet is in the frame. Set the ISO mid-high and take a 10-second test exposure. Check the comet is really there and examine for a tail. Position the comet so it's in the central portion of the frame, if possible, and all of the tail remains in shot.

STEP 3

If you have reorientated your camera, you'll need to refocus, then set your ISO to a mid setting and take your shot. Your camera's RAW format will give the best results. For slow-moving C/2015 V2 Johnson, try 60- to 120-second exposures; watch for star trailing at the higher end. For fast-moving 41P Tuttle-Giacobini-Kresak, keep exposures to 30-60 seconds.

STEP 4

Experiment to determine the best length of shot. Once you're happy, take a sequence of shots – the more the better. Then cap your scope and take at least 16 dark frames. Flat fields can be taken by stretching a clean, white cloth over the front of your scope, pointing it an evenly lit portion of the sky and exposing to achieve 60-70 per cent saturation.



STEP 5

Use a program such as DeepSkyStacker or PixInsight to calibrate your light frames (the comet images) with the darks and flats. For C/2015 V2 Johnson, align the calibrated images on the stars. Finally, stack (integrate) the calibrated and aligned results to produce your final image. If the comet is blurred, try reducing the number of frames to stack.

STEP 6

For 41P Tuttle-Giacobini-Kresak, stack the calibrated results on the comet's head to produce a sharp comet image, with the stars as trails. For sharp stars as well, you'll need a more advanced processing workflow, described in this month's Bonus Content. Such routines work better with faster comets as it's easier to separate them from background stars digitally.


Forestry Commission
England
Forest
Stargazing
Have a
stargazing
adventure
in the forest
Come along to a Forestry Commission England stargazing event or take the family on a 'Why stars matter' self-led trail.
Find out more and download the free 'Beginner's guide to stargazing' at
forestry.gov.uk/stargazing

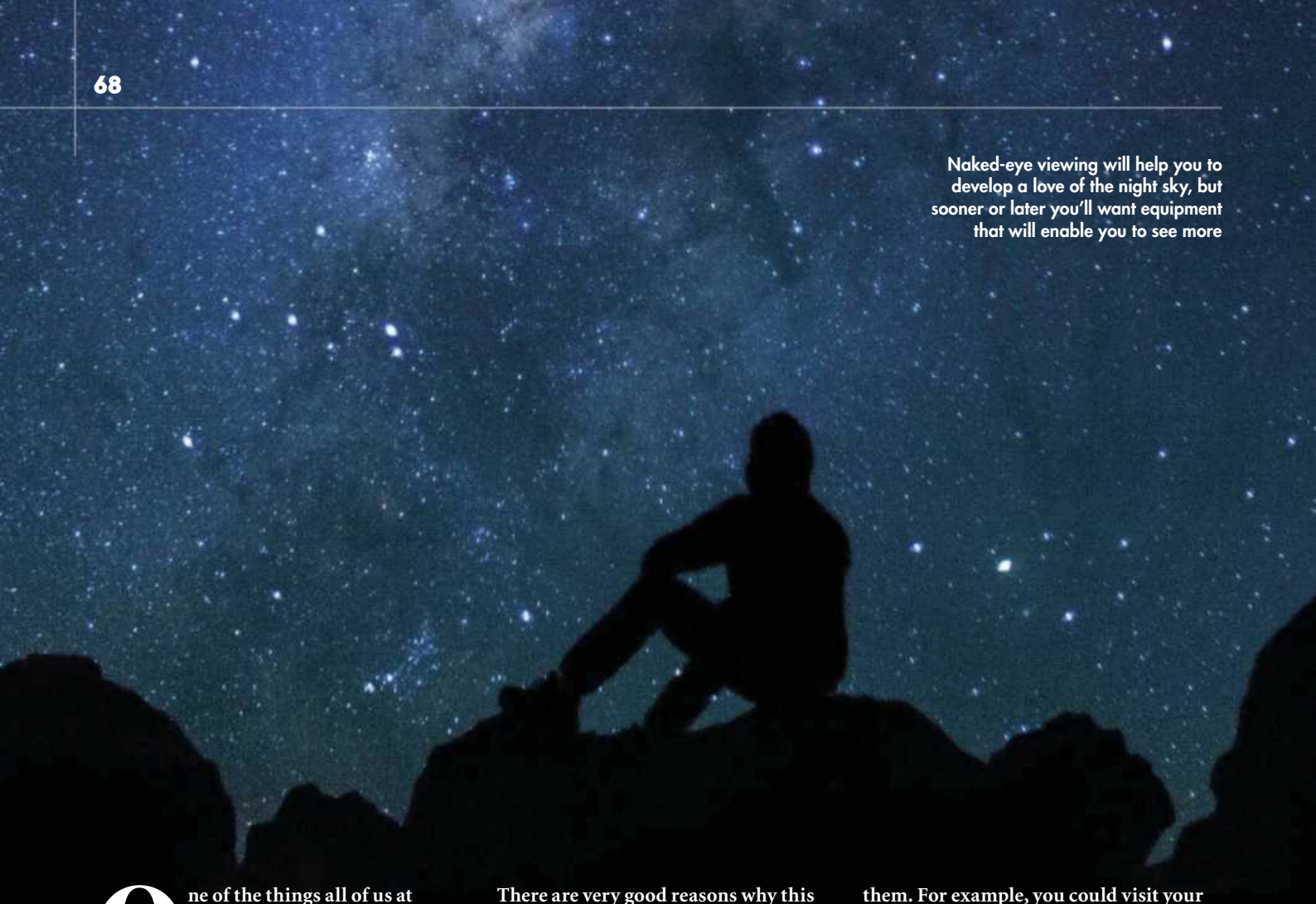
BUYING YOUR FIRST TELESCOPE

Astronomer **Will Gater** offers tips and advice on the exciting moment you decide to take the plunge and invest in a scope

A telescope will give you a better view of the stars, but there's a lot to think about when buying one

ABOUT THE WRITER
Will Gater is an astronomy journalist and presenter. Follow him on Twitter at @willgater.

PAUL WHITFIELD



Naked-eye viewing will help you to develop a love of the night sky, but sooner or later you'll want equipment that will enable you to see more

One of the things all of us at *BBC Sky at Night Magazine* love the most about astronomy is that you don't need any fancy or expensive equipment to get started. A warm coat, clear skies and a sense of intrigue about what's up there are all you need to begin your adventure in this wonderful hobby.

But there comes a time, naturally, when your thoughts turn to delving deeper into the heavens and when that happens most people start to think about getting a telescope. If you're at that point now, the following pages will help to guide you through the process of selecting your first telescope, from the things to look for in an instrument, its mount and the essential, and non-essential, accessories.

What about binoculars?

The best way to begin is not by diving into the world of apertures and eyepieces, but by taking a step back and asking a question. For the purposes of this guide we're going to assume that you're familiar with the naked-eye night sky and can identify many of the bright stars and constellations, but have never used a telescope before. That's important, because the question, which has become something of a cliché in astronomy circles, is: have you considered getting a decent pair of binoculars first?

There are very good reasons why this question is repeated so often that is become a cliché. First, binoculars can open up a great many more objects to observation than the naked eye, from rich Milky Way star fields to star clusters and the brighter galaxies and nebulae. What's more, a good pair of binoculars will often outperform a cheap, poor-quality starter scope. But the other reason – and one of the key arguments for considering binoculars before a telescope – is that they offer an easy way to learn crucial observing skills that will be useful later in your astronomy career. For example, with binoculars the experience of moving from a naked-eye view to one seen through an eyepiece is easier, as is learning the essential skill of 'hopping' from one star to another, in a magnified view, to track down a celestial target.

You may have already been using binoculars for a while, though, or perhaps you simply want to jump straight to a telescope. In which case there are some other questions to answer before you begin choosing an instrument. Questions such as what type of telescope do you want; what you intend to do with it; and, of course, how much you're willing to spend. Don't worry if you can't answer these straightaway as there are ways to gather the information you need to make an informed decision for each of them. For example, you could visit your local astronomical society, star party or astronomy trade show before you set foot in a shop. At a society meeting you may be able to see some small telescopes in use and speak to people who have used specific models. At a star party, however, you might even get to look through the scopes, perhaps even the model you're considering.

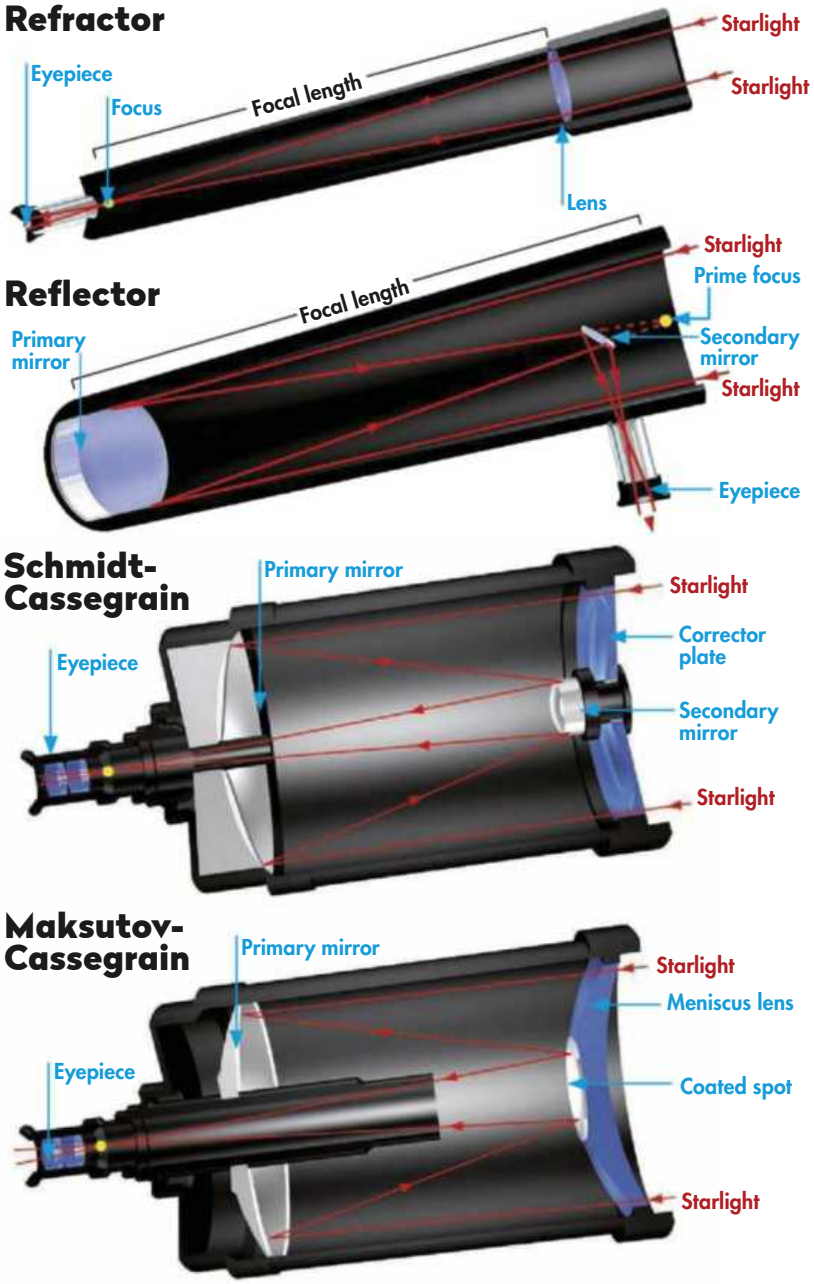
What will become immediately obvious when you go to any of these events is the huge array of telescope designs, sizes and mountings that are available. So it's well worth getting to know the different types of telescopes and how to decipher the specifications you may encounter.

Types of telescopes

Generally speaking, telescopes fall into one of three categories. Firstly, there are reflectors, whose defining feature is an arrangement of mirrors that collect and focus light; then there's refractors, which use glass lenses to do the same things; and finally there are catadioptrics, the telescopes that use a combination of lenses and mirrors to do the job. Within these categories there are numerous permutations and, of course, designs that vary from one manufacturer to another.

Refractors tend to be what most people imagine when they think of a telescope:

ISTOCK X 2, PAUL WHITFIELD, ILLUSTRATIONS BY PAUL WOOTTON



◂ The arrangement of mirrors and lenses is what defines the different types of telescope

a lens, or group of lenses, mounted in a long metal tube with the eyepiece (the bit you look through) at the bottom end. Refractors often come with a 'diagonal', an accessory that reflects the view 90° up off the scope's axis to make your observing easier.

The two most common catadioptric designs are the Maksutov-Cassegrain and the Schmidt-Cassegrain. A Maksutov-Cassegrain scope uses a curved lens and mirrors mounted in a relatively short, stubby tube while a Schmidt-Cassegrain has a large, glass corrector plate holding a small secondary mirror at one end with the primary mirror mounted at the other end.

When it comes to reflector telescopes, many beginners gravitate towards Newtonian models. In telescopes of this design light is collected by a main mirror housed at the bottom of a long tube. Once it hits this primary mirror the light is reflected back to a smaller secondary mirror that bounces it out at a right angle through the eyepiece. For this reason you look through a Newtonian by standing by the top end of the telescope, rather than the bottom end, and peering through an eyepiece that's mounted on the side of the tube.

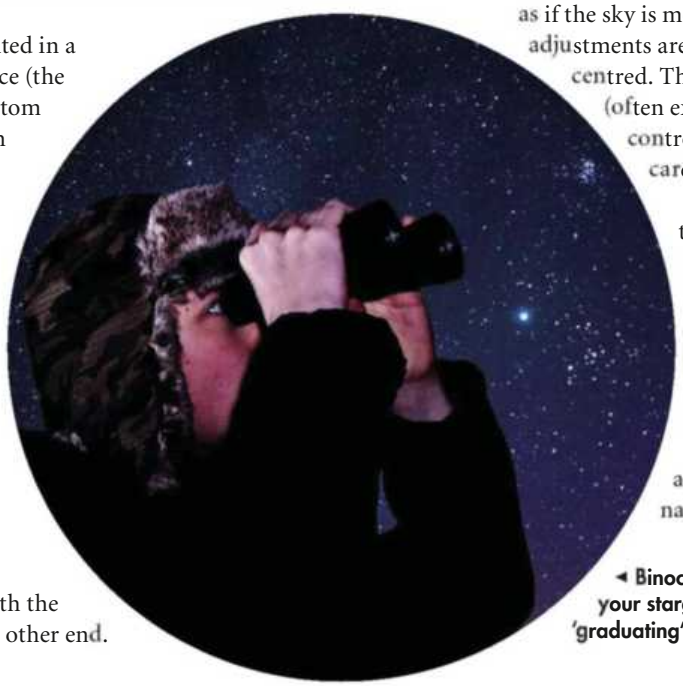
The Newtonian design uses the same optical configuration as the other popular type of reflector, the Dobsonian. The difference with a Dobsonian is that the telescope's tube is mounted on a simple rotating base and not the more complex type of mount that Newtonians are typically found on… Which brings us onto the matter of mounts.

Mount up

If a telescope's lens is its eyes, then the mount is its neck. When you look at something, you use your neck to tilt your head up or down and turn it left or right to point your eyes in the right direction. Telescope mounts do exactly the same – they allow the scope to be moved up and down and turned to the left or right. Astronomers call that upward or downward tilt altitude, and left or right rotation azimuth. So, for instance, Dobsonians sit on a basic altitude-azimuth (more commonly known as altaz) mount, while many Maksutov-Cassegrain and Schmidt-Cassegrain telescopes are attached to one or two computer-controlled arms that are essentially just advanced versions of an altaz mount.

With an altaz mount you need to adjust both the altitude and azimuth settings in order to track an object across the sky and keep it in view. This is because Earth's rotation makes it appear as if the sky is moving, so frequent manual adjustments are required to keep your target centred. That is unless you have an advanced (often expensive) motorised and computer-controlled altaz mount that will take care of the adjustments for you.

But there's another type of mount that gets around this issue in a simple way. The equatorial, or EQ, mount also moves on two axes, but instead of having altitude and azimuth axes, equatorial mounts have a right ascension (RA or polar) axis and a declination axis. These two axes refer to an astronomical coordinate system for navigating the sky that's similar to ▸



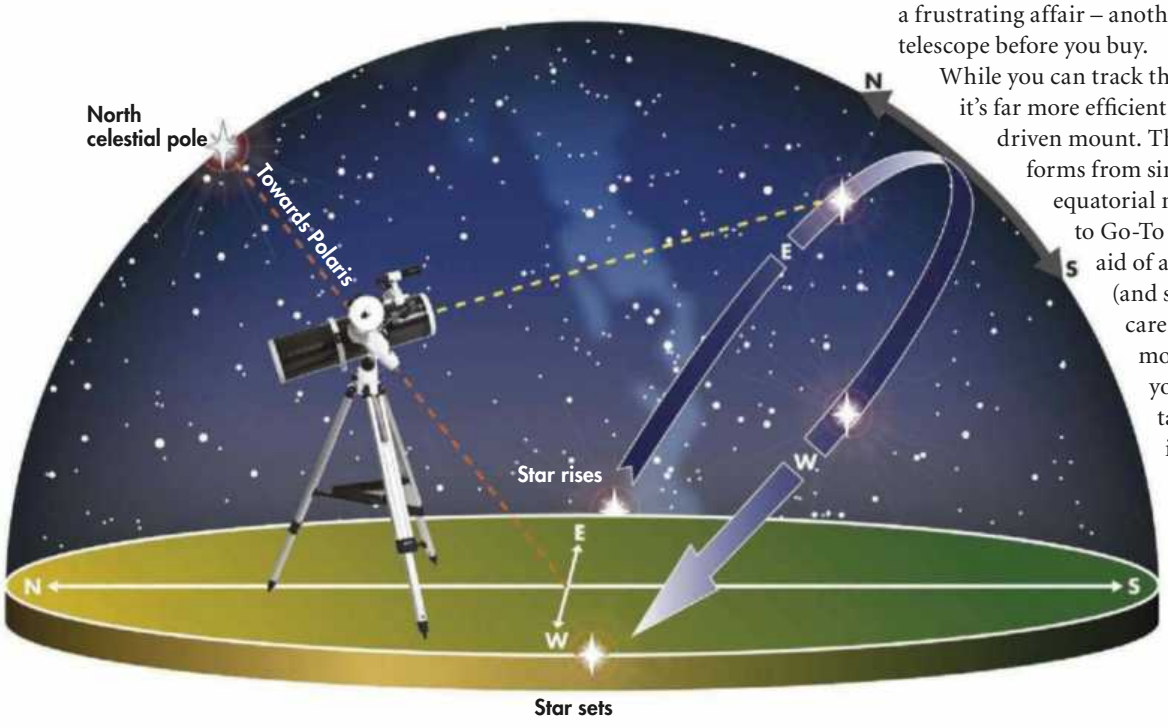
◂ Binoculars can be the best place to take your stargazing to the next level before 'graduating' to a telescope

TYPES OF TELESCOPE – A VISUAL GUIDE

▸ the latitude and longitude system that's used for navigating on Earth. An equatorial mount is built in such a way that when the RA axis is aligned with Earth's rotational axis, changes need only be made to that one axis to match the sky's movement.

To align an equatorial mount to Earth's rotational axis, the mount's RA axis needs to be pointing precisely towards the north celestial pole – the same point in the sky that Earth's rotational axis points towards. In the northern hemisphere this point is very close to the star Polaris. It's for this reason that many mid-range equatorial mounts come with a small 'polarscope' within the RA axis that has a reticule (targeting crosshair) for precise polar alignment.

▾ **Once aligned to the north celestial pole you only need to move one axis of an equatorial mount to keep a target in view**



Manual or automatic?

Whatever type of mount you end up with it has to be rock-solid. If there's any instability in the tripod's legs or play in the mount's fixings and controls then you'll find observing can become a frustrating affair – another reason to try any telescope before you buy.

While you can track the moving sky manually, it's far more efficient to use an electronically driven mount. These come in several forms from simple, motor-driven equatorial mounts, all the way up to Go-To mounts that, with the aid of a small computer handset (and sometimes GPS), take care of all tracking. Go-To mounts allow you to point your telescope towards a target simply by typing in the object's name or New General Catalogue (NGC) number.

Modern Go-To systems are a superb tool for observing but can often add

a lot of money to the price tag of a beginner telescope; money that might be better spent on larger optics sitting on a simpler mount. After all, it's the telescope's aperture – the size of its main mirror or lens – that is perhaps the most important specification. The larger the aperture, the more light can be gathered. Hence most beginners are usually better off going for a good reflector, such as a Newtonian, since refractor scopes tend to be more expensive than reflectors of the same aperture.

Eyepieces and finderscopes

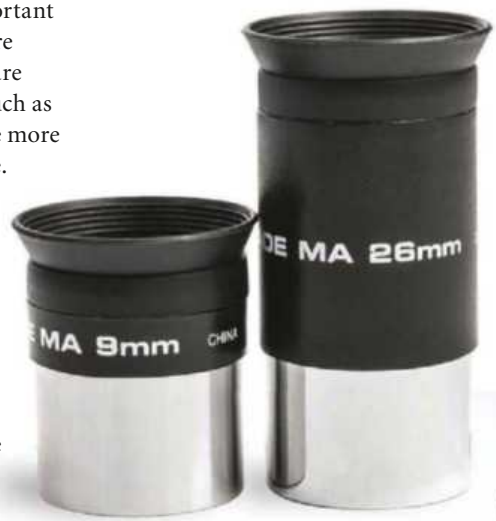
After the telescope's main body and the mount, the other key component of any stargazing setup is the eyepiece. The eyepiece is the glass lens that you look through to see whichever celestial body you're observing.

On the side of the eyepiece you'll find a measurement given in millimetres. This is the focal length of the eyepiece and it's by using eyepieces with different focal lengths that you change the magnification of the view through the telescope. The longer the focal length of the eyepiece, the less magnified the view through it will be. It's a good idea to have one or two good-quality eyepieces – one with a short focal length, perhaps around 10mm, and another maybe in the region of 25-30mm – rather than a whole range of cheap ones. And you can completely ignore any marketing hype boasting that a scope can provide hundreds of times magnification – this isn't the measure of a good instrument or a guarantee of superior views. A poor-quality scope can still magnify many hundreds of times.

Finally, on top of the telescope you'll often find a miniature, low-magnification refractor telescope. This is a finderscope and it's used for centring a celestial object in the main scope's eyepiece. Finderscopes – or their cousins the illuminated red dot/reticule finders – are extremely useful when it comes to tracking down celestial targets.

Needless to say, there's certainly a lot to consider when you buy a telescope. But, then again, a good first telescope will last you many years and be a joy to observe with throughout that time. Choose wisely and your scope will take you on a thrilling journey of discovery that no other pastime can offer.

▼ Buying a couple of good quality eyepieces is often better purchasing a wider range of cheaper ones



Finderscopes help you accurately train your telescope on a target

WHICH SCOPE IS BEST FOR YOU?

Answering these questions should help you choose the right first telescope for your needs

What do you want to look at?
Sounds obvious right? The night sky! If you're keen to focus primarily on observing faint galaxies, clusters and nebulae, then it makes sense to go for something like a Dobsonian with as big a mirror as you can afford. A smaller aperture Newtonian on a fancier mount will be more suited to closer, brighter objects.

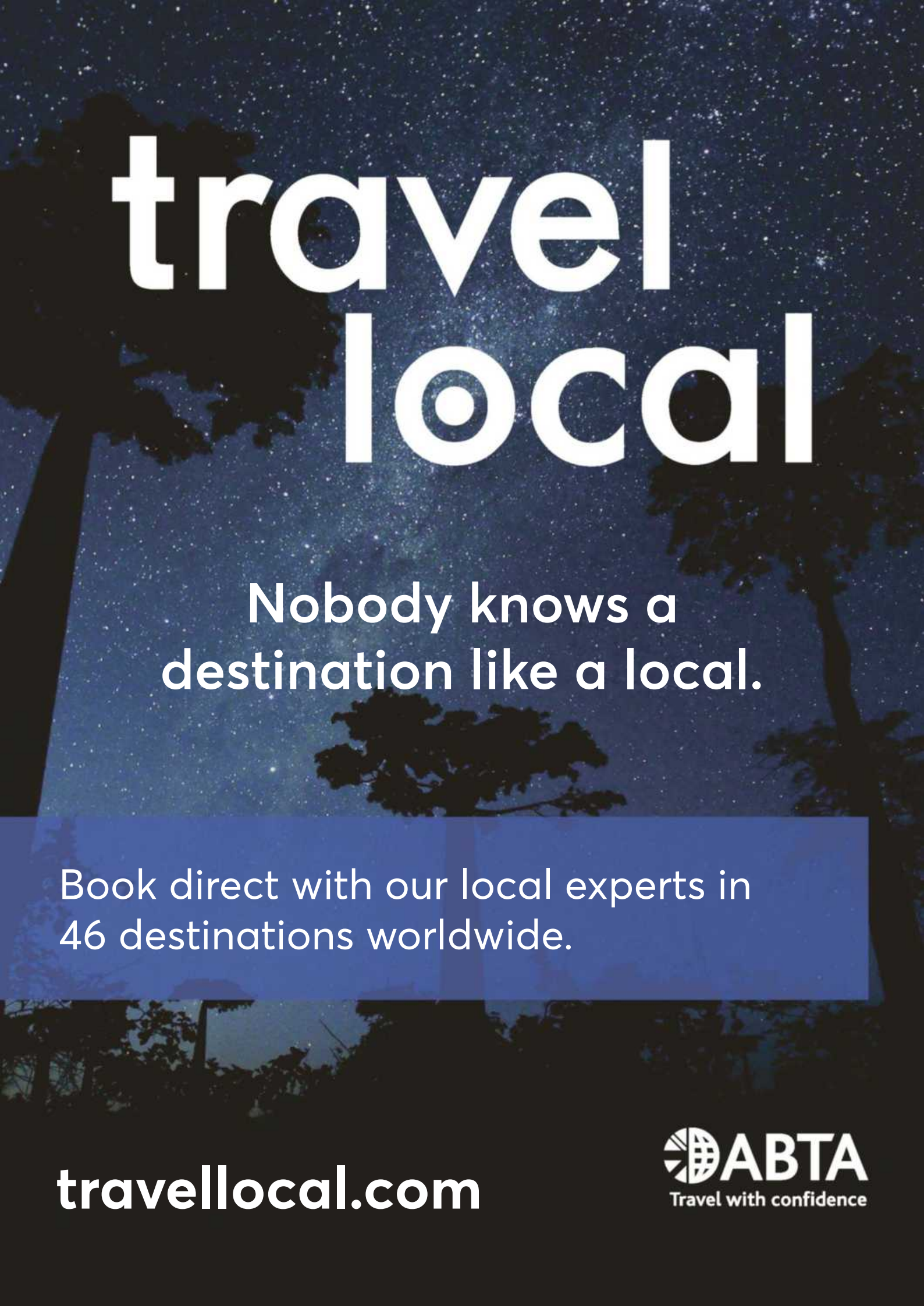
Trade shows give you a chance to check out potential telescope purchases

Which scope has the right size, weight, portability for you?
A good large-aperture Dobsonian will provide superb views but it may hardly ever be used if you've got to lug it downstairs to observe with. Trade shows are useful for examining many different scopes in detail to gauge their true size, portability and, to some extent, their build quality.

Is the scope right for your future aims?
It's worth considering early on where you think your interests may develop in the future. If you think you might eventually want to do more imaging, for example, you may want to choose a scope with a mount that you can easily upgrade to a more advanced model at a later stage.

Do you need 'feature X' when you could get a better 'feature Y'?
The allure of electronic gadgetry or a computerised mount can be strong when buying your first scope, but do you really need all that extra tech? You may find that your budget would go much further on a simpler setup with larger optics that'll probably give you better views.

PAUL WHITFIELD X 4, WWW.SECRETSTUDIO.NET, CHRIS BRAMLEY, ILLUSTRATION BY STEVE MARSH


travel
local
Nobody knows a
destination like a local.
Book direct with our local experts in
46 destinations worldwide.
travellocal.com
ABTA
Travel with confidence

The right LIGHT at night

There's been a revolution in the way our streets are lit in recent years as councils across the country switch to LEDs. Here, **Bob Mizon** looks at whether new LED lighting ticks all the boxes

ABOUT THE WRITER
Bob Mizon MBE is the coordinator of the British Astronomical Association's Commission for Dark Skies

Last September, a three-day conference took place in Cluj, Romania's second city and the chief town of Transylvania. That region's best known fictional inhabitant would not have been out of place at the conference since its theme was the preservation of the night. The fourth International Conference on Artificial Light at Night (www.artificiallightatnight.org) drew delegates from all over the world. Speakers covered topics such as lighting and the night sky, health, wildlife, the design and spectra of modern lights and many others. The recurring theme in many presentations was LED lighting. ▸

Turning night into day: bright LEDs provide great illumination but need to be carefully deployed to avoid flooding areas with too much light

ISTOCK

▸ American astronomer and broadcaster Bob King has written of a "tsunami of LED lighting currently sweeping the world". Highways authorities and local administrations all over the globe are buying and installing LEDs at a prodigious rate because they tick many boxes. LED lamps for street lighting are cheaper to manufacture and run than sodium ones. They're energy-efficient and long-lived – some of the new units used in road lighting will last 100,000 hours. They come on immediately instead of at first glowing feebly. LEDs don't waste as much of their energy as heat and they are easier to dispose of.

For these reasons bright white LED lighting is appearing in many places, but its blue-rich spectral component is not good news for the surrounding environment. Over-bright or poorly aimed luminaires cause light pollution, blotting out the stars just as much as the sodium bulbs that preceded them. And there are other negative side effects.

New LED road lights are normally well directed downwards, but if they're too bright a proportion of their emissions is scattered outwards and upwards off surfaces, atmospheric particles and aerosols. Without side shielding the light from LED arrays is spread more broadly than older types of flat-glass, cut-off lights, since they have multiple point sources. A solution to this is to use 'egg crates': shallow, multi-box grilles common in office lighting that prevent the excessive sideways spread, which can dazzle drivers and cause light intrusion into nearby premises. It's domestic and commercial LED floodlighting that's most often too bright for the task and installed without directional control. This causes glare, intrusion of light indoors and disruption of local wildlife habitats.

The need for darkness

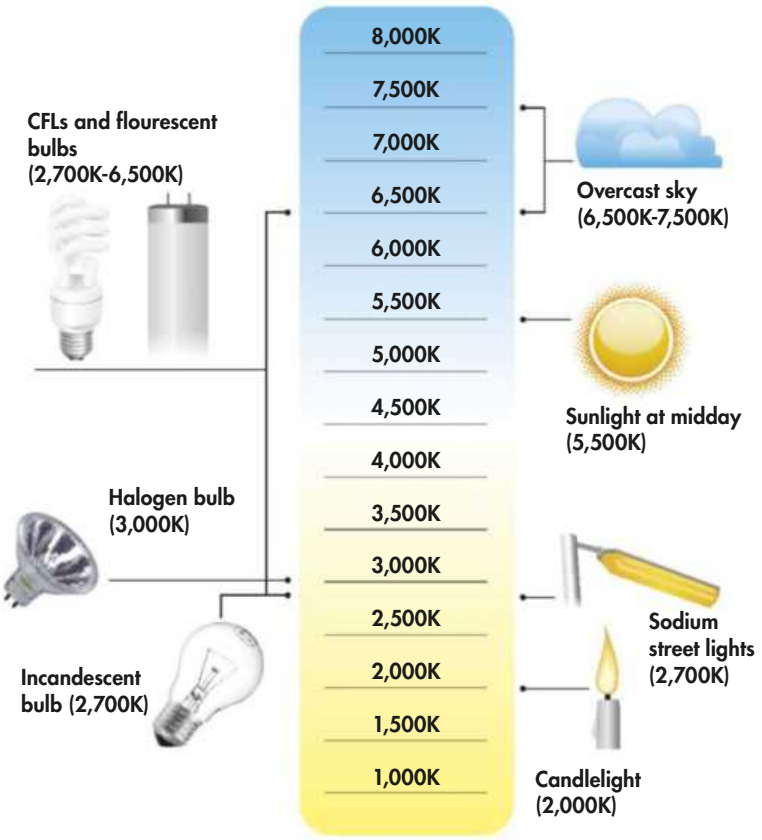
Another aspect of LED lighting discussed at the conference was the colour of the light. Also known as correlated colour temperature (CCT), this is measured in Kelvin (K) and ranges from low temperature, warm orange light (around 3,000K) to higher temperature, blue white light (over 5,500K).

There's evidence that the blue component of LEDs with a CCT over 3,000K is harmful to living things, including humans (http://darksky.org/lighting/led-practical-guide) and in 2009 the American Medical Association voted to support efforts to control

ISTOCK X 3, ILLUSTRATIONS BY PAUL WOOTTON

▸ 'Egg crate' grilles focus an LED array's light to stop it bleeding too far sideways

Particles in the air along with natural and man-made surfaces reflect LED light up into the sky

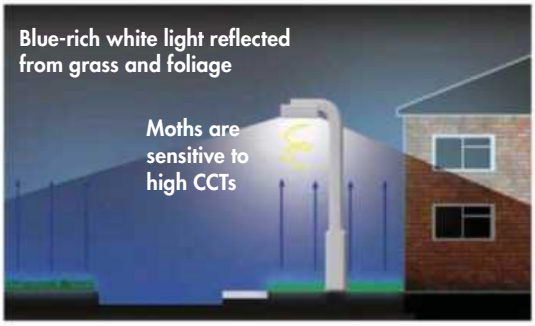


▲ The correlated colour temperature (CCT) scale defines the colour appearance of different light sources in terms of colour temperature, measured in Kelvin (K)

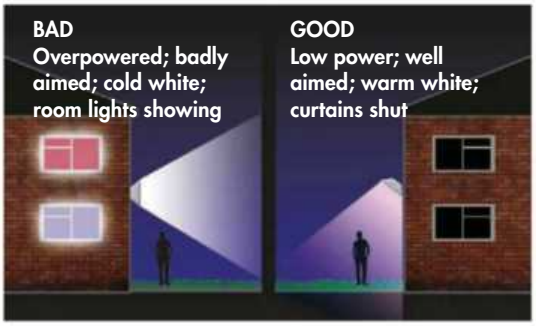
light pollution, on the grounds that glare from bad lighting is a public health hazard.

All species have a requirement for darkness. Nearly every organism on Earth has the day-night cycle caused by our planet's rotation hard-wired into it, including humans. As a species, we have spent the majority of our evolutionary history with night-time light levels hundreds of times lower than the lighting we have now. Because of this a precautionary principle should apply and LED lighting chosen not just to save money in the long term, but also to cause least harm to the environment when all negative effects have been identified. Continued research and evaluation of LED lighting are therefore critical.

A recent survey of UK amateur astronomers conducted by the Commission for Dark Skies suggests that, on the whole, LED street lighting causes less light pollution of the night sky. However, all astronomers concerned with the loss of darkness should ensure that local lighting authorities are ▸

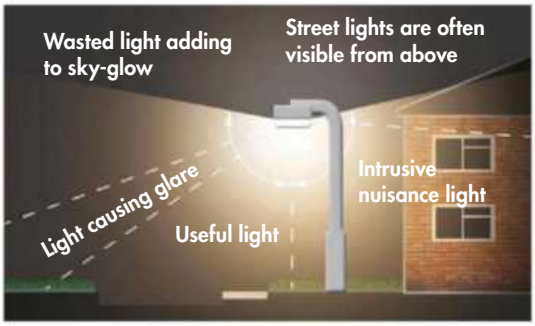


▲ High correlated colour temperature LEDs are bright enough to scatter off natural surfaces



▲ A few, simple considerations regarding indoor and outdoor lighting can cut down on light pollution

▲ With a bulb or LED shrouded by a cut-off structure the field of light can be confined to a suitable area



▲ Without a cut-off structure, a bulb or LED floods light over a far wider and potentially problematic area

ENLIGHTENED LIGHTING

Following guidelines in a few key areas can give efficient LED lighting that saves energy, respects the environment and preserves the night skies.

LIGHTING UNITS: Full cut-off units that spill no light upwards, fitted with shields to stop the light spreading further than 70° from the vertical.

COLOUR: Warm white or orange colour lights with a CCT of less than 3,000K.

CONTROL: Dimmer switches or remote control allows lights to be dimmed or turned off completely if local conditions and policies allow.

BRIGHTNESS: The minimum power of light (or luminous intensity) necessary to meet regulations, taking care not to over-specify.

DESIGN: Lighting professionals will know how to meet a brief to minimise sky-glow both locally and over a wider area.

WILDLIFE: Consider introducing dark corridors, especially near water, to give nature a chance.

▸ aware of problems caused by over-bright and blue-rich LEDs, and advise neighbours that there are good and bad LEDs for domestic use.

A realistic approach

UK astronomers should be proud that this country has more dark-sky protected areas than any other in the world, outside the US. Wales has a greater percentage of its land beneath protected stars than any other nation: 18 per cent, in fact. Darkness for night-sky observing is guaranteed in the Snowdonia and Brecon Beacons National Parks and the Elan Valley Estate. This is the result of great efforts by each area's environmental teams to ensure good lighting policies within their boundaries and to raise awareness among locals of the value of starry skies.

There are astronomers who call for total black-outs, but what's needed is a realistic approach: not total darkness all-night everywhere, but the right amount of light, only when and where it's needed. People, including astronomers, need light at night for obvious reasons. But better lighting gives us something like the dark skies that people enjoyed long ago. Lighting, a comfortable night-time environment and dark skies are three things that need not be mutually exclusive. S

The Milky Way visible over the Brecon Beacons National Park, one of the UK's many dark-sky areas

EARTH HOUR

On 25 March at 8.30pm, join 172 countries across the globe to turn off your lights for an hour or more to highlight the message of dark-sky preservation and environmental conservation.

EXPERT INTERVIEW

Peter Harrison, technical services manager at the Institute of Lighting Professionals, spoke to Chris Bramley about LED lighting

The main role of LED light sources is energy efficiency. They've been used extensively now in residential and commercial properties as a replacement for incandescent tungsten halogen lighting. Their ability to turn electrical energy into light energy is very good and they last an awfully long time. They're relatively low maintenance, very focused and have become really affordable. So there are lots of benefits to the public.

As far as I'm aware, the health drawbacks raised in the UK about the correlated colour temperature of LEDs being in the blue end of the visible spectrum and affecting people's circadian rhythm, have not been proven yet. I understand this is being researched by the CIE (International Commission on Illumination) presently and that Public Health England also has it on their radar to have a look at. The jury is still out on the extent to which that is a problem and how much it may affect the general public.

LEDs can be very bright light sources though. A single LED almost qualifies as a point light source, which is absolutely intense: all the light is produced at a very narrow angle and there are a number of them pointed in the same direction in a typical unit. This brightness can be controlled by good design. But with funding for local and public bodies diminishing there is a whole layer of competency, particularly in lighting, that is missing in many authorities.

The switch to LED lighting is a massive shift. I've been involved in lighting for nearly 30 years and I've never known a shift in technology as quick as the take-up of LEDs. It is an entirely different way of looking at artificial light and how you control it. If you're going to retrofit high-intensity discharge lighting – things like sodium and mercury streetlights – it's not just a case of a 10 Watt LED being equivalent to a 35 Watt low-pressure sodium bulb; distribution, effects on the ground and glare need to be looked at too, in more of a holistic approach.

ISTOCK

SKILLS

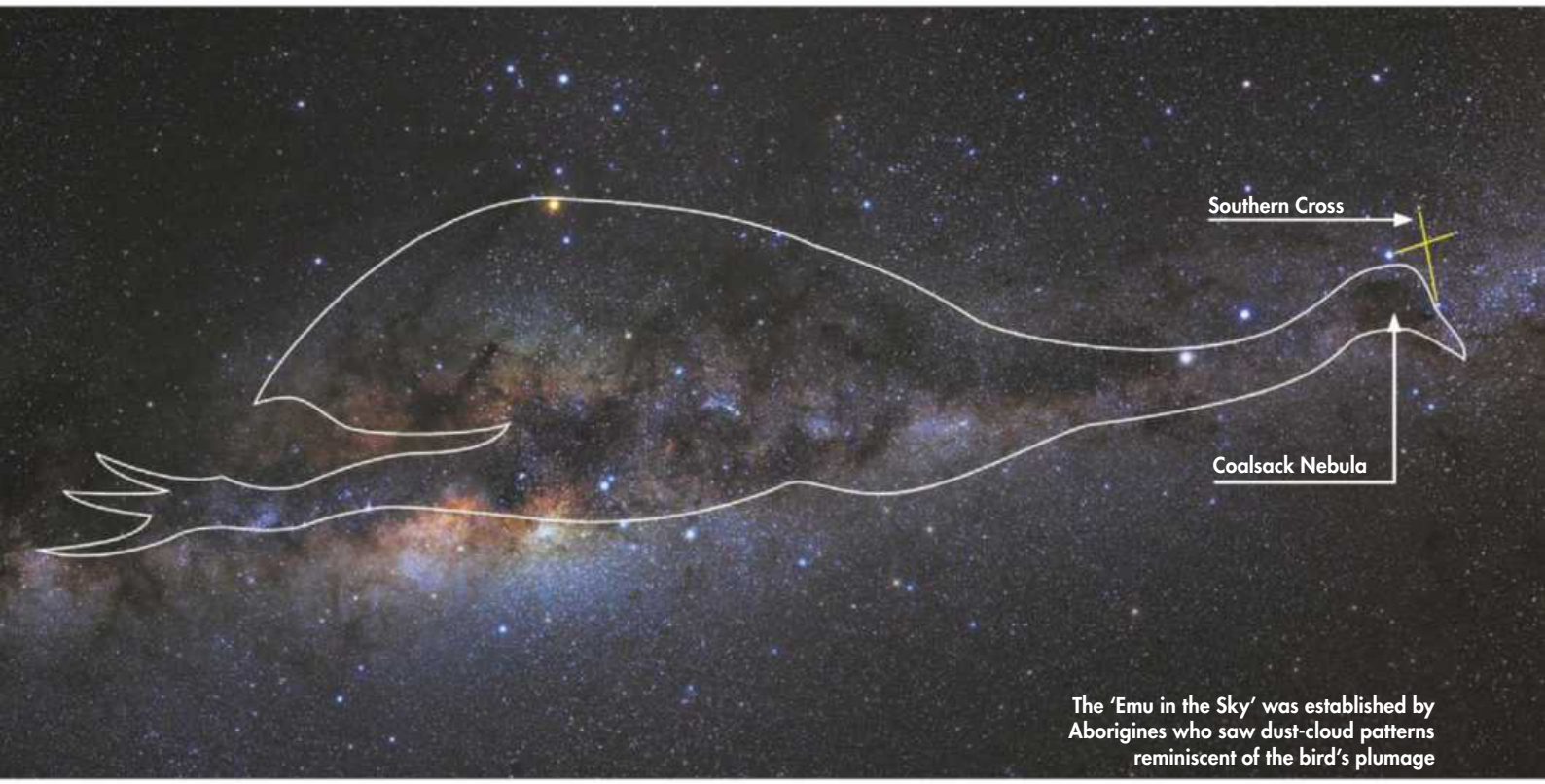
Brush up on your astronomy prowess with our team of experts

The Guide

With
Ray Norris

The astronomy of the Aborigines

How Australia's indigenous people view and use the night sky



The 'Emu in the Sky' was established by Aborigines who saw dust-cloud patterns reminiscent of the bird's plumage

ISTOCK X 3, TEAM CEDIC/HERBERT WALTER/CCDGUIDE.COM, PENNY TWEEDIE/ALAMY STOCK PHOTO

Aboriginal Australians may be the world's first astronomers, as stargazing plays a crucial part in the ancient cultures of the 300 or so Aboriginal communities.

Some Aboriginal elders can name almost every one of the 3,000 stars that are visible to the naked eye. They can point out the ecliptic along which the planets travel. They carry an intuitive map of the sky in their heads, so that a quick glance at the night sky tells them the time and the direction in which they're travelling. Of course, this knowledge doesn't come easily. An elder spends a large chunk of their life memorising information that's been passed on from generation to generation.

A sky full of stories

With every star comes a story and, as in Europe, the stars are often grouped into constellations. Some are similar to ours: Scorpius is seen as a scorpion in some parts of Australia and a crocodile in others. Some are different, such as the 'Emu in the Sky' constellation, which is actually made of the dark space between stars caused by clouds of interstellar dust in the Milky Way. The head of the emu is the Coalsack Nebula, next to the Southern Cross, and its body is marked by black clouds along the Milky Way, up through Scorpius and down the other side of the sky. Today's emus are flightless, but they used to fly back in the Dreaming, the mystical time when Aboriginal cultures believe creator spirits roamed Earth, which is why the emu in the constellation is soaring across the sky.

Curiously, the Pleiades, or Seven Sisters from Greek mythology, are also called 'Seven Sisters' in many Aboriginal languages, which is odd because, depending on your eyesight, you may see five, six or many stars in the Pleiades, but

▲ To some Aborigines, the constellation of Scorpius was perceived to be a crocodile

nobody sees seven. It's a mystery why they're called the Seven Sisters and a double mystery why they're called that in both the Greek and Aboriginal traditions.

Most Aboriginal cultures see Orion as a hunter, a young man or a group of young men chasing the Seven Sisters, just as in the Greek story. So why is the Aboriginal story so similar to that of the Greeks given that there was almost no contact, even indirectly, between the two cultures? Perhaps it pre-dates both cultures, going back to campfire tales told in Africa around 100,000 BC, before the ancestors of all modern humans spread over the globe.

Practical applications

Aboriginal people used astronomy to navigate and define their calendars. For example, the calendar of the Yolngu people in northern Australia has six seasons. The start of winter is marked by the first appearance at dawn (the heliacal rising) of the Pleiades, while the heliacal rising of Arcturus marks the time when lotus and water chestnut roots should be harvested.

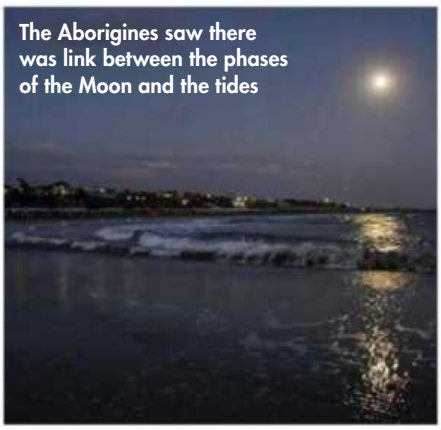
Songs and stories also show that Aboriginal thinkers tried to figure out how the sky works. There are many stories that tell how the Sun-woman travels from east to west across the sky each day and then returns to her camp at night. How does she get back? Some say it's under the water, some say through a tunnel, some say she takes a path beyond the northern horizon.

The appearance of bodies such as the Pleiades cluster served as calendar indicators for the Aborigines

Enigmatically, one group says she goes underneath Earth, implying they know that it's a body in space.

I call these stories 'ethno-science' as they're similar to science in that they're attempts to understand the world, but couched in terms of a particular culture. There are many examples of ethno-science, one of which tries to explain what causes a solar eclipse. Some groups say it's caused by the Moon-man and the Sun-woman making love – his body covers hers, so you can't see the Sun. It's remarkably close to the modern scientific explanation of the Sun being obscured by the Moon.

What about tides? One Aboriginal explanation is that, as the Moon rises through the ocean on the east coast of Australia, it alternately fills and empties with water. That's why the highest tides occur at full Moon and new Moon, and smaller tides are seen at the quarter Moon, when the Moon only half fills with water.



The Aborigines saw there was link between the phases of the Moon and the tides

The model might seem a little odd, but it works. Given the limited information available to its originators, it's a perfectly good scientific hypothesis.

The evidence for Aboriginal astronomy goes beyond word of mouth. We see it in ancient rock art as well, and some stone arrangements seem to be laid out astronomically to a precision of a few degrees. The Wurdi Youang stone arrangement, built by the Wathaurung people in Victoria hundreds or thousands of years ago, has been carefully built to point towards the setting Sun at midwinter, midsummer and the equinoxes. My guess is that Wurdi Youang is just the tip of the iceberg and much more remains to be discovered that will open our eyes to the depth and complexity of Aboriginal culture. S

Prof Ray Norris is an astronomer with CSIRO Astronomy & Space Science and Western Sydney University

▲ Aboriginal star lore forms part of traditional culture passed down from generation to generation

With
Will Davis

How to...

Make a simple binocular mirror mount

Keep your binoculars steady with a mount that faces down to look up

Comfortable, steady, hands-free viewing provided by a home-made mirror mount

When you're contemplating what equipment to buy for observing the night sky, the first thing that probably comes to mind is a telescope. While telescopes are capable of showing you astronomical objects in great detail, for considerably less expense, binoculars can provide you with views of the heavens that are just as breathtaking. In fact, many astronomical vistas appear more impressive when seen through the wide, low power view that binoculars offer. Additionally, being able to use both of your eyes gives you a significantly more immersive experience when you're taking in the celestial view.

That said, one of the well known negatives of binoculars is the challenge of holding them steady. Mounting them on a tripod is an option, but this can make viewing targets at higher altitudes uncomfortable. One solution to both of these problems is the binocular mirror mount. Simply put, a binocular mirror mount is a device that securely holds your binoculars in a comfortable downward-facing position pointing towards a mirror that presents a reflected view of the sky.

Commercially produced binocular mirror mounts can be purchased, of course, but since the devices are relatively simple – mechanically speaking – they can be quite easily constructed using basic materials and a few tools. This article will show you how.

Mirror matters

The mount in this article is made from two sizes of aluminium angle section, plywood sheet, some standard fixing hardware and a front reflecting, or first surface, mirror. Regular mirrors have their reflective coating on the rear of the glass. They produce a slight double image, which although is imperceptible in general use, would compromise a magnified view. First-surface mirrors can be sourced from many specialist suppliers and usually made to your requested size. The mirror must be sufficiently optically flat to ensure that the paths of light reaching the objective lenses of your binoculars remain parallel. It's therefore important to make the supplier aware of its intended use when ordering your mirror.

The mount can either be rested on a flat surface or attached to a telescope tripod with a flat top and central mounting hole. Both options are possible as the mount uses a long coach bolt that acts as a supporting leg on a flat surface or a bolt to attach the mount to a tripod. Using a tripod is often a more convenient option than trying to find a suitable flat ▸

ALL PICTURES: WILL DAVIS

TOOLS AND MATERIALS

TOOLS
Hacksaw, vice, engineering square, pencil, drill (with 4, 6 and 8mm bits), small adjustable spanner, screwdrivers, fine metal file, sandpaper.

MATERIALS
One 1,425mm length of 25x25mm aluminium angle and one 380mm length of 25x40mm, both 3mm gauge. A 145x220mm first surface mirror, a piece of 12mm-thick 225x150mm marine plywood, a CD.

SUNDRIES
One M8x180mm coach bolt with nut, a wing nut and two 25mm penny washers, two M6x30mm nuts and bolts with four washers, 16 M4x15mm machine screws (four need to be countersunk), M4 nuts and washers, silicone sealant.

Finding a suitable viewing site is easier with the mount fitted to a tripod

▸ surface outdoors that's at a comfortable viewing height. To work with this mount your binoculars must have a threaded, central mounting point for which you'll need the correct hand screw. This mount was designed around a 12x60 pair of binoculars, but it is also compatible with the more commonly used 7x50 or 10x50 variants.

Using the mount

When attached to the mount, your binoculars are secured at an approximately 45° downward angle. You adjust the view up and down by simply tilting the mirror. The open frame design allows you to position the mirror by holding its plywood mounting cell, meaning that there's no need to touch the reflective surface of the mirror. The azimuth is altered by rotating the entire assembly, either on your chosen surface or around the axis of the central tripod mounting bolt. Because the underside face of the mount's supporting angle section sits on the flat top of your tripod, a CD is inserted in-between to act as a washer – reducing friction and minimising wear on the tripod's top face. By simply tightening their respective fixings, the friction for the mirror pivot and tripod mount can be easily adjusted for the ideal balance between ease of movement and rigidity while viewing.

In use, the reflected view initially makes locating celestial objects slightly more challenging than if you were holding your binoculars. But once you've mastered the technique of using this mount, you may well find yourself gazing downward into space instead of upwards for many hours!

Will Davis is a technical service manager in the sound industry and a keen practical amateur astronomer

ALL PICTURES: WILL DAVIS

STEP BY STEP

STEP 1

Cut the 25x25mm angle into two pieces of 350mm, two of 280mm, two of 25mm and one of 90mm. Cut the 25x40mm angle to 380mm. Drill and bolt the 350mm and 280mm pieces together using the M4 fixings to form the main rectangular frame.

STEP 2

Drill two 6mm holes through the corner of the 25x40mm angle at 45° and 12mm in from each end. Then, file flats on the outside corners around the holes. Also, drill an 8mm hole in the centre of the widest face for the coach bolt.

STEP 3

At one end of the main frame, drill two 4mm holes as shown. Then, drill an 8mm hole in the 90mm piece for your binoculars' mounting screw. Using the 4mm holes in the main frame as a guide, mark, drill and fit the 90mm piece using 4mm nuts and bolts.

STEP 4

Drill three 4mm holes in the two 25mm pieces and bolt them to the plywood using the M4 countersunk screws. Then, drill M4 holes in the sides of the main frame and mount the plywood on its brackets using 4mm nuts and bolts.

STEP 5

Invert the whole assembly, then, using the 25x40mm angle as a guide, mark and drill through the main frame and attach it using the M6 nuts and bolts. The mirror can now be attached to the plywood using silicone sealant and left to cure.

STEP 6

For tabletop use, attach the coach bolt head downwards through the 8mm hole in the 25x40mm angle using the M8 nut, wing nut and penny washers. The bolt serves as a supporting rear leg and can be used to secure the mount to a tripod.

ALTAIR ASTRO™

info@altairastro.com
+44(0)1263 731 505
www.altairastro.com

Norwich Showroom
Open 10am - 4pm
Mon-Friday

GP-CAM & HYPERCAM SCIENTIFIC CAMERAS

Solar, planetary, lunar, deepsky. Guide port, latest sensors!

Image gallery:
cameras.altairastro.com

Altair 8" Steel Pier

Easy adjustment in rotation and tilt AFTER installation. Zinc flame-sprayed steel. Powder-coated marine spec corrosion resistance. iOptron, Meade, Skywatcher, EQ8/6/5 Celestron, Paramount MX.

UK MADE

iOptron Sole Distributor

SkyTracker PRO

Ultra-portable DSLR imaging anywhere!

NEW AZ PRO

Featuring "level-and-go" intuitive GOTO setup.

STARWAVE 80 ED-R

NEW FPL-53 Optics

Kitakaru Ortho Eyepieces

NEW Carbon Positive LOCK Star-Diagonals

iEQ PRO Series EQ Mounts

Solid, stable, and whisper quiet.

iEQ30 PRO

6.4kg head weight.

iEQ45 PRO

11.4kg head weight.

100mm Giant Astro-Binoculars

The ultimate stereo viewing experience - with astro-eyepieces!

STARWAVE MINI-AZ

Ultra-portable Mini-AZ Mount and Starwave 70ED COMBO!

CEM25

Portable imaging quick setup.

CEM60

12.3kg head weight, super accurate GOTO & tracking.

GOTO, GPS, Guiding, Polar Align Assist. And a **head-weight only 4.7kg !**

IanKing imaging

01580 212356
info@iankingimaging.com

LOSMANDY® ASTRONOMICAL PRODUCTS EQUATORIAL MOUNTS

The return of a classic mount! The Losmandy G11 has provided astrophotographers with a stable, accurate and well engineered platform for several decades.

It is now even better with the introduction of the fantastic new Gemini 2 controller that offers incredible functionality and accuracy as well as the capacity to operate the mount remotely.

The Losmandy G11 and Gemini 2 combination offers a high quaity and superbly engineered mount for modern day astronomy and astroimaging.

Image PROCESSING

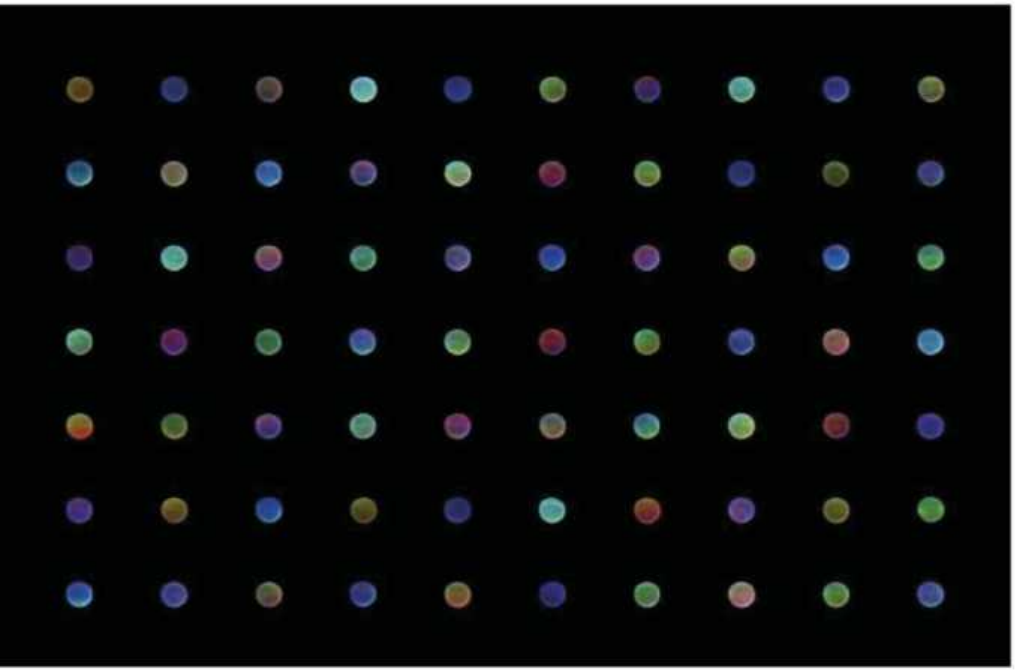
With **Steve Brown**

INSIGHT ASTRONOMY PHOTOGRAPHER OF THE YEAR

Top advice from 2016's Stars and Nebulae category winner

The many colours of the rainbow star

How to combine the kaleidoscopic flashes of Sirius into a single masterpiece



▲ **Sirius's twinkling seems to take it through every colour of the rainbow and beyond, especially when it is close to the horizon, and the final image lays that bare for us to see**

The bright star Sirius often displays a stunning array of colours as it twinkles, especially when close to the horizon. Indeed, it is nicknamed the 'Rainbow Star' for this reason. While visually stunning, these colours can be quite hard to capture photographically. To do this we must bend the traditional rules of astrophotography a little. To start with we need a method of not only showing the colour of each twinkle, but also of capturing the rapid range of colours on display. In other words, we need to take a video.

To capture a large enough image of the star you should use a lens with a focal length of at least 200mm. A DSLR with video capability and a zoom lens is an ideal method here. Alternatively, you could use a telescope and webcam. You should also use a tracking mount to keep the star in the frame of the camera.

Deliberate defocusing

Now comes the part where we bend the rules. The trick to capturing the colours of Sirius is to deliberately defocus the image. By doing this, the light is spread out over a wider area and the resulting colours become more obvious. The resolution of the video should be as high as your camera will allow and the frame rate should be at least 24 frames per second. Use a remote shutter release to allow you to start and stop the video without touching the camera and therefore introducing a wobble to the video. Capture a range of one-minute videos at different levels of focus, you're after one that shows a large enough disc and which also displays bright colours.

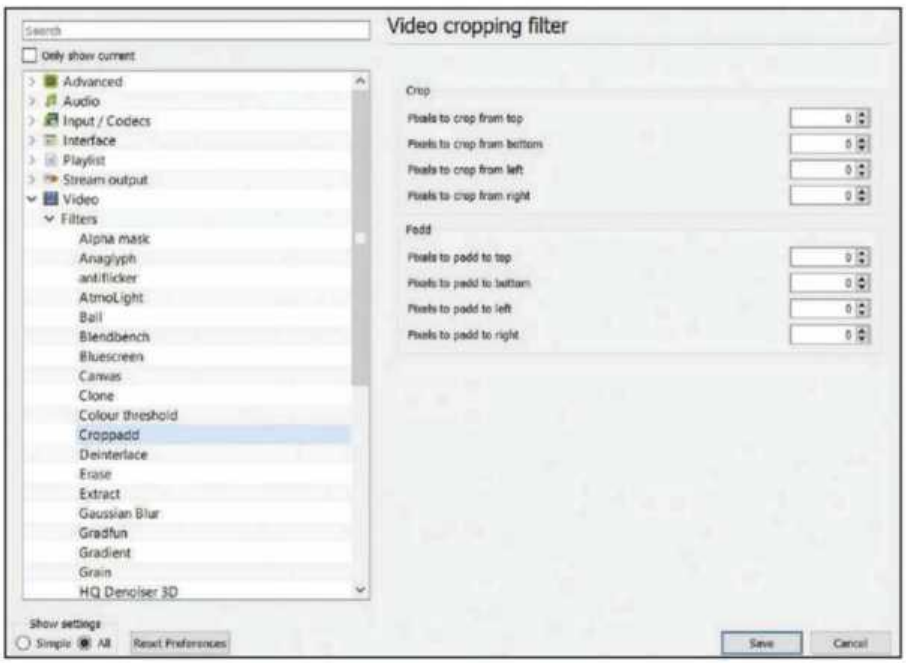
Dealing with disc size

As the size of the star's disc in the video will be quite small, so you'll need to crop the video before extracting the frames. You can do this using the free VLC media player software (**www.videolan.org/vlc**). In VLC select **Tools > Preferences** and then tick **All** under **Show settings**. From the list on the left of the window, click the down arrow to reveal the **Video** list. Expand the **Filters** list under this and select **Croppadd**. Enter values on the right of the window to crop the video tightly on Sirius.

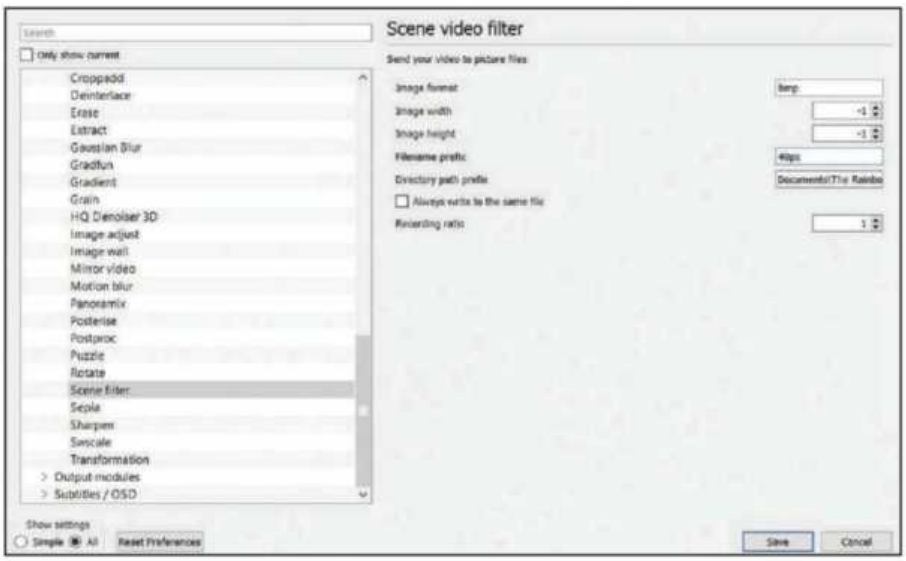
Leave space around Sirius of between 20 and 50 pixels. Next, click on the **Filters** heading on the right (above the list you previously expanded). Tick the **Video cropping filter** box from the list on the right and then click save. Next, click **Media > Convert/Save**. Add your video and select **Convert** from the **Convert/Save** drop-down menu at the bottom. Choose a destination and file name for the cropped video using the **Browse** option. Then click on the **'Edit'**

▲ **These frames of Sirius were taken from separate videos captured at different degrees of defocusing. What you are looking for is one where the disc is large but still has bright colour**

ALL PICTURES: STEVE BROWN



◂ The video cropping filter window; use the croppadd function to trim your video so you only retain the part containing the Dog Star



▲ The scene video filter window; use this tool to extract your video frames as still images to a specified folder

button next to the named video profile. Select the **Video codec** tab and then from within this the **Filters** tab. From the list tick the **Video cropping filter** box, then save and click **Start**. This should save a new video cropped to the dimensions you requested.

Extracting stills

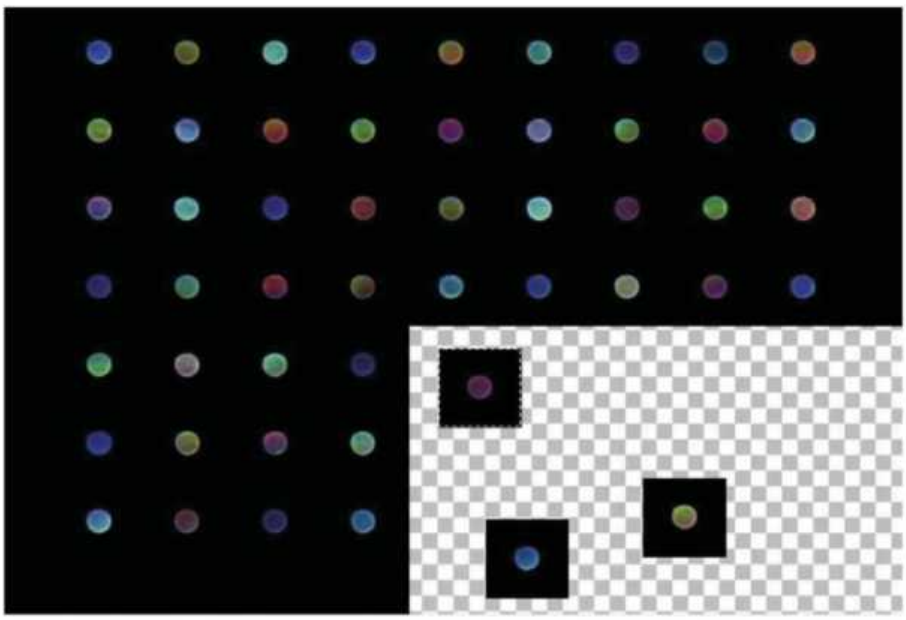
Decide where you want to save the frame files and copy this file path. In VLC return to the **Advanced settings** window. This time select 'Scene filter' from the **Video** > **Filters** list. The image format should be 'bmp'. Choose a filename prefix and enter the file path into the **Directory path prefix** box. Set the **Recording ratio** to 1 – this value means every frame will be extracted. Leave all other settings as they are. Click save and then tick **Scene video filter** from the **Filters** list. Play your video and let it run to the end. Once it is finished you should see all the frames in your destination folder. Afterwards, untick **Scene video filter**; otherwise you'll extract the frames from the next video you play.

Choosing the best images

The last stage is to choose and stitch the images you want to use. You'll have several hundred to choose from so there should be plenty of bright, colourful examples with which to make a final composite image. View the images as large icons and scroll through them until you find one you like. Copy this to another folder ready for the next stage. Continue this process until you have the number of images you need.

Using a graphics program, you can then stitch them together as a single image, as shown below. Start with a black background and simply copy and paste each image to build up a mosaic, which becomes the final image. The one below became the winning entry for the Stars and Nebulae category of the Insight Astronomy Photographer of the Year competition in 2016.

Steve Brown is an award-winning astrophotographer. See his astronomy images on Twitter at @sjb_astro



▲ Assemble the cropped video stills into a glittering mosaic using a layer-based graphics program

Far-Sighted
Astronomy Centres

Stockists of

OSTARA Visionary OLIVON KEPLER OPTIK

ASTRO TELESCOPES, EYEPIECES and ASTRO ACCESSORIES

LOW PRICES
we'll match any genuine web price!

Visionary Classic 7x50
Good optics and excellent value for money. Classic styling with rubber armour.
£28.99

Visionary Classic 10x50
Good optics and excellent value for money. Classic styling with rubber armour.
£29.99

Kepler GL 10x50
A strong and sturdy binocular - excellent value. Great tool for viewing the night sky at a great price.
£34.99

Ostara Elinor 10x50
BAK 4 prisms, Fully multi coated , waterproof and nitrogen filled.
£179.99

Olivon WP-Pro 7x50
Great quality IF focus system binoculars. Rubber armoured, waterproof, BAK4 optics, shock resistant.
£279.99

Eyepieces & Accessories

EYEPIECES/ACCESSORIES			
Plossl 5mm (1.25")	£14.99	Ostara crystal moon filter 1.25"	£9.99
Plossl 10mm (1.25")	£14.99	Ostara Crystal moon filter 2"	£19.99
Plossl 15mm (1.25")	£14.99	Ostra O-III filter 1.25"	£49.99
Plossl 20mm (1.25")	£14.99	Ostara O-III filter 2"	£59.99
Plossl 25mm (1.25")	£17.99	Ostara 2x achro barlow	£34.99
Plossl 30mm (1.25")	£17.99	Ostara 3x achro barlo	£39.99
Plossl 40mm (1.25")	£19.99	Ostara 45 degree 1.25"	£29.99
Super Wide angle 10mm (1.25")	£39.99	ostara 90 degree 1.25"	£29.99
Super Wide angle 20mm (1.25")	£44.99	Ostara 45degree 2"	£99.99
FF 8mm (1.25")	£49.99	Ostara 90degree 2"	£99.99
FF 12mm (1.25")	£49.99		
FF 19mm (1.25")	£49.99		
FF 27mm (1.25")	£49.99		
SWA 26mm (2")	£79.99		
SWA 32mm (2")	£79.99		
SWA 38mm (2")	£79.99		

Ostara 7pc filter set £49.99 *with free filter wallet*

Extending 3pc camera adapter 1.25" **£49.99**

Prime camera adaptor 1.25" for SLR photography **£12.99**

EYESHIELDS Fit comfortably around the eyes blocking out all distracting light and wind, enveloping the eyes in total darkness and complete comfort. It's a "WOW!" experience.

Eyeshield Single	for scopes and astro eyepieces	£14.99
Eyeshield pair	for compact binoculars	£19.99
Eyeshield pair	for larger binoculars	£19.99

We stock T2 mounts

Many more filters and accessories in stock, great prices!

Visionary FIRST VIEW
3" starter telescope complete with finderscope, table base and eyepieces.
£49.99

Visionary STARLA 80
80mm objective refracting telescope Sets up in minutes and really easy to use. This is a great starter telescope yet has all the features to grow with your hobby
£169.99

Visionary TELESTO
4.5" mirror reflecting telescope with full astronomical equatorial mount takes just a short time to set up and use. Great for the beginner wishing to learn all the basics of astronomy
£129.99

Visionary MIRA CETI
6" mirror reflecting telescope with full astronomical equatorial mount for those taking things a little more seriously. Supplied complete with full size tripod and EQ2 mount, side finder scope and two eyepieces.
£229.99

Visionary HD
Very high quality optics at a great price. Traditional styled binoculars featuring BAK4 prisms, fully coated lenses. Long eye relief, rubber armour body.

HD 8x42	£69.99
HD 8x56	£99.99
HD 7x50	£79.99
HD 10x50	£79.99
HD 12x60	£89.99
HD 15x70	£99.99
HD 20x80	£149.99
HD 20x80T	£249.99

Visionary HD 15x70 only £ 99.99

HUGE RANGE
of eyepieces and accessories

Clearview Binoculars: Four Square Chapel, Mapplewell. S75 6GG. Tel 01226 383736.
www.clearviewbinoculars.co.uk Callers very welcome, please check website for opening times.

Binocular Outlet: 01162 430 967. Check our website and visit us on shows and events throughout the UK:
www.binocularoutlet.co.uk NEW STORE - unit 4A, 2 Cropston Rd ANSTEY LE7 7BJ - 0116 235 4402

Objective Optics / D & E Hughes: Tel: 01758 613 291, 24 Penlan Street, Pwllheli, Gwynedd LL53 5DE
www.objectiveoptics.co.uk

J M Optics: Denby Dale Road, Durkar, Wakefield. Tel 01924 763056 E: info@jmoptics.co.uk
Callers very welcome - by appointment only, call to arrange your visit.

The Army Surplus Store: 01297 23867, High Street, Totnes, Devon, TQ9 5NN
www.thearmysurplusstore.co.uk

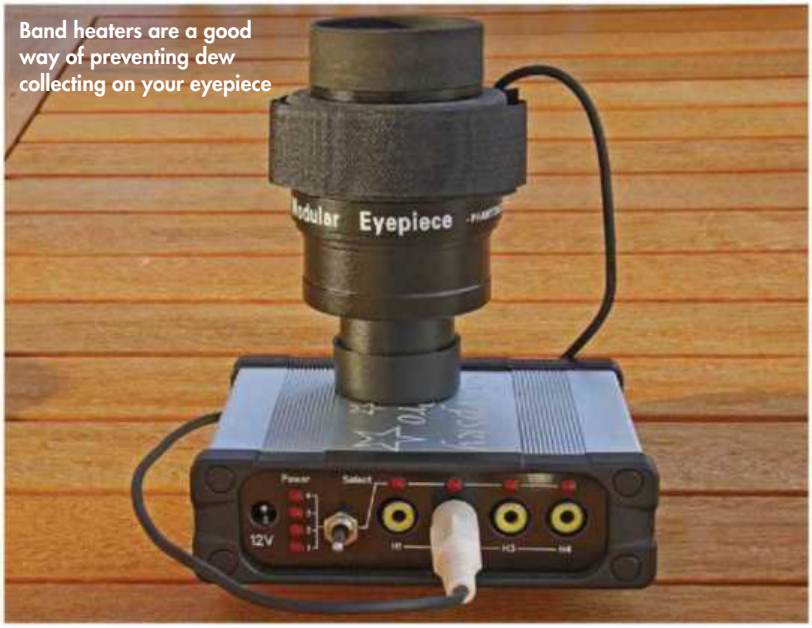
The Far-Sighted binocular company is a group of independent specialist optical goods suppliers. For more information please visit: www.far-sighted.co.uk.

Offers are subject to availability and at participating outlets only. Prices and specifications are subject to change without notice.

Scope DOCTOR

With **Steve Richards**

Our equipment specialist cures your optical ailments and technical maladies



Band heaters are a good way of preventing dew collecting on your eyepiece

My eyepieces keep fogging up when I'm out observing. Should I put an anti-fog coating on them?

ALAN REDLAND

Eyepieces can dew up easily as their optics are exposed to the atmosphere and, unlike the lenses of a refractor, a dew shield can't be used. In addition, the simple act of exhaling while you're at the eyepiece can exacerbate the problem as you introduce moist air to the area. Experienced observers exhale away from the eyepiece to avoid this issue.

Eyepiece lens elements have special anti-reflection coatings applied to all glass-to-air surfaces to increase light transmission though the eyepiece. This coating is very thin and relatively delicate so it's not be a good idea to put any chemicals on the surface including anti-fogging fluid.

To stop dew forming many observers use a heated dew band to keep the temperature of the glass just above the dew point and this can be extremely effective.

If you don't have a dew heater, passing the warm air from a hair dryer gently across the lens surface will remove dew. This is only a temporary fix, however, and you'll have to repeat the action during the course of an observing session.

The key to keeping dew at bay is to keep the glass at a higher temperature than the surrounding air. Keeping eyepieces in an inside jacket pocket, close to your body, before using them is a good start point and it's free!

STEVE RICHARDS X 2

I've seen you can get laptop trays for your mount. Is this the best place to keep my laptop when I'm imaging?

KAREN PRESTON

Although these trays appear to be a convenient place to rest your laptop when you're imaging, they can introduce another problem in the form of vibration. The vibrations caused by you typing on the keyboard or swiping the touch pad would be enough to disrupt the pointing of your telescope, which is the last thing you want during an imaging session. Ensuring there is as little disturbance as possible to the tripod is the best way to get sharp images: even walking around nearby can cause unwanted tremors.

Most astrophotographers use a small folding table to place their laptop on and suitable examples can be found at camping shops or online. It can often be helpful to place a box on its side on top of the table to shield glare from the screen. Additionally, the box also traps a small amount of warm air from the laptop's cooling system, which helps to prevent dew forming on the keyboard and screen.

Reduce vibrations from using your laptop with a table and box

STEVE'S TOP TIP

What is collimation?

To make sure the best views are captured on camera or seen though an eyepiece, it's important to ensure that all the optical elements are correctly aligned with one another. Refractor lens elements tend to remain accurately aligned for their entire lives but reflectors require constant adjustment to their mirrors and the process of aligning the various optical components is called collimation.

Telescopes with small focal ratios require more frequent and more accurate collimation than those with high focal ratios. Practice makes perfect here, but there are tools like Cheshire eyepieces and laser collimators to make the task less tedious.

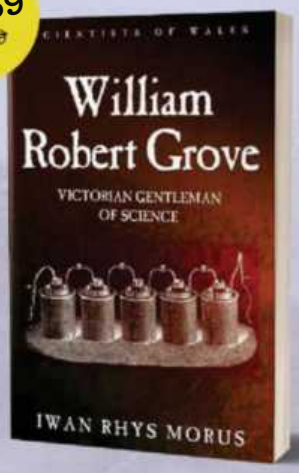
Steve Richards is a keen astro imager and an astronomy equipment expert

Email your queries to scopedoctor@skyatnightmagazine.com

UNIVERSITY of WALES PRESS

20% OFF any of these titles on our website when you use code **HIST17** at the checkout

£13.59 ~~£16.99~~



William Robert Grove:

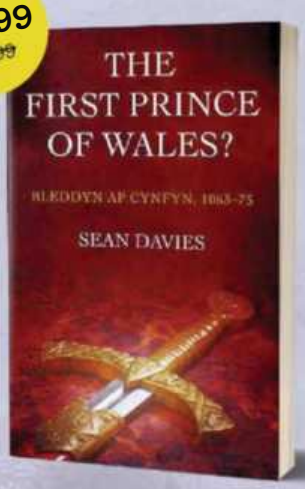
Victorian Gentleman of Science

Iwan Rhys Morus

January 2017
9781786830043
PB

This authoritative biography of the Welsh man of science, William Robert Grove, places him at the heart of Victorian scientific culture.

£11.99 ~~£14.99~~



The First Prince of Wales?

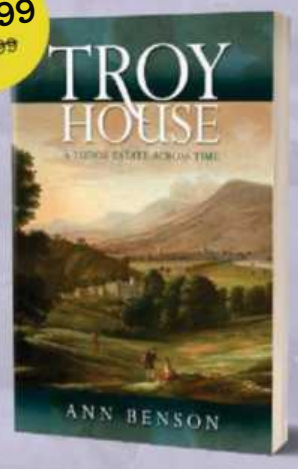
Bleddyn ap Cynfyn, 1063–75

Sean Davies

October 2016
9781783169368
PB

This is the first book on the early leader of the kingdom of Wales, whose years as prince are argued to have set the foundations of the future principality.

£23.99 ~~£29.99~~



Troy House

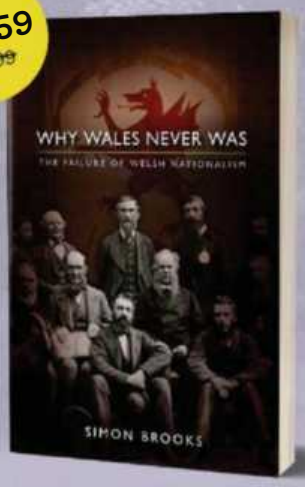
A Tudor estate across time

Ann Benson

March 2017
9781783169894
HB

This extensive new research volume on the architectural, landscape and ownership histories of the Duke of Beaufort's Welsh Troy estate, from the twelfth century to the present, reveals its prime historical importance.

£13.59 ~~£16.99~~



Why Wales Never Was

The Failure of Welsh Nationalism

Simon Brooks

May 2017
9781786830128
PB

Contrary to the popular view that Welsh radical politics was a boost for Welsh nationalism, *Why Wales Never Was* shows that this was the very reason for its failure, despite its emergence during the 'Age of Nationalism'.

www.uwp.co.uk

@UniWalesPress @UniversityofWalesPress @uniwalespress

Sky at Night MAGAZINE

Reviews

Bringing you the best in equipment and accessories each month, as reviewed by our team of astro experts

HOW WE RATE

Each category is given a mark out of five stars according to how well it performs. The ratings are:

★★★★★ Outstanding
★★★★½ Very good
★★★★☆ Good
★★★☆☆ Average
★★☆☆☆ Poor/Avoid

This month's reviews

FIRST LIGHT

90 Celestron Inspire 100AZ refractor

94 Bresser Solarix 76/350 reflector with solar filter

98 Sky-Watcher Star Adventurer Mini mount

BOOKS

102 We rate four of the latest astronomy titles

GEAR

104 Filter sets, filter film, battery packs and more

Find out more about how we review equipment at **www.skyatnightmagazine.com/scoring-categories**

SEE INTERACTIVE 360° MODELS OF ALL OUR FIRST LIGHT REVIEWS AT WWW.SKYATNIGHTMAGAZINE.COM

90

Celestron's Inspire range of beginner scopes is topped by a 100mm-aperture instrument, which we've had a chance to test

FIRST **LIGHT**

See an interactive 360° model of this scope at **www.skyatnightmagazine.com/inspire100az**

Celestron Inspire 100AZ refractor

A beginner's scope with an ingenious adaptor for astrophotography

WORDS: STEVE RICHARDS

VITAL STATS

- **Price** £259
- **Optics** Achromatic lens
- **Aperture** 100mm (4 inches)
- **Focal Length** 660mm, (f/6.5)
- **Focuser** Single-speed rack and pinion with micrometer scale
- **Mount** Manual Altazimuth
- **Extras** Red-dot finder, erect image star diagonal, 10mm and 20mm eyepieces, red light LED torch, printed instruction manual
- **Weight** 6.1kg
- **Supplier** David Hinds
- **www.**celestron.uk.com
- **Tel** 01525 852696

Choosing your first telescope can often be a confusing proposition as there's such a wealth of options available (although Will Gater provides plenty of tips starting on p67). A telescope that's too basic can lead you to become disenchanted with astronomy, while one that's too advanced only begins to be useful after a steep learning curve. Celestron hopes to make the task of finding a suitable starter scope easier with the introduction of its Inspire series, which has been designed specifically for beginners. The range includes 70mm, 80mm, 90mm and 100mm-aperture refractors.

Its the 100mm version we're focusing on here. The Celestron Inspire 100AZ offers a complete observing package with a good-sized aperture, a focal length of 660mm and plenty of features at a reasonable cost. This telescope would appeal to younger astronomers, in particular, as it's not only affordable but also attractively designed.

The 100mm-wide alloy optical tube is finished in a light metallic blue gloss paint with black plastic fittings and an orange, Vixen-style dovetail bar. The tripod has a robust and modern-looking asymmetrical pan and tilt head with 32mm-diameter, stainless-steel adjustable-height legs. As well as the 20mm and 10mm Kellner eyepieces supplied, there's a 90° erect image diagonal included, meaning the telescope is also suitable for terrestrial observations. Completing the package is a useful red light LED torch, accessory tray/leg spreader and a dual-purpose dust cap.

> ***SKY SAYS...***
> The ease with which this scope can be set up is a real bonus for beginners wanting to start observing asap

At just 6.1kg the whole assembly is light and easy to carry around even when it's fully assembled, making it ideal for impromptu observing sessions. The ease with which it can be set up is a real bonus for allowing beginners to get on with observing as quickly as possible.

Focus and colours

The achromatic doublet lens is fully coated. It's only a thin coating, but it's evenly applied with no bad spots. Stars examined through the Inspire 100AZ retained good shapes up to almost 80 per cent of the field of view. As expected, bright stars showed some chromatic aberration but, generally, the correct star colours were observed – orange Aldebaran, the blue-white Pleiades and the lovely contrasting pair of Albireo were all accurately represented.

We enjoyed early evening views of Venus, where the planet's phase was ▸

DUST CAP CAMERA MOUNT

Although this telescope and its non-motorised mount are not designed with astrophotography in mind, the Inspire 100AZ's dust cap has a novel feature – you can strap a smartphone to it and then attach the pairing to one of the two eyepieces that come with the scope.

Although your smartphone camera already has a lens and therefore can't be used at prime focus, light collected by the telescope can be projected into your phone's camera by an eyepiece in a process known as afocal photography.

For this process to work, it's important that your camera's lens is aligned centrally with the eyepiece and the adjustable elastic straps on the dust cap make doing that easy. Next, the dust cap is placed over the eyepiece and held in position with two thumbscrews. It's then a simple matter of pointing the Inspire 100AZ at a Solar System object (including the Sun if a suitable front-mounted solar filter is used), adjusting the focus and capturing a short video for processing in AutoStakkert! or RegiStax.

STARPOINTER PRO RED DOT FINDER

The stylish StarPointer Pro red dot finder projects a reticule onto the view, making it easy to align with Solar System objects or bright stars. The light intensity is adjustable and alignment with the main telescope is easy using two thumbscrews to adjust its mounting platform.

DOUBLET LENS

The Inspire 100AZ has an achromatic doublet objective lens with a generous aperture of 4 inches, the largest in the Inspire range. Larger apertures increase the light grasp of a telescope making it easier to observe dimmer objects. The fully coated lens surfaces increase light transmission by decreasing reflections.

10MM & 20MM EYEPIECES

The 10mm and 20mm 1.25-inch Kellner eyepieces supplied are suitable for a wide range of observations, providing magnifications of 66x and 33x respectively. They have basic fold-down rubber eyecups, but there isn't quite enough eye relief for observing the whole field of view with spectacles.

EASY-TO-ASSEMBLE TRIPOD

The steel-tube tripod has extendable legs with simple locking handles. There's a built-in folding accessory tray that doubles as a leg spreader to help stabilise the tripod. The spreader is locked in place by folding it out and twisting a locking capstan.

FIRST LIGHT

▸ easily observed and Mars was very clearly a non-stellar red disc. Lunar observations were particularly enjoyable, with plenty of detail visible in the craters and not too much false colour on the limb. That said, however, the 20mm eyepiece afforded much better views than the 10mm eyepiece, which was rather lacklustre. The Double Cluster in Perseus showed well through the 20mm eyepiece and the view through the telescope took less than five seconds to stabilise after it had been given a sharp knock.

Photos and films

The dust cap has a smartphone holder built into it and we used this to capture a video of the Moon through the 20mm eyepiece. Stacking the results into a single image produced a pleasant picture for such a basic set of components, despite the rather poor seeing conditions. Beginners would have a lot of fun with this feature, although a phone isn't sensitive enough for deep-sky objects.

Although we were able to achieve focus perfectly adequately, the single-speed rack and pinion focuser is the Inspire 100AZ's weak point. Made with several plastic parts that made it floppy when racking in and out it doesn't inspire confidence in the product, although this is a minor niggle.

The tripod and mount are nicely produced and the solid, 30cm-long tilt handle made locating objects simple. A quick twist to lock the altitude in place, leaving the azimuth with just a small amount of friction, allowed us to track objects as they moved across the sky.

After an initial alignment with the main telescope, the red dot finder proved useful and, again, is an ideal addition for beginners taking their first steps into stargazing – especially if they're learning how to find objects by star hopping with a star chart and the supplied red flashlight.

The Inspire 100AZ telescope would be most suitable for younger beginners as the views and versatility would keep their interest going. S

The Moon captured with a smartphone and the supplied adaptor

WWW.THESECRETSTUDIO.NET, STEVE RICHARDS

VERDICT	
ASSEMBLY	★★★★½
BUILD & DESIGN	★★★½☆
EASE OF USE	★★★★☆
FEATURES	★★★★☆
OPTICS	★★★½☆
OVERALL	★★★★★

SKY SAYS...
Now add these:

1. Omni 15mm eyepiece
2. Omni 1.25-inch 2x Barlow lens
3. 1.25-inch Moon filter

RACK AND PINION FOCUSER WITH MICROMETER SCALE

A simple single-speed rack and pinion focuser with 1.25-inch eyepiece holder is supplied. It has two eyepiece-retaining thumbscrews to hold the star diagonal securely. On the right-hand side of the focuser there's a convenient window showing an etched scale so that you can quickly locate previous focus positions.

FIRST LIGHT

See an interactive 360° model of this scope at www.skyatnightmagazine.com/solarix

Bresser Solarix 76/350 telescope with solar filter

A multi-use telescope that helps you find your way in astronomy

WORDS: NICHOLAS JOANNOU

VITAL STATS

- **Price** £75
- **Optics** 76mm (3 inches)
- **Focal Length** 350mm (f/4.6)
- **Extras** 4mm and 20mm eyepieces, 2x Barlow lens, solar filter, smartphone photo adaptor, accessory tray
- **Weight** 2.5kg
- **Supplier** Telescope House
- **www.**telescopehouse.com
- **Tel** 01342 837098

WWW.THESECRETSTUDIO.NET X 4

The Bresser Solarix 76/350 telescope is an interesting, multi-purpose offering. It's aimed at beginners who want to try out some of the different aspects of astronomy while only buying one piece of equipment that doesn't break the bank.

It's comprised of a 3-inch (76mm) Newtonian reflector on top of an aluminium tripod with a manual push-to mount. This combination makes for a small and light unit once it's been assembled. A decent collection of accessories is bundled with the telescope, including 20mm and 4mm eyepieces, a 2x Barlow lens, a smartphone photo adaptor and a certified solar filter. The only omissions are a finderscope and a finder bracket on the telescope to allow you to install your own. But, due to the Solarix having a large field of view, it's possible (even without a finder) to aim it by using the 20mm eyepiece for the lowest magnification and sighting along the length of the telescope tube.

Setting up the Solarix is quick and easy. The few parts all fit together nicely and take only a minute or two to assemble without tools. Its small size and low weight also make it easy to transport to dark-sky sites. Its instructions come in two booklets: one is a generic telescope set-up manual, the other explains solar use and safety.

SKY SAYS...
A Newtonian reflector and aluminium tripod with push-to mount makes for a small and light combination

Converting the Solarix to solar use is simple – all you need to do is attach the front-mounted solar filter. As with all solar observing, caution is strongly advised. Equipment (in particular the solar filter) should always be carefully inspected before use. Once correctly fitted to the apparatus, it should only be used in the prescribed manner as detailed in the manual and you should never look at the Sun without the proper protective measures in place. Together, the solar-use instruction manual and the many safety stickers on the Solarix do a good job of informing you how to go about safely observing the Sun. A welcome addition would have been a protective cover for the solar filter, though.

A sucker for photography

By using the provided smartphone photo adaptor, simple astrophotography is also possible with the Solarix. The adaptor amounts to a sucker pad that holds your smartphone and attaches to the focuser. The suckerpad isn't 100 per cent guaranteed to ▸

MULTI-PURPOSE ACCESSIBILITY

For curious beginners, the best type of scope is often a good, multifaceted telescope that will enable them to try a range of astronomical techniques, so as to see where their interests may lie. The Solarix 76/350 is just such a scope, offering budding astronomers the chance to experience lunar, planetary, deep-sky and solar observation and take pictures using a smartphone. The Solarix does all of these without the need to purchase any further equipment as many of the necessary extras are included in the relatively low price. This should encourage more people to take the plunge without worrying about having to spend too much money trying things out before making any larger purchases. If you're buying for a child it would also be a good choice as its many features should keep them interested and busy for hours. Small enough to sit on a balcony, light enough to travel anywhere easily, quick to set up and simple to use, the Solarix 76/350 is great as an introductory-level, multi-purpose system, even if it does have a few collimation issues.

OPTICS

The Solarix is a 3-inch Newtonian reflector with a short focal length of 350mm, giving a focal ratio of f/4.6. It uses a single-arm strut to hold the secondary mirror. When collimated, the Solarix gives good views at low magnifications, with only a small amount of the coma usually associated with Newtonian telescopes.

FOCUSER

The Solarix is fitted with a single-speed rack and pinion focuser that has adequate strength to hold all the equipment in place. Even with the addition of the photo mount and a large smartphone, the focuser was solid enough to take steady pictures of the Moon without the focus shifting at any time.

PUSH-TO FORK MOUNT

With a similar action to that of a Dobsonian mount, the push-to altaz fork mount is easy to use. Large knobs on the sides of the fork and at the base of the mount are used for adjusting the mount head and telescope.

TRIPOD WITH ACCESSORIES TRAY

The Solarix sits on an aluminium tripod that comes with a useful screw-on accessory tray to keep the various bits handy. The tripod is height adjustable, lightweight and strong, all of which makes the whole assembly easy to transport.

FIRST LIGHT

▸ retain your phone when in use, so it's a good idea to also use a lanyard to tie your smartphone down with – you can loop the free end around the telescope's focus tube.

Our first test for the Solarix 76/350 was observing the Moon. Using the 20mm eyepiece provided a rich iew of the full lunar disc, showing good detail in the craters and along the terminator. Once the eyepiece was swapped for one of a higher power, however, the Solarix's weakness came to light: collimation. Since only the secondary mirror is provided with collimation screws, it's difficult to get the optics fully lined up. This made many of the higher power magnifications almost unusable; flaring of the objects in the eyepiece was a common occurrence, as was an inability to find sharp focus at higher magnifications. This was especially evident while observing Venus and Mars on the same evening.

Solar observations echoed the lunar and planetary experiences with decent views of the Sun's disc at lower powers, but distorted views, once again, when higher magnifications were used.

Switching to deep space, nice views of the Orion Nebula (M42), the Pleiades (M45), the Andromeda Galaxy (M31) and the Double Cluster (NGC 869 and 884) were all possible. The wide field of view at low magnification was just right to frame the deep-sky objects in their entirety.

Using the Solarix for astrophtography produced a similar experience to observation: good results were possible at low magnification, such as on the Sun or Moon, but the results were not so good at higher magnifications. As such, we'd recommend using low magnification for most purposes.

The Solarix is a decent attempt at an affordable, all-round telescope package even though it's marred by collimation issues that make it difficult to achieve sharp detail at higher magnifications. It's perhaps best suited to beginners or children – anyone looking for a telescope with which to take their first steps into the world of astronomy. S

VERDICT	
ASSEMBLY	★★★★☆
BUILD & DESIGN	★★★☆☆
EASE OF USE	★★★½☆
FEATURES	★★★☆☆
OPTICS	★★★☆☆
OVERALL	★★★½★

SKY SAYS...
Now add these:

1. Explore Scientific CLS 1.25-inch fit nebula filter

2. Orion padded telescope bag

3. Bresser SPL 9.5mm 52° super Plössl eyepiece

SMARTPHONE MOUNT

The smartphone mount has a separate elastic loop that helps to secure your phone. The mount is easy to install, you just slide it onto the focuser, insert an eyepiece and press your smartphone onto the pad with the camera's lens directly over the lens of the eyepiece. Fine tuning is achieved by moving the whole photo mount up and down the eyepiece barrel.

FIRST **LIGHT**

See an interactive 360° model of this mount at **www.skyatnightmagazine.com/staradvmini**

Sky-Watcher Star Adventurer Mini

A little, lightweight tracking mount packs a big punch

WORDS: PAUL MONEY

VITAL STATS

- **Price** £279
- **Payload capacity** 3kg
- **Latitude adjustment** 0-90°
- **Tracking rates** Sidereal, 0.5x sidereal, 2x sidereal, lunar, solar, no tracking (all via Wi-Fi)
- **Power requirements** 2x AA batteries
- **Polarscope** Polarscope with separate red-light illuminator
- **Extras** L mounting bracket, built-in Wi-Fi, snap camera control port, 1/4–3/8-inch thread converter
- **Weight** Mount 650g, wedge 518g
- **Supplier** Optical Vision
- **www.**opticalvision.co.uk
- **Tel** 01359 244200

Imaging the night sky was once the domain of the specialist astro imager with a telescope. They'd either image directly through the scope or piggyback their camera on it for wide field constellation photography. But in recent years a number of small, lightweight tracking mounts have appeared, bringing astrophotography to a greater number of astronomy enthusiasts and the latest entry into this field is Sky-Watcher's Star Adventurer Mini.

Sky-Watcher has taken its original Star Adventurer tracking mount and shrunk it to make it an ideal travelling companion. The Star Adventurer Mini Wi-Fi bundle consists of the tracking mount, an equatorial wedge, a dovetail L-bracket, a ball-head adaptor, a polarscope and a polarscope illuminator along with built-in Wi-Fi. Power is provided by two AA batteries or connection to a laptop via the mini-USB port. We were also loaned the optional 1kg counterweight and shaft to allow the use of larger lenses. Sky-Watcher recommends a maximum load weight of up to 3kg; we found a Canon EOS 50 DSLR and Canon 100-400mm lens comes in at 2.5kg combined. For most astrophotography Sky-Watcher also suggests using lenses of up to 100mm, but we tried a range that included wide-field 18mm and 200mm lenses (the latter produced slight tracking issues noticeable only when really zoomed into the images).

> ***SKY SAYS...***
> Sky-Watcher has taken its original Star Adventurer and shrunk it down to make a mount that's ideal for travelling

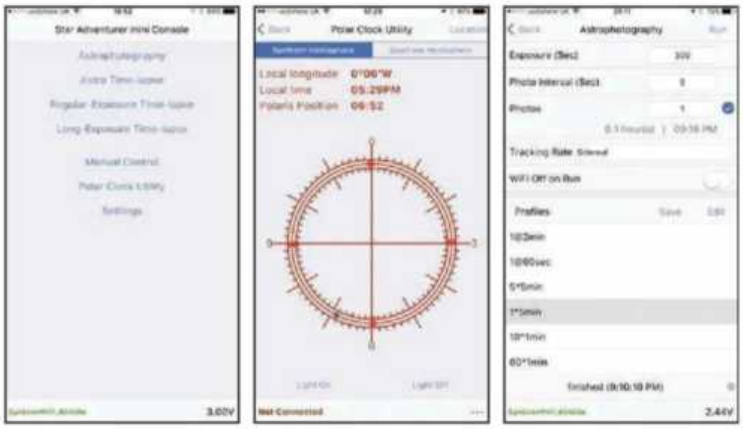
Able to cope with more

The Star Adventurer Mini tracking mount can be attached directly to a tripod, using the latter's tilt head to provide the adjustment for your latitude when polar aligning. It weighs just 650g so if weight is critical, such as when you're travelling abroad, it gives you the option of leaving behind the equatorial wedge. However, the latter provides sturdy support for the tracking mount and excellent adjustment for polar alignment. It only weighs 518g and has a bubble level so we'd always use it as part of the kit for astrophotography.

We used a Canon EOS 50 DSLR and 18-55mm lens for wide-field astrophotography. The ball-head adaptor has a short Vixen-style bar that slots into the Vixen-style dovetail on the mount head. Using a ball head to attach a camera provides greater flexibility for framing your targets. For larger lenses, up to the suggested weight and lens size, ▸

TRACKING THE APP

A tracking mount with built-in Wi-Fi might seem to be overkill for such a simple piece of equipment. Why go to the trouble of making it controllable via a smartphone app when all that's needed is to turn on the power and perform a rough polar alignment via the sighting tubes? However, it only took moments for us to become completely hooked on using a smartphone to set up and control both the Star Adventurer Mini and our camera. This facility will have huge appeal to tech-savvy internet-loving astro-imagers. With the power on and Wi-Fi connected, the app gives you total control and includes a polar-alignment chart showing you exactly where to place Polaris in the polarscope. The green LED on the mount informs you of the Wi-Fi connection and the mount is almost silent in operation while the app has a multitude of functions that includes controlling the duration of the exposure. This adds a fun element to imaging the night sky and one that we found enjoyable to use.



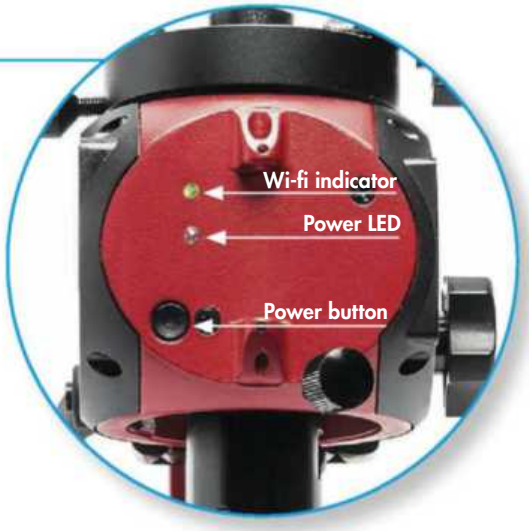
▲ Simple menus and control options make the free app user-friendly

TRACKING MOUNT BODY

The main Star Adventurer Mini body is small enough to fit in your palm and weighs just 650g. It can be used either attached to a tripod, with latitude adjustment done via the tripod's tilt head, or with the supplied equatorial wedge.

WI-FI & APP

The tracking mount has a built-in Wi-Fi network that allows you to connect your smartphone or tablet to it and control the tracking and other aspects of the mount via the free Star Adventurer Mini app. It also allows you to control your camera via the snap port, however the correct camera remote cable is an optional extra.



EQUATORIAL WEDGE

The equatorial wedge provides greater flexibility for levelling the mount on a tripod, with the included bubble level, as well as a wide range of latitude adjustment from 0-90°. Two adjustment bolts for azimuth make it easy to line up with the azimuth direction of the polar axis.

POLARSCOPE/SIGHT

Polar alignment is achieved with a pair of line-of-sight holes for rough alignment, then with an integrated polarscope for accurate fine-tuning. The polarscope can be lit with a small illuminator that fits over the front of the unit or with the supplied adapter for when the L bracket is installed.

FIRST LIGHT

SKY SAYS...
Now add these:

1. Fotomate H-26qr tripod ball head

2. Sky-Watcher shutter release cable

3. 1kg counterweight and shaft

▸ the dovetail L bracket is replaced with the ball-head adaptor.

The built-in Wi-Fi network allows you to sync your smartphone or tablet to the tracking mount and control its various functions. The Star Adventurer Mini app – downloadable for free for both iOS and Android – is extremely easy to use and has a multitude of functions that are too numerous to cover in detail. Its primary function, however, is to set the tracking rate, length and number of exposures, all of which can be stored for future use. Various tracking rates can be chosen and there are also functions that make time-lapse photography possible. Sky-Watcher has given the app a great deal of thought but one slight niggle is that the night light option is not particularly effective.

The faintest of trails

After making sure the setup was polar aligned, we used the app to program a range of timings. With the DSLR and its 18-55mm lens set at 18mm we were able to take a 10-minute exposure of Taurus and Auriga with barely any trailing evident until we zoomed right into the image. We then set the camera lens to 55mm and framed the Pleiades and Hyades and were able to take a five-minute exposure that again showed barely any trailing.

Swapping to a 100-400mm lens required us to use the L bracket along with the optional counterweight and shaft. We set the lens to 200mm, framed the Pleiades and achieved a two-minute exposure. Sky-Watcher suggests a maximum lens of 100mm, but we found it could cope with bigger lenses, which makes this an ideal basic solar setup for eclipse chasers. Overall, the ease of use, highly practical app and Wi-Fi connection make the Star Adventurer Mini a winning combination and a highly recommended piece of kit for budding astrophotographers who like to travel. S

VERDICT	
ASSEMBLY	★★★★★
BUILD & DESIGN	★★★★½
EASE OF USE	★★★★½
FEATURES	★★★★½
TRACKING ACCURACY	★★★★½
OVERALL	★★★★½

▲ The Pleiades (M45) taken with 100-400mm lens set at 200mm, f6.3, with a two-minute exposure, ISO 400. Light pollution has been removed and the levels adjusted

L BRACKET AND BALL-HEAD ADAPTOR

The supplied ball-head adaptor allows you to attach a camera directly or fit an optional ball head if you're using a DSLR and wide-angle lens. For larger lenses the dovetail L bracket provides better support and balance while an optional counterweight and shaft is useful for the heaviest lenses.

WWW.THESECRETSTUDIO.NET X 2, PAUL MONEY

Books

New astronomy and space titles reviewed

RATINGS

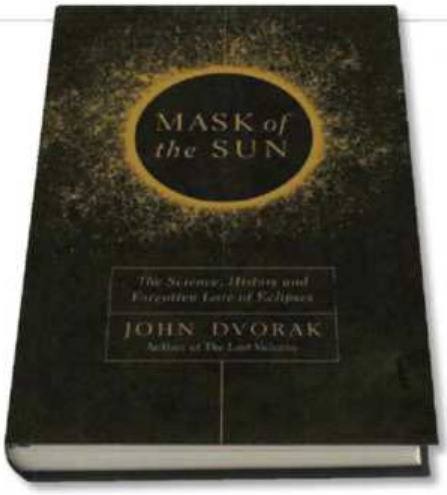
★★★★★ Outstanding
★★★★☆ Good
★★★☆☆ Average
★★☆☆☆ Poor
★☆☆☆☆ Avoid

Mask of the Sun

The Science, History and Forgotten Lore of Eclipses

John Dvorak
Pegasus Books
£20 ● HB

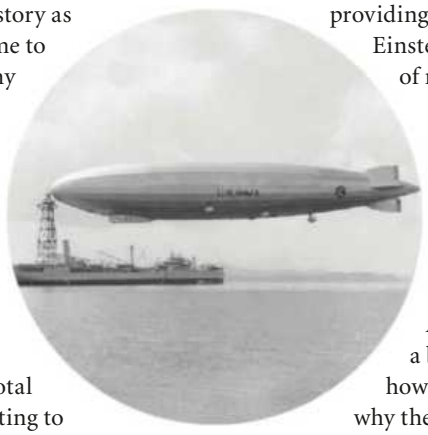
BOOK OF THE MONTH



Written Western history spans around 40 centuries, during which there have been around 10,000 solar eclipses and 6,000 lunar eclipses. In *Mask of the Sun* we're treated to an informative and well-presented account of their history. These impressive events have inspired fright, superstition and awe in many of the people who witnessed them and, as the book makes clear, eclipses have often defined the course of human history as we slowly but surely came to understand how and why these stunning celestial showpieces occur.

Mask of the Sun opens with an evocative account of the flight of the *USS Los Angeles* airship above New York in January 1925 to enable 40 people to witness a total solar eclipse. It's interesting to note that the *Los Angeles* was elevated through the lifting effects of helium, an element named after the Greek god of the Sun, Helios. As we learn, helium was first detected by Norman Lockyer who carried out spectroscopic observations of solar prominences, which sprang into view during solar eclipses.

Eclipses have been passports to our deeper understanding of many events in Earth's history, even allowing us to determine when the first Olympic Games took place. They have helped us to gain insights into the properties of the Sun and Moon, such as realising the lunar surface is covered by a layer of dust long before mankind sent probes there. They've enabled us to unravel the mysteries of gravity as well as providing insights into Einstein's general theory of relativity.



The USS *Los Angeles* airship was used as a viewing platform for the 1925 eclipse

The book rounds off with a look at the forthcoming total solar eclipse – due to take place in August 2017 and visible across America – as well as a brief outline as to how eclipses occur and why they're unique to our planet. As this book clearly shows, Dvorak is a worthy narrator who has an eye for detail, and does an excellent and inspirational job of portraying the fascination that eclipses hold for those who are lucky enough to witness them.

★★★★★

BRIAN JONES *has written 17 books on astronomy and space*

U.S. NAVAL HISTORICAL CENTER

TWO MINUTES WITH John Dvorak

How many eclipses have you seen?
I've seen about a dozen lunar and solar eclipses, though only two total solar eclipses. Those were the last two that crossed the United States, in 1979 and 1991.

Your book tells of some extreme reactions to eclipses. Which one stands out the most?
[Probably] the lasting effect three eclipses had on the Catholic church. In the 17th century astrology and sorcery were still part of church rituals. As a result of these three eclipses, which were used to predict the death of the Pope, a papal bull was issued in 1632 prohibiting any church member or official from engaging in such activities. The bull has been reinvoked several times since then, most recently in 1998 by Pope John Paul II.

Eclipses have astonished humanity for millennia. Did this make it a difficult book to research?
The problem came with searching through the volume of material, ranging from the writings of Shakespeare to those by James Fenimore Cooper and Virginia Woolf. The Babylonians kept detailed eclipse records, as did the Mayas and the ancient Chinese. Isaac Newton is pivotal in providing the first theory of lunar motion and, from that, the first accurate eclipse predictions. Albert Einstein owed his celebrity to a solar eclipse and one can be sure future eclipses will continue to influence history and human culture.

JOHN DVORAK *is a geologist, author and former telescope operator at Mauna Kea for the Institute for Astronomy, University of Hawaii*

Women Spacefarers
Sixty Different Paths to Space

Umberto Cavallaro
Springer
£24 ● PB

"Hey sky, take off your hat, I'm on my way!" These were the words shouted by Valentina Tereshkova as she blasted off on 16 June 1963 to become the first woman in space. Tereshkova's lift-off began a long legacy of women in space, currently numbering over 60 and making up 10 per cent of the total number of astronauts and cosmonauts.

While the preface to *Women Spacefarers* provides a backdrop to the Cold War space race and the role of women as pawns in this competition, the book is more of a chronological review of female pioneers than an historical analysis of equality in human space exploration.

It details each woman's journey in getting to space, whether they began as fighter pilots or parachutists, engineers, tennis pros or teachers. The common thread between them is their tenacity and the single-mindedness required to challenge female stereotypes. The cosmonaut Svetlana Savitskaya, for example, was thrown an apron when she boarded the Salyut 7 in 1982.

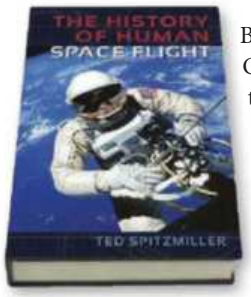
For all women who've ever dreamed of travelling beyond Earth, this book is an insightful analysis of the commitment, dedication and exceptional skills required. It's a testament to the adversity and tremendous challenges these women had to overcome to earn their rightful place in the history of space. While it's a comprehensive overview of the subject, it hints at a bigger, more important story: that these mavericks helped define new role models for women. On that basis alone, we have much to thank them for.

★★★★☆

DR NIAMH SHAW *is an engineer, science communicator and ESERO-UK space ambassador to Northern Ireland*

The History of Human Space Flight

Ted Spitzmiller
University Press of Florida
£38.50 ● HB



Before Cape Canaveral there was the Stratobowl in South Dakota, built to launch manned balloons into the stratosphere. Ted Spitzmiller's chronicle presents these 1930s and 1950s ascents as a fascinating prelude to the spacecraft, complete with live media coverage, US-Russia rivalry and fatalities along the way. Aeronauts had probed the air for a century and a half, but above a certain height they had the unfortunate tendency of dying. It was only in the 1930s that the idea took hold of bringing life support along in a sealed 'capsule', the same terminology applied to early spacecraft.

Intended as an introductory history, there's a lot to pack in and Spitzmiller smooths his narrative with rare black and white photos and box-outs covering key technical concepts. At a time when more enthusiasts are operating their own virtual space missions through simulation games such as *Kerbal Space Program*, there's value in a backgrounder of this sort. It allows readers to trace the evolution of such disciplines as extravehicular activity while weaving between astronaut and cosmonaut tales.

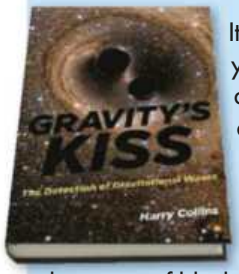
Over half the book is devoted to the dozen incredibly dramatic years between Sputnik 1 and the Moon landing. Spitzmiller maintains less detailed focus on the four decades since then; for instance China's taikonauts get little more than a footnote. The author complains of a falling off in public enthusiasm since Apollo, but polling records suggest the public was ambivalent even then. The good news is that the more people learn, the more their enthusiasm grows, hence the importance of books like this.

★★★★☆

SEAN BLAIR *writes for the European Space Agency website*

Gravity's Kiss
The Detection of Gravitational Waves

Harry Collins
MIT Press
£24.95 ● HB



It's little more than a year since physicists announced the discovery of gravitational waves – ripples in the fabric of the Universe created by a pair of black holes spiralling into each other. Any science journalist would be keen to recount the story of this landmark moment, but Harry Collins's new book does more than just that.

Collins has spent much of his career embedded within the gravitational wave research community, not as a physicist, but as a sociologist. In three previous books on the subject, he has chronicled the way that science actually gets done in meticulous detail, but as of late 2015 he was one of the first people in the world to learn of the tell-tale signal picked up during an early test run of the Advanced LIGO gravitational wave detector. Collins was in a unique position to capture every aspect of the researchers' reactions over five fraught months of secrecy as the potential discovery was analysed and argued over. Could the signal be a blind test injected into the data to test the protocols for a possible discovery? Might it be the work of malicious hackers? Or could it possibly be the real thing? Told in real time, Collins's book gives a vivid understanding of the excitement and tensions around an epoch-making scientific discovery. It's both a topical must-read, and a future classic of the genre.

★★★★★

GILES SPARROW *is a science writer and fellow of the Royal Astronomical Society*

Gear

Elizabeth Pearson rounds up the latest astronomical accessories

1 ZWO 1.25-inch Narrowband Filter Set

Price £392 • **Supplier** First Light Optics
www.firstlightoptics.com

These three 7nm narrowband filters are optimised to pick out the important Ha, SII and OIII transmission lines. They're perfect for capturing nebula detail even in areas of high light pollution.

2 Planetaria Coasters

Price £20 • **Supplier** Red Candy
0121 224 7728 • www.redcandy.co.uk

Bring the cosmos to your coffee table. This set of nine coasters features a stylised and colourful depiction of each of the eight main planets and Pluto.

3 Explore Scientific Solar Filter Film

Price £16.99 • **Supplier** Harrison Telescopes
www.harrisontelescopes.co.uk

This A4 solar filter film allows you to create your own solar filters and glasses. The film has been safety tested and gives a beautiful yellow-orange cast to solar observations.

4 TS Filter Quick Change Adaptor

Price £84 • **Supplier** 365 Astronomy
020 3384 5187 • www.365astronomy.com

Lighter and thinner than a filter wheel, the quick changer lets you pre-load filters so you can rapidly swap between them in the field.

5 Pegasus DSLR Buddy

Price £95 • **Supplier** Altair Astro
01263 731505 • www.altairastro.com

The Buddy allows you to connect your Canon DSLR and lens dew heater to an external power source – no more battery swapping!

6 Night Sky Star Chart Glasses

Price $40 • **Supplier** Cognitive Surplus
www.cognitive-surplus.com

One of these stemless wine glasses is decorated with a chart of the winter sky, while the other depicts summer's stars. Bottom's up!

WHAT I REALLY WANT TO KNOW IS...
When will we find intelligent alien life?

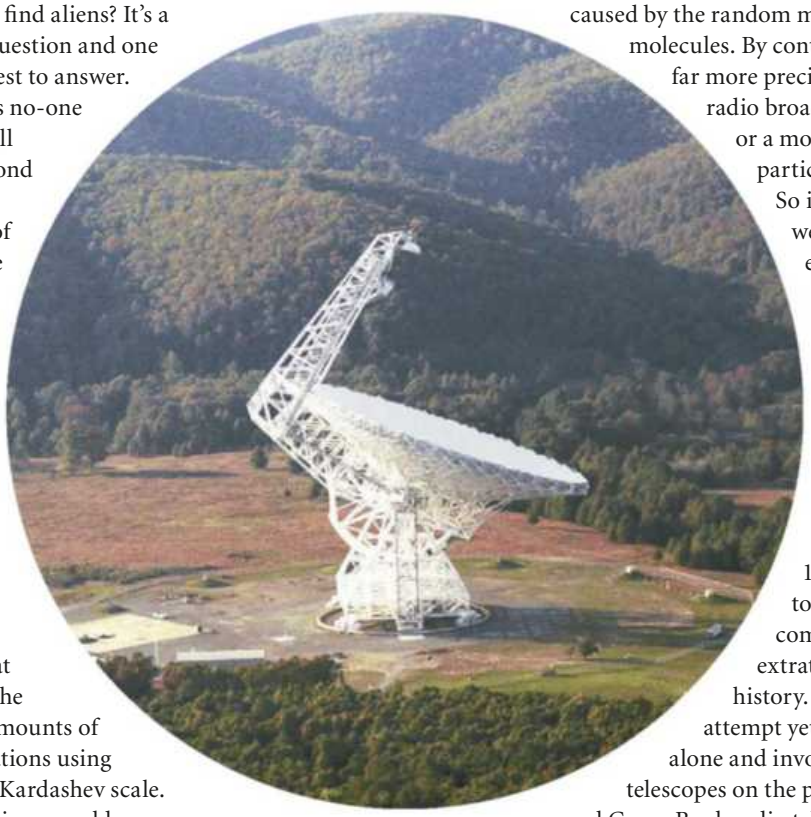
Andrew Siemion is leading a hunt for signals that would tell us if there are other civilisations out there in the Universe

INTERVIEWED BY PAUL SUTHERLAND

When will we find aliens? It's a profound question and one of the hardest to answer. The truth is no-one knows when, or even if, we'll discover intelligent life beyond Earth and that's why we're searching. We have plenty of evidence that intelligent life at our own technological level isn't common in the Universe – we don't see spaceships flying through our Solar System every few weeks.

Recently we've tried to find alien civilisations that have harnessed the energy of their stars. Our own technological progress over the last couple of thousand years suggests that 10,000 or 100,000 years in the future we'll need massive amounts of energy to continue. Civilisations using star power are rated on the Kardashev scale. Kardashev Type III civilisations would use energy equivalent to all the stars in their galaxy.

Searches so far, out to a distance of around half the age of the Universe, have found no evidence for energy consumption on such a scale. That tells us that if there are many other advanced civilizations out there, then they're probably existing in a very different manner to the way we do today.



The Green Bank Telescope in West Virginia is part of the Breakthrough Listen project to detect alien signals

Technological clues

If there were the alien equivalent of chimpanzees in a forest on an exoplanet, we'd have absolutely no way of knowing that they were there. It's quite difficult to detect basic life at interstellar distances. Using spectroscopy of exoplanets' atmospheres might help us out to a distance of 50 lightyears or so, but it won't be easy. Detecting intelligent life, however, should be easier as emissions produced by technology differ from the astrophysical background.

Electromagnetic emissions from natural processes we see in physics and astrophysics are smoothed out across frequencies because they're caused by the random motion of atoms or molecules. By contrast, technology can create far more precise signals, similar to a radio broadcast, a pulse from a radar or a monochromatic laser at a particular wavelength of light. So in our SETI experiments we look for electromagnetic emissions, of whatever wavelength, that would stand out from the natural background.

It's important to note that we're talking about detection. Decoding a signal would come later.

The Breakthrough Listen initiative is a 10-year, $100 million effort to conduct the most comprehensive search for extraterrestrial intelligence in history. It's humanity's boldest attempt yet to discover whether we're alone and involves some of the largest telescopes on the planet, including the Parkes and Green Bank radio telescopes in Australia and West Virginia respectively, and the Automated Planet Finder optical telescope in California.

Our best chance at detecting advanced life is to expect that, like us, they broadcast high-power radio signals in the terrestrial microwave window. It represents a relatively low noise level in the spectrum, which is why humans have used it for devices ranging from the first analogue cellphones to downlinks to satellite dishes.

We might have an answer within 20 or maybe 30 years. Until recently, we've only been able to check small regions of the radio spectrum at a time for an alien signature, limited by the speed of our computers. But computers are now powerful enough to instantaneously search the entire range of frequencies from one observation with a large radio telescope. Within two or three decades we should have been able to check the entire sky.

I think after we've done the experiment, either we'll have detected alien life or we'll have to go back to the drawing board to think about some other types of experiments to help us search.

ABOUT ANDREW SIEMION

Dr Andrew Siemion is Director of Berkeley SETI Research Center in California and leading the Breakthrough Listen initiative to detect electromagnetic signatures of alien life.

IMAGE COURTESY OF NRAO/AUI

Telescope House

Telescope Specialists Since 1785

Web: www.telescopehouse.com
Email: sales@telescopehouse.com
Tel: 01342 837098

Sign Up To Our Mailing List

Bresser Messier T52 Goto From £1280 Exos 2 Manual From £924

Bresser Messier 127 Goto From £827 Exos 2 Manual From £991

Bresser Messier 102-S Goto From £910.00 Exos 1 Manual £471

Bresser Messier MC152 Goto £1351 Exos 2 Manual £994

Bresser Messier MC127 Goto From £1026 Exos 1 Manual From £586

Bresser Messier NT203 Goto £1072 Exos 2 Manual £717

Bresser Messier NT150 Goto From £941 Exos 2 £585 Exos 1 £501

Bresser Messier NT130 Exos 2 £531 Exos 1 £365

BRESSER® Messier Range

The Explore Scientific Achromatic Doublet Refractors

AR 102mm f/6.5 £538
AR 127mm f/6.5 £507
AR 152mm f/6.5 £733

EXPLORE SCIENTIFIC

Explore Triplet Apo Refractors

127mm Deluxe FCD100 - £1762
127mm Essential Version £1853

102mm FCD100 Deluxe - £1370
102mm Essential Version- £1048

80m Deluxe FCD100 Apo - £930
80mm Essential Apo £684

EXPLORE SCIENTIFIC

92° 12mm & 17mm 92 Degree Explore Scientific Eyepieces £420

68° Degree Explore Scientific eyepieces from £115

82° Degree Explore Scientific eyepieces from £116

100° Degree Explore Scientific eyepieces from £249

120° Degree 9mm Explore Scientific eyepiece £948

ZWO

We are pleased to offer the ZWO ASI Camera Range. At Telescope House

NEW! ZWO ASI1600 APS-C Sensor Cameras Was £841 Now £755!

ZWO ASI071MC Cool APS-C One Shot Colour Camera - an ideal DSLR Replacement - £1408

WiFi Camera

NEW! Bresser WiFi Camera - See site for details!

Altair Astro GP CAM2 & GPCAM2 IMX224 Colour & Mono Planetary, Lunar & Solar Cameras Colour IMX224 - £189.99 Mono AR0130 - £189.99

Bresser Messier 8-inch Dobsonian £391

Dobsonians are the best value visual telescopes available - visit our Showroom to see a large range of these telescopes

New Bresser 10" Dobsonian - £557

Revelation ASTRO

15x70s £49

25x100s £240

Revelation Observer's Eyepiece Kit - £124

Meade ETX90 Observer Edition With Hard Case, & Full Height Tripod Now £499

Meade LX200 From £2895

Meade LX90s From £1825

MEADE

Telescope House are TeleVue Star Dealers. We always have a full range of their Plossl, Panoptic, Delite Delos & Ethos eyepieces on display & ready to test at our Starborough showroom

TeleVue Plossls Eyepieces from £91

TeleVue Delite Eyepieces £246

Bresser MikrOkular Full HD USB Eyepiece £57

NEW! Explore Scientific Solarix Solar Film Filter £16.99

Excellent Value 100% Safe Solar Film. Ideal for DIY!

Universal Smartphone Adapter- £30 - £28!

BRESSER

Gooseneck Smartphone Holder - £18!

Image through telescopes and binoculars with the Bresser Universal Smartphone Adapter

Find your way around the sky with binoculars and telescopes with the Bresser Gooseneck Smartphone Holder

Meade ETX80 Goto Scope - £229

Meade HD-60 Eyepieces - £105

HOT PRICE USA

Lunt LS50 - From £1041

Excellent pressure-tuned portable Solar Scope

Lunt LS60 - From £1704

Lunt LS80/B1800 - £5276

THE SOUTHERN HEMISPHERE IN APRIL

With Glenn Dawes

WHEN TO USE THIS CHART

1 APR AT 00:00 UT
15 APR AT 23:00 UT
30 APR AT 22:00 UT

The chart accurately matches the sky on the dates and times shown. The sky is different at other times as stars crossing it set four minutes earlier each night. We've drawn the chart for latitude –35° south.

APRIL HIGHLIGHTS

Jupiter is at opposition on 8 April and at its brightest for the year (mag. –2.5). Although it normally gives good views of its cloud bands and the Great Red Spot in any telescope, its maximum diameter of 44.3 arcseconds makes seeing them a bit easier. Being visible for the whole night allows more time to observe these surface features and its brightest moons as they move in front of and behind Jupiter. On the evenings of 7th and 15th all four moons will be close to the planet.

STARS AND CONSTELLATIONS

Pull your gaze away from the southern Milky Way and focus your attention on the sky in the north. Looking out of the plane of our Galaxy there are fewer stars and less matter to obstruct your view of distant galaxies. Located to the right (east) of mag. +2.1 Denebola (Beta (β) Leonis) is the enormous Virgo-Coma Berenices cluster of galaxies, which straddles these constellations. Enjoy getting lost in this swarm with dozens of these distant bodies visible in the smallest telescope.

THE PLANETS

Jupiter rises in the east at sunset and dominates the night sky, easily outshining the mag. –1.5 Sirius (Alpha (α) Canis Majoris), now in the west. Mars is low in the west, setting around the end of twilight. Saturn arrives around 22:00 EST mid-April and is best seen in the morning. Turning to the dawn sky, brilliant Venus rises rapidly out of the Sun's glare in the first week of April. It's well up by the start of dawn at the month's end and, during this period, reaches mag. –4.7.

DEEP-SKY OBJECTS

T Centauri (RA 13h 41.7m, dec. –33° 36') is a variable star and well placed in the evening sky for you to watch brighten this month. It's expected to reach a minimum of around mag. +8.5 in late March and by early May peak at about mag. +5.5. Being located only 1° southwest of mag. +4.2 star i Centauri, it can be easily found and its full cycle observed with binoculars. You can download a finder chart with comparison stars from www.aavso.org.

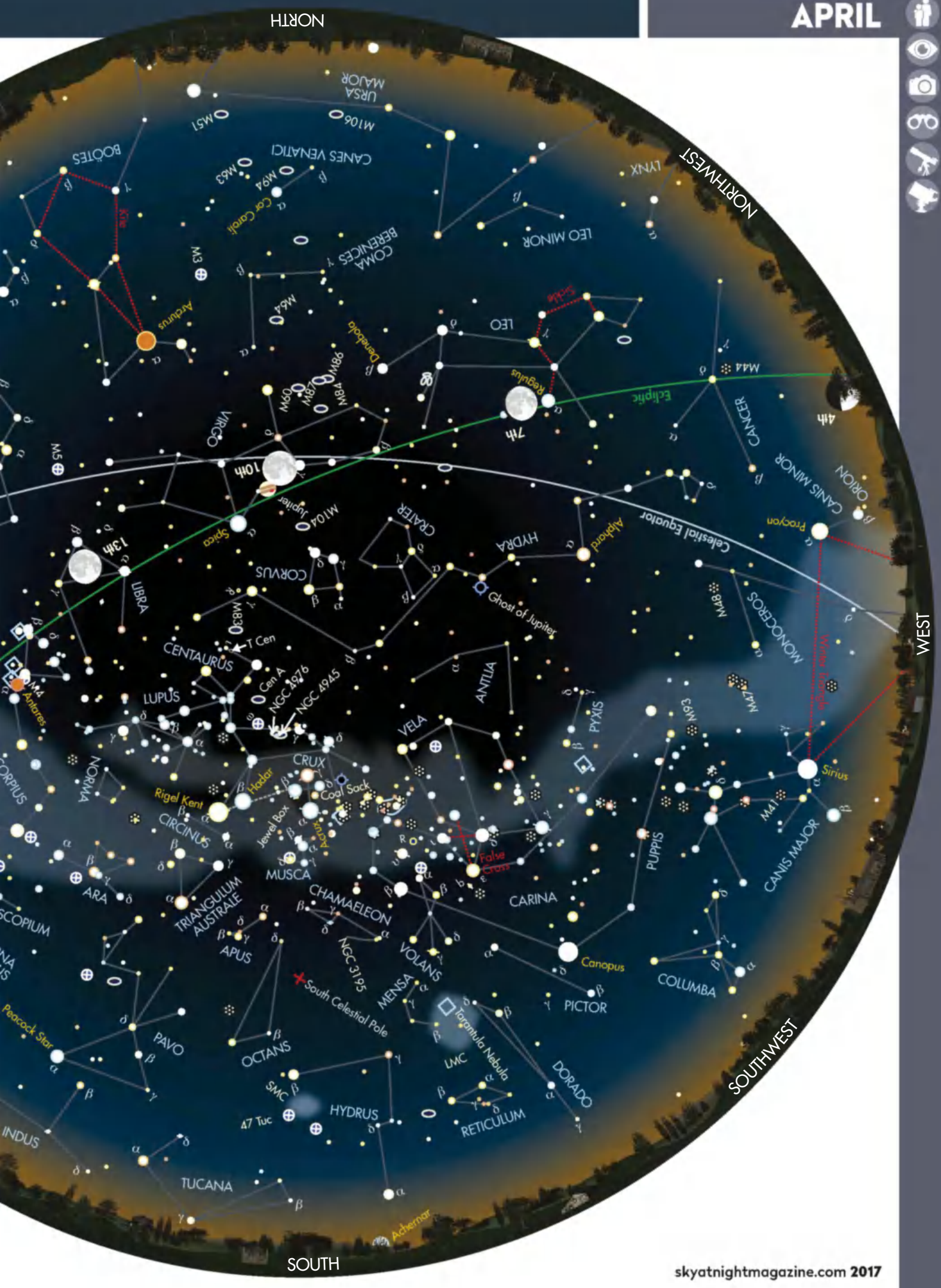
Centaurus is also home to the near edge-on spiral galaxy NGC 4945, which you can use to find the mag. +10 elliptical galaxy NGC 4976 (RA 13h 08.6m, dec. –49° 30'; pictured) that's only a low-power eyepiece field (0.5°) east of NGC 4945. It's elongated (3x2 arcminutes) with an obvious bright core.

CHART KEY

- GALAXY
- OPEN CLUSTER
- GLOBULAR CLUSTER
- PLANETARY NEBULA
- DIFFUSE NEBULOSITY
- DOUBLE STAR
- VARIABLE STAR
- COMET TRACK
- ASTEROID TRACK
- METEOR RADIANT
- QUASAR
- PLANET

STAR BRIGHTNESS:
- MAG. 0 & BRIGHTER
- MAG. +1
- MAG. +2
- MAG. +3
- MAG. +4 & FAINTER

CHART: PETE LAWRENCE, IMAGE: DANIEL VERSCHATSE/CCDGUIDE.COM


NORTH
NORTHWEST
WEST
SOUTHWEST
SOUTH
URSA MAJOR
M51
M106
CANES VENATICI
M63
M94
Cor Caroli
BOÖTES
Arcturus
Alkaid
LYNX
LEO MINOR
COMA BERENICES
M3
M64
LEO
Denebola
Regulus
Eclipse
M44
CANCER
CANIS MINOR
PROCYON
ORION
M86
M87
M84
M90
VIRGO
M5
10h
Jupiter
M104
Spica
7h
4h
Celestial Equator
CRATER
HYDRA
Alphard
13h
LIBRA
CORVUS
Ghost of Jupiter
MONOCEROS
M48
M83
T Cen
CENTAURUS
Cen A
NGC 4976
NGC 4945
M4
Antares
LUPUS
ANTLIA
VELA
PYXIS
M93
M47
Milky Way
Sirius
CRUX
Hadar
Rigel Kent
Coal Sack
Jewel Box
Acrux
NORMA
CIRCINUS
MUSCA
False Cross
PUPPIS
M41
CANIS MAJOR
ARA
TRIANGULUM AUSTRALE
CHAMAELEON
CARINA
SCOPIUM
APUS
NGC 3195
VOLANS
Canopus
COLUMBA
South Celestial Pole
MENSA
PICTOR
Peacock Star
PAVO
OCTANS
Tarantula Nebula
LMC
DORADO
SMC
47 Tuc
HYDRUS
RETICULUM
INDUS
TUCANA
Achernar

Sky-Watcher®

PARABOLIC DOBSONIANS

All these Sky-Watcher Dobsonian Models feature High Quality Parabolic Primary Mirrors to eliminate spherical aberrations.
The mirrors are 'parabolised' to bring all the light rays to the same focal point to produce sharp, contrasty images, which are full of detail.

HERITAGE-100P
4" (f/4)
Prod.Code 10245
SRP £109

HERITAGE-130P FLEXTUBE™
5.1" (f/5)
Prod.Code 10213
SRP £169

HERITAGE-114P VIRTUOSO™
4.5" (f/4.4)
Prod.Code 10240
SRP £219

SKYLINER CLASSIC DOBSONIANS

150P 6" (f/7.8)	Prod.Code 10716	SRP £259
200P 8" (f/5.9)	Prod.Code 10717	SRP £339
250P 10" (f/4.7)	Prod.Code 10668	SRP £499

Skyliner-200P Classic
SRP £339

Skyliner-300P FlexTube™
SRP £949

SKYLINER FLEXTUBE™ PARABOLIC DOBSONIANS

"Despite their great performance to cost ratio, Dobsonians can be rather bulky in larger apertures, but Sky-Watcher have addressed this with their innovative and aesthetically-pleasing Flextube™ range. With their collapsible tube design, these versatile instruments are easy to store and can be readied for observation at a moments notice. Ideal for deep-sky viewing; these scopes will also deliver stunning planetary images."
Ade Ashford, www.scopetest.com

SKYLINER FLEXTUBE™ DOBSONIANS

250P 10" (f/4.7)	Prod.Code 10157	SRP £599
300P 12" (f/4.9)	Prod.Code 10158	SRP £949
350P 14" (f/4.5)	Prod.Code 10228	SRP £1429
400P 16" (f/4.4)	Prod.Code 10230	SRP £1899

Skyliner-350P FlexTube Synscan™ Go-To
SRP £2149

SKYLINER FLEXTUBE SYNSCAN™ GO-TO DOBSONIANS

200P 8" (f/6)	Prod.Code 10224	SRP £879
250P 10" (f/4.7)	Prod.Code 10225	SRP £1099
300P 12" (f/4.9)	Prod.Code 10226	SRP £1649
350P 14" (f/4.5)	Prod.Code 10227	SRP £2149
400P 16" (f/4.4)	Prod.Code 10231	SRP £2699

StarGate-450P Parabolic Truss Tube Dobsonian
SRP £3699

STARGATE PARABOLIC TRUSS TUBE DOBSONIANS

450P 18" (f/4.1)	Prod.Code 10242	SRP £3699
450P 18" (f/4.1) Go-To	Prod.Code 10255	SRP £4699
500P 20" (f/4) Go-To	Prod.Code 10256	SRP £5499

Email us for a FREE copy of our 76 page Full Colour Optical Product Catalogue

Our Products are Available from Dealers throughout the UK — OVL — **Please contact us, or Check our Website for your Nearest Stockist**

OPTICAL VISION LTD
UNIT 3, WOOLPIT BUSINESS PARK
WOOLPIT, BURY ST. EDMUNDS
SUFFOLK IP30 9UP
Email: info@opticalvision.co.uk

OPTICAL VISION LIMITED

www.opticalvision.co.uk
www.barrandstroud.com

Importers and Distributors of Sky-Watcher Astronomical Telescopes, Helios, Acuter, Barr and Stroud Binoculars & Spotting Scopes and 'Zenith' Microscopes.