NWASNEWS

Volume22, Issue 5

January 2017

Newsletter for the Wiltshire, Swindon, Beckington Astronomical Societies and Salisbury Plain

HAPPY NEW YEAR

Tonight is our forum meeting and I have only received one set of questions on facebook and nothing from e-mail. I have included several articles on setting up telescopes and first telescope purchase in the full newsletter.

Please check this out on our website.

The Facebook page yields quite frequent interest and I put articles from the media on there as I see then.

Sorry for the confusion last month but it was outside our control, and Philip has exacted our annoyance with the committee member involved at the Lyefield Pavilion.

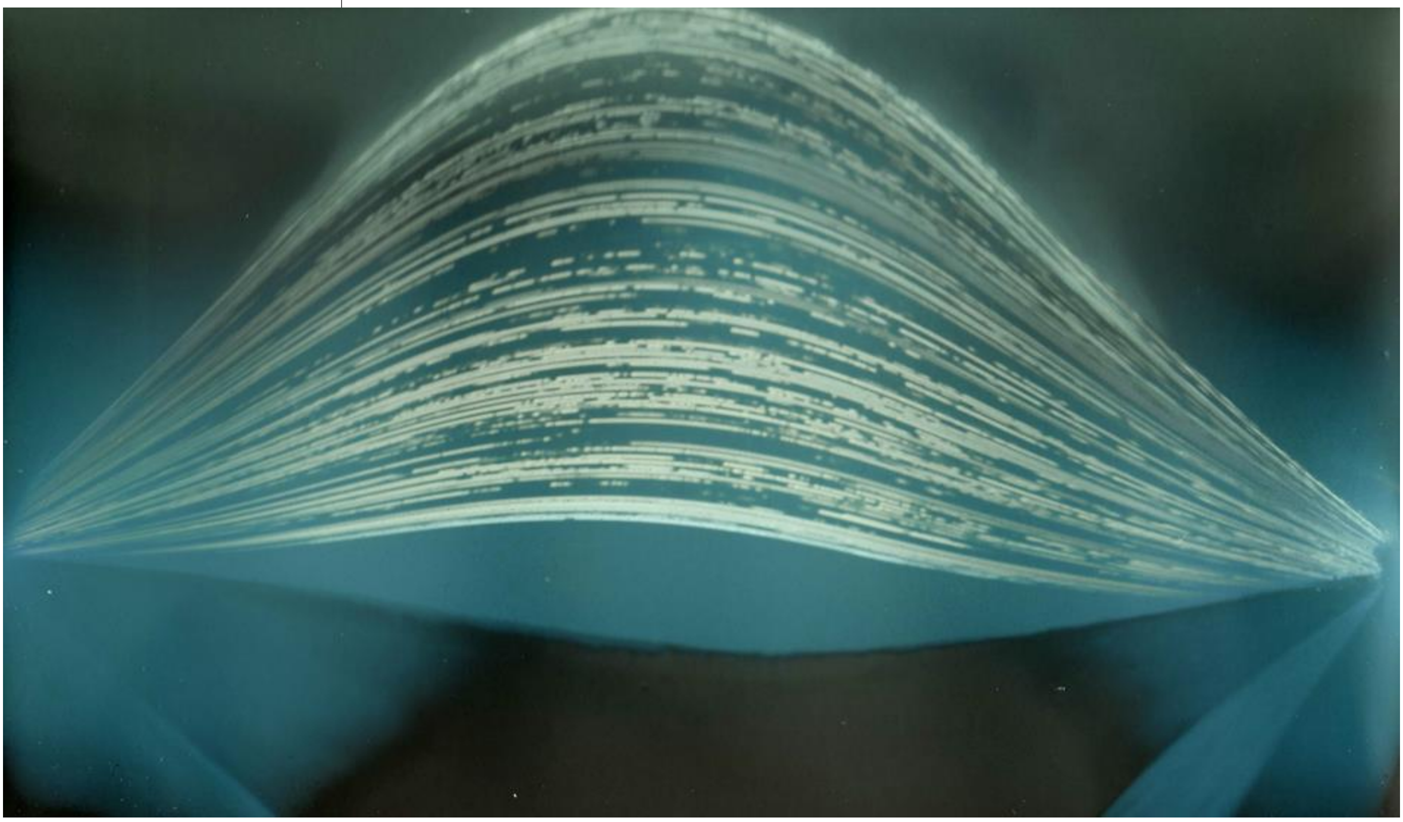
New year, more Windows issues not allowing access to into net at home so I have hurried through to finish this edition, hence the short introduction.

But a nice Moon with Mars and Venus out of the window…

Image is from last night...

Clear skies

Andy



Please find attached beer can pinhole camera Solargraphs which may be of interest for the WAS newsletter. This is a southern horizon solargraph of the Vale of Dauntsey overlooking the M4. I did not get the detail of the view but both show a the full east west sweep of the Sun from the Summer Solstice in June 2016 to the Winter Solstice in December 2016. I used Ilford Multigrade Photographic Paper for the six month exposure. A neighbour gave permission for me to set up the solargraphs taped to a fence in their garden.   John Dartnell

Wiltshire Society Page

Wiltshire Astronomical Society

Web site: www.wasnet.org.uk

Meetings 2015/2016Season.

NEW VENUE the Pavilion, Rusty Lane, Seend

Meet 7.30 for 8.00pm start

2016

3 Jan TBA (Probable beginners set up session)

7 Feb Professor david Southwood, 10 Years of Space Science at the European Space Agency

7 Mar Steve Tonkin, And yet it Moves!

4 Apr Dr Chris North, Telescopes through the Ages

2 May Martin Griffiths, Planetary Nebulae Marathon

6 Jun Mark Radice, Observing from the Caribbean + AGM

Membership Meeting nights £1.00 for members £3 for visitors

Wiltshire AS Contacts

Andy Burns (Chairman, and Editor) Tel: 01249 654541, email: anglesburns@hotmail.com

Vice chair: Keith Bruton

Bob Johnston (Treasurer)

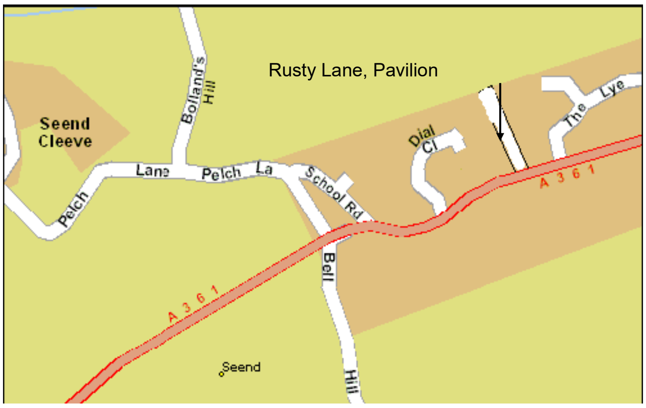
Philip Proven (Hall coordinator)

Peter Chappell (Speaker secretary)

Nick Howes (Technical Guru)

Observing Sessions coordinators: Jon Gale, Tony Vale

Contact via the web site details. This is to protect individuals from unsolicited mailings.



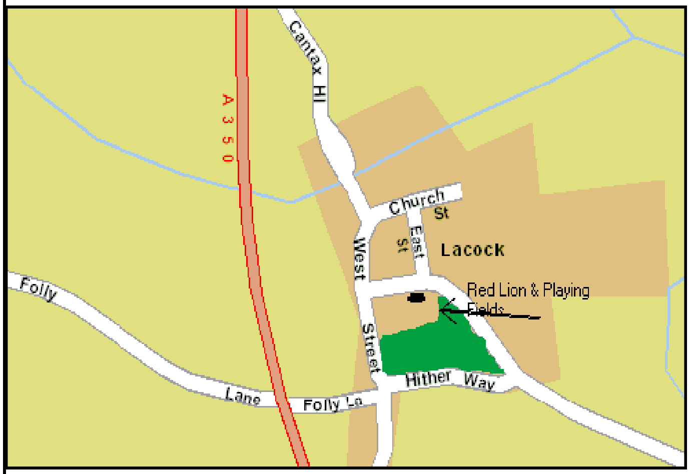
Observing Sessions

The Wiltshire Astronomical Society's observing sessions are open, and we welcome visitors from other societies as well as members of the public to join us.

We will help you set up equipment (as often as you need this help), and let you test anything we have to help you in your choice of future astronomy purchases.

Please treat the lights and return to full working order before leaving. With enough care shown we may get the National Trust to do something with them!

PLEASE see our proposed changes to the observing sessions, contacting and other details. Back Page



Swindon Stargazers

Swindon's own astronomy group

The club meets once a month at Liddington Hall, Church Road, Liddington, Swindon, SN4 0HB at 7.30pm. See programme below.

Sally Russell – Astronomical Sketching

Our January meeting sees the return of Sally Russell who is an amateur astronomer and accomplished artist who sketches the objects of the Cosmos.

Soon after you begin studying the sky through your small telescope or binoculars, you will probably be encouraged by others to make sketches of what you see. Sketching is a time-honoured tradition in amateur astronomy and dates back to the earliest times, when telescopes were invented. Even though we have lots of new imaging technologies nowadays, including astrophotography, most observers still use sketching to keep a record of what they see, make them better observers, and in hopes of perhaps contributing something to the body of scientific knowledge about the Moon. Some even sketch because it satisfies their artistic side.

Sally has also been published in *Sketching the Moon: An Astronomical Artist's Guide (The Patrick Moore Practical Astronomy Series,* and is regarded as one of the five best lunar observer-artists working today. The Moon presents some unique challenges to the astronomer-artist, the Moon being so fond of tricks of the light.

Ad-hoc viewing sessions

Regular stargazing evenings are being organised near Swindon. To join these events please visit our website for further information.

Lately we have been stargazing at Blakehill Farm Nature Reserve near Cricklade, a very good spot with no distractions from car headlights.

We often meet regularly at a lay-by just outside the village of Uffcott, near Wroughton. Directions are also shown on the website link below.

When we use East Kennett, we meet at the public car park just below The Red Lion pub at Avebury; we usually hang on for 10 minutes and then move on to our viewing spot at East Kennett. Information about our evenings and viewing spots can be found here:

http://www.swindonstargazers.com/noticeboard/noticeboard06.htm

If you think you might be interested email the organiser Robin Wilkey (see website). With this you will then be emailed regarding the event, whether it is going ahead or whether it will be cancelled because of cloud etc.

We are a small keen group and I would ask you to note that you DO NOT have to own a telescope to take part, just turn up and have a great evening looking through other people's scopes. We are out there to share an interest and the hobby. There's nothing better than practical astronomy in the great cold British winter! And hot drinks are often available, you can also bring your own.

Enjoy astronomy at it's best!

Members of the Wiltshire Astronomical Society always welcome!

At Liddington Village Hall, Church Road, Liddington, SN4 0HB – 7.30pm onwards

The hall has easy access from Junction 15 of the M4, a map and directions can be found on our website at:

http://www.swindonstargazers.com/clubdiary/directions01.htm

Meeting Dates for 2017:

Friday 20 January 2017
Programme: Sally Russell - Astronomical Sketching

Friday 17 February 2017

Programme: David Boyd - Spectroscopy

Friday 17 March 2017

Programme: AGM plus Dr Bob Gatten - Using the Faulkes Telescope Project's remote telescopes, results so far

Friday 24 April 2017

Programme: Dr Pauline Norris - The Ancient Egyptians and their Astronomy

Friday 19 May 2017

Programme: Martin Griffiths - Contact with extraterrestrials, how will it affect us

Friday 16 June 2017

Programme: Paul Roche - Robotic Astronomy

---------SUMMER BREAK--------

Friday 15 September 2017

Programme: Prof. Richard Harrison MBE BSc Phs FRAS FinstP - Space Weather

Friday 20 October 2017

Programme: Steve Tonkin - Binocular Astronomy

Friday 17 November 2017

Programme: Mike Leggett: Exploration of Mars

Friday 15 December 2017

Programme: Christmas Social

Website:

http://www.swindonstargazers.com
Chairman: Peter Struve

Tel No: 01793 481547
Email: peter.struve@sky.com
Address: 3 Monkton Close, Park South, Swindon, SN3 2EU

Secretary: Dr Bob Gatten (PhD)
Tel Number: 07913 335475

Email: bob.gatten@ntlworld.com

Address: 17, Euclid Street,

Swindon, SN1 2JW

BECKINGTON ASTRONOMICAL SOCIETY

Society Details & Speakers programme can be found on our Web-site www.beckingtonas.org

General enquiries about the Society can be emailed to chair-man@beckingtonas.org.

Our Committee for 2016/2017 is

Steve Hill-----------Chairman- 01761 435663

John Ball-----------Vice Chairman- 01373 830419

………….john@abbeylands1.freeserve.co.uk

Sandy Whitton---- Secretary-07974-841239

…………………..sandy.whitton@blueyonder.co.uk

Jacky Collenette---Treasurer…collenettejacqueline@yahoo.co.uk

Mike Witt---------- Membership-………mjwitt@blueyonder.co.uk.

John Dolton------Committee…. member@jdolton.freeserve.co.uk

Meetings take place in Beckington Baptist Church Hall in Beck-ington Village near Frome.

See the location page for details of how to find us on our web-site…………

Post Code for Sat Nav is BA11 6TB.

Our start time is 7.30pm.

Programme details for 2016/2017

2016

Jan 20th: Tales from the Dark Side (Pt. 2)………. Mike Witt

Feb 17th: A Very Victorian Scientist……………. Andy Burns

Mar 17th: The Sun……………………………….. Ron Westmaas

Apr 21st: Observing the Solar System……………. Mark Radice

May 19th: Imaging Colloquium `Open discussion bring your kit along`……………… Steve Hill.

All are welcome to come along for a chat from beginners to ex-perts.

SALISBURY PLAIN OBSERVING GROUP

Where do you meet?

We meet at a variety of sites, including Pewsey Downs, Everleigh, Bratton Camp, Redhorn Hill and Whitesheet Hill. The sites are cold in winter so you will need warm clothing and a flask. We are always looking for good sites around the edge of the Plain.

Do I join?

No. We are not a club. We meet informally, so aside from contacting our friends to give a yes or no to meet-ing up, that's it.

I am a beginner—am I welcome?

Of course you are — whether you have a telescope, binoculars or just your eyes, there will be someone to observe with. We have a variety of equipment and are always happy for newcomers to look through.

So I just turn up?

Essentially yes, but please drop us an email as parking can be an issue at some of the meeting areas or at the pubs.

I am more experienced—what's in it for me?

If you have observing experience we prepare a monthly observing list chosen in rotation by the group. We pick some easy objects, some moderate and some tough ones. If you are experienced, why not share what you know?

Any ground rules for a session?

Common sense applies in the group; red light is essen-tial to preserve night vision; we park cars so you can leave when you wish and not disturb others with your headlights.

Contact Details

Our Website

www.spogastro.co.uk

Our Email

spogastro@googlemail.com

Twitter

http://twitter.com/SPOGAstro

Facebook

http://www.facebook.com/group.php?gid=119305144780224

Big Science in Small Packages

By Marcus Woo

About 250 miles overhead, a satellite the size of a loaf of bread flies in orbit. It's one of hundreds of so-called CubeSats—spacecraft that come in relatively inexpensive and compact packages—that have launched over the years. So far, most CubeSats have been commercial satellites, student projects, or technology demonstrations. But this one, dubbed MinXSS ("minks") is NASA's first CubeSat with a bona fide science mission.

Launched in December 2015, MinXSS has been observing the sun in X-rays with unprecedented detail. Its goal is to better understand the physics behind phenomena like solar flares – eruptions on the sun that produce dramatic bursts of energy and radiation.

Much of the newly-released radiation from solar flares is concentrated in X-rays, and, in particular, the lower energy range called soft X-rays. But other spacecraft don't have the capability to measure this part of the sun's spectrum at high resolution—which is where MinXSS, short for Miniature Solar X-ray Spectrometer, comes in.

Using MinXSS to monitor how the soft X-ray spectrum changes over time, scientists can track changes in the composition in the sun's corona, the hot outermost layer of the sun. While the sun's visible surface, the photosphere, is about 6000 Kelvin (10,000 degrees Fahrenheit), areas of the corona reach tens of millions of degrees during a solar flare. But even without a flare, the corona smolders at a million degrees—and no one knows why.

One possibility is that many small nanoflares constantly heat the corona. Or, the heat may come from certain kinds of waves that propagate through the solar plasma. By looking at how the corona's composition changes, researchers can determine which mechanism is more important, says Tom Woods, a solar scientist at the University of Colorado at Boulder and principal investigator of MinXSS: "It's helping address this very long-term problem that's been around for 50 years: how is the corona heated to be so hot."

The $1 million original mission has been gathering observations since June.

The satellite will likely burn up in Earth's atmosphere in March. But the researchers have built a second one slated for launch in 2017. MinXSS-2 will watch long-term solar activity—related to the sun's 11-year sunspot cycle—and how variability in the soft X-ray spectrum affects space weather, which can be a hazard for satellites. So the little-mission-that-could will continue—this time, flying at a higher, polar orbit for about five years.

If you'd like to teach kids about where the sun's energy comes from, please visit the NASA Space Place: http://spaceplace.nasa.gov/sun-heat/

Astronaut Tim Peake on board the International Space Station captured this image of a CubeSat deployment on May 16, 2016. The bottom-most CubeSat is the NASA-funded MinXSS CubeSat, which observes soft X-rays from the sun—such X-rays can disturb the ionosphere and thereby hamper radio and GPS signals. (The second CubeSat is CADRE — short for CubeSat investigating Atmospheric Density Response to Extreme driving - built by the University of Michigan and funded by the National Science Foundation.) Credit: ESA/NASA

The Astronomers Bookshelf: Commencing your collection

Jonathan Gale

Once you start amassing astronomy books, your bookshelves will groan under the weight of your purchases, so this month's column aims to give you some ideas to make those first ones the foundation of your collection.

Since you've read last month's article, I hope you have now bought that shiny new atlas (I am guessing it was the Pocket Sky Atlas, or maybe the Deep Sky Reistalas?) so now you need some ideas of what to look for and some information about what you are seeing. Nearly all the books mentioned are on my bookshelves and have been used in planning my observing, or out in the field at the eyepiece.

If there is one book, and one book only you buy, make it "Nightwatch" by Terence Dickinson. This is considered to be amongst the best, if not the best, introduction to astronomy and for understanding what is going on up in the night sky. "Nightwatch" gives you essential information on telescopes, binoculars and useful astronomical equipment, together with star charts for the seasons and well-illustrated explanations of the celestial sphere and the objects you can observe. It is also fairly rugged so could be used in the field.

One step up from this is the "Backyard Astronomer's Guide" co-authored by Terence Dickinson and Alan Dyer, which gives more in-depth information on equipment, delving to the depths of filters, along with the rather more quirky observing aids such as electric focusers. Since I bought my edition it has been updated so make sure you get the latest version.

If you want a smaller pocket size format, try "Stargazing: Beginners guide to astronomy" by Tom Kerrs and Radmila Topalovic. Recently reviewed by a BAA member in the December Journal, it got the nod of approval so it should be worth adding to the shortlist.

The Moon being regular and readily observable is the first object the beginner looks at and may remain hooked on for the rest of their lives. There is of course a vast amount of detail to be observed on the moon, so a good guidebook is essential. Lacroux and Legrand's "Discover the Moon" from Cambridge is an excellent start to give the novice a night by night guide to features revealed as the phase progresses. Each night has a main map of the phase with the major features marked, then more detailed images with the features described. One of the strengths of the book is the whole Moon maps which are shown for binocular, refractors, reflectors and SCT's enabling quick orientation with the lunar surface.

The late Peter Grego produced the excellent "Moon Observers Guide" which gives more detail, and sketched maps to find your way around. If you just want a general map, then Phillips publish a large wall chart you can have endless fun folding and refolding to find the area you want, or maybe purchase the "Reiseatlas Du Mond" from Oculum. As with the deep sky version, this atlas has quite detailed photographic maps again with laminated pages. I find that the photo maps suit me rather better than the hand drawn ones in Peter Grego's book, especially if you are following a program such as the Lunar 100.

The budding deep sky observer is spoilt by the choice on the bookshop shelves, with plenty to occupy the binoculars or telescope. Most beginners wisely purchase "Turn Left at Orion" which is an excellent start and competently does the job of introducing the observer to finding objects and becoming acquainted with the basics of star hopping, plus some useful information on the care and feeding of your telescope. The authors, Guy Consolmagno and Dan Davis have produced a classic book which is now in its 4th edition and spirally bound for use outdoors.

For binocular observers, my top observing book is Gary Seronik's "Binocular Highlights", published by Sky and Telescope. Grouped by the seasons, Gary gives some well and not so well known objects to pursue, with good finder maps and explanations. It is also spiral bound so very suitable for folding flat, a fact that you never anticipate you need until you are observing and become irritated by a book closing itself.

Alternatively, taking a walk on the wild side, try "Viewing the Constellations with Binoculars: 250+ Wonderful Sky Objects to See and Explore" by the exotically named Bojan Kambic. One main difference between this and other binocular books I have, is that it rates each object on its "excitability" of observation - will it blow your socks off or not!

The Messier catalogue is the novice observers training ground and you could run your first Messier Marathon using Harvard Pennington's "All Year Round Messier Marathon". This has excellent charts and is an upbeat guide to finding these 110 objects and logging them. If you want rather more background or science, then try Steve O'Meara's "The Messier Objects" or Ronald Stoyan's "Encyclopaedia of the Messier Objects", which is considered to be the definitive work on the subject.

"101 Astronomical Wonders" by Barbara and Alan Thompson is a good next step from the Messier catalogue as it weaves in NGC and IC objects, along with equipment advice, and giving coverage to the use of filters, a subject guaranteed to provoke heated discussion amongst astronomical folk.

My first dedicated deep sky book was Neil Bone's "Deep Sky Observer's Handbook" published by Phillips. His observations were made with an 80mm refractor, with some of his sketches accompanying the text. There is quite a wide choice to hunt for and it is a handy pocket size. In practice the finder charts were a bit limiting for me, so partner it with a good atlas for field use.

After reading Mr Bone's book, I became acquainted with Steve Coe, a lifelong amateur astronomer and an author who writes with more enthusiasm and dedication than many I know. His recent second edition of the "Deep Sky Astronomical Tourist" published by Springer, is a worthwhile purchase as it has good chapters on equipment, techniques, together with observations and sketches of many different objects in a variety of instruments.

So where to go from here? There are many, many, deep sky books but I would suggest anything by Steve O'Meara, or the very practical "Night Sky Observer's Guide" from Willmann Bell. Whilst they are not cheap, they are the fundamental toolkit of the intermediate observer who wants objects and finder charts to peruse.

If you prefer some science and astronomical biography weaved into your reading, then the "Annals of the Deep Sky" are for you. Very recently published, they have up to date astrophysical information on a constellation by constellation basis with a selection of objects to view and read up on.

Whilst the Internet and mobile apps can provide monthly "what's up in the night sky" information, there is nothing like flipping through an annual sky guide to see what is observable and plan your program to suit. For the past 50 years, Patrick Moore edited the "Yearbook of Astronomy", and then by John Mason following Patrick's demise. Last year's edition was sadly the penultimate though as the publishers have now discontinued it, so in terms of a replacement, we can only await an independent replacement due March/April 2017.

Ian Ridpath's "Monthly Sky Guide" covers several years from its publication date and gives sky maps for the northern hemisphere and a brief monthly narrative for planets and constellations. Whilst this is a good *printed* book, a word of caution for Kindle lovers in that the book translates poorly to this format. I bought a copy in a hurry and regretted it.

In my search for a replacement for the Yearbook (at least the monthly information), I came across Heather Couper and Nigel Henbest's "Stargazing 2017". This low cost paperback gives the necessary monthly information for constellations and planets to keep you occupied throughout the year. I have purchased a copy and so far it seem to be good.

If you a fan of older books, one of my favourites dates back to 1948! “The Night Sky” was written by Dr Guy Porter, who gave regular radio astronomical broadcasts prior to Patrick Moore’s days. This wonderful little book begins in October and takes you on a trip around the sky each month, acquainting you with the constellations and what you can see. Modern books are of course lavishly illustrated, but I enjoy the simplicity of the line drawings and the very readable style of the author. You can download a pdf copy from the Internet Archive using the address at the end of this column.

So a few titles to get you started in your observing life. By no means an exhaustive list, don’t forget there is a treasure trove of “out of print” books found on the second hand market and are of value both from a historical perspective and for the hints, tips and wisdom from past observers. Remember too, that once the collection is begun, there is always another book to purchase, another slot to fill on the book shelf and another entry in the book catalogue to be made.

Jonathan Gale

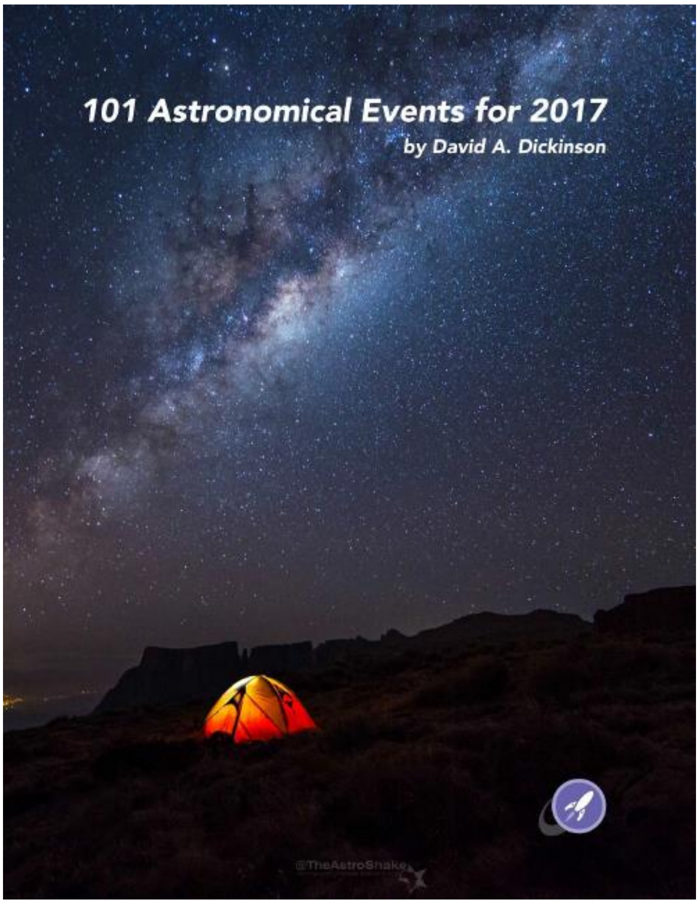
Web Links

JG Porter’s “The Night Sky”

https://archive.org/details/TheNightSky

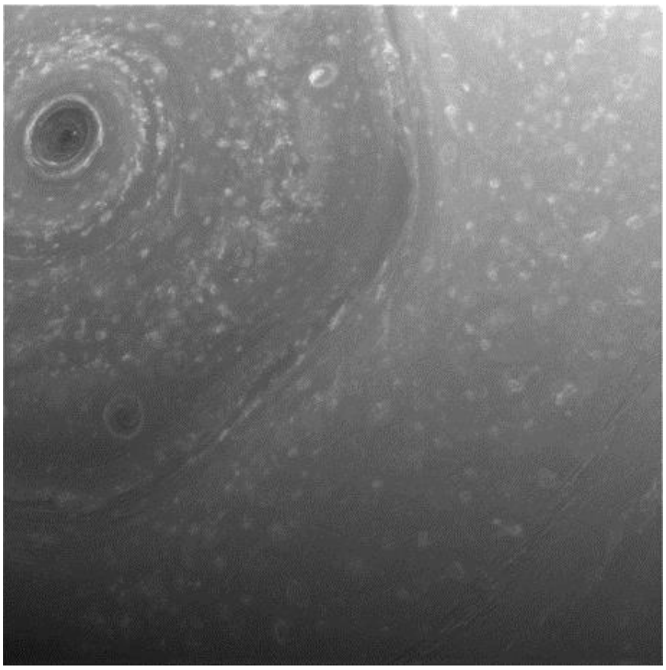
Andy:

One I would add to the list as an on line guide for the years events from The Universe Today website. This free and is now compiled by David Dickenson a well known eyeball mark 1 observer. He has taken over from the late much lamented Tammy Plotner who died at the end of 2015.



SPACE and ASTRONOMY NEWS

Cassini beams back first images from new orbit



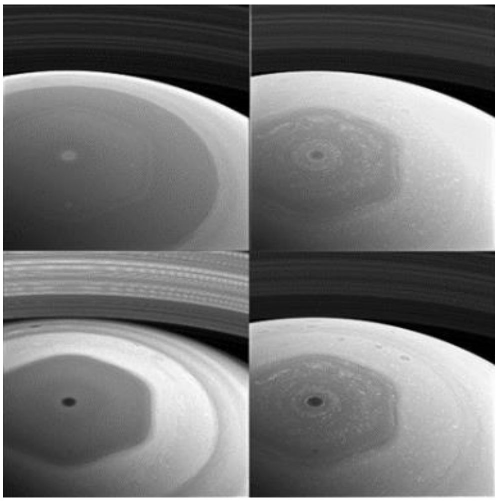
9 December 2016 Astronomy Now

This view from NASA’s Cassini spacecraft was obtained about half a day before its first close pass by the outer edges of Saturn’s main rings during its penultimate mission phase. Image: NASA/JPL-Caltech/Space Science Institute.

NASA’s Cassini spacecraft has sent to Earth its first views of Saturn’s atmosphere since beginning the latest phase of its mission. The new images show scenes from high above Saturn’s northern hemisphere, including the planet’s intriguing hexagon-shaped jet stream.

Cassini began its new mission phase, called its Ring-Grazing Orbits, on 30 November. Each of these weeklong orbits — 20 in all — carries the spacecraft high above Saturn’s northern hemisphere before sending it skimming past the outer edges of the planet’s main rings.

Cassini’s imaging cameras acquired these latest views on 2 and 3 December, about two days before the first ring-grazing approach to the planet. Future passes will include images from near closest approach, including some of the closest-ever views of the outer rings and small moons that orbit there.



This collage of images from NASA’s Cassini spacecraft shows Saturn’s northern hemisphere and rings as viewed with four different spectral filters. Each filter is sensitive to different wavelengths of light and reveals clouds and hazes at different altitudes. Image: NASA/JPL-Caltech/Space Science Institute.

"This is it, the beginning of the end of our historic exploration of Saturn. Let these images — and those to come — remind you that we've lived a bold and daring adventure around the solar system's most magnificent planet," said Carolyn Porco, Cassini imaging team lead at Space Science Institute, Boulder, Colorado.
The next pass by the rings' outer edges is planned for 11 December. The ring-grazing orbits will continue until 22 April, when the last close flyby of Saturn's moon Titan will once again reshape Cassini's flight path. With that encounter, Cassini will begin its Grand Finale, leaping over the rings and making the first of 22 plunges through the 2,400-kilometre-wide (1,500-mile) gap between Saturn and its innermost ring on 26 April.
On 15 September, the mission's planned conclusion will be a final dive into Saturn's atmosphere. During its plunge, Cassini will transmit data about the atmosphere's composition until its signal is lost.
Launched in 1997, Cassini has been touring the Saturn system since arriving in 2004 for an up-close study of the planet, its rings and moons. Cassini has made numerous dramatic discoveries, including a global ocean with indications of hydrothermal activity within the moon Enceladus, and liquid methane seas on another moon, Titan.

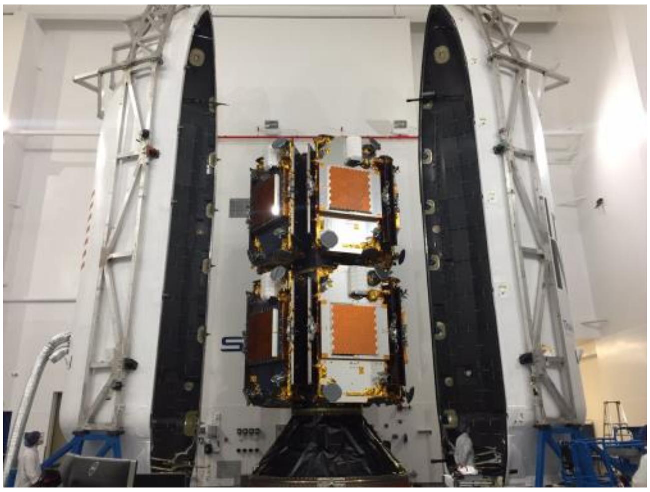
SpaceX Finds Failure Cause, Announces Sunday Jan. 8 as Target for Falcon 9 Flight Resumption

Article Updated: 3 Jan , 2017

by Ken Kremer

Upgraded SpaceX Falcon 9 blasts off with Thaicom-8 communications satellite on May 27, 2016 from Space Launch Complex 40 at Cape Canaveral Air Force Station, FL. 1st stage booster landed safely at sea minutes later. Credit: Ken Kremer/kenkremer.com

After an intensive four month investigation into why a SpaceX Falcon 9 rocket exploded without warning on the launch pad last September, the company today announced the failures likely cause as well as plans of a rapid resumption of flights as soon as next Sunday, Jan. 8, from their California launch complex – carrying a lucrative commercial payload of 10 advanced mobile relay satellites to orbit for Iridium Communications.
"Targeting return to flight from Vandenberg with the @IridiumComm NEXT launch on January 8," SpaceX announced on their website today, Monday, Jan. 2., 2017.
"Our date is now public. Next Sunday morning, Jan 8 at 10:28:07 pst. Iridium NEXT launch #1 flies!" Iridium Communications CEO Matt Desch quickly confirmed by tweet today, Jan 2.
SpaceX has been dealing with the far reaching and world famous fallout from the catastrophic launch pad explosion that eviscerated a Falcon 9 and its expensive $200 million Israeli Amos-6 commercial payload in Florida without warning, during a routine preflight fueling test on Sept. 1, 2016, at pad 40 on Cape Canaveral Air Force Station.



The first ten IridiumNEXT satellites are stacked and encapsulated in the Falcon 9 fairing for launch from Vandenberg Air Force Base, Ca., in early 2017. Credit: Iridium

After the Sept. 1 accident at pad 40, SpaceX initiated a joint investigation to determine the root cause with the FAA, NASA, the US Air Force and industry experts who have been "working methodically through an extensive fault tree to investigate all plausible causes."
"We have been working closely with NASA, and the FAA [Federal Aviation Administration] and our commercial customers to understand it," said SpaceX CEO Elon Musk.
Via the "fault tree analysis" the Sept. 1 anomaly has been traced to a failure in one of three helium storage tanks located inside the second stage liquid oxygen (LOX) tank of the Falcon 9 rocket, according to a statement released by SpaceX today which provided some but not many technical details.
The failure apparently originated at a point where the helium tank "buckles" and accumulates oxygen – "leading to ignition" of the highly flammable liquid oxygen propellant in the second stage.

SpaceX Falcon 9 rocket moments after catastrophic explosion destroys the rocket and Amos-6 Israeli satellite payload at launch pad 40 at Cape Canaveral Air Force Station, FL, on Sept. 1, 2016. A static hot fire test was planned ahead of scheduled launch on Sept. 3, 2016. Credit: USLaunchReport

The helium tanks – also known as composite overwrapped pressure vessels (COPVs) – are used in both stages of the Falcon 9 to store cold helium which is used to maintain tank pressure.
"The accident investigation team worked systematically through an extensive fault tree analysis and concluded that one of the three composite overwrapped pressure vessels (COPVs) inside the second stage liquid oxygen (LOX) tank failed."
"Each COPV consists of an aluminum inner liner with a carbon overwrap."
"Specifically, the investigation team concluded the failure was likely due to the accumulation of oxygen between the COPV

liner and overwrap in a void or a buckle in the liner, leading to ignition and the subsequent failure of the COPV."
SpaceX says investigators identified "an accumulation of super chilled LOX or SOX in buckles under the overwrap" as "credible causes for the COPV failure."
Apparently the super chilled LOX or SOX can pool in the buckles and react with carbon fibers in the overwrap – which act as an ignition source.
"Investigators concluded that super chilled LOX can pool in these buckles under the overwrap. When pressurized, oxygen pooled in this buckle can become trapped; in turn, breaking fibers or friction can ignite the oxygen in the overwrap, causing the COPV to fail."
Very concerning to this author is the fact that the helium loading conditions are confirmed to be so low that they can actually freeze the liquid oxygen into solid form. Thus it cannot flow freely and significantly increases the chances of a "friction ignition."
This same Falcon 9 rocket will be used to launch our astronauts to the ISS in 2018 – seated inside a Crew Dragon atop the helium tank bathed in super chilled LOX.
"Investigators determined that the loading temperature of the helium was cold enough to create solid oxygen (SOX), which exacerbates the possibility of oxygen becoming trapped as well as the likelihood of friction ignition."
SpaceX says they will address the causes of the mishap through a mix of both short term and long term "corrective actions."
"The corrective actions address all credible causes and focus on changes which avoid the conditions that led to these credible causes."
The short term fixes involve simpler changes to the COPV configuration and modifying the helium loading conditions.
"In the short term, this entails changing the COPV configuration to allow warmer temperature helium to be loaded, as well as returning helium loading operations to a prior flight proven configuration based on operations used in over 700 successful COPV loads."
The long term fixes involve changing the COPV hardware itself and will take longer to implement. They are also likely to be more effective – but only time will tell.
"In the long term, SpaceX will implement design changes to the COPVs to prevent buckles altogether, which will allow for faster loading operations."
Liftoff of the SpaceX Falcon 9 with the payload of 10 identical next generation IridiumNEXT communications satellites will take place from Space Launch Complex 4E on Vandenberg Air Force Base in California – assuming the required approval is first granted by the Federal Aviation Administration (FAA).
No Falcon 9 launch will occur until the FAA gives the 'GO.'
Furthermore, in anticipation of announcing the targeted 'Return to Flight' launch date, technicians have already processed the Falcon 9 rocket for the 'Return to Flight' blastoff with the vanguard of a fleet of IridiumNEXT mobile voice and data relay satellites for Iridium Communications – as I reported last week in my story here – and subsequently tweeted by Iridium CEO Matt Desch saying "Nice recap."

IridiumNEXT satellites being fueled, pressurized & stacked on dispenser tiers at Vandenberg AFB for Falcon 9 launch. Credit: Iridium

Last week, the first ten IridiumNEXT mobile voice and data relay satellites were fueled, stacked and tucked inside the nose cone of the Falcon 9 rocket designated as SpaceX's 'Return to Flight' launcher in order to enable a blastoff as soon as possible after an approval is received from the FAA.
"Iridium is pleased with SpaceX's announcement on the results of the September 1 anomaly as identified by their accident investigation team, and their plans to target a return to flight on January 8 with the first Iridium NEXT launch" Iridium Communications said on their website today, Jan. 2.

Iridium's SpaceX Falcon9 rocket in processing at Vandenberg Air Force Base, getting ready for launch in early Jan. 2017. Credit: Iridium

The Iridium 1 mission is the first of seven planned Falcon 9 launches – totaling 70 satellites.
"Iridium is replacing its existing constellation by sending 70 Iridium NEXT satellites into space on a SpaceX Falcon 9 rocket over 7 different launches," says Iridium.
The goal of this privately contracted mission is to deliver the first 10 Iridium NEXT satellites into low-earth orbit to inaugurate what will be a new constellation of satellites dedicated to mobile voice and data communications.
Iridium eventually plans to launch a constellation of 81 Iridium NEXT satellites into low-earth orbit.
"At least 70 of which will be launched by SpaceX," per Iridium's contract with SpaceX.

Comet: 45P/Honda-Mrkos-Pajdusakova

Article Updated: 25 Dec , 2016

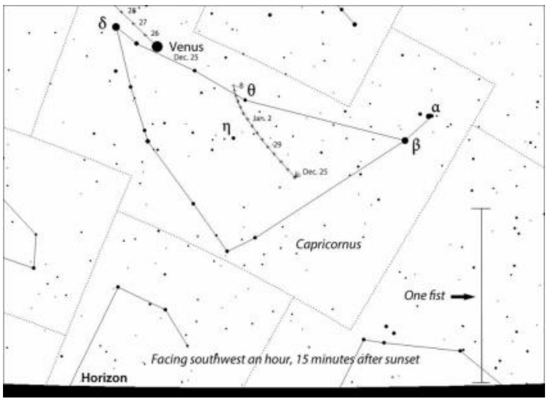
by Bob King

Comet 45P/Honda-Mrkos-Pajdusakova captured in its glory on Dec. 22, 2016. It displays a bright, well-condensed blue-green coma and long ion or gas tail pointing east. Comet observers take note: a Swan Band filter shows a larger coma and increases the comet's contrast. Credit: **Gerald Rhemann**

Merry Christmas and Happy Holidays all! I hope the day finds you in the company of family or friends and feeling at peace. While we've been shopping for gifts the past few weeks, a returning comet has been brightening up in the evening sky. Named **45P/Honda-Mrkos-Pajdusakova**, it returns to the hood every 5.25 years after vacationing beyond the planet Jupiter. It's tempting to blow by the name and see only a jumble of letters, but let's try to pronounce it: HON-da — MUR-Koz — PIE-doo-sha-ko-vah. Not too hard, right?

Tonight, the comet will appear about 12. 5 degrees to the west of Venus in central Capricornus. You can spot it near the end of evening twilight. Use larger binoculars or a telescope. Stellarium

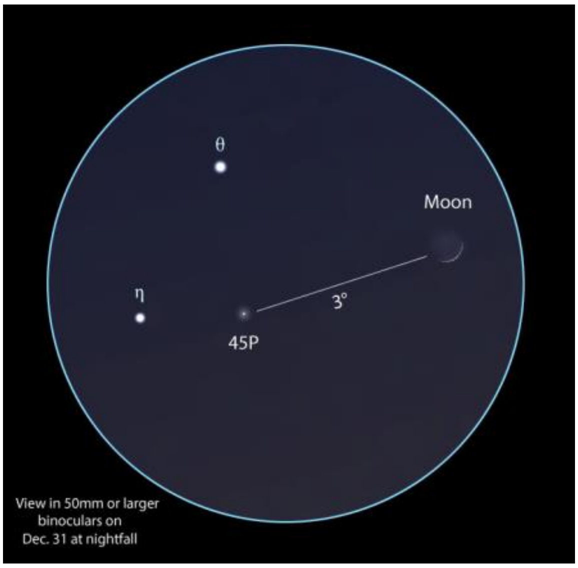
Comet 45P is a short period comet — one with an orbital period of fewer than 200 years — discovered on December 3, 1948 by **Minoru Honda** along with co-discoverers Antonin Mrkos and Ludmila Pajdusakova. Three names are the maximum a comet can have even if 15 people simultaneously discover it. 45P has a history of brightening rapidly as it approaches the sun, and this go-round is proof. A faint nothing a few weeks back, the comet's now magnitude +7.5 and visible in 50mm or larger binoculars from low light pollution locations. You can catch it right around the end of dusk this week and next as it arcs across central Capricornus not far behind the brilliant planet Venus. 45P will look like a dim, fuzzy star in binoculars, but if you can get a telescope on it, you'll see a fluffy, round coma, a bright, star-like center and perhaps even a faint spike of a tail sticking out to the east. Time exposure photos reveal a tail at least 3° long and a gorgeous, aqua-tinted coma. I saw the color straight off when observing the comet several nights ago in my 15-inch reflector at low power (64x).



Use this map to help you follow the comet night to night. Tick marks start this evening (Dec. 25) and show its nightly position through Jan. 8 around 6 p.m. local time or about an hour and 15 minutes after sunset. Venus, at upper left, is shown through the 28th with stars to magnitude +7. Click the chart for a larger version you can save and print out for use at your telescope. Created with Chris Marriott's SkyMap software

Right now, and for the remainder of its evening apparition, 45P will never appear very high in the southwestern sky. Look for it a little before the end of evening twilight, when the sky is reasonably dark and the comet is as high as it gets — about a fist above the horizon as seen from mid-northern latitudes. That's pretty low, so make the best of your time. I recommend you being around 1 hour 15 minutes after sunset.

The further south you live, the higher 45P will appear. To a point. It hovers low at nightfall this month and next. That will change in February when the comet pulls away from the sun and makes a very close approach to the Earth while sailing across the morning sky.



How about a helping hand? On New Year's Eve, the 2-day-old crescent Moon will be just a few degrees from 45P. This simulation shows the view through 50mm or larger binoculars with an ~6 degree field of view for the Central time zone. Map: Bob King, Source: Stellarium

45P reaches perihelion or closest distance to the sun on Dec. 31 and will remain visible through about Jan. 15 at dusk. An approximately 2-week hiatus follows, when it's lost in the twilight glow. Then in early February, the comet reappears at dawn and races across Aquila and Hercules, zipping closest to Earth on Feb. 11 at a distance of only 7.7 million miles. During that time, we may even be able to see this little fuzzball with the naked eye; its **predicted magnitude of +6** at maximum is right at the naked eye limit. Even in suburban skies, it will make an easy catch in binoculars then.

I'll update with new charts as we approach that time, plus you can check out **this earlier post** by fellow Universe Today writer David Dickinson. For now, enjoy the prospect of 'opening up' this cometary gift as the last glow of dusk subsides into night.

What type of telescope should I buy?

A good all-round beginner's telescope is a Newtonian reflector (below). It's a simple design and is relatively cheap for the size of mirror you'll get for your money – ideal if you're just starting out.

A Newtonian reflector 6 inch (150mm) mirror will give you good views of the brighter galaxies and nebulae, and should also perform well when you train it on the Moon and planets.

But what about the other types of telescope? Well, refractors are perhaps the most recognisable of all designs. They use a series of lenses to bring what you're looking at to focus at the eyepiece end of the tube, and are great for observing the Moon or rich star clusters.

There's also the Dobsonian, which is a type of reflector that has a simple mount and because of that, often has a much larger mirror for its price. As this collects more light it will let you see dimmer objets, so it's a great choice if you want to see faint galaxies and nebulae.

Finally, there are the catadioptric telescopes that use a combination of corrector lenses and mirrors. Their compact size makes them relatively portable and their high focal ratios mean that they're ideal for lunar and planetary observing.

What do all the numbers on a telescope mean?

When you're buying a car you want to know how fast it can go, how big the boot is and how many miles per gallon you'll get. A telescope is no different, so let's look at some of the specifications you'll need to know.

The first important spec is the size of the telescope's front lens or main mirror – its 'aperture', which is measured in millimetres today, but is often given in the more traditional inches. The bigger a telescope's mirror or lens, the more light can be captured and the brighter distant celestial objects will appear.

The quality of the lenses is also very important. Before you buy, ask to have a look through it in daylight at a distant object. When it's in focus, a telescope with quality lenses should show clear crisp edges to objects in its field of view.

You'll also encounter the 'f number', which is the focal ratio of the scope – the focal length divided by the aperture. The higher the focal ratio, the narrower the field of view that you see in the eyepiece. So if you want to study small features on the Moon, then a scope with a high focal ratio is for you.

You'll sometimes hear people referring to a telescope's focal ratio as its speed. Scopes with low focal ratios, like f/5, are said to be fast, while high focal ratios like f/10 are slow.

Finally, don't be fooled by claims of massive magnification – that's not the measure of a good telescope. Even poor telescopes can magnify things many times.

What is the mount for?

The mount is the most important part of the telescope. A telescope with superb optics will always be let down by a poor-quality mount: if you can't keep the optics stable, your view of the night sky will be completely ruined, so make sure that the mount is sturdy. The heavier the mount is the better it will be, because it will be a solid platform for the telescope to rest on.

However, its weight has obviously got to be offset by how portable you want your telescope to be. It shouldn't have any flimsy plastic parts and it should never flex or wobble noticeably.

There are two main types of mount that you'll come across: the altaz and the equatorial. Altaz stands for altitude and a

zimuth, and is the simplest of all mounts. The telescope moves on a base parallel to the ground, up and down (in altitude) and left and right (in azimuth).

The equatorial mount is different and more complex to use. One of its axes is tilted to your latitude, your position on the Earth north or south of the equator, and the other is parallel to the celestial equator, like Earth's equator but in the sky.

It moves in units of right ascension and declination, which are similar to longitude and latitude but mapped onto an imaginary sphere on the sky.

Most Newtonians come on an equatorial mount, and they're really good for astronomy because you only need to adjust one axis, the right ascension one, to keep track of an object in the sky as it moves through the night. With an altaz mount (right), you'd need to adjust both axes to keep one object in view for any longer than a few seconds.

What's the little telescope on top of the big one?

That's the finderscope. It has a wider field of view than the main telescope, with crosshairs over it, so you can find things and aim the main scope much more easily. Before observing you'll need to align the main telescope and the finderscope. In the daytime, point the main telescope at a distant object like a telegraph pole. Be careful not to look at the Sun or you could damage your eyes. Centre the top of the telegraph pole in the main eyepiece and then adjust the little screws around the finderscope, one by one, to centre the top of the pole in the crosshairs. Once done, you'll be able to point at something with the finderscope and it will appear in the main eyepiece.

How much money should I spend?

A good Newtonian on a sturdy equatorial mount costs around £200 in the UK, while a good refractor costs around £300. A 6-inch Dobsonian can cost as little as £155. What's most important is that you buy from a well-respected astronomical dealer, like the advertisers in this magazine.

Avoid the cheap, poor-quality models you sometimes see in mail order catalogues or in high street stores.

I've unpacked the scope – how do I set it up?

For detailed instructions on your own make of telescope, it's best to have a good read of the manual, but here are a few tips. Set up the tripod and mount arrangement first, and make sure any leg screws are screwed in and secure enough to take the weight of the telescope. If you have an equatorial mount make sure that the 'north' leg is indeed pointing north. Then put the telescope tube on the mount. Check that the tube is secured firmly with the tube ring screws and that it can't slip out of them. If you're setting up a Newtonian, position the telescope tube in the rings so that you can easily look into the eyepiece –it's best to have it parallel to the ground or slightly above parallel. And remember, it'll help if you balance the telescope and counterweights before observing.

What is the eyepiece for?

Most telescopes will have one or two eyepieces included in the price. They come in two standard barrel sizes to fit into the telescope focuser – 2-inch or 1.25-inch – and have several optical designs such as Plössl, Nagler or orthoscopic.

The number on the eyepiece is its focal length, measured in millimetres. The smaller the number, the greater the magnification it will give when used.

Two good quality eyepieces with a small (10mm) and a larger (20-40mm) focal length will provide you with a decent range of magnifications to get you started.

However, if you had to choose just one eyepiece, get a 20mm Plössl. Only use or buy eyepieces that have glass lenses, because plastic lenses will almost always disappoint.

Should I get a computerised Go-to scope?

Go-To telescopes come with an in-built computer and handset that, once set up correctly, automatically aim the telescope and track an object. Although this is helpful, we'd recommend that you get a scope without Go-To as your first-time buy.

If you aren't familiar with using a telescope, setting up a scope without Go-To is much easier. A non-Go-To is also much cheaper and will be a gentler introduction to how telescopes work.

How do I align my equatorial mount?

First, check that the north leg of the tripod is pointing roughly north, or simply make sure that the polar axis itself is pointing north. You then tilt the polar axis (the one that moves in right ascension) to the angle of your latitude – your position in degrees north or south of the equator. There will be a graduated scale on the side of the mount head to help you do this, as shown in the image on the left.

The polar axis should now be pointing roughly towards Polaris, which is in Ursa Minor. Check this by looking along the axis, or through the finderscope. For simply observing the night sky this setup is fine and you can now rotate the right ascension (polar) axis with the motion of the stars.

More advanced equatorial mounts include a polar scope, fitted inside the polar axis, that allows for a far more accurate alignment. To use it, set up your telescope as above and when you look into the polar scope you'll see a diagram on a reticule inside the eyepiece and the star Polaris. You should now align the diagram with the polar axis itself. Point the crosshairs in the reticule so they are on Polaris. Now unlock the polar axis and rotate it. If Polaris doesn't move, your reticule and polar axis are already aligned and you don't need to adjust it. If it does shift, adjust the alignment of your polar scope until it doesn't move when you rotate the axis.

The final step is to offset Polaris using the reticule so that the polar scope is pointing at the north celestial pole, which is a very short way from Polaris. To do this, tweak the altitude and azimuth knobs on the mount until Polaris is in the correct position in the polar scope's reticule. See your manual for exact details.

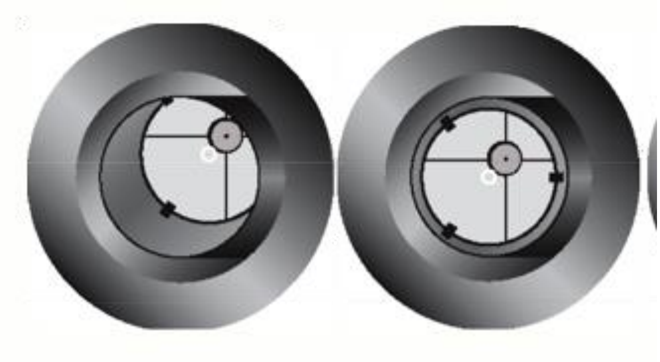
What is collimation and how do I do it?

Collimation is when you accurately line up all the optics in your scope. This alignment can be upset if the scope gets knocked, or after it's been moved around a lot. You'll get the best views out of your telescope if it's well collimated, so it's good to occasionally do it.

If you followed our advice and bought a Newtonian reflector, then to collimate it you need to carry out the steps below.

But first things first, check whether you need to do it in the first place by looking at a star out of focus. If you can see a circle with some practically perfect concentric and symmetrical rings around it, your telescope's collimation is good and you don't need to do anything.

If they're not concentric or symmetrical, then you can collimate your scope indoors during the day using a homemade collimation tool following the steps below. Just point the telescope at the ceiling to get a bright, uniform view.



Collimate with a homemade tool

1. Get an old plastic film canister and pierce the base in the centre with a 1-2mm drill bit. Put a paper-reinforcing ring on the exact centre of the telescope's main mirror.

2. Take out the eyepiece and replace it with the collimation tool. Adjust the set of screws on the secondary mirror that aren't on the back of it so that the paper ring is in the centre of the view, seen through the tool.

3. Make sure that the secondary mirror appears circular, not slightly elliptical, when seen through the collimating tool by adjusting the same screws on the secondary mirror.

4. Centre the main mirror by adjusting the screws on the back of the mirror holder. Look directly through the collimation tool. The view should look like the third image above, with the hole in the collimation tool in the middle of the paper-reinforcing ring. Your scope is now collimated.

How do I focus the telescope?

With a reflector, you can use the tiny spikes that you'll see coming out of the stars to help with focusing: when the view is defocused the spikes will be doubled up. Adjust the focus knob until you only see one set of spikes to bring the scope to focus. These spikes come from the 'spider' brackets that hold a little secondary mirror in the tube.

Refractors don't have a secondary mirror so when you look at stars they don't have spikes coming out of them – they appear as round points. You can tape a cross of string in front of your refractor's main lens to create these spikes.

Another focusing aid, for refractors and reflectors, is a Scheiner mask. This is a mask that you can make from card that fits over the front of the scope. The mask has three circular holes cut into it, so that when you look through the eyepiece you see three of every star if the scope isn't focused. Focusing the scope will bring the views together and when it's focused you'll see each star as one. Don't forget to take the mask off afterwards!

So, you've decided to take the plunge and buy a telescope -- congratulations! Astronomy can be a life long pleasure, with the right equipment. But what to buy? And how do you not wind up with a room that looks like the above? There's more equipment out there than ever before. This article will attempt to make some sense out of the seemingly huge selection of scopes and accessories.

Ready? Good. Let's begin.

First of all, some words of advice:

1) **Learn** to spot a few constellations and maybe a planet or two with the naked eye. If you can't point to M42, how do you expect to able to point a telescope (which has a much narrower field of view) there?

2) **Subscribe** to one of the two major magazines, Sky and Telescope or Astronomy. These will get you started not only with finding celestial objects, it will also acquaint you with the variety of equipment out there. Don't buy anything yet!

3) **Join** a club, or tag along on one of their observing sessions. This is the single best piece of advice I can give you. There is no substitute for spending time with real equipment out in the field. You may discover, for example, that you like the portability of Schmidt-Cassegrains, or that you enjoy the views through a good refractor, or that the big Dobsonian you saw in the catalog is much more of a handful than you imagined. Or whatever. There's no substitute for experience.

That said, your ideal first telescope may not be a telescope at all, but a pair of binoculars. Perhaps you have a pair lying around the house already. Most experienced astronomers keep a pair of binoculars close by, for quick peeks or for scanning the field of view before using their telescopes. The common recommendation is to get a pair of 7X50's, or at least, 7X35's. The first number "7" is the magnification, the second "50" is the aperture of each objective lens, in mm. You want the largest lenses you can comfortably hold.

Many astronomers opt for 10X50's, although you should make sure in advance that you can hold them steady at that power. It seems that the current trend is towards 10X50's, but I still like the traditional 7X50 size.

There are new "giant" binoculars which can give stunning views of the heavens, *if you know how to use them.* If someone offers you a view through one of these, by all means oblige, but hold off buying a pair for now. You'll know later if you want them. OK, so binoculars aren't exciting the way telescopes are. Before I leave the topic, allow me to make a final case for good binoculars: 1) Cheap binoculars are much, much more useful than cheap telescopes. Trust me on this one. 2) Good binoculars can last you a lifetime. As you trade up (or down) your telescopes, you'll still need a pair of binoculars for quick peeks and scanning. As a result, binoculars tend to be something you buy only once or twice. Finally, some find that a "spotting scope" - a small, stand-mounted telescope that can be used for astronomical and terrestrial purposes - can be a good stepping stone to a first telescope.

Telescopes!

Ask a roomful of people what the purpose of a telescope is, and chances are they will say something like, "to make distant objects look bigger." I'm a frequent guest speaker at local schools, and I always get that answer (or something close to it) when I ask that question.

Is the primary function of a telescope really to make things look bigger? Not necessarily. The primary function of a telescope is to **gather light**. The more light a scope gathers, the more powerful it is. And remember, telescope apertures are circles, and the areas of circles increase with the **square** of the radius, so moving up in aperture, even modestly, can yield big results. Our hypothetical 7X50 binoculars (above) gather over twice the light of the 7X35's, even though they look about the same size. Put another way, the owner of an 10" Schmidt-Cassegrain who decides to upgrade to a 12" will see a 44% increase in light-gathering ability. Not bad for a 2" increase, eh?

So, you should buy the biggest telescope you can afford, right?

The answer, is an unqualified MAYBE, and for some people, the answer will be NO. But we're getting ahead of ourselves.

Types of Telescopes

Modern amateur telescopes can be divided into three classes:

1) The **refractor** is what most people think of when they hear the word "telescope". Refractors gather light with an objective lens at one end and focus the light at the eyepiece at the other end. Refractors were almost extinct at one point, but modern glass elements (including an exciting new artificially grown crystal known as fluorite) have brought the refractor back to prominence.

Refractor advantages: Potential for the best images, no obstruction in light path.

Refractor disadvantages: Some secondary color ("chromatic aberration") still visible in all but the best units, large aperture instruments can be massive, most expensive of the three designs (often by a large margin), "Guilt By Association" with horrible department store refractors.

A typical 4" refractor

2) The **Newtonian Reflector**, invented by Sir Isaac Newton, uses a parabolic mirror at the end of a tube and focuses the light back at the front of the tube, where the eyepiece sits, after being deflected by a smaller secondary mirror in the light path.

Reflector advantages: Cheapest of the three designs (especially those on Dobsonian mounts), more portable than refractors of similar aperture, inherently color free (no chromatic aberration).

Reflector disadvantages: Secondary obstruction results in some loss of contrast, still quite large compared with Schmidt-Cassegrains, can require frequent collimation (alignment) of optics.

An 8" Newtonian Reflector

3) The **Schmidt-Cassegrain** and its derivatives (Maksutov-Cassegrain, Schmidt-Newtonian, etc.) use BOTH mirrors and lenses to fold the optical path back onto itself, resulting in a compact tube. The technical term for these scopes is **catadioptrics**, but since nobody seems to use this term, I won't. A Schmidt-Cassegrain telescope is sometimes simply referred to as an "SCT."

SCT Advantages: Most compact of the three designs, less expensive than refractors, huge assortment of after-market accessories, can be totally computer driven, very popular.

SCT disadvantages: More expensive than reflectors, images are potentially the worst of the three designs (notice I said "potentially!"), most subject to dew of the three designs.

Meade's ETX, a Maksutov-Cassegrain

So, which one should I buy?

Depends. The "right" telescope depends on you, your observing habits, and your financial situation. Back before 1990, picking a telescope used to be a simple matter. You started out with a 60 mm refractor (probably from a department store), then you upgraded to a 6" f/8 reflector from either Criterion or Meade, and if you stuck with it long enough, you eventually bought an 8" Schmidt-Cassegrain from Celestron.

My, how things have changed. Throughout the 1960 and 1970's, the Newtonian reflector ruled the amateur roost. From about the 1980's onward, astronomers flocked to the portability of Schmidt-Cassegrains as both Meade and Celestron duked it out to try and out-do one another on features. Then, the refractor, long given up for dead, came roaring back with the advent of ED and fluorite glass. Now, you see all three designs in use regularly. The advantages/disadvantages of each design are well-documented elsewhere, so I'll attempt to give you some "other" information which may be useful to you.

- Despite the optical superiority of good refractors and the lower cost of reflectors, most astronomers still wind up with Schmidt-Cassegrains as their primary instruments. It's not hard to see why. An 8" S-C is relatively affordable and portable. An 8" reflector is a handful, especially an equatorially- mounted one. And an 8" refractor? Forget it -- assuming you can even find one, you'll probably need a separate observatory to house one.

- 4.5" or 6" reflectors make excellent beginner's instruments. For $250-$400, you get a decent aperture and a scope that's relatively portable. On the refractor side of the table, look for an 80 mm scope on a stable mount.

- Avoid like the plague any cheap refractor sold on the basis of its magnification. A "675X" 60 mm telescope is almost certainly a piece of junk. Maximum useful magnification is usually given as 50X-60X per inch of aperture. Thus, the 60 mm example given above is really only a 120X-144X telescope (and its images will probably break down well before that point). You find these scopes all over the place, in department stores, toy stores, etc. This is not just what Ed Ting thinks you should do. This same important advice can be found in any responsible text on telescopes. Let me repeat that one again: **Do NOT buy a telescope from your local department store, toy store, or from a television commercial.** Most scopes found at the Nature/Science stores at your local mall also fall under this category. These telescopes are little more than toys and will likely kill your budding enthusiasm. Buy from a retailer who specializes in serious amateur telescopes. Some of the better ones are linked off my "links" page. As a general rule, avoid any telescope that costs less than $200 or so. **Please do not e-mail me with something you have found in a dept store.**

- I'll say one thing for Newtonians. They're the most comfortable to use of the three designs. The eyepiece is nearly always at a convenient height. Refractors are the worst in this regard. Looking at anything near the zenith with most any refractor is a less-than-appealing proposition.

- Many astronomers give up trying to decide what's best for them and buy more than one scope. While this may not be the best advice for beginners, newcomers might want to keep this in mind when making a purchasing decision. For example, if your first scope is an 80 mm refractor, you might balance things out by getting a 10" Dobsonian in a year or two. That way, you'd have both a light bucket and a planetary/double star scope.

- **Avoid any thoughts of astrophotography for now.** You are going to have your hands full dealing with the scope itself. Trust me. More astronomers leave the hobby due to excessive involvement with astrophotography than for any other reason, save the cheap department store telescopes.

- If you're interested in terrestrial viewing, you need something called a "spotting scope," which is out of my area of expertise. I'm sure there are lots of people online who are willing to help you though!

- Finally, avoid "paralysis-by-analysis." If you spend more than an hour a day reading telescope catalogs, you are probably in this category. Just get something; you'll feel a lot better.

OK, Ed -- You still haven't answered the question: Which one would you buy, if you could only get one?

This is a tough one to answer, since everyone has their own priorities and preferences. Still, knowing what I know, if I were starting out today, I would probably get a 6" or 8" Dobsonian-mounted reflector. The fact that I am something of a "refractor guy" says a lot about this choice. A 6" Dobsonian is simple, cheap, and will teach you a lot. The simplicity part is important, since you will spend your time aiming and observing with your telescope, rather than playing around with the sometimes complicated controls on an equatorial mount. Beginners need early success, and the 6" or 8" aperture is big enough to throw up a bright image of most common celestial objects.

A great beginner's scope: Orion's XT8, an 8" Dobsonian reflector ($349) (Note: Prices change over time, check Orion's web site for the latest deals)

I like all the 6" Dobsonians from Meade, Celestron, Orion, and Discovery. Offshore manufacturing means that the same basic unit is now available under a variety of name-plates. You may find similar Dobsonian reflectors sold as Zhumell, Skywatcher, Bresser, Konus, Hardin, Apertura, and others, depending on where in the world you live. I like the Orion the best, but you can just pick one; they're all good. If you're feeling ambitious, get an 8" version. The differences between the brands show up mainly in the quality of the accessories. Look for a 6X30 finder (or larger), Plossl instead of Kellner eyepieces, and Pyrex instead of plate glass mirrors. **If I were pressed to recommend one telescope for beginners, it would be the Orion Skyquest XT8.** The scope weighs about 41 lbs and is about 4-5 feet high. The XT6/XT8 telescope is complete as shown, and simply sits on the ground. *There is no need to purchase any additional mount or tripod.*

Avoiding "Aperture Fever"

Audiophiles have a saying that goes something like this: The stereo system which reveals the most music to you is the one you use the most.

For most of us, that's our car stereo.

Astronomy is a lot like that. The probability that a telescope will be used is inversely proportional to its size. This seems to apply to just about everyone, regardless of experience. I've carried on a correspondence with a fellow astronomer. He has an 18" "Luxo-Dob", I have a tiny TeleVue Ranger. Our conversations tend to go something like this:

Me: So, did you see Saturn last night?

Him: No, it was too cold out to go observing.

Me: Oh.

Him: But my 18" Dob blows your puny little 2.7" refractor out of the water, you teeny dweeb!

OK, so maybe it doesn't go *exactly* like that, but you get the idea. Sure, he's got me whipped on aperture, but I got in 2.7" worth of observing that night, and he got in zero.

Little scopes get used more often, and thus show you more. Your Luggability Tolerance may be different from mine, however, and that's where visiting public star parties becomes an invaluable experience.

The star parties also come in handy when I DO want to look through a big scope. I just look through someone else's. This way, I get my share of "big gun" observing time and I don't have to deal with the hassle of set up and break down.

For balance, I should state that I have recently learned to dodge this "bulk" issue with larger telescopes by placing them on rolling platforms with lockable castors. Go to your local lumber yard/hardware store and get 3/4"-1" thick plywood and four castors. Don't skimp on the quality of the castors; get the best ones the store carries. Also remember to use lock washers or the nuts will eventually work themselves loose. I can leave the 20" Obsession fully assembled in my garage, and when I want to use it I just roll the whole thing outside. I can be observing in less than 5 minutes. There is something rather nice about kicking a 20" Dob out the door and observing with it within a couple of minutes while your friends are still assembling their small equatorial mounts. This works so well, I built platforms for the rest of my scopes as well.

Eyepieces

The TeleVue Radians

Here's one area where beginners tend to go overboard. You don't really NEED more than 3 or 4 carefully chosen eyepieces, a barlow, and perhaps a filter or two, but most of us eventually wind up with collections, some of them needlessly impressive. Still, the first accessory a newcomer buys is usually a new eyepiece. Below is a guide to various designs.

Ramsden and **Huygenian** are 2-element eyepiece designs. While simple, they exhibit narrow fields of view, have numerous aberrations, and terrible edge correction. Generally supplied only with the least expensive telescopes. While not of much use visually, they make good solar projection eyepieces (i.e. you can risk 'em). About $25-$40.

The **Kellner** is a three element design that shows an acceptable 40-45 degree FOV, and good correction of spherical and chromatic aberration. Offshoots include the Meade MA, Celestron SMA, and Edumnd RKE. A decent general-purpose eyepiece for the price. About $30-$50.

Orthoscopic eyepieces were once considered the best for general use, but have lost some of their luster compared with newer Plossl designs. Using 4 elements, they are still popular for planetary work. They are well corrected throughout their 45 degree FOV. About $40-100.

The **Plossl** seems to be the most popular eyepiece design today. Using 4 or 5 elements, they are very well-corrected and have a wider (50-52 degree) FOV than Orthoscopics. However, some models have shorter eye relief than equivalent Orthos. About $50-$150.

Erfles seem to have fallen out of favor these days. Using 6 elements, Erfles throw up a wide 60-65 degree FOV, with increasing distortions near the edge. Rapidly becoming extinct. About $75-$150. Newer designs, primarily from the efforts of TeleVue, are gaining in popularity. These include the 6 element, 67 degree FOV **Panoptics** (about $200-$400) and the 7-8 element, 82 degree FOV **Naglers** (about $175-$425). Both series are truly amazing. It is said that once you have looked through a Nagler, nothing else will be good enough for you. As a Nagler owner, I think they might have a point. And if you thought the Nagler eyepieces were impressive, wait until you see the new TeleVue **Ethos** line (just try not to look too hard at the prices.)

Sparked by the success of the TeleVue eyepieces, the Japanese have gotten into the act. The **Meade Super Wides** ($140-$300) and **Ultra Wides** ($170-$300) are virtual clones of the TeleVues. And **Pentax's** 6-7 element **SMC-XL** (about $250 each) are thought by some to exceed the performance of the TeleVues, especially at the lower focal lengths. Vixen's **Lanthanums** ($100-$200) and TeleVue's **Radians** ($250) throw out a generous 20 mm of eye relief regardless of focal length, and are a godsend to those who must wear glasses while observing. In recent years, the Chinese have gotten into the game. Eyepieces from **Astro-Tech**, **Explore Scientific**, and others are offering excellent value for the money, while getting better with each revision.

Many observers find a **barlow lens** to be a valuable accessory. Inserted between the focuser and your eyepiece, a barlow will typically double or triple the magnification of any eyepiece. Thus, for $60-$100, you have effectively doubled the size of your eyepiece collection. Also, a barlow preserves the eye relief of your longer focal length eyepieces, thus reducing the amount of squinting you have to do. Having said that, a common beginner's mistake is to use barlows much too often, chasing high magnifications, resulting in shaky, fuzzy images. If you're new at this, keep the powers low for now. Your eyes (and your patience) will thank you.

Again, don't go crazy with eyepieces. It is especially important not to go chasing high magnifications - beginners make this mistake a lot. Keep in mind that most of the time (75% - 80% of the time) you will be using your *lowest* power eyepiece. I'm even more extreme this way than most observers. I am at my lowest power 90% - 95% of the time.

What can I expect to see?

Next to "What telescope should I buy?" this is the most common question I usually get asked. This is a tougher question to answer than you may think. What you can see depends on a lot of factors, including the type of telescope you bought, the quality of your local seeing conditions, and your level of skill.

Since the quality of your instrument and conditions are largely out of your control, it would make sense to hone your observing skills. Sadly, I don't see this happening much anymore. Observers, eager for instant results, often upgrade to larger and larger telescopes without bothering to learn how to "see" properly.

Seeing well is both an art and a skill. You need to spend lots of quality time with your telescope. The more you look, the more you will see, and the better you will get. As a result, an experienced observer might enjoy deep sky objects in an 80 mm refractor, while a beginner with a light bucket next door is still struggling to find the Orion Nebula. Astronomy is a patient hobby. Don't be in too great a rush. The cosmos will still be there tomorrow. OK, now that the lecture is over, here's what you can see with a typical 6" reflector under reasonably good skies:

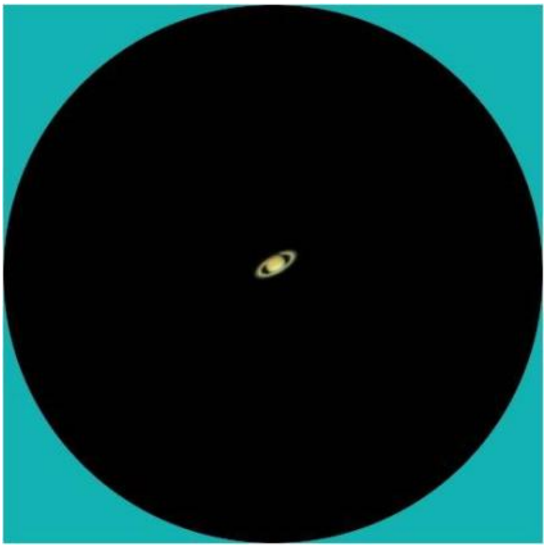
- All 110 Messier objects, which includes nebulae, open and globular clusters, and extended galaxies. Most of these will seem impossibly dim to you at first. Later in your career, they will seem really bright.
- All of the planets except Pluto. Saturn's rings are easy. Shadow transits on Jupiter are easy. Detail on Mars is somewhat harder, but gets a little easier once every two years. Venus, Mercury, Neptune, and Uranus are pretty much featureless balls.
- Hundreds of named craters on the moon.
- Sunspots and other activity on the sun, with a proper filter. **Do not look at the sun without proper filtration!**
- Hundreds of other various objects.

Have Realistic Expectations

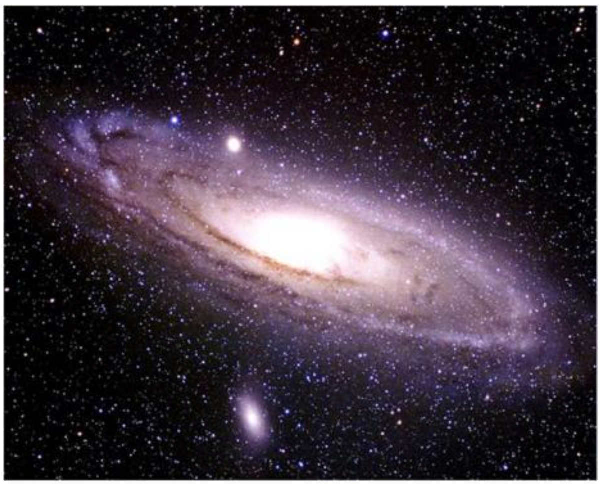
I've been getting this a lot lately. In this age of video games and HDTV, people are starting to get wildly unrealistic expectations as to what they'll see. At least once a week, I get an email from an excited newcomer looking for a *Call of Duty* - like experience. Know this: *most objects in your telescope will appear to be nothing more than dim, gray, featureless blobs.* The excitement of visual astronomy is in knowing and pondering what those objects are. Below are some simulated images to let you know what to expect.

Modern image of Saturn (photo courtesy Joe Roberts):

Simulated image of Saturn through a 6" telescope at about 100X:



Professional long exposure image of M31, the Andromeda Galaxy:



Simulated image of M31 through a 10" telescope at low power:

Professional image taken of M13, the globular cluster in Hercules:

Simulated image of M13 through a 6" telescope at low power:

Hopefully you get the idea.

What about Astrophotography?

Don't.

Just don't.

I know, I know, you want to. The urge to photograph what you see is almost irresistible. The problem is, beginners have *no idea* what they're getting into. This is way more involved than you can possibly imagine. You've got a lot to learn, between the night sky and your new telescope. Don't complicate matters by getting involved with astrophotography. What's more, photographers, as a rule, have a *harder* time adjusting to astrophotography, than "civilians." They assume their knowledge of conventional photography will shorten the curve for them, but usually the opposite happens. Next to department junk-scopes, astrophotography is the #1 reason people drop out of the hobby.

My friend and fellow club member Herb B, who is really good at this, estimates he's spent tens of thousands of dollars, over a decade of his life, and untold thousands of rejected images, to get where he is today. When new members excitedly ask him for advice on getting started in astrophotography, his usual response is this:

"Don't."

Summing it up...

In summary, here are the prominent points given above:

1) **Binoculars**, even cheap ones, are sometimes a good substitute for a cheap telescope. In addition, binoculars are almost always good companions to a telescope.

2) **Avoid** department store, toy store, and "Nature/ Science" store telescopes. I cannot restate this strongly enough: **STAY AWAY from department store telescopes!**

3) The primary purpose of a telescope is to **gather light**. Thus, all other things being equal, beginners should buy the largest aperture telescope they can afford. A 6" Dobsonian reflector is an excellent first telescope.

4) **BUT**, if the instrument is too large, you may never use it. Be realistic about what you're willing to lug around.

5) You don't need more than 3 or 4 carefully chosen eyepieces in your collection at first. The minimum quality you should consider are **Kellners** (and their offshoots). A **barlow** is useful tool for doubling your collection at minimal cost.

6) If I were pressed to recommend one telescope for a beginner, it would be a **6" or 8" Dobsonsian reflector** (£250-£400.)

7) If you're interested in daytime terrestrial viewing, you need something called a "spotting scope" which is out of my area of expertise.

8) **Avoid** any thoughts of astrophotography.

End Beginner's Advice

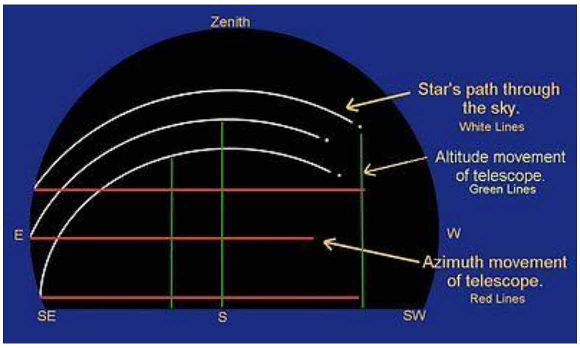
POLAR ALIGNMENT OF THE EQUATORIAL TELESCOPE MOUNTING FOR BEGINNERS.

(Northern Hemisphere)

The most important thing to know before you start...

It's easy to set up sufficient for visual observing and it is something that can be done in under a minute with a little practice. This guide is intended for those wanting to learn how to set up their telescope for simple visual observation.

Having got your new telescope the first thing that will occur to you is that once you have got it together you'll need to know how to set the mounting up correctly. Many people are put off buying a telescope with an equatorial mounting because they think it's hard to set up. They think that the more familiar Altitude-Azimuth (Up and Down - Left and Right. Known in astronomy circles as Alt-Az.) will do the job just as well. This is actually quite untrue. The Alt-Az mounting is a very difficult mounting to use well with the heavenly bodies.

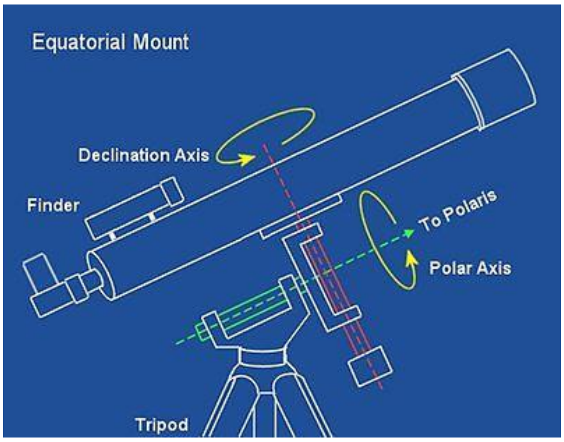


Left: It looks very complicated I know, but, this diagram attempts to illustrate simply how the move-ments of the heavenly bodies and the Alt-Az mounting's up-down-left-right motions aren't very compatible.

The Equatorial Mounting makes following the objects we see in the sky easy and the simple application of the simple instructions in this guide will see you set up in a very short time. The EQ mounting automatically follows the white lines. This allows you stress-free observation of the wonders of the night sky.   All you have to do is set your mounting up with the correct 'polar alignment'.

Above: Polar alignment? :o)

The principal behind the equatorial mounting is very simple. The Earth revolves around its axis every 24 hours. To compensate for this rotation the mounting has to rotate the telescope around the same angle axis and in the opposite direction at a speed equal to one revolution in 24 hours.



To allow different objects to be seen the telescope mounting has to allow the telescope to move up and down the sky's longitude lines to view different 'latitudes' (Declinations) in a North-South direction. The mounting therefore has two axes. The Polar Axis mirroring the Earth's axis and the Declination axis looking from horizon to Zenith and beyond!

The mounting can be motorised to turn at the same speed as the Earth, or it can have manual controls to effect this rotation called 'Slow Motions'. Once your mounting has been set up correctly it can follow the heavenly bodies with ease by rotating around the Polar Axis.

Squint: Looking up the Polar axis to line up with Polaris.

This set-up method is sufficient for normal viewing of objects.

You can stop here and start observing...

That's it: I've done my best to keep it simple and short!

Read on for more detailed information:

In use the polar axis continues to point at polaris. IT DOES NOT NEED TO MOVE. The entire sky is accessible without moving the polar axis.

The equatorial mounting is by no means intuitive - You have to learn how it moves. When I look at eBay listings for telescopes there are many that have obviously been set up to work as an alt-az mount because that's the only thing in our usual experience that makes sense. The polar axis is horizontal and the declination axis is therefore vertical. That is the perfect set-up for the equator, by the way. The Alt-Az mounting is an equatorial on the poles!

This picture shows how some people resort to trying to make this equatorial work as an Alt-Az (Up and Down - Left and Right) mounting.
If you lived in Northern Equador, or Kuala Lumpur it would be properly set up for observation!

However, this telescope was in use in the UK!
By reading this guide I hope you will understand the principle and set up correctly for your latitude.

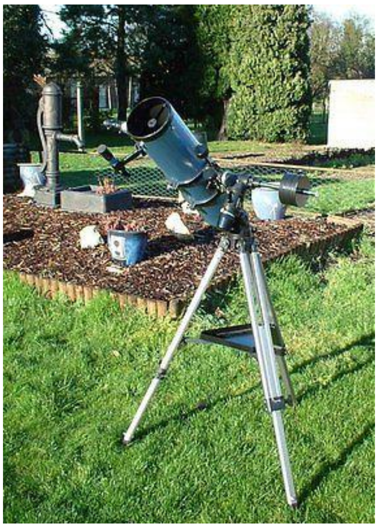
It is benficial to experiment with your mounting in daylight. Start by rotating the telescope on the axis with the counter-weight. This moves the telescope in the north and south (+ & - declinations).
Then rotate about the polar (RA) axis. This is the motion that follows the movement of the sky.
It's not intuitive by any stretch of the imagination. In use the telescope very seldom looks like it does when 'parked' and pointing to the pole (As it does in most photos!)
For an excercise in aiming the telescope: Decide on a position in the sky that you'd like to look at and then try to put your telescope in a position that would allow you to view that point. Then decide on another point. You'll soon get the idea of how the mounting moves.

Using the Telescope on the mounting.

Once set up the telescope can be carefully pointed to any part of the sky.
Make sure that the telescope is in balance. That is that the telescope doesn't swing up or down (Move the telescope in it's cradles back and forth to balance this): Make sure the telescope doesn't rotate about the Polar (RA) axis, either telescope heavy or Counterweight heavy (Move the counter-weight to balance this movement). You can leave the axis locks slightly engaged to stop the fully free movement of the telescope.

Then, to locate an object, simply loosen off the axis clamps a little so there is only a very slight friction and the telescope will stay wherever it's pointed.
Here are a few photo's of telescopes in a more 'in use' position. Try to emulate these and you'll get an idea of how everything moves. Have a look at each and see the relationship between the polar axis (Which never moves from it's alignment on Polaris) and the declination axis which does all sorts

of things!



Left: This Newtonian is in a position as if it were looking at say the Orion Nebula. Due south and about on the celestial equator.

Horncastle UK - polar Axis at 53 degrees.

Left: Now it is looking at Jupiter high in the East.

Here we are looking high into the Southern sky.

This is when I was in Lanzarote (Note the Polar axis is way down at 29 degrees!)

This refractor seen from the North is pointing low on the Eastern horizon - Venus rising pre-dawn?

Uk Midlands - Polar axis 52.5 degrees

Now we are looking into the high South Western sky.

It's unusual to see telescopes photographed in these 'in use' positions. I hope that this has allowed you to understand a little of how the mounting works and see how the telescope looks in use.

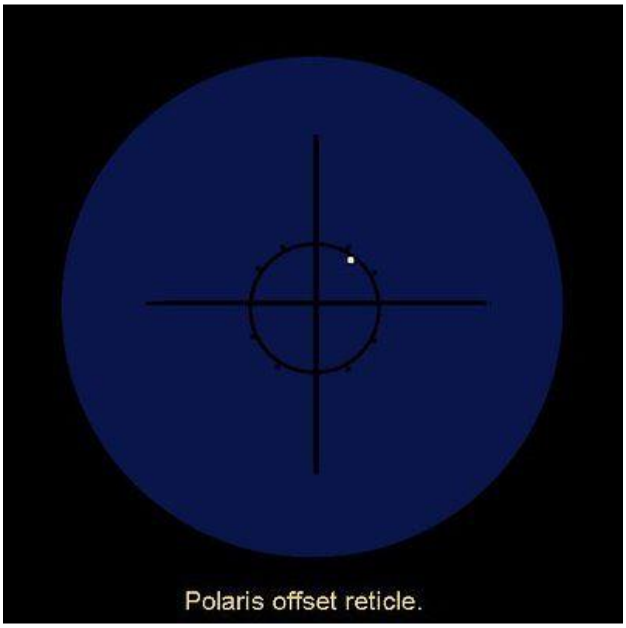
Return here in the future for more info - I am going to insert a video to explain the mounting in use.

Other Information:

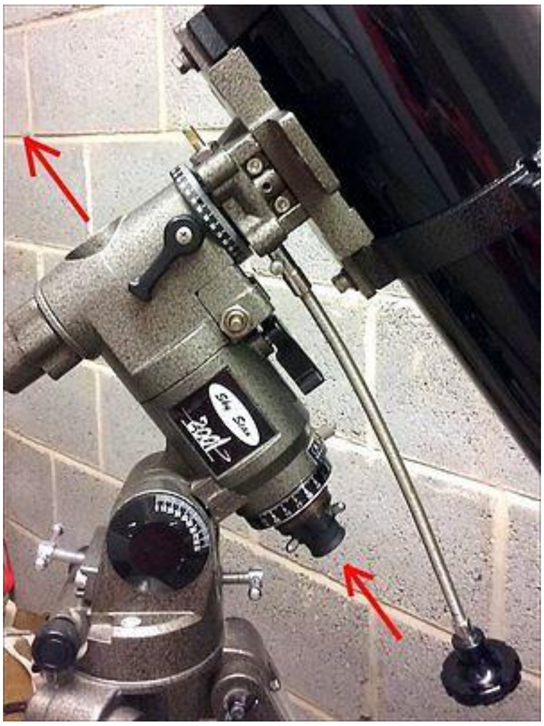
Polaris is actually 3/4 of a degree from the celestial pole, in the direction of the W shaped constellation of Cassiopeia. Or, to put it another way - the celestial pole is 3/4 degrees from Polaris, in the direction of Alkaid, the end star in the handle of the Plough (Big Dipper).

(Polaris Co-ordinates = 2h 40m R.A. +89.25 degrees Dec.)

If your mount has a Polar Axis alignment scope you're laughing! This is a small sighting telescope that you use to spot Polaris through the Polar Axis of your mount. The view shows a 1.5 degree circle (3/4 degree x 2) and with a little bit of calculation, (or just twist your star atlas around until the constellations are at the same angle), you can figure out what angle Polaris should be in the sight. Once this is known you simply put Polaris on the line as shown in the example diagram below, and bingo - You're accurately set up in a few seconds!



Sighting: Using the Polar Axis sight with reticle, place Polaris on the circle at the position it is in the sky. Job done!



Left: EQ5 Mounting with a PolarScope.

Red arrows indicate the line of sight to poalris through the PolarScope.

Make it Easy to Realign in Future!

Mark the positions of your tripod's feet. It is at this point that you could mark the positions of your tripod's feet to help with rough alignment next time. Particularly if you plan to take your telescope in and out of the house each time, as so many observers have to do. If you don't have a hard surface (ie you plan to observe on grass) it is wise to put down some small area to set up your telescope on so the feet don't sink into your lawn. You can opt for three small flagstones, three 8" circles of cement (See garden centre stepping-stones), one for each foot, set flush with the grass to allow mowing, or making a triangle of angle-iron to spread the weight of the feet.

Above: Mark the feet! Whether you use flag-stones or circles of cement you can easily mark the correct leg positions not only the position on the flag but the length of each leg if you extend them each time. Make the marks easy to see as you will have to do this by the light of the moon or a dim red torch!

Your 'set up' is now all done. Once you have done the above stages you can begin observing the sky with your telescope, which will be well enough aligned for visual observation and know that it will be just a few moment's work to set it up in the same position in the future...

For photographic long exposures the mounting has to be aligned much more accurately (and permanently is a good idea!) - The setting up of a telescope like this is well beyond the scope of this simple guide!

The other degree scales on the R.A. and Dec. axes are for finding stars using the co-ordinates of Right Ascension and Declination. This is beyond the scope of this guide and is quite inaccurate with small degree circles.

Getting a Telescope

1.

Consider the type of telescope. Different telescopes are better for different types of viewing. There are really on three basic telescope types: refractor, reflector and catadioptric. Which one you choose will be based on what you want to observe, where you are, and so on.

- The refractor basically has a long thin tube with an objective lens at the front that collects and focuses the light. This one is better for viewing the Moon and planets, usually giving a nice, crisp image. It travels well and doesn't need much maintenance. Unfortunately, it is very hard to see faint objects like galaxies and nebulae.

- The reflector employs a large concave mirror rather than a lens for the purposes of accumulating and focusing light. This is one of the better beginner telescopes and it usually has pretty good visibility, although water has a tendency to condense on the optics of the telescope which can be irritating. Also, you can't view terrestrial objects with this telescope.

- The catadioptric is a compound telescope, combining both lenses and mirrors. They are good photographic telescopes and they are a lot easier to carry than the reflector. This one tends to be more versatile, but they do tend to be more expensive than the other types.[1]

2.

2

Consider where you live. You'll need different power levels considering where you are. If you have an area where the light pollution is better or worse. If you are in an area where it rains more, etc.

- If you want to bird watch (for example) with your telescope, you'll be better off not choosing the reflector telescope because it won't show you terrestrial objects.

- If you're in a place where it dews frequently and you're planning on using your telescope at night, you'll need to consider whether choosing a refractor or catadioptric telescope might be your best option.

3.

3

Consider what you want to look at. Objects like the planets, the Moon, and closer stars need a high power, good contrast and sharp resolution in a telescope. So if this is what you want to look at, your best bet is to go with a refractor or a reflector. If you're looking at faint objects such as galaxies and nebulae, you'll need a bigger aperture and choose a big reflector telescope.

4.

4

Consider the power capabilities of your telescope. People generally have the mistaken impression that more power automatically means higher resolution and better viewing, but this is not actually true. High power simply dilutes the brightness of the image and amplifies any blurriness.[2]

- For any telescope the maximum amount of magnification equals 50-power per inch of aperture. So say you have a 6-inch reflector. 300-power is as high as you should go (for a 3-inch reflector it would be about 150-power).

- Even if you're using a Barlow lens, magnifying it too far will only result in a blurred image. The telescope's image can only be blown up to a certain point.

Part 2

Understanding Your Telescope

1.

1

Learn the finderscope. This is typically attached the side of the telescope. It displays more of the sky than the scope itself. For instance, a 50 power telescope covers an area about as small as the fingernail on your little finger, whereas an 8x finderscope covers an area about the size of a golf ball.[3]

2.

2

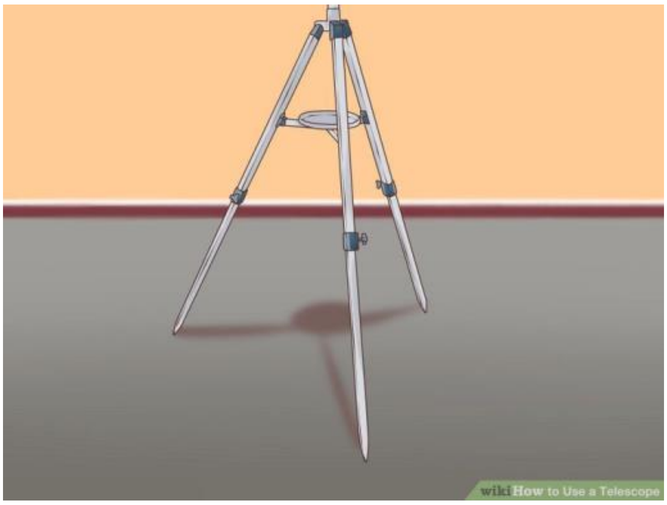
Learn the mount. Telescopes typically come in two types: equatorial or altazimuth. You'll need to know which kind of telescope you have so you can learn how to operate your telescope.[4]

- Altazimuth mount operates my going up and down and side to side, making it easier for beginners to operate. It is more simple than the equatorial telescope.

- Equatorial mount swings across the celestial North to South and East to West. The polar axis (which is the rotating part closer to the telescope's base) needs to be aligned to Polaris, the North Star. It will then follow the motion of the sky around this point, moving from east to the west (as the stars move).

- It takes more time to get accustomed to the equatorial mount each time you want to look at a different star or planet you have to unlock the axis and take aim at the heavenly body using the finderscope and lock it once you have the general location. From there you'll use the slow motion cable controls or panhandle controls to make the smaller movements. The equatorial mount is generally considered to be more helpful.

3.



">

3

Learn the tripod. You'll need to make sure that the three legs of your telescope are properly balanced otherwise the telescope can fall over and become damaged. When you're scouting out locations, always look for areas that have a flat, level area for your telescope.

Part 3

Scanning the Sky

1

Learn the sky. Before you start tromping around in the dark with your expensive telescope, you'll need to figure out what you're looking for. Maybe you want to have a gander at the moon, or want to check out the planets. Maybe you're interested in a meteor shower. You'll need to find out timing, place, weather, etc.

- If you're trying to observe the stars, for instance, going out on a moon-lit night won't get you very far.
- Look at books on stars and constellations. These will tell you when the best viewing times are and when the planets are easiest to be seen.
- Examine sky charts so that when you are out in the dark you know where to point your telescope.
- Train your eye. To do so, make sketches of the moon and the planets. You don't have to be a great artist to capture them as accurately as possible. This will help you to look more closely at the sky and observe details.

2.

Choose your spot. You'll need to choose your spot carefully, once you've decided what you're looking for and where it will be. It will need to be accessible at night and have a place with solid level ground for your telescope's tripod.

- You'll need to consider light pollution. For instance, if you're in a big city, going up on a high roof (As long as it is safe) can get you away from the worst of the light pollution and allow you to see more clearly.
- Try to avoid decks and blacktop driveways and concrete. Footsteps on a deck can cause vibrations in the image. Blacktops driveways and concrete can create thermal issues for your telescope.

3.

3

Practice. You'll need to practice setting up your telescope and pointing to the correct part of the sky before you start fiddling around at night. Otherwise it is very easy to lose bits of your telescope and forget how to do something.

- For practice set up your telescope and, using the lowest power eyepiece, point the main scope at something about 100 feet (30.5 m) away like a tree (not the sun!). Center the object in your crosshairs and make sure it's clear. Switch to a higher powered eyepiece and try again.

4

Be comfortable. Make sure that when you're having your big night out with the stars that you have dressed appropriately. If it is going to be cold, make sure you have the right clothes on and bring along a canister of something warm.

Guiding a Telescope for Imaging

By: **Mark J. Coco** | August 8, 2006

4Share

We all do it -- ogle over the astrophotographs taken by the masters. The deep-sky images look so exquisite with their masses of detail and perfectly round, pinpoint stars. We know they didn't come easily.

Impressive celestial photography is a lot more feasible for amateurs now than it was a generation ago. But good results still require a willingness to learn the intricacies of cameras, focusing techniques, exposure times, films, and miscellaneous equipment. In particular, taking deep-sky pictures requires a skill that's involved in no other kind of photography: guiding on a star.

Why Guide?

To get a sharp image from a long exposure, you must keep a guidestar centered on cross hairs for the entire time the shutter is open -- from a few minutes to an hour or more. While watching the star, you must often adjust the telescope's aim slightly to keep the star on the crosshairs and the image motionless on the film.

No telescope drive, no matter how well made, can eliminate the need for guiding. Any gear system contains some *periodic error* that shifts the telescope back and forth slightly in right ascension, typically with a period of 4, 8, or 15 minutes. If the telescope is not perfectly polar aligned it will probably drift slightly in declination too. The telescope tube may flex a little as it tracks the subject across the sky. Atmospheric refraction varies as an object's altitude changes, altering the object's apparent position enough to blur photographs after as little as a few minutes. The electricity running the drive motor may be slightly irregular. And the slowest component of atmospheric "seeing," or turbulence, can make a whole star field creep around slightly with a characteristic time of many seconds. You have to guide the telescope on a star to follow all of these image motions.

The aiming corrections required are so tiny -- just a few arcseconds -- that you cannot push the telescope by hand. Instead you need an electronic *drive corrector* that speeds or slows the telescope's drive motor. This allows fine guiding in right ascension (east-west), where the most frequent corrections are needed.

You also need a fine-motion control in declination (north-south). A turn-by-hand control will work only if the mounting is rigid enough so it doesn't wiggle at high power when you turn the knob. An electric declination motor usually gives much better results. Typically the buttons or joystick for controlling both right ascension and declination are mounted on a single hand paddle.

How To: Guiding A Telescope for Imaging

The first thing you need to do is polar align your mount. This means aligning the right-ascension axis parallel to the Earth's axis of rotation. Otherwise, even with perfect guiding, everything in the photograph will circle slightly around your guidestar, a problem known as field rotation.

How good a job of polar alignment do you need to do? That depends on the exposure time and image scale of the picture you are taking. Wide-field photography with a normal (50-millimeter) camera lens requires minimal alignment. Simply pointing the mount's polar axis at Polaris as best as you can judge is usually enough for normal-lens exposures of a few minutes.

When you start using longer lenses or a telescope, you need better alignment. Some mounts come with a *polar alignment finder,* a miniature telescope with an engraved reticle that you position on Polaris and surrounding stars. These devices work quickly and well. If you want the best possible alignment, however, especially for a permanently mounted telescope, use the *declination drift method* described in the article Accurate Polar Alignment; it takes a little time, but it's simple and needs no special equipment. Nothing else gets you closer to the celestial pole.

Piggyback Photography

The easiest way to enter the realm of guided deep-sky astrophotography is by the piggyback method. Simply attach a camera to the side of the telescope, point skyward, and open the shutter. You guide the camera by tracking on a star seen in the telescope itself.

Piggyback photography puts the least demands on your guiding ability. Most piggyback photographers start with a normal or a wide-angle lens (such as 28 mm) that will capture whole constellations at once. Almost any camera lens has a much shorter focal length than the telescope, so the image scale is much smaller. This means you can make numerous small guiding mistakes without affecting the photograph. Piggybacking provides just the type of practice you need to gain experience for other, more difficult forms of astrophotography.

Guiding Eyepieces

What kind of eyepiece do you need for watching the guidestar? For piggyback guiding you might try a plain, extremely-high-power eyepiece with no cross hairs or reticle. Simply keep a bright guidestar centered in it as best you can judge.

For photography at longer focal lengths, you need an eyepiece with an illuminated reticle or cross hairs. Dozens of guiding eyepieces are on the market, and many perform other functions as well. What do you really need?

Some people feel that the best design is still the old-fashioned plain cross hairs. Any motion is revealed when the star emerges from behind their intersection. Some astrophotographers like to keep the star in view, tucked in a corner adjacent to the intersection. If you use a double or dual cross hair, the guidestar can be placed at any of the four intersection points or defocused to nearly fill the small central square.

Another approach is to use an eyepiece reticle with concentric circles, each denoting a different guiding tolerance. If you can keep the star inside the appropriate circle, you know that all is well. For this approach to work, however, you have to know the guiding tolerance for your particular photographic setup and which circle on the reticle this corresponds to. Guiding tolerances are usually very tight, so most astrophotographers simply prefer to guide as accurately as they possibly can and hope it's good enough.

One often overlooked approach is the projection reticle. This device superposes a reticle's image onto the view in an ordinary eyepiece. Some designs have a 3x Barlow lens built in to allow the use of medium-power eyepieces that have comfortable eye relief. Another advantage is that the reticle's image can be moved around the field to align on a guidestar; you don't have to move the whole telescope to the star. This allows more flexibility in aiming and composing your photographs.

Reticle illuminators today are a vast improvement over the incandescent bulbs with their tangles of wires that were the rule in the past. Today's standard illuminator is a dim, red LED (light-emitting diode) that draws only a tiny current from a small battery that's right inside the eyepiece unit itself. The brightness should be adjustable so you can set it to the best level for any guidestar. One of the latest and greatest improvements is the blinking LED, which gives you alternate views of the guidestar with and without the cross hairs. This allows much fainter stars to be used for guiding.

Through the Telescope

When it comes to deep-sky photography through a telescope, you have two choices: using a separate guidescope or an off-axis guider.

A *guidescope* attaches to the main telescope via mounting rings that allow it to be aimed independently to some degree. This lets you choose any guidestar up to a couple of degrees from the field being photographed. As a rule of thumb, the guidescope should have about as long a focal length as the telescope you are photographing through. It should also have a reasonably large aperture. Such a guidescope is a substantial instrument in its own right, adding a lot to the whole set-up's cost, size, weight, and demands on the mounting.

Guidescopes have another problem: flexure. During an exposure the guidescope must not bend, shift, or otherwise change orientation with respect to the main telescope's optical axis. Nor can anything in the main telescope bend or shift. Otherwise stars will come out elongated, double, or irregular even when you guide perfectly.

For such reasons the guidescope has been largely eclipsed in the last 20 years by the *off-axis guider.* This device allows you to look through the main telescope at the same time you're photographing through it.

Off-axis guiders generally use a little "pick-off" prism to divert a small part of the image to the guiding eyepiece. The pick-off prism is near or outside the edge of the camera frame, so its shadow has little or no effect on the photograph. You maneuver the prism around to find a good guidestar before starting the exposure. Alternatively, some guiders use a full-aperture window called a pellicle that transmits most of the light to the film while reflecting 10 or 20 percent to the eyepiece.

At long focal lengths, off-axis guiding gives the best results. The starlight you see in the eyepiece goes through the same optical assembly, by and large, as the light going to the film, so tube flexure ceases to be an issue. If it happens you just guide it out.

There are, however, a few inconveniences to consider. Finding a guidestar can be tough, because the area of the field accessible to the pick-off prism is limited. The guiding eyepiece extends out at a 90° angle to the light path of the telescope, and to find a good star you may have to rotate the eyepiece holder around the optical axis to an inconvenient angle. (Some new off-axis guiders allow the eyepiece holder to be rotated independently of the camera.)

Focusing is another consideration. To focus, aim at a bright object, look through the camera's viewfinder, and turn the focus knob until the image seen through the camera is as sharp as you can get it. Leave everything right there. To focus the guiding eyepiece, slide it up or down in its holder; resist the temptation to touch the main focus.

Finally, what you see in an off-axis guider is not exactly what you get. You cannot use a star to guide on a moving comet or asteroid. To track such an object you either have to revert to a guidescope, in which you can track it directly, or calculate the object's expected motion and move your guidestar slowly and steadily at exactly the right speed in the right direction.

Whether you use a guidescope or an off-axis guider, photography through a telescope requires that you work with very high power. The rule of thumb is to use a magnification about five times the telescope's focal length in inches. Thus, with an 8-inch f/10 Schmidt-Cassegrain (focal length 80 inches), try guiding at about 400x. In an off-axis guider, a 9- or 12-mm eyepiece with a 2x Barlow lens will always be just about right, no matter what your telescope.

Guiding Technique

Get comfortable, center the guidestar, and take a couple of minutes to practice before opening the shutter.

Astrophotographers generally align their cross hairs north-south and east-west, parallel to the motions of the equatorial mount. This makes it easy to see the corrections to make. However, if you're guiding on a faint star you may prefer to orient the cross hairs 45° to these directions. This way, as soon as the star begins to drift it will move into open space rather than remain hidden behind a cross hair.

If you have a four-button hand controller, hold it in the same orientation as east-west and north-south in the eyepiece so you won't have to think about which button to push. If the north-south buttons work right but the east-west buttons are reversed, turn the paddle over to orient them correctly. In this case you'll have to press the buttons from underneath.

Declination drives are notorious for having a little loose play -- a "dead zone" -- where nothing happens for a couple of seconds whenever you reverse direction. A trick that may help a bit with this problem is to unbalance the scope slightly; this way its weight stays hanging on one side of the dead zone. In some cases, however, imbalance just makes the situation worse. Another trick is to set the polar alignment slightly east or west of the true pole. This creates a very slow declination drift, but it will always be in the same direction, so you'll never have to reverse direction and go across the dead zone. Just don't misalign so much that you get field rotation.

In many telescopes, especially commercial Schmidt-Cassegrains, the optics themselves have a certain amount of play. The primary mirror can sometimes make a sudden shift after the telescope crosses the meridian. This "mirror flop" may be so large that you can't guide it out, and you end up with doubled or tailed stars. To keep this from happening, if it proves to be a problem with your scope, start your exposure after the subject has crossed the meridian or finish before it gets there.

Autoguiders

It sounds almost too good to be true: a robotic device that watches the guidestar and adjusts your telescope automatically, with a machine's tireless precision, while you relax or even sleep. It's no pipe dream; this is part of the CCD revolution that's sweeping high-end amateur astronomy. A CCD (charge-coupled device) is a chip that records images electronically and sends them to a computer, which in this case is rigged to drive the right ascension and declination motors. An autoguider can use a modest, low-cost CCD, making this capability affordable at something like the $400 level.

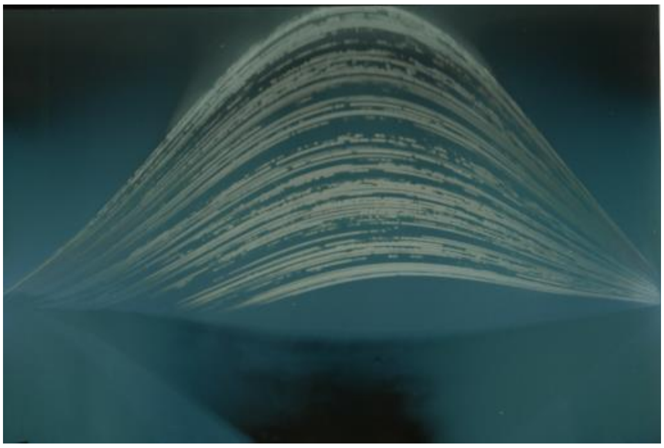
Some CCD cameras themselves (as opposed to autoguiders) have a "track and accumulate" function that allows them to take many short exposures, then stack them by computer, finding the best possible fit, to create one long exposure. This reduces and can even sometimes eliminate the need for guiding. Some advanced CCD cameras now include *two* CCD chips -- a small one to autoguide the telescope and a bigger, better one to record the image.

We've come a long way from the days when amateur astrophotography was limited to fanatical tinkerers who had their own machine shops, darkrooms, and entire nights to spend attempting to make things work. Astroimaging has opened up to anyone willing to buy the gear and take the time to gain skills using it. And now the day has arrived when, once completely set up and running, you can literally sleep through the whole thing!

MEMBERS VIEWING LOGS and IMAGES

Hi Andy,

Please find attached beer can pinhole camera Solargraphs which may be of interest for the WAS newsletter.



Both are southern horizon solargraphs of the Vale of Dauntsey overlooking the M4. I did not get the detail of the view but both show a the full east west sweep of the Sun from the Summer Solstice in June 2016 to the Winter Solstice in December 2016. I used Ilford Multigrade Photographic Paper for the six month exposure. A neighbour gave permission for me to set up the solargraphs taped to a fence in their garden.

Merry Christmas and a Happy New Year!

Regards,

John Dartnell

From Philip Proven on behalf of Lyefield Committee

Hi Andrew, on behalf of the Lyefield Committee I apologise for the inconvenience and disappointment to the members when the Pavilion was double booked on the 6th of December. I investigated the reasons and the person responsible apologised several times over. I hope the alternative venue at least kept everyone warm, unlike the finger food ! As ever Philip

Sent from my iPad

Hi WAS, Are you still going to do the beginners set up session on Tuesday? If you are, I wouldn't mind a bit of help with two areas. Firstly I have a fast Newtonian (Skywatcher 10" Quattro) that I intend to use for photography but is proving a little difficult to get the collimation spot on enough. The scope is notorious for this so either confirmation that it is collimated correctly or some help in doing so would be great. Secondly I have an ATIK One 9.0 camera with built in filter wheel and OAG which is connected to the scope. I have loaded the software ok and can control both the cameras and the filter wheel no problem the bit I am unsure of is setting up and getting the OAG to guide my NEQ6 mount. I can bring the whole set up in including all the bits of equipment, cables etc to do both the above I just need the confidence that what I am doing it correct as my success at any astrophotography has been limited. Cheers Chris Brooks

A laser collimating would help, but getting 'slop' out of the system is important. Newtonian are big mirrors to control and you can get bogged down re collimating every time you use it instead of imaging. The NEQ 6 should be controlled by a cable from the Off Axis Guider running into the mount. But it needs a bright star in the field of view to pick up and track. I hope Tony will be there, he is the collimating expert on Newtonian.

Viewing Log for 26th of December

I decided I needed some Christmas cheer as I had spent the previous five days getting over food poisoning! So with Boxing Day being a clear evening and I had a free evening I decided I would go outside and do some viewing J.

Usually I would go Uffcott and view from there but as the Salisbury Plain Observing Group (SPOG) was also holding a viewing session I thought I would join them instead. This meant a 45 minute/25 mile route to Casterley Camp just above Upavon, when I arrived around 20:00 there was already four cars there, so I had company this evening. The top of the camp is fairly flat and there was a lot of surface water around even though not much rain had fallen recently, so there were a lot of large puddles around the place. After changing parking positions a couple of times it was time to set up my equipment, this time I would be using my Meade LX90 with a 14 mm Pentax WX eye piece (standard viewing set up for this telescope). After doing the set ups I was ready to start viewing 20:21, I had already missed Venus as this planet had set by 20:03 L, I did see it close to the horizon as I drove to the meeting place. So I went to the next planet out from Earth and located Mars about 20 ° above the horizon, I could not make out any detail apart from it being red, combination of being too low and small? Neptune was just above Mars but could not make anything out apart from it being blueish, seeing conditions and position was against this ice giant planet. So this left Uranus as the only planet visible in the night sky, as this was much higher I made it out to be a bright blue/ green dot, might be the best I have even seen this mag 5.7 planet? During the evening I think I spent more time talking with other SPOG members than actually doing astronomy! Mark Radice (will be giving a talk to WAS in June) had a 14 inch scope with him and I asked if he could locate the 'Horsehead Nebula', AKA Barnard 33 which is just below the eastern most belt star (Alnitak) in Orion. After star hoping to the area and fitting a Hydrogen Beta filter to the eye piece, we could not make it out, so this Dark Nebula will have to wait until another day when hopefully the sky conditions will be better? The temperature was around the zero mark but there was not really any frost on the car roof or equipment, so I guess the air was very dry? After having a Mince Pie (one of many I have had over the last week!) with Mark I headed back to my own scope and carried on with the Caldwell (C) list (which I have not been doing very well at recently!). First object was C 2, the Bow-Tie Nebula in Cepheus, this Planetary Nebula (P N) looked like a dim star to view at? For my next object I sought some advice off of Owen Brazell (Astronomy Now's Deep Sky expert) about viewing the North American Nebula (C 20) in Cygnus? I said about putting a 0.5 focal reducer on my scope, this would give me a wider field of view. Owen suggested I put my widest eye piece on as well, as I only had one case with me the best I could would be a 20 mm WX eye piece, in my other case I do have the Televue 31 mm Nagler (looks like a hand grenade) which would really open the sky, he also suggested using a Deep Sky filter. So after loading all this gear up I think I could make out the Mexican part of the nebula? It is a large object to view, bigger than the Moon in the sky? The Eskimo Nebula (C 39) in Gemini was my next object to look at, this P N was fairly bright to look at! Hubble's Variable Nebula (C 46) in Monoceros looked like an out of focus star, this nebula is lit by the nearby star R Mon?

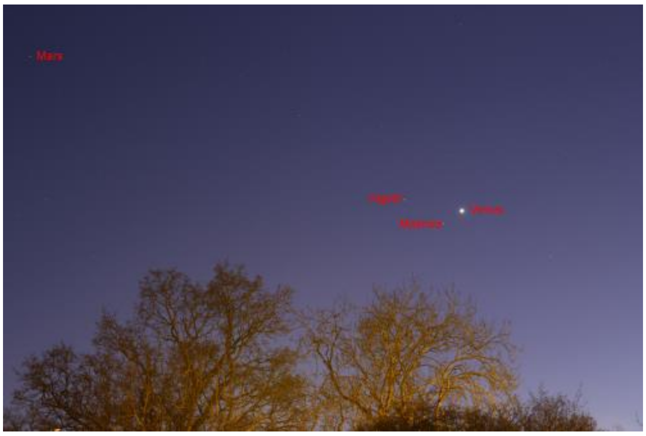
I was going to carry on with some other objects in Monoceros but I noticed the time was now 00:35 and I still had a 40 +

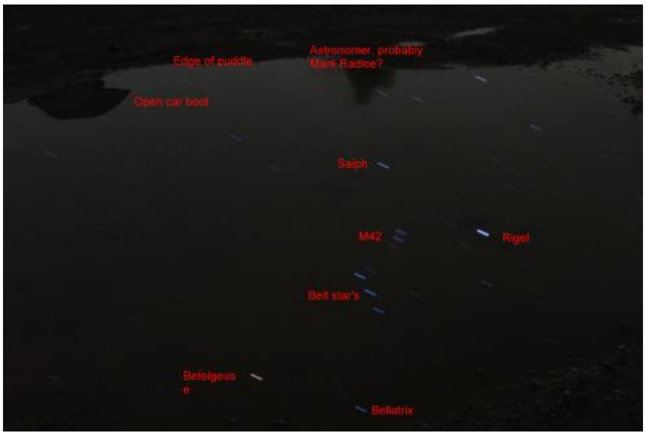
minute trip back home plus drying all the gear out afterwards, so I packed my gear into the car and wished all of those who were still there a Happy 2017 for stargazing. It does not seem a lot to view in four hours but I also did some photography with a twist, I was talking to Owen when I looked into a puddle and noticed the stars of Cassiopeia shining in the water, wonder what Orion would look like? So I had a go at seeing what this would look like (pictures elsewhere in current magazine?) and they came out okay.

Hopefully 2017 will be better for stargazing than 2016? I found early autumn to be not very good for getting out and about, we still have about three months of good dark skies before the spring skies take over and then I will be thinking about my garden/plot instead?

Clear skies.

Peter Chappell





The last one reproduced as received… Images Peter Chappell.

Pyjama log from Andy Burns.

3:40am, just been out with binoculars to prepare for the spring skies, mist and light pollution there but also my own Christmas lights... Oh joyous fun.
My southerly skies are a mixture of high trees and covering/avoiding street lights...we are on an 'emergency services' route so lights stay on.
Having said that the run from Gemini and Monoceros to the west and through to Jupiter, Spica and Virgo to the east gives plenty of quick binocular objects.
Messier 35, one of the most one of the most glorious of all open cluster and visible in Gemini, also splitting Castor in the 15x80 binoculars I was using.

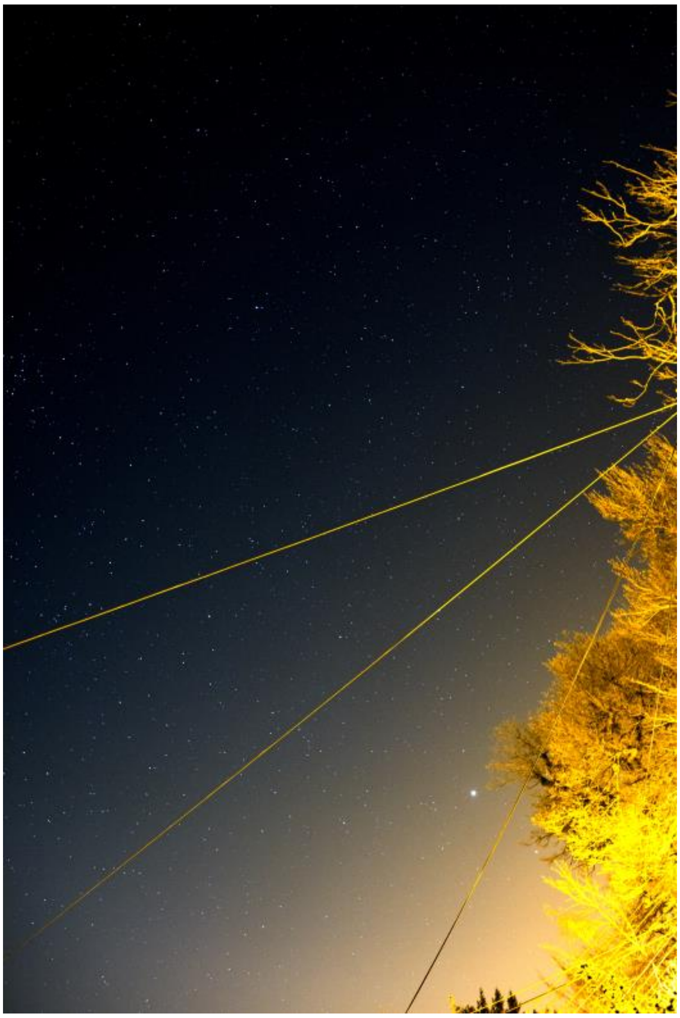
Then into Cancer, with the distant tight cluster M67 showing then to one of the fabulous binocular views, M44 the Beehive with its central pentagram hive and a buzz of smaller stars acting as bees around the hive.

Into Leo… while the M95,96 105 cluster of galaxies were not visible just through binoculars at least towards the 'back leg' M65 and M65 galaxies showed up over the trees.

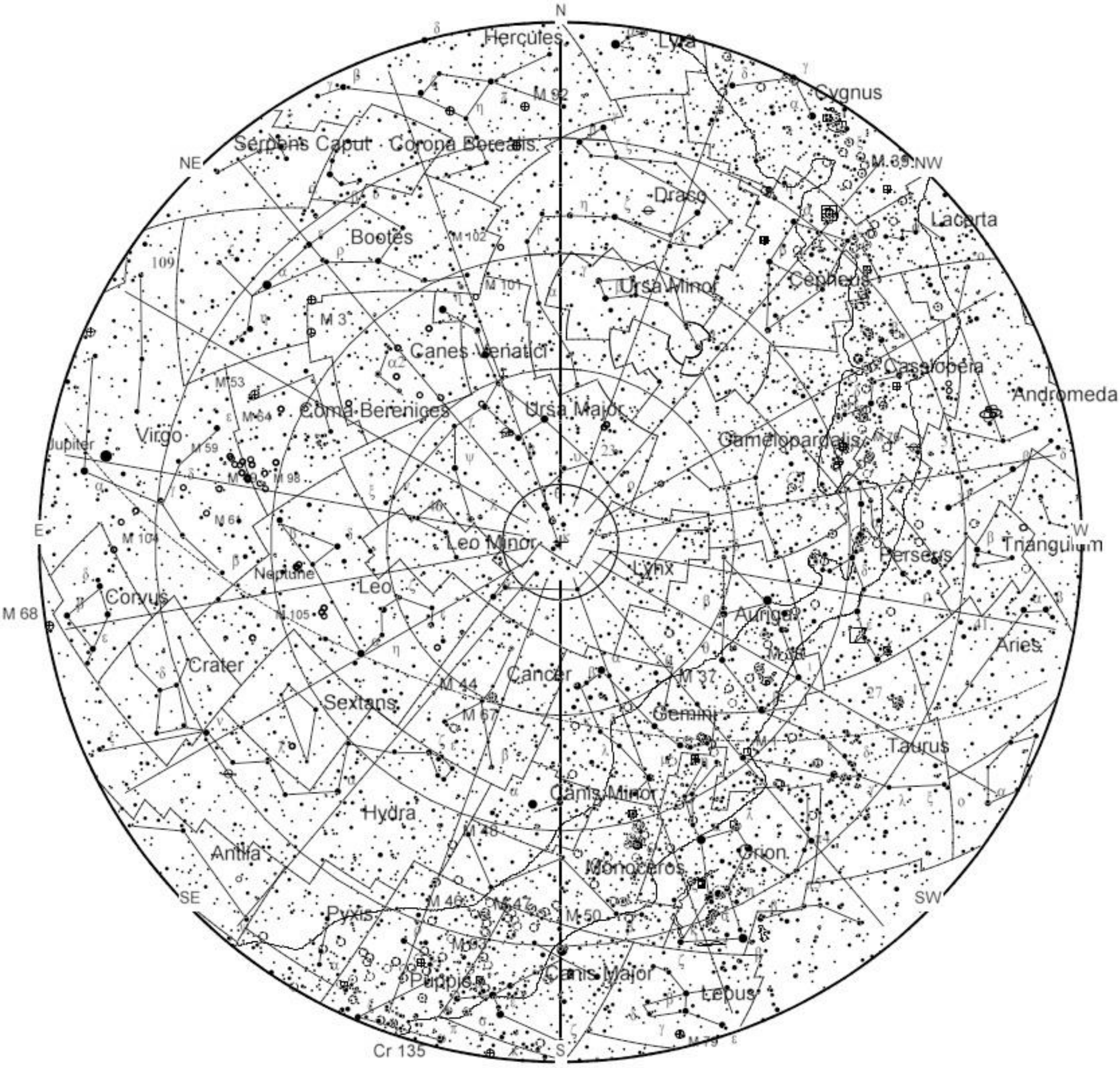
Down past Porrima and Vindermaitrix in the bowl of Virgo and down to Spica and Jupiter. All 4 Galilean moons to one side, Callisto and Europa, then Io and Ganymede were too close to separate in the binoculars. M104 the sombrero was just about visible as a thin smear but any galaxies higher up were in the branches of the trees that reflected a street light.

Up into Coma Berenices, the queens hair tresses wonderful as the huge open cluster Melotte 111 hove into view.

Also imaging with a 35mm camera at the same time…



WHATS UP, JANUARY 2017



· January 3, 4 - Quadrantids Meteor Shower. The Quadrantids is an above average shower, with up to 40 meteors per hour at its peak. It is thought to be produced by dust grains left behind by an extinct comet known as 2003 EH1, which was discovered in 2003. The shower runs annually from January 1-5. It peaks this year on the night of the 3rd and morning of the 4th. The first quarter moon will set shortly after midnight leaving fairly dark skies for what could be a good show. Best viewing will be from a dark location after midnight. Meteors will radiate from the constellation Bootes, but can appear anywhere in the sky.

· January 12 - Full Moon. The Moon will be located on the opposite side of the Earth as the Sun and its face will be will be fully illuminated. This phase occurs at 11:34 UTC. This full moon was known by early Native American tribes as the Full Wolf Moon because this was the time of year when hungry wolf packs howled outside their camps. This moon has also been know as the Old Moon and the Moon After Yule.

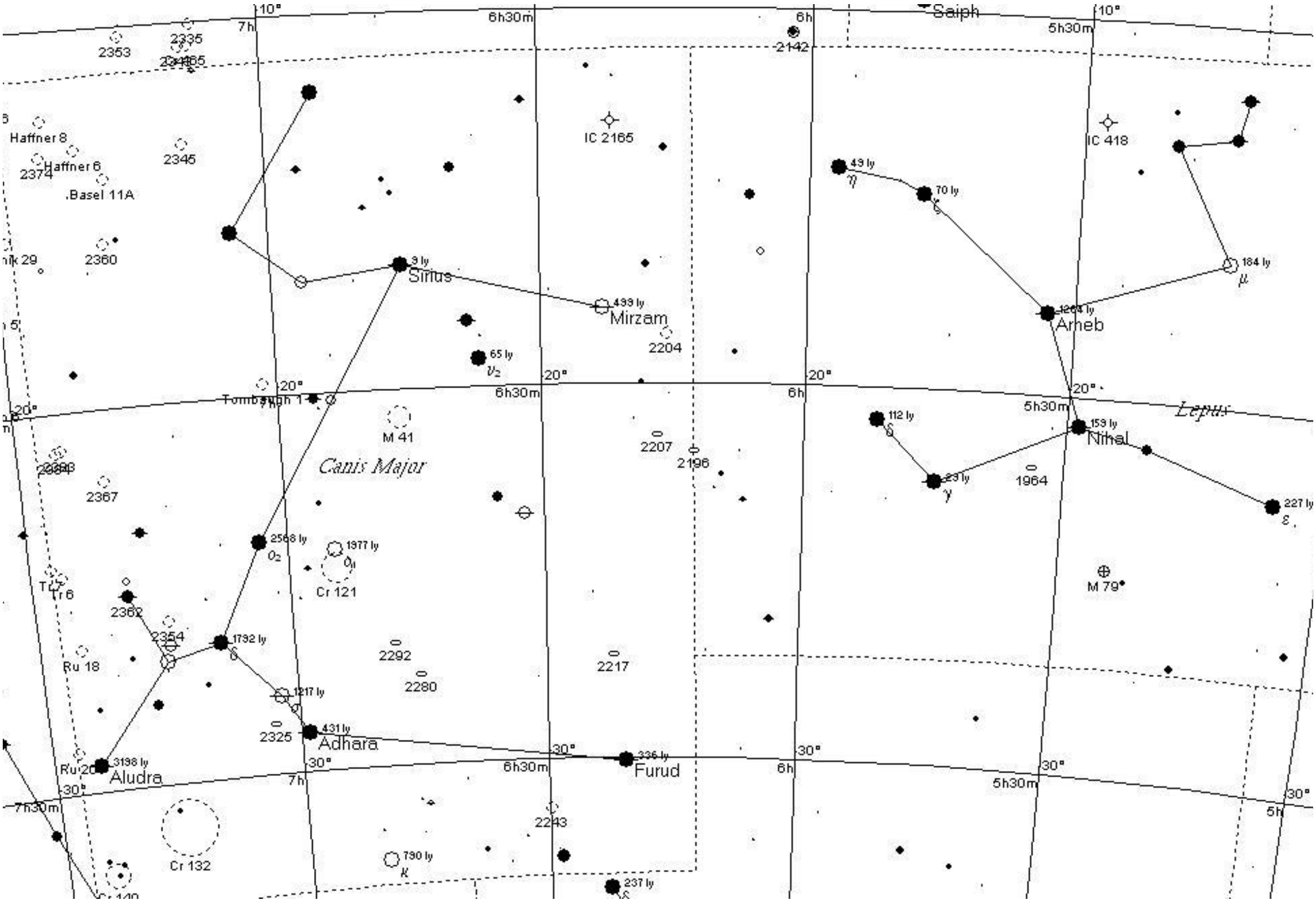
· January 12 - Venus at Greatest Eastern Elongation. The planet Venus reaches greatest eastern elongation of 47.1 degrees from the Sun. This is the best time to view Venus since it will be at its highest point above the horizon in the evening sky. Look for the bright planet in the western sky after sunset.

· January 19 - Mercury at Greatest Western Elongation. The planet Mercury reaches greatest western elongation of 24.1 degrees from the Sun. This is the best time to view Mercury since it will be at its highest point above the horizon in the morning sky. Look for the planet low in the eastern sky just before sunrise.

· January 28 - New Moon. The Moon will located on the same side of the Earth as the Sun and will not be visible in the night sky. This phase occurs at 00:07 UTC. This is the best time of the month to observe faint objects such as galaxies and star clusters because there is no moonlight to interfere.

Orion is the king of the winter constellations and still has the power to draw you into the observing mode is it lifts above the horizon in the early evening. Binoculars readily show the nebula in the sword dangling from his belt. Following the belt down takes is to Sirius in Canis Major and follow the line up and right takes you into Taurus and the Pleiades, another binocular jewel.

CONSTELLATIONS OF THE MONTH: Canis Major and Lupus



The big dog chases the hare below Orion the hunter.

Canis Major, the largest of Orion's two hunting dogs, might be chasing Lepus, the Rabbit, who is just in front of him. Or perhaps he is ready to help Orion battle the great bull.

The stories concerning Orion's dogs are not of mythic proportion, but the Greeks did have several interesting beliefs concerning Sirius, *alpha Canis Majoris*.

The Athenian New Year began with the appearance of Sirius. He was seen as two-headed, like the Roman God Janus: looking back at the past year and forward to the new one.

Sirius was sometimes confused with another two-headed beast called Orthrus. This was Geryon's watchdog; his job was to guard this tyrant's cattle. Heracles captured the cattle (as his Tenth Labour), killing Orthrus in the process.

In antiquity, as Homer and Hesiod were penning their stories, the Dog Star was already associated with the Sun, since the Sun enters that part of the sky in the hot summer months. While the brightest of stars, it hadn't the best of reputations in antiquity as it was said to bring sickness and death. Perhaps this was due to the fact that July and August were habitually the times of drought and disease.

The name *Sirius* may come from the Greek meaning "scorching", or it may not. Burnham's *Celestial Handbook* (as always) offers a wide background into the matter of etymology. The star is mostly thought of now as a winter star, accompanying Orion, rather than as the summer home of the sun.

Some facts about Sirius:

Although the brightest star, Sirius is rather Sun-like in size and luminescence; certainly it is no giant at an estimated 1.5 Sun diameters.

Its brightness comes from the fact that it is very close to us: at 8.56 light years away it ranks as the sixth closest star.

The star is a notable binary, but with a companion which is very dim and very close. The companion is a white dwarf, and its presence wasn't really discovered at first; it was just a hypothesis.

In 1834 Friedrich Bessel noticed a slight oscillation in Sirius's orbit. He made the calculations and predicted the existence of an unseen companion. But by his death, in 1846, the companion hadn't yet been discovered. It was only in 1862 that verification came.

This white dwarf has since been the subject of much study. Named Sirius B or *The Pup*, it is an eighth-magnitude star with an estimated radius of only 10,000 km (about twice the size of the earth). Yet its mass is nearly equal to that of our Sun's, which creates a density so high that a tablespoon full of its matter would weight over a ton.

Such a small dense object is the first phase of the collapse of the so-called *main-sequence stars*. First white dwarfs, as they continue to cool they become yellow dwarfs then red dwarfs. Finally they die completely and are known as black dwarfs.

Beta Canis Majoris is also of some interest. Its name, "Murzim" means "The Announcer", as its appearance on the horizon signifies the approach of Sirius. This is a pulsating giant that has become the prototype of a class of variable stars (see below).

The Bayer stars are quite bright, ranging from -1.5 to fifth magnitude, with a dozen stars of third magnitude or better.

Double stars in Canis Major

Sirius B: The companion describes an orbit of 50.09 years. At 1 January 2000, it will have a PA of 150 degrees and a separation of 4.6".

Mu CMa is a fixed multiple binary, with components B, C, and D at these fixed spots: B: 340º, 3", C: 288º, 88.5", and D: 61º, 101".

h3945 is a gorgeous yet rather unknown binary: gold and blue. It isn't terribly difficult to find nor to resolve, and when you do find it you will keep coming back to enjoy its colours.

The primary is a fairly bright 5.0; the companion has a visual magnitude of 6.1 and is found at PA 55º and separation 26.6".

To locate the primary, first find tau CMa, which is just to the northeast of delta CMa. Now look north of tau CMa, about 1.75 degrees and very very slightly to the west of due north. You should find the fairly bright primary with no problem. Focus carefully and study this star. Its companion should be quite visible, particularly if you enjoy clear dark skies. You will know when you find it; the colours are unmistakable.

Variable stars in Canis Major

Beta CMa is a pulsating giant star, and the prototype of a small class of variables. Its variations are too slight to be noticed by the naked eye, as it changes from only 1.93 to 2.00 every 6h, 2.6s.

This class of variable is also called the "beta Cepheid type", as this particular star was the first in this class to be discovered (in 1901).

These are all young stars, with a spectra of O or B. Characteristically, they have extremely small changes in magnitude over very short periods (the longest period is ES Vul, with a period of 14h 38.4m). Interestingly, the radial velocity appears to fluctuate with the same period, often quite dramatically (e.g. more than 100 km/s). Reasons for this phenomenon are still not understood.

Other beta CMa variables are *iota Canis Majoris* and *xi*^{1} *CMa*. Both of these stars fluctuate only about 0.04 visual magnitude; in *iota's* case, in every 1h 55m, while *xi* takes almost 5h to make the cycle.

There are no long-period Mira-type variables of any consequence in Canis Major. Indeed, unless one is studying cepheid variables, this is not a particularly fruitful area of the sky for the student of variable stars.

Deep Sky Objects:

M41 is a globular cluster easily located four degrees south of Sirius. Perhaps a hundred or so stars make up this bright group, fifty of them bright enough to be easily seen in binoculars. At the centre of the group is a red giant. The group is thought to be about 2500 light years away.

Lepus, "The Hare", is an ancient constellation found under the feet of Orion, the Hunter. No one seems to know just which culture first saw the constellation as an animal; the Arabs saw it as the "throne of the central one" (i.e. Orion).

Lepus, The Hare is not to be confused with *Lupus, The Wolf,* which is a spring constellation.

Lepus is often ignored, as Orion is such a dominating constellation. Yet Lepus contains a number of interesting objects. Its Bayer stars are generally third and fourth magnitude.

Double stars:

Beta Leporis is a close binary with faint companion: 2.8, 11; PA 330 degrees, separation 2.5".

Gamma Leporis is a wide binary with slight colour contrast, yellow and orange (although observers vary): 3.7, 6.3; PA 350, separation 96.3".

Kappa Leporis (Struve 661) is a fixed system: 4.5, 7.4; PA 358 degrees, separation 2.6".

h3750 is a fixed binary: 4.7, 8.5; PA 282 degrees, separation 4.2".

h3752 is a fine multiple in the same field as M79.

AB: 5.5, 6.5; PA 97 degrees, separation 3.1". AC: 9; PA 106 degrees, separation 59".

h3780 is a noted multiple system which also goes under the name NGC 2017.

AB: 6.4, 7.9; PA 146 degrees, separation 0.8"
AC: 8.5; PA 136 degrees, separation 89.2".
AE: 8.4; PA 7, separation 76.1".
AF: 8.1; PA 299, separation 28.8".
AG: 9.5; PA 49, separation 59.8".

Variable stars:

Mu Leporis is an alpha CV type variable: 2.97 to 3.41 about every two days.

Rho Leporis is an alpha Cygni type variable: 3.83 - 3.90.

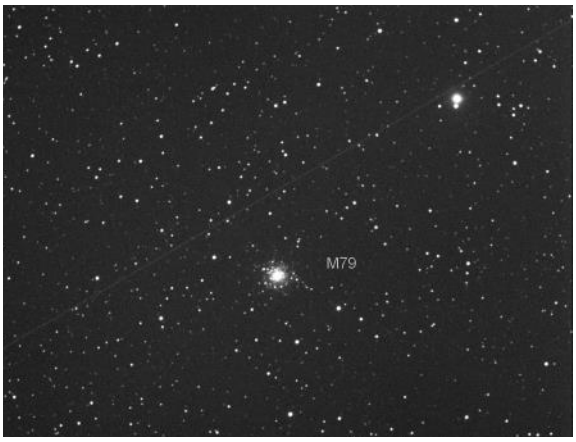
R Leporis is a long-period (Mira) variable that ranges from about 6 to about 11.5 every 427.07 days. However sources vary over this figure, and you will find quoted a period ranging from 427 to 440 days. In 2000 the maximum may occur in the last week of December, depending of course on the star's current period.

The star glows with an unusually intense red; it goes by the name of *Hind's Crimson Star* since John Russell Hind (in 1845) wrote that it resembled "a blood-drop on the background of the sky". Although, unfortunately, as the star brightens it loses much some of its intense colour.

The star is 3.5º NW of mu Leporis. Burnham (p.1094) has a finder's chart. (The star less than two degrees south of R Lep is the close binary b314.)

Deep Sky Objects:

Lepus has one Messier and a tiny star cluster which is actually the half dozen stars which go to make up the multiple h3780.



M79 (NGC 1904) is a small globular cluster about 3.5 degrees SSW of beta Leporis. In the same field, half a degree to the SSW of this cluster, is h3752 (see above).

NGC 2017 is a group of a half dozen stars, all gravitationally bound (h3780, see above). The "cluster" is found seven arc minutes due east of alpha Leporis.

Upcoming Local Astronomy Events.

Herschel Society programme for next year is to start as follows:

Fri 6 Jan 17	7.30 pm	Elwin	Dr Hendrik van Eerten	Understanding Cosmic Explosions: gamma-ray bursts and other violent phenomena in astrophysics	University of Bath
Fri 3 Feb 17	7.30 pm	Elwin	Prof Graham Machin	Mercury rising - measuring temperature through time	NPL
Fri 3 Mar 17	7.30 pm	Elwin	Prof Carole Mundell	TBD	University of Bath
Sat 4 Mar 17	Morning	Duncan	WHS AGM		

Hope to see you there!

Tony Symes

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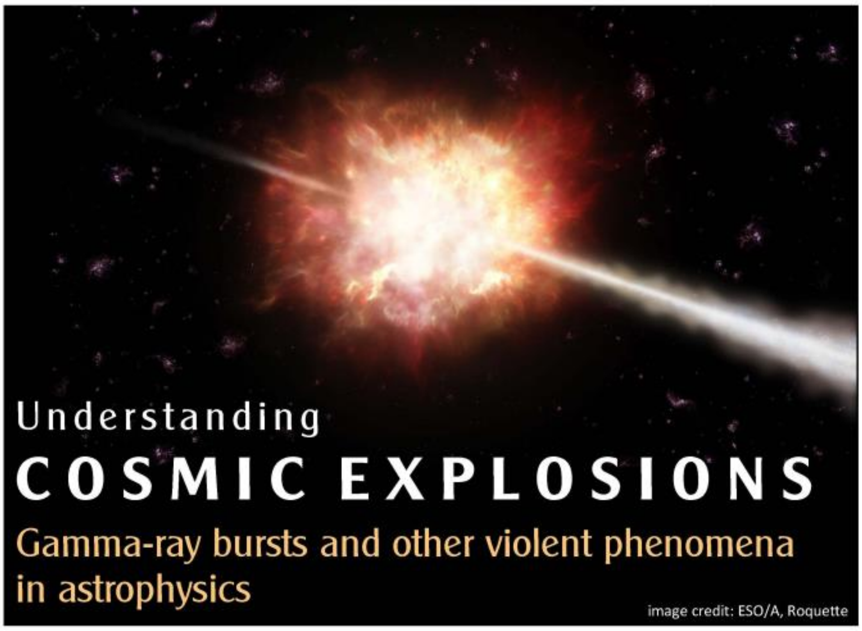

Dr Hendrik van Eerten University of Bath

The brightest events in the universe are also the most violent. Massive stars explode at the end of their lifetime to produce a supernova blast wave, in some cases approaching the speed of light, giving rise to a burst of gamma rays that is detectable from across the universe. Similar blast waves can be triggered by collisions between neutron stars, or by stars venturing too close to the huge black hole at the centre of their galaxy. Stellar-sized black holes can collide and merge as well, causing an invisible shock that reverberates through the universe as a gravitational wave. All these phenomena pose their own fascinating challenges to the theoretical astronomer, and we try to use all means at our disposal, including numerical simulations on massive computer networks, in order to make sense of the underlying physics.

HERSCHEL / ASTRONOMY

Friday 6 January 2017 • 7.30 pm

BRLSI

VISITORS £4 • MEMBERS / STUDENTS £2

ISS PASSES For January to Mid Feb 2017 From Heavens Above website maintained by Chris Peat

Date	Brightness	Start			Highest point			End		
	(mag)	Time	Alt.	Az.	Time	Alt.	Az.	Time	Alt.	Az.
04 Jan	-0.1	04:56:38	13°	ESE	04:56:38	13°	ESE	04:57:24	10°	ESE
04 Jan	-2.7	06:29:20	19°	SW	06:31:26	54°	SSE	06:34:38	10°	E
05 Jan	-2.1	05:39:38	38°	SE	05:39:38	38°	SE	05:42:29	10°	E
05 Jan	-3.4	07:12:30	10°	W	07:15:46	89°	NNW	07:19:02	10°	E
06 Jan	0.1	04:49:49	13°	E	04:49:49	13°	E	04:50:15	10°	E
06 Jan	-3.3	06:22:29	36°	WSW	06:23:40	78°	SSE	06:26:57	10°	E
07 Jan	-1.9	05:32:35	39°	E	05:32:35	39°	E	05:34:50	10°	E
07 Jan	-3.4	07:05:15	13°	W	07:08:04	85°	N	07:11:21	10°	E
08 Jan	0.3	04:42:36	11°	E	04:42:36	11°	E	04:42:42	10°	E
08 Jan	-3.4	06:15:16	53°	W	06:15:57	87°	N	06:19:14	10°	E
09 Jan	-1.5	05:25:15	31°	E	05:25:15	31°	E	05:27:07	10°	E
09 Jan	-3.4	06:57:55	17°	W	07:00:22	86°	S	07:03:38	10°	E
10 Jan	-3.5	06:07:52	67°	WNW	06:08:15	86°	N	06:11:31	10°	E
11 Jan	-1.1	05:17:48	26°	E	05:17:48	26°	E	05:19:23	10°	E
11 Jan	-3.2	06:50:28	19°	W	06:52:36	65°	SSW	06:55:50	10°	ESE
12 Jan	-3.5	06:00:23	79°	SW	06:00:30	81°	SSW	06:03:46	10°	ESE
13 Jan	-0.8	05:10:20	22°	E	05:10:20	22°	E	05:11:39	10°	E
13 Jan	-2.6	06:42:59	21°	W	06:44:44	41°	SSW	06:47:50	10°	SE
14 Jan	-3.0	05:52:57	55°	S	05:52:57	55°	S	05:55:55	10°	ESE
14 Jan	-1.2	07:26:35	10°	W	07:28:42	16°	SW	07:30:50	10°	S
15 Jan	-0.5	05:02:56	17°	ESE	05:02:56	17°	ESE	05:03:51	10°	ESE
15 Jan	-1.8	06:35:36	20°	WSW	06:36:47	24°	SSW	06:39:30	10°	SSE
16 Jan	-1.9	05:45:38	30°	S	05:45:38	30°	S	05:47:49	10°	SE
17 Jan	-0.1	04:55:43	11°	SE	04:55:43	11°	SE	04:55:56	10°	SE
17 Jan	-1.2	06:28:24	14°	SW	06:28:41	14°	SW	06:30:27	10°	S
18 Jan	-0.8	05:38:33	14°	S	05:38:33	14°	S	05:39:19	10°	SSE
30 Jan	-1.3	18:17:35	10°	S	18:19:32	15°	SE	18:20:07	14°	SE
30 Jan	-0.3	19:52:17	10°	WSW	19:52:48	14°	SW	19:52:48	14°	SW
31 Jan	-2.3	19:00:19	10°	SW	19:02:56	35°	S	19:02:56	35°	S
01 Feb	-1.9	18:08:32	10°	SSW	18:11:20	26°	SSE	18:13:00	17°	ESE
01 Feb	-1.0	19:44:15	10°	WSW	19:45:40	24°	WSW	19:45:40	24°	WSW
02 Feb	-3.3	18:52:07	10°	WSW	18:55:22	60°	SSE	18:55:41	56°	SE
03 Feb	-2.6	18:00:05	10°	SW	18:03:14	43°	SSE	18:05:39	15°	E
03 Feb	-1.7	19:36:18	10°	W	19:38:19	34°	W	19:38:19	34°	W
04 Feb	-3.4	18:44:05	10°	WSW	18:47:23	83°	S	18:48:16	46°	E
04 Feb	0.1	20:20:36	10°	W	20:20:55	12°	W	20:20:55	12°	W
05 Feb	-3.2	17:51:55	10°	WSW	17:55:12	67°	SSE	17:58:11	12°	E
05 Feb	-2.3	19:28:22	10°	W	19:30:51	47°	W	19:30:51	47°	W
06 Feb	-3.4	18:36:08	10°	W	18:39:27	85°	N	18:40:46	33°	E
06 Feb	-0.2	20:12:40	10°	W	20:13:26	16°	W	20:13:26	16°	W
07 Feb	-3.3	17:43:55	10°	W	17:47:13	87°	S	17:50:31	10°	E
07 Feb	-3.1	19:20:25	10°	W	19:23:21	67°	W	19:23:21	67°	W
08 Feb	-3.4	18:28:11	10°	W	18:31:30	87°	N	18:33:18	24°	E
08 Feb	-0.6	20:04:44	10°	W	20:05:58	20°	W	20:05:58	20°	W
09 Feb	-3.1	19:12:28	10°	W	19:15:43	60°	SSW	19:15:57	57°	S

END IMAGES, OBSERVING AND OUTREACH

.The Belt of Orion. Always worth a look. The three bright stars of Alnitak, Alnilam and Minatak are young blue giant stars around 690 light years away, very similar to the distance to the Orion nebular. Not surprising to see some of the nebulosity still glows around these stars, Minatak on the right also has an easily seen binary partner. Alnitak in the left is also a double star, but a large telescope will begin to show the flame nebula with its dark lane of material running through it. Photo Andy Burns, 60 seconds through 102 Televue using Nikon D810a

Date	Moon Phase	Observing Topic
2017		
Friday 27th January	New Moon	Deep Sky
Friday 24th February	Waning crescent (sets 3pm)	Deep Sky
Friday 24th March	Waning crescent (sets around 2pm)	Deep Sky
Friday 28th April	Waxing crescent (sets 11pm)	Deep Sky & Lunar targets
Friday 26th May	Waxing crescent (sets around 10pm)	Deep Sky & Lunar targets

OUTREACH ACTIVITIES

Still awaiting clear Thursday to tie in with Chippenham Scouts.

January 26th Lacock Positives Photographic Society Talk.

Paragon School, Bath February 7th or 14th depending on weather.