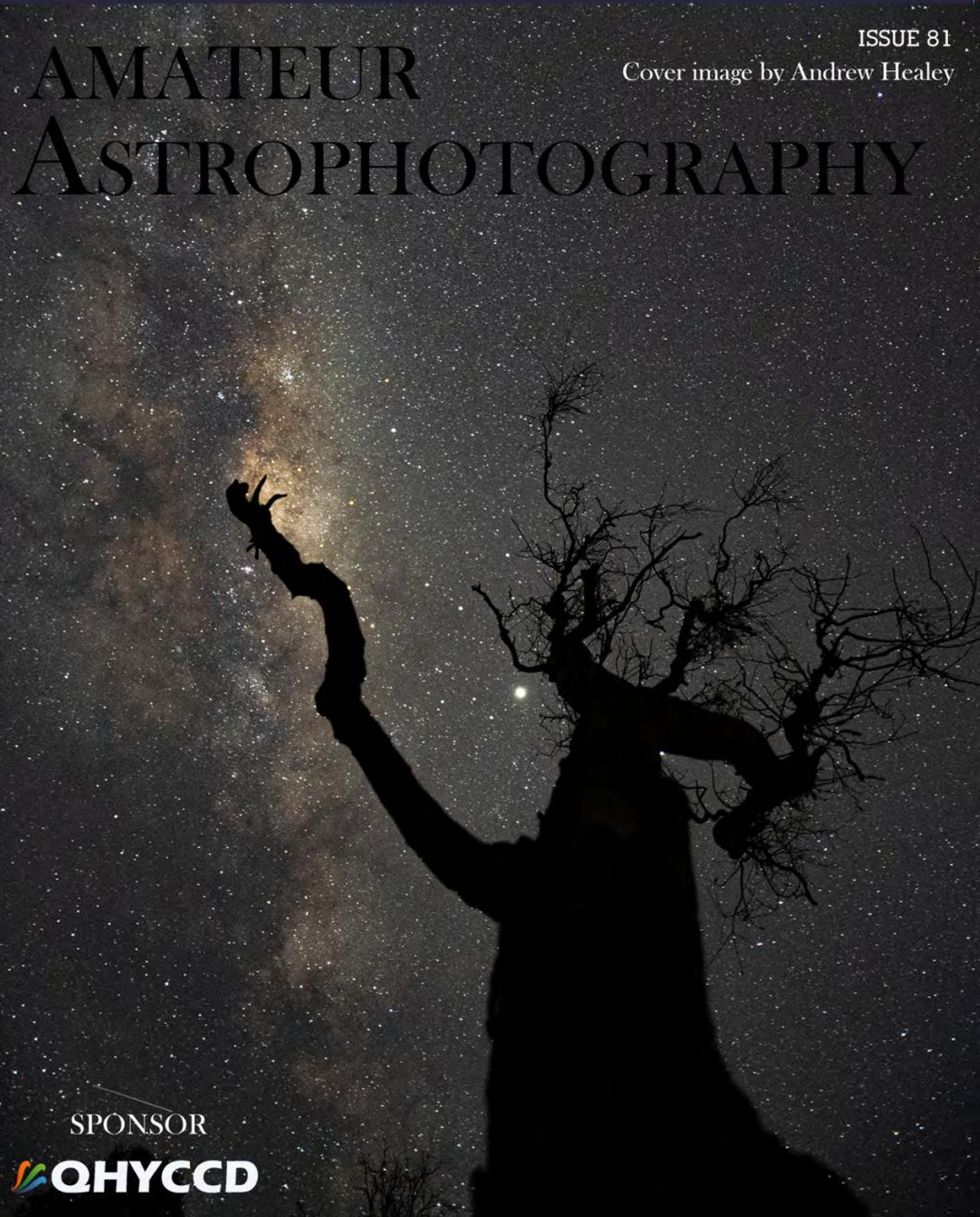
INCLUDING DARK SKY TRAVELS NIGHTSCAPE PHOTOGRAPHY

AMATEUR ASTROPHOTOGRAPHY

ISSUE 81

Cover image by Andrew Healey



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Step : 0.01mm (at focal plane 0.06mm)
Power Input : 12 to 16V DC
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Hand controller included
ASCOM compatible
Optional 2"&3.5" Fixed focus camera adapter

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RSF-10 : FOR 10" RC
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Compatible with GSO, Astro-tech, TPO or similar RC

[LIST OF COMPONENTS]

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Instrument Capacity : 30lbs (13.5kg)
Slew Speed : Max 6° /second
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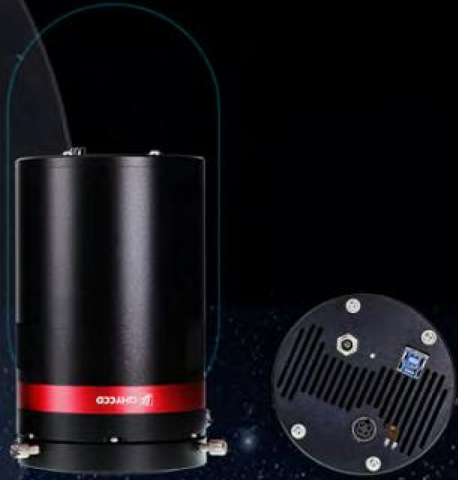

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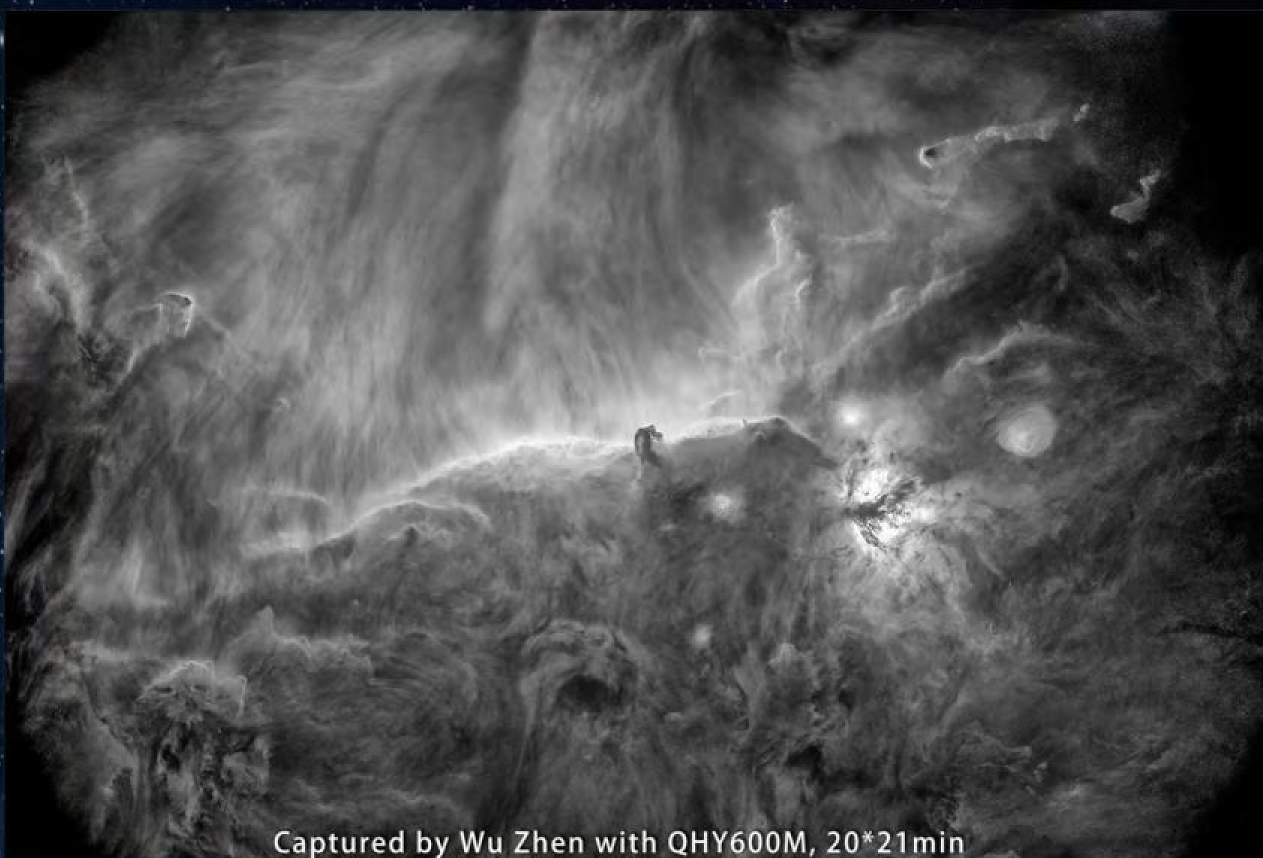

Captured by Wu Zhen with QHY600M, 20*21min

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Camera + Filter Wheel + LRGB Filters $4995
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Part 2- More considerations for beginners who are selecting cameras and accessories for astrophotography:

1. Read Noise
2. Special Planetary Imaging Considerations
3. Cooling and Dark Current
4. Sky Background
5. Guiding and Polar Alignment
6. Filter Wheels and Filters
7. Adapters and Accessories
8. Software Compatibility
9. Warranty
10. Putting it all together

Of the several possible sources of noise in an astronomical image, most of us concentrate on reducing one or more of the three main sources: dark current, read noise and sky background. Of the three, obviously, only the first two can be blamed on the camera! But even the third source of noise, sky background, can be managed at the camera without having to move to the Andes mountains to find dark skies.

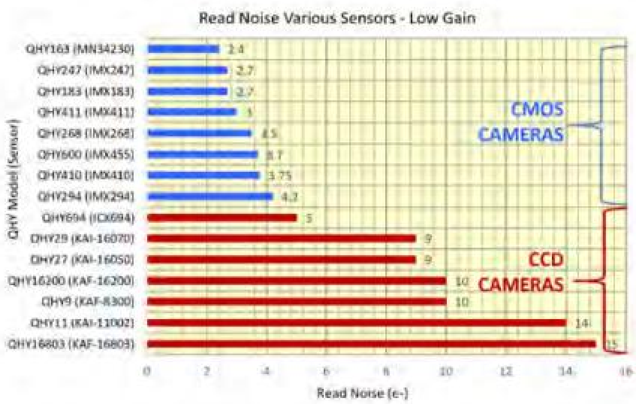
1. Read Noise

Read noise is noise that is introduced into the image as the sensor is read out after exposure. Unlike dark current or sky background noise, read noise does not increase with integration time. It is one dose of noise per exposure whether it is a one second exposure or an hour-long exposure. It does increase as you add multiple exposures to produce a final image.

If a camera has high read noise, the imaging strategy is to increase the integration time until the read noise becomes insignificant compared to other sources of noise like dark current or sky background. If you can increase your integration time by holding off the effects of sky background (by say using a long focal length and imaging through narrowband filters) then dark current becomes the limiting noise factor. Cooling reduces this culprit, so by employing these various means, long deep exposures even in relatively light polluted skies are possible. Modern CMOS sensors have such low read noise (and such low dark current) this is not much of an issue any more.

It is fair to say that, today, the appearance of highly sensitive, low noise, CMOS sensors has changed the landscape when it comes to imaging philosophy (and guiding). QHYCCD makes both CCD and CMOS cameras using a variety of popular sensors. Looking at the chart, below, it is clear that even at lowest gain our CMOS cameras generally have much lower read noise than our CCD cameras. At high gain, where many of our CMOS cameras achieve around 1e- of read noise, this difference is even greater.

A few years ago, when CCDs were the sensor of choice, imagers worked very hard to build a guiding system that could track accurately for hours, not minutes. The idea was to "bake in" the exposures to get the most of each frame and thus reduce the contribution of read noise when adding several sub-exposures. Some CCD cameras have read noise as high as 15 or 20 electrons. Even the best struggle to get read noise much under 9 or 10 electrons and almost none have read noise below 5 electrons.



The AVERAGE read noise (at high gain) of the eight CMOS cameras in graph, above, is one electron! At lowest gain the same eight models average only 3.6e-. With such low read noise, taking multiple shorter exposures has become commonplace, particularly in planetary imaging. Shorter exposures mean less stress on the guiding system but also requires sensors to have high QE to do well in less time. This is now the case as well. Compare, for example, the QE of the CMOS cameras and the CCD cameras in the quantum efficiency chart shown in Part 1. The average peak QE for the three CCD sensors in that chart is around 56% while the average QE for the four CMOS sensors is around 85%. Even discarding the highest CMOS and lowest CCD, the difference is still about 60% vs 80% and I think it's fair to say that this is pretty typical when you compare modern CMOS vs. older CCDs. Of course, there are exceptions, but generally it is the case that modern CMOS sensors are more sensitive than typical CCD of days past.

2. Special Planetary Imaging Considerations

This image of Jupiter was taken many years ago by Ed Grafton using an ST-6 camera and C-14 telescope. The ST-6 had 375x242 pixels at 23x27 microns! Read noise was 23e- and dark current was 10e-/p/s at -30C. Download time for one frame was 22 seconds. The ST-6 had a monochrome sensor so this color image was made with separate RGB frames shot through color filters, each one taking 22 seconds to download. The camera sold for about $3000 (20 years ago).

Based on everything that has been said in this article, there is nothing about this camera that would lead you to select it for planetary imaging (or any other kind of imaging for that matter) but this image isn't too bad! I wanted to include it here to illustrate two things: First, planetary imaging ain't what it used to be and, second, that despite figuring out all the fine details of what is optimum, the person taking the image and his location play the most important roles in the results. One should not get too obsessed with specs and technical details.

The availability of sensors that have both high QE and very low read noise has facilitated a different approach to imaging planets. In deep space imaging one generally needs longer exposures to capture the subtle detail of very dim objects. But for planets, which are much brighter, the key is to take exposures as short as possible to "freeze' the seeing and then stack hundreds or thousands of these images to bring out the subtle detail.

Today, more often than not, planetary imaging is done with a small, fast, uncooled camera like the QHY5III462C. Compared to the ST-6 it has 23X more pixels, 46X lower read noise, and it can capture almost 3,000 images in the time it took the ST-6 to download one frame. And it costs 1/10th as much. The 462C also has 2.9um pixels compared to the ST-6's huge 23x27um pixels.

To get an image scale a little better than 0.25 arcseconds, Ed used eyepiece projection to effectively increase the focal length of his C14 to 24,000mm (f/68). To achieve the same pixel scale with the 462C camera, one needs a focal length about 1/10th of Eds - about 2400mm, or very roughly the typical focal length of a C11 at prime focus. As mentioned before, the emphasis today is taking hundreds or thousands of images, then grading and stacking them to bring out detail, similar in application to "lucky imaging." This was simply not possible with CCD cameras that had high read noise and took 22 seconds to download a single frame to boot.

Possibly the two best amateur planetary imagers in the world today are Christopher Go and Damien Peach. Both use C-14 scopes with their planetary cameras. Christopher Go uses a QHY5III290M or QHY5III462C. Damien Peach uses several cameras and has just recently turned in some incredible images with a QHY5III462C. In all cases the pixel scale is about 0.15 arcsec. While this would seem to violate the formula for optimum pixel size per focal length used for deep space imaging, their results clearly demonstrate that planetary imaging is an exception that has its own set of rules and resolution is king.

Saturn by Damien Peach using a QHY5III462C and C14

Jupiter by Christopher Go using a QHY5III462C and C14

3. Cooling and Dark Current Noise

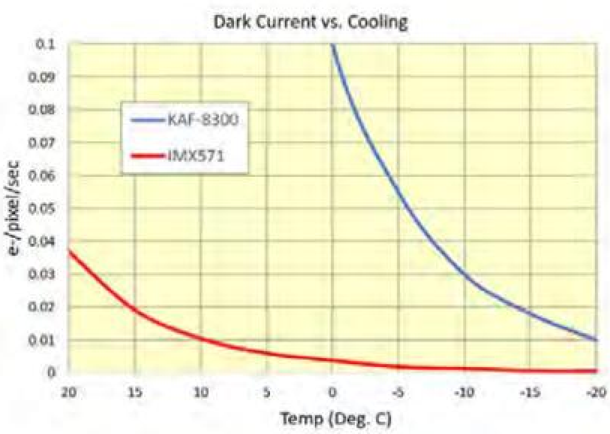
Cooling and dark current noise increase with exposure time and are therefore more significant issues in deep space imaging. They are mentioned together because one is dependent on the other. Dark current is the generation of electrons in the sensor itself just by virtue of being turned on. It is called dark current because it will produce these electrons in the pixels even if you are not exposing the sensor to light during an integration (i.e., taking a exposure in complete darkness). Dark current is usually expressed as electrons per pixel per second at a specific temperature. (e.g., e-/p/s @ -15C).

One fortunate property of dark current is that it is greater at higher temperature and is reduced at lower temperature. This is why cooling CCD and CMOS sensors is a common design feature of cameras intended to take long exposures. Another fortunate property of dark current is that it creates a pattern that is quite repeatable. This means that you can take an image of just the dark current (a "dark frame") and subtract the result from a light frame to remove the dark current pattern from an exposure of long duration, leaving only the random noise. Of course, the less dark current there is, the less noise will remain after subtracting the dark frame. Noise associated with dark current is also sometimes referred to as "thermal noise." Dark current noise follows Poisson statistics, the rms dark current noise is the square root of the dark current.

Since dark current can be reduced in CCD and CMOS sensors by reducing the temperature of the sensor, nearly every astronomical camera intended to be used for long exposures features thermoelectric cooling of the sensor. Typically, the dark current present in the sensor is reduced by 50% for about every 6 to 7 degrees C of cooling. In other words, if the sensor has 10e-/pixel/second of dark current at 25 degrees C, and the temperature of the is lowered to 18 or 19 degrees C then the dark current will be reduced to only 5e-/pixel/second, and if the temperature is lowered another 6 or 7 degrees to around 12 or 13 degrees C then the dark current will be 2.5e-/pixel/second, and so forth.

When this article was first written, cameras having less than about 0.1e- of dark current at zero degrees C was considered pretty low. It meant that dramatic cooling of the sensor was not required to get very low dark current under typical operating conditions. Cooling an 8300 sensor to -20C, for example, reduced the dark current to only 0.01e-/pixel/second. To reach comparable dark current with, say, a KAF-3200 sensor, it would require cooling to -40C and for a KAF-1001 with its large 24um pixels, such low dark current could not be reached even if the sensor was cooled to -50C.

Again, all of this has changed with the current level of CMOS technology. The chart below compares the effect of cooling on dark current of an 8300 sensor and Sony's new IMX571 used in the new QHY268 cameras.

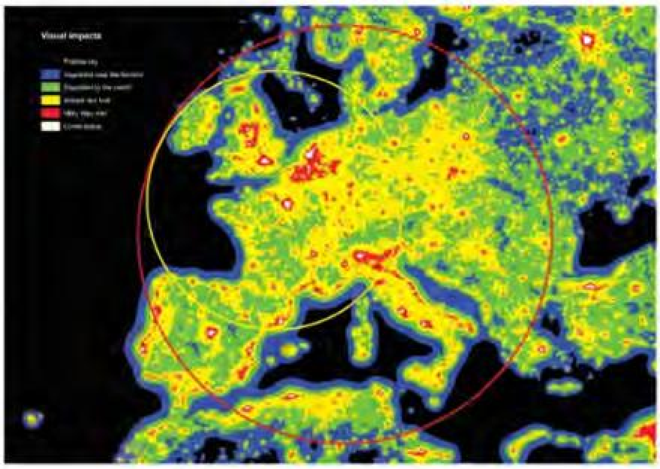


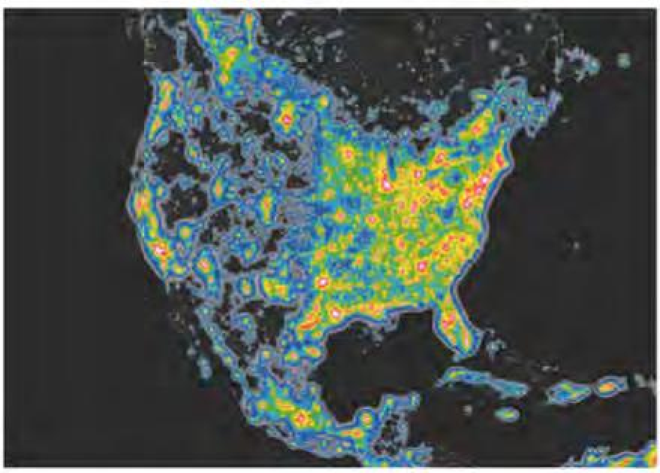
At zero C where the 8300 has about 0.1e- of dark current, the Sony sensor has less than 0.005e-. About 20X lower! And where the 8300 reaches 0.01e- at -20C the Sony part reaches this same level of dark current at +10C.

What this means is that in modern CMOS astro cameras, dramatic cooling is not as critical a requirement as it once was for noisier CCDs in days past. Cooling of CMOS sensors to -20C or -30C is enough to reduce the dark current to almost insignificant levels. At -20C for example, the 8300 sensor has 0.01e- of dark current whereas the IMX571 has an amazingly low 0.0005e-.

4. Sky Background Noise

Sky background illumination or brightness is the number of counts in the image in areas free of stars or nebulosity and is due to city lights and sky glow. Unlike read noise, sky background and dark current noise accumulate over time. High levels of sky background can increase the noise in images just like dark current.





Most of us live in or near urban areas where sky background is greater than it is out in the country. The sky background is often the limiting factor in taking astronomical images, unless one has very dark skies or is imaging through narrowband filters. In our area, here in Santa Barbara, at f/6, we are typically limited to around 10 – 15 minutes of exposure time before sky background overwhelms the dark current noise.

The maps of Europe and North America on the previous page are colored according to the brightness of the sky background and the legend describes the brightness in terms of reduced visual perception of the night sky:

Black - Pristine Sky
Blue - Degraded near the horizon
Green - Degraded to the zenith
Yellow - Natural sky lost
Red - Milky Way lost
White - Cones active

The sky background spectrum (depending on where you live) has a significant spike in intensity around 5577 angstroms (around 558nm) right between the green and red filter passbands in an RGB filter set. Many years ago, my partner at the time, Alan Holmes, designed LRGB filters with a gap between the green and red filters to balance the intensity of O-III and H-a from emission nebula while still properly rendering the continuum of background stars. This gap also happened to coincide with the 558nm background spectrum and so reduced sky background while color imaging. When introduced, this design was criticized by some (who were making their own filter designs) but the results obtained with this design were spectacular and it is interesting to see today several top manufacturers using a similar approach to LRGB filter transmission design (See for example the graph of RGB filters displayed in the section on filter wheels and filters).

Another way to reduce sky background is to simply use a red filter or LPR filter for monochrome imaging or narrowband filters when imaging certain kinds of objects. Imaging with narrowband filters significantly reduces sky background by allowing only a narrow passband at selected wavelengths for nebula that emit light in the wavelengths of H-alpha and/or O-III. With an H-alpha filter, for instance, exposures of half an hour to an hour are not a problem in our location where 15 to 20 minutes would be the limit without filters.

5. Guiding and Polar Alignment

The need for guiding is often overlooked – or thought of only after everything else – when initially building an imaging system. Guiding is an extremely important function in astronomical imaging that should not be trivialized. Without good guiding you will not get very good images.

Good guiding begins by having a good polar alignment of your scope. If your polar alignment of off, it will introduce image rotation in images of long duration. Even when the final image is made up of multiple short exposures, none of which appear to have much rotation, the result will show the shift in star positions over time.

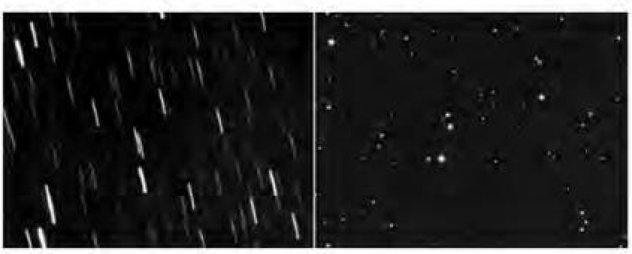
Image rotation manifests as star images looking like small arcs rather than single points. Getting good polar alignment can be a tedious task when you do it without aid.

One of the things that QHYCCD is famous for introducing to astrophotographers is the PoleMaster accessory that makes getting highly accurate polar alignment a relatively simple task. Simple enough to do before every imaging session. The PoleMaster is an indispensable accessory to improve your alignment.

As the resolution of sensors increases with more and smaller pixels, guiding becomes more critical. Most imagers use either off-axis guiding or guiding through a separate guide scope. Of these two solutions, the off-axis arrangement offers the best accuracy as separate guide scopes are subject to differential deflection that can cause guiding errors. A word of caution, however. Many inexpensive radial off-axis guiders have a severe problem in that a small prism or mirror is used to pick off a tiny portion of the light to direct to the eyepiece. Guide stars tend to be dim, and one is forced to rotate the assembly to find a guide star. When one rotates the assembly, the star motion directions (in response to guiding inputs) also rotate, and one is forced to recalibrate the autoguider quite often. Also, the dim stars force some autoguiders to require very long exposures, negating their ability to compensate for periodic errors and drive hops. In short, many radial guiders are clumsy to use.

QHYCCD offers several sizes of off-axis guiders to accommodate various camera and sensor sizes. These OAGs use large enough prisms to avoid the problem mentioned above and the method of attachment to the camera or filter wheel is rock solid.

The other main alternative is to use a separate guide scope. While this can work quite well for refractors and fast Newtonians, it is not the best solution for SCT systems. The problem here is differential deflection – slight tilts or wobbles of the primary mirror can shift a star position significantly on the imaging CCD. The mirror tends to shift since the gravity loads change as the telescope counteracts the earth's rotation.



So, how does all of this affect guiding decisions? Well, low noise and high QE make multiple short exposures a viable alternative to single long guided exposures. In this case good polar alignment is still critical but it is easier to manage good guiding through an exposure of a few minutes rather than one hour. And if you do get some wind or other unexpected bump in guiding, its less painful to throw out one short bad frame than to find out after a long night of guiding that you had a problem!

6. Filter Wheels and Filters

I should start this section with a caveat. It used to be the case that if you wanted to take GOOD color images, you would naturally choose a mono camera and shoot through LRGB filters. It also used to be the case that putting an automatic transmission in a high-performance sports car was akin to wearing tennis shoes with a tuxedo. So called "one-shot" color cameras were for beginners or the lazy.

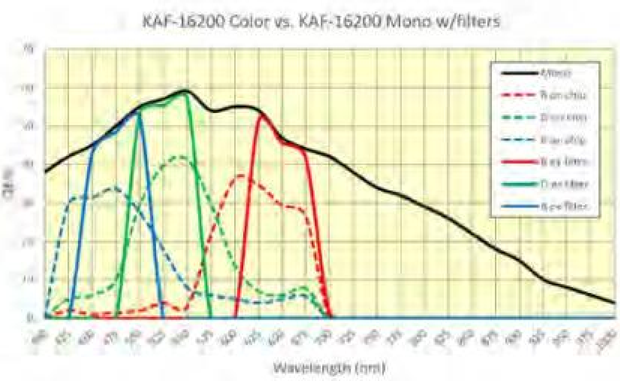
Again, there were exceptions, but the exceptions were few and far between and there was good reason. Color CCD cameras were generally far less sensitive than their monochrome counterparts. At my former company, maybe 1% of cameras sold with the popular 35mm sized 11002 sensors were the one-shot color version. The same is true of the very popular 8300 which also came in color. In both cases the peak QE for RGB was between 30% to 40%. Imagers just preferred to take LRGB to get the best results.

Orion by Tony Hallas using a QHY128C color camera

This has now changed. It is still true that using a filter wheel with select filters, one has much more control over the passbands and color balance, not to mention the ability to use specialized filters for certain kinds of imaging. Nevertheless, just as most high-performance sports cars now come with automatic transmissions as standard equipment the incredible sensitivity of back-illuminated color sensors, driven by the high-end consumer camera market, has made imaging with color sensor much more commonplace and quite respectable. The latest QHY410C is a back-illuminated version of the QHY128C. With 5.94um pixels it is expected to be the most sensitive color camera we've ever made.

OK, having said that, why get a filter wheel with filters instead of a color camera? There are several reasons why you might like to have external filters: First, you can select filters with the passbands that you want, and you can freely change them. Second, filters made for astronomy generally have higher transmission ratios than the filters built onto a color sensor. Third, custom filters, like emission line filters, IR filters and photometric filters can be used without interference by the built-in RGB filters over the sensor. Filter wheels come in a variety of capacities, usually 5 positions for LRGB and clear, or 7 positions (or more) for LRGB plus narrowband filters, etc.

Although the Bayer matrix layer of RGB filters on sensors have made improvements over the years, just as CMOS sensors have improved, the example shown below of a KAF-16200 CCD sensor that is available in both monochrome and color highlights several points in favor of using a mono camera and filter wheel for advanced color imaging. The QE chart for both the mono and color version of the sensor are from the sensor manufacturer and the external filter transmission characteristics are from Antlia, an astronomy filter manufacturer of high quality filters.



It is clear that the on-chip filters have a significant effect on the overall QE of the sensor. Using external filters in this case appears to improve this by 30% or more (just eyeballing). Also, while both types of filters capture the blue-green O-III emission lines around 500nm equally with the blue and green passbands, the external filter set does so with much higher efficiency. The other obvious difference is the gap I mentioned before - between the green and red filters of the external filter set. This means that the Bayer filters would capture the sky background (light pollution) around 578nm with both the green and red filters, but the external filter set would not see this portion of the sky background at all.

7. Adapters and Accessories

Fitting together a camera, OAG, filter wheel, field flattener or reducer, focuser and getting it all to focus with your OTA can be a challenging experience! It can also be extremely frustrating, particularly when you are building a system made of pieces from various manufacturers who are each trying to make their bit fit as many different configurations as possible.

QHYCCD makes a set of adapter rings that can space pieces of a system just right in a variety of configurations. Recently, a sort of "standard" has evolved that requires 55mm of backfocus for field flatteners or other rear optical elements of several poplar types of scopes. In response to this QHYCCD now includes a set of adapter rings with each camera/filter wheel and/or OAG configuration to enable the user to achieve this magic number without having to figure out what adapters are needed. The most important thing here is to do one's homework before hand and make sure that all the pieces you want to combine are compatible with the optics you intend to use.

For example, Canon and Nikon camera lens adapters fit a variety of other things, even filter wheels. However, certain camera, OAG and filter wheel combinations require more space than the backfocus requirement of the lens allows and infinity focus may not be possible even though the parts can all be mechanically screwed together. So planning in advance may save you a frustrating *gotcha*!

8. Software compatibility

Unlike DSLRs, virtually every astronomical camera is operated with an external computer of some kind. So, no matter how good your camera might be, if it does not have good control software, it's just an expensive bunch of wires and metal. Getting focused, framing an object that is difficult to see, processing the results, etc., all go into the final result. Good software makes these and other tasks easier to get right. To make QHY cameras compatible with the widest variety of third part software, we offer both native and ASCOM drivers as well as drivers for TheSky. And as of this writing, we are working on new drivers for Software Bisque's Linux based Fusion System and are about to release a new version of the compact StarMaster controller.

9. Warranty

Probably the last thing you want to think about is what happens if my camera fails? QHYCCD cameras have a two-year warranty. But other things can happen, too. Cameras fall and hit the cement; they don't do so well under water; lightning strikes (literally!); gremlins inside (no, not literally). The point is you want to be comfortable with your purchase and know that if lightning does strike, you have some expedient way to getting a repair or replacement without flying to Timbuktu.

QHYCCD is aware of this concern and for this very reason we have already created a stock of new cameras in the US for quick and easy replacements when the delivery drops your camera off the back of the truck. In addition, we are also setting up a complete repair facility here in the US for in warranty and out of warranty repairs so cameras do not need to be sent overseas for routine repairs and maintenance. This repair facility should be operational by holiday time this year.

10. Putting It All together

Don't obsess over number too much. Use them to get you in the ball park and then PLAY BALL!

Make a couple of big decisions up front, like do you want to do color imaging with a color camera or with a mono camera and filter wheel. The color camera is simpler and cheaper - the mono camera and filter wheel with filters is more equipment, more to go wrong and more expensive. But it is also more flexible and offers advantages especially if you are in a light polluted area and/or want to use narrowband filters. Decide how you are going to guide. The best method is off-axis. Also, consider a PoleMaster to get good polar alignment. This will save you hours of frustration.

Try to narrow down what you are interested in imaging. If you want to start just imaging planets, save your money and get a planetary camera. They are small and relatively inexpensive and good. You can always use it for a guider as well when you decide to do deep space imaging. If your interest is solar or lunar imaging, remember that these are both about 1/2 degree in diameter and pick a sensor/scope combination that can accommodate a full disk. Then you can use a barlow for higher magnification of surface features. The sun and moon are also relatively bright objects and the need to optimize the sensitivity of your camera by matching the pixel size to the focal length is somewhat meaningless. Here it is more important to achieve good resolution (ability to resolve detail) and for this you basically need lots of small pixels.

If you know you want to image deep space, use the charts in Part 1 to select a sensor size and pixel size that is good for your intended targets and your scope. If you don't know, buy as much sensor as you can afford. Again, the numbers should be used as a guide, not a requirement. With today's high QE low noise CMOS cameras, I think it's better to over sample than under sample. You will get higher resolution and lose very little sensitivity if you sample FWHM stellar images with 3 or 4 pixels instead of 2. You can always bin 2x2 for nights of poor seeing (but you can't "unbin" 1x1 pixels to improve resolution). Many beautiful wide field images are taken with cameras that have pixels that are "too big" and many fine deep space images of spiral galaxies have been taken with pixels that are "too small." Some of the most beautiful astro images are taken with camera lenses. They are a great way to get started and I highly recommend it. They are easier to guide and produce very satisfying results while you are learning to use your equipment. And for planets, over sampling has become the order of the day when stacking hundreds or thousands of images to tease out detail. Above all, have fun and enjoy the night sky!

Michael Barber has been involved in camera manufacturing for amateur astronomy for over 30 years. He is currently CEO of Santa Barbara Scientific, LLC, and is also working with QHYCCD as Director of Marketing and US Warranty Service since 2017.


ALTAIR™
HYPERCAM
Image: David Tyrer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SkyTech
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Image: Stacey Downton


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ALTAIR
MG32
MINI-GUIDER
Image: Dean Hucklesby


ALTAIR
60 EDF
Image: Gary Palmer


Image: Neil Phillips
ALTAIR
ADC
ATMOSPHERIC DISPERSION CORRECTOR

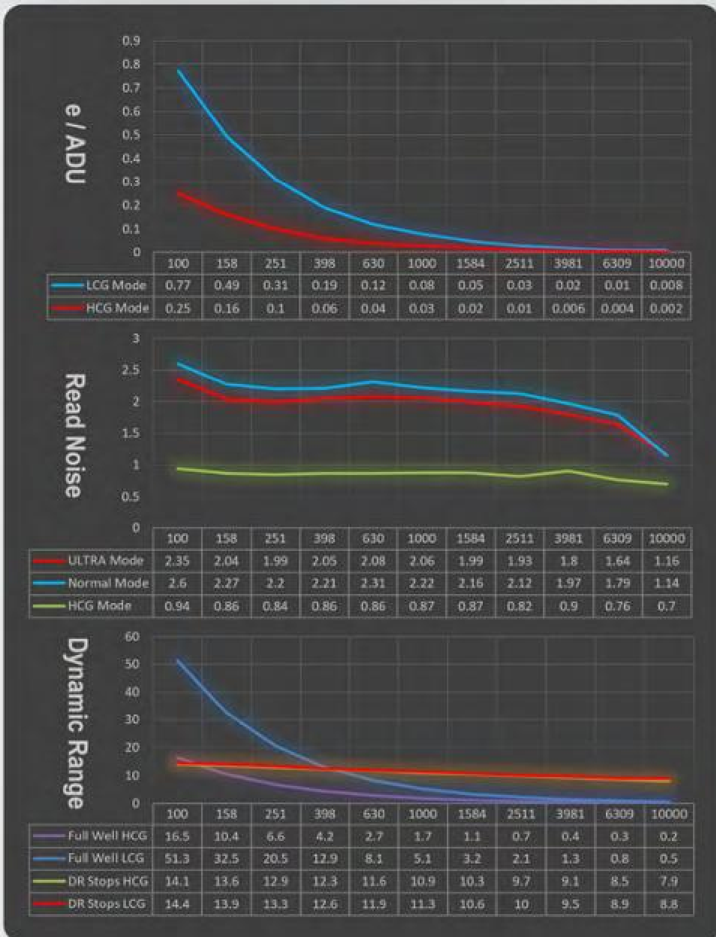
ALTAIR™ HYPERCAM 26C

A 16bit CMOS camera with 65,536 grey levels.

Based on the latest APS-C format Sony IMX571 sensor with back side illumination.

TEC cooled, with Ultra low noise mode and zero amp glow.

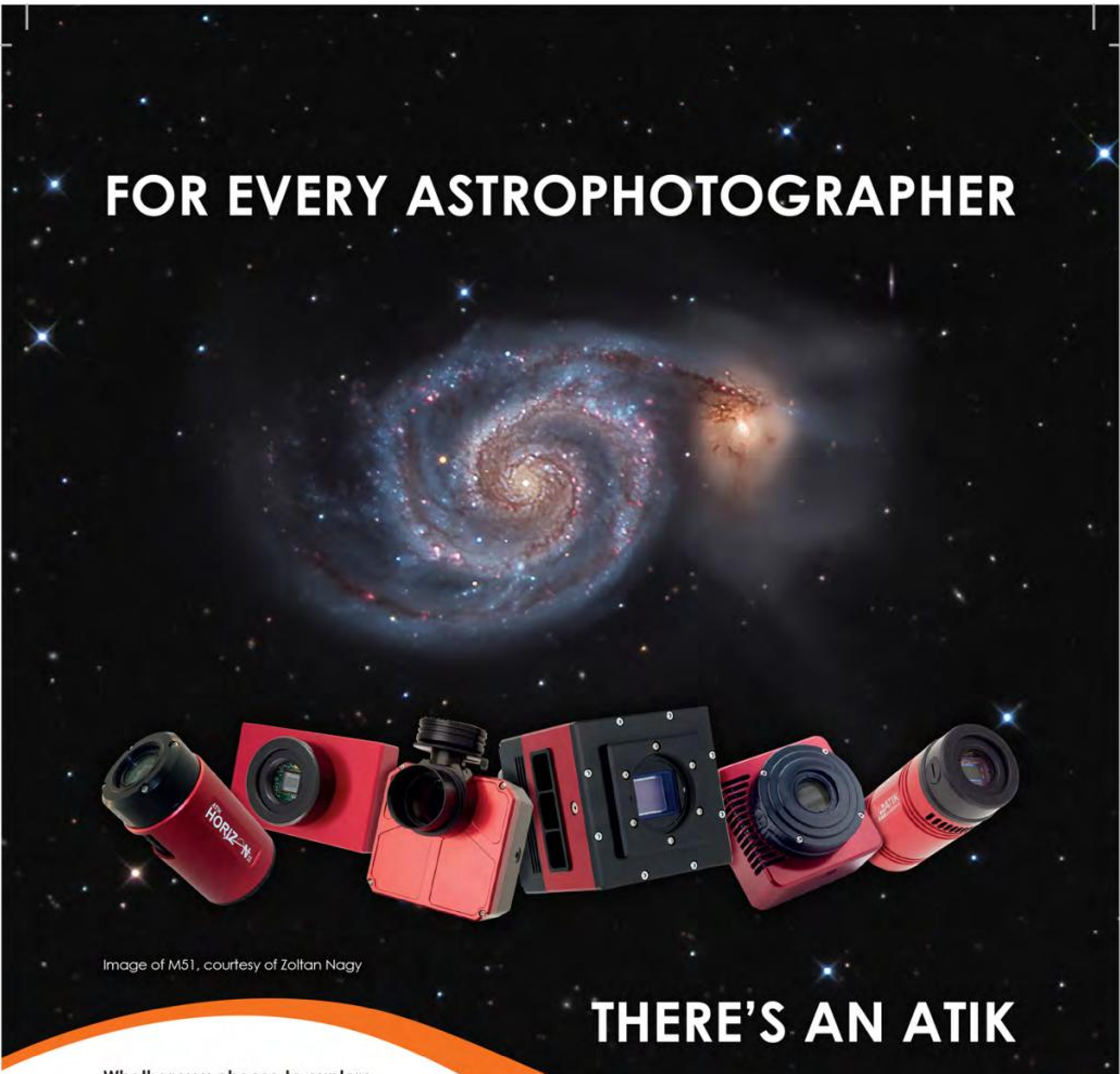
Front dew heater and zero-frost purged sensor chamber as standard.



e / ADU	100	158	251	398	630	1000	1584	2511	3981	6309	10000
LCG Mode	0.77	0.49	0.31	0.19	0.12	0.08	0.05	0.03	0.02	0.01	0.008
HCG Mode	0.25	0.16	0.1	0.06	0.04	0.03	0.02	0.01	0.006	0.004	0.002

Read Noise	100	158	251	398	630	1000	1584	2511	3981	6309	10000
ULTRA Mode	2.35	2.04	1.99	2.05	2.08	2.06	1.99	1.93	1.8	1.64	1.16
Normal Mode	2.6	2.27	2.2	2.21	2.31	2.22	2.16	2.12	1.97	1.79	1.14
HCG Mode	0.94	0.86	0.84	0.86	0.86	0.87	0.87	0.82	0.9	0.76	0.7

Dynamic Range	100	158	251	398	630	1000	1584	2511	3981	6309	10000
Full Well HCG	16.5	10.4	6.6	4.2	2.7	1.7	1.1	0.7	0.4	0.3	0.2
Full Well LCG	51.3	32.5	20.5	12.9	8.1	5.1	3.2	2.1	1.3	0.8	0.5
DR Stops HCG	14.1	13.6	12.9	12.3	11.6	10.9	10.3	9.7	9.1	8.5	7.9
DR Stops LCG	14.4	13.9	13.3	12.6	11.9	11.3	10.6	10	9.5	8.9	8.8



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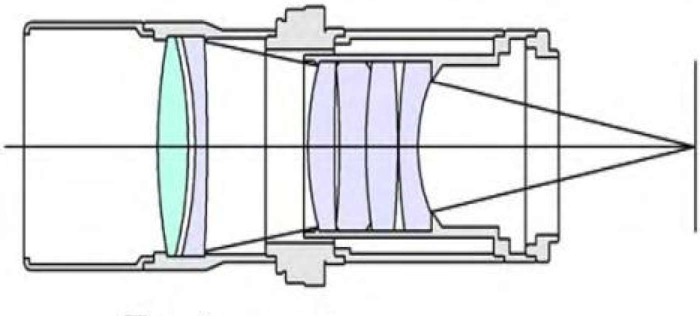

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The Universe at Your Finger Tips

Two thriving remote observatories in Northern Chile

By Elke Schulz

The observatories El Sauce and Chilescope in the Río Hurtado Valley in Chile © Elke Schulz

It's an open secret: a unique combination of first-rate sky and the largest, most powerful telescopes of the world have made Northern Chile an astronomer's paradise. Awe-inspiring projects such as the ELT (Extremely Large Telescope) on Cerro Armazones, the GMT (Giant Magellan Telescope) on Las Campanas and the Vera Rubin Observatory on Cerro Pachón ensure that Chile will remain the home of astronomical superlatives for the foreseeable future.

Astro-tourism is flourishing, supported by dozens of new observatories and a robust tourism infrastructure offering everything from hotel rooms with installed telescopes to stargazing night hikes and cosmological story telling around campfires (live music included).

Astrophotography is not taking a back seat either. In the remote Río Hurtado valley, within eyeshot of the professional observatories on Cerro Pachón, two observatories specializing in remote astrophotography share a mountain top: the observatories El Sauce and Chilescope. While El Sauce focuses on telescope hosting, Chilescope offers "Astronomy on Demand", i.e., astronomy via the internet. The site's conditions for astronomy are excellent: seeing is under one arc second, the sky quality values reach 22, and the number of clear nights is around 300.

Following the aptly named star route ("Ruta de las Estrellas") from the provincial town of Ovalle to Río Hurtado, you reach the turn-off to El Sauce after approx. 33 miles. The dirt road winds through various valleys, passes the tiny village El Sauce and climbs up to the observatories at 5249 ft. While the white domes of Chilescope are visible from a distance, the observatory El Sauce remains hidden for a long time and only reveals itself upon arrival.

The road leading to the observatories © Elke Schulz

The white domes of Chilescope are visible in the foreground © Elke Schulz

The Observatory El Sauce

The Observatory El Sauce is operated by the company Obstech that was founded by astronomers and optical engineers in 2013. The observatory itself was established in 2015 as a fully automated remote observatory. Today the number of telescopes on El Sauce is 47 – and rising. Most of the telescopes share large roll-off or clamshell buildings. There are only a handful smaller structures. The largest building accommodates 11 telescopes. The precise placement of the telescopes ensures a safe distance between the instruments.

Currently, the biggest telescope is a 70-cm reflector, operated by an astrophotography aficionado from Asia. In a few months, however, it will already be surpassed by a 1-meter telescope from a university in Kazakhstan, which will be used to trace supernovas and transient phenomena.

The owners and operators of the telescopes can be divided into three groups of similar size: amateur astronomers/astro-photographers, scientists, and corporations.

Place for a new dome © Elke Schulz

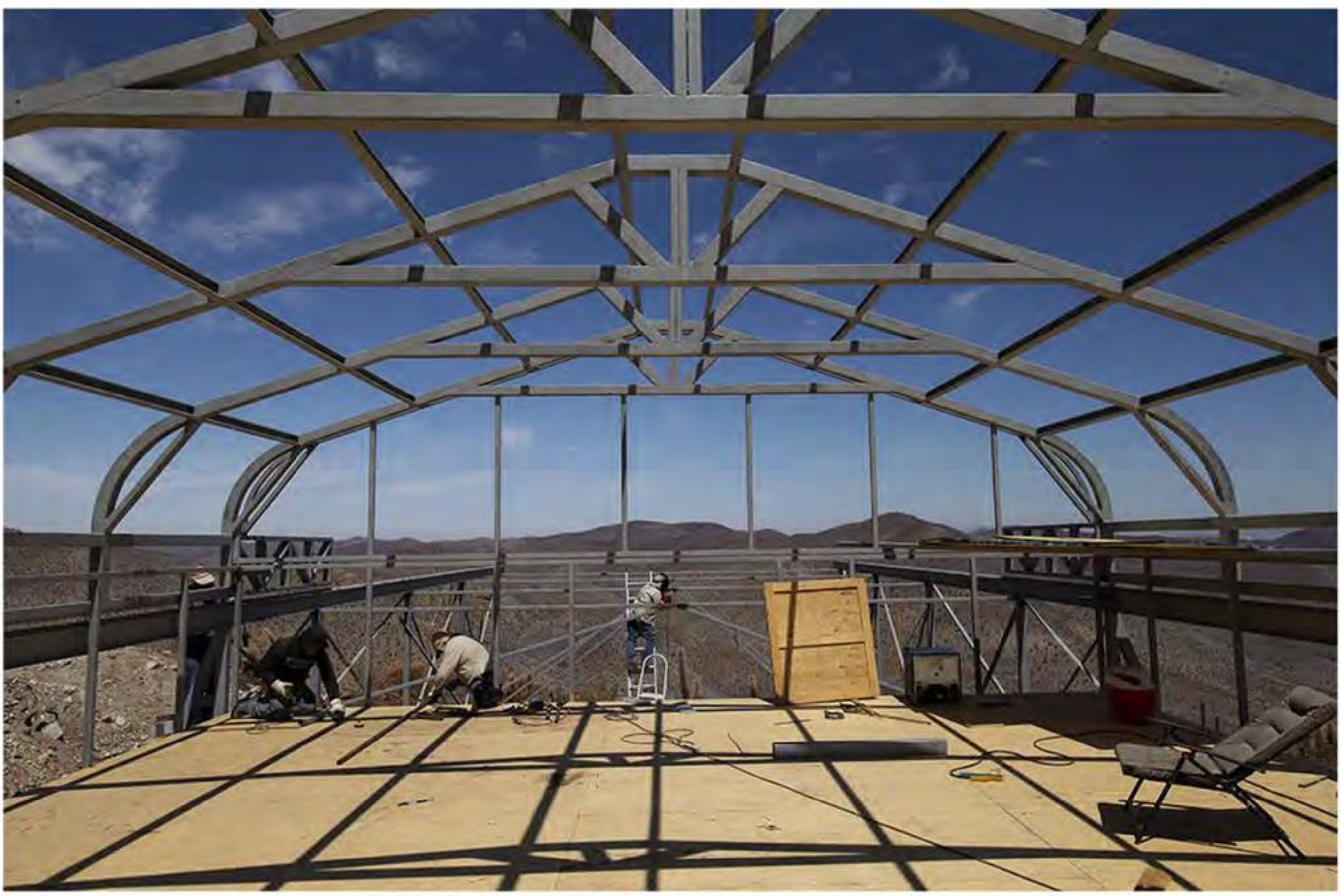
The boundaries, however, are not always clear-cut. For instance, the amateur astronomers Phil Evans and Nick Dunkel provide data for professional scientific projects on exoplanets and asteroids. Well-known astrophotographers such as Martin Pugh and ESO Ambassador Jose Joaquín Perez also opted for El Sauce as remote home for their telescopes. Ciel Austral, a well-known astrophotography group from France, traveled to Chile as a group to set up their own building and install their instruments. One of their results, a high-resolution mosaic of the Large Magellanic Cloud with a total of 1,060 hours exposure time, became a huge hit last year.

The majority of the corporations that are operating telescopes on El Sauce are active in the field of Space Situational Awareness, a sector which, according to Dr. Vincent Suc, CEO of Obstech, will continue to grow in the coming years. The reasons for this development are the ever-growing number of Starlink satellites and the fact that more and more countries are planning to conduct their own monitoring of space debris.

This year, a new science project will come to El Sauce: the ATLAS project, an early warning system for asteroids and comets, developed by the University of Hawaii and funded by NASA. ATLAS currently operates two 0.5-meter telescopes in Hawaii. In order to extend its radius of operation to the Southern hemisphere, two new telescopes will be installed this year: one on El Sauce (ATLAS-3) in Chile and the other in South Africa (ATLAS-4).

Almost all of the customers come from abroad. In fact, only two clients are from Chile. The political unrest that has flared up in Chile in recent months has not had notable repercussions for astronomy on this remote mountain top. International interest in this location remains undiminished. According to Vincent Suc, the number of installed telescopes alone will double this year, requiring the construction of new buildings and an increase of energy supply.

For this reason, the solar energy installation, which consisted of 40 solar panels and 60 batteries, has been doubled recently. Although the previous installation drew only one third of its output limit, Obstech decided to boost capacity in anticipation of future needs, which will guarantee prolonged power supply from batteries without having to rely on the backup diesel generator.



Construction of a new roll-off roof building for 11 telescopes © Elke Schulz

Solar panels © Elke Schulz

The operators of the observatory exhibit similar caution with respect to the internet connection. A radio connection to an existing broadband line provides an excellent symmetrical speed of 100 Mbit/s. In addition, Obstech invested in two backup connections from another provider that enable symmetrical 70 Mbit/s as well as 4G. The average data volume generated per night is less than 500 GB and each user can upload 10 GB of original data per night. Should a project require a larger data volume, this can be allocated easily via dedicated lines.

Sunset © Elke Schulz

When night falls over El Sauce, and the weather plays along, the roofs open fully automatically. The control mechanism of the roofs is linked to the weather station. Should the weather conditions change during the night, the roofs will close automatically.

The basic construction of the roll-off buildings ensures that the roofs can be moved instantly, regardless of the telescopes' current position. With the help of special software written by Obstech itself, the observatory staff is always informed about the latest status of each roof, including video transmissions. In addition, the respective owners of the telescopes always receive an email or SMS whenever the roof moves. Of course, the system is also supervised around the clock by an employee on site, and additionally monitored during the night by an engineer from Santiago.

Those who would like to treat their telescopes to a spot at the observatory El Sauce have to dig deep into their pockets. The standard price for a telescope place is currently a whopping $7,500 US per year, which might be cost-prohibitive, especially for individual amateurs. As a result, more and more astronomy groups and associations invest together in a group-owned facility, effectively reducing the monthly amount per person and making this pleasure more affordable.

Although Obstech offers to install new telescopes, amateur astronomers in particular prefer to travel to Chile to install their instruments themselves. Currently these visitors can only be accommodated in a rather small room at the observatory. But this will also change. There are plans to add a small cottage with a total of three bedrooms, three bathrooms and a large kitchen-dining-living space, offering a spectacular view of the surrounding area.

Adjacent to the lodge, a platform will be built for a 20-inch Dobson. This telescope is intended for visual observation for interested amateur astronomers, astronomy aficionados, and clubs that would like to travel to Chile as a small group to visually explore the southern skies under excellent conditions.

Chilescope

The first thing you notice when you are standing in front of the white domes of Chilescope is the distinctive fence that surrounds the entire complex. Four domes are located within the fenced-in area, one clamshell building, and various containers.

Although the fence might convey the impression of a strict separation between the observatories, collaboration is very important in this remote area, and the respective teams work well together. Obstech's technical support team also supervises the installation of Chilescope.

Chilescope domes © Elke Schulz

The solar energy system and the internet connection are shared by both parties, as is the surveillance of the entire mountain.

The company Chilescope was founded in 2015 by the Russian astronomy aficionados Ivan Rubtsov and Sergey Pogrebisskiy. Their vision is "Astronomy on Demand", that is, renting powerful telescopes via the internet under a first-class Southern sky.

Chilescope has been operating successfully since late 2017. International customers come primarily from China, Europe and North America. Most of the customers are amateur astronomers; only ten percent come from the science community.

Positive comments in astronomy forums and the high number of returning customers (80%) seem to prove that this service is spot-on.

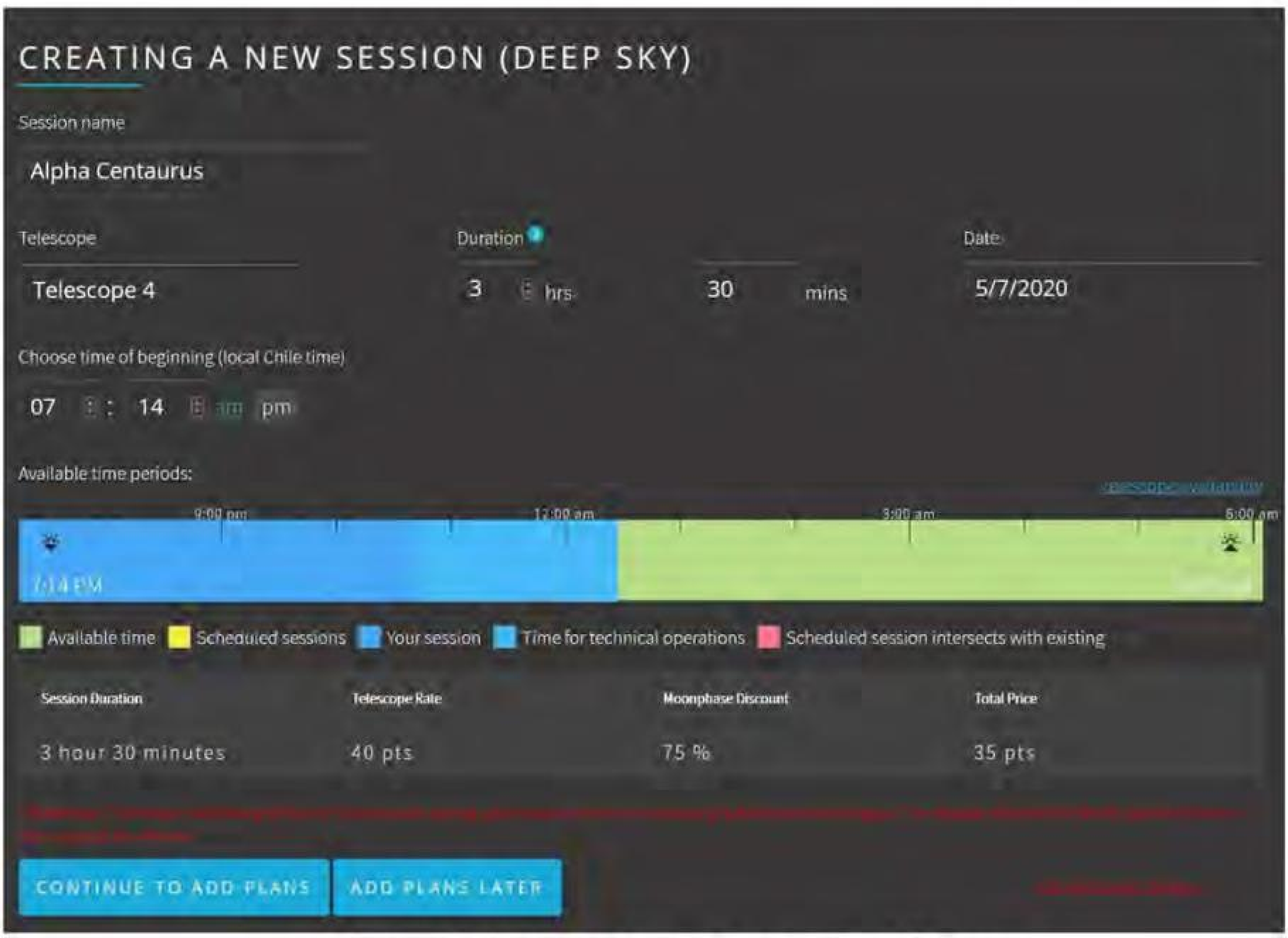
The domes of Chilescope after sunset © Elke Schulz

The Chilescope Observatory comprises of two 4-meter domes, each equipped with a 0.5-meter ASA Newton Astrograph (F3.8) on a Direct Drive mount. A third 4-meter dome is rented to a private company and therefore not available on the rental platform. The fourth and largest dome (5.5 meter) houses a 1-meter Ritchey-Chrétien telescope (f6.8) on an AltAzimuth mount, which is equipped for both deep sky and planetary imaging. In fact, Chilescope was the first commercial remote observatory in the world to offer planetary imaging.

Apart from the domes, there is a smaller clamshell building that contains a Nikon 200mm (f2.0) lens, affectionately known as VST (Very Small Telescope), on a high-precision robotic mount. Regarding the usage of the telescopes, there is no clear favorite among the instruments, however, there is a slight tendency towards the 0.5-meter astrographs. The existing range of instruments will be expanded to include additional fast astrographs (300mm aperture, f3.0), according to Sergey Pogrebisskiy.

Another offer is ready to roll as well: Astrophotographers who own first-class equipment and have a reliable remote installation can rent out their telescopes on the Chilescope platform when they are not using them. This integration can be implemented within three days since Chilescope already has the necessary programming interfaces (APIs).

The rental process for the Chilescope telescopes starts at www.chilescope.com. The website, available in English and Chinese, is clear and concise so that new visitors can easily find their way around. It provides detailed descriptions of the telescopes and comprehensive current data on weather, seeing, and SQM values.
You will also find a step-by-step description of the rental process, the prices (including discounts and refund options) and the payment mode.



Screenshot of creating a deep sky photo session © Chilescope

Once you have familiarized yourself with the equipment (FOV, focal length, aperture ratio) and have a clear idea of the object you want to image, renting is easy. You register, pay (via PayPal) and can then enter your planning session. At the beginning of your planning session you have to decide if you want to do deep sky or planetary imaging. The latter is only offered for the 1-meter telescope and with the support of a live operator. At Chilescope, the live operator function is fulfilled by the renowned British astrophotographer and planetary specialist Damian Peach.

If you have opted for deep sky photos, you need enter the day and time (in local Chilean time), RA and DEC of the object, information regarding filters and binning as well as the number and duration of exposures. Further parameters such as dithering and autofocus can also be selected. You can image all objects that are at least 30 degrees high during astronomical darkness (in local time). If you err in this respect, the system will issue a warning. If you have entered and saved your imaging plan correctly, it will be executed at the specified time. Shortly after the start of the imaging session, you will receive a status message, along with a link to the log file, which you can use to follow the session in real time. When the imaging session is finished, the FITS files as well as the calibration files are available for download.

Screenshot of the log file © Chilescope

You only pay for the actual imaging time, which is calculated by the system with the help of an elaborate formula. Depending on which telescope you use, Chilescope adds 50, 60 or 80 percent to this imaging time as so called "technical time". This "technical time" refers to items like changing filters, refocusing, approaching objects, performing dithering and plate solving, dome movements, etc. As a customer, you do not pay for this "technical time".

The minimum rental period for a telescope is 30 minutes, which can be increased in 10-minute intervals. The prices depend on the respective instruments and range, for example, from 20 USD for the VST, 30 USD for the ASA Newtons to 100 USD for the 1-meter telescope for a 30-minute time frame. The payment system at Chilescope is based on so-called points, where one point corresponds with one USD. After you made your payment via PayPal, the respective amount will be credited to your profile as points.

As astrophotographers well know, astrophotography, especially advanced astrophotography, is susceptible to mishaps and glitches. These can be caused by the weather, technology, hardware or software, or any combination of these elements. For this reason, Chilescope offers a number of refunds, including very poor seeing (FWHM over 3"), blurred stars, poor guiding or positioning errors. Refunds can be received as points or can be credited to the respective PayPal account.

If you would like to get an idea what kind of images have been produced with the help of Chilescope and their instruments, you can find them in Chilescope's own gallery as well as on the renowned NASA website "Astronomy Picture of the Day" (APOD).

The 1-meter telescope at work © Elke Schulz

On the right you can see the Chilescope facility with the distinctive fence, on the left the buildings of the El Sauce observatory. © Vicente Fontana

The Mountain Top

Coordinates: W 70‘ 45“, S 30‘ 27“

Altitude: 5249 ft

Clear Nights/Year: ca. 300

SQM: 21,8

Seeing: below one arc second

Observatory El Sauce

Website: www.obstech.cl

E-Mail: info@obstech.net

Contact: Dr. Vincent Suc

Communication available in: English, Spanish, French

News: www.facebook.com/obstechelsauce

Observatory Chilescope

Website: www.chilescope.com

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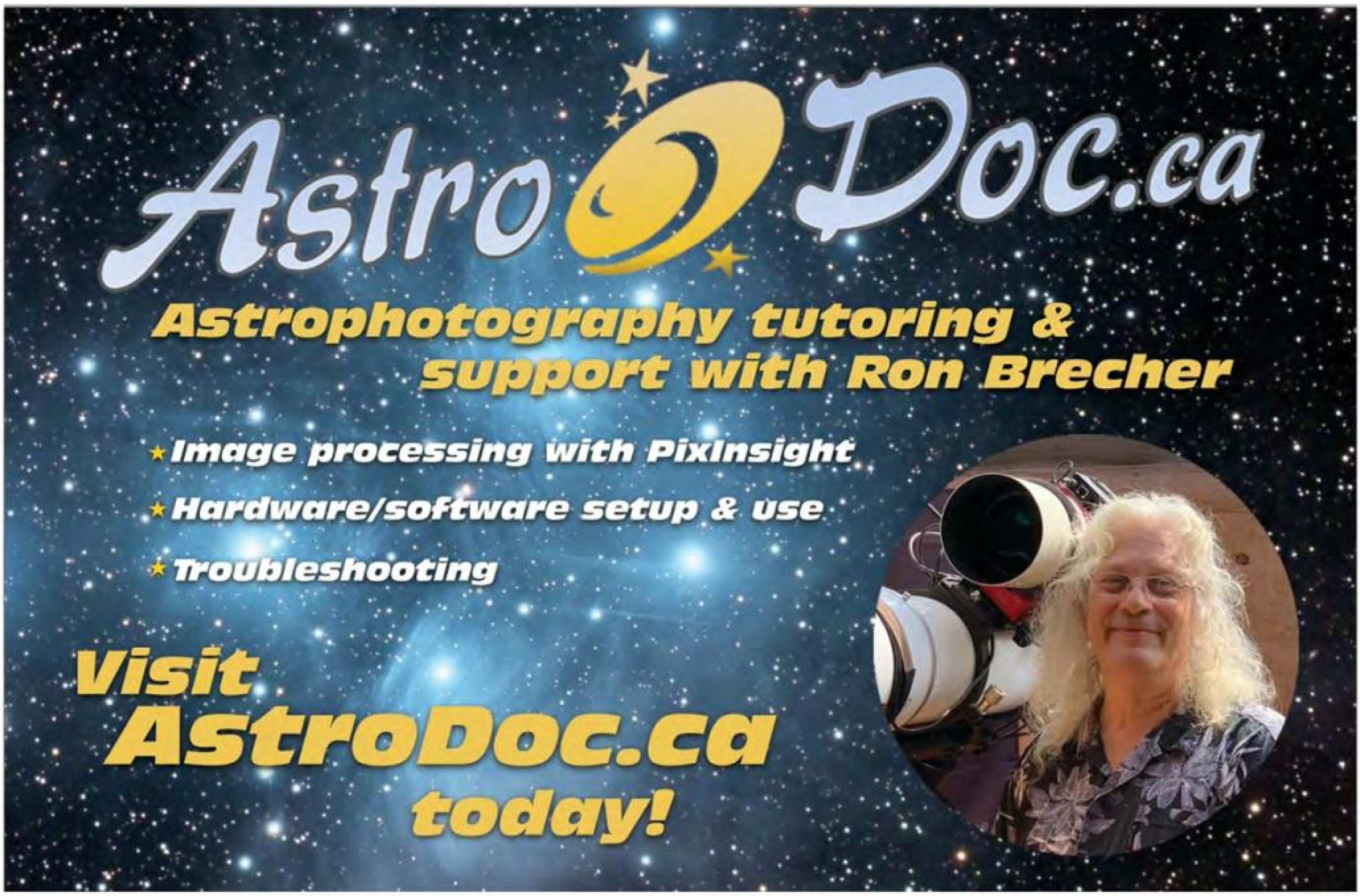
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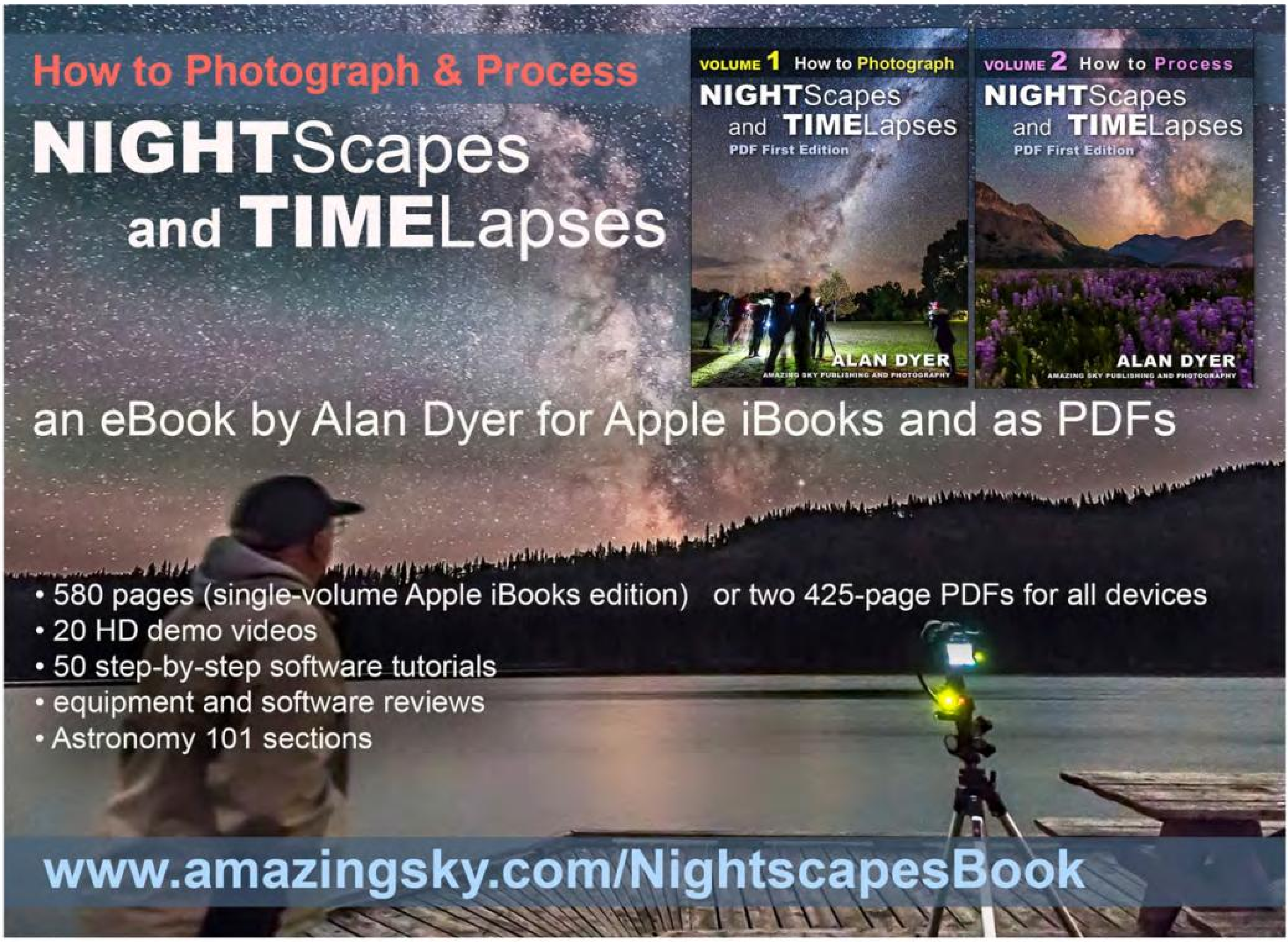
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RMG Astronomy Photographer of the Year 2020: Data Analysis

by Anthony Robinson

skiesandscopes.com

The Royal Museums Greenwich Astronomy Photographer of the Year contest is one of the most prestigious astrophotography awards.

Photographers from all around the world submit their images for consideration and the finalists and winners are announced once a year.

This September 2020, all the shortlisted photos were released along with helpful information about how the pictures were taken, including settings and equipment used.

In this article, we have trawled through the information provided on the 100+ images to pull out the relevant and interesting astrophotography trends in 2020 and presented these below.

What types of photos made the finalists of the competition?
What cameras were used?
What telescopes were used?
What mounts were used?
Highlights from two-year's worth of data.

1. What types of photos made the finalists of the competition?

Overall, there were 133 images shortlisted as finalists in 11 different categories: moon, sun, people & space, galaxies, skyscapes, image innovation, planets/comets/asteroids, stars & nebulae, newcomer and young photographer.

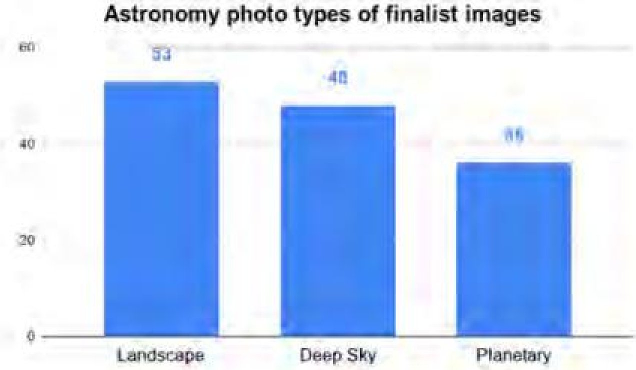
Because these categories can cross over with different kinds of astronomy images, we have broken these images down into the traditional three types of astrophotography – landscape, deep sky, and planetary:

Landscape astrophotography includes images of the Milky Way and star trails above the Earth – as long as part of the Earth's landscape makes up part of the image.

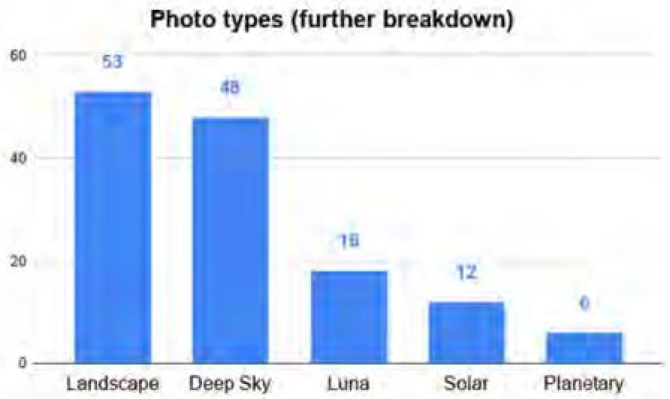
Deep Sky photography images of galaxies and nebulae.

Planetary photography covers the major planets and objects in our solar system.

The results show that it's a fairly even split, but that landscape astrophotography images are the most likely to make the shortlist of finalists:



We can also break down the planetary category down further to pull out the sun (solar) and moon (luna) images:



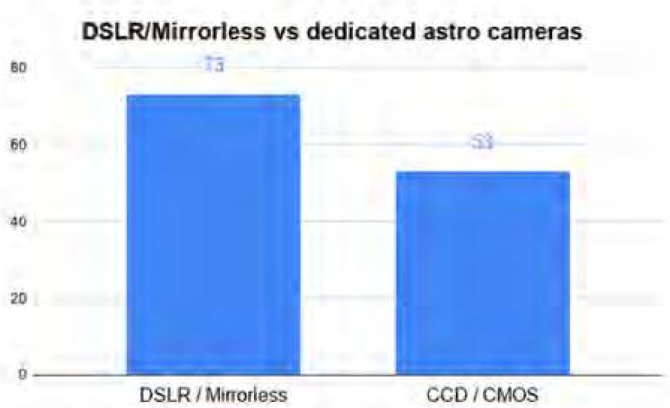
As you can see, there were only six planetary images (4.5% of the total) made the final shortlist if you take our the sun and moon pictures.

This information might be interesting to you if you plan on entering the competition next year, but it's also necessary as we break down the cameras and other pieces of equipment used below.

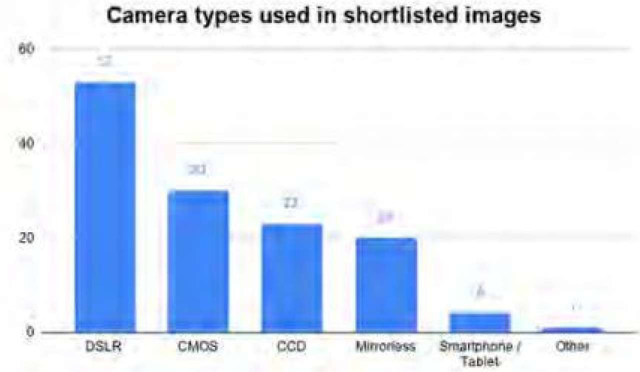
2. What cameras were used?

From the shortlisted images, 73 used DSLR or mirrorless cameras, and 53 used dedicated astronomy cameras like CCD and CMOS cameras.

This reflects the different types of images outlined above, as dedicated astronomy cameras can be used for deep sky and planetary photography only, whereas DSLR and mirrorless cameras can be used for these as well as landscape astrophotography.



If you break this down further you can see that across all images DSLR cameras are the most likely to be used:



These findings are fairly close to the results last year, but there is an increase in the number of photographers using mirrorless cameras (it was 14 in 2019).

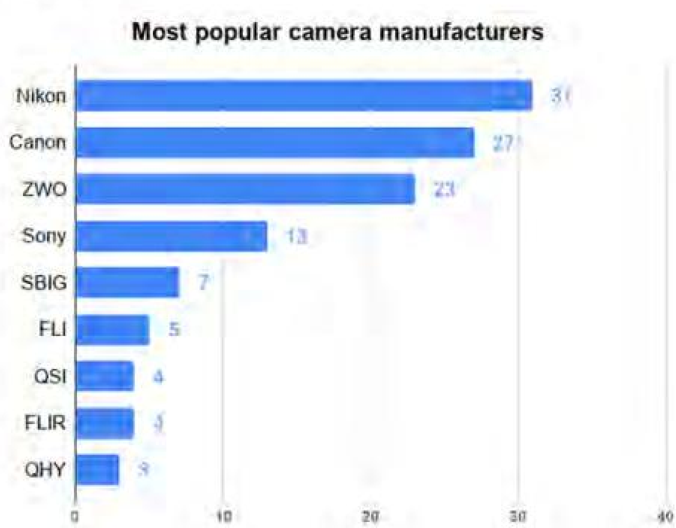
This likely reflects the general trend of mirrorless cameras growing in popularity in comparison to DSLRs and as more high-performing and affordable models become available, like the Sony Alpha, Nikon Z, and Canon EOS R ranges.

Four shortlisted images used smartphones or tablets. This was an increase from just one in 2019 and may be an indicator of the ever-improving performance of smartphone cameras.

The one other was a beer can pinhole camera with a three-month exposure

Most popular camera manufacturers

Nikon just edges out Canon as the most commonly used camera make:

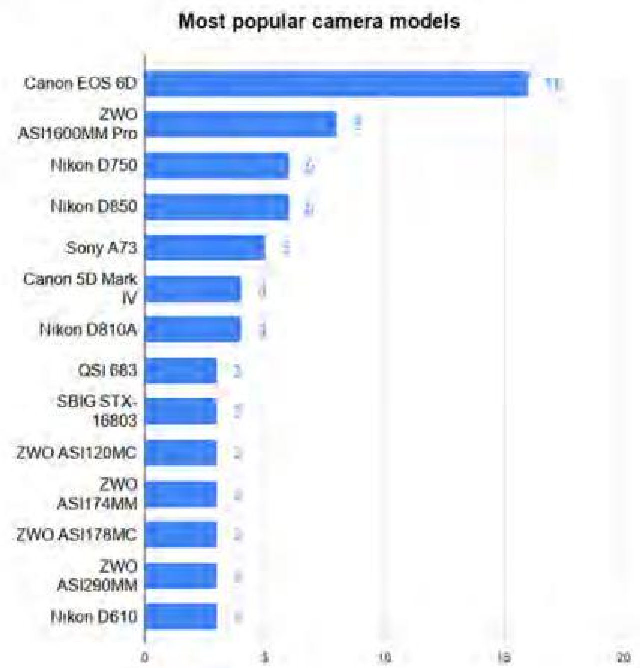


This is actually a big turnaround from 2019, when Canon beat Nikon by some distance.

ZWO is by far the leading manufacturer of astronomy cameras.

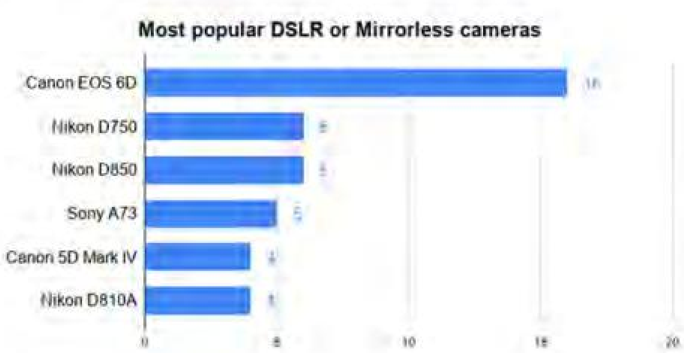
Most popular camera models

In terms of camera models, the Canon EOS 6D reigns supreme for the successful astrophotographers in this competition (for the second year in a row):



For anybody looking to get a new camera for astrophotography then these results are great news since it is not the most expensive or newest models only being used. In fact cameras like the Canon 6D and the Nikon D750 are relatively old models and can be bought for very reasonable prices (new or used).

For ease, we have also pulled out only the DLSR/mirrorless cameras into the chart:



Notably, no shortlisted photo used the Canon EOS Ra, which is the only pre-modified astrophotography DSLR/Mirrorless camera on the market in 2020.

The Nikon D810a is also a pre-modified astrophotography DSLR/Mirrorless camera but has been discontinued and is hard to find even second-hand these days.

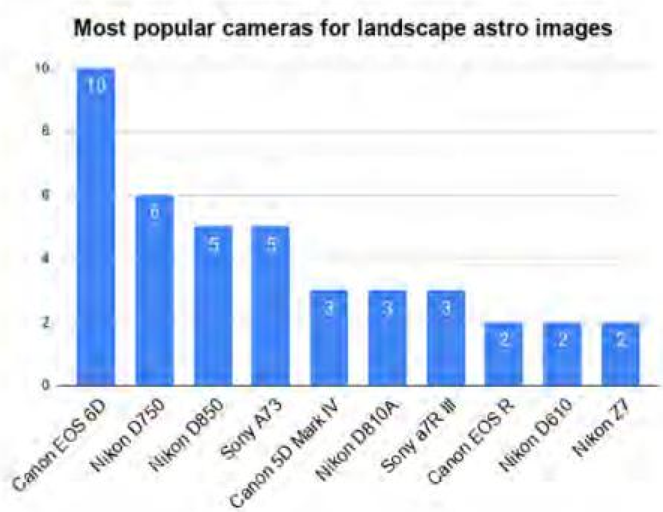
These results are likely not anything against the Canon EOS Ra but rather just reflect that it's very new on the market (it was released late-2019) and so fewer photographers have got their hands on one and also would have had very little time to make the deadline for submitting images to this competition. Look out for it in next year's competition.

Landscape vs deep sky vs planetary cameras

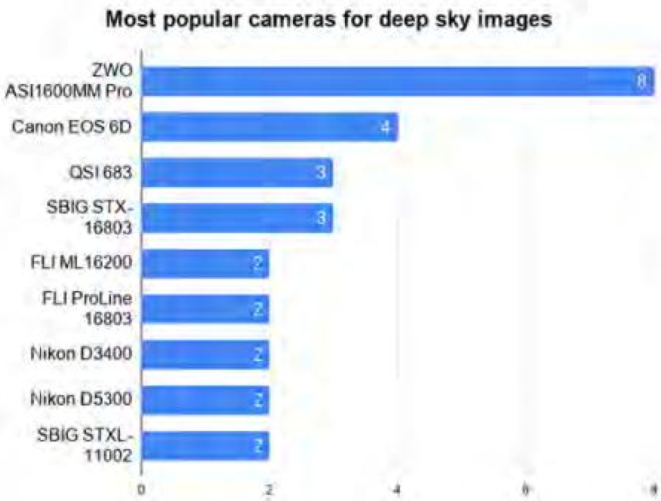
As noted earlier, it's worth breaking down the cameras used for astro image type out of landscape, deep sky or planetary images.

For landscape astrophotography the Canon EOS 6D is top dog. Followed by the Nikon D750 and Nikon D850.

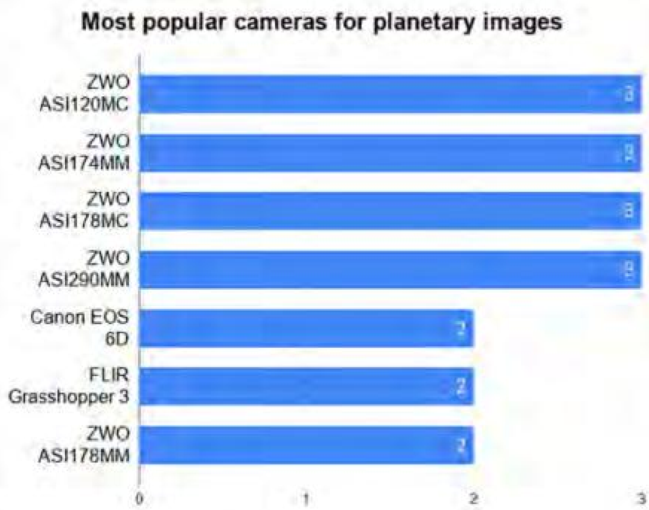
The Sony A7III was the most popularly used mirrorless camera, followed by the Sony A7RIII, Canon EOS R, and the Nikon Z7.



For deep sky imaging, the most popular camera is the ZWO ASI1600MM Pro:



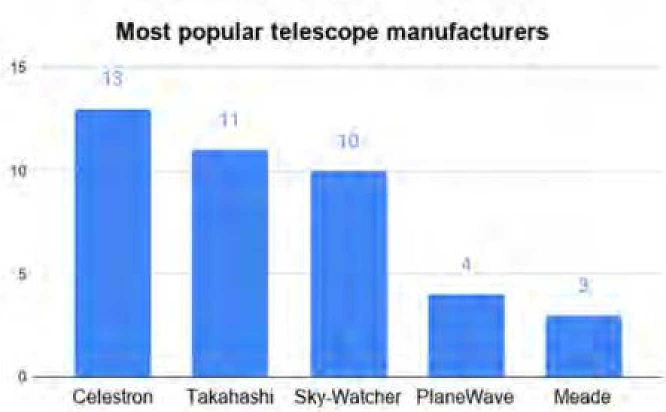
For planetary imaging, it is split between four different ZWO models:



3. What telescopes were used

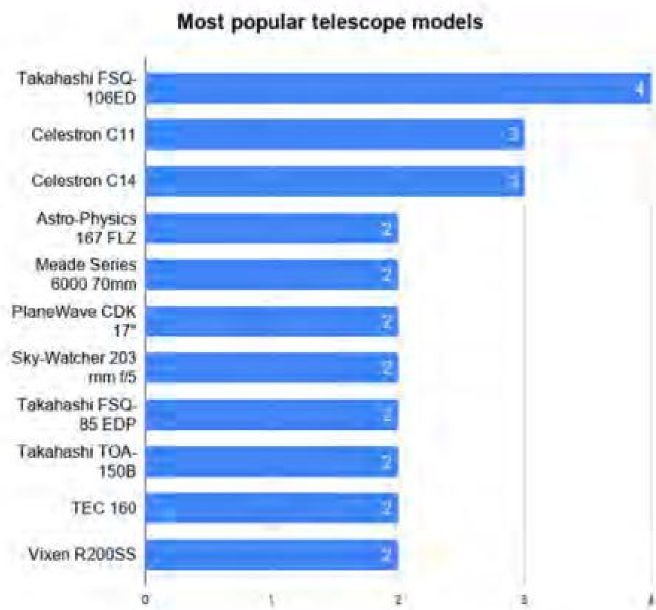
63 of the shortlisted images used telescopes.

The most popular telescope make is Celestron, followed by Takahashi, Sky-Watcher, PlaneWave and Meade Instruments:



The most commonly used single telescope model was the Takahashi FSQ-106ED. This is quadruplet astrograph refractor for experienced astrophotographers.

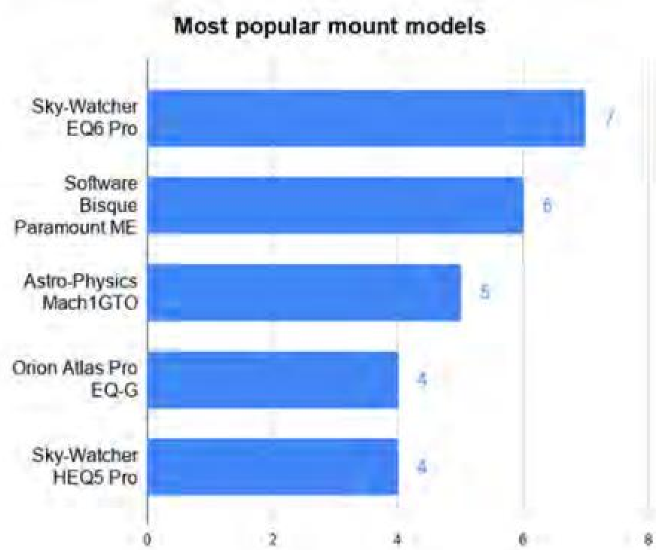
More accessible for beginners (but not necessarily cheaper) would be the Celestron C11.



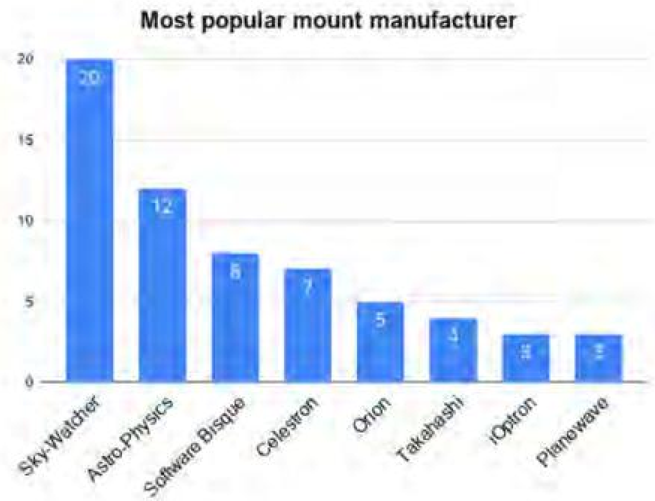
4. What mounts were used?

64 of the photographers named the tracking mounts used in their images.

The most popular mount is the Sky-Watcher EQ6 Pro:



The most popular mount manufacturer was also Sky-Watcher, followed by Astro-Physics:



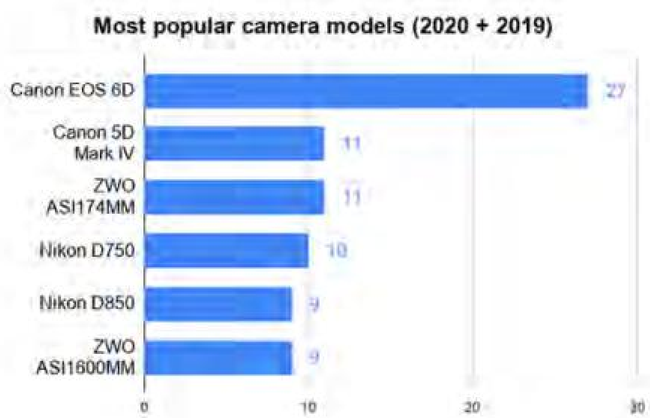
5. Highlights from two years' worth of data

We did this analysis in 2019 also and you can see those results here.

Bringing the two years' worth results together then we get a bigger set of data from 252 pictures (133 in 2020 plus 119 in 2019).

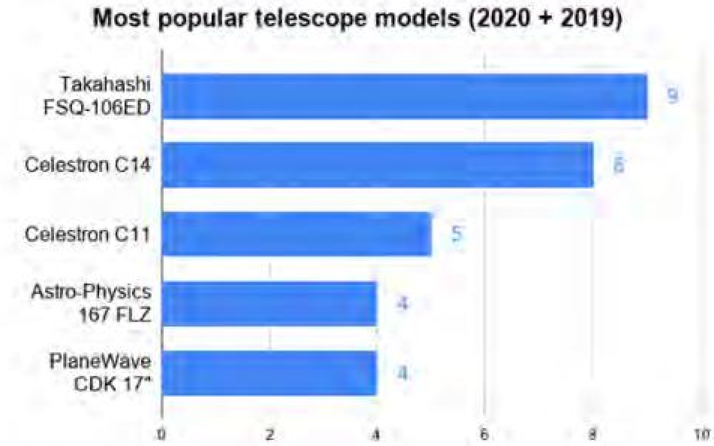
Cameras

The Canon EOS 6D is by far the most commonly used camera in the past two years:



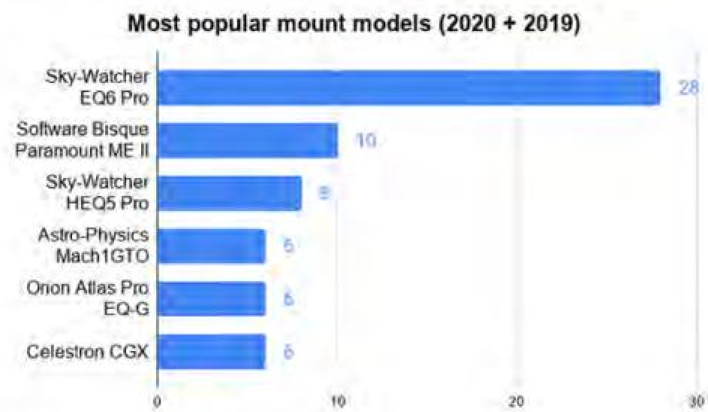
Telescopes

The Takahashi FSQ-106ED has been the most successfully used telescope for astrophotography, followed closely by the Celestron 14-inch model:



Mounts

The Sky-Watcher EQ6 has been the most commonly used mount by some distance:



Methodology

We did this by manually analyzing the information provided on the 133 images on the Royal Museums Greenwich website.

It's worth noting the below where it may seem that there are minor anomalies in the results:

*Some individual photographers have more than one photo shortlisted and so may use the same equipment more than once and will be counted more than once in the results.

*Some may also use more than one camera or lens for a single photo, in these cases both pieces of equipment are counted in the results.

*Some equipment details are not always clear, i.e. different names used for the same equipment or manufacturer not named, etc. In these cases, we've tried to find the correct make/model used in the US market. There are also anomalies such as the FLIR Grasshopper camera which combines CCD and CMOS sensor, so are counted towards both.

*Sometimes equipment information is missing, for example, no star tracker or tracking mount mentioned even though the length of the exposure would have required it.

*Some cameras may have been astro modified and some images used filters.

*The image innovation category is for images that have been processed from publically available data provided by space telescopes like Hubble. These haven't been included in the equipment analysis as it wouldn't make a useful comparison.

*Some photographers used homemade mounts or telescopes and these have been left out of the results.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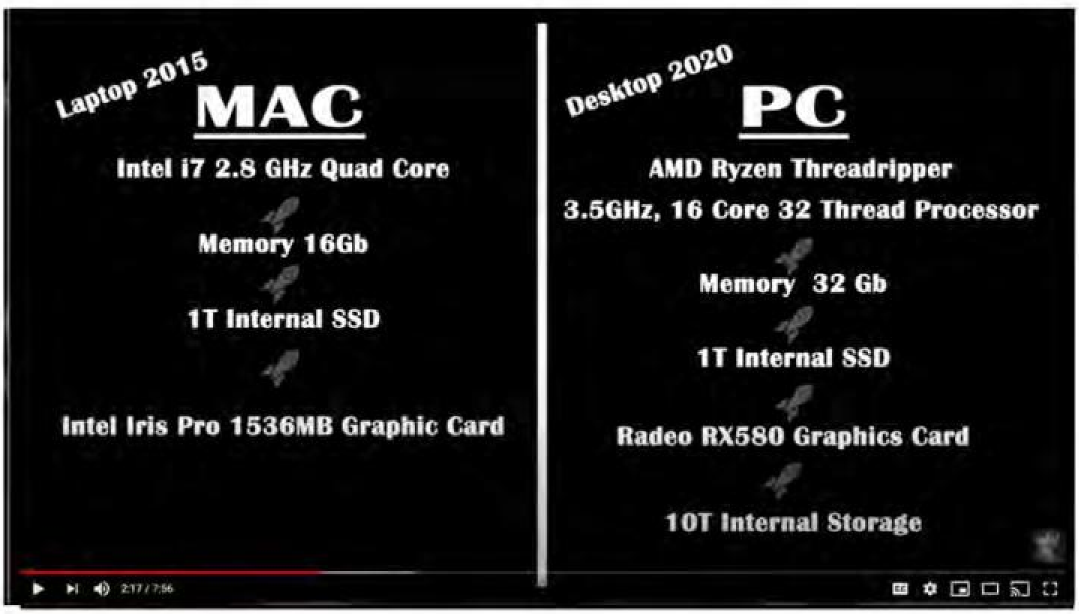
Amy Astro

With this Channel I will share my love of the night sky. We will chase the stars, learn about gear, imaging and processing.

Join me on this adventure beyond our atmosphere. Together we will learn and have a great time.



New Astro PC, How much time did I gain?

Did building a custom PC save me processing time? Will I dump the Mac?

Check out how my new PC performed running the same process as the Mac.

The PC was designed using the website PC Part Picker.

It is time to see how the Raven Rig is looking with it's recent modifications. Also I really messed up, fair warning of what NOT to do.

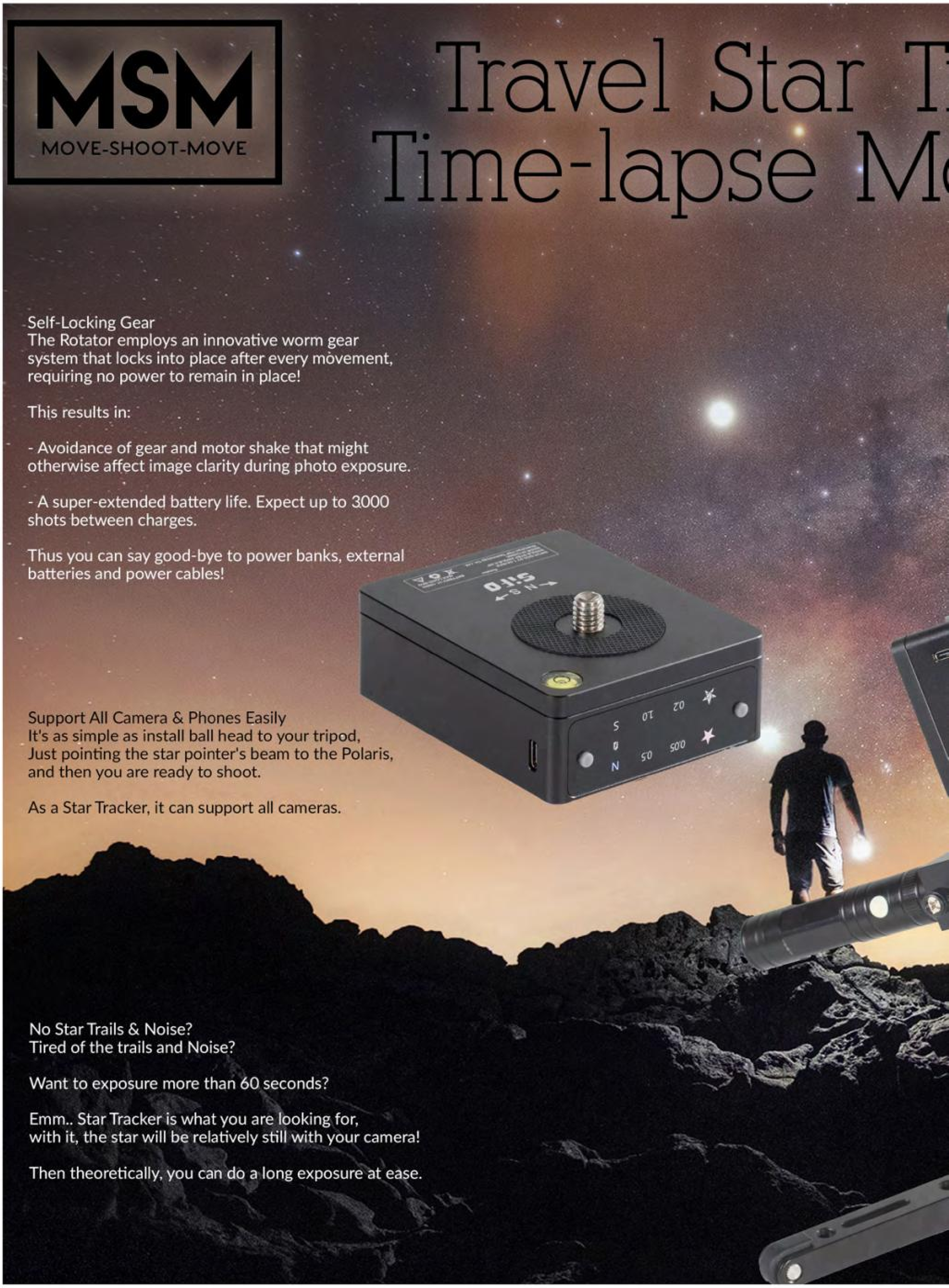
Telescope Rig Update & What NOT to do. *WARNING*

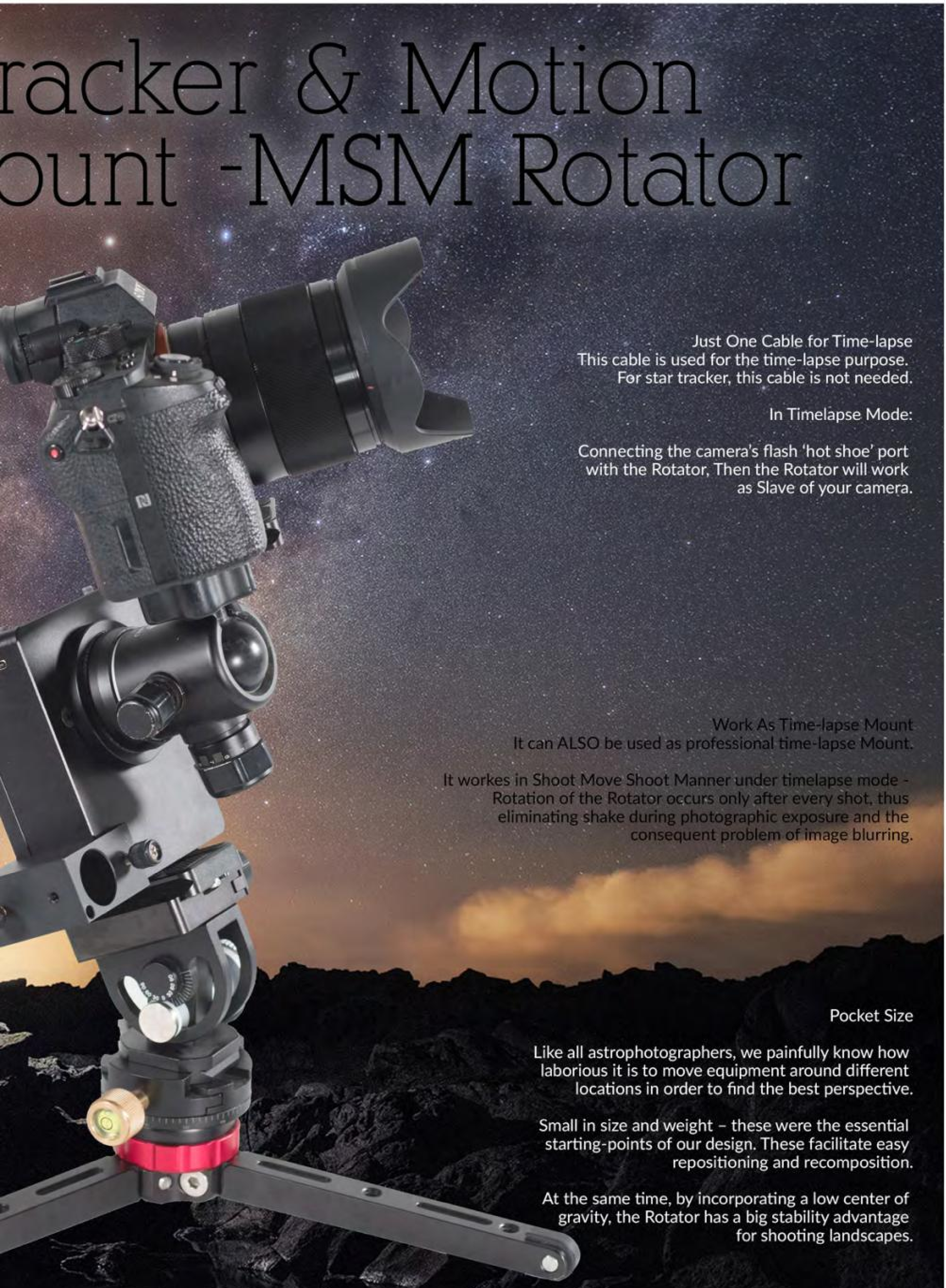
Are you ready to take control of how your image looks, rotate the frame, and plate solve. Are you tired of clipping corners off galaxies. If you are, this is the video for you. I will show you how to rotate your image, plate solve, all without a rotator.

Rotate and Plate Solve with Sequence Generator Pro

A frequent question I get asked is how do people create multi night images? How do you line your telescope up in the same place? How to you process all the images from different nights? I'm hoping this video clarifies the mystery some. I had to figure this out on my own, if you know of other ways please share below in the comments. Clear skies!

Astrophotography - How do I create multi night images?


MSM
MOVE-SHOOT-MOVE
Travel Star
Time-lapse
Self-Locking Gear
The Rotator employs an innovative worm gear system that locks into place after every movement, requiring no power to remain in place!
This results in:
- Avoidance of gear and motor shake that might otherwise affect image clarity during photo exposure.
- A super-extended battery life. Expect up to 3000 shots between charges.
Thus you can say good-bye to power banks, external batteries and power cables!
Support All Camera & Phones Easily
It's as simple as install ball head to your tripod, Just pointing the star pointer's beam to the Polaris, and then you are ready to shoot.
As a Star Tracker, it can support all cameras.
No Star Trails & Noise?
Tired of the trails and Noise?
Want to exposure more than 60 seconds?
Emm.. Star Tracker is what you are looking for, with it, the star will be relatively still with your camera!
Then theoretically, you can do a long exposure at ease.



racker & Motion ount -MSM Rotator

Just One Cable for Time-lapse
This cable is used for the time-lapse purpose.
For star tracker, this cable is not needed.

In Timelapse Mode:

Connecting the camera's flash 'hot shoe' port with the Rotator, Then the Rotator will work as Slave of your camera.

Work As Time-lapse Mount
It can ALSO be used as professional time-lapse Mount.

It workes in Shoot Move Shoot Manner under timelapse mode - Rotation of the Rotator occurs only after every shot, thus eliminating shake during photographic exposure and the consequent problem of image blurring.

Pocket Size

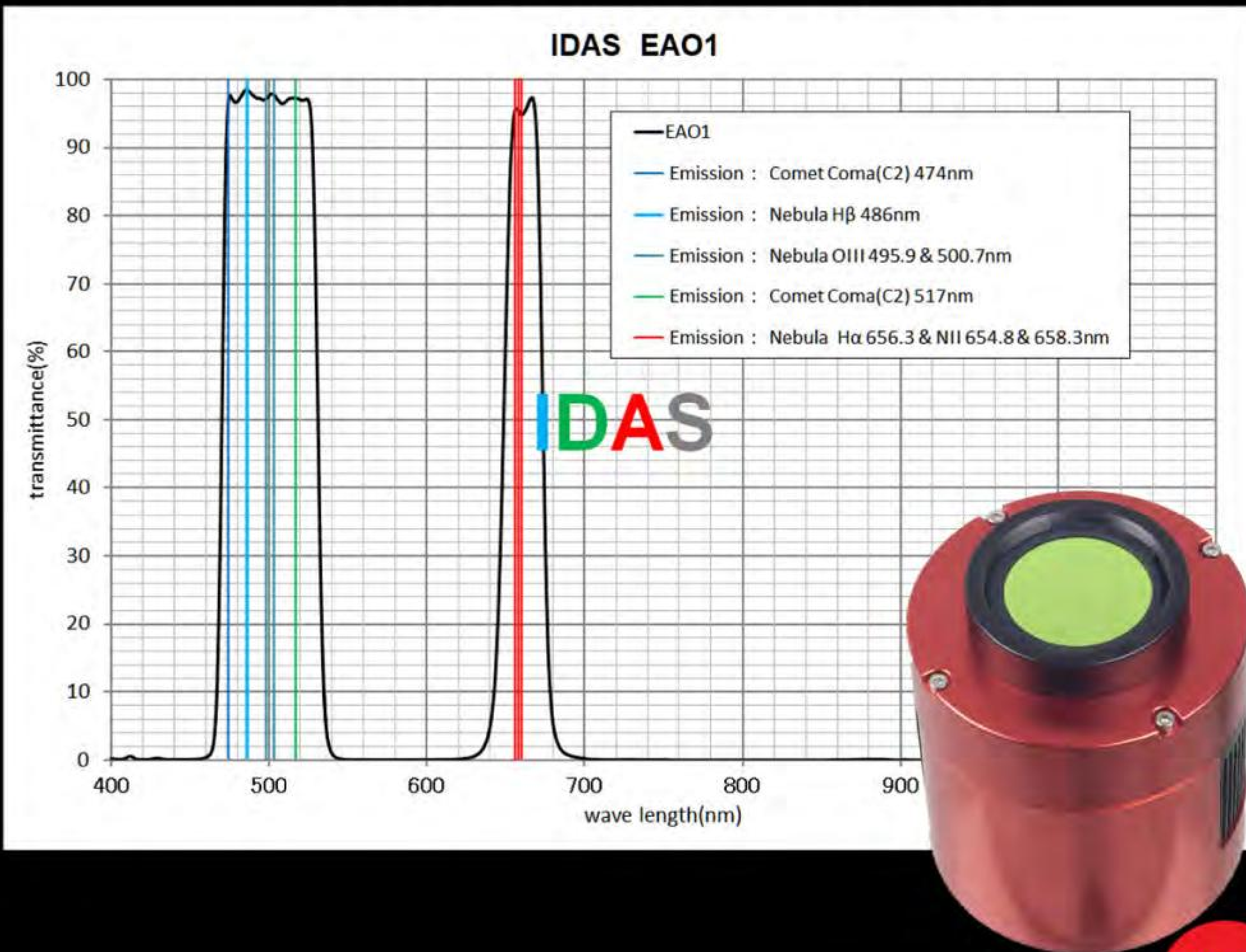
Like all astrophotographers, we painfully know how laborious it is to move equipment around different locations in order to find the best perspective.

Small in size and weight – these were the essential starting-points of our design. These facilitate easy repositioning and recomposition.

At the same time, by incorporating a low center of gravity, the Rotator has a big stability advantage for shooting landscapes.

IDAS

IDAS EAO1
EAA & Comet Filter



NEW

Features :

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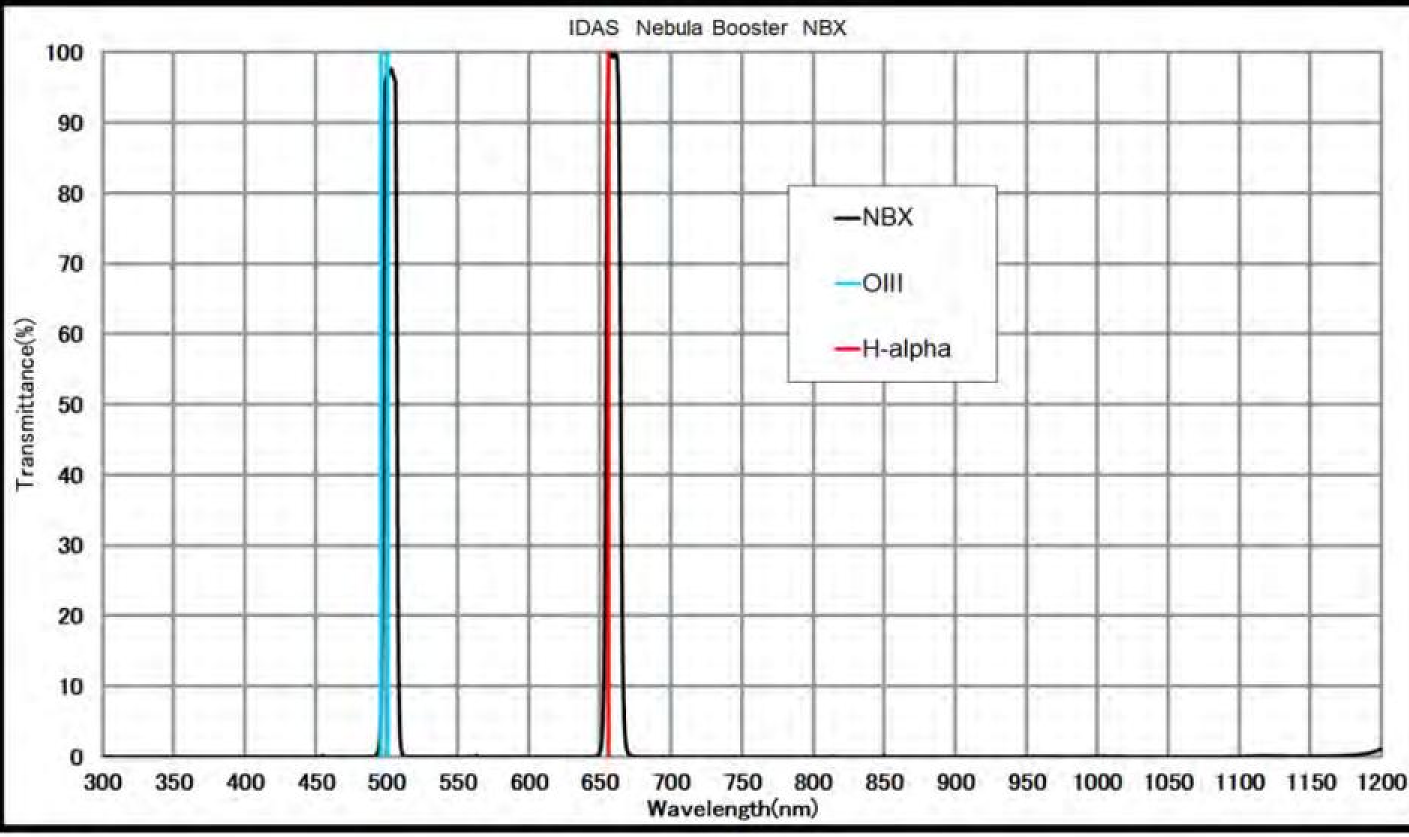
- Also passing the comets’ two major C2 lines to enhance the image contrast while darkening the background.
- Moderate bandpass allows to shoot galaxies in the towns.
- Narrow bandpass for Ha enhancement
- 1.25” or ASI body-mounted(183, 294 amd 533) available

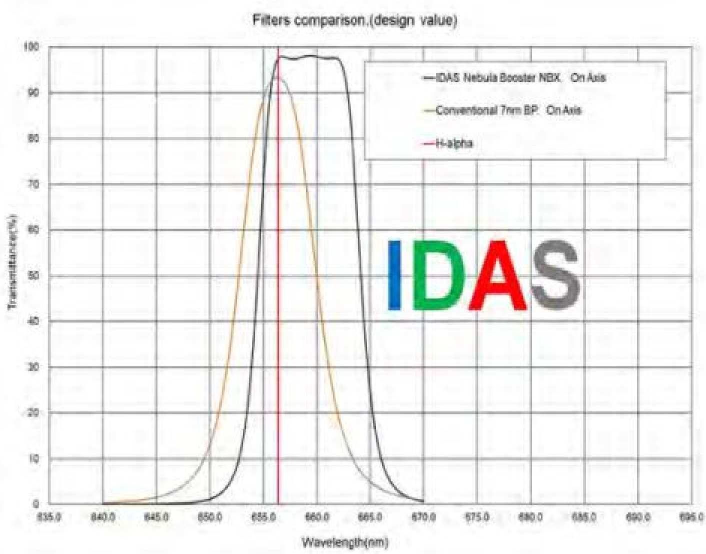
Contact your local IDAS dealers for more details

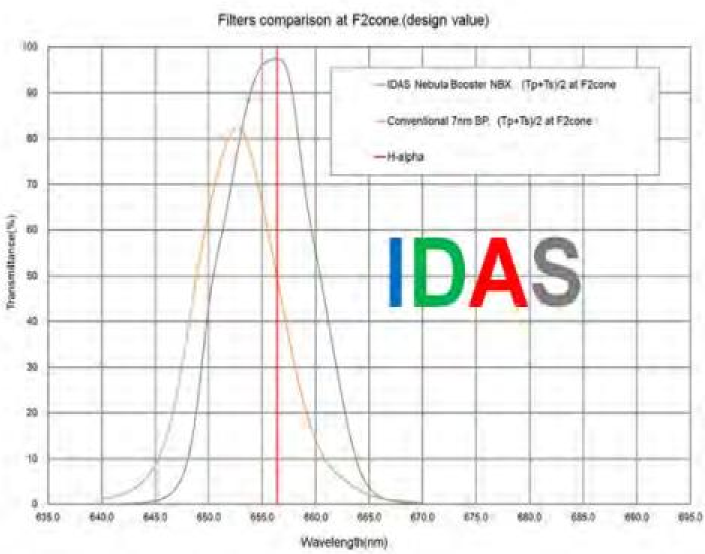
New IDAS Nebula Booster NBX



Features :

- Each 10nm bandpass for OIII and Ha
- IDAS-proprietary flat-top and off-center peak design
- Fully performs at F2 optics without loosing the emission signals due to the spectrum shift
- Made in Japan
- 48mm(2”), 52mm and drop-in type available





Contact your local IDAS dealers for more details

by Jeff Mark

When Rita Hu of SVBONY posted on social media that she was inviting expressions of interest to receive a sample of their new telescope to review, I replied without any great expectation that I would be among those chosen. I was then surprised when I received an e-mail from Rita saying that a review sample of the new scope was in the UK and asking for my details so the 'scope could be sent to me.

A week or so later, the telescope arrived.

The SV503 is marketed as an ED doublet telescope using Ohara S-FPL51 glass in it's 80mm (3.15- inch) objective lens. The focal length is 560mm with a focal ratio of f7.

The SV503 is attractively finished in a white-powder-coat, type effect, with gold accents at the base of the dewshield and micro-focuser, something similar in appearance to the Gold-accented Zenithstar scopes from William Optics.

The tube itself is very substantial and when tapped, gives off a sound what I remember to be similar to tapping on old-fashioned, cast iron rainwater downpipes!. This is a scope which is clearly designed to last a life-time.

At the objective end, there is a push-fit lens cap, much more substantial and easier to fit and remove in the dark, than the fine-threaded cap on my Skywatcher Evostar 72 which can be really fiddly. The dew shield with the SVBONY-branding is retractable, again an improvement on my own scope where the shield is retractable only in the sense of you take it off or leave it on!

The supplied tube rings are felt-lined and provided with large, easy to grip adjustment knobs. The provided dovetail bar measures 14cm. Having encountered balance issues with my own 'scope where the addition of cameras and flatteners can make the set-up back-heavy, I would have preferred a longer dovetail bar, but did eventually get the arrangement to balance. with the provided bar.

Moving down the tube to the focus end, the first surprise was a built in field rotator, a vast improvement on my Evostar 72 where I had the option of paying extra for the Skywatcher rotator which screws into the end of the draw tube or, as I did, fashioning my own by adapting the T-ring which fits to my camera.

The focus adjuster is a rack and pinion set-up with a 10:1, dual speed adjustment knob on the one side, allowing for fine focus adjustments.

The focus tube extends out to 90mm, with a clearly marked cm/mm scale, allowing for repeatable set up for different camera combinations whereas my Evostar focus tube has no graduations and I have had to mark the tube with a Sharpie to know where to set up my initial focus.

The eyepiece adaptor is a 2" version with a substantially made 2" to 1.25' reducer and both the 2" and 1.25" use compression-type fittings which minimise any damage to eyepieces and flatteners. from direct-screw fittings.

The only slight disappointment was the lack of a provided finder mount despite there being fixing points for one, hence for my review, I installed the finder mount from my own Evostar 72 so I could attach a finder and, later, my guide scope.

Overall, the length of the tube assembly measures between 45cm with the dew shield and focus tube withdrawn and 62cm with dew shield and focus tube fully extended.

The tube assembly with tube rings and dovetail bar weighs 2730g.

With my Canon EOS600d and field flattener, the weight goes up to 3515g and when fully loaded with an additional ZWO224mc and Astroessentials 32mm f4 guide scope, the scales read 3900g.

On paper, this is within the 5kg payload capacity of my Skywatcher Star Adventurer tracking mount, but in the real world, I find that my own Evostar set-up, at just under a kilo lighter, is at the useful limit of this mount, hence my only use of the SV503 was by way of it being mounted on my Skywatcher EQ6r equatorial mount.

IN USE.

In this traditional UK summer, it was several weeks before I had enough clear-sky opportunities to use the scope for astronomy. Until that time, I only had the opportunity of using the scope for terrestrial viewing where the scope produced rich, contrasty images, with a pleasing colour balance and no sign of fringing, colour aberration or other artefacts.

On the first opportunity I had to use the scope for astronomical viewing, I was able to view a just over 50% illuminated moon, as well as Jupiter and Saturn.

The wide focus range allowed me to use a wide variety of eyepieces and barlows, with no issues about bringing any of them to focus, unlike my own Evostar 72 where the narrow focus range and lack of in-travel means that certain eyepieces can't achieve focus.

With the moon, the images were clear and crisp. With my SVBONY 6mm, 66° eyepiece which combines with the SV503 to produce a magnification of just over 90, the moon nicely filled the field of view. I even tried my 3mm Explore Scientific eyepiece which produces a magnification of 187 and despite this exceeding the age-old 50x per inch of aperture guide for usable magnification, the image was perfectly satisfactory.

Despite some haze, I did manage to take some photographs. Without my field flattener, my EOS600d was right at the end of the range of travel for the focus tube although could bring it to focus, but my ZWO224mc could not be brought into focus without using a diagonal to extend the focal path. Using the latter, I was able to take a series of movies which I stacked and then combined into the 3-panel photograph below.

Jupiter and Saturn were very low in the sky from my observing position, hence viewing was not ideal, so I could not discern the divisions in Saturn's ring system which i would ordinarily expect to see but despite the poor seeing, the Jovian moons and belts were clearly visible.

As the haze closed in, I did point the scope at M57, the ring nebula and although small, the smoke-circle structure was clearly visible with moderate magnification. Before I packed in, I could not resist a look at my favourite double star, Albireo, in the constellation of Cygnus and with a 9.7mm Meade 4000-series eyepiece producing a magnification of just under 60, the pair were a beautiful sight, the SV503 producing faithful colour rendition of the yellow primary and contrasting steely-blue of the secondary.

Having set up, polar aligned, focused and plate solved my way to M31, I set up an imaging sequence, but almost every image was ruined by clouds which left me with only a single, unstacked, uncalibrated image to use.

For deep sky images, I had to wait another week or so for a forecast of clear skies.

From this single image, it was apparent that, like nearly every other 'scope of this design, the SV503 suffers from field curvature meaning that images might be correctly focused in the centre of the field, but stars away from the centre are not at the same focus, producing doughnut shaped stars which require the use of a field flattener to correct. I was not expecting to be able to avoid using a flattener, but wanted to have at least one attempt at using the scope uncorrected so that I could see whether curvature would be an issue and, if so, by how much. (see cropped section- right)

My next imaging session was far more successful. This time with my StellaMira field flattener attached to my EOS600d, I was able to complete an imaging session of 30 x 4-minute exposures, at ISO800 of the Eastern Veil nebula. With an equivalent amount of dark frames and then additional bias and flat frames, I was able to obtain the image shown below. This time, even with a flattener not specifically designed for this 'scope, the stars were pin-point all the way into the corners, albeit the image I have used for this review is cropped for composition.

Over the course of the next couple of weeks, I was able to use the SV503 a number of times and produced images which I was really happy with, despite my rather limited photo processing skills.

What I noticed about having the scope mounted, ready for use over several nights, was how stable the focuser was. Once I achieved focus (which for my DSLR and flattener, was with the focus tube extended to 33mm) and locked it down, I could come back to it night after night knowing that my focus for polar alignment and image acquisition would need little, if any further adjustment.

Over the next pages, I have posted a sample of some of the images I was able to acqui

The Heart Nebula

The Soul Nebula

Finally, after several sessions of deep sky astrophotography, I turned back to the planets and this time, to Mars which was now rising early enough for me to see it.

The SV503 produced stunning views of the Red planet, with clear surface features and the glittering polar ice cap being visible.

For these observations, my Meade 9.7mm eyepiece with a Celestron 2.5x Luminos-series Barlow lens yielding a magnification of approximately 145 produced the best view. Again, I tried the Explore Scientific 3mm eyepiece, with a magnification of 187, but I found the image less sharp than the lower magnification combination, so maybe that 50x per inch rule of thumb still stands true.

I was able then to take an image, this time with a ZWO224mc camera, through the 2.5x Celestron Barlow.

In conclusion, I very much enjoyed my time with the SV503 and was sorry to have to package it up and send it to the next reviewer.

It is a very capable telescope being equally at home for visual observing or photography and for those looking for a telescope and whose research has so far only included the better-known brands, I would certainly have no hesitation in recommending the SVBONY SV503 be added to their shortlist.

What I liked:

Most importantly! Excellently detailed and coloured images when used both visually and photographically

Substantial build quality and attractive

Quality SPL-51 objective lens

Extendable dew shield

Built-in field

Strong and stable focuser, with it's graduated Focus Scale

Compression-fitting for 2" and 25" eyepieces What I didn't like or would change.

Longer dovetail bar to help balance with heavier cameras

Longer focus travel to use dedicated planetary camera without a diagonal

Absence of a finder

As for the price? The telescope currently sells through SVBONY's website for just US$399.99. Compared to the roughly equivalent Skywatcher ED80, which retails at £379, the SV503 80ED is extremely competitively priced, even taking into account the Skywatcher 'scope including a finder shoe and a hard carry case and, if my experience is anything to go by, anyone choosing the SV503 will be extremely happy with that choice.

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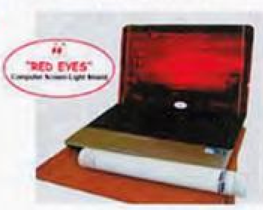

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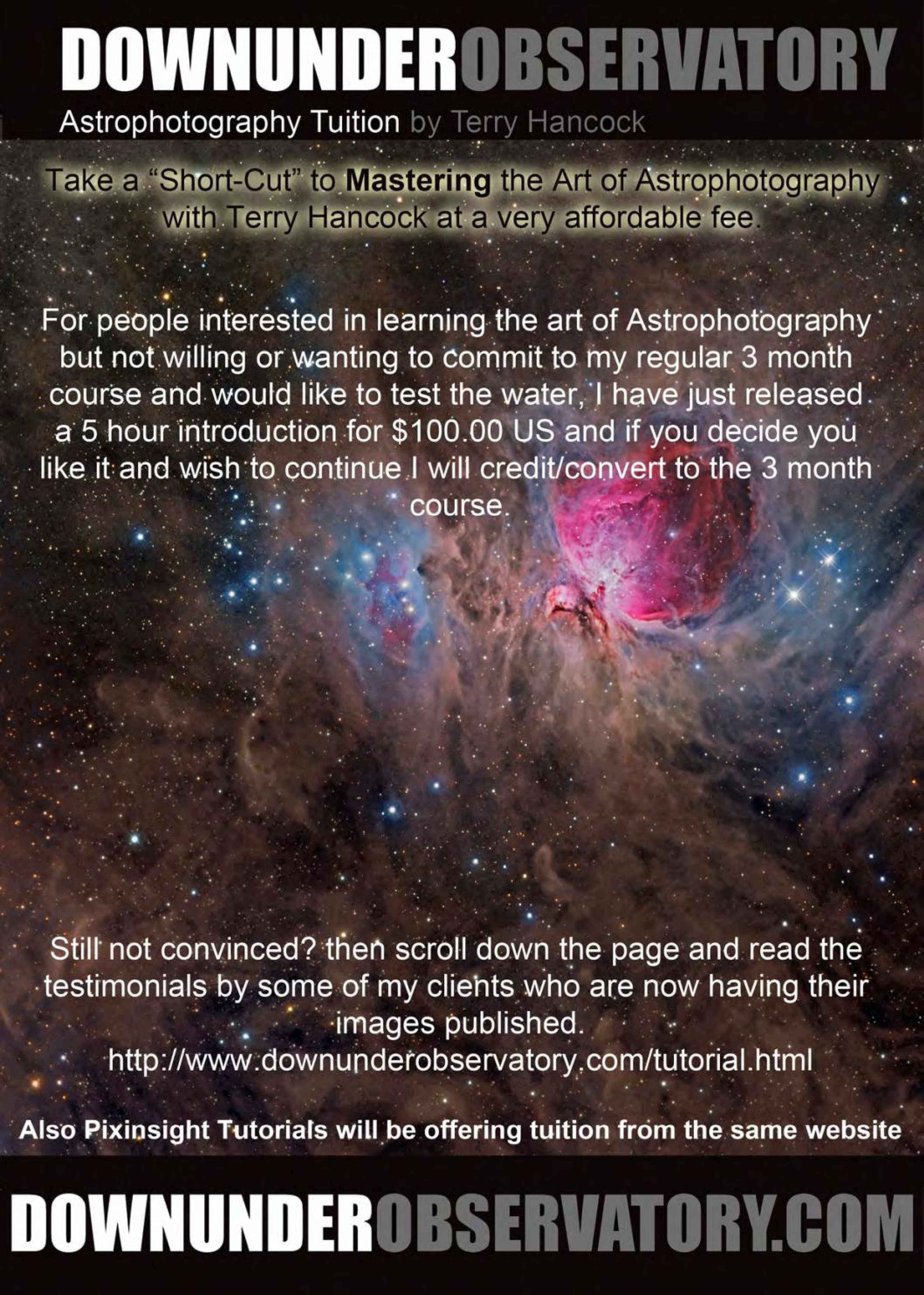
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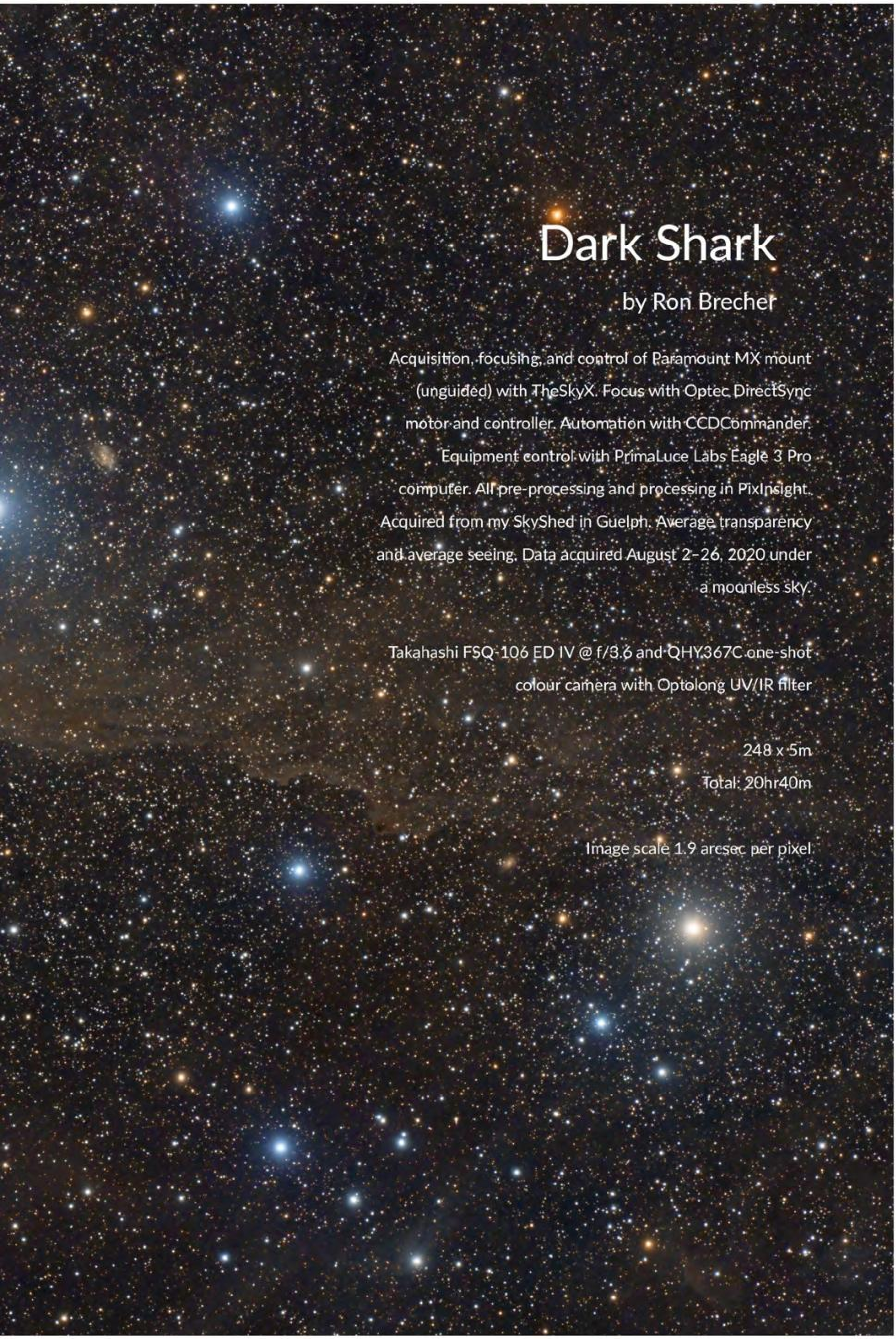
The Fireworks Galaxy

NGC 6946 in Cepheus and Cygnus

is a face-on, intermediate spiral galaxy with a starburst core, and straddles the constellations of Cepheus and Cygnus. About 25,000,000 light-years distant, it is a member of the Virgo Supercluster of galaxies. Discovered by William Herschel in 1798, it has a diameter of about 40,000 light-years, and contains only about half the number of stars of the Milky Way. Due to its location close to the galactic plane of our Milky Way, it is heavily obscured by interstellar dust. Note the very interesting, round, blue feature at about 1 o'clock on the arms of the galaxy. Hodge's Complex was discovered in 1967, and in 2017 it was conjectured to be an interacting dwarf galaxy superimposed on top of NGC 6964, rather than part of it. My thanks go out to David Alexander who acquired and calibrated the data at Sierra Remote Observatory near Fresno, California.

Image by Warren A. Keller



Dark Shark

by Ron Brecher

Acquisition, focusing, and control of Paramount MX mount (unguided) with TheSkyX. Focus with Optec DirectSync motor and controller. Automation with CCDCommander. Equipment control with PrimaLuce Labs Eagle 3 Pro computer. All pre-processing and processing in PixInsight. Acquired from my SkyShed in Guelph. Average transparency and average seeing. Data acquired August 2–26, 2020 under a moonless sky.

Takahashi FSQ-106 ED IV @ f/3.6 and QHY367C one-shot colour camera with Optolong UV/IR filter

248 x 5m

Total: 20hr40m

Image scale 1.9 arcsec per pixel

Name: Nikola Milićev

Location: Horgoš, Serbia

Date: August 15th

Acquisition info: 255x60s/ISO1600/f2.8

Gear:

-Canon 1300D Baader modified

-Samyang 135mm f2 lens

-SkyWatcher Star Adventurer mount

Softwares:

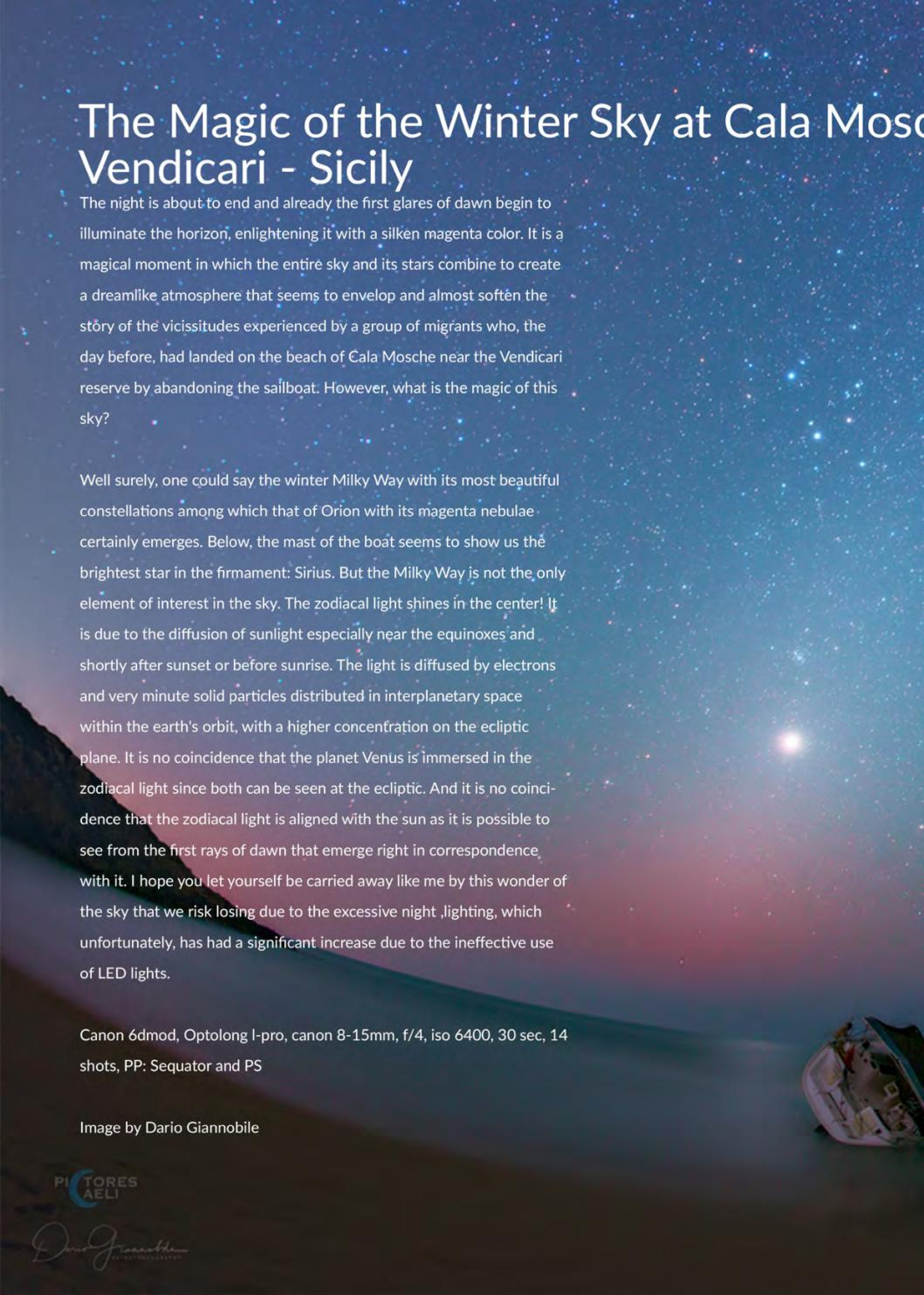
-DeepSkyStacker for registering and stacking the RAW images

-PixInsight for editing (gradient removal, channel extraction, lots of contrast tweakings, dust enhancement, star mask for star reduction, saturation)

-Photoshop CS6 for Color Noise reduction

Bortle 4 backyard. Please, if possible follow me on instagram @nikolaastro.

The Magic of the Winter Sky at Cala Mosc Vendicari - Sicily



The night is about to end and already the first glares of dawn begin to illuminate the horizon, enlightening it with a silken magenta color. It is a magical moment in which the entire sky and its stars combine to create a dreamlike atmosphere that seems to envelop and almost soften the story of the vicissitudes experienced by a group of migrants who, the day before, had landed on the beach of Cala Mosche near the Vendicari reserve by abandoning the sailboat. However, what is the magic of this sky?

Well surely, one could say the winter Milky Way with its most beautiful constellations among which that of Orion with its magenta nebulae certainly emerges. Below, the mast of the boat seems to show us the brightest star in the firmament: Sirius. But the Milky Way is not the only element of interest in the sky. The zodiacal light shines in the center! It is due to the diffusion of sunlight especially near the equinoxes and shortly after sunset or before sunrise. The light is diffused by electrons and very minute solid particles distributed in interplanetary space within the earth's orbit, with a higher concentration on the ecliptic plane. It is no coincidence that the planet Venus is immersed in the zodiacal light since both can be seen at the ecliptic. And it is no coincidence that the zodiacal light is aligned with the sun as it is possible to see from the first rays of dawn that emerge right in correspondence with it. I hope you let yourself be carried away like me by this wonder of the sky that we risk losing due to the excessive night ,lighting, which unfortunately, has had a significant increase due to the ineffective use of LED lights.

Canon 6dmod, Optolong l-pro, canon 8-15mm, f/4, iso 6400, 30 sec, 14 shots, PP: Sequator and PS

Image by Dario Giannobile


che -

Milky Way and aurora from Mount Rainier National Park

by Matt Dieterich

The night sky has countless gems to reveal, and when multiple gems appear at the same time I believe it makes for a very impactful and emotional image. On the night of June 22nd, 2015 a large solar storm was wreaking havoc on much of the northern United States. Above is a panorama from Reflection Lake location near Paradise in Mount Rainier National Park composed of over 15 frames at ISO 1600 using 90 second exposures with my D800 and 14-24mm lens at F/2.8 and 14mm on a tracking mount. This image captures pink aurora, green air glow, our Milky Way galaxy, and light pollution on the horizon at the far end of the lake.

Hours prior to capturing this a gentleman from Germany who attended our night astronomy program asked me for advice on how to take night photos. I showed him a few techniques and we noticed that his camera picked up some beautifully pink aurora from over Mount Rainier.

I packed up my gear after the astronomy program and headed down to the lake where I wanted to capture some gems. This location was wonderful as it contained a view of Mount Rainier, water for star reflections, and a relatively open view of the southern portion of our Milky Way core. I setup my D750 along the path to capture a timelapse video while I worked on the panorama. Here is a star-trails photo I made with the 200 some odd frames of the timelapse video with the D750.

This night was incredibly emotional to me because it was the first time in my life I visibly witnessed an aurora. Although I have captured the aurora in camera before, not ever have I witnessed it with my unaided eye.

Cameras are so much more sensitive to color and light at night that aurora can be seen in a photograph, yet invisible to the human yet. The aurora appeared to be black and white in color and as if someone was shining a spot light into the air to the right side of Mt. Rainier (see the columns in the photo). These black and white columns over the course of nearly 5-10 minutes slowly faded as they danced on the horizon. Emotional nights witnessing natural phenomena like these keep me coming back to the night sky, they keep me striving to improve my work, and they keep inspiring me to share my love for connecting with the night sky. To me the night sky is home. The night sky is where my deceased loved ones are and are sharing their energy by sending me natural phenomena to photograph. The experience of feeling comforted and in awe is how I felt at the end of this night. Even if I might not understand fully what is out there in the night sky, I am incredibly humbled knowing that I am just a mere speck in a sea of stars and galaxies and will eventually return home.

WORKSHOPS

MattDieterich.com

Instagram.com/MattDieterich

Youtube.com/MattDieterich

Richard Tatti

My name is Richard Tatti and my passion is Astrophotography, and more specifically creating awe inspiring Nightscape Images. I've spent many years photographing the stars and perfecting the craft of light painting and blending of images. If you're passionate about shooting the milky way and creating unique and inspiring images then I'm here to help you learn how to do that.

I am based in Central Victoria in the amazing country of Australia. I spend a lot of the year conducting night photography workshops and never tire of spending time with like minded people out under the amazing milky way.

Nightscape Online Workshop Guide: https://www.nightscapeimages.com.au/workshops.html

Shooting Nightscapes In Cloud

In todays video we take a look at how I like to shoot nightscape images when it's cloudy. Not all clouds are created equal and when mixed with various lighting, many forms of cloud cover can be quite magical.

Today we look at using a Star Tracker to capture long exposure images of the milky way with the intention of blending in with a suitable foreground. This is a classic composite image workflow and to be honest I don't do a lot of this. Many people have asked about this though and I thought I'd tackle it here in this video.

Tracking The Milky Way

There is nothing quite like an open sky over a lake featuring rocks and trees. That's exactly what we have in this video. I wanted to shoot a few panoramas of the setting milky way in the western sky as I'd been waiting for a while for the stars to get into alignment at this particular spot.

Milky Way Panoramas Over The Lake

Today we take a detailed look at the technique I used to shoot this gorgeous old Morris Commercial truck under the Southern Cross. I go into fine detail regarding the lighting and editing of the image using Lightroom, Sequator and Photoshop.

Under The Southern Cross - Full Edit

A Colourful Night Sky

by Mário Abade

When we look at the night sky, we cannot distinguish the colour of each star. At first glance, all stars look white. However, if we register a sequence of long exposure photographs, due to the rotation of the Earth around its own axis, and consequently the rotation of the celestial sphere, it is possible to perceive how colourful the night sky is in reality. In the image below, we can see a Startrail, a product resulting from 279 images taken using ISO 1600, an exposure of 25 seconds each, and edited using the StarStax and Adobe Photoshop 2020 software programs. These images were captured in the sky of Noudar Park, more specifically in Noudar Castle with little light pollution.

In astronomy, stellar classification is the classification of stars based on their spectral characteristics. Electromagnetic radiation from the star is analysed by splitting it with a prism or diffraction grating into a spectrum exhibiting the rainbow of colours interspersed with absorption lines.

Each line indicates an ion of a certain chemical element, with the line strength indicating the abundance of that ion. The relative abundance of the different ions varies with the temperature of the photosphere. The spectral class of a star is a short code summarizing the ionization state, giving an objective measure of the photosphere's temperature and density. Although stars have no solid surface, the surface temperature designation refers to the region where the concentration of matter begins to fall abruptly. Its core temperatures are much higher. Stars are seen as having different colours depending on their surface temperatures. The higher the surface temperature of a star, the bluer its colour will be. Stars with lower temperatures have a reddish colour.

Stars can be classified according to the Morgan-Keenan (MK) system using the letters O, B, A, F, G, K, and M, from the hottest to the coldest, respectively. O-type stars are blue and are the hottest, with very high surface temperatures of approximately 35 000 K or even higher. They are stars of very high mass, great luminosity and relatively short life. In their spectra, the typical lines of ionized helium, nitrogen and oxygen stand out. B-type stars are bluish-white, with high surface temperatures of around 20 000 K. They are high-mass stars, as well as extremely luminous. The helium lines stand out intensely in their spectra. A-type stars are white, with surface temperatures of about 10 000K. They are of considerable brightness, typically 50 to 100 times more luminous than the Sun, although less brilliant than type O and B stars. Their spectra do not show helium lines, but they display typical well-defined hydrogen lines. F-type stars are yellowish-white, with surface temperatures of approximately 7000 K.

These are less luminous than A-type stars and their spectra show weak hydrogen lines, as well as very prominent calcium lines. G-type stars are yellowish-white with surface temperatures of about 6000 K. These are known as solar type stars, because the Sun is of this spectral type. The spectrum of these stars show weak hydrogen lines and quite strong lines of several metals. K-type stars are orange with surface tem peratures between 4000 K and 4700K. In their spectrum, we can distinguish weak lines of hydrogen, as well as spectral lines and bands that are typical of various metals and hydrocarbons, respectively. M-type stars are red, with lower surface temperatures between 2500 K and 3000 K.

In the MK system, a luminosity class is added to the spectral class using Roman numerals. This is based on the width of certain absorption lines in the star's spectrum, which vary with the density of the atmosphere and so distinguish giant stars from dwarfs. Luminosity class 0 or la+ stars for hypergiants, class I stars for supergiants, class II for bright giants, class III for regular giants, class IV for sub-giants, class V for main-sequence stars, class sd for sub-dwarfs, and class D for white dwarfs. The full spectral class for the Sun is then G2V, indicating a main-sequence star with a temperature around 5800 K.

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Davagh Forest Park Becomes First International Dark Sky Place in Northern Ireland

Davagh Forest Park has become only the second place on the island of Ireland — and the first in the north — to be accredited as an IDA International Dark Sky Park

Davagh Forest Park has become only the second place on the island of Ireland – and the first in the north – to be accredited as an IDA International Dark Sky Park. It is one of only 85 places around the globe to hold this distinction.

"I would like to formally congratulate the newest addition to IDA's Dark-Sky Places Program," said Adam Dalton, IDA International Dark Sky Places Program Manager. "The application was unanimously endorsed and the Mid Ulster Council should be truly proud of the incredible effort put towards this application".

The Forest, in the foothills of the Sperrin Mountains outside Cookstown, is renowned for its lack of light pollution, which means the night sky is at its darkest and and at its best to really see the stars.

Achieving the accreditation, follows years of careful monitoring of the night sky, in all seasons, all phases of the moon and all weather conditions. Data indicate that Davagh is about 30 to 40 times darker than major cities like Belfast or Dublin.

"At Davagh, a natural cauldron in an ancient landscape, the skies are at their darkest and you can experience unrivalled and wondrous views of the night sky which makes it perfect for star-gazing," explained Councillor Cathal Mallaghan, Chair of the Mid Ulster District Council.

The announcement comes ahead of next month's opening by Mid Ulster District Council of the new OM Dark Sky Park and Observatory at Davagh. An exhibition there will take visitors on a journey through our solar system, using binoculars, mini-telescopes and the naked eye to gaze upon our galaxy, with touch screens, virtual reality and a moon hologram among the latest technology to feature.

The observatory will also be home to a 14 inch LX600 Meade telescope, which will be in action during special star-gazing events and VIP tours.

IDA INTERNATIONAL DARK-SKY ASSOCIATION

Utah's East Canyon State Park Named World's Newest International Dark Sky Park

The night sky over covered wagons on display at East Canyon State Park in Utah, U.S., evokes conditions when pioneers passed through the area in the mid-nineteenth century. Photo by Ryan Andreasen.

East Canyon State Park in northeastern Utah, U.S., has been accredited as an International Dark Sky Park. This designation means that East Canyon State Park has beautifully dark night skies that allow visitors to clearly view the Milky Way and other celestial objects. It is the fourteenth overall International Dark Sky Places Program designation in Utah, and the fifth International Dark Sky Park for Utah State Parks.

"With today's announcement, Utah State Park leads the state park systems of the United States in terms of total designations," said IDA Executive Director Ruskin Hartley. "Not only is this an important achievement for East Canyon State Park, but it is a testament to the commitment shown by Utah State Parks to elevate the importance of dark-sky protections among its constituent park units."

In order to be designated as an International Dark Sky Park, park staff, interns, and volunteers, had to meet the stringent programming, monitoring and infrastructure requirements set forth by the International Dark Sky Association. In 2014, the East Canyon Dark Sky Team started hosting fun and informational "Star Park Academy" courses for the public.

The Dark Sky Team began measuring the quality of the darkness within the park in 2016. From 2017-2019, they worked on changing out old park lights for new dark sky-friendly fixtures that have low Kelvins, low lumens, full cut-off shielding, motion detectors and timers. Changing lighting helped enhance the natural darkness within the park.

East Canyon now joins Dead Horse Point, Goblin Valley, Antelope Island and Steinaker State Parks in attaining official recognition for their dark sky stewardship. Three additional Utah State Parks have submitted their International Dark Sky Park applications and four more parks are currently working on their applications.

East Canyon State Park will host a ticketed, socially-distanced dark sky event in early October to celebrate their designation. For more information, check the park's event webpage in mid-September at: https://stateparks.utah.gov/parks/east-canyon/events/.

Slumgullion Center International Dark Sky Park Designation Approved

Photo by Michael Underwood.

Hinsdale County is now home to the newest International Dark Sky Park. The Lake Fork Valley Conservancy's (LFVC) application to designate the 58-acre Slumgullion Center was approved last week by the International Dark Sky Association (IDA) Board of Directors in Tucson, Arizona. Head writer for the application was LFVC's Executive Director, Camille Richard. She was assisted by the LFVC board and staff as well help from local photographer Michael Underwood and amateur astronomer Phillip Virden, who was the initiator of this endeavor.

The IDA founded the International Dark Sky Places (IDSP) Program in 2001 to encourage communities, parks and protected areas around the world to preserve and protect dark sites through responsible lighting policies and public education.

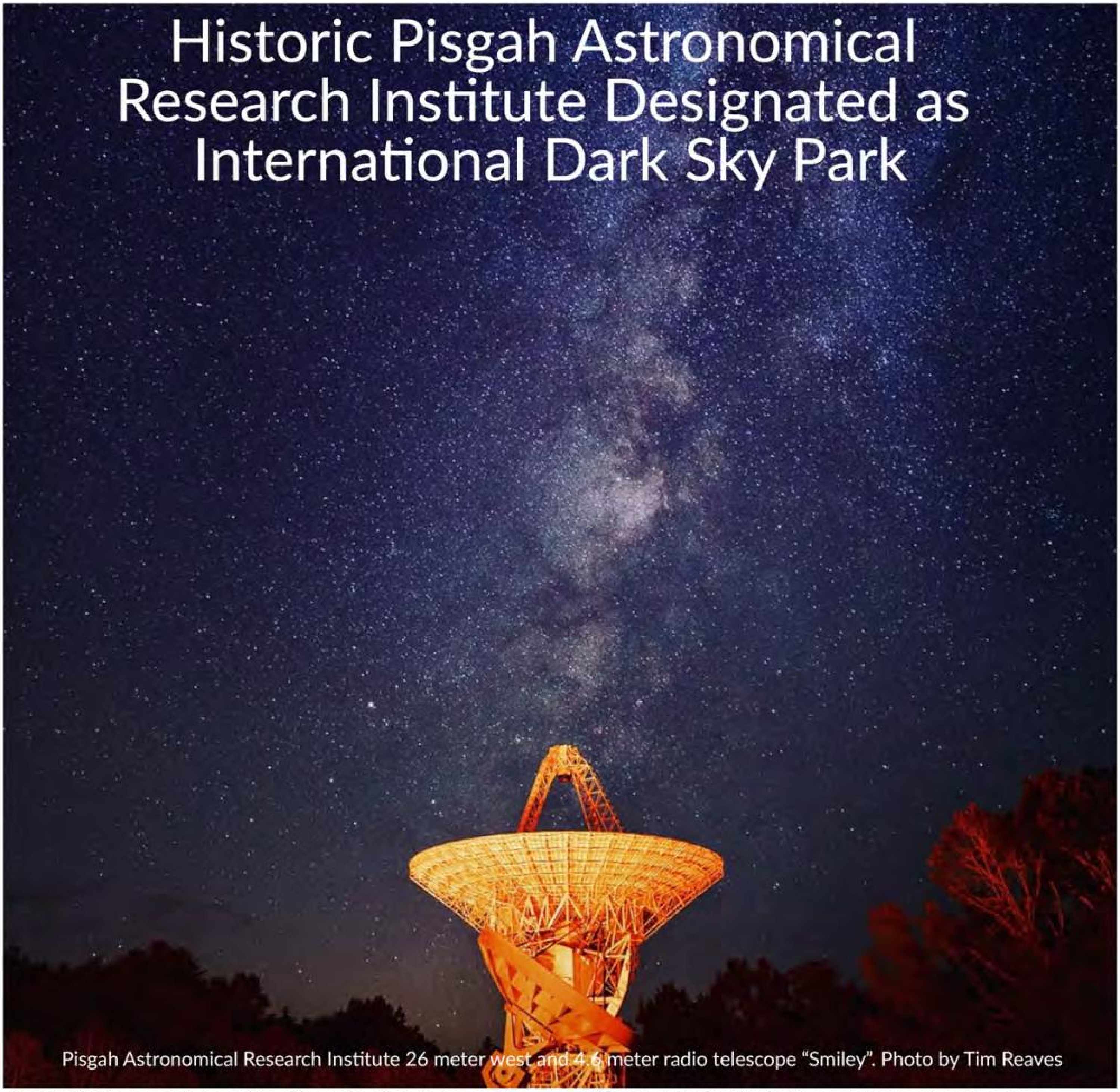
"Today's annoucment is a thrilling one," stated International Dark Sky Association Executive Director Ruskin Hartley. "This designation demonstrates the commitment that Lake Fork Valley Conservancy has made to protecting the night and we applaud their efforts."

Currently the Slumgullion Center Dark Sky Park is undeveloped with no lighting. All future development will meet the standards set by the IDA to prevent light pollution. LFVC is planning to coordinate small group stargazing sessions at the Center starting next summer. Additionally, astronomy program plans are in the works up on Slumgullion Pass and in town utilizing the Lake City Community School's portable planetarium (which was donated to the school by the University of Colorado).

"We are blessed in Lake City and Hinsdale County to have extraordinary dark skies for viewing the remarkable wonders of our star filled universe," remarked Phillip Virden. "We want to do everything possible to preserve this unique setting for our children, grandchildren, and for all future generations who live and visit here."

The LFVC is excited to take on this challenge and offer quality programming to the public. Stay tuned for news of a starry celebration next June! To arrange astronomy programs at the Slumgullion Center for next season, please contact the LFVC at 970-944-5382, or email info@lfvc.org.

Historic Pisgah Astronomical Research Institute Designated as International Dark Sky Park



Pisgah Astronomical Research Institute 26 meter west and 4.6 meter radio telescope "Smiley". Photo by Tim Reaves

Nestled in the mountains of the Pisgah National Forest at a former historic NASA facility, the Pisgah Astronomical Research Institute (PARI) in Transylvania County has been awarded the prestigious designation of International Dark Sky Park by the International Dark-Sky Association. This is in recognition of the exceptional quality of the night sky over PARI and their commitment to educational outreach. This certification means that PARI is protecting the beautiful dark night skies, allowing the Milky Way and other celestial objects to be clearly seen.

"We are delighted that Pisgah Astronomical Research Institute is now a certified International Dark Sky Park," said Ruskin Hartley, International Dark-Sky Association Executive Director. He added, "This is an exciting accomplishment that has tremendous potential to educate people about the value of dark skies."

The International Dark-Sky Association established the International Dark Sky Places conservation program in 2001 to recognize excellent stewardship of the night sky. Designations are based on stringent outdoor lighting standards and innovative community outreach. More information about the program may be found here.

Natural nighttime darkness is a rapidly vanishing resource east of the Mississippi River, and few locations remain where stargazers can find dark night skies within easy reach. The preservation of dark areas in parks and protected lands is important to ensure the wellbeing of wildlife and accessibility of dark skies for future generations. PARI is one of these critical nighttime habitats.

PARI is founded on the proud science legacy of the US space and satellite research programs. Located in the heart of a breathtaking natural forest and dwelling under the dome of the dark sky, PARI is building on its historic past to create a destination for the study, celebration, and enjoyment of science. In order to be designated as an International Dark Sky Park, PARI had to meet stringent programming, monitoring, and infrastructure requirements set forth by the International Dark-Sky Association. Existing park lights were modified to be dark sky-friendly fixtures including low temperature (3000 degrees Kelvin or less) bulbs, full cut-off shielding, motion detectors, and timers. These changes enhance the natural darkness within the park.

Activities and learning experiences abound at PARI for educators and their students at all levels—on campus, at school, locations elsewhere, and online. Approximately 2700 students were served by PARI educational outreach experiences and over 1000 people visited the park for evening viewings and the enjoyment of celestial events. More information about PARI can be found here.

Student Working to Protect Brazil's Starry Skies

Star trails over Brazil by Vitor Barbato Honorato.

In his third year at São Paulo State University (UNESP), the campus of Rosana, in Brazil, Vitor Barbato Honorato is studying tourism and conducting studies about astrotourism and dark skies. He's also the first IDA delegate in Brazil, and together with several biologists and astronomers, he recently helped establish a working group called Ceus Estrelados do Brasil or Brazil's Starry Skies.

Honorato grew up in São Paulo, which is Brazil's largest and most light-polluted city. He couldn't see the stars from home, but when he traveled with his parents to places with dark skies, he noticed the stark difference. Today, from his rural university campus in Rosana, he appreciates being able to see the night sky and the Milky Way from his backyard.

Vitor in one of his favorite places – Morro da Boa Vista.

Interested in astronomy from a young age, Honorato wants to work in astrotourism because it is an undeveloped field in Brazil that will allow him to work in many different places. At first, his interest led him to investigate space tourism like SpaceX, but he got frustrated with that type of research because he didn't feel like it would make a difference to society. This led him to start looking at astrotourism possibilities on Earth. Using light pollution maps and light intensity meters, his current research project is focused on identifying areas of Brazil with strong potential for developing astrotourism opportunities and preventing light pollution. He's particularly interested in looking at natural areas like quilombos (rural settlements) as well as national and state parks. He believes these areas are opportune for astrotourism, and he thinks this budding industry can benefit everyone involved — as he puts it, in communities that promote astrotourism, "the environment wins, the economy wins, and the residents win."

Comet NEOWISE by Vitor Barbato Honorato.

Some members of the working group Honorato is involved in, Brazil's Starry Skies, are also planning to conduct research to help bring attention to the issue of light pollution in the country. They recently submitted a research proposal to the National Council for Scientific and Technological Development to monitor Brazil's night skies and research the incidence of light pollution in the country. The goal of the working group is to conduct research, educate, and inspire action in Brazil to protect dark skies as a valuable natural resource.

Although Honorato says that science is not as appreciated as it should be in Brazil by its governing politicians and astronomy is not easily accessible in the country, he believes that it is ripe for astrotourism.

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